
वार्षिक प्रतिवेदन
ANNUAL REPORT
2004-2005
HYSICAL LABORATORY, NEW DELHI
Welcomes
SHIRAKAWA-NOBEL LAUREATE-2000
XXX KS KRISHNAN MEMORIAL
on
CONDUCTING POLYMER-POLYA
RTUITY & INEVITABILITY-
February, 2005
NATIONAL PHYSICAL LABORATORY, NEW DELHI
Welcomes
PROF. ALAN J. HEEGER NOBEL LAUREATE-2000
LECTURE ON
"PLASTIC ELECTRONICS & OPTOELECTRONICS"
1st MARCH, 2005
A. R. Verma
Nobel Laureate-2000
Nanoscience"
"USER AWARENESS PROGRAM
MATERIAL CHARACTERIZATION TECH
NATIONAL PHYSICAL LABORATORY, NE
NPL INDIA
राष्ट्रीय भौतिक प्रयोगशाला
NPL - INDIA
संसदीय राजभाषा समिति के माननीय सदस्यों का हार्दिक अभिनन्दन
राष्ट्रीय जल विकास अभिकरण,
भारतीय राष्ट्रीय विज्ञान अकादमी,
राष्ट्रीय भौतिक प्रयोगशाला, नई दिल्ली-110 012
NATIONAL PHYSICAL LABORATORY
NEW DELHI – 110 012

okf"kd ifronu

ANNUAL REPORT

2004-2005

jk"Vªh; Hkkfrd izkx'kkyk] ubZ fnYyh&110 012

NATIONAL PHYSICAL LABORATORY

Dr. K.S. Krishnan Marg, New Delhi – 110 012

National Physical Laboratory

Dr. K.S. Krishnan Marg, New Delhi-110012

Director	Dr Vikram Kumar Tel.: +91-11-25846296, 25726931 E-mail : dnpl@mail.nplindia.ernet.in
Editing, Compilation & Publication	Mr. S.K. Chakladar Dr. S.K. Gupta Dr. Ravi Mehrotra Dr. M.K. Goel Dr. V.N. Ojha Dr. R.K. Aggarwal Dr. (Miss) P.L. Upadhyaya Dr. (Mrs) Rina Sharma Dr. (Mrs) S. Sharma Dr. T.D. Senguttuvan
Acknowledgements	Divisional Heads Activity Leaders
EPABX (Hunting Numbers)	+91-11-25742610, 25742611, 25742612
E-mail	root@mail.nplindia.ernet.in
Website	www.nplindia.org
Fax	+91-11-25726938
Telegram	NATPHYLAB
Working Hours	0900 to 1730
Weekly Off	Saturday and Sunday

(March, 2006)

Published by : Director, National Physical Laboratory, New Delhi-110 012

Printed by Royal Offset Printers, A-89/1, Naraina Indl. Area, Phase-I, New Delhi-110 028
Ph.: 011-25797524, 09811622258

Contents

iv

ikDdFku

राष्ट्रीय भौतिक प्रयोगशाला की वर्ष 2004-2005 की वार्षिक रिपोर्ट सहर्ष प्रस्तुत है। एनपीएल एक मुख्य प्रयोगशाला होने के कारण इसकी गतिविधियों के स्पैक्ट्रम के अन्तर्गत राष्ट्रीय मानक, पदार्थ विज्ञान और वायुमण्डलीय भौतिकी के क्षेत्र आते हैं।

भौतिकी के इन प्रमुख क्षेत्रों में उन्नत अनुसंधान विभागीय संरचना जिसमें सात विभाग आते हैं में किए जाते हैं फिजिको-मैकेनिकल स्टैण्डर्ड, इलैक्ट्रिकल एवं इलैक्टानिक स्टैण्डर्ड, इंजीनियरिंग मैटीरियल्स, मैटीरियल्स कैरेक्टराइजेशन, रेडियो एवं वायुमण्डलीय विज्ञान और सुपरकंडक्टिविटी व क्रायोजेनिक्स। जबकि मापन के राष्ट्रीय मानको का अनुरक्षण एवं अपग्रेडेशन (माप एवं तोल अधिनियम 1956 के विधान के अनुसार, संसद के 1976 के अधिनियम के अन्तर्गत 1998 में पुनः जारी) राष्ट्रीय भौतिक प्रयोगशाला की संवैधानिक जिम्मेदारी है। भौतिक के फ्रंटियर क्षेत्रों में गहन अनुसंधान एवं विकास कार्य विभिन्न बाह्य निधिबद्ध और इन हाउस प्रोजेक्ट के अन्तर्गत किए जाते हैं। सीएसआईआर द्वारा आरंभ की गयी नेटवर्क परियोजनाओं में एनपीएल इन परियोजनाओं में से कई में निर्णाय भूमिका निभा रहा है जिसे इस वार्षिक रिपोर्ट में उल्लिखित गतिविधियां द्वारा देखा जा सकता है।

वर्ष 2004-2005 के दौरान निम्नलिखित मानकों जैसे लम्बाई एवं विमीय, फोर्स, अल्ट्रासोनिक, डीसी उच्च वोल्टता, काल एवं आवृति व क्वांटम हॉल मानकों की अंशाकन मापन क्षमताओं का अन्तर्राष्ट्रीय तकनीकी विशेषज्ञों द्वारा पीअर रिव्यु किया गया ताकि इसे बीआईपीएम (BIPM)-एमआरए (MRA) के परिशिष्ट 'सी' में समाविष्ट किया जा सके। स्टैण्डर्ड के दो विभागों ने छह अन्तर्राष्ट्रीय स्तर पर आयोजित अन्तर्तुलना में भाग लिया। एनपीएल-एनएबीएल (NPL-NABL) एमओयू (MoU) के अन्तर्गत डीसी प्रतिरोधक के दक्षता परीक्षण के प्रथम चरण को और धारिता मापन का द्वितीय चरण भी एनएबीएल (NABL) अधिकृत प्रयोगशालाओं द्वारा पूरा किया गया है।

पदार्थ विज्ञान के क्षेत्र में एनपीएल ने मौलिक अनुसंधान के साथ-साथ विभिन्न सामरिक महत्व के और औद्योगिकी अनुप्रयोग दोनों के लिए पदार्थों का व्यापक विकास किया है। जनरल मोटर्स ने ऑटोमोबाइल्स एप्लीकें ाएन के लिए विशेष Mg मिश्र धातु को विकसित करने हेतु एक सहयोगी परियोजना को प्रायोजित किया है। अतंरिक्ष एजेन्सियों द्वारा निर्धारित टारगेट मैकेनिकल प्रोपर्टीज सहित विशिष्ट एयरोस्पेस पदार्थों (Y- तथा Zn - युगमित Mg मिश्र धातु) का विकास भी किया गया है।

उच्च T_c (Bi 2223) को लंबी ट्यूबलरों (300mm x 30mm व्यास) के आकार में विकसित किया गया है। इनका धातु इलैक्ट्रोड संस्पर्श प्रतिरोध <0.02 micro-ohm/cm^2 है तथा इनका उपयोग क्रायोजोन मुक्त सुपरकंडकिंग मैग्नेट में उच्चधारा के तार के रूप में है।

9 सर्टिफाइड रेफरेंस मैटीरियल्स सीआरएमस (CRMs) के नए बैच तैयार किए गए थे जिन्हें बीएएम (BAM) फैडरल इंस्टीट्यूट फॉर मैटीरियल्स रिसर्च एण्ड टैस्टींग, बर्लिन द्वारा सृजित सीआरएमस CRM सीओएमएआर (COMAR) के अन्तर्राष्ट्रीय डेटाबेस में शामिल किया गया है।

एनपीएल ने सागर कन्या पोत पर बंगाल की खाड़ी से अरब सागर तक शीतकालीन अवधि में एयरो सोल, ट्रैस गैसों और यूीव सौर विकिरण का विस्तृत अध्ययन किया। इसरो (ISRO) द्वारा संचालित राष्ट्रीय एयरोसोल स्थल अभियान में एनपीएल ने 20 प्रतिभागी संस्थाओं के इण्डो-गेन्जेटिक मैदानों के आर-पार 6 स्थलों में उनके द्वारा निष्पादित उपकरणों का राष्ट्रीय स्तर के अन्तर्तुलनात्मक प्रयोग द्वारा उल्लेखनीय योगदान दिया।

मानव संसाधन विकास में एनपीएल विश्वविद्यालयों और अन्य शैक्षिक संस्थानों के विद्यार्थियों को उनके परियोजना कार्य एवं प्र ाक्षण

के लिए सुविधाएं उपलब्ध कराने में अपना योगदान दिया है। सम्पूर्ण भारत में स्थिति विभिन्न संस्थाओं में लगभग 200 (दो सौ) विद्यार्थी एमएससी, एमई/एम-टेक, एमसीए, बीई/बी-टेक आदि का अध्ययन कर रहे हैं, ने अल्प कालीन व दीर्घकालीन प्रशिक्षण प्राप्त किया है। आठ रिसर्च फैलो के शोध प्रबन्ध पूर्ण होने पर उन्हें पीएचडी की डिग्री प्रदान की गयी। उद्योगों के लिए 10 प्रशिक्षण कोर्स आयोजित किए गए जिनमें 175 व्यक्तियों ने भाग लिया। इसके अतिरिक्त एनपीएल में आने वाले शैक्षेणिक संस्थाओं/संगठनों के आगमन की व्यवस्था की गयी।

वर्ष 2004-2005 के दौरान 173 विभिन्न जरनलस् में वैज्ञानिक एवं तकनीकी शोध पत्र प्रकाशित हुए। विभिन्न राष्ट्रीय एवं अन्तर्राष्ट्रीय सम्मेलनों में 362 पेपर्स प्रस्तुत किए गए जिनमें से 237 पेपर्स सम्मेलन काकर्य विवरण (Proceedings) में प्रकाशित हुए। एनपीएल ने संस्थानों/सोसाइटी के संयुक्तीकरण से तीन सम्मेलनों का आयोजन एनपीएल में किया। इसके अतिरिक्त दो सम्मेलनों का आयोजन किया गया जिनमें वैज्ञानिक प्रस्तुतीकरण हिन्दी में किए गए। भारत में पांच पेटेंस और विदेश में सात पेटेंट पंजीकृत कराए गए। पूर्व वर्षों में पंजीकृत कराए गए छह पेटेंस वर्ष 2004-2005 के दौरान स्वीकृत हुए। 9 नयी परियोजनाएं आरंभ की गयी और 93 लाख रूपए का इसीएफ (ECF) अर्जित किया गया।

मैं एनपीएल के वैज्ञानिकों, इंजीनियरों और प्रशासन, वित्त, भण्डार एवं क्रय के स्टॉफ सदस्यों, सहायक स्टॉफ तथा इन्फ्रास्ट्रक्चर सर्विसेज स्टॉफ की रूचि एवं सहयोग के योगदान के प्रति आभार व्यक्त करता हूं। अन्त में मैं प्रका ान समिति तथा सम्बद्ध टीमों का इस रिपोर्ट को तैयार करने में दिए गए योगदान के प्रति आभार प्रकट करता हूं। श्री वी डी अरोडा, श्री प्रेम एवं श्रीमती एस के जेतली का विशिष्ट प्रयास भी सराहनीय है।

विक्रम कुमार

(विक्रम कुमार)
निदेशक

vi

Foreword

It is my pleasure to present the NPL Annual Report for the year 2004-05. NPL being a prime laboratory for physics, the spectrum of its activities covers the areas of National Standards, Material Sciences and Atmospheric Physics.

Advanced research in these important areas of physics is carried out under the Divisional Structure comprising of seven divisions namely Physico-mechanical Standards, Electrical & Electronic Standards, Engineering Materials, Electronic Materials, Materials Characterization, Radio and Atmospheric Sciences, and Superconductivity and Cryogenics. While maintenance and upgradation of National Standards of Measurements remain the statutory responsibility of NPL (as per the Legislation of Weights and Measures Act of 1956, re-issued in 1998 under the 1976 Act of the Parliament), intensive R & D in Frontier areas of Physics is carried out under several externally funded and in-house projects. With the initiation of Network-projects programme of CSIR, NPL has been playing a crucial role in many of these projects as can be seen by the activities reported in this Annual Report.

During 2004-05, Calibration Measurement Capabilities (CMCs) of the following Standards viz. Length & Dimension, Force, Ultra-sonic, DC High voltage, Time & Frequency and the Quantum Hall Standards were peer-reviewed by technical experts for inclusion in the Appendix C of the BIPM-MRA. There was participation in six internationally organized inter-comparisons from the two divisions of Standards. Under the NPL-NABL MoU, the first phase of Proficiency testing on DC-resistance and the second phase of capacitance measurement was also completed for the NABL accredited labs.

In the area of Materials Science NPL has developed a wide range of materials, both for basic research as well as for a variety of strategic and industrial applications. General Motors have sponsored a collaborative project for development of special Mg alloys for automobile applications. Specialized aerospace materials (Y- and Zn added Mg alloys) with target mechanical properties laid down by Space agencies were also developed.

High Tc superconductors (Bi-2223) have been developed in long tubular form (300 mm x 30 mm diameter) having a metal-electrode contact resistance of <0.02 micro-ohm/cm^2 for use as high current leads in a cryogen-free superconducting magnet.

New batches of 9 certified reference materials (CRMs) were prepared which have been included in the International database of CRMs, COMAR created at BAM, Federal Institute for Materials Research and Testing, Berlin.

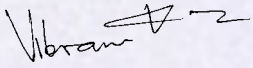
NPL made a significant study of aerosol, trace gases and UV solar-radiation onboard the cruise-ship Sagar Kanya, covering parts of Bay of Bengal and the Arabian sea for a winter period. As part of the ISRO led National Aerosol Land Campaign NPL made notable contribution by organizing the national level inter-comparison experiment for aligning the performance of instruments deployed by 20 participating institutions over six sites spread across the Indogangetic Plains.

In the human resource development, NPL has been contributing by providing facilities to students from Universities and other educational institutes for project-work and training. About 200 students studying

M.Sc., M.E. / M.Tech., MCA, B.E./B.Tech. etc. from various institutes located all over India have undergone short and long term training. Eight research fellows on completion of their thesis work have been awarded Ph.D. Ten training courses for industry were organized where 175 persons participated. Besides number of visits by educational institutes/organization to NPL were arranged.

During 2004-05, 173 number of scientific and technical papers were published in various journals. 362 papers were presented at various national and international conferences out of which 237 papers were published conference in proceedings. NPL organized three conferences jointly with institutes / society at NPL. Besides, two conferences were organized where scientific presentations were made in Hindi. Five patents were filed in India and seven were filed abroad. Six patents filed in previous years were granted during 2004-05. Nine new projects were taken and an ECF of Rs. 93 lakhs was generated.

I would also like to acknowledge the contributions of NPL scientists, engineers, and the staff of administration, finance, stores and purchase, the support staff and the infra-structure services for all their interest and cooperation. Last, but not the least, I would like to acknowledge the contributions of the publication committee and the associated teams in bringing out this report. Special efforts made by Shri V.D. Arora, Shri Prem and Smt. S.K. Jaitely are also appreciated.



(Vikram Kumar)
Director

viii

Preamble

The National Physical Laboratory is one of the earliest national laboratories set up under the Council of Scientific & Industrial Research. Late Shri Jawaharlal Nehru laid the foundation stone of NPL on the 4th January 1947. Late Dr. K.S. Krishnan, FRS, was the first Director of the laboratory. The main building of the laboratory was formally opened by Late Deputy Prime Minister, Sardar Vallabhbhai Patel on the 21st January 1950. The Silver Jubilee Celebration of the Laboratory was inaugurated by Late Prime Minister, Shrimati Indira Gandhi, on 23rd December 1975.

CHARTER

The main aim of the laboratory is to strengthen and advance physics-based research and development for the overall development of science and technology in the country. In particular its objectives are :

- To establish, maintain and improve continuously by research, for the benefit of the nation, National Standards of Measurements and to realize the Units based on International System (Under the subordinate Legislations of Weights and Measures Act 1956, reissued in 1988 under the 1976 Act)
- To identify and conduct after due consideration, research in areas of physics which are most appropriate to the needs of the nation and for advancement of field
- To assist industries, national and other agencies in their developmental tasks by precision measurements, calibration, development of devices, processes, and other allied problems related to physics
- To keep itself informed of and study critically the status of physics.

CUSTODIAN OF NATIONAL STANDARDS OF MEASUREMENT

National Phisical Laboratory has the responsibility of realizing the units of physical measurements based on the International System (SI units) under the subordinate legislations of Weights & Measures Act 1956 (reissued in 1988 under the 1976 Act). NPL also has the statutory obligation to establish, maintain and update the national standards of measurement & calibration facilities for different parameters. The Seven SI base units are metre, kilogramme, second, kelvin, ampere candela, mole (mol) and the SI supplementary units are radian (rad) & steradian (sr). The other derived units for physical measurement that the laboratory currently maintains are : force, pressure, vacuum, luminous flux, sound pressure, ultrasonic power; ac voltage; current and power; low frequency voltage; impedance and power; high frequency voltage; power; impedance; attenuation and noise; microwave power; frequency. impedance; and attenuation and noise.

NATIONAL APEX BODY FOR CALIBRATION

The laboratory provides apex level calibration services in the country; offering National Accreditation Board for Testing and Calibration Laboratories (NABL), the national accrediation body in the country (i) its qualified assessors as needed for establishing best measurement capability of the applicant laboratory; in particular its scientific, (ii) its technical input to enable NABL to decide the suitability of the applicant laboratory for accreditation, and (iii) its faculty to train testing laboratories for extimation of uncertainty in their measurements.

Besides, the laboratory is engaged in developint Certified Reference Materials to ensure high quality measurement and traceability of analytical measurements to national/international measurement system (SI unit) in order to fulfill the mandatory requirement of quality systems (ISO/IEC guide 17025) and of the NABL.

R & D ACTIVITIES

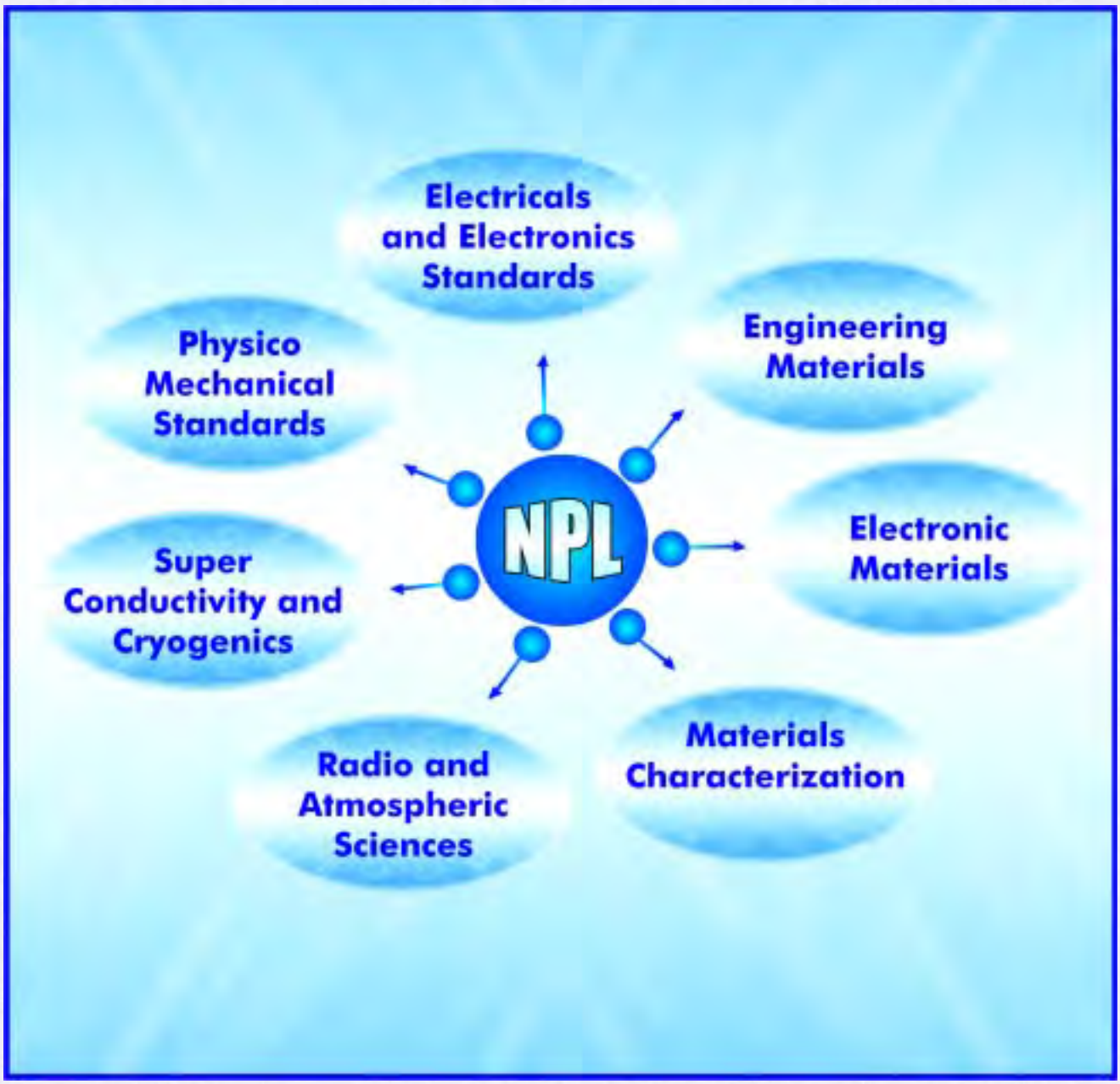
In the pursuit of its chartered objectives, the laboratory undertakes sponsored projects, consultancy assignments and in-house research projects in areas such as physical measurement standards, engineering materials, electronic materials, soft and polymer materials, materials characterization, radio and atmospheric sciences and cryogenics and superconductivity.

ORGANIZATION AND MANAGEMENT

The laboratory has structured its total activities under seven scientific decision units. These are: (i) Physico-mechanical standards, (ii) Electrical and electronic standards, (iii) Engineering materials, (iv) Electronic materials, (v) Materials characterization, (vi) Radio and atmospheric sciences, and (vii) Cryogenics and superconductivity.

In addition, it has set up nine support units for its organization and management. These are (i) Director's office, (ii) Administration & House keeping, (iii) Finance & Accounts, (iv) Store & Purchase, (v) Library, (vi) Scientific support service, (vii) Technical suport service, (viii) Workshop, (ix) Computer centre.

R & D Groups


Electricals and Electronics Standards
Engineering Materials
Physico Mechanical Standards
NPL
Electronic Materials
Super Conductivity and Cryogenics
Materials Characterization
Radio and Atmospheric Sciences

xii

भौतिक - यांत्रिक मानक

PHYSICO-MECHANICAL STANDARDS

भौतिक - यांत्रिक मानक

भौतिक यांत्रिक मानक राष्ट्रीय भौतिक प्रयोगशाला, भारत का मानक गतिविधियों में एक अत्यन्त महत्वपूर्ण अंग है। यह प्रभाग विभिन्न यांत्रिक मापन सम्बन्धी गतिविधियों के लिए स्थापित किया गया है जिसके निम्नलिखित पैरामीटर हैं :-

1. द्रव्यमान, आयतन, घनत्व और विस्कोसिटी (श्यानता) मानक
2. लम्बाई, घात मानक
3. ताप मानक
4. प्रकाशीय विकिरण मानक (दृश्य अवरक्त पराबैंगनी क्षेत्र)
5. बल एवं कठोरता मानक
6. दाब एवं निर्वात (vacuum) मानक
7. ध्वनिक मानक
8. तरल बहाव मानक
9. पराश्रव्य मानक
10. आर्द्रता मानक
11. प्रघात एवं संवेदकों पर अनुसंधान एवं विकास
12. प्रकाशीय पैरामीटर

इस प्रभाग का कार्य उपर्युक्त गतिविधियों से सम्बन्धित माप के राष्ट्रीय मानकों की स्थापना करना, उनका रख-रखाव करना, निरन्तर उनमें आवश्यक संशोधन करना तथा देश के उद्योगों एवं संस्थानों का अनुमार्गणीयता तथा शीर्ष स्तर की अंशांकन सेवाएं प्रदान कर मानकों का प्रचार करना है।

आज के निर्माण एवं सेवा उद्योग मुख्यतः विज्ञान आधारित है और यथार्थ मापों पर अधिक निर्भर करते हैं। यांत्रिक क्षेत्र में ही केवल इंजीनियरिंग उत्पादों का विश्वसनीय माप तैयार करने की आवश्यकता आधुनिक औद्योगिकी समाज में सभी पहलुओं में व्याप्त है चाहे वह लम्बाई, द्रव्यमान, प्रकाशीय, तापमान, दाब, ध्वनिक बल मापन ही क्यों ना हो। द्रव्यमान, लम्बाई तापमान और प्रकशिकी की बेस यूनिटों के लिए राष्ट्रीय मानकों को कार्यान्वित कर राष्ट्रीय भौतिक प्रयोगशाला उद्योगों की मांग पूरी करने में सक्षम है। इसके लिए प्रयोगशाला भौतिक मापों के लगभग सभी पैरामीटरों में गहन रेंज की अंशांकन एवं माप सेवाएं प्रदान करती है।

तापीय और लम्बाई मापिकी राष्ट्रीय माप मानकों का रख-रखाव व विकास करती है और तापीय तथा इंजीनियरिंग विमीय मापिकी के लिए माप मानकों का प्रचार करती है। यांत्रिकी माप समूह-ध्वनिक द्रव्यमान, घनत्व, बल, बल आघूर्ण, कठोरता, दाब और वैक्यूम पराश्रव्य के प्रोविजन और प्रचार को लिए विश्वस्तरीय सुविज्ञता और सुविधाएं उलब्ध कराता है। प्रकाशीय मापिकी समूह दीप्त घनत्व-केण्डेला और अन्य प्राथमिक प्रकाशीय विकिरण मात्राओं के लिए एस.आई. यूनिट को कार्यान्वित करने के लिए उत्तरदायी है। जैसे-जैसे ग्लोबलाइजेशन और क्रॉस बार्डर व्यापार बढ़ता है विभिन्न औद्योगिकी सैक्टरों को उपकरणों और स्वीकार्य मापों की आवश्यकता पड़ती है। इसी के फलस्वरूप राष्ट्रीय भौतिक प्रयोगशाला ने ब्यूरों इंटरनेशनल डेसप्वाएड्स एवं मेजर्स (BIPM) पैरिस के सहयोग से 14 अक्टूबर 1999 को म्यूच्युल रिकगनिशन अरैंजमेंट (MRA) पर हस्ताक्षर किया है।

इससे भारतीय निर्यातकों को बड़ा लाभ हुआ है। अन्तर सरकारी निकाय जैसे विश्व व्यापार संगठन (WTO) ने व्यापार में तकनीकी बाधाओं को दूर करने और पूरे विश्व में परीक्षण एवं अंशांकन सर्टिफिकेट को एक परस्पर मान्यता देने के कारण मापिकी के योगदान को सम्मानित किया है।

इस प्रभाग की गतिविधियां बी आई पी एम और/अथवा ए.पी.एम.पी. (एशिया पेसिफिक मीट्रोलॉजी प्रोग्राम) आर.एम.ओ. (रीजनल मीट्रोलॉजी आर्गेनाइजेशन ऑफ एशियन रीजन) द्वारा आयोजित/समन्वित अन्तर्राष्ट्रीय अन्तर तुलना में भाग लेती है जिससे कि यूनिट की अन्तर्राष्ट्रीय पद्धति की यूनिट और मात्रा को मान्यता प्रदान की जा सके।

वर्ष 2004-2005 में प्रभाग की विभिन्न गतिविधियों ने पांच अन्तर तुलना में सफलता पूर्वक भाग लिया। उद्योगों, संस्थानों और मान्यता प्राप्त प्रयोगशालाओं को 2096 अंशांकन रिपोर्टस् और 276 इनहाउस रिपोर्टस् जारी की। मापिकी से सम्बन्धित समस्याओं को हल करने में चार निजी/सार्वजनिक ठेकेदारों को सलाह प्रदान की। दो प्रौद्योगिकी की विकसित की जिसमें से एक प्रौद्योगिकी वाणिज्यिक उपयोग के लिए उद्योग को दी। विभिन्न पैरामीटरों में सात प्रशिक्षण कार्यक्रम आयोजित किए गए और देश में मापिकी के क्षेत्र में दक्ष मैन पावर (Man Power) के विकास में योगदान दिया।

प्रभाग के SCI जरनलस् में 6 लेख और SCI से अलग अन्य जरनल जिसमें मापन, जे एस एम आई (JSMI) शामिल है, में 24 लेख प्रकाशित हुए, 53 आमंत्रित वार्ताएं दी गयी तथा उनके द्वारा मापिकी, गुणवत्ता पद्धति और अंशांकन प्रयोगशालाएं स्थापित करने के क्षेत्र में हासिल किए गए ज्ञान को फैलाने में सहायता की।

पी टी बी जर्मनी, नेशनल मीट्रोलॉजी इंस्टीट्यूट (NMI) सी एस आई आर ओ, आस्ट्रेलिया और राष्ट्रीय भौतिक प्रयोगशाला (NPL) यू.के. के तकनीकी विशेषज्ञतों ने क्रमशः बल, लम्बाई और विमीय एवं पराश्रव्य मानकों की अंशांकन माप योग्यताओं का पिअर रिव्यू किया गया।

ए पी एम पी (APMP) सैक्रेटिएट और सम्बन्धित तकनीकी समिति अध्यक्ष द्वारा CIPM MRA द्वारा तैयार किए गए मार्ग निर्देशों के अनुसार अंशांकन माप योग्यताओं (CMC) का सूक्ष्म परीक्षण किया जाता है। यह कार्य BIPM वैब साइट के परिशिष्ट 'सी' पर CMC के रखने से पहले किया जाता है।

इस प्रभाग के वैज्ञानिक, NABL भारत में अंशांकन और परीक्षण प्रयोगशालाओं के प्रत्यायन के लिए एक निकाय जो राष्ट्रीय माप पद्धति के नेटवर्क को विकसित करता है, के लिए मार्गदर्शक और तकनीकी निर्धारक हैं। वैज्ञानिकों ने विभिन्न प्रयोगशालाओं की तकनीकी योग्यताएं निर्धारित करने के लिए NABL की सहायता की है।

इसके अतिरिक्ति द्रव्यमान, लम्बाई और तापमान गतिविधियों ने दक्षता परीक्षण कार्यक्रम आयोजित किए है।

इस प्रकार राष्ट्रीय भौतिक प्रयोगशाला NABL को वैज्ञानिक और तकनीकी सहायता प्रदान कर रही है ताकि देश में राष्ट्रीय माप पद्धति को मजबूत बनाया जा सके।

इस प्रभाग के वैज्ञानिक भारतीय मानक ब्यूरों (BIS) नई दिल्ली की विभिन्न अनुभागीय समितियों के मनोनीत सदस्य/अध्यक्ष हैं और भारतीय मानक ब्यूरों को तकनीकी और वैज्ञानिक इनपुट (In Put) प्रदान करते हैं जिससे कि मापिकी और अन्य क्षेत्रों से सम्बन्धित विभिन्न भारतीय मानकों की जरूरतों को सूत्रबद्ध किया जा सके।

PHYSICO-MECHANICAL STANDARDS

Physico-Mechanical Standards Division is one of the most important arm of the Standards activities of National Physical Laboratory, India. The division constitutes of various mechanical measurement activities involving the parameters of

1. Mass, Volume, Density and Viscosity Standards
2. Length and Dimension Standards
3. Temperature Standards
4. Optical Radiation Standard (visible infrared and ultraviolet regions)
5. Force and Hardness Standards
6. Pressure and Vacuum Standards
7. Acoustic Standards
8. Fluid Flow Standards
9. Ultrasonic Standards
10. Humidity Standards
11. R & D on Shock and Vibration Sensors
12. Optical Parameters

The division is engaged in establishing; maintaining and continually upgrading the National Standards of Measurements related to above said activities and disseminate the standards by providing the traceability and apex level calibration services to the industry and institutions of the country.

Today's manufacturing and service industries are increasingly science based and even more dependent on accurate measurements. In the mechanical field alone, the need to make reliable measurements of engineering products pervades all aspects of a modern industrial society, be it length, mass, optical, temperature, pressure, acoustics, force measurements. NPL is able to meet the demands of industry by realizing the National Standards for the base units of mass, length, temperature and optics by providing an extensive range of calibration and measurement services in almost every parameter of physical measurements.

Thermal and Length Metrology maintains and develops national measurement standards and disseminate measurement standards for thermal and engineering dimensional metrology. The group for mechanical measurements viz. Acoustical, Mass, Density, Force, Torque, Hardness, Pressure and Vacuum, Ultrasonic metrology devote world class expertise and facilities to the provision and dissemination of measurement standards ultrasonic. The Optical metrology group is responsible for the realization of the SI units for Luminous intensity, the Candela, and other primary optical radiation quantities. As globalization and cross border business increases, various industrial sectors need equipments and acceptable measurements. Consequently, NPL has signed Mutual Recognition Arrangement (MRA) on 14th October, 1999 coordinated by Bureau International des Poids and Measures, (BIPM), Paris bringing enormous benefits to Indian exporters. Inter-governmental bodies such as World Trade Organization (WTO) recognize the contribution made by metrology in reduction of technical barriers to trade and to mutual recognition of tests and calibration certificates through out the world.

The activities of this division participate in international inter-comparison organized/ coordinated by BIPM and or APMP (Asia Pacific Metrology Program) / RMOs (Regional Metrology Organization of Asian region) regularly to cross-check and to validate the units and quantities of International System of Units (SI).

In 2004-05 various activities of the division successfully participated in five intercomparison, issued 2096 Calibration reports to industries, institutions and accreditated laboratories and 276 in house reports, provided consultancy to four private/public entrepreneur in solving the metrology related problems, developed two technologies out of which one technology was transferred to industry for commercial exploitation, seven

training programs in various parameters were organized and contributing to the development of skilled man power in the field of metrology in the country.

The division published six articles in SCI Journals and twenty four articles in Non SCI Journals including MAPAN, the JSMI, delivered fifty three invited talks and helped in disseminating the knowledge acquired by them in the field of metrology, quality system and setting up of calibration laboratories.

Calibration Measurement Capabilities (CMCs) of Force, Length and Dimension and Ultrasonic Standards were peer-reviewed by technical experts from Physikalish-Technische Bundesanstalt (PTB) Germany, National Metrology Institute (NMI), CSIRO, Australia and National Physical Laboratory (NPL) UK respectively.

The CMCs are being scrutinized by APMP Secretariat and respective Technical Committee Chairman as per guidelines laid down by CIPM MRA before CMCs are placed on Appendix 'C' of BIPM website.

The scientists of this division are the Lead and Technical Assessors for National Accreditation Board for Testing and Calibration Laboratories (NABL), a Govt. body for accreditation of the Calibration and Testing Laboratories in India which is developing the network of National Measurement System. The scientists have helped NABL in assessing technical capabilities of several laboratories.

Besides, Mass, Length and Temperature activities, the group has organized proficiency testing program in assessing the technical competence of NABL accredited calibration laboratories vis-à-vis the approved uncertainties / best measurement capabilities of these laboratories as approved by NABL. NPL have thus been providing scientific and technical support to NABL in strengthening the National Measurements System in the country.

The scientists of this division are nominated members/chairmen of various sectional committees of BIS (Bureau of Indian Standards), New Delhi and have been providing technical and scientific inputs to BIS for formulating the requirements of various Indian Standards related to Metrology and other areas.

Mass, Volume, Density and Viscosity Standards

This section maintains primary standards of Mass (1kg) National Prototype copy No. 57 of the International Prototype and National standards of Density (solid sphere), Volume (derived through mass and density), Viscosity (in terms of standard viscometers). It actively disseminates the traceability by way of providing apex level calibration services to industry, institution, legal metrology departments and NABL accredited calibration laboratories.

The section issued 874 calibration reports for weights and balances etc. and earned an ECF of Rs 42.81 lakhs. It also calibrated the standards of other sections of NPL and issued 24 calibration reports. During the year the laboratory piloted key comparison coded APMP M.M.K2 in mass measurements. NPL will calibrate the two sets of mass standards (five weights in each set) in the beginning and at the end of the programme. At present the artifact is with fourth participant laboratory. Eleven NMI's of APMP region are participating. The section also conducted two proficiency testing programmes for evaluating the technical competence of 20 (twenty) NABL accredited calibration laboratories.

It also calibrated its own Transfer Mass Standards against the National Prototype of Mass and primary solid density standards for maintaining unbroken chain of traceability. Similarly, the standard hydrometers and viscosity meters were also calibrated in house. NPL provided traceability to the Nepal Bureau of Standards and Metrology by calibrating their National Standard against NPL Transfer Standard. The section provided one week training to five participants from industry and four week training to two trainees from Saudi Arabia Standards Organization (SASO) Saudi Arabia. Besides, it organized a 2 day Training Course for the industry personnel in calibration of mass and related standard artifacts. Seventy professionals joined the course. The scientists of the section published several papers/ articles and delivered invited talks.

Length and Dimension Standard

Length and Dimension standard maintains the national standards of length and related parameters and is actively involved in the dissemination of traceability by way of calibration and testing services. The services were provided to clients from industries and other organizations and 460 calibration /test reports were issued. During this year the laboratory started providing calibration services using its recently added facilities like Gauge Block Interferometer and length measuring machine, to customers. A Dynamic Laser Calibrator was established for calibration of laser interferometers for indicated distance. Experiments were initiated to establish a facility for thermal expansivity measurement of the gauge block. A new setup has been designed for this purpose.

A non-contact technique for the measurement of fine dimension has been developed. The technique can be applied for the measurement of surface roughness, sieve dimensions, waviness and fine hole measurements. The technique uses CCD Camera, Wavelet filters and image processing devices.

Statistical methods of weighted mean and Birge ratio were applied to analyze the results of PT on Gauge Blocks. The consultancy in setting up a calibration laboratory was provided to M/s Mitutoyo South Asia(P) Ltd, New Delhi.

Under MoU with NABL, the fourth Proficiency Testing (PT) program coded NABL-M-Length-004 for the measurement of central length of gauge blocks was started. Various NABL accredited laboratories participated in this Programme. NABL, DST, funded the program.

During this year the laboratory has undergone peer review as part of CIPM MRA, The review includes assessment of the quality system as per ISO-IEC 17025, its implementation, calibration procedures and technical capability of staff. Comments from reviewers were very appreciative. The report is under consideration for including the Calibration Measurement Capabilities (CMCs) in Appendix C of BIPM Web Site.

Temperature Standards

The section continued to provide calibration services to industry for calibration of temperature measurement devices viz., thermometers, thermocouples, pyrometers, SPRT's etc. The section issued 311 calibration reports to industry and 58 reports to various sections of NPL.

Quality system documents including calibration schedules, calibration procedures, uncertainty budget etc., were prepared for peer review as per ISO / IEC 17025 quality standard. The laboratory was also renovated for improving the environmental conditions and maintenance of these as per quality manual.

The efforts have been initiated to enhance the capabilities of calibration of thermometers to 700° C from 300° C and for thermocouples to 1600° C from existing 1000° C. Argon fixed point is also planned to be established for direct traceability to measurements at (84K). A furnace with temperature range of 1600° C is being established. The section participated in International comparison in the range upto 1000° C for establishing the International traceability in this region. Fixed point cells of Zn Al and Ag are planned to be established to improve the uncertainty of the temperature measurement in this range.

Optical Radiations (visible, ultraviolet, and infrared regions)

Light emitting diodes (LEDs) have started making their place for lighting applications so much so that New York city is going to have its street lighting with LEDs in a short time The research and developmental work on studying the photometric characteristics of light emitting diodes including their color characteristics, wavelength and intensity variations on the environmental conditions was carried out. Calibration facilities for the photometric parameters were extended to various lamp and lighting industries, R & D institutions etc. Calibration of broad band UV intensity in UV-A, UV-B and UV-C spectral region was carried out. Measurement of UV radiation emitted from GLS lamps of different wattage has been initiated. The aim of this study was to see (although, the emission of UV radiation from a single lamp is very little), a cumulative effect of UV radiation emanated from GLS lamps on the health of human being and on the environment. Spectral irradiance of TF Lamps of different colour temperature and wattage are being measured to calculate their colour temperature and colour coordinates so that these lamps may be used as reference standards.

Sponsored projects

Birla Management Corporation Limited, Bombay

Sponsored project entitled "NIR spectroscopy technique for cellulosic materials"

A number of pulp, alkcell and viscose samples of different varieties, in eleven different lots, were received from the Grasim Chemical Laboratory, Nagda. All these samples were analyzed in mid infrared region and near infrared region using attenuated total reflectance and diffuse reflectance accessories respectively. Chemical analyses of these samples were carried out for hemi and alpha cellulose, resins, fats and pentosans. Moisture analysis of the pulp samples was done using Karl-Fisher analyzer. The results obtained at NPL for different parameters namely alpha cellulose, hemi cellulose, moisture, resins & fats and pentosans are compared with those obtained at Nagda. A commercial program based on GRAMS 386 for multivariate spectral data analysis was used to process the data and to develop model for moisture content in pulp samples. No single wavelength was found selective for quantitative analysis for moisture in pulp samples. Calibration was, therefore performed in different wavelength regions. Calibration for other parameters is on the way.

CSIR sponsored project entitled "Optical and spectral properties of organic compounds used as building blocks for nanostructures"

A novel method is developed for fabrication of polyaniline nanotubules. Polyaniline nanotubules of different dimensions are fabricated on a ground glass surface using an in-situ vapour phase method. Optical studies for investigating the morphology are conducted. A comparative spectroscopic study using FTIR and UV of polymeric nanomaterials with their macroscopic counterparts is underway.

DST sponsored project on "Studies on Spatial-coherence spectral filters and their applications" completed

Theoretical investigations made not long ago regarding the construction of spatial-coherence spectral filters are rendered into experiments by designing and fabricating experimental setups analyzed in the theoretical studies. It is shown that the phenomenon of spectral shift due to spatial coherence also known as the Wolf effect can be exploited to make special types of low-pass and band-pass spectral filters with special spectral characteristics that are not shown by the conventional filters.

Combining the Indebetouw system with a Fourier-achromat and with the help of a pupil mask a broadband spectrum is split into many lines within the original spectrum of the source. Spatial separation of two close lying lines is also achieved by making use of the Indebetouw system with a Fourier-achromat with special type pupil mask. The experimental results within the experimental limitations and measurement uncertainty agree well with the theory. These filters might find applications in (i) splitting of a single spectral line into several lines (ii) separation of two close lying spectral lines and in (iii) optical signal processing.

DST sponsored project on "Studies on the effect of dynamic multiple scattering on the frequency shift of spectral lines and applications"

Doppler-like wavelength shift proposed in dynamic multiple scattering theory by Roy et al (the source and the medium are at rest with respect to the observer) has been tested using the results of experimental studies of the redshift and broadening of Hg lines on scattering of the light emanated from Hg discharge source from an anisotropic plasma medium. These results are consistent with the theoretical results and are expected to produce new insights for the astronomical domain, particularly for discordant redshifts in quasars.

Force, Torque and Hardness Standards

The section provides calibration services to the industry for calibration of force proving devices, load cells, force transducers, hardness standards etc., The section issued 445 calibration reports and earned an ECF of Rs 43.5 lakhs by calibration. The quality system documents including calibration procedures, uncertainty budget etc., following ISO/IEC 17025 Standards requirements were prepared. The Force activity has been successfully peer-reviewed by the technical expert from PTB Germany in October 2004. Efforts are being made to get the hardness facility in the Rockwell 'C' scale peer reviewed. The efforts are also being made to establish the primary standard of hardness in the Vickers and Brinell scale with the help of NABL, DST, Government of India. The laboratory was completely renovated and now the environmental conditions are maintained as per quality manual.

Research and Development

A. Design, Development and Fabrication of a 500 kg load cell testing machine

A fully automated load cell testing machine (Fig 1.1) based on the first principle was designed to suit the tailor made requirement of the Regional Reference Standard laboratory, Bangalore (Ministry of Consumer Affairs, Food & Public Distribution). A novel technique using pneumatic operated bellows was used to load and unload the dead weights. Load cells within the range of 50-500 kg can be tested / calibrated on the machine for load as per OIML R-60 within the measurement uncertainty of ± 50 ppm and repeatability better than 10 ppm. The machine has an edge over the existing conventional type of dead weight machine wherein the dead weight movement is controlled by a motor driven mechanical system and is thus prone to produce vibration and rotation leading to lower repeatability and longer stabilization time. The machine is in operation at RRSL Bangalore since last three months. (Patent has been applied for)

Fig. 1.1 Force transfer standard for the medium range

B. Microstructure studies of standard hardness blocks

The repeatability and the stability of Standard hardness blocks are of prime importance for the verification and testing of the hardness machine to maintain the uniformity in the hardness measurement in industries. In order to identify the blocks with good repeatability and long term stability, for use as a standard to verify the machine, detailed microstructure and surface roughness studies were carried out on a few blocks procured from two Indian manufacturers

and one manufacturer from Germany. Preliminary studies show (Fig. 1.2 & 1.3) presence of porosity and segregated phase of carbon particles which are detrimental to the quality of the blocks. This can be taken care of by optimizing the critical parameters like the heat treatment, tempering etc.

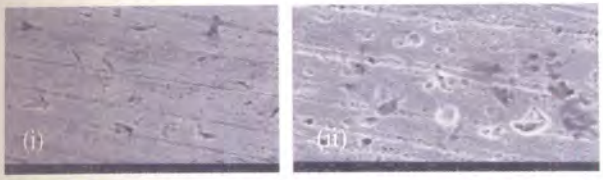


Fig.1.2 SEM micrographs of standard hardness block 'a' etched with 50% C for (i) 5 minutes and (ii) 45 minute indicating no segregation

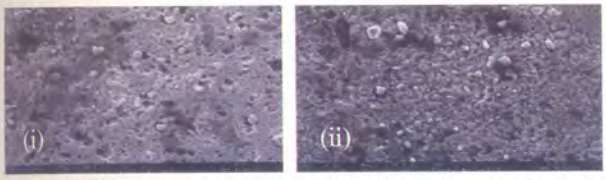


Fig.1.3 SEM micrographs of standard hardness block 'b' etched with 50% HCl for (i) 5 minutes and (ii) 45 minute indicating no segregation of phase

C. An import substitute low cost high efficiency transfer force standard up to 700 kN

Force transfer standard for the medium range 100-700 kN, which can be used to measure the static forces with an accuracy of ± 0. 02 % or better is designed and fabricated using a build-up system (Fig 1.4). The system which are available in the international market are all for a very high capacity i.e. about 20 –30 times higher than the present case with measurement uncertainty of ± 0.5%.

One of the main advantages is that the device under reference can be used to establish the force calibration facilities to undertake the calibration of the force transducers used for the verification of the material testing machines as per ISO 376-1999 and IS 4169-1988. It is a low cost, reliable and user friendly prototype device which can be used either as transfer force standard when used independently or as force standard machine when it is attached to the ram of the hydraulic machine. (Patent has been applied for)

The section has designed and developed transfer standards to measure static force up to 500 kN ± 0.04% and transferred technology to M/s J.Ragrau Instruments, New Delhi on Technology day 2004. The total ECF generated by the group during 2004-2005 is in excess of Rs 77 lakh.

Fig. 1. 4 - Load cell testing machine

Pressure and Vacuum Standards

Vacuum Standards

Recently the group acquired high accuracy resonant silicon gauges of two different ranges, one 130 kPa full scale and the other 1 kPa full scale for measurement of the initial and final pressures. These gauges have been utilized in a cumulative expansion process for the measurement of the volume ratio of the NPLI Static Expansion System, which is nominally 2820. With these new gauges, and with the use of calibrated Platinum Resistance Thermometers mounted inside the vacuum chambers, it has been possible to measure the volume ratio with a relative expanded uncertainty (k=2) of 0.0014.

The standard thus characterized has been used to calibrate SRGs at a number of pressures in the range 0.1 Pa to 1 Pa in steps of 0.1 Pa. The Gauge Constant at each of these pressures, defined as equal to the ratio of the indicated pressure to the true pressure is then plotted against the true pressure. The resulting straight line plot has a negative slope and its intercept equals the gauge coefficient. The two SRGs, NPL-0 and NPL-2 thus calibrated are used (i) as a device for measuring the pressure rise in the flow meter of the NPLI orifice flow system and (ii) as a secondary standard for the calibration of the user gauges.

Some pressure measuring instruments, namely Capacitance Diaphragm Gauges (CDG), Quartz Bourdon Gauges (QBG) and Digital Pressure Indicators (DPI) are established as secondary Pressure Standards through proper maintenance of their measurements traceable to Ultrasonic Interferometer Manometer (UIM), a Primary Pressure Standard working in the Barometric Pressure region, as per the norms and guidelines stipulated in ISO/IEC 17025. The performance characteristics of the above secondary standards over several years are also thoroughly studied through preparation of "Control Charts".

In many a situations, calibration of some Pressure/ Vacuum Gauges require the method of linear regression, to identify and account for pressure dependent and independent errors components. In this calibration process, the slope (m) and the intercept (c) are to be treated as correlated parameters. As per the "ISO Guide to Expression of Uncertainty in Measurement", the covariance of correlated parameters are required to be considered along with their degrees of freedom while accounting for uncertainty contributions. Also the coverage factor is to be worked out for the required level of confidence according to effective degrees of freedom while reporting expanded measurement uncertainty. Some software in VBASIC is developed incorporating procedures for computing all the above parameters and augmented with the existing "CALIBRATION DATABASE" that is being used for day to day work.

The measurement Uncertainty of UIM has further been reduced through measurements in real experimental conditions and properly tuning the "Phase Sensitive System". For this the Uncertainty is evaluated at each pressure point through some software developed and integrated with the existing "Data acquisition and Control System". Towards evaluation of measurement Uncertainty, 14 different parameters were considered along with their correlation. The contributions of some of these parameters, such as, "tilt", "zero position", "fractional fringes", etc were estimated experimentally along with the correlation coefficients, wherever applicable. At a particular pressure point, 44 length measurements are made at different multiple frequencies, covering two complete cycles of fringes and the mean of these 44 points is taken as the value of length and corresponding pressure, thus minimizing uncertainty due to phase errors. A comparison of uncertainty thus estimated in real experimental conditions has been compared with the theoretically estimated uncertainty using the uncertainty budget developed in line with "ISO Guide to Expression of Uncertainty in Measurement". Through this comparison it is observed that above a pressure of approximately 1000 Pa, the measurement uncertainty of UIM is less than the theoretical value, whereas, at lower pressures, it is not constant, but fluctuating above and below the theoretical value. This variation at lower pressures may be accounted for imperfection in 90° phase shift in PSD signals and the ecentricity of sine-cosine signals.

Pressure Standards

Participation in CCM Sponsored key Comparison

Participated in the CCM Sponsored International Key Comparison (CCM.P-K7) in the pressure range 10 to 100 MPa. NPL, India is selected among the best nine laboratories [PTB, Germany; LNE, France; IMGC, Italy; NPL, UK; NIST, USA; CENAM, Mexico; NRC, Canada; NMIJ, Japan and NPL, India] to participate in this comparison. PTB, Germany had worked as Pilot Laboratory in this comparison. The comparison was carried out at NPL, New Delhi during March 15, 2004 – April 15, 2004 and a typical experimental setup showing cross-floating of the artifact against NPL 100 MPN, a secondary hydraulic standard is shown in Fig. 1.5. The Draft B report of

Fig. 1.5 Photograph of the CCM.P.K7 experiment

this comparison is already released and results are being presented during forthcoming CCM International Conference on Pressure Metrology being held at Institute of Physics, London during April 19-21, 2005. Our results in this comparison are found very encouraging and are summarized in the Fig. 1.6. The maximum relative deviations of our values from the reference values are $>11.5 \times 10^{-6}$ thorough out the entire pressure range of 10–100 MPa which is well within our reported standard uncertainty of 30×10^{-6} (k=1). This comparison also demonstrates that all Ap values agree with each participant within our reported expanded uncertainty of 60×10^{-6} (k=2).

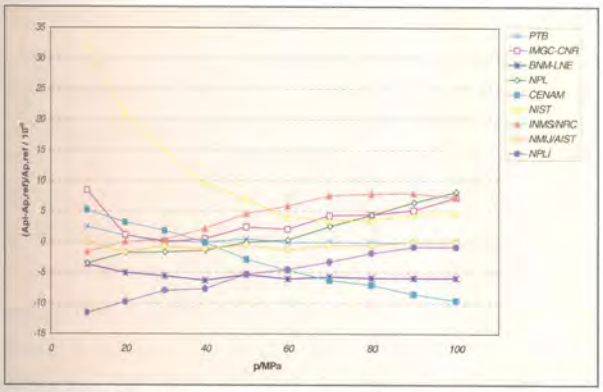


Fig. 1.6 Relative deviations of the participant results' from the reference value

Results of APMP.M.P. K7 Key Comparison

This key comparison (APMP.M.P.K7) of hydraulic high-pressure standards was carried out for sixteen National Metrology Institutes (NMIs: NMIJ/AIST, NPLI, CSIR-NML, NIS, KRISS, SCL, SPRING, NMIA, VMI, NML-SIRIM, KIM-LIPI, NSCL, PTB, NIMT, CMS/ITRI and NIM) during the period October 2002 to July 2004 within the framework of the Asia-Pacific Metrology Program (APMP) in order to determine their degrees of equivalence at pressures in the range 10 MPa to 100 MPa for gauge mode. The pilot institute was the National Metrology Institute of Japan (NMIJ)/ AIST. Although NPLI performed the measurements during November 2002, the final report of the results was just released during March 2005. The sensing element of the transducer was a precision quartz crystal resonator. The degrees of equivalence in this comparison were transferred to the corresponding CCM key comparison, CCM.M.P-K7. The hydraulic pressure standards in the range 10 MPa to 100 MPa for gauge mode of the sixteen participating NMIs were found to be equivalent within their claimed uncertainties. The maximum relative deviations of our values from the reference values are $>19.1 \times 10^{-6}$ thorough out the entire pressure range of 10 – 100 MPa as shown in Fig.1.7. Final Report on APMP.M.P-K7 reveals that all Ap values agree well within our reported standard uncertainty of 25×10^{-6} (k=1) through out the entire pressure range of 10 – 100 MPa. The values for the linkage are established by using the combined differences, which are calculated by a weighted mean method using the results of the corresponding differences of the linking institutes in the both comparisons CCM.P.K-7 and APMP.M.P-K7, from three linking institutes, NMIJ, PTB and NPLI, which participated into both comparisons CCM.P.K-7 and APMP.M.P-K7. The relative deviations of each participant from weighted mean values of obtained from linking institutes are found well within their expanded uncertainties at k=2.

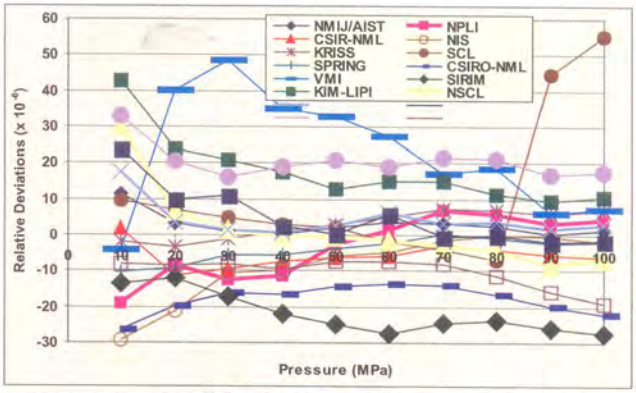


Fig. 1.7 Relative Deviations of (Ap) from reference value

Participation in Bilateral Comparison with NIST, USA

Participated in the bilateral key comparison with NIST, USA in the pressure ranges 40 to 80 MPa and 80 to 200 MPa using two NPL transfer standards namely NPL 100 MPN and NPL 500 MPN. The comparison was performed in both the institutes in three complete and identical pressure cycles in increasing and decreasing pressures using both TSs. The comparison data were analyzed in terms of the effective area [Ap (mm2)] as a function of pressure [p (MPa)] of the two transfer standards in the respective pressure ranges of (40 to 80) MPa and (80 to 200) MPa. The degree of equivalence between

NPLI and NIST is given as the relative difference in the institutes' results for effective area of the transfer standards, and is within 7.7×10^{-6} in the whole pressure range (40 to 200) MPa. This is substantial smaller than the standard uncertainty in the difference in effective area, which is estimated as 30×10^{-6} for NPLI-100 MPN and as 44×10^{-6} for NPLI – 500 MPN. The degree of equivalence is shown in Fig. 1.8 The relative difference ranges from 0.4×10^{-6} to 7.7×10^{-6}. The results of the present bilateral comparison also compared with the results of CCM.P-K7 in the overlapping range from 40 MPa to 100 MPa, and it is very interesting, they also agree well within the relative standard uncertainty. The results are being presented during forthcoming CCM International Conference on Pressure Metrology being held at Institute of Physics, London during April 19-21, 2005.

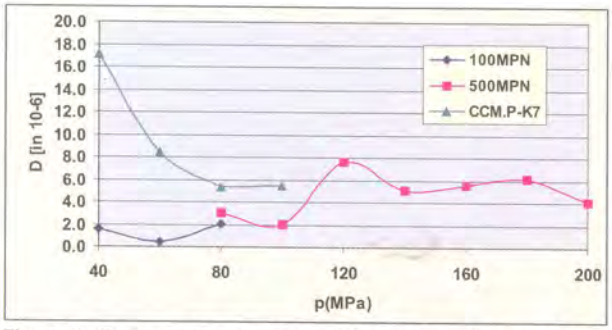


Fig. 1. 8: Degree of Equivalence (D) as a function of p(MPa) and DNIST-NPLI of CCM.P-K7 [40 MPa to 100 MPa] are shown for comparison

Coordination of NABL Sponsored Proficiency Testing in the Hydraulic Pressure Measurements up to 70 MPa

NPL, New Delhi has coordinated three NABL sponsored proficiency testing programs, namely NABL-Pressure-PT001, NABL-Pressure-PT002 and NABL-Pressure-PT003 in the pressure range 0 – 700 MPa using three different artifacts. The total number of 25 NABL accredited pressure laboratories form all over India participated in this program. The results of all the three PTs have been analyzed and detailed reports have already been submitted to NABL during the current financial year.

In the pneumatic pressure, bilateral inter comparison with NIST, USA was carried out for pneumatic pressures upto 4MPa, using our secondary standard NPL-4. The comparison was performed using three increasing and decreasing pressure cycles and effective area values analyzed. This secondary standard was used for inter-comparison with secondary standard NPL-8 at NPL.

High pressure Raman studies have been performed on Sm_2O_3 using Raman spectroscopy wherein the high pressure was generated using a diamond anvil cell. High pressure Raman studies were also performed on $LaSrMnFeO_3$ and the pressure induced changes studied, which along with Maussbaeur studies have given significant information on the behaviour of the system under application of pressure. Ambient Raman and XRD studies have also been performed on 14 samples of rare earth oxides e.g Sm_2O_3, Gd_2O_3, Y_2O_3, Pr_2O_3, Ce_2O_3, Ho_2O_3, Eu_2O_3, Yb_2O_3, Tm_2O_3, etc while Raman analysis was done for a number of other samples including carbon nano-tubes, Laser treated GaAs, CdTe, InN, c-BN thin films, c-BN compacts, etc. in collaboration with a number of Institutes as already mentioned above.

Acoustic Standards

Besides the normal activity of maintaining two primary standards viz. the standard of sound pressure and vibration amplitude and undertaking apex level calibration of secondary standards from Echelon II & III level calibration laboratories, the Acoustics Section undertook the following important assignments during the year.

APMP Regional Key Comparison (APMP.AUV.A-K1) of standard condenser microphones under the initiative of NMI, Japan in which two one inch B & K standard condenser microphones (Type 4160) were calibrated by absolute method on NPL reciprocity calibration system (B & K type 9699) in the frequency range 31.5 Hz to 8000 Hz using plane wave couplers. The results were in close agreement with the assigned sensitivity values with a standard deviation of ± 0.01 dB with an overall uncertainty of ± 0.1 dB @ k=2 and 95% confidence level.

Acoustic Evaluation of Ashoka and Durbar Halls of Rashtrapati Bhawan was undertaken to help the Expert Committee consisting of Prof. B.S. Ramakrishna, Sh. K.D. Pavate, Dr. V. Mohanan and Sh. R.K. Srivastava, constituted by DG, CSIR towards improving the listening conditions inside the halls where important functions are held. The evaluation

consisted of determining i) the background noise level ii) sound distribution iii) reverberation time etc. which are important to select an appropriate PA system for the hall.

Compliance Testing of DG sets were undertaken for various DG set manufacturers in the country as the maximum permissible sound pressure level for DG sets or less rated capacity up to 1000 KVA manufactured / imported after 1st Jan. 2005, shall be 75dB(A) @ 1m distance from the enclosure surface and all the DG sets should be provided with integral acoustic enclosures at the manufacturing site itself.

Compliance Testing of firecrackers were undertaken for CPCB, New Delhi to ascertain whether the noise levels produced by a variety of firecrackers manufactured in the country and procured from the local market are within the allowable limits of 125 dB(Al) or 145 dB(C)pk @ 4m distance from the point of bursting the crackers. NPL measurements had shown that the measured noise levels were well above the prescribed limits.

Developed a battery operated mobile sodar system for extensive field experiments aimed at the following

*Fog monitoring under NPL-ISRO collaborative studies.

*Multi institutional inter-comparison studies of ABL data.

*ABL studies in collaboration with IAF, New Delhi.

*Ambient air quality studies along highways over Delhi-Haryana-Punjab-Himachal Pradesh-Jammu Kashmir–Delhi sectors and Delhi-Lucknow corridor.

ABL studies in relation to bio-mass burning in Itanagar, Arunachal Pradesh (under ISRO-GPB sponsored project) and Inversion studies for carrying capacity of Teesta Basin in Gangtok (in collaboration with IIT, Delhi)

Fluid Flow Measurement Standards

Two digital pressure transducer (Make-WIKE) have been recalibrated and are found to have expanded uncertainty for coverage factor k = 2, as Q (0.5770 m bar 0.06% reading) and Q (0.5760 m bar 0.05% of reading) respectively. These pressure tranducers fitted in the domestic water test line have been used for pressure loss measurement at maximum flow rate (Qmax) and nominal flow rate (Qn).

Domestic water meters, class-B, size-15 mm, of different water meter manufacturers, have been tested for production routine tests. Some of the meters were found to be in conformity with the clauses laid down in the standard, IS-779. Seventeen number of test reports have been prepared and about Rs.1.03 lakh have been realized as test charges. Also another six domestic water meters, class-A, size-15 mm, have been tested for temperature suitability tests including routine tests before and after the suitability test. Analysis of the results is in progress.

A consultancy project entitled as "Augmentation of the water meter test facility at Aman Engineering Works (AEW), Jalandhar" has been taken up. The objectives and scope of the project are (i) to design the test facility for meter accuracy test, pressure loss test and pressure tightness test, (ii) preparation of the equipment list along with specification, (iii) supervision during fabrication and installation of the facility (fabrication will be done by AEW), (iv) preparation of the procedures for testing of the meters, (v) training to the staff for testing the water meters at the site. Engineering design work has been completed, detailed drawing along with the list of equipments and machinery handed over to AEW. Fabrication of the test benches is likely to commence soon at AEW. ECF of Rs. 3.93 lakh has been realized.

Document Manual of the section has been prepared and submitted. However, as the primary water flow test rigs are under repair, the peer review could be done at a later stage.

Ultrasonic Standards

The facility for the total ultrasonic power measurement has been augmented. It is now possible to measure power output of transducers upto a diameter of 30 mm as against 17 mm earlier. The measurement of change in weight has been computerized. This has also resulted in improvement of uncertainty from 2µg to 1µg. A new method has been developed for the measurement of acoustic impedance of liquids directly. This will allow simultaneous measurement of ultrasonic velocity and density.

Facility has been setup for the measurement of non-linear parameter in liquids. This will help in characterizing the underwater transducer at wider range of frequencies and power. A system has been developed for creating artificial rainfall. The amount and type of rainfall has also been measured by analyzing signal received by low frequency hydrophone.

While continuing the calibration of various ultrasonic items, such as, medical equipment (scanner), non-destructive test equipment (UFD, N3, FBH, probe, V1, V2, step wedge, thickness gauge), calibration of underwater hydrophones was also started.

Humidity Standards

This section maintain reference secondary standard (an aspirated psychrometer using two precise quartz thermometers) for calibrating RH instruments/ hygrometers, in the RH range of 15% to 95% with an uncertainty of ± 1% RH.

Thirty three hygrometers/RH measuring instruments (Analog and Digital type) were calibrated and calibration reports issued. An ECF of Rs 2.2 lakh was realized. In addition 74 digital RH and temperature remote Indicators were calibrated at five calibration points for other sections of NPL (with notional calibration charges of Rs 6.14 lakh).

Developed a simple and compact Dew Point/ RH generator, the product has been sold to M/s Belz Instruments Pvt. Ltd, Faridabad for Rs 49,500/=.

Two pressure and two temperature RH generator have been developed. The preliminary results are encouraging. Efforts are being made to improve the performance of this RH generator at par with international level.

R & D on Shock and Vibration Sensors

Piezoelectric Accelerometers

With the current trend of expanding technologies, more and more problems of dynamic nature are being encountered, as the scientist and engineers coping with extreme environments, strive for higher energy levels, higher speeds, lighter materials, faster, safer, quieter, and more efficient/reliable operations - automatically. To meet the current challenges in the critical field of vibration measurements, the team of experts working at the laboratory, for indigenous development of vibration sensors, continued its efforts for the gradual (evolutionary) development of newer sensors and technologies. The recent developments of the laboratory include a seismic accelerometer and an integrated circuit piezoelectric voltage mode accelerometer (ICVM), with built-in charge pre-amplifier. The seismic accelerometer is devised by adopting a novel approach of beam bending operation to achieve low frequency response and high sensitivity. Characteristic specifications of this accelerometer, type PL-1000, are given in the table below. Technological Process Know-Hows for commercial production of all of these low cost, high performance accelerometers are readily available from the laboratory. Owing to its low frequency response and high sensitivity to pick up sub milli g vibration levels, the configuration PL-1000 is most suitable for structural and ground vibration measurement applications, particularly in seismic measurements (seismographs). Laboratory tests and evaluations of this indigenous accelerometer have proved their superior quality. Based on this successful development, a seismic alert system, to avert colossal losses during major earthquakes, is under development at another CSIR laboratory, by employing PL-1000. The laboratory is also undertaking further the developmental work of the Tri-axial version of PL-1000.

With the advent of microelectronics in the past decades, modern accelerometers uses advance technology of in built hybrid circuit charge pre-amplifiers. These accelerometers realize their potential by features of high output sensitivity, high signal to noise ratio, and low impedance voltage mode out put which is directly compatible with measuring instruments. They are also capable to drive even less expensive long cables, without loss of sensitivity or increase in noise. Due to these additional advantages such accelerometers are now being widely used. However, the in-built hybrid circuits are proprietary trade secrets of individual manufacturers worldwide and hence they are not commercially available. Their development is also extremely expensive, tedious and time consuming. For a cost effective economic development, an attempt was made to develop an integrated circuit piezoelectric voltage mode (ICVM) accelerometer by using commercially available

MODEL No.	PL-810	PL-811	PL-900	PL-901	PL-812S	PL-1000
Weight	40 g	19.35 g	24.5 g	18 g	36 g	54 g
Sensitivity	22 mV/g	10 mV/g	15 mV/g	~5 mV/g	18 mV/g	98 mV/g
Resonance	39 kHz	46.8 kHz	32 kHz	>60 kHz	>50 kHz	>15 kHz
Freq. Range	10 Hz–15 kHz	20 Hz-20 kHz	10 Hz–10 kHz	1 Hz – 20 kHz	1 Hz – 18 kHz	0.1 Hz – 5 kHz
Linearity	0.1%	0.1%	0.47%	0.2%	0.5%	-
Max. Shock	3000 g	3000 g	3000 g	3000 g	5000 g	50 g
Dimensions	19 Hex X	14 Hex X	19Hex X	16Hex X	19Hex X	20Hex X
mm	23H	20H	21H	20H	20H	26H
Case Material	SS 316	SS 316	SS 316	SS 316	SS 316	SS 316

Piezoelectric Accelerometers Developed at NPL. Models PL-810, PL- 811, PL-900, PL-901, and PL-812S were developed in previous years.

components. A piezoelectric accelerometer is designed with a miniature PCB by using subminiature SMD components, and a commonly available charge preamplifier IC. The frequency response and amplitude characteristics of this circuit has been studied and found excellent for the purpose, under dynamic loading. Although by adopting this method the size of the final accelerometer is slightly bigger but soon it will be presented to the market, to suit many industrial applications, after its extensive tests and evaluations in shock vibration environments.

Dynamic Pressure Standards

To facilitate the calibration of dynamic piezoelectric pressure sensors, up to ballistic range (10 k bar), the laboratory is planning to establish the Dynamic Pressure Standards, a unique facility that does not exists in the country, so far. This will not only provide calibration standards for ballistic and other pressure sensors, but also allow to calibrate the metrological characteristics of static force and pressure transducers (hysteresis and linearity) and to determine their accuracy. The dynamic pressure phase will also allow to measure the response time of standard reference transducers and transducers under test. The dynamic calibration of pressure transducers requires that the measurand produced by the dynamic pressure generator vary in time in both known and appropriate manner. Towards the development of Dynamic Pressure Calibration Standards, the laboratory has developed a dynamic pressure calibration chamber. In this developmental effort a unique technique of sudden pressure release is devised to convert the high static pressure into a dynamic shock pressure pulse. The chamber has been tested satisfactorily up to a pressure of 1000 bar. Figs. 1.9,1.10 and 1.11 show photographs of the first prototype trial module of dynamic pressure calibration chamber set up in operation, developed at the laboratory.

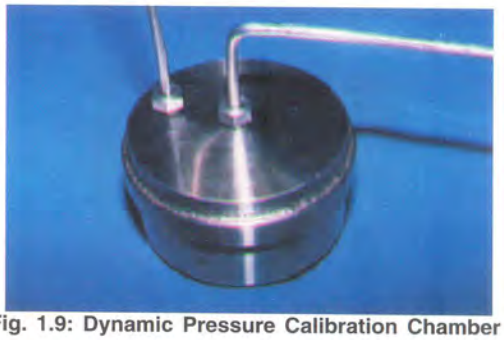


Fig. 1.9: Dynamic Pressure Calibration Chamber

Fig. 1.10 Dynamic Pressure Generation

Fig.1.11 Dynamic Pressure Calibrator in operation

Like previous years the group continued to provide its specialized scientific services to the Defence and other Govt. departments and to various industrial portions. The group has developed a unique in-house capability and expertise for taking up developmental work of advance nature in the field, for the development of specialize products and processes, to provide low cost, high value solutions for a particular application in mind. The group has already

served many reputed organization in the past and this year it has served the Defence Laboratory, RCI, Hyderabad, under a Grant-in-Aid project, funded by RCI, by providing them 15 units of accelerometers type PL-901 developed at NPL for their specific applications in missile research. It has also developed an accelerometer for ERDA, Vadodara, as per the specifications chartered by ERDA, under a project sponsored by them, and provided Test and Calibration services to a number of industries and other organizations.

Optical Measurements Standards

Optical components and Instruments are widely used in Research / Academic Institutions, and industry. These users need calibration and characterization of their Optical Instruments and Components. The Optical Measurements Standards Activity has been rendering services to the external as well as in-house users. Presently, samples of optical components such as Plane Mirrors of Cars, Glass Plates, Neutral Density Filters, Stage Micrometer, Glass Lens, Medical Microscope Objectives and Eyepieces, Quartz Control Plates etc. were calibrated and 25 Test Reports were issued. A few methods were also devised to calibrate the new parameters of the samples received from the industry. The users were advised and guided accordingly. Some R & D work was carried out in Optical Instrumentation to upgrade the existing facilities.

विद्युत तथा इलेक्ट्रॉनिक मानक

ELECTRICAL AND ELECTRONIC STANDARDS

ELECTRICAL AND ELECTRONIC STANDARDS

The mission of the Electrical & Electronic Standards Division is to maintain primary / secondary standards of various electrical, electronic and magnetic parameters. The division is actively involved in the International intercomparison organized by BIPM, APMP and bilateral comparison to establish international traceability and degree of equivalence. Under MoU between NPL and NABL, the division has co-ordinated various proficiency testing programmes.

Recently the division has established Vibrating Sample Magnetometer (VSM), a new facility to strengthen the activity in magnetic measurements and materials.

This year too, three sections, namely DC High Voltage, Time & Frequency and Quantum Hall Resistance Standards have successfully completed the International Peer Review.

विद्युत तथा इलेक्ट्रॉनिक मानक

इलेक्ट्रिकल एवं इलेक्ट्रॉनिक मानक प्रभाग का उद्देश्य विभिन्न इलेक्ट्रिकल एवं इलेक्ट्रॉनिक पैरामीटर्स को भौतिक/द्वितीय मानक को बनाए रखना है। यह डिवीजन BIMP, APMP द्वारा आयोजित अन्तरराष्ट्रीय अन्तर्तुलना और अन्तरराष्ट्रीय अनुमार्गणीयता व समानता की अवस्था स्थापित करने के लिए द्विपक्षीय तुलना (साम्य) में सक्रिय रूप से सम्मिलित है। एन.पी.एल. (NPL) और एन.ए.बी.एल. (NABL) के बीच MoU के अन्तर्गत इस प्रभाग ने विभिन्न दक्षता परीक्षण प्रोग्रामों को समन्वित किया है।

हाल में ही प्रभाग ने मैग्नैटिक पैरामीटर्स में गतिविधि को स ाक्त करने की एक नई दक्षता (कौशल) बाइब्रेटिंग सैम्पल मैग्नैटोमीटर (VSM) को प्रमाणित किया है।

इस वर्ष तीन अनुभागों तथा डी सी हाई वोल्टेज, टाइम एण्ड फ्रीक्वेंसी और क्वांटम हाल रेसिसटेंस स्टैण्डर्ड ने अन्तरराष्ट्रीय पीअर रिव्यू को सफलतापूर्वक पूरा किया है।

Time & Frequency Standards

NPL maintains Indian Standard Time with the help of Commercial Cs Atomic Clock. These clocks have been continuously traceable to BIPM through GPS network. The position co-ordinates of the antenna have been re-determined precisely with the help of NGRI Hyderabad. All cable-delays related to GPS-BIPM link have been recalibrated. These steps have reduced the noise in the link of UTC (NPLI) and BIPM. The development of a time scale based on ensemble of few Cs clocks is in progress.

According to the requirement of Quality System, the Time & Frequency Section has been reviewed by external peers successfully conforming to all requirements of Quality System. 11 CMCs have also been approved by the Experts Committee.

In addition to maintaining the Standard Time & Frequency Signal via INSAT (STFS) systems supplied to users throughout the country, STFS receiving systems have been installed recently at six North-Eastern states: Itanagar, Arunachal Pradesh, Guwahati, Assam, Shillong, Meghalaya, Kohima, Nagaland, Aizawl, Mizoram and Agartala, Tripura. Technical consultancy was also given on the STFS receiving to HAL, who are planning to use STFS for time synchronization of their Integrated Communication System to be delivered to Indian Air Force.

Time Service via telephone line has been commissioned in Nepal with the help of NPL developed equipments. Around 40 Teleclock receivers have been installed in eight north eastern states. The service via Telephone Line in NPL is gaining popularity and some developments to cope with the demand of the users have been made.

The design and development of the Laser cooled Cs Fountain frequency standard is in progress. Several parts for the optical setup of the Laser cooled Cesium Fountain Clock have been procured and the purchase of the remaining parts is in progress. The overall schematic of the optical setup has been finalized, out of which the frequency stabilization has already been achieved. Initial design of the microwave cavity for the fountain has been worked out and a prototype is being developed for testing. The design of the ultra-high vacuum chamber and the magnetic shields for the cooling and launching sections of the fountain has been finalized and the parts are being ordered. The design of the home-made assembly of the optical viewports has been tested and the octagonal cooling chamber has been tested for vacuum leaks together with few viewports. Generation of magnetic field with a linear gradient for the Magneto-Optic Trap (MOT) has been investigated by designing a set of anti-Helmholtz coils.

Work on Coherent Population Trapped (CPT) Rb standard has been initiated in collaboration with IISc Bangalore in November 2004. A prototype physics package consisting of Rb 85 absorption cell + 50 Torr Nitrogen, heaters, solenoid for DC magnetic field, magnetic shield and CPT absorption resonance signal detector is being developed.

Experimental and theoretical work was done on studies of spurs and PM noise in frequency dividers. This work leads to a better understanding of the PM noise in frequency synthesis related to Cs fountain research.

Collaborative work with PTB, Germany involved studies of prediction of time scales using external measurements such as Two-Way time transfer and GPS inter-comparison data. This work is related to the proposed timing service on the forthcoming European Galileo programme.

Self mixing effects in single mode diode lasers have been investigated and two distinct types of effects have been observed depending upon feedback conditions. Self-mixing interference fringes have also been observed, which could be utilized for measurement of displacement, velocity, flow, vibration etc.

Experiments with a polarimeter system with reflection grating as polarization converter indicated that the reflection grating could be effectively used as polarization converter as the polarization state and the intensity at a particular diffraction order depend upon the angle of incidence and the incident polarization.

Quantum Hall Resistance Standards & Superconducting Devices

Quantum Hall Resistance Standard

NPL maintains primary standard of dc resistance

based on integer quantum Hall effect that provides an invariable reference standard of resistance linked to the fundamental physical constants. The standard is used to calibrate a secondary 1 kΩ resistor regularly at different temperatures with combined expanded uncertainty (at coverage factor k = 2) of 0.08 ppm. International peer review as per ISO/IEC-17025 was successfully conducted by technical expert from PTB-Germany for one CMC relating to the calibration of 1 kΩ against QHR value by using room temperature direct current comparator bridge.

Microwave Characterization

Effects of dopants on low temperature microwave dielectric properties of $Ba(Zn_{1/3}Ta_{2/3})O_3$ was investigated in collaboration with Regional Research Laboratory (RRL) Trivandrum. The dopants used are 0.5 mol% Ti, Mn, Sb and In and 1mol% In, Zr and Ce. Microwave dielectric properties were studied using Hakki-Coleman configuration at cryogenic temperatures down to 20 K. The dielectric permittivity was found almost independent of temperature. With decrease in temperature, the loss tangent was found to decrease marginally and then increases at temperatures lower than 100 K. Increase in loss tangent at lower temperatures was found to be less for dopants with smaller ionic radii. The temperature coefficient of resonant frequency (τ_f) slowly decreased from positive value to negative value when temperature was lowered. Temperature for τ_f to become zero was found to vary for different dopant.

The microwave properties of ceramic dielectric resonators in a stack configuration were also investigated, in collaboration with RRL –Trivandrum, using two different dielectric materials with opposite temperature coefficients of resonant frequency. The two dielectrics, which have been studied, are $Ba_5Nb_4O_{15}$ and $5ZnO\text{-}Nb_2O_5$, synthesized by the conventional solid-state ceramic route. The temperature coefficient of resonant frequency of the stack resonator was tuned by varying the volume fraction of the materials used and found to approach zero at a certain temperature with appropriate ratio of the materials.

Low field magneto-transport in LBSMO-PMMA composite

The low field magneto-transport has been studied as a function of temperature in the range 77-300 K and magnetic field; H≤3.6 kOe for $La_{0.7}Ba_{0.2}Sr_{0.1}MnO_3$ (LBSMO)-x wt% PMMA composites where x = 0, 2, 6 and 10. The X-ray diffraction (XRD) study reveals that no structural modification has occurred in the LBSMO in the composite. Scanning electron microscopy (SEM) investigation shows PMMA getting dispersed through the sample volume and some LBSMO grains appear to be coated with the polymer. The metal-like transition observed at ~150 K in the virgin LBSMO sample disappears in the composite samples and the resistance shows an increase of about three orders of magnitude as the polymer concentration is increased to 10 wt%. Despite this huge increase in the resistance, the low field magneto-resistance (LFMR) shows an enhancement although smaller than the values commonly observed for other manganite-polymer composite systems. Spin polarized tunneling that causes LFMR seems to be enhanced in the composites. Fig. 2.1 shows the variation of LFMR with magnetic field at 77 K.

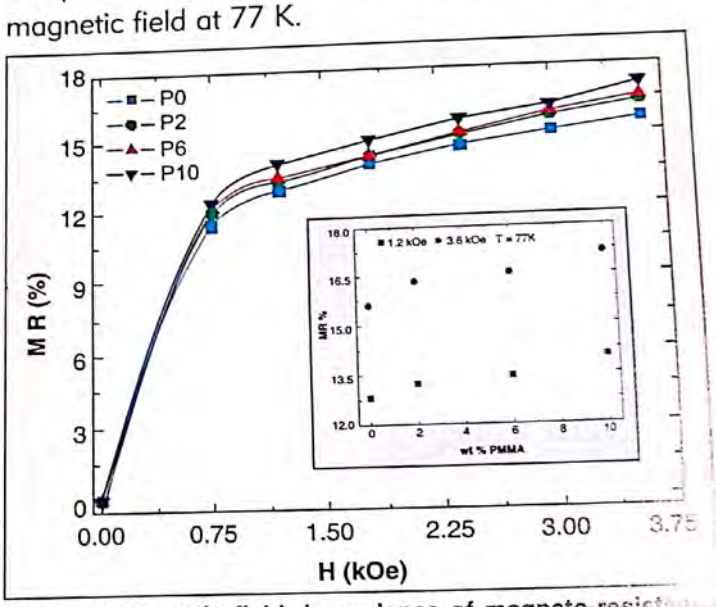
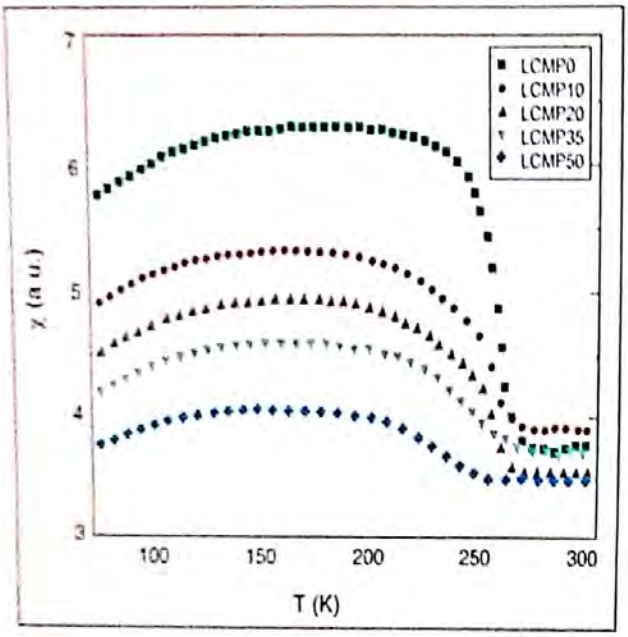


Figure2.1.Magnetic field dependence of magneto-resistance of LBSMO-PMMA composite samples measured at 77 K. The inset shows the variation of MR with PMMA concentration

Low field magneto-transport in $La_{0.7}Ca_{0.3}$... PMMA composites synthesized by poly... precursor route

A detailed investigation of the effect of PMM... the structure, microstructure and magneto-tran... properties of manganite $La_{0.7}Ca_{0.3}MnO_3$ (LCMO) ... been carried out. LCMO–PMMA nanostructure... composites have been synthesized by a unique polymeric sol-gel route, which leads to improved

solubility of PMMA in the LCMO matrix. The LCMO phase is grown in the presence of varying PMMA concentration at ~500 °C. This route yields single phase material and the grain size is observed to decrease slightly with increasing PMMA concentration. On increasing the PMMA concentration, T_c undergoes a small decrease (Fig. 2.2 a), resistivity is observed to increase by two orders of magnitude, with a concomitant large decrease in insulator to metal transition temperature(T_{IM}), e.g., from 218 K for virgin



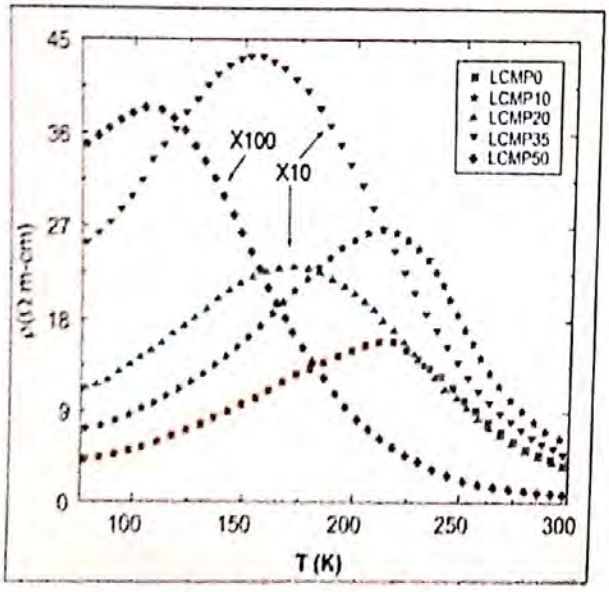


Fig. 2.2 a & b Temperature dependence of ac susceptibility and resistivity (at zero magnetic field) of $(LCMO)_{1-x}(PMMA)_x$ (x=0.0, 10, 20, 35, 50 wt%) composites.

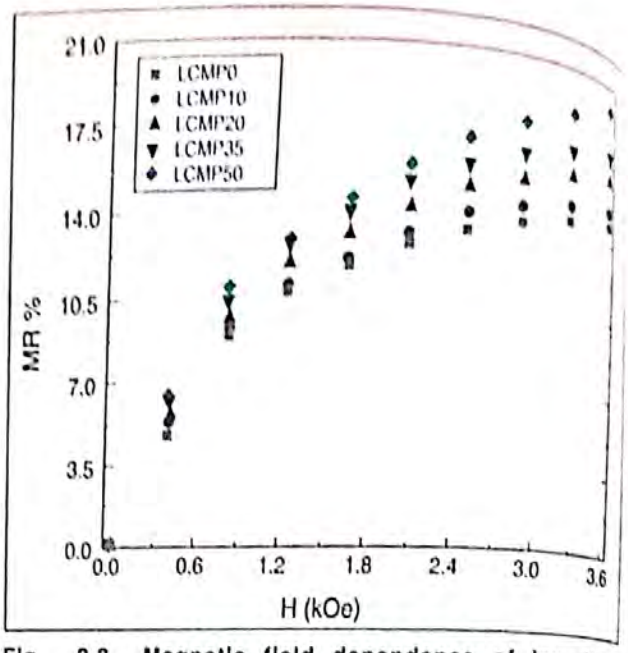


Fig. 2.3 Magnetic field dependence of low field magnetoresistance (MR %) of $(LCMO)_{1-x}(PMMA)_x$ (x=0.0, 10, 20, 35, 50 wt%) composites measured at 77 K.

LCMO to 108 K for 50 wt % PMMA admixed LCMO (Fig. 2.2 b). Low field magneto-resistance measured in the temperature range 77-300 K shows considerable enhancement as a function of the PMMA concentration. MR-H variation measured at 77 K is shown in Fig. 2.3. These phenomena are explained by taking into account the increased inter-granular disorder as a consequence of PMMA admixture.

Josephson Voltage and DC Current, Voltage & Resistance Standards

Josephson Voltage Standard

Josephson series array voltage standard is being maintained at 1 volt level. The 'National Standard' of volt is being calibrated at regular interval of six months against the Josephson Voltage Standard (JVS). The establishment of the Josephson series array voltage standard at 10 V level is at final stage.

DC Current, Voltage an Resistance Standards

National Standards of unit volt and ohm is maintained in the form of a bank of 1Ω resistors and bank of Zener standards. These are monitored and calibrated at regular intervals to maintain the traceability and to understand the drift (one component of uncertainty).

Apex level calibration services are being provided to various user organizations in the country to maintain the traceability chain in dc parameters. In-house calibration services were also provided to the

other standard divisions of the laboratory to maintain the traceability and implementation of quality system.

A high precision reference digital multimeter model Fluke 8508A has been installed to improve the measurement uncertainty and to extend the range. By this instrument, we can measure the resistance from 1Ω to 20GΩ and DC current from 1μA to 20 A.

The first phase of Proficiency Testing programs (under NPL-NABL) on DC Resistances (1Ω, 100Ω, 1kΩ and 10kΩ) has been completed and report submitted to NABL. There were 47 accreditated laboratories all over India, which took interest in this programme. In first phase there were 17 laboratories and in second phase 18 laboratories out of remaining, were selected based on their technical competence. The second phase of the programme is continuing and NPL is coordinating as reference laboratory in this programme.

DC High Voltage Standard

Established DC High Voltage Standard up to 100 kV, traceable to Josephson Voltage Standard, NPL, India. International peer-review for this activity was successfully completed in March, 2005.

Fig. 2.4 High voltage standard resistive divider

In India, this is one of the first calibration facility for HV sources, kV meters, probes & dividers up to 100 kV using this facility. The uncertainty of measurement is as follows:

Equipment	Range	Uncertainty
1. HV sources	1-100kV	50 ppm
2. HV probes/dividers	1-100kV	100 ppm
3. kV meters	1-100kV	100 ppm

For this activity there are three calibration & measurement capabilities (CMCs) on the BIPM Website. The HV divider, the primary standard of DC high voltage, is shown in Fig. 2.4.

AC Power & Energy Standards

The results of a Bilateral Comparison of Watt Converter C-1/2 for AC Power & Energy, between NPL, India and PTB, Germany are given in Table-2.1 and Table-2.2 and were compiled in March 2005. The values are in very close agreement and all the uncertainty bars of NPLI are overlapping over those of PTB Germany as shown in Fig. 2.5 & Fig. 2.6..

Measurement Results

Applied Range		Power factor	Relative errors in 10^{-6} for active power referred to apparent power		Uncertainties in 10^{-6} for active power referred to apparent power	
Voltage	Current	(Cosϕ)	PTB, Germany	NPL, India	PTB, Germany	NPL, India
120V	5.0A	1.0	-23.50	-9.70	25	76
120V	5.0A	0.5(lag)	-15.60	-11.55	25	72
120V	5.0A	0.5(lead)	-5.35	+12.30	25	72
120V	5.0A	0.25(lag)	-9.72	-11.45	25	71
120V	5.0A	0.25(lead)	+0.05	+8.44	25	71

Table-2.1 Bilateral Comparison of Watt Converter C-1/2 for AC Power.

Applied Range		Power factor	Relative errors in 10^{-6} for active power referred to apparent power		Uncertainties in 10^{-6} for active power referred to apparent power	
Voltage	Current	(Cosϕ)	PTB, Germany	NPL, India	PTB, Germany	NPL, India
120V	5.0A	1.0	-26.20	-16.90	30	76
120V	5.0A	0.5(lag)	-12.70	-7.57	30	72
120V	5.0A	0.5(lead)	-2.10	+15.25	30	72

Table-2.2 Bilateral Comparison of Watt Converter C-1/2 for Energy.

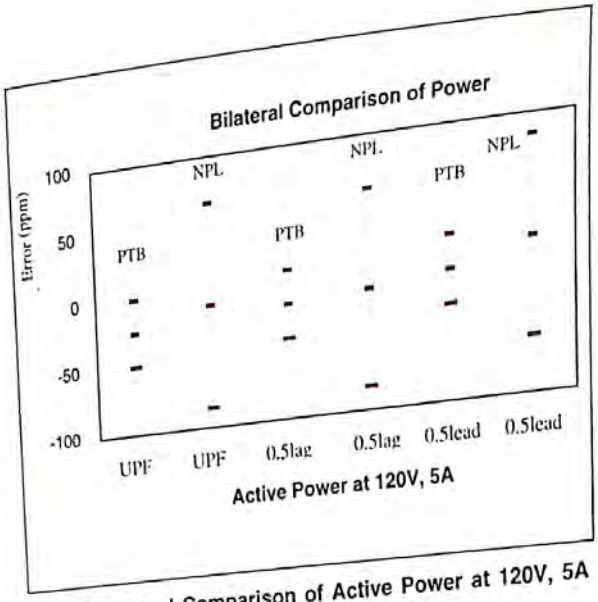


Fig.2.5 Bilateral Comparison of Active Power at 120V, 5A

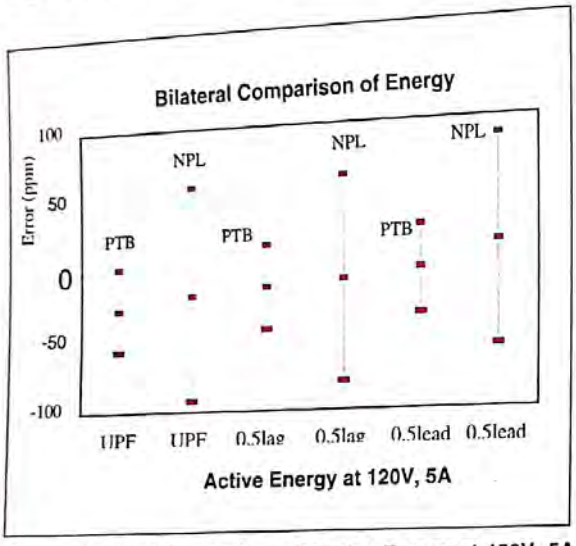


Fig. 2.6 Bilateral Comparison of Active Energy at 120V, 5A

AC High Current & High Voltage Standards

This section is maintaining National Standards of AC High Current and High Voltage Ratios at power frequencies (50Hz) by using Reference Standard Current Transformers and Reference Standard Voltage Transformers. Calibration services were provided for Current Transformers, Current Transformer Testing Sets, Clamp Meters, Weld Testers, CT Burdens and for Voltage Transformers, Voltage Transformer Testing Sets, HV Probes, Electrostatic Voltmeters (ESVMs), HV Breakdown Test Sets and Voltage Transformer Burdens etc. 28 calibration certificates were issued to the electrical manufacturers and utilities.

LF & HF Impedance Standards

This Group is maintaining primary standards of capacitance, Calculable Cross Capacitance, based on Lampard-Thompson theorem. The unit of inductance, Henry, is realized from capacitance using Maxwell-Wien Bridge. The unit of resistance, Ohm, is also realized from capacitance using Quadrature Bridge and other precision ac bridges. The ac voltage ratio is derived through absolute calibration of Inductive Voltage Dividers. This activity also provides apex level calibration for the above parameters at low and high frequency, to various calibration laboratories and R & D organizations.

Under the NPL-NABL MoU second proficiency testing in capacitance measurement for NABL accredited laboratories was conducted. In this programme 15 laboratories participated. This programme was conducted in two phases. First phase was initiated in January 2003 and completed in August 2003 while second phase started in September 2003 and finished in April 2004. NPLI acted as pilot and reference laboratory. A 10 pF air capacitor was used as traveling standard.

An automated setup was established to measur temperature coefficient of standard inductors. Th measurements are based on Transformer Rati Bridge, Unbalanced Voltage Measurement, an Substitution Technique.

This setup can also be used to determine the time to stabilize the value of inductor and study the behaviour of inductor with time.

LF & HF Voltage, Current & RF Power Standards

A Thermocouple Power Sensor of Rohde and Schwarz make has been investigated as RF-DC Voltage Transfer Standard for Precise Measurement of RF Voltage. This Thermocouple Power Sensor, which is based on a 'Novel' design, for RF power measurement in DC to 18 GHz has been established as a RF-DC voltage transfer standard for precise measurement of high frequency voltage up to frequencies of 1 GHz. This power sensor has been found to be better in performance as RF-DC transfer standard in comparison to, a well characterized, high frequency thermal voltage converter. This new RF-DC voltage transfer standard can, therefore, be used to calibrate other RF-DC transfer standard and other RF voltage measuring standards.

As per the BIPM-MRA requirement we have participated in BIPM Key Comparison 'CCEM K6.c'. BIPM had provisionally accepted the results of this comparison in Key Comparison Data Base (KCDB) subject to final approval of its report by JCRB. In January 2005, JCRB has accepted the final report of this Key Comparison and our results have been accepted for establishment of formal Equivalence of our ac-dc transfer standards in the frequency range 1 MHz to 100 MHz. The degree of equivalence of our standards and the automated measurement set up used in the comparison are shown in Fig. 2.7 and 2.8 respectively.

Frequency range of RF power measurement has been extended to 26 GHz from 18 GHz with traceability to PTB, Germany. RF Power level measurement range has also been extended to 30 watts from existing 100 mW in the frequency range 1MHz to 1000 MHz.

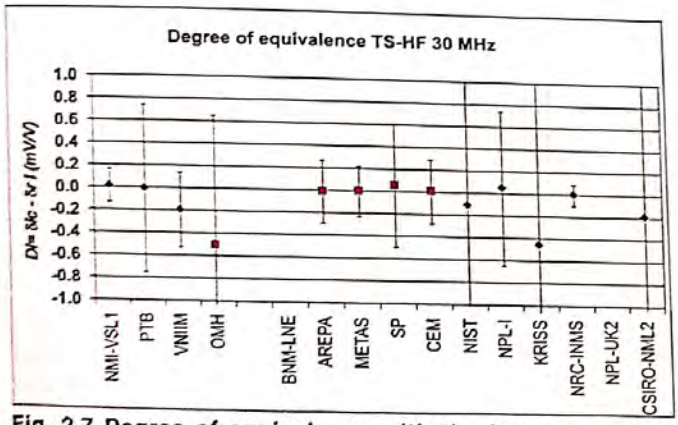


Fig. 2.7 Degree of equivalence with the key comparison reference value at 30 MHz with the corresponding expanded uncertainties (k=2). (blue diamonds: included in the KCRV; red squares: not included in the KCRV)

Fig. 2.8 Automated set up for comparison of high frequency thermal voltage converters used in intercomparison

RF Attenuation & Impedance Standards

The traceability in attenuation measurement has been established after the re-calibration of Primary standard 30 MHz WBCO attenuator from NMI, Australia to maintain five CMC entries in the Appendix C of MRA. The calibration facilities established in attenuation and impedance parameters are being used for the calibration of transfer standards of attenuation and impedance of various user organizations e.g. AMSE Air Force, Palam, ERTLs/ ETDCs, BEL, ISRO, Naval Dockyard etc.

Magnetic Standards

Vibrating Sample Magnetometer (VSM) system, a new facility as shown in Fig. 2.9 has been established in June 2004 for industrial use and R & D work in the area of magnetic materials. The VSM system has been optimized using standard Ni reference sample traceable to NIST, USA. A typical M-H curve for Ni standard is shown in Fig. 2.10.

R & D work on conducting polymer has been

Fig. 2.9 Photograph of the VSM facility established at NPL

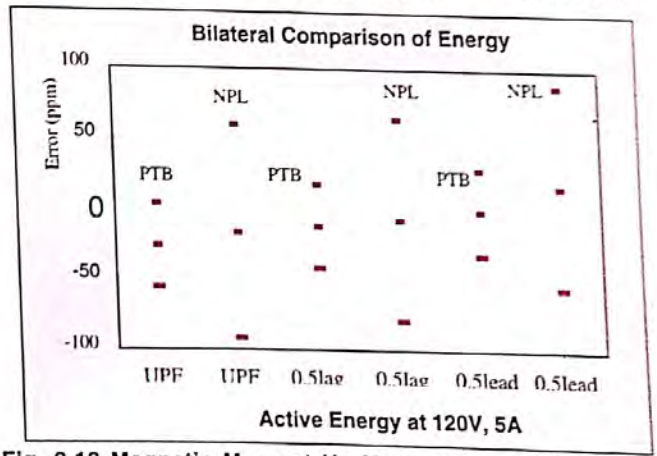


Fig. 2.10 Magnetic Moment Vs Magnetizing field curve for standard nickel reference sample

carried out on the behaviour of ferromagnetic dopants in polyaniline polymers matrix for electromagnetic interference (EMI) shielding.

Biomedical Measurements and Standards

Research on the bio-piezo-composites for sensor applications was undertaken in collaboration with FAU-Erlangen University, Germany. Study of electrical, ultrasonic, and physical characteristics of teeth and other bio-materials was continued, to develop 'safety standards'. The development and establishment of standards and calibration facilities for electro-medical equipment was continued, for better health care in the country. Study of biochips and associated sensors was also carried out.

New Piezo-Composites for Sensors Applications (in collaboration with Germany)

A new programme on piezo-composite based sensors for biomedical and scientific applications has been initiated between NPL and FAU, Erlangen, Germany.

The conventional piezoelectric ceramic materials (PZT in this case,) have been combined with piezoelectrically passive polymers in a variety of geometrical configurations to improve transducer performance and to tailor the effective electromechanical properties for a specific application. Such Piezocomposite materials have been developed and characterised for various parameters, to achieve better acoustic impedance match with the tissue. The transducer surface reflects back incident energy to a lesser extent, resulting in reduced reverberations in the near field. Piezocomposites facilitate better electromechanical coupling constant. This has allowed more control over the trade-off between the sensitivity and the bandwidth.

The novel transducers (0.5 to 5 MHz) have been developed and evaluated for parameters like power output, beam profile and behaviour in terms of frequency v/s dielectric properties. Although the current work is focused on the piezocomposite transducers operating at low-frequency, the research results and conceptual understanding will have importance for optimizing the design of piezocomposites in other applications viz. non-destructive testing, underwater sonar and biomedical imaging as well.

Study of Biochips

The study of 'biochips' was pursued further by choosing different biological materials like bone, proteins and physiological liquids. Conventional semiconductor devices by loading them with biological material have also been studied.

Basic Tissue Research

The research on ultrasonic, acoustic, electric l, thermal, dielectric and electro-optical parameters h s been extended further on new biological tissues ar l materials media. IR and XRD studies on the kidn stones have been completed.

Evaluation of Coating Materials for the Preservatio of Ancient Monuments

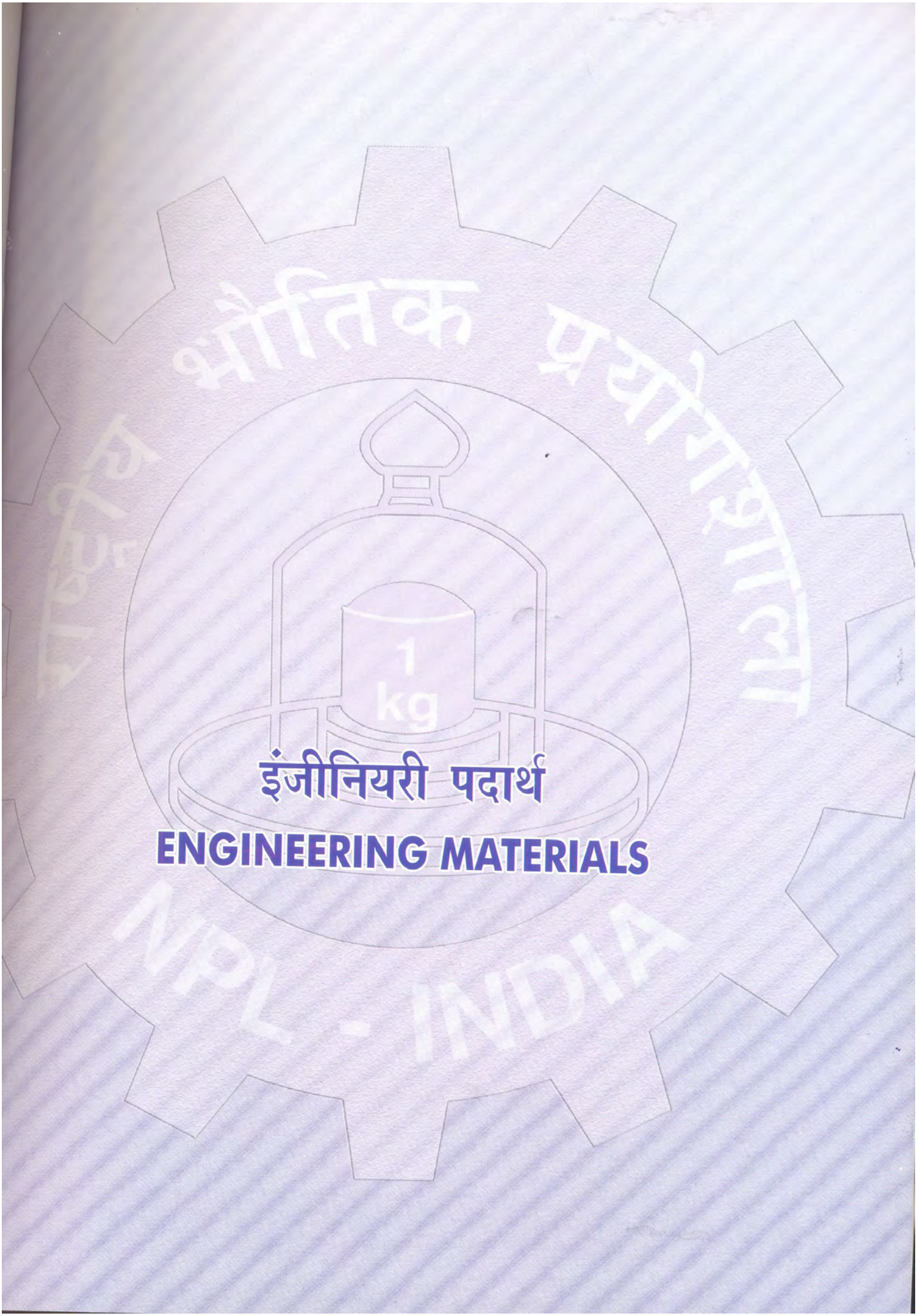
The study of different types of coating material on the exposed walls of the ancient monuments wa continued, to protect them from weather condition and to maintain their originality for longer period.

Cancer Hyperthermia

Thermal profile in the brain tumour has been modelled and studied under different conditions of cancer therapy with focussed ultrasound.

IT and Electronics Activity: New Group

Director, NPL, has formulated a new Group of IT and Electronics, as general facility to design and develop hardware and software systems for different projects in the Laboratory. Senior scientists from CEERI-Delhi Centre have been inducted.



इंजीनियरी पदार्थ

ENGINEERING MATERIALS

इंजीनियरी पदार्थ

इंजीनियरिंग पदार्थ प्रभाग के अन्तर्गत मुख्यतः धातु एवं मिश्र धातु, एडवांस्ड कार्बन - कार्बन उत्पाद, पालीमरिक एवं मृदु पदार्थ व तरल क्रिस्ट ग्रुपस् आते हैं। इस प्रभाग का मुख्य उद्देश्य उपरोक्त क्षेत्रों में पदार्थों, घटकों, के लिए प्रक्रिया और प्रौद्योगिकी, डिवाइसेज और प्रणाली को विकसि करना है। प्रभाग के आर एण्ड डी आऊटपुट में एयरोस्पेस धात्विक पदार्थों, कम्पोजिट्स, एण्वांस्ड कार्बन उत्पाद, तरल क्रिस्टल, चालक पॉलिमर्स, आप इलेक्ट्रॉनिक डिवाइसेज, आर्गेनिक प्रकाश उत्सर्जक डायोड्स, सैंसर्स, स्वास्थ्य देखभाल डिवाइसेज आदि का विकास शामिल है। इन पदार्थों का अनुप्रयो सामरिक एवं औद्योगिकी अनुप्रयोगों में होता है। उदाहरणार्थ जनरल मोटर्स ने ऑटोमोबाइल अनुप्रयोगों के लिए मिश्रधातु के उत्सारण प्रौद्योगिकी के विकास पर एन.पी.एल. को एक सहयोगी परियोजना को प्रायोजित किया है। इसी प्रकार भविष्य के लिए रिलायंस इंडस्ट्रीज, राणे ग्रुप ऑफ इंडस्ट्रीज के साथ औद्योगिकी अनुबंध पर विचार किया जा रहा है।

बहुत सी अन्य विकास परियोजनाएं जैसे सी एस आई आर नेटवर्क, स्पांसर्ड, ग्रांट-इन-एड, कोलेबोरेटिव एवं कंस्टलटेंसी विभिन्न आर एण्ड डी संस्थानों सार्वजनिक एवं निजी क्षेत्रों के साथ सफलतापूर्वक लागू की/पूरी की जा रही हैं।

ENGINEERING MATERIALS

The Division of Engineering Materials mainly comprises of Metals & Alloys, Advanced Carbon Products, Polymeric & Soft Materials and Liquid Crystal groups. The objective of the division is to develop materials, processes and technologies for components, devices and systems in the above mentioned areas. The R & D output of the division includes the development of aerospace metallic materials, composites, advanced carbon products, liquid crystals, conducting polymers, optoelectronic devices, organic light emitting diodes, sensors, health care devices etc. These materials find application in strategic and industrial applications; for example, General Motors have sponsored a collaborative project to NPL on the development of extrusion technology of Mg alloys for automobile applications. More such industrial linkages such as Reliance Industries, Rane Group of Industries are envisaged for future.

Several development projects such as CSIR network, sponsored, grant-in-aid, collaborative and consultancy are successfully being implemented/completed for different R & D organizations, both in the public and private sectors.

Metals & Alloys

Development of different grades of Magnesium and Aluminum light weight alloys and their composites

The work was concentrated during the year in developing light weight Magnesium and Aluminum alloys and their composites to evaluate their applications for aerospace and automobile industries. The work on a project sponsored by General Motors was initiated this year to develop extrusion technology for Mg-alloys. Under the VSSC sponsored project on spray forming technology of Mg-alloys with Yttrium and Zinc as alloying additives, spray forming process parameters were optimized. These spray formed alloys were characterized for their microstructural and mechanical properties. Work was also initiated on the CSIR Network project on Aerospace Materials with revised objectives of synthesizing Mg-alloy AZ31 (Mg-3Al-1Zn) using spray atomization and deposition technique followed by secondary processing using extrusion. The aim of this project is to obtain dense spray-formed deposits of Mg-alloy AZ31 in conical shapes with fine equiaxed microstructure and meeting the specified target mechanical properties. Work was also started to explore the study of Al & Mg alloys using equal channel angular pressing, to severely plastically deform the material to obtain refined and submicron size microstructure.

Magnesium Alloys

General Motors sponsored project entitled "Development of Extjrusion Technology of Mg-alloys"

This project is being undertaken under an MoU signed between General Motors (USA) and NPL. The main objective of this project is to study the extrusion characteristics of different Mg-alloys and to optimize various extrusion processing parameters like temperature, strain rate, die design, extrusion ratio and lubrication to develop concentric extruded tubes with excellent surface finish. Different compositions of Mg-alloys and two types of die assemblies were used for conducting the extrusion experiments and the extruded tubes were thoroughly characterized for their microstructural features and mechanical properties.

Several experiments were conducted to develop Mg-alloys tubes employing extrusion process using a 500-ton vertical hydraulic press. Mg-alloy of three compositions were initially taken up for extrusion studies viz. AM 30 (Mg-Al-Mn) and AZ30 (Mg-Al-Zn) & Mg-Al-Ce. Two types of die assemblies were used for extrusion experiments – one was the port-hole die, which is a die generally used for industrial production and other a dish shaped die, which was designed and got fabricated at NPL. Circular tubes were successfully developed for both compositions of Mg-alloys using hot extrusion technology and employing both types of dies. The as-extruded tubes were perfectly concentric with excellent surface finish for both the feed alloys, AM 30 & AZ30 and employing both types of die assemblies.

The as-extruded tubes were thoroughly characterized for their microstructure and mechanical properties. These characterization results on the as-extruded Mg-alloy tubes indicated that on using the port-hole die for extrusion, the extruded tubes exhibit a reasonably uniform microstructure, both in

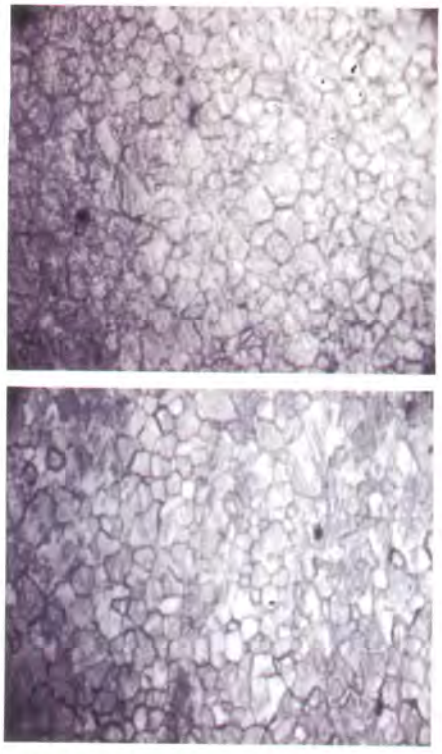


Fig 3.1 Microstructure of Mg – alloy tubes extruded using port-hole die (X500) (a) transverse direction and (b) longitudinal direction

longitudinal and transverse directions, giving a UTS of 235 MPa with an average elongation of 5.5%. However, Mg-alloy tubes extruded using the dish-shaped die also exhibit a uniform microstructure in both longitudinal and transverse direction (Fig 3.1), but exhibit an average UTS of 232 MPa with 8.5% elongation. This indicated that, although, the port-hole die is more industrially common but our investigation shows that the Mg-alloy tubes extruded using conventional dish-shaped die gives comparable result.

Vikram Sarabhai Space Centre (VSSC) sponsored project on "Spray forming technology of Mg-alloys"

Work was continued in this on-going project on spray atomization and deposition of Mg-alloy with Yttrium and Zinc as alloying element. Several compositions of these Mg-alloys, viz. WZ155 (Mg-15Y-5Zn), WZ55 (Mg-5Y-5Zn), WZ103 (Mg-10Y-3Zn) and WZ103+0.5Zr, were taken up for spray forming experiments. Various process parameters, such as, melt temperature, flight distance, delivery tube dimensions, gas to melt ratio, substrate motion, for all these different alloys were optimized to spray form these alloys in nearly flat shapes. In all the cases it was found that the spray forming yields were in the range of 55-65 % and density of the spray formed deposits was found to be 93-95% of the theoretical density, depending on the composition and processing parameters. The microstructure for all the spray-formed alloy compositions revealed equiaxed features with grain size in the range of 30-90 microns in the core of the deposit. The mechanical properties of the spray formed Mg-alloy deposits (with Yttrium and Zinc as additives) indicated the UTS to be 195-229 MPa with elongation 5-10%. These properties are further expected to improve after secondary processing. The Youngs modulus, measured using the elasto-sonic technique, exhibited values in the range of 42-46 GPa. These properties are meeting the target properties, as laid down by VSSC in this project. Spray forming experiments are presently being carried out under the last phase of this work to consistently get reproducible microstructural and mechanical properties in the spray formed deposits.

CSIR Network project on Specialized Aerospace Materials entitled, "Synthesis of Mg alloys using rapid solidification and employing spray forming followed by secondary processing"

This CSIR Network project, which commenced this year, has the main revised objective to synthesize Mg-alloy AZ31 employing spray forming followed by hot extrusion to obtain good spray yields, near theoretical density, equiaxed microstructure with improved mechanical properties in the spray-formed alloys. The target mechanical properties of the extruded product are : UTS : 300 MPa; YS : 250 MPa and elongation : 10%.

Under this project a few experiments were made to spray deposit Mg-alloy AZ31 on the existing spray atomization and deposition unit using about 2 kgs of alloy. Initial results indicate that this alloy has been successfully spray formed in shape of a conical deposit. Several precautions were taken while undertaking these spray-forming experiments due to the extremely reactive and pyrophoric nature of Mg-alloys. The X-ray diffraction results indicate no presence of the MgO phase in the spray formed deposit,suggesting thereby that the precautions taken while spray forming of Mg-alloys have avoided the formation of MgO phase in the spray formed Mg-alloy deposit. The microstructural results on the spray formed deposits after etching indicated equiaxed microstructure with grain size in the range of 5-25 micron, (Fig.3.2) with porosity of about 2%. Work is presently underway to make spray forming experiments to study the repeatability of these results and to further optimize various processing parameters

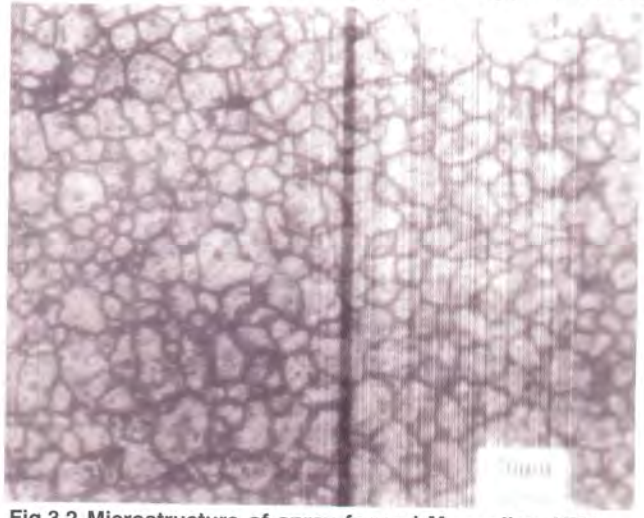


Fig.3.2 Microstructure of spray formed Mg – alloy AZ32

to achieve homogeneous microstructure throughout the spray formed deposit with low grain size and minimal porosity in the spray formed products.

Secondary Processing of alloys using Equal Channel Angular Pressing

Exploratory work was carried out this year on the study of Equal Channel Angular Pressing (ECAP) of Al & Mg-alloys using 90° angular die. In order to study the forming characteristics in ECAP technique, specially designed die made out of Perspex was first employed and plastercine was used to study the flow characteristics in severe plastic deformation. Later the deformation of lead was studied by extruding it through a mild steel die. After studying the forming characteristics using these dies, it is now intended to use actual material of Al and later Mg-alloy using the actual die, which is under fabrication. The final aim is to obtain bulk metallic alloy rods with particle size in the sub-micron range. Efforts are presently underway to modify the ECAP die assembly so as to increase the number of passes to have severe plastic deformation leading to further refinement of microstructure of the product.

Aluminum Alloys & their composites

The synthesis of Al-alloys ($Al_{12}Si_{0.4}Fe$) employing spray atomization & deposition technique was undertaken in order to optimize the processing parameters to obtain equiaxed microstructure with low grain size and minimal porosity. Work was also initiated to synthesize functionally gradient metal matrix composites using Al-alloy 2124 (Al-Cu-Mg) as matrix material reinforced with ceramic SiCp and employing stir-casting at high churning speeds.

In-house project on "Spray atomization of Al-Si alloys"

Work was continued on this in-house project this year. Several experiments were conducted to spray deposit $Al_{12}Si_{0.4}Fe$ alloys employing the spray atomization and deposition unit by depositing the atomized melt droplets on a rotating water-cooled copper substrate, in order to optimize various process parameters to spray form Al-Si alloys with equiaxed microstructure with low porosity. The microstructural characterization results after etching indicated that the mother alloy, used for spray forming, exhibited eutectic microstructure with needle shaped Si embedded in the Al-matrix. However, after optimizing the various spray forming process parameters, an equiaxed morphology of Al-matrix grains is observed with an average grain size of ~ 20-25 μm with nearly uniformly distributed Si particles surrounding the Al-matrix particles having average size of ~ submicron to 3 μm. The particulate-like morphology of Si is attributed to the high cooling rates associated with rapid solidification process. These fine sizes of Si particles in Al matrix obtained in this work are at par with the best reported in the literature and would considerably enhance the mechanical and tribological properties significantly. The average spray forming yield was found to be ~ 70% with a porosity level of about 7% in the core of the deposit, which can be eliminated after secondary processing.

Synthesis of one dimensional functionally gradient Al-alloy/SiCp MMC

Exploratory work was initiated this year to synthesize functionally gradient metal matrix composite (MMC) material using 2124Al-alloy as the matrix material reinforced with SiCp (28 micron) using stir-casting technique and employing high stirring speeds (upto 400 rpm). The functionally gradient material MMC billets were cast using bottom pouring arrangement. The as-cast billets were characterized for their density/porosity, volume fraction of reinforcement, microhardness and microstructure along the direction of deposition. The results indicate reasonable gradient in reinforcement SiCp along the length of deposition in the as cast MMC billets which leads to similar gradient in the microhardness along the direction of deposition. The characterization results also indicated a decrease in density with increasing distance from the base of the MMC ingot, which is primarily due to an increase in porosity as a function of corresponding distance. Presently work is underway to study the effect of speed of churner rotation and SiCp reinforcement particle size on the gradient of reinforcement in the as-cast MMC billets. Also a new modified process of synthesizing functionally gradient MMC namely, gradient slurry disintegration & deposition technique, is in process of being set up so that a more steep & controlled gradient in properties is obtained in the MMC billet

along the direction of deposition, due to disintegration of melt by gas jets using gas atomizer, resulting in rapid cooling of the melt.

Synthesis of Boron Nitride nanotubes

Boron nitride nanotubes are superior to carbon nanotubes in some respects as they have a wider bandgap and can withstand higher temperature upto 1000 °C. The exploratory work on the synthesis of boron nitride nanotubes was carried out this year. In this work hexagonal boron nitride was ball milled at 300 rpm on a high energy ball mill for a period of 50-100 hours. The ball milled powder is then annealed

Fig.3.3 Transmission electron micrographs of boron nitride nano tubes

at 1300°C in N_2 atmosphere for a period of 5 hours. The initial characterization results (Fig.3.3) indicate the growth of boron nitride nanotubes, as evidenced by X-ray diffraction, TEM and FTIR results.

Advanced Carbon Products

Carbon-Ceramic Composites

Carbon based materials have many potential applications in aerospace, defence, sports and medicine fields because they possess many unique properties. The use of these carbon materials for high temperature applications is limited due to their susceptibility to oxidation in air at temperature as low as 400 °C. Efforts have been made to inhibit the oxidation of carbon material by incorporation of ceramic materials such as silicon carbide and boron carbide into coal-tar pitch based green coke developed in-house. The C-SiC-B_4C composites, developed at 1400 °C, have shown high oxidation resistance at temperatures of 800–1200 °C when a total ceramic content of 66.7% coupled with SiC : B_4C ratio of 50 : 50 is used. Besides this, a lower value of overall ceramic content (53.8%), accompanied with SiC : B_4C of 60 : 40 / 66.7 : 33.3, or 60 : 40 is also found to be good for application temperatures of 800 °C or 1200 °C, respectively. The composite heat-treated to 2200 °C have been found to be more resistance to air oxidation in comparison to those heat-treated to 1400 °C.

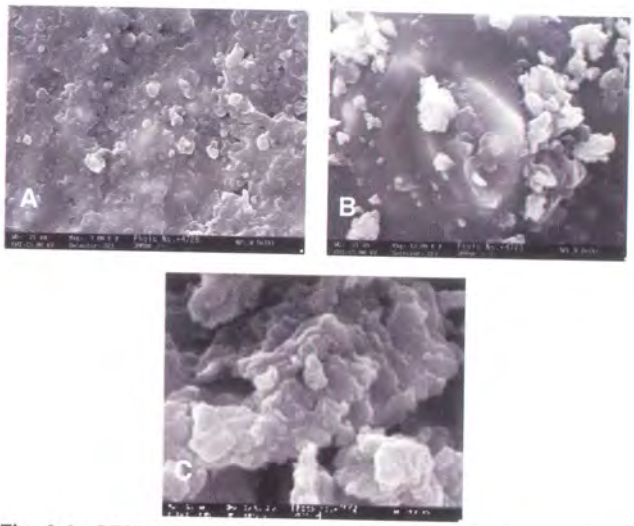


Fig. 3.4 SEM photographs of carbon-ceramic composites oxidised for 10h at (A) 800 °C (B) 1000 °C (C) 1200 °C

Carbon-ceramic composites (C-SiC-B_4C) have also been developed through in-situ formation of silicon carbide by mixing coal-tar based green coke, silicon carbide (SiC) forming precursor and boron carbide (B_4C) and heat-treatment to 2200 °C in an inert atmosphere and characterized for their physical, mechanical and oxidation resistance properties. The composition of carbon-ceramic composites which could withstand oxidation at 800–1200 °C for about 10 hours in air have been identified. The formation of protective coatings during oxidation of the composites was confirmed by using SEM (Fig.3.4), X-ray, EDX and porosity measurement studies.

Silicon Carbide Nanofibres

Silicon carbide nanofibres have been synthesized using tetraethylorthosilicate (TEOS) / methyltriethoxyorthosilicate(MTEOS) as silicon source and polycarbonate (PC) as carbon source. TEOS / MTEOS were hydrolysed to get silica sol and blended with PC dissolved in an organic solvent to obtain silica incorporated polymer which served as SiC precursor.

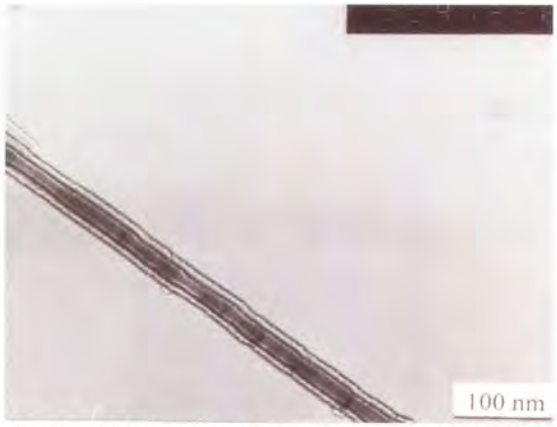


Fig.3.5 TEM of SiC nanofibres synthesized from PC + MTEOS derived silica

The SiC precursor thus prepared on heat treatment at 1400°C in argon gas yielded SiC nanofibres as seen by TEM (Fig.3.5) The morphology of SiC nanofibres synthesized from PC+TEOS derived SiO_2 was found to be different from that of SiC nanofibres synthesized from PC + MTEOS derived SiO_2 which was attributed to methyl group linked to Si atom in MTEOS. Work is continuing to develop SiC nanomaterials from polymer blend and disubstituted silicon alkoxides.

Low PAH Coal Tar Pitch

Extensive R & D work was carried out on the development of a coal tar pitch with a reduced content of polycyclic aromatic hydrocarbons (PAH), especially Benzo(a)pyrene [B(a)P], a known carcinogen, under a project sponsored by the Ministry of Environment and Forests, New Delhi. Distillation of coal tar pitch under partial vacuum and solvent extraction techniques were employed for the reduction of B(a)P. Two industrial solvents identified for solvent extraction were found to be capable of reducing B(a)P content in both binder grade as well as impregnating grade coal tar pitches to a value of 0.35% from original value of 0.90%. The resultant pitches were obtained in high yields of ~80%. The distillation of coal tar pitches under reduced pressure of 2 cm of Hg also led to decrease in B(a)P value to 0.36%, which was desired in the sponsored project. The project has since been successfully completed.

Development of High Thermal Conductivity Carbon Materials

The high thermal conductivity carbon materials, namely, special graphite and carbon-carbon composites envisaged to be developed under the special project sanctioned by the CSIR in lieu of NPL winning the 1999 CSIR Process Technology Shield.

Special graphite

The special graphite to be developed is to have a thermal conductivity of 90–120 W/mK, besides a bulk density of ≥1.80 g cm^{-3}, bending strength of ≥40 MPa , Young's modulus of 8–12 GPa, Shore hardness of 50–75, electrical resistivity of 1.0–2.5 mΩcm, etc. To develop this graphite, the green coke method of high density - isotropic graphite was made the basis. Two different natural graphites (I&II) were procured, ground into fine powders and characterised w.r.t. several parameters, particularly the ash content, which was brought down to ~0.5% in both the cases by suitable chemical treatments.

Work was carried out to produce the desired graphite by the addition of these two natural graphites in different proportions to a suitable green coke prepared in-house. The uniaxially-pressed plates (size 60 mm x 20 mm x 4mm) and isostatically-pressed moulds (35mm dia. x 40 mm ht.) were heat-treated to 1000°C and 1400°C, respectively, and characterised for various properties. The electrical resistivity of the resulting carbons is found to decrease with the addition of 0–30% of natural graphite –I / II from average of 4.2 mΩcm at a HTT of 1000 °C to 1.8-1.9 mΩcm and from 2.5 mΩcm at a HTT of 1400°C to 1.4–1.5 mΩcm in the resulting plates. Since the thermal conductivity is inversely proportional to the electrical resistivity, the thermal conductivity is expected to go on increasing with the increasing addition of natural graphite in the green coke. Isostatically prepared blocks show an increase in baked density from 1.65 to 1.72 g cm^{-3} at 1000 °C and from 1.79 to 1.81 g cm^{-3} at 1400 °C with the addition of the two types of natural graphite. Further work towards increasing the HTT of the plates / blocks to 2500 °C or higher, is in progress, which is expected to cause a further reduction in the electrical resistivity or a further enhancement in the thermal conductivity.

Carbon-carbon composites

The C-C composites to be developed are to have a bulk density of 1.7 g cm^{-3}, compressive strength of 150–200 MPa and a thermal conductivity of 100-150 W/mK. To develop such composites, PAN based

T-300 carbon fibres (as available, heat-treated to 1400 °C and 2400 °C) were used along with a special pitch produced in-house for carbon-carbon composites of size 150 mm x 150 mm x 5 mm. A density of 1.45–1.48 g cm^{-3} of composites was achieved in these composites after carbonisation to 1000°C and two successive impregnation–carbonisation steps. The carbon composite samples prepared in autoclave at 600 °C, showed a bulk density of 1.47g cm^{-3} on carbonisation and one impregnation. C-C composites of size 15 mm x 15 mm x 3 mm using chopped high thermal conductivity pitch based carbon fibres (dialed type) were also prepared using the in-house prepared pitch as well as commercially available mesophase pitch. The in-house prepared pitch gave a density of 1.41–1.53 g cm^{-3} after carbonisation and two impregnations whereas those prepared with a mesophase pitch gave a density of 1.39–1.51 g cm^{-3} after carbonisation and one impregnation. Further work is in progress to achieve high density and high thermal conductivity in the C-C composites.

Under the CSIR network project, entitled "Development of high thermal conductivity C-C composites for thermal management", UD and 2D C-C composites (25 mm x 25 mm x 3 mm size) were prepared from Pitch based carbon fibres with mesophase pitch as carbon matrix. The two types of pitch fibres used as reinforcement possess different value of thermal conductivity i.e. P120 fibre (T.C. 640 W/mK) and Dialed K1310 carbon fibre (T.C. 140 W/mK). The variation in bulk density and electrical resistivity of composites at different stages of processing is shown in Fig. 3.6(a) and Fig. 3.6(b). It was found that by using multiple impregnation and carbonization process, the desired bulk density of 1.80 g/cm^3 in case of P120 fibres based composites could be achieved. The electrical resistivity also decreases with HTT in both the types of composites. After heat treatment to 2500°C, the resistivity of P120 fiber based composites reaches an order of 0.02 mΩcm parallel to the fibre axis and 1.6 mΩcm in the transverse direction. This value of electrical resistivity of C/C composites may lead to high thermal conductivity.

Single Step Fabrication of High Density Carbon / Carbon Composites

Mass scale applications of C/C composites are restricted primarily because of its high cost. Processing of carbon/carbon composites forms about 60% of the total cost and all round efforts are going on throughout the world to reduce its processing cost for making carbon/carbon composites of reasonably good bulk density.

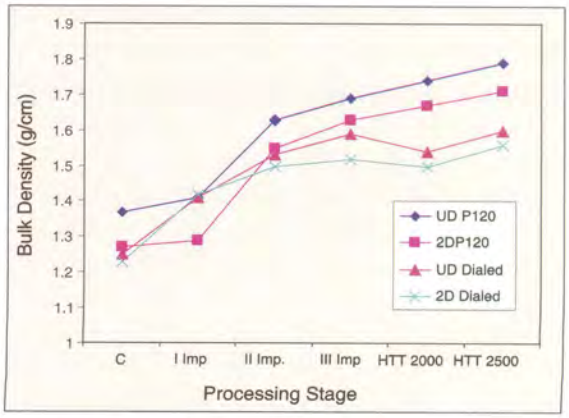


Fig. 3.6 (a) Variation in bulk density with processing stages

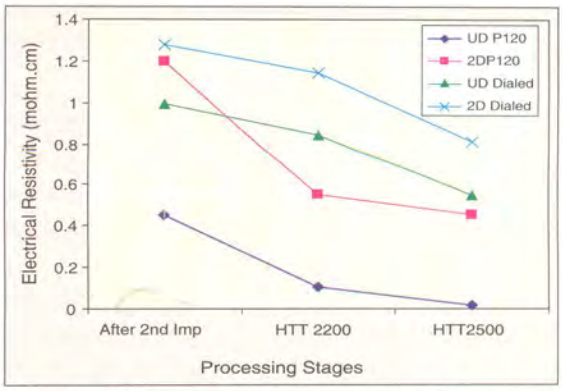


Fig. 3.6 (b) Variation in electrical resistivity with processing stages.

Carbon – carbon composites of high density of 1.80–1.85 g/cc, without any impregnation or infiltration, have been developed , using commercially available VGCF , vapour grown carbon fibres as reinforcement and a suitable pitch as a matrix precursor, using a special processing technique for which a patent have been filed (No.567/DEL/2005). Samples were prepared with 20%- 50% fibre volume, typical density of 1.35 g/cc at 1000 °C which increases to 1.76 g/cc on heat treatment at 2000 °C and to 1.85g/cc at a HTT 2600 °C . Compressive strength of the composite samples varies between 85-140 MPa which makes them a strong candidate for use in high

temperature dies, moulds and other aerospace applications.

Synthesis of Carbon Nanotubes by CVD Route

An experimental set-up to synthesise carbon nanotubes in the laboratory by using CVD technique was established. Several experiments were conducted by varying the processing parameters such as reaction temperature, nature of carrier gas, gas flow rate, ratio of organometallic catalyst to hydrocarbon, and nature of hydrocarbon etc. It was found by TGA, SEM, TEM and Raman analysis that the sample produced contains 85-90% pure multiwalled carbon nanotubes. Typical TEM micrograph of the as- produced samples is shown in Fig. 3.7. Several experiments were run to collect sufficient amount of carbon nanotubes for using them in composites

Carbon Nanotubes based polymer composites

A. Dispersion of nanotubes in polymer matrix

Different weight fractions of carbon nanotubes were dispersed in phenolic resin used as the matrix. The nanotubes and phenolic resins were first mixed with acetone separately in beakers and sonicated. After half an hour sonication the two were mixed together and sonicated again for another half an hour. The mix was then allowed to settle and kept in an oven to evaporate the solvent. The slurry was then moulded into composites of size 50 mm x 5mm x 3mm. The samples were cured at 180°C under specified conditions. The technique was optimized for different wt. fractions of nanotubes and a very uniform dispersion was achieved.

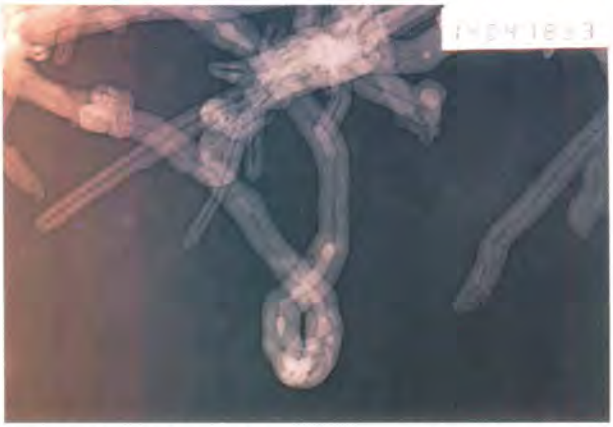


Fig. 3.7 TEM photograph of the carbon Nanotubes showing inclusion of the presence of metal catalyst inside the cavity

B. Electrical and Mechanical properties of the carbon nanotubes reinforced phenolic resin composites

Electrical conductivity of the composite samples prepared (cured) with different nanotube fractions i.e. 5,10,15,20, and 25% was measured using four point probe technique and the results are reproduced in Fig.3.8(a). The curve shows that the conductivity increases exponentially with increasing wt. percent of nanotubes and peaks and reaches a value of 2.5 ($\Omega^{-1}cm^{-1}$) at 25% reinforcement. The conductivity values are good enough for these composites to be used as EMI shielding materials even with 10% nanotube reinforcement.

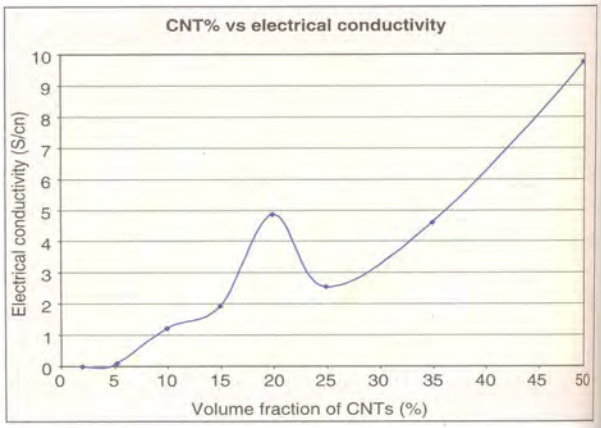


Fig.3.8(a) Variation of electrical conductivity of the nanotube reinforced polymer composites with different weight fractions of carbon nanotubes

Flexural strength as well as flexural modulus of the test samples was measured on the INSTRON 4411 universal testing machine using three point bending technique. As shown in the Fig,3.8(b), the strength values continue to increase w.r.t. volume percent of reinforcement whereas the modulus values tend to saturate around only 10% of reinforcement. The results are quite encouraging. More batches of samples with the similar reinforcements are being prepared with the surface treated nanotubes so as to further improve the mechanical properties. Further these composites will be carbonized to 1000°C to obtain carbon-carbon composites for high temperature applications.

Fuel Cell Project

Studies were carried out on the development of A-Porous conducting carbon paper, B-Advanced

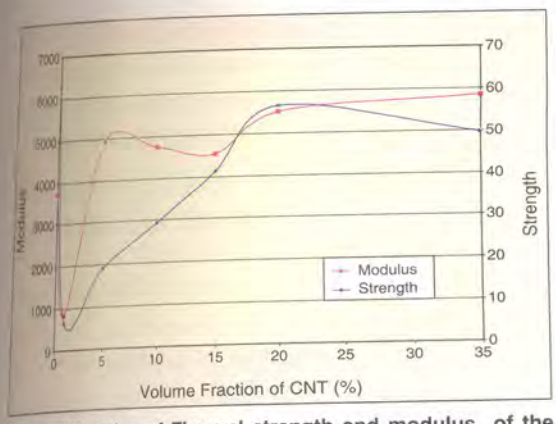


Fig.3.8(b) Variation of Flexural strength and modulus of the nanotube reinforced polymer composites with different weight fractions of carbon nanotubes

composite bipolar plate under the CSIR / NMITLI programme to develop 'Fuel cells based on hydrogen'. Specifications for both the components i.e. porous paper and the bi-polar plate were finalized in consultation with CECRI, Karaikudi, who are the collaborating partner with NPL for the development of fuel cell technology in the above programme. Based on the end characteristics of the components, different raw materials were selected e.g., type of carbon fibres, graphite powder, coke, binder resins etc.

Consultancy Project

The consultancy project entitled, "Upscaling of the green coke based high density graphite technology", sponsored by M/s. Graphite India Ltd., Bangalore was continued. The company engineers were advised to modify green coke by solvent extraction with suitable solvents, which was then isostatically moulded into cylindrical blocks at their plant. These green blocks were carbonised to 1000 °C and graphitised to 2600 °C respectively in inert atmosphere. The graphite so produced had apparent density of > 1.80 g cm^{-3}. Further characterisation and optimization work is under progress.

Polymeric and Soft Materials

Ferroelectric Liquid Crystals

Liquid crystal is the phase between isotropic liquid and anisotropic solid and has interesting basic and applied properties. There are mainly three types of liquid crystalline phases: nematic, smectic and cholesteric. The chiral tilted smectic phases show the ferroelectric phase. The important phase sequence in tilted chiral smectic phase is the smectic C* to smectic A phase where smectic C* is the ferroelectric phase and smectic A is the paraelectric phase. It is well known that the Curie-Weiss law deals with fluctuation of order parameter and related physical properties near the ferroelectric to paraelectric transition temperature. Generally, the validity conditions that make the Curie-Weiss law applicable at a first order transition (discontinuous) or second order transition (continuous) from ferroelectric to paraelectric transitions are that at the curie temperature (T_c) there is a change in the symmetry of the molecules in the two phases. In solid ferroelectrics, Barium Titanate ($BaTiO_3$) has cubic symmetry above 120°C, which is the centro symmetric (paraelectric) phase and below 120°C it exhibits tetragonal phase, which is the ferroelectric phase. Also in ferroelectric liquid crystals (FLCs), the ferroelectric phase possesses C_2 symmetry of molecules, which transforms into D_∞ in paraelectric phase.

In ferroelectric liquid crystal (FLCs) materials, the tilt (θ) of the molecule is an order parameter. In smectic C* phase the molecules have a natural tilt and at the transition temperature and above the tilt becomes zero. Therefore, near the transition temperature the tilt, which is the order parameter, becomes soft and contributes for the soft mode dielectric permittivity and obeys the Curie-Weiss law at T_c. As shown in Fig.3.9 the relaxation frequency is minimum at the transition and shows the soft mode relaxation, thus obeying Curie-Weiss law. This behaviour was obeyed in almost all types of ferroelectric liquid crystal materials. When the FLC material is cooled down from Sm A phase to the smectic C* phase the layer spacing in smectic C* phase decreases due to the tilting of the liquid crystal molecules. There is another type of ferroelectric liquid crystal called electroclinic liquid crystal where the electroclinic coefficient (dθ/dE) is very high as compared with the FLCs. These materials have a switching time in nano-second range and hence have lot of potential for applications. The phase sequence in electroclinic liquid crystal material is like in any other FLC material therefore; one should expect that Curie-Weiss law is obeyed at T_c. Recently, it has been observed and demonstrated at N.P.L. that this law is not obeyed in electronic liquid crystal material as shown in Fig.3.10 where the relaxation frequency is

constant near T_c over a wide temperature range which is not expected in FLCs. It has been shown that in case of Sm C* to tilted Sm A electroclinic liquid crystals the layer spacing and optical tilt remains the same in both Sm C* and Sm A phases near the transition temperature which result into the disappearance of soft mode and appearance of a new dielectric mode near T_c in such materials. The basic question that arises now is what are the basic differences in Sm C* and tilted Sm A phases? In the former, interlayer polarization is not zero but in the latter it is zero due to randomization of tilt within layers. Therefore, a new dielectric mode can be expected due to the randomization of the tilt within the layers near T_c. The studies are still being carried out to find out the new dielectric mode (random mode) in electroclinic liquid crystal materials near T_c of Sm C*-Sm A phase.

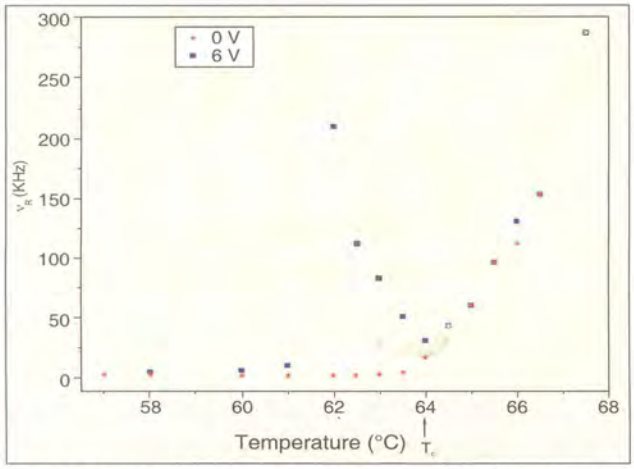


Fig. 3.9 Temperature dependence of relaxation frequency (υ_R) at 0V and 6V bias in Smc* and SmA phases of ferroelectric liquid crystal materials

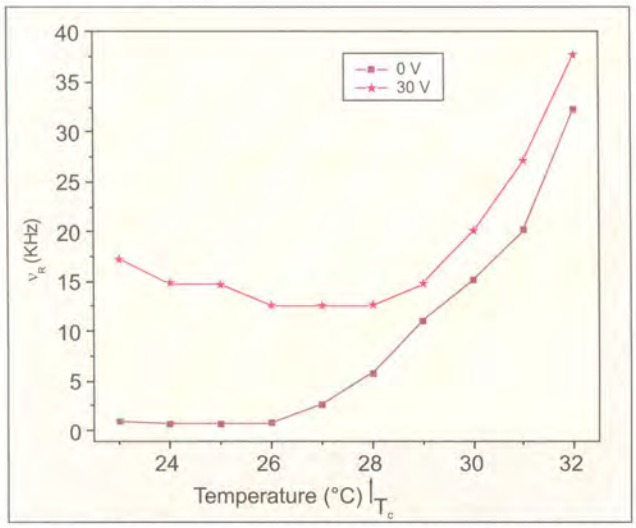


Fig. 3.10 Temperature dependence of relaxation frequency (υ_R) at 0V and 30 V bias in Smc* and SmA phases of ferroelectric liquid crystal materials

Exploratory Research work on Development of Photoactive TiO_2 Coatings on Glass for Self Cleaning Action

Windows can be one of the home's most attractive features. Windows provide views, day lighting and ventilation. But at the same times they are the weak links between the interior and exterior climate. The problem can be minimized by adopting new window technologies like coatings, applying film etc. of low solar heat gain co-efficient (SHGC) on windowpanes. At the same time cleaning of windowpanes, facades and building material causes considerable trouble, especially in high-rise buildings. This leads to high consumption of energy and chemical detergents, consequently high costs. To realize self-cleaning material surfaces there are two principal ways: the development of so-called super-hydrophobic or super-hydrophilic surfaces.

Hydrophobic materials ("water hating") have little or no tendency to absorb water and water tends to "bead" on their surfaces (discrete droplets). Hydrophobic materials posses low surface tension values and lack active groups in their surface chemistry for formation of "hydrogen-bonds" with water. The wetting of a solid with water, where air is the surrounding medium, is dependent on the relation between the interfacial tensions (water/air, water/solid and solid/air). The ratio between these tensions determines the contact angle with a water droplet on a given surface. A contact angle of 0° means complete wetting, and a contact angle of 180° corresponds to complete non-wetting. Hydrophobic surfaces with low wettability and contact angles of about 100° are known for a long time. The higher this angle the lower is the adhesion work (hydrophobic surfaces). The water repellency of plant surfaces has been known for many years. The water-repellent surfaces also indicate self-cleaning properties has been completely overlooked till now.

Surface of window pane acquires self cleaning property when coated with either super-hydrophobic material or super-hydrophillic material. TiO_2 films attain

super-hydrophillic when exposed to UV radiations. These films retain this property upto several hours after UV exposure is stopped. Also TiO_2 surfaces have the ability to dissociate organic dirt on its surface to CO_2 and H_2O in presence of photons with $\lambda \leq 380$ nm.

Uniform TiO_2 films on large area substrates can be obtained by atmospheric pressure chemical vapour deposition (APCVD) and sol-gel techniques. We have obtained TiO_2 films ordinary glass substrates by sol-gel technique by pulling it at constant speed at right angle to the liquid surface. Thickness of the film is controlled by the lifting speed. XRD and SEM studies has revealed that as coated films are amorphous, development of anatase phase appears after baking the film at ~ 200°C or more. All the films are adherent (scratch proof) transparent (transparency > 75%) in the visible region i.e. 400 – 700 nm. It appears that self-cleaning property is directly related to concentration of T_i^{3+} ions in the film, which increases initially with increase in baking time and temperature due to removal of organic radicals and decreases again for more baking period and temperature.

Conducting Polymers

The most important aspect of conjugated polymers from the technological perspective is their ability to control their electronic conductivity. π-electron polymers have been the subject of extensive research ranging from applications in charge storage devices such as batteries and super capacitors, to new polymers with specialized conductivity properties such as low band gap, organic light emitting diode devices, antistatic bags, electromagnetic interference shielding in radio frequency range and microwave range and sensors & biosensors.

Synthesis of conducting polymers has been carried out by chemical oxidative polymerization as well as by electrochemical techniques. Practical uses of conducting polymers are not very likely because of their poor mechanical properties. Thus, the unique combination of electronic and mechanical properties of blends of conductive polymers with conventional polymers has great promise for many applications. Conducting polymer composites are being designed by melt blending techniques with conventional polymers such as LDPE, HDPE, PP such that the

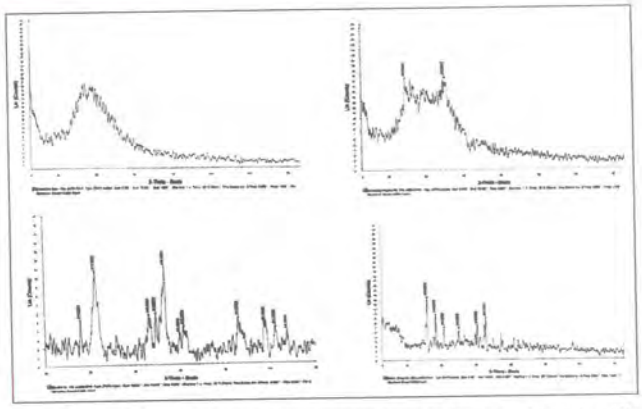


Fig.3.11 XRD of Emeraldine base (a), polymer doped with BSA (b), polymer doped with $CoCl_4^{2-}$ (c) and ferric oxide incorporated with polymer (d)

composites can be used to drain the static charge from the electronic equipments. Focus is made on to develop RAM polymers in microwave range by incorporating magnetic constituents in the conducting polymer backbone. Fig.3.11 shows the XRD behaviour of magnetic entrapped moiety in the conducting polymer.

Organic Light Emitting diodes

Recently there has been a lot of interest among researchers towards organic electroluminescence (EL) because of their potential applications in thin and flat panel display systems in the near future. A number of electroluminescent materials for their use in OLED devices have been synthesized at National Physical Laboratory . Some of these materials already synthesized are

(a) Small molecules – Alq_3, $LiBq_4$, $Almq_2$, sexi-phenyl

(b) Electro luminescent polymers like PPV, MEH-PPV, Benzene-naphthalene co-polymer, Anthracene-benzene co-polymer etc.

Recently we have synthesized some new materials like SAlq , $LiBqm_4$ and electro phosphorescent material $Ir(ppy)_3$.

Devices were fabricated on cleaned and patterned ITO substrates using TPD as hole transport layer (30nm). Over the TPD layer, $LiBqm_4$ was vacuum deposited (40nm). 150nm thick aluminum layer was used as cathode. The electrical characterization of the devices were done using a Keithley 617 electrometer coupled to a computer. The

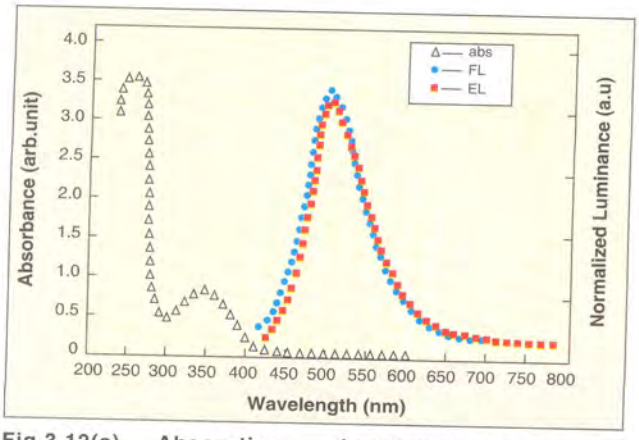


Fig.3.12(a) Absorption, photoluminescence and electroluminescence of LiBqm$_4$ films

photoluminescence (PL) and electroluminescence (EL) spectra of thin films were recorded using HR 2000 Ocean Optics spectrometer, shown in Fig.3.12 (a). EL spectrum is similar to PL spectrum, which shows that both emissions are due to the singlet excitons decay.

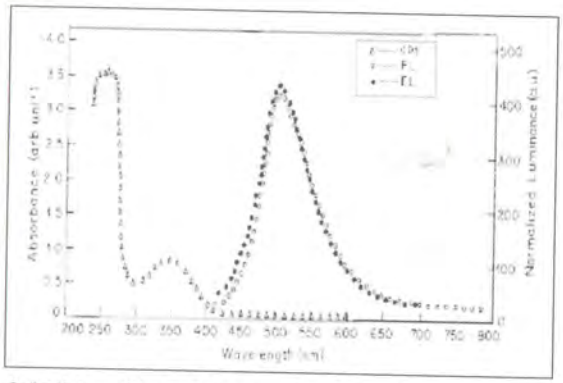


Fig.3.12(b) Absorption, photoluminescence and electroluminescence spectra of LiBqm$_4$ films

The electroluminescence (EL) of the emitted light were taken at different applied voltages as shown in Fig. 3.12 (b).

The typical I-V characteristic of device ITO/TPD (25 nm)/LiBqm$_4$ (35 nm)/Al (150 nm) were also obtained. It was found that they are highly non-linear in nature with ohmic conduction at low voltages and trap limited conduction at high voltages. The current rises steeply above 6 Volts, indicating the onset of light emission. The emission was uniform over the entire active area of the device.

The better device fabrication and performance analysis of organic light emitting diodes is in progress at NPL by using other newly synthesized material.

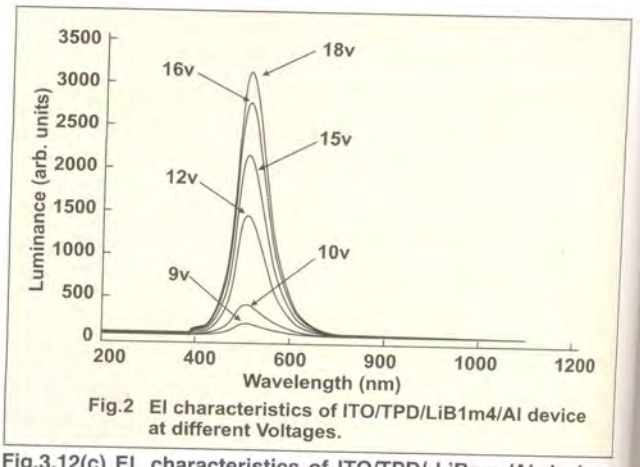


Fig.2 EI characteristics of ITO/TPD/LiB1m4/Al device at different Voltages.

Fig.3.12(c) EL characteristics of ITO/TPD/ LiBqm$_4$/Al device at different voltages

Biomolecular Electronics & Conducting Polymers

Cholesterol Biosensor

Cholesterol esterase (ChEt) and cholesterol oxidase (ChOx) enzymes were entrapped within polypyrrole (PPy) films on a platinum disc electrode during electrochemical polymerization. The characteristics of the PPy/ChEt/ChOx enzyme electrode thus prepared were investigated as a function of the time, pH, temperature, and concentration of cholesteryl palmitate by a spectrophotometric method. PPy/ChEt/ChOx electrodes can be used for the estimation of cholesteryl palmitate concentrations from 1 to 8 m*M*, can be used least 10 times, and have a shelf life of about 1 month at 4–10°C.

A. Effect of the substrate concentration on the response of the PPy/ChEt/ChOx electrodes

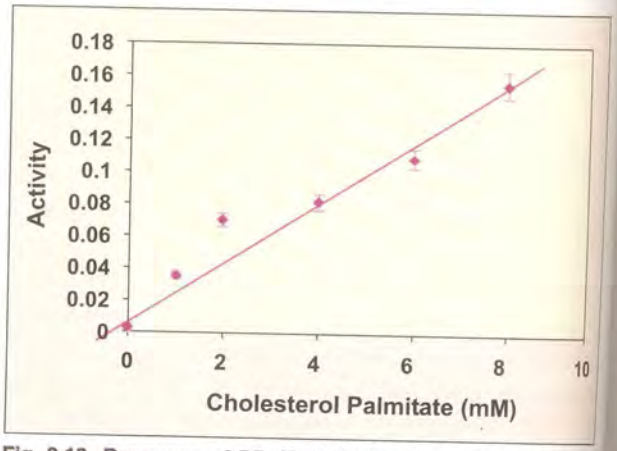


Fig. 3.13 Response of PPy/ChEt/ChOx electrodes to different cholesteryl palmitate concentrations.

Spectrophotometric studies were carried out for PPy/ChEt/ChOx electrodes at different concentrations of cholesteryl palmitate. The measurements were also carried out with different electrodes to determine the response at each concentration. Fig.3.13 shows the results of the responses obtained for the PPy/ChEt/ChOx electrodes to different cholesteryl palmitate concentrations (1–8 m*M*). Each point in the curve is the average of three measurements carried out under the same conditions of pH (7.0) at room temperature. A variation of about 5% in the response was observed, implying that the enzyme electrodes showed reproducible results. A linear relationship between the activity and cholesteryl palmitate concentration was obtained from 1 to 8 m*M*. However, when the response studies were carried out for higher cholesteryl palmitate concentrations, no significant change in the absorbance was observed. This may be due to the substrate saturation effects at very high substrate concentrations. These results indicated that the PPy/ChEt/ChOx electrodes could be used for the estimation of cholesteryl palmitate from 1 to 8 m*M*.

B. Storage stability of the PPy/ChEt/ChOx electrodes

Fig.3.14 shows the results of the spectrophotometric studies carried out for the activity measurements of the PPy/ChEt/ChOx electrodes at intervals of 3 days up to about 4 weeks with 4 mM cholesteryl palmitate. When the electrodes were not in use, they were stored at 4–10°C. A partial fall in the activity of the PPy/ChEt/ChOx electrodes was observed during the storage. It can be seen from Figure 2 that about 84% enzyme activity was retained for about 18 days, after which a slight fall in activity occurred. After about 18 days, a sharp decrease in activity was observed, which was attributed to the fact that with the storage time, the enzymes underwent partial denaturation. The electrodes showed 70% of the initial activity. The results were found to be repeatable and reproducible during the activity measurements in this period of storage with approximately a 5% experimental error.

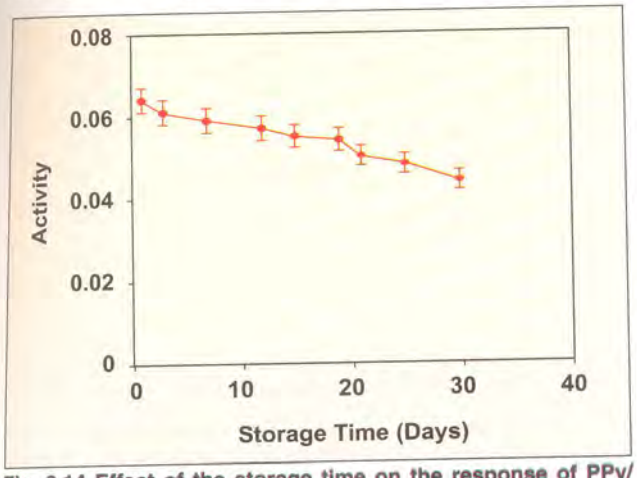


Fig. 3.14 Effect of the storage time on the response of PPy/ChEt/ChOx electrodes in the presence of 4 m*M* cholesteryl palmitate, 4-AAP, phenol, and POD at pH 7.0.

DNA Biosensor

A. Effect of O-cholorophenol on DNA/PPY/PVS film

Fig. 3.15 shows that the increased concentration of the toxicants/pollutants e.g. O-cholorophenol when tested with DNA/PPY/PVS film, results in decrease in oxidation current/peak current. It may be due to DNA interaction with OCP in terms of variation in the electrochemical signal of guanine that either intercalation or electrostatic interaction of the molecule with DNA has resulted in this effect of decrease in electrochemical current of guanine oxidation. It has been observed that the linearity in the reduction of current with the increase in the concentration of OCP.

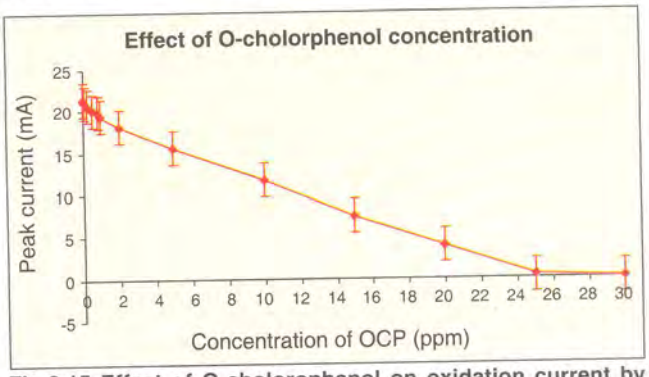


Fig.3.15 Effect of O-cholorophenol on oxidation current by using DNA/PPY/PVS electrode.

B. Effect of pH on DNA/PPY/PVS electrode

The effect of pH on DNA/PPY/PVS films were carried out at 25°C using phosphate buffer (0.05 M) of pH varying from 5.0 to 9.0. It can be seen from Fig. 3.16 that oxidation current increases as pH increases from 5.0 to 7.0 and after that a subsequent decrease was observed, indicating that the pH 7.0 is the optimum pH for studying DNA/PPY/PVS film. Since DNA exists in double stranded form in the neutral pH range and variation in pH on either direction results in its denaturation i.e. strand

separation. This may result in reduction of conductivity due to restriction in the movement of holes. These holes are formed due to oxidation of guanine, indicating hoping of electrons form one guanine to another.

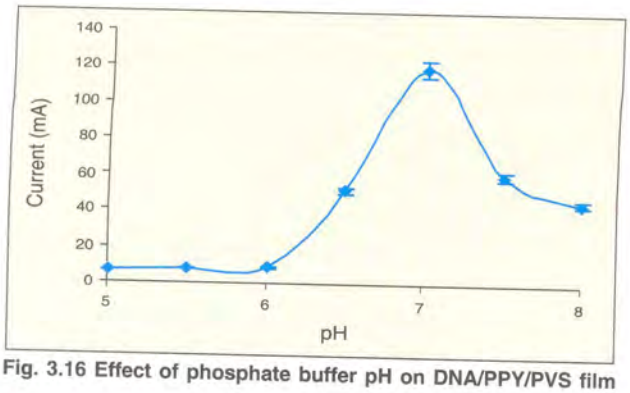


Fig. 3.16 Effect of phosphate buffer pH on DNA/PPY/PVS film

Galactose Biosensor

An enzymatic amperometric biosensor has been developed for the estimation of galactose in milk and blood serum. Galactose oxidase was immobilized with poly(3-hexyl thiophene)/stearic acid (P3HT/SA) onto indium tin-oxide (ITO) coated glass plates using Langmuir– Blodgett film deposition technique. The effect of galactose concentration, pH, and stability of the immobilized galactose oxidase in LB films were studied.

A. Amperometric Response of P3HT/SA/GaO LB electrode used for detection of galactose in human blood

Amperometric response was measured in 0.1 M phosphate buffer, pH 7.4 as well as in serum samples. No significant change was observed with either medium (Fig. 3.17). P3HT/SA/GaO LB electrode was linear from 0.05–0.5 g galactose l-1 in blood serum after which a limiting value of current was obtained. After measuring the current, the electrode was washed with water, air-dried and reused for the same concentration of galactose. Separate electrodes were used for different concentrations of galactose. The electrode could be reused 10 times with a loss of 10–15% in amperometric response.. It could be used from 25–40°C without loss of activity.

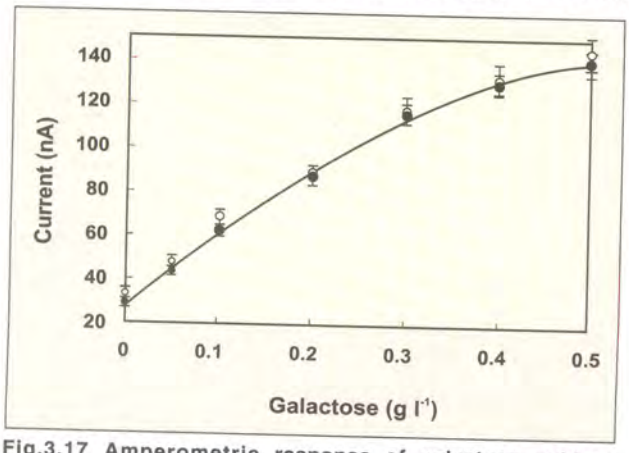


Fig.3.17 Amperometric response of galactose oxidase immobilized in poly(3-hexyl thiophene) and stearic acid Langmuir–Blodgett films at different concentrations of galactose in 0.1 M phosphate buffer, pH 7.4 (•) and in blood serum (O).

B. Langmuir–Blodgett film based biosensor for estimation of galactose in milk

The amperometric response determined at room temperature (25°C) for P3HT/SA/GaO LB film is shown in Fig. 3.18. Five LB film electrodes were tested for each measurement. P3HT/SA/GaO LB electrode shows linearity for 1–4 g/dl galactose in 0.1M phosphate buffer and soya milk, after which a limiting value of current was obtained. After measuring the current response, the electrode was washed with water and dried. The same electrode was again used for testing the reusability. It was observed that the electrode could be repeatedly used for about 10 times. Thereafter, a severe drop in the current was noticed. The repeated polarization of the electrode at 0.4V might have caused the denaturation of GaO. The saturation value of current (780 nA) was achieved at galactose concentration of 4 g/dl and detection limit of galactose in solution was observed 1g/dl.

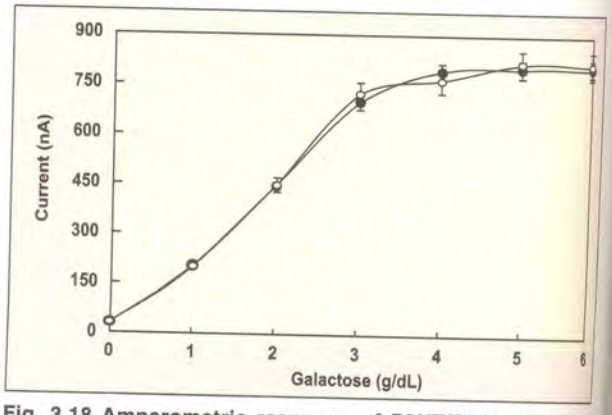


Fig. 3.18 Amperometric response of P3HT/SA/GaO LB film electrode at different concentrations of galactose in 0.1M phosphate buffer, pH 7.0 (•) and in soya (lactose/galactose free) milk solution (O).

Lactate / Galactose Biosensor

Also developed an amperometric biosensor sensitive to lactose as well as galactose, by immobilizing β-galactosidase(β-Gal) and galactose oxidase (GaO) in Langmuir–Blodgett (LB) films of poly-3-hexyl thiophene (P3HT) mixed with stearic acid (SA). The monolayers of P3HT/SA were fabricated by dispensing a solution (1:1) of P3HT(1 mM) and SA (2 mM) in chloroform onto water sub-phase containing $CdCl_2$ (0.2 mM), using Joyce-Loebl LB trough. Such P3HT/SA monolayers were transferred onto the ITO-coated glass plates at a surface pressure of 30 mN/m at 30°C by vertical dipping method. The dipping speed during upstroke and down stroke was maintained at 5 mm/min. β -Galactosidase and galactose oxidase (2.5 mg each) were mixed in a solution of P3HT/SA in chloroform and this solution was spread onto air-water interface of the LB trough. Thirty monolayers of P3HT/SA/ β-Gal/GaO were then transferred onto indium-tin-oxide (ITO) coated glass plates by vertical dipping method. The β-Gal/GaO immobilized P3HT/SA LB films were characterized using Fourier-Transform-Infra-Red spectroscopy (FTIR) and scanning electron microscopy (SEM) technique. Performance and characteristics of P3HT/SA/β-Gal/GaO LB electrodes were studied with respect to varying concentrations of lactose, temperature and pH. The results of the amperometric response determined at room temperature for P3HT/SA/ β -Gal/GaO LB films are shown in Fig. 3.19. P3HT/SA/ β-Gal/GaO LB electrode shows linearity from 1 to 6 g/dl after which a limiting value of current was obtained. The thermal stability and effect of pH on β-Gal/GaO immobilized P3HT/SA LB film was investigated at 3 g/dl lactose concentration by amperometric measurements.

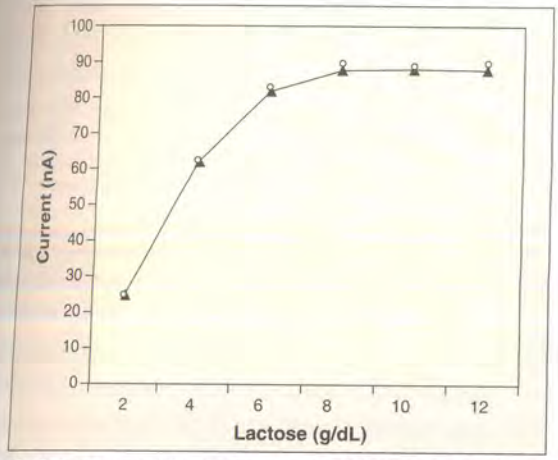


Fig. 3.19 Amperometric response of P3HT/SA/ β -Gal/GaO LB films at different concentration of lactose in phosphate buffer, pH 7.0 (O) and in milk (△). Different concentrations of lactose were prepared in lactose and galactose free milk and change in current was observed.

Glucose Biosensor

An attempt has been made towards the preparation and characterization of LB films of poly-3-hexyl thiophene mixed with stearic acid (SA). Glucose oxidase (GOX) has been immobilized onto the P3HT/SA LB films via LB technique. The GOX immobilized P3HT/SA LB films have been systematically investigated. The activity of the glucose oxidase (GOX) immobilized onto P3HT/SA LB films were performed by colorimetric method using UV-visible spectrophotometer (Schimatzu 160A).

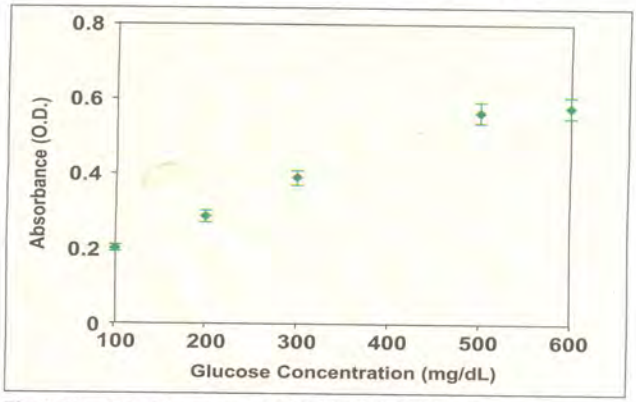


Fig.3.20 Absorbance of P3HT/SA/GOX LB electrode at 540 nm as a function of glucose concentration.

Photometric response of glucose oxidase (GOX) immobilized P3HT/SA LB film was also monitored with varying concentration of glucose in phosphate buffer (pH 7.0). The intensity of dye produced was found to be directly proportional to the concentration of glucose in the solution. A plot between the absorbance at 540 nm with varying concentration of glucose is plotted and is shown in Fig. 3.20. It is clear from the figure. that the absorbance increases linearly as glucose concentration increases form 100 to 500 mg/dl. These results suggest that these P3HT/SA/GOX LB electrodes may be used for the estimation of glucose from 100 to 500 mg/dl glucose solution.

Development of semiconducting nanocrystalline polymeric thin film sensors

Vacuum deposited nanocrystalline thin films of

copolymers of aniline and formaldehyde with a variety of dopings have been prepared and gas sensors for detection of ammonia, carbon monoxide, HCl, mocrobiological organisms have been prepared. For this a wide variety of combination of dopants such as Al, Fe, Co, Cu in various stoichiometric combinations have been used to prepare fat response and highly sensitive sensors. A prototype of electronics gadgetry to provide audio-visual alarm has been developed. The sensors were tested for their response, time, decay, recovery, specificity and selectivity for various gases at relevant institutions. Besides this, doped and undoped polyaniline thin films were prepared and characterized for their structural, electrical and optical properties using SEM X-ray, electron diffraction techniques etc.

Organic Insulating Polymers for Device Applications

To find the suitability of polymers for various applications such as photoreceptors, organic light emitting diodes and polymer solar cells it is essential to understand their charge storage and transport properties. Keeping this in view fundamental properties of some new polymers such as poly vinylfluoride (PVF), copolymer of poly (vinyledene chloride – acrylonitirle) i.e. P(VDC: ACN} were investigated. To understand the mechanism of charge storage in vacuum deposited PVF films their thermally stimulated discharge (TSD) current behaviour was studied in detail as a function of various polarization parameters such as field ($1.0x10^3$ - $14.0x10^3$ V/cm), temperature (313 - 453 K), time ($3.6 x10^3$ - $6.0x10^3$ sec), electrode work function (copper, silver, aluminum and indium) and thickness (2000 - 10000 Å). In a field dependent case the TSD spectra of PVF films showed a single relaxation peak centered around 430 ± 1 K. The peak current, charge, peak position and activation energy associated with the peak were found to depend strongly on the polarization parameters. For example, the peak position shifted from 410K to 445K and activation energy associated with the peak increased from 0.55 eV to 0.69 eV with the corresponding increase in polarization temperature from 313 K to 453K. Figs. 3.21 (a) and 3.21(b) show the effects of polarization field and temperature on relaxation peak obtained in vacuum deposited PVF

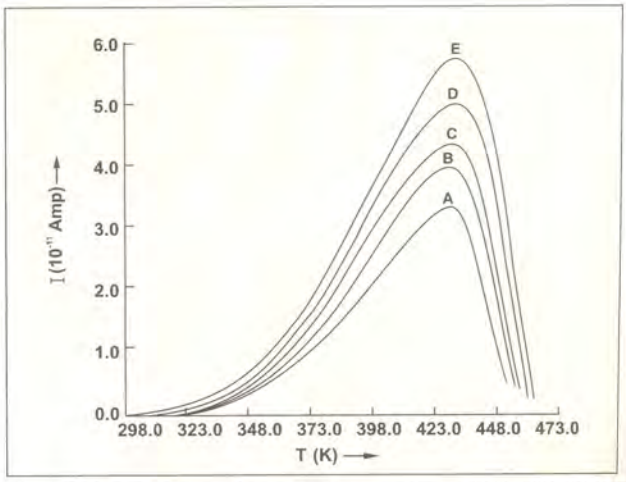


Fig.3.21(a) TSD spectra of vacuum deposited PVF films (~10000Å), polarized at 393K; for 4.5 $x10^3$ sec for different fields. Curves A, B,C, D and E correspond to field of $1.0x10^3$, $2.0x10^3$, $4.0x10^3$, $8.0x10^3$ and $1.4x10^4$ V/cm, respectively

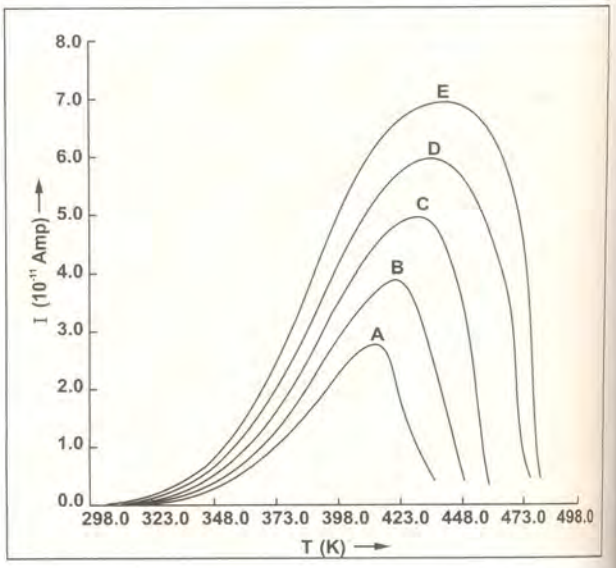


Fig.3.21(b) TSD spectra of vacuum deposited PVF films (~10000Å), polarized at $8.0x10^4$V/cm; for 4.5 $x10^3$ sec at different temperatures. Curves A, B,C, D and E correspond to temperatures, 313,353,393,433 and 453K, respectively

films. The mechanism of origin of the relaxation peak has been attributed to the space charge polarization where the charge carriers injected at the electrode-polymer interface barrier are displaced at macroscopic distances and get subsequently trapped at trapping levels that are distributed in their activation energies and relaxation times.

As regards P(VDC: ACN) copolymer the mechanisms of charge transport and storage were

studied using dc conductivity and TSD techniques respectively. Log J-LogV characteristics of P(VDC-CAN) copolymer films were studied as a function of thickness (40-130 μm) and temperature (305 - 368K) at different voltages (10 - 600V). These results were analyzed in various possible transport mechanisms such as Poole-Frenkel effect, space charge limited conduction, Richardson Schottky effect etc. The interface lowering barrier due to Richardson Schottky effect was suggested as the dominant mechanism of conduction in this copolymer. Also, the charge storage behaviour of solution grown P(VDC-CAN) copolymer was studied as a function of polarization field ($7x10^3$-$3.6x10^4$V/cm) and thickness (50-120 μm) at a fixed polarization temperature (308K) and time $3.6x10^3$sec using the TSD technique. The TSD spectra of these films show a single relaxation peak at ~330K whose current and charge increases initially with the increase in field and thickness and saturated towards the high fields and increased thicknesses. The origin of the relaxation peak was attributed to the migration of charge carriers, injected from the electrodes, at macroscopic distances and their subsequent trapping at levels lying ~1.1 eV.

Organic Polymer Solar Cells

Work was initiated in the area of organic polymer solar cells. Fundamental investigations with regard to the study of charge transport phenomena in conjugated polymers was undertaken to find their suitability for polymer solar cell applications. Current density -voltage (J-V) characteristics of poly(3-octylthiphene) (P3OT) thin films were investigated with and without incorporation of poly (3,4-ethylene-dioxythiophene) :poly (styrene sulphonic acid) (PEDOT:PSS) (~80 nm) interface layer. It was found that the incorporation of PEDOT:PSS interface layer converts the contact into efficient hole injector in P3OT thin films and switches the charge transport from ohmic to non-linear behaviour having four distinct regions of conduction. Subsequently, the J-V characteristics were studied as a function of P3OT layer thickness (50-200 nm) and temperatures (243-303K), in the device configuration ITO/PEDOT:PSS/P3OT/Au. Based on the analysis of these results space charge limited conduction (SCLC) was suggested as the dominant mechanism of charge transport in P3OT thin films as moderate and high fields. The value of fundamental SCLC transport parameters i.e. average free carrier density (n_0), density of traps (N_t), free carrier mobility (μ_0), effective mobility in the presence of shallow traps (μ_e) and activation energy (E_A) were calculated as ~$1.1x10^{14}$ cm^{-3}, $3.3x10^{16}$ cm^{-3}, $0.8x10^{-2}$ cm^2/Vs, $1.0x10^{-4}$ cm^2/Vs and 0.19 eV, respectively.

Automation Group

Automation Group is engaged in upgradation of existing old systems to make them fully computer controlled and unattended systems. For upgrading the systems this group develops the required hardware as well as software. This group also develops the custom built software for the different sections in National Physical Laboratory, New Delhi. Besides all this the group is also engaged in development of the microcontroller based custom built hardware (using embedded technology) for data acquisition and control as per the user requirement. Automation group has already developed several custom built hardware and software for the different sections of National Physical Laboratory, New Delhi to suit the requirements of the users. These systems are working satisfactorily and many of such systems are under development. The group is also engaged in the development of water pollution monitoring system in collaboration with Institute of Genomics and Integrative Biology (IGIB), (CSIR), Mall Road, Delhi. It will be able to give directly BOD in less than fifteen minutes whereas the conventional methods give the BOD results in three days.

Self Assembled Monolayers and Liquid Crystals

Rapid fabrication of microstructures in polymers and metals using soft lithographic techniques

Significant progress has been made towards developing some new set of non-photolithographic techniques (variants of new emerging soft lithographic techniques) to fabricate microstructures in polymers and metals with dimensions varying from tens of microns to a few hundred nanometers. These techniques include micro replica molding (μRM), micro transfer molding ((μTM), micromolding in capillaries (MIMIC) and solvent assisted micromolding (SAMIM). The μTM and MIMIC have been used to fabricate microstructures in polymers and polymer-

based microfluidic channels and systems to be potentially useful for developing miniaturized analytical systems for applications in the areas of biology, biotechnology, pharmaceutical and chemical assaying.

Poly (dimethylsiloxane) (PDMS) is a very useful and attractive material for fabrication of microfluidic devices. We have extended our efforts on microcontact printing (μCP) of self-assembled monolayers (SAMs) using soft elastomeric stamps (PDMS) to create patterned structures, microchannels and microfluidic systems in polymers. The primary goal was to fabricate microfluidic devices for nanoliter and picoliter

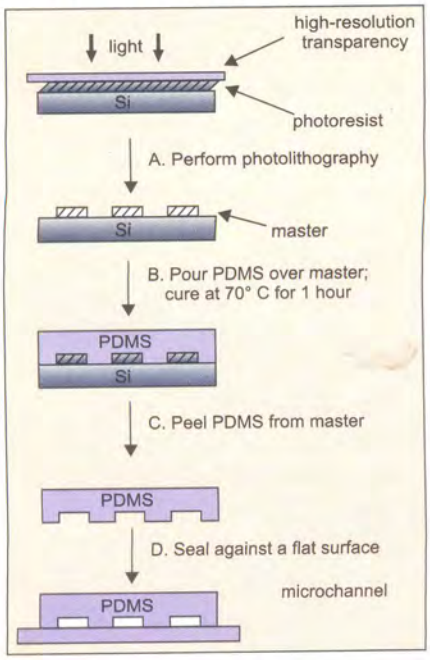


Fig 3.22 Schematic diagram to fabricate microchannels in a *polymer*

liquid sample handling. Basically micromolding of polymers has been utilized to fabricate microchannels inside the polymer.

The size of the micro channels to be prepared inside the polymer is defined in artwork from which the master is prepared. The depth of the microchannel is governed by the thickness of the photoresist film that could be varied from 1 to 75 micron using epoxy-based photoresists. The PDMS prepolymer mixed in appropriate ratio is cast against the master and is subsequently cured at 65°C for a few hours. The cured polymer is peeled off from the master. It has the necessary microchannel engraved inside the polymer. The feature size of the microchannel shows high fidelity as revealed by microscopic and SEM studies. Typically the fabricated channels have cross-section of a few tens of microns to a few hundred microns with length ranging from a few mm to several cm. A variety of techniques have been developed to seal these channels against flat PDMS, substrates like glass, Plexiglas and acrylic sheet etc.

Appropriate techniques have been developed to connect the channels to the external sources for fluid flow and the controlled fluid flow inside the microchannels has been demonstrated.

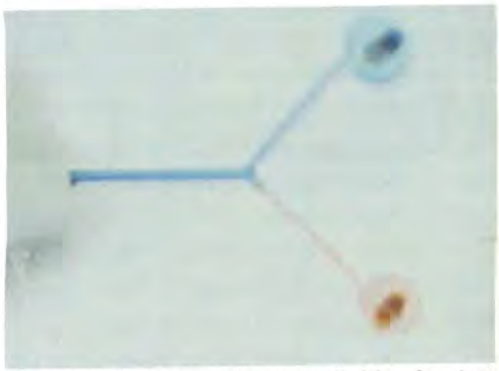


Fig.3.23(a) Two different fluids in two independent Channels and mixes

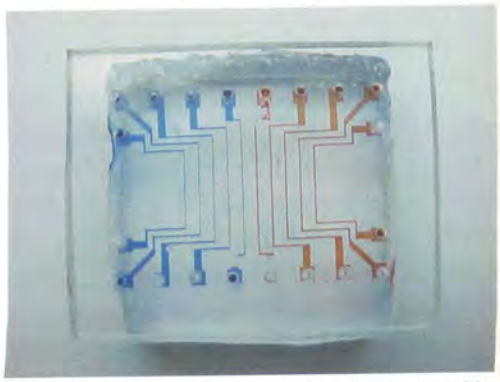


Fig.3.23(b) Several independent channels with independent fluid filling pads

Figure 3.23 (a) and 3.23(b) show the fluid flow in the developed polymer based microfluidic systems with microchannels width ranging from 50-200 micron in two different geometries. In Fig3.23 (a), two different fluids flow in two independent channels and mixes inside the neck, while in Fig.3.23(b), there are several independent channels with independent fluid filling pads. The developed micro channels systems are being explored for wide variety of biological applications including patterning of biomolecules, DNA phase separation and for chemical analysis etc.

इलेक्ट्रॉनिक पदार्थ

ELECTRONIC MATERIALS

byDVkfud inkFkZ

पिछले कई दशकों से एन. पी. एल. का इलेक्ट्रॉनिक पदार्थों के क्षेत्र में अनुसंधान और विकास कार्य सक्रिय रूप से किया जा रहा है, जिसका उद्दे श्य प्रमुख सरकारी और निजी संगठनों की जरूरतें पूरी करने के लिए अभिनव सामग्रियां, उपकरण और सिस्टम विकसित करना है। इस क्षेत्र में प्रमुख क्रिया कलाप, प्रभाग के निम्नलिखित ग्रुपों द्वारा किए जा रहे हैं।

संदीप्तिशील पदार्थों और उपकरण ग्रुप विभिन्न अकार्बनिक फास्फर तथा सम्बद्ध साधनों के विकास कार्य में लगा है। दीप्तिशील लैम्पों के अतिरिक्त, टेलीविजन (टीवी) टयूबों और एक्स-रे स्क्रीनों, इलेक्ट्रोल्युमिनिसेंट डिस्पले, वैक्यूम फलूरोसेंट डिस्पले, प्लाजमा डिस्पले और फील्ड उत्सर्जन डिस्पले में भी फास्फर का प्रयोग किया जाता है। इस ग्रुप ने पाउडर और पतली फिल्म, दोनों के रूप में इलेक्ट्रोल्युमिनिसेंट फास्फर और पैनल विकसित किए हैं। इसने औद्योगिकी अनुप्रयोगों के लिए नैनोफास्फर और साधन विकसित करने के लिए एक मंहगी योजना भी तैयार की है।

पदार्थों का प्लाज्मा प्रसंस्करण ग्रुप आर एफ प्लाज्मा परिवर्धित रसायन वाप जमाव तकनीक (स्थायी पतली फिल्म सैलों तथा सफेद LED's के निर्माण में संभावित अनुप्रयोगों) द्वारा बड़े क्षेत्र सबस्ट्रेटों पर माइक्रो/नैनो क्रिस्टलीन का जमाव करके हाइड्रोजिनेटिड एमार्फस सिलिकॉन का विकल्प विकसित करने, अर्धचालन (सेमिकंडक्टिंग) के रूप में टेट्राहेडल एमार्फस कार्बन का विकास और अन्त्रोण और सख्त तथा बचावकारी कोटिंग सामग्री के रूप में क्यूबिक बोरोन नाईट्रेड (C-BN) का विकास करने के काम में लगा है।

इल पदार्थ और युक्तियांः नैनो संदीपक पदार्थो का परिवर्धन, विभिन्न तकनीकों का निर्माण, संवधित पदार्थो का विस्तृत अभिलक्षण, नील और हरित वरन दीर्धकाल दीप्ति नैनो उत्सर्जक, उत्सर्जक पट्टीयों और प्रदर्शन पाटों का निर्माण, कम्प्यूटरीकृत कण विश्लेषक, प्रकाश चालक पाउडर और संवेदक इत्यादि विषयों पर कार्य हुआ।

flfydku rFkk flfydku lk/ku] ,e b ,e ,l vkj lljl xi mUur

सिलिकॉन p-i-n फोटोडायोडस के डिजाइन, विकास और विशेषीकरण का काम करता चला आ रहा है। लाइफटाइम पदे p-type सिलिकॉन मापने के लिए 'फोटोकरेंट जेनरेशन विधि' के आकार पर एक उन्नत अविनाशकारी विधि विकसित की गयी है। नैनो तथा माइक्रो संरचनागत छिद्रित सिलिकॉन विकसित करने का काम भी हाथ में लिया गया है। टाइटेनियम ऑक्साइड, सिलिकॉन ऑक्साइड तथा सिलिकॉन नाइट्राइड फिल्म पर सिलिकॉन ऑक्साइड जैसी फिल्मों का सिलिकॉन सौर सेल पर प्रयोग करते हुए सौर सेलों के प्रतिप्रावर्तन (antireflection) गुणधर्मों से सम्बन्धित प्रयोग किए गए। स्क्रीन प्रिंटेड सौर सेल पर PECVD द्वारा जमायी गयी सिलिकॉन नाइट्राइड फिल्म की रचना का गहराईपूर्वक अध्ययन किया गया है जिसमें प्रारंभिक दृष्टिकोण के रूप में एक्स-रे फोटोइलेक्ट्रॉन स्पेक्ट्रोस्कोपी का प्रयोग किया गया।

नैनोसंरचनागत, प्रकशीय, इलेक्ट्रोक्रोमिक और पॉलीमरिक पदार्थों के विकास ग्रुप ने निम्नलिखित में विविध क्रियाकलाप शुरू किए हैं :-

- नैनोसंरचनागत फिल्मों तथा पदार्थों के उनकी चुम्बकीय और संरचनागत विशेषताओं के लिए और गैस सेंसरों के रूप में उनके प्रयोग के लिए अन्वेषणात्मक अध्ययन।
- CWDM अनुप्रयोगों के लिए संकीर्ण वैंडपास पतले फिल्म फिल्टरों का विकास।
- ऑप्थैल्मिक और अन्य अनुप्रयोगों में प्रयोग की जाने वाली पॉलीमरिक फिल्मों के लिए प्लाज्मा बहुलकीकरण प्रणाली और प्रक्रिया का विकास ।
- प्रोटोटाइप इलेक्ट्रोक्रोमिक विंडोज निर्मित करने के अंतिम उद्देश्य के साथ डिपकोटेड और इलेक्ट्रो-डिपाजिटिड WO_3 तथा प्रशियन (Prussian) ब्लू फिल्मों के अन्वेषण।
- पॉलीमर सोर सैल के विकास में प्रयोग के लिए युग्मित पॉलीमरों तथा संश्लिष्ट सामग्रियों का संश्लेषण और विशेषीकरण ।

mPp rki lijdMfDVx lkefx;k vkj mUur fljfed xi

हाई करेंट ट्रांसपोर्ट के लिए Bi.2223(BPSCCO):Ag टयूब/रॉड कंडक्टरों, HTSC चुम्बकीय स्थलों और केबलों के लिए लम्बी लम्बाई वाले मोनो/मल्टी फिलैमेंटरी का विकास करने, वस्तुतः बाउंड स्टेटस के माध्यम से पिनिंग सेंटरों की संभावनाओं का पता लगाने, कंडक्शन इलेक्ट्रॉन/छिद्रों पर लैंथेनाइडज के प्रभाव का पता लगाने, के लिए HTSC की पेअरिंग एवं हाल ही में खोजी गयी उच्च Tc MgB_2 सामग्रियों की लम्बी लम्बाई वाली तारों के बुनियादी अध्ययन तथा विकास करने में लगा है। इसके अतिरिक्त, एकॉस्टिक उत्सर्जी सेंसरों के लिए पीजोइलेक्ट्रिक ट्रांसस्डयूसर एलीमेंटों का विकास, रेजोनेंट टाइप एकॉस्टिक उत्सर्जी सेंसर का निर्माण और ZST सिरैमिक्स पर सिटरिंग अध्ययन किए गए।

सतह भौतिक और नैनो संरचनाग्रुप के क्रियाकलापों में मुख्य रूप से ऐसी दृश्य घटनाओं सम्बन्धी मुद्दों पर कार्य किया जाता है जो ठोस पदार्थों की सतहों पर घटित होती हैं। एकल क्रिस्टल सेमीकंडक्टर सतहों पर धातुओं के 2D तथा 1D के हीटरोऐपिटेक्सियल विकास की प्रारंभिक अवस्थाओं और क्वांटम डॉटस के शैल अध्ययन की ओर विशेष ध्यान दिया जा रहा है।

ELECTRONIC MATERIALS

Over the past several decades, R & D work in the area of electronic materials has been pursued actively in NPL, with the aim of bringing forth novel materials, devices and systems to meet the requirements of leading government and private organizations. The major activities in this area are being pursued in the following groups in the Division :

Luminescent Materials and Devices group is engaged in the development of various inorganic phosphors and related devices. Apart from fluorescent lamps, television (TV) tubes and X-ray screens, electroluminescent displays, vacuum fluorescent displays, plasma displays and field emission displays also use phosphors. The group has developed electroluminescent phosphors and panels both in powder and in thin film form. It has also drawn up an extensive plan for development of nanophosphors and devices for industrial applications.

Plasma Processing of Materials group has been engaged in the development of an alternate material to hydrogenated amorphous silicon by depositing micro/nano crystalline films on large area substrates by RF plasma enhanced chemical vapour deposition technique (possible applications in the fabrication of stable thin film solar cells and white LED's), growth and investigations of tetrahedral amorphous carbon as a semiconducting material and the development of cubic boron nitride (c-BN) as a hard and protective coating material.

Silicon and Silicon Devices, MEMS and Sensors group has been engaged in the design, development and characterisation of improved silicon p-i-n photodiodes. An improved non-destructive method based on "Photocurrent Generation Method" to measure lifetime in p-type silicon has been developed. Growth of nano- and micro-structured porous silicon has also been undertaken. Experiments related to antireflection properties of solar cells using films such as titanium oxide, silicon oxide, and silicon oxide over silicon nitride film, on silicon solar cell were carried out. In depth composition of silicon nitride film deposited by PECVD on screen printed solar cell was studied by using X-ray photoelectron spectroscopy as a function of take off angle.

Development of Nanostructured, Optical, Electrochromic and Polymeric Materials group has undertaken multifarious activities in

- Investigative studies of nanostructured films and materials for their magnetic and structural features, and for use as gas sensors.
- Development of narrow bandpass thin film filters for CWDM applications.
- Development of plasma polymerization deposition system and process for polymeric films to be used in ophthalmic and other applications.
- Investigations of dip-coated and electro-deposited WO_3 and Prussian Blue films, with the ultimate objective of fabricating prototype electrochromic windows.
- Synthesis and characterization of conjugated polymers and composites for application in the development of polymer solar cell.

High Temperature Superconducting Materials and Advanced Ceramics group is engaged in the development of Bi-2223 (BPSCCO):Ag tube/rod conductors for high current transport, Bi-2223 long length mono/multifilamentary tapes for HTSC magnetic spools and cables, exploring the possibilities of pinning centers through virtual bound states, studies to understand the effect of lanthanides on conduction electron/holes pairing of HTSC as well as basic studies and development of long length wires of recently discovered high T_c MgB_2 materials. Moreover, the development of piezoelectric transducer elements for acoustic emission sensors, fabrication of resonant type acoustic emission sensor devices as well as sintering studies on ZST ceramics were carried out.

Surface Physics and Nanostructures group activity primarily addresses issues regarding phenomena that occur on the surfaces of solids. Special focus has been on the study of the initial stages of the heteroepitaxial growth of 2D and 1D nanostructures of metals on single crystal semiconductor surfaces and the relation between the core and shell structures of quantum dots.

R & D ACTIVITIES

Advanced Luminescent Materials and related devices

The group is dynamically progressing with an objective of developing various industrially important nanophosphors and nanophosphor based devices. Nanophosphors are being prepared using three techniques viz., chemical precipitation, sol-gel and auto-combustion.

Chemical co-precipitation and Sol-gel methods were employed for the synthesis of capped (both polymer and inorganic) ZnS:Mn nanophosphor samples. Zinc acetate, manganese acetate and sodium sulphide were used as reactants. An appropriate capping agent is used for controlling particle sizes and avoids agglomeration. Room temperature optical absorption was used to study the band structure of the material.

Quantitative amounts of ZnS:Mn based nanophosphors of desired size, shape and tailored properties for various practical applications have been successfully prepared with inorganic matrices like silica, zinc oxide etc. as capping agents and studied for its structure and luminescence properties. On annealing, the silica-capped nanocrystals grow in size and undergo phase transition from cubic to hexagonal at temperatures between 700-900°C. This is one of the rare findings identified by our group related to hexagonal nano-ZnS formation due to combined effect of high temperature (~900°C) and annealing related compressive stress induced by inorganic cage. In contrast, ZnO capped samples remained cubic for all capping thickness. Transmission electron microscopy (TEM) observations and X-ray photoelectron spectroscopy (XPS) results suggested the capping formation. Unannealed cubic nano-ZnS:Mn samples gave a broad photoluminescence (PL) peaked at ~585 nm while samples annealed at 900°C for 5 hrs on the other hand gave the narrow and sharp PL at ~590 nm. This is attributed to more efficient $^4T_1 \rightarrow {}^6A_1$ transitions of Mn in the resultant hexagonal nano-ZnS matrix. Thickness variation of ZnO was seen to have an effect on the PL peaks – 30% capping gave the strongest PL peak related to a maximum capping related stress. ZnO capped samples had a PL peak at 610 nm (Fig.4.1). The peak shift with respect to silica-capped samples is related to high Mn concentration. The ZnO capped samples were found to have relatively stronger intensity due to their relatively small capping thickness and more effective excitation/emission processes.

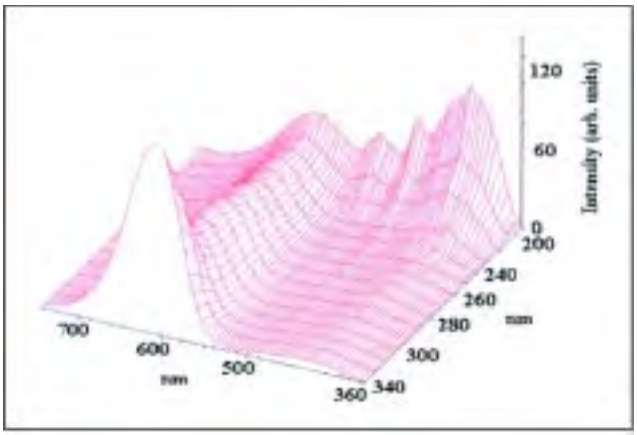


Fig.4.1: 3D plot showing the variation in PL profile of ZnS:Mn/ ZnO with change in excitation wavelengths

Synthesis and characterization of nanocrystalline long persistent $SrAl_2O_4$:Eu, Dy phosphor via modified combustion process has been established. In this synthesis process, a mixture of respective metal nitrates, flux and combustible agent (urea/camphor) were thermally treated with slight modification in the experimental conditions at 400-600°C for about 5 minutes. The process resulted in a low-density voluminous mass easily reducible to quite fine particles with almost no physical effort. Conditions prevailing during the processing favoured the formation of stand-alone nanoparticles. The aim to achieve the homogeneous incorporation of dopants and large-scale production of the nanophosphor in a short interval of time has been fulfilled. The samples have been characterized for nanophase, structural and luminescent properties. It is very interesting to note that as we vary the chemical composition and processing conditions, it is possible to change the morphology of the nanoparticles from spherical particles to nanowires. The Fig. 4.2 shows the different morphologies of particles obtained from solid-state reaction (Fig. 4.2(a)) and modified combustion processes (Fig. 4.2(b) & (c)).

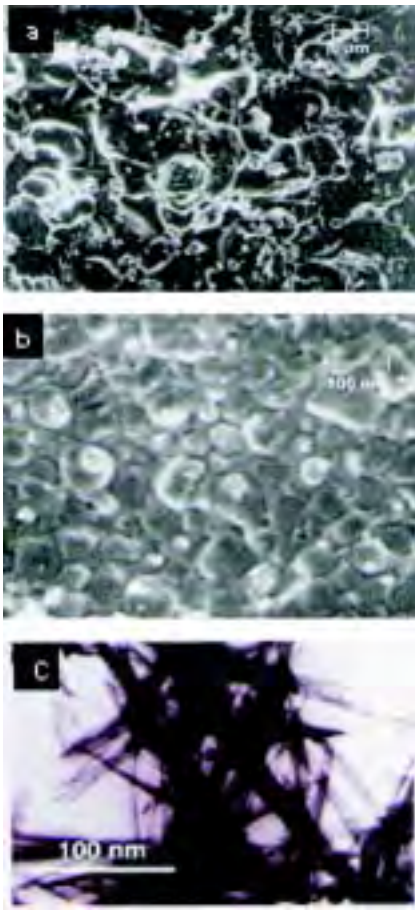


Fig. 4.2: Micrographs of $SrAl_2O_4$: Eu, Dy phosphors prepared by (a) solid-state reaction, (b) auto-combustion process and (c) modified combustion process

A further refinement in auto-combustion process is under progress with a view to reduce the overall cost of production of nanophosphor. Efforts are being made to design a unique set-up to heat the sample-containing capsule form all sides. The experience gained will be extended for the development of blue and red emitting $CaAl_2O_4$:Eu;Nd and $CaZnTiO_3$:Pr nanophosphor.

Plasma Processed Materials, Devices and Systems

Amorphous, micro & nano crystalline silicon

Hydrogenated amorphous silicon (a-Si: H) micro / nano crystalline films were deposited on large area (10x10 cm^2) by RF plasma enhanced chemical vapour deposition (RF-PECVD) technique. The micro / nano crystalline hydrogenated silicon (μc / nc Si : H) films were grown using high H_2 and Ar dilution and the substrate temperature was kept lower than the normal temperature generally used in the deposition of hydrogenated amorphous silicon. At the same time the RF power was kept higher than normally used to deposit a-Si:H films by PECVD technique. The properties of amorphous, microcrystalline and nanocrystalline Si:H films were characterized by various techniques. The bandgap of nc-Si:H films was found to be 2.3 to 2.8 eV which is higher than that of amorphous silicon (normally in the range of 1.75 to 1.8 eV) films. The photoluminescence (PL) studies shows that the PL peak position shifts from 2.18 eV (569 nm) to 2.94 eV (421 nm) with the increase of argon dilution (Blue shift). The PL spectra confirm the high bandgap of the nc-Si:H silicon films. The SEM and AFM studies show the cluster of nano crystalline silicon grains embedded in amorphous silicon matrix. The cluster size was found to be in the range 80-120 nm. The micro laser Raman spectroscopy study shows Raman peaks around 514 cm^{-1} which also indicates nano-crystallinity in these films. It was found that the Ar dilution favours the formation of nano crystalline silicon films. These films can find applications in the fabrication of stable thin film solar cells and white LED's.

Tetrahedral Amorphous Carbon (ta-C) as semiconducting material

The potentiality of tetrahedral amorphous carbon (ta-C), as a relatively new semiconducting material has been examined. Main findings are: (i) The physical properties of as grown ta-C film depend on the substrate bias / ion energy applied during the growth and optimum substrate bias was found to be 150-200 V (ii) Hydrogen incorporation reduces the electrical conductivity, residual stress, density of states and field emission threshold and increases the activation energy and optical band gap and the sp^3 content. It gives a modest gain in semi conducting properties by passivating some of the defects but not to the extent as has been reported in a-Si:H (iii) Nitrogen incorporation increases the sp^3 content, electrical conductivity, emission current density and decreases the residual stress, activation energy and field emission threshold (iv) Boron doping increases the activation energy without affecting the band gap whereas the electrical conductivity is increased by one order only and the tetrahedral nature is not

destabilized up to 2.0 at % B which decreased only marginally (v) Phosphorous incorporation decreases the activation energy and increases the electrical conductivity by one order only. It acts as n-type dopant and at low level of phosphorous up to 1.0 at % it destabilizes the network and sp^3 content is reduced drastically.

Cubic boron nitride (c-BN) as hard and protective coating

We have deposited boron nitride films on 7059 corning glass and c-Si substrates at relatively low temperature and pressure using diborane and ammonia as precursor gases in a dual frequency (RF + microwave) PECVD system. The c-BN films adhere well to the substrates and were characterized by various techniques. The films are optically transparent (>90%) in the visible range (400-700 nm) having hardness values in the range of 3000-3200 kg/mm^2. The surface morphology and structure of these films was found to be strongly dependent upon the feedstock gas ratio (B_2H_6 to NH_3)

Silicon Devices, MEMS and Sensors

Improved silicon photodiodes were designed and developed in NPL. The performance of the device was improved by tailoring the dopand profile of P in the n^+ region of p^+-n -n^+ (PIN) photodiode by controlling drive-in temperature and time subsequent to diffusion .The structure of the photodiode is shown in Fig 4.3, it had a Ti/Ag (500A°/8000A°) rim in the p^+ front emitter near the periphery and a completely covered n^+ back emitter. The V_{oc}, dark reverse I-V characteristics as a function of temperature, spectral response, reflectivity of the emitter and quantum efficiency were measured. Effect of properties of n^+ back emitter on the diode characteristics was analysed. Spectral response (SR) and quantum efficiency (QE) showed significant improvement in long wavelength range and the dark reverse I-V characteristics showed lower leakage currents when the depth of the L-H junction at the back was higher.

A part of the processing for some PIN photodiodes using n-type (1000 Ω cm FZ) silicon and involving oxidation, photolithography, diffusion and Al-Si metallization was also carried out at CEERI, Pilani. The spectral response of the photododes in the 350-800 nm range was found to be as good as that of UDT photodiode (RD100). However, in the 800-1100nm wavelength region, SR was inferior in comparison to that of the UDT photodiode (Fig. 4.4) because the value of minority carrier lifetime in the base region of our photodiodes was rather limited (~16 μ s).

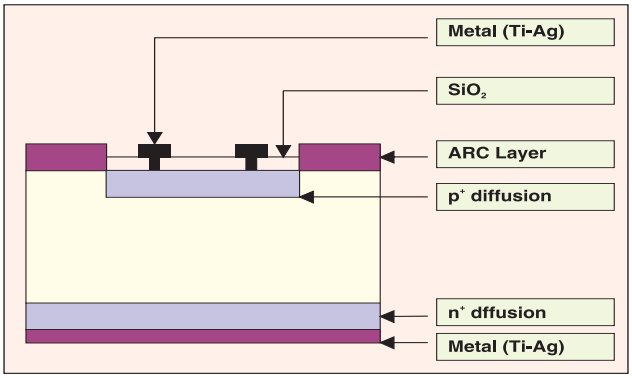


Fig. 4.3 Cross section of silicon PIN photodiode

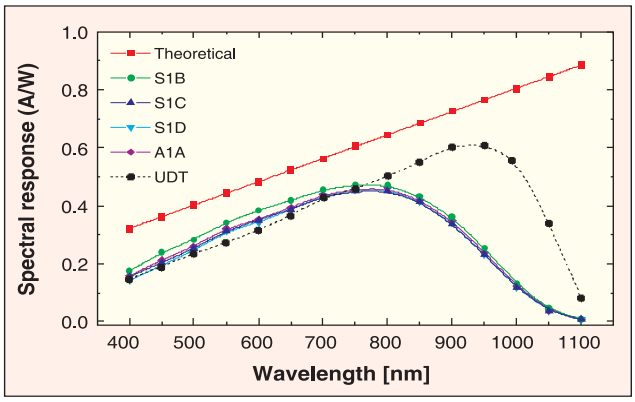


Fig.4.4: Spectral response of PIN silicon photodiode and a photodiode from UDT.

An improvement was made in the application of "Photocurrent Generation Method (PCG)" for measurement of minority carrier lifetime is p-type silicon wafers. The Photocurrent Generation Method is based on an induced n^+-p-p^+ structure, which results from creation of inversion and accumulation layers in p-Si wafer. The layers are created by deposition of thin semitransparent Al and Pd layers on the two sides of the p-Si wafer. For illumination from the p^+ side the photo generated short circuit current density (J_{sc}) for illumination from the p^+ side is related with the intensity (P_{in}) of the incident light as

$$J_{sc} = \frac{q\lambda\,(1-R_\lambda)LL_\lambda}{hc(L^2-L_\lambda^2)\cosh(w/L)}P_{in}$$

where R_λ is the reflectivity, w is the wafer thickness and d_p is the accumulation layer (p^+) thickness and $L >> L_\lambda >> d_p$. Here L is the diffusion length of electrons and L_λ is the reciprocal of the absorption coefficient α_λ of the incident monochromatic light. For most cases of interest $w >> d_p$ and surface recombination velocity of electrons in the p-region near the accumulation layer is small ($< 10^3$ cm/s). For the wavelength of the incident light in the 750-900nm range, the J_{SC} vs. P_{in} curve is a straight line and its slope $\phi = dJ_{SC}/dP_{in}$ can be utilized to obtain L using the equation

$$L = w/\cosh^{-1}(\phi_m / \phi)$$

where $\phi_m = q(1-R_\lambda)\lambda/hc$

The test structures were made on highly polished p-Si wafers. In the earlier methodology a semitransparent layer of Pd on one side and that of Al on the other side of the wafer were deposited after growing a 100 Å thick layer of thermal SiO_2 . In the present case the deposition of Pd & Al layers was done directly on the polished surface without growing SiO_2 layer, thus avoiding the heat treatment of the wafers . The photocurrent was measured as a function of intensity of light (determined using a reference silicon solar cell of known spectral response) using 853 nm interference filter. It was found that exposure to atmosphere ambience deteriorated the quality of the p^+-p-n^+ structure and gave lower value of τ (Fig.4.5). When the measurements were carried out by keeping the specimen under vacuum no degradation of τ was observed. It thus provided a reliable way of application of PCG method for measurement of lifetime without subjecting wafer to any heat treatment. It is important since heat treatment is known to generally degrade the lifetime of minority carriers.

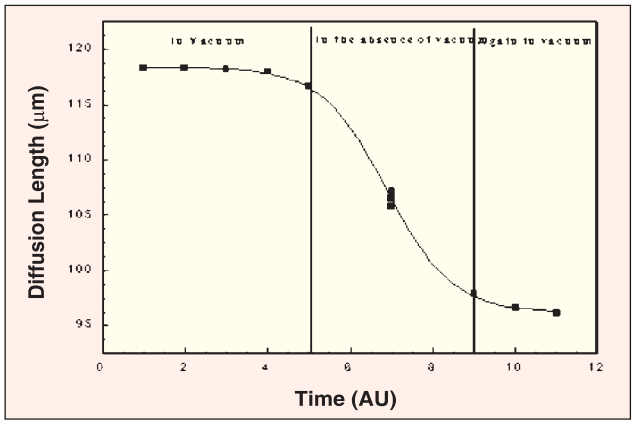


Fig. 4.5:The effect of delayed measurement on the value of τdetermined by PCG method. The middle part of the curve shows that exposure to atmosphere has a deleterious effect on the induced p^+-p-n^+ structure leading to erroneous values of τ. Time is in units of 12 hr.

Nano and micro structured porous-Si (PS) has been grown on <100 >, <110> and <111> Si substrates. The effective thickness (x) of the PS formed and the refractive index (μ) were measured by an ellipsometer. All these measurements were made as a function of anodization current density (J in mA cm^{-2}) and time (t in min.) of PS formation. The x vs. t data was fitted to parabolic, linear parabolic and power law ($x = at^c$ where c is a dimensionless constant and a is in nm $min.^{-c}$). The power law gave the best fit with coefficient of correlation (r^2) approximating to 99.9%. The values of n were found to be highest for <111> and least for <100>.The value of refractive index μ varied from 1.85 to 2. The reflectivity (4-6%) and pore sizes (200-400 nm) showed strong dependence on orientations and growth conditions.

Experiments related to antireflection properties of solar cells using films such as titanium oxide, silicon oxide, and silicon oxide over silicon nitride film, on silicon solar cell were carried out . Silicon nitride film has been deposited by PECVD method. Titanium oxide and silicon oxide deposited by electron beam evaporation method. It has been observed that spectral response improved further by using these films as second ARC layers. Spectral response was measured in the wavelength region 400-1100 nm, using a standard secondary reference solar cell supplied by PRC Krochamann, Germany. From these SR data and reflectivity R_λ of the front surface internal quantum efficiency (Q_{int}) and diffusion length were determined. Effect of annealing of silicon solar cells in hydrogen was investigated for its effect on spectral response.

In depth composition of silicon nitride film deposited by PECVD on screen printed solar cell was studied by using X-ray photoelectron spectroscopy as a function of take off angle. The method allows the study of silicon nitride layer on screen printed solar cell. Presence of carbon and oxygen in silicon nitride layer was detected by XPS.

Nanostructure devices, Optical thin films, Electrochromic devices, Polymer devices

Nanostructure devices

Systematic investigation of exchange bias development in the NiFe/FeMn/NiFe trilayer system used in spin valves, prepared by magnetron sputtering was carried out. Nanoparticles of the ferromagnetic semiconductor oxide, ZnO doped with 5 to 20% cobalt, were synthesized by thermal decomposition of a citrate precursor complex at 400°C. Doping leads to ferromagnetic hysteresis loops with a coercivity around 50 Oe at room temperature. UV-visible spectra show the absorptions corresponding to the d-d transitions of Co^{2+} in the tetrahedral sites of the ZnO wurtzite structure at 565, 615 and 660 nm corresponding to the $^4A_2(F) \rightarrow {}^2E(G)$, $^4A_2(F) \rightarrow {}^2T_1(P)$, $^4A_2(F) \rightarrow {}^2A_1(G)$ transitions, which confirm substitution of Co at the Zn site. Barium hexaferrite films of micrometer scale thickness, with potential application in microwave devices, were prepared on quartz substrates using a spray pyrolytic deposition method, starting from a citrate precursor solution. Influence of annealing on magnetic and structural properties were carried out.

Nanocrystalline ZnO and SnO_2 powders were prepared using hydrothermal route. Effect of surfactants such as AOT, CTAB and SDS on the powder preparation was studied. Nanosized powders of spherical and rod like shape were obtained depending on the additives. Hydrothermally prepared nanocrystalline powders were tested for the sensitivity to CNG and LPG. No appreciable change in sensitivity was observed for CNG but the sensitivity to LPG increased by almost one order of magnitude. The recovery time however deteriorated for these sensors. Complete sensor devices were fabricated using. Pastes developed from the tin oxide powders prepared by different routes. A procedure for high temperature lead attachment using resistance welding was optimized. The sensor devices are using regularly investigated in the test facility setup as part of the DST project.

Sensors were fabricated in porous silicon formed on textured substrates. For measuring the sensitivity to gases, the samples were placed in a test chamber and diluted ethanol, methanol and water-vapours using argon as the carrier gas were passed over them and corresponding changes in photoluminescence and electrical resistivity were monitored at different intervals of time. A blue-shift in PL peak position from 700 nm to 600 nm was observed for PS sample prepared at Id = 20 mA cm^{-2} when exposed to ethanol vapors for 20 min. However, the PL intensity remains the same upon exposure to ethanol. However, PS sample when exposed to H_2O-vapours exhibits a drastic reduction in PL intensity and a relatively higher blue-shift in PL from 700 nm to 560 nm as compared to ethanol-exposed PS sample for the same time of exposure. The PS sample shows lower response towards methanol gas as evident from a marginal reduction in PL intensity and blue-shift in PL peak position from 700 nm to 690 nm respectively. Resistivity studies using electroless gold contacts reveal that PS sample prepared at Id = 20 mA cm^{-2} shows maximum and minimum sensitivity ($\triangle R/R$) values ~ 90% for both ethanol and humidity and ~ 40 % for methanol gas respectively. With increase in current density, the response time in general decreases and the sensitivity value increases for PS samples upon exposure to ethanol and humidity in particular.

Optical thin films

The fabrication of optical thin film multilayer narrow bandpass filters in the 750 – 950 nm range was undertaken. Several deposition runs were carried out in the Leybold L-560 vacuum coating plant, to deposit multilayer coatings of around 30 layers. Typical specifications of the filter coatings developed are : centre wavelength 900 nm, bandwidth 16 nm, peak transmittance about 90%, stopband (transmittance less than 1 % and no sidebands) range 840 – 1020 nm. The spectral characteristics of a few such filters are shown in Fig. 4.6.

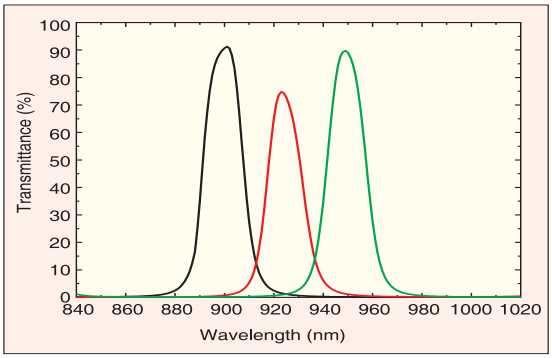


Fig. 4.6 : Spectral characteristics of three typical narrow band pass filters with centre wavelengths at 900, 924, 950 nm

The fabrication of various components and sub-systems, and the assembly and trail run operation of a home-made parallel plate plasma polymerization reactor, were undertaken successfully. The system is to be used for depositing SiO_2-like and TiO_2-like polymeric films on plastic lenses for ophthalmic applications, using liquid precursors like TEOS and TIPT respectively. Some films have been deposited and characterized for their optical properties and chemical composition, with promising results. A view of the deposition chamber with a plasma discharge inside is shown in Fig. 4.7.

Fig. 4.7 Home-made plasma polymerization deposition system

Fabrication of prototype electrochromic windows

In order to attain the ultimate objective of fabricating prototype electrochromic windows based on WO_3 and Fe^{III}_4 $[Fe^{II}(CN)_6]$ (Prussian Blue - PB) , of dimensions 300mm x 300 mm, dip-coating and galvanostatic electrodeposition techniques were adopted. Optimization of various parameters to deposit the films, so as to give the best possible electrochromic response when incorporated into a transmissive device for window application, was carried out critically. This mainly involved, in addition to other properties like uniform coatings with high cosmetic quality, high optical modulation, getting comparable ion storage capacity of the films when operated at the same voltage. Typical characteristics are shown in Fig. 4.8. Films deposited under such optimized parameters when incorporated into a prototype electrochromic window (Fig. 4.9) exhibited good performance.

Polymeric Materials and Devices

Conjugated polymers and composites have been

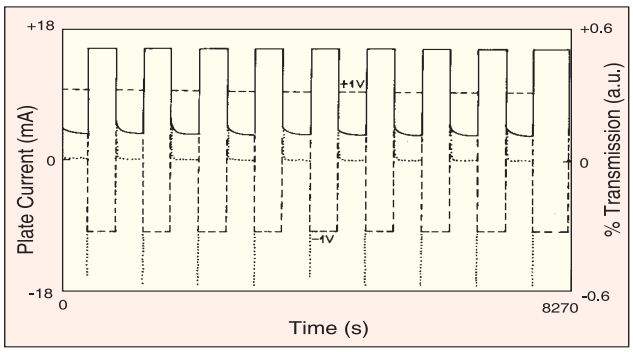


Fig. 4.8 Typical characteristics of electrochromic films of prussian blue

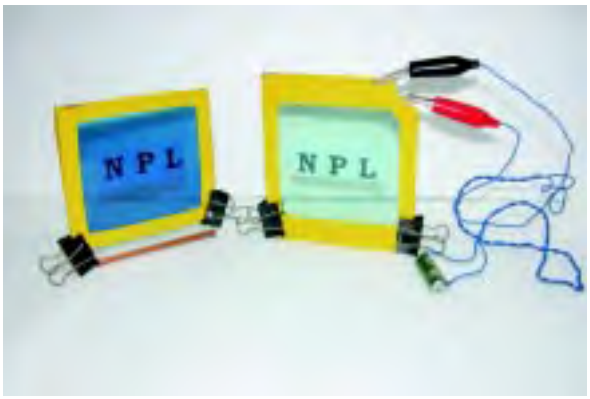


Fig. 4.9 Prototype electrochromic window developed at NPL

synthesized and characterized for their application in the development of polymer solar cell.

Poly(3-octylthiophene) (P3OT) has been synthesized by chemical oxidative polymerization technique at low temperatures -40^{0}C using an oxidant ferric chloride ($FeCl_3$) in an inert atmosphere. De-doping of the synthesized polymer has been performed by ethylenediaminetetraacetic acid (EDTA) and liquid ammonia (NH_3) to get different doping levels in P3OT polymer matrix. Films of P3OT having different doping levels were prepared by solution evaporation technique at room temperature. The synthesis of the polymer was confirmed by Fourier transform infrared (FT-IR) spectroscopic technique. Scanning electron microscopy (SEM) studies reveal the gradual evolution of a partial crystalline mat-type structure as dopant is washed out stepwise. This is attributed to the lamellar 3D-type partial crystalline growth in this polymer. The effect of de-doping on the surface morphology and conductivity of P3OT films having different dopant level have been studied. The effect of annealing on the surface morphology

and conductivity of P3OT films having an intermediate doping level has also been seen. It is observed that the annealing increases the periodic arrangement of the polymer chains thereby increasing the conductivity with increase in annealing time. This is probably due to the increased charge mobility because of the better polymeric chain arrangement and its planarity in this conjugated polymer matrix. Synthesis and characterization of poly (3-hexylthiophene) (P3HT) are also in progress along with P3OT and other conjugated polymer and its composites.

Investigations of charge transport in P3OT thin films was undertaken to find out its suitability for its application in polymer solar cell. Current density-voltage (J-V) characteristics on samples of thin films of P3OT were studied with and without incorporation of an interface layer. It has been observed that the incorporation of an interface layer makes it efficiently hole injecting. This efficient hole injection changes the charge transport behaviour from ohmic to non-linear having four regions of conduction. When this study on P3OT thin films was carried out as functions of thickness and temperature in the device configuration mode, it suggests that the possible charge transport mechanism is space charge limited conduction (SCLC) at moderate and high fields. The estimated values of charge transport parameters i.e. average free carrier density (n_0), density of traps (N_t), free carrier mobility (μ_0), effective mobility in the presence of shallow traps (μ_e) and activation energy (E_A) are ~$1.1x10^{14}$ cm^{-3}, $3.3x10^{16}$ cm^{-3}, $0.8x10^{-2}$ cm^2/Vs, $1.0x10^{-4}$ cm^2/Vs and 0.19 eV, respectively.

Fundamental investigations have been performed on solution grown films of poly(vinylidene fluoride) (PVDF) for using it in making polymer electrolytes for application in super capacitors. The brief results are given here. AC conductivity [$\sigma_m(\omega)$], dielectric constant [$\varepsilon'(\omega)$] and dielectric loss[$\varepsilon''(\omega)$] of solution grown poly(vinylidene fluoride) (PVDF) films (thick. □ 85-100 μm) have been measured in the temperature range 77-400 K and in the frequency range 100 Hz-10 MHz. A frequency dependent conductivity described by the relation $\sigma(\omega) = A\omega^s$, is observed in the low temperature region where $s < 1$ and is independent of temperature up to 200 K and decreases with increase in temperature. The density of states at the Fermi level [$N(E_F)$] estimated at 77 K is □ $1.1x10^{18}$-$4.8x10^{19}$ cm^{-3} eV^{-1}. The dielectric constant in the low temperature region (<200 K) shows a very weak frequency and temperature dependence. However, in the higher temperature region (>250 K) a strong frequency dispersion of dielectric constant and strong temperature dependence of ac conductivity are observed. Three relaxations; the α_c-, the α_a- and the β-relaxations, appearing from high temperature side to the low temperature side in the dielectric loss versus temperature spectrum, having activation energy ~0.232-0.474, ~0.189-0.226 and ~0.052-0.068 eV, respectively have been observed in the present investigation. The α_c-relaxation is attributed to the molecular motions in the crystalline regions of the polymer main chain whereas the α_a-relaxation is assigned to the micro-Brownian motion of the main polymer chain in the amorphous regions of the polymer matrix. The β-relaxation is attributed to the rotation of the side group dipoles or to the local oscillations of the frozen polymer main chain. The activation energies(~ 0.02-0.05 eV) of the charge carriers calculated at 77 K indicates the evidence of electronic hopping conduction in the low temperature region.

High Temperature Superconducting (HTS) Materials/Devices and Advanced Ceramics

Applied Research Studies

High superconducting (Bi-Pb)-2223 10 wt.% Ag rod/tube current leads of various dimensions have been fabricated (Fig. 4.10) using an improved and low cost process for their use in cryogen free magnet systems. Metal electrode portion contact resistivity is not more than $0.02\mu\Omega.cm^2$ and the critical current (I_c) is not less than 200A at 77K in self-field. Further, these bulk current leads can carry continuous current of 200A for at least 2 to 4hrs. without adding any heat load to the cryogen (A patent has been filed: 160 NF 2005). A 43cm long (ID=42mm, OD=45mm) tube conductor of (Bi-Pb)-2223: 10 wt.% Ag is under development. After initial sintering for 80 hours, an I_c up to 50Amps has been studied.

In continuation of work on joining of bulk tubes of Bi(Pb)2223, several experiments were done for optimization of processing parameters to make a superconducting joint with reliability and

reproducibility. This lead to a novel method for joining tubes of length varying from 100 to 300mm, OD varying from 10 to 30mm and ID varying from 10 to 28mm. The joint made according to this method is not only mechanically strong but is also able to stably carry not less than 85% of the critical current of the component superconducting tubes. Incidentally this is the first report in literature.

A 30 meter long monofilamentary silver clad (Bi,Pb)-2223 superconducting tape (Fig.4.11) with end-to-end superconductivity having J_c of the order of $10^4 - 10^5$ amps/cm^2 at liquid helium temperature (4.2K) has been fabricated. The sintering process of such long length tapes has been developed by NPL group indigenously. A three-zone muffle furnace which was under optimization process having a constant zone length of 90cm, dia 10cm with a temperature variation of $\pm 2^oC$ max, indigenously fabricated by the group has been successfully tested, calibrated and installed. This furnace is being used for sintering of long length (43cm tube, more than 30 meter tapes have already been processed) HTSC products.

Work on MgB_2 superconductor has been initiated by powder in tube (PIT) technique. Various sheath materials e.g. mild steel, stainless steel, copper have been tried (Fig.3). In copper clad MgB_2 monofilamentary tapes, J_c is 10^2 amps/cm^2 at 4.2K in self-field. A $J_c \sim 10^4$ amps/cm^2 at 4.2K in self-field has been achieved in MgB_2 embedded in mild steel , optimization studies are in progress.

Fig. 4.10 HTSC $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10+x}$ (10wt.% Ag) Rod/ Tube Current leads of various dimensions [L X O.D. X I.D. in mm]
i) Rod : 115 X 4 ii) Rod : 135 X 7
iii) Tube : 100 X 12.4 X 10.0 iv) Tube : 300 X 12.4 X 10.0
v) Tube : 200 X 30.8 X 28.0 vi) Silver Metal Electrode
vii) (Bi,Pb)-2223 Superconductor

Fig. 4.11 30 meter long monofilamentary silver clad (Bi,Pb)-2223 superconducting tape

Fig. 4.12 Stainless steel, mild steel and copper clad monofilamentary MgB_2 tapes.

Basic Research Studies

ESR studies of magnetic impurity Eu-doped (0 – 0.12 mole%) Bi(Pb)2223 with angular variation (0 – 360^o) both at 300K and at 105K (near below $T_c^o \sim 110$K) were carried out in order to see the role of Eu in the formation of VBS. At 300K, all the samples showed not only a main line at g~2.002 (nearly free electron value) with satellite lines on either side of it but also shifting of these latter lines with angular variation. This shows the presence of conduction electron spin resonance (CESR) with Platzmann Wolf spin waves. This suggested the enhancement of correlation effects at E_f. Further, reduction in the intensity of the entire spectra on lowering temperature to 100K indicated strongly the role of exchange interaction in pairing in HTS. Furthermore, the observation of reduction in signal intensity on doping with Eu is an indicative of probable formation of virtual bound state. ESR studies of MgB_2 were also done showed similar variations.

Advanced Ceramic Materials and Devices

Development of Piezoelectric Ceramic Material possessing high dielectric permittivity along with high charge constant.

Development of Piezoelectric Transducer elements for A.E. Sensor :

To achieve high electromechanical and Dielectric parameters for Acoustic Emission (AE) Sensor application the Lead Lanthanum Zirconate Titanate (PLZT) of different compositions were prepared by conventional mixed oxide route. The disc shape sample of 12 mm diameter having thickness (1mm

to 3.0 mm) and high value of d_{33} (Piezoelectric charge constant of the order of (550 - 600 × 10^{-12} C/N) were achieved. The sample of 800 kHz resonant frequency were prepared from them and tested by Vector Impedance Spectroscopic technique using computer controlled Solatron 1260 Impedance /Gain-Phase Analyzer coupled with Solatron 1296 Dielectric Interface.

An attempt has been made to modify the electromechanical properties of PLZT by addition of Cr_2O_3 (Y = 0-0.5wt% Cr_2O_3). The Vector Impedance Spectroscopic measurements revealed that this material posses high electromechanical parameters with low quality factor. Such materials are useful for Wide band A.E. sensor applications

Fabrication of Resonant type Acoustic Emission Sensor Devices

The various components required to fabricate the A.E. sensor device such as stainless steel (SS) casing, wear plate, backing materials etc. have been designed, developed optimised and produced. The resonant type A.E. sensor of frequency 800 kHz has been developed and tested through VIS technique. Four fabricated NPL make resonant type A.E. sensors with different design parameters have been handed over to BARC for A.E. testing. The comparison testing has been done which shows that most of the sensors are quite comparable with R-80 PAC Physical Acoustic Corporation (USA) make A.E. sensors. Further 03 Nos. of resonant type AE sensors have also fabricated with some modification in basic design of device along with 02 Nos. of wide band and 01 No. of resonant type A.E. sensor of frequency 300 kHz (both three terminal device) these devices have also been tested through VIS technique.

Special Ceramics

Sintering studies on ZST ceramics were carried out after preparing them by solid state reaction method. In an effort to lower the sintering temperature we have added 1 wt % NiO. Scanning electron Micrograph of ZST processed below 1350°C shows two phase structure with powdery un-reacted powders (Fig. 4.13). Where as Ni doped samples sintered at the same temperature reveals uniform microstructure with traces of second phase (Fig. 4.14). As a part of LPG sensor development Zn, Pb and Cu doped SnO_2 ceramic powders were prepared. Doping materials loss was analyzed by EDS. It has been found that loss of 5–8% Pb in the sintered samples as compared to as prepared powder. The resistance of these samples was measured in air between 50-250°C temperatures. In 50-150°C range resistance of the sensor element decreases at the rate of 0.04Ω/°C. where as beyond 150°C the change in resistance is decreased two orders of magnitude.

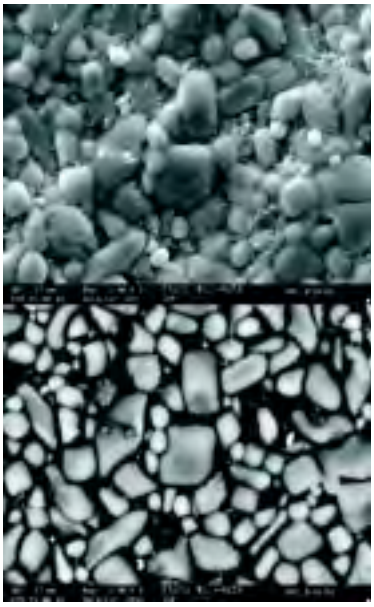


Fig.4.13 Scanning and back scattered electron micrograph of ZST : Ni sintered at 1350°C

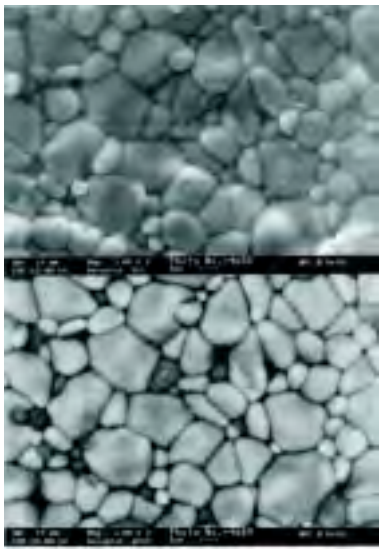


Fig.4.14 Scanning electron and backscattered electron micrograph of Zirconium tin titanate ceramics processed at 1350°C (ZST:1350)

Surface Physics and Nanostructures

The activity primarily addresses issues regarding phenomena that occur on the surfaces of solids. Special focus has been on the study of the initial stages of the heteroepitaxial growth of 2D and 1D nanostructures of metals on single crystal semiconductor surfaces and the relation between the core and shell structures of quantum dots as follows:

Formation of antimony 1D-nanostructures on Si (5 5 12) surface

We have studied the adsorption-desorption of Sb onto (2x1) reconstructed surface of Si(5 5 12). The experiments have been performed in UHV with *in-situ* growth and probed by using AES, LEED and EELS studies. The uptake curve shows the initial simultaneous multilayer growth of Sb upto 4ML and then covers the Si surface completely at 20ML. Annealing the RT formed interface system to about 790^{0}C results in (1x1)-Si (337) facets at a low coverage of about 0.2ML. The anisotropy in the LEED spots suggest an ordered Sb adsorption along ($\bar{1}10$) and a local disorder in the (66 $\bar{5}$) direction. Thus we suggest the formation of a zig-zag 1D-nanowire of Sb grown on the (5 5 12) as a result of various competing kinetic and thermodynamic factors.

PbO capped Pb nanoparticles

The study addresses the issue of surface passivated cap layer formation of the Pb nanoparticles The nanoparticles formed by Differential Mobility Analyzer have sizes of 15, 17.5, 20, 25 and 30 nm as determined by Transmission Electron spectroscopy (TEM) and Atomic Force Microscopy (AFM) studies. Analysis of Pb core level from the nanoparticles show two different oxidation states of lead, corresponding to Pb(II) and its reduced state Pb(0). The Pb and O core levels were monitored after controlled Ar^+ ion bombardment that eroded by surface layer by layer. The depth profiling study along with deconvolution of the core the core levels of Pb and O, showed that the core is made up of Pb nanoparticles that are stabilized by the lead oxide layer acting as the shell. The results have been explained by the enhanced redox reactions in the nanophase causing the surface cap layer formation. While the PbO shell passivates the Pb core, the cap layer consists of a high defect density.

TOPO capped CdSe Nanoparticles

Monodispersed and semiconducting CdSe nanoparticles of varied sizes were synthesized using CdO and Se as precursors and TOPO (trioctyl phosphine oxide) as a capping agent. The nanoparticle sizes were determined using UV-Vis and the monodispersity was ascertained from photoluminescence studies. The formation of monodispersed and stoichiometric CdSe could be obtained at an optimum precursor ratio (Cd/Se) of 2:1. XRD results of CdSe (3:1) & (1:1) cases showed a humped background suggesting polydispersity unlike in 2:1 case where a flat background was obtained. Also the XPS studies with the depth profiling of CdSe nanoparticles using Ar^+ ions determined a stoichiometric CdSe with 2:1 as a starting ratio. The XPS results were used to model the CdSe nanoparticles indicating the excess of Se inside CdSe (1:1) and a Cd capping being formed at a higher precursor ratio of 3:1.

A. colour neutral Gd nanoparticle switchable mirror

This is the first report of the application of nanoparticle route for achieving an all-round improvement in the characteristics of rare-earth metal switchable mirrors. It has been shown that the use of Gd nanoparticles results in better colour neutrality than for polycrystalline alloy and multilayer films. The Gd nanoparticle sample also shows an improvement in optical contrast and response time in comparison to polycrystalline Gd films under identical measurement conditions. The observed improvement in colour neutrality is a direct consequence of a size dependent blue-shift of optical absorption edge, and the better optical contrast and response time are due to the enhanced surface area at nano-dimensions and the absence of a deteriorating effect of alloy formation in Gd/Pd interface. A size induced structural transition from hcp to higher symmetry fcc structure is observed in Gd nanoparticle films. This study opens up new research directions related to the size dependent tuning of switching characteristics and the possibility of fabricating switchable mirror devices at nanoscale.

पदार्थ अभिलक्षणन

MATERIALS CHARACTERIZATION

पदार्थ अभिलक्षणन

हाल के वर्षों में विभिन्न प्रक्रियाओं द्वारा संश्लेषित नैनो पदार्थों पर आधारित उन्नत पदार्थों तथा उपकरणों के विकास में जबरदस्त दिलचस्पी देखी गयी है। इन पदार्थों का अभिलक्षणन नैनों प्रौद्योगिकी पर आधारित और अन्य उन्नत पदार्थों के गुणधर्मों के नियंत्रण और विकास के लिए महत्वपूर्ण भूमिका अदा करता है। पदार्थ अभिलक्षणन प्रभाग के पास शुद्धता, तात्विक संयोजन, सूक्ष्म अशुद्धताओं का अनुमान लगाने, संरचनात्मक विश्लेषण, पारदर्शक अवस्थाओं की पहचान करने, सतही और इंटरफेस अभिलक्षणन तथा क्रिस्टल दोषों पर जानकारी मौजूद है। यह प्रभाग विभिन्न अनुप्रयोगों के लिए लगभग दोषरहित एकल क्रिस्टलों का विकास करने का कार्य भी कर रहा है। अंतर प्रयोगशाला सहयोगी कार्यक्रम के अन्तर्गत प्रमाणित संदर्भ सामग्रियों का आयोजन, तैयारी और प्रसार भी इस प्रभाग का एक अन्य महत्वपूर्ण क्रियाकलाप है।

पदार्थ अभिलक्षणन सुविधाएं एन.पी.एल. के विभिन्न अनुसंधान और विकास समूहों एवं अन्य संगठनों/उद्योगों को भी प्रदान की गयीं। यह प्रभाग विभिन्न सी.एस.आई.आर. नेटवर्क परियोजनाओं में भी सक्रिय रूप से कार्य कर रहा है जैसे कि 'प्रथा अनुरूप विशेष पदार्थ' CMM (022) तथा प्रमाणित संदर्भ पदार्थों CMM (022) को तैयार और प्रसारिता करता है, इस अवधि के दौरान किए गए कुछ महत्वपूर्ण अनुसंधान और विकास कार्य इस प्रकार हैं :-

(i) ग्रीन हाउस गैसों (GHG_2) तथा विभिन्न स्त्रोतों से CO, NO-NO_2-NO_x CO_2 जैसे प्रदूषकों का विश्लेषण गैस क्रोमेटोग्राफी तकनीक का प्रयोग करके किया गया। एयरोसोलस आई एस आर ओ-जी बी पी भू अभियान, विकिरणों तथा सूक्ष्म गैस मापनों का दो चरणों में विश्लेषण किया गया और इससे प्राप्त डाटा का विश्लेषण किया गया। वातावरण सीमा परत और उससे ऊपर एरोसोल ब्लैक (BC) प्रोफाइलों को दिल्ली और हैदराबाद जैसे शहरी स्थानों पर पहली बार मापा गया। इस प्रकार प्राप्त किया गया डाटा जलवायु मॉडल तैयार करने में उपयोगी सिद्ध होगा।

(ii) अकार्बनिक अम्लों के साथ मिश्रित बहुलकों (पॉलीमरस) के चालन और देश में विकसित फिल्टरड कैथोडिक वैक्यूम आर्क (एफ सी वी ए) सिस्टम का प्रयोग करते हुए विभिन्न अभिनत (वायस) वोल्टताओं पर तैयार किए गए सिलिकॉन वेफरों पर जीम टेट्राहेड्रॉल एमार्फस कार्बन (ta-C) फिल्मों का ई पी आर स्पेक्ट्रोस्कोपी द्वारा अध्ययन किया गया। कुछ बहुलकों में बने चार्ज वाहकों की पहचान की गयी और मिश्रण स्तरों के साथ उनके सांद्रण के अन्तर का अन्वेषण किया गया। ई पी आर परिणाम इस प्राकल्पना का समर्थन करते हैं कि ta-C फिल्मों के गुणधर्मों पर वर्धन प्रक्रिया के दौरान डाली गयी सबस्ट्रेट बॉयस वोल्टता का प्रभाव पड़ता है। टैरनरी ऑक्साइड ग्लासिज पर भी ई पी आर अध्ययन किया गया।

(iii) जलीय आधार Ca Fe O_4 लौहद्रव को नियंत्रित के अन्तर्गत रासायनिक सह अवक्षेपण विधि द्वारा संश्लेषित किया गया और लौह द्रव चालन बहुलक फिल्मों को एक्स आर डी, टी ई एम तथ ई पी आर द्वारा विशेषीकृत किया गया। उन्नत सामग्रियों के कई प्रकार के बहुत से नमूनों को एस ई एम/टी ई एम तथा एक्स आर डी का प्रयोग करके विशेषीकृत किया गया जैसे कि कार्बन सिरैमिक सम्मिश्रण वाली ZnO पतली फिल्मों, PLZT पतली फिल्मों ZnS, SiO_2 जैल मैट्रिक्स में Mn नैनोफॉस्फोर, सन्दर्भ पदार्थ के रूप में प्रयोग किया जाने वाला a-Al_2O_3 पाउडर, Ni तथा Co उत्प्रेरक के साथ एमफिस और क्रिस्टलीक Si और La_3 Ba Ca CuO_{115} तथा $PbZrO_3$, $SrTiO_3$, $BaZrO_3$ जैसी सुपर कंडक्टिंग सामग्री आदि।

(iv) इस अवधि के दौरान नौ CRM_s के नए बैच, जो पहले तैयार किए गए थे पूर्ण और प्रमाणित किए गए । खाद्य, पेट्रोलियम, स्पेक्ट्रोस्कोपी तथा भू रसायनों के चार नए क्षेत्रों में CRM_s तैयार करने का काम आरम्भ किया गया है ।

(v) Fe-मिश्रित $LiNbO_3$ एकल क्रिस्टलों की संरचनात्मक पूर्णता पर तापानुशीतल प्रभाव का हाई रेजोल्यूशन एक्स-रे डिफ्रैक्टोमीटरी (HRXRD) एक्स-रे टोपोग्राफी (XRT) तथा FTIR स्पेक्ट्रोस्कोपी द्वारा अध्ययन किया गया है। पारदर्शक अवस्थाओं (क्रिस्टैलाइन) पूर्णता, पीजोइलेक्ट्रिक प्रतिक्रिया और .02 m01% Fe_2O_3 के साथ स्थानास्थ पोल किए गए $FeLiNbO_3$ क्रिस्टलों की प्रकाशीय पारदर्शिता का भी अध्ययन किया गया। स्लो इवैपोरेशन सोलूशन तकनीक (SEST) तथा वर्टिकल ब्रिजमैन तकनीक (VBT) द्वारा विकसित बेंजिमिडेजोल (BMZ) एकल क्रिस्टलों के अध्ययन यह दर्शाते हैं कि VBT द्वारा विकसित क्रिस्टलों की गुणवत्ता की तुलना में SEST क्रिस्टलों की गुणवत्ता बेहतर होती है।

(vi) UHV स्थितियों में ई बीम वाष्पण तकनीक द्वारा Si वैफर (100) पर बहुपरतीय संरचना तैयार की गयी और इस पर आयनों द्वारा प्रकाश डाला गया। का प्रयोग करते हुए इंटरफेस पर एक मिश्रित क्षेत्र देखा गया और अवस्था पहचान के लिए तथा रमन द्वारा और आगे अध्ययन किया गया। यह अध्ययन दर्शाता है कि आपस में जुड़ी संबद्ध दबी परत सिलिसाइड रचना के लिए, द्रुत भारी ऑयन किरणन का कक्ष तापमान पर प्रयोग करना भी फायदेमंद रहता है और इसमें थर्मल तापानुपीतन की जरूरत नहीं पड़ेगी।

(vii) एन पी एल में एक राष्ट्रीय कान्फ्रेन्स, भारतीय संदर्भ सामग्रियों से संबंधित अंतर प्रयोगशाला कार्यक्रम पर एक गोष्ठी, उपस्कर परस्पर तुलना पर एक बैठक, दो कार्यशालाएं और पदार्थ अभिलक्षणन तकनीकों पर एक प्रयोक्ता जागरूकता कार्यक्रम (UPMAT) आयोजित किया गया। लगभग तेंतीस अनुसंधान लेख विख्यात जर्नलों में प्रकाशित किए गए और आयोजित परियोजनाओं, परामर्शी कार्यों, परीक्षण तथा आशंकन के जरिए 24.89 लाख रूपए का ई.सी.एफ. अर्जित किया गया।

MATERIALS CHARACTERIZATION

In the recent years there has been a tremendous interest in the development of advanced materials and devices based on the nano materials technology synthesized by various processes. Characterizations of these materials play an important role for the control of properties and development of these nano technology based and other advanced materials. Material characterization Division has the facilities for purity, elemental composition, estimation of trace impurities, structural analysis, identification of crystalline phases, surface and interface characterization and information on crystal defects. This division is also engaged in the growth of nearly perfect single crystals for various applications. Planning, preparation and dissemination of certified reference materials under an inter-laboratory collaborative programme is another important activity of this division.

Material characterization facilities were provided to various R & D groups of NPL as well to other research organizations/industries. This division is also actively engaged in the various CSIR network projects such as "Custom Tailored Special Materials" CMM (022) and Preparation & Dissemination of certified reference materials (CMM 024). Some of the important R & D activities pursued during this period are:

(i) Green House Gases (GHGs) and pollutant viz CO, NO-NO_2–NOx CO_2 from different sources were analyzed using Gas Chromatography technique. ISRO-GBP land campaign on aerosols, radiation and trace gas measurements was carried out by NPL in two phases and the data so obtained were analyzed. Altitude profiles of aerosol black (BC) in the atmosphere boundary layer and above it were measured for the first time in India over the urban locations like Delhi and Hyderabad. The data thus received would be useful for climate modeling.

(ii) Conducting polymers doped with inorganic acids and tetrahedral amorphous carbon (ta-C) films deposited onto silicon wafers prepared at different bias voltages using indigenously developed filtered cathodic vacuum arc (FCVA) system were studied by EPR spectroscopy. Charge carriers formed in some polymers identified and variation of their concentration with doping levels were investigated. EPR results support the hypothesis that properties of ta-C films are influenced by the substrate bias voltage applied during the growth process. EPR study on ternary oxide glasses was also carried out.

(iii) Aqueous base $CoFeO_4$ ferrofluid was synthesized by chemical co-precipitation method under controlled pH and ferrofluid conducting polymer films were characterized by XRD, TEM and EPR. A large variety of samples of advanced materials such as carbon ceramic composition, ZnO thin films. PLZT thin films ZnS, Mn nanophosphor in SiO_2 gel matrix, a-Al_2O_3 powder to be used as a reference material, CAST's with Ni and Co catalyst, SnO_2, amorphous and crystallized Si and superconducting material like $La_3BaCaCuO_{11.5}$ and $PbZrO_3$, $SrTiO_3$, $BaZrO_3$ etc. were characterized by using SEM/TEM and XRD.

(iv) During the period new batches of nine CRMs, which were prepared earlier had been prepared and certified. Work on preparation of the CRMs in four new sectors namely food, petroleum, spectroscopy and Geo-chemicals has been initiated.

(v) Annealing effect on the structural perfection of Fe-doped $LiNbO_3$ single crystals has been studied by high-resolution X-Ray diffractometry (HRXRD), X-Ray topography (XRT) and FTIR spectroscopy. Crystalline perfection, piezoelectric response and optical transparency of in-situ poled Fe-$LiNbO_3$ crystals with .02 mol% Fe_2O_3 were also studied. HRXRD studies of, benzimidazole (BMZ) single crystals grown by slow evaporation solution technique (SEST) and vertical bridgeman technique (VBT) show that the SEST crystals have better crystalline quality than that of VBT grown.

(vi) A multilayered structure Si/Co/Si on Si wafer <100>was prepared by e beam evaporation technique under UHV conditions and was subjected to irradiation by 120 MeV Au^- ions .A mixed region at the interface was detected using SIMS and it was further studied by XRD and Raman for phase identification. The study reveals that swift heavy ion irradiation can be advantageously used for interconnect related buried layer silicide formation even at room temperature avoiding thermal annealing.

(vii) One national conference, one seminar on Inter laboratory programme on Indian Reference Materials, one meeting on equipment inter comparison, two workshop and one users awareness program of materials characterization techniques (UPMAT) was organized at NPL. About thirty-three research papers were published in reputed journals and ECF of Rs. 24.89 Lakhs through sponsored projects, consultancy, testing & calibration was generated.

Analytical Chemistry

Characterization of materials for ascertaining purity, chemical composition and environmental species by chemical metrology have been done for various areas viz. chemicals, ecology & environment, health, metals, minerals, manufacturing sector including scientific and technological support. This activity caters the need of industries, government agencies and institutions for characterization of a large variety of materials e.g. poly aluminum chloride and alumina ferric used for treatment of water by Delhi Jal Board; indelible ink for election purpose from Election Commission of India. The facilities utilized for trace metal analysis of materials are Flame Atomic Absorption spectrometer (FAAS), Graphite Furnace Atomic Absorption spectrometer (GFAAS), UV-Visible Spectrophotometer and Flame Photometer. The Gas Chromatographic techniques have been utilized for evaluation of gaseous samples from different sources for Greenhouse Gases (GHGs), and pollutants viz. CO, NO-NO_2-NO_x, CO_2 using respective online gas analyzers. Suspended particulate matter (SPM) and respirable suspended particulate matter (RSPM or PM-10) using high volume samplers were studied for their chemical composition. Aerosol size and mass distribution by Anderson and quartz crystal microbalance (QCM) have been studied in relation to anthropogenic influence on fog/ smog in Delhi.

ISRO-GBP land campaign phase-I on aerosols, radiation and trace gas measurements was carried out during the period Feb.1 to Feb. 29, 2004 and data were analyzed during 2004-05 period. Among other results, altitude profiles of aerosol black carbon (BC) in the atmospheric boundary layer and above it were measured for the first time in India, over the urban location Hyderabad, onboard an aircraft during two consecutive days of February 2004. The profile on both the days were consistent, and showed a rapid decrease in BC concentration within the boundary up to ~550m AGL (where convective activity prevailed). Sodar measurements from the nearby location revealed the mean boundary layer height to be ~600 m during the flight period. The decrease in BC above the boundary layer was quite weak up to ~2.2 km AGL. (Geophysical Research Letters, vol 31, L22103, doi: 10.1029/2004GL021336, 2004)

ISRO-GBP land campaign phase-II on aerosols, radiation and trace gas measurements was done during the period Dec.1 to Dec. 31 2004, by NPL. It was funded by ISRO-GBP under Dept. of Space. NPL is carrying out these studies in Delhi mega-city and in the Indo-gangatic plains as one out of eight sites in the region. These simultaneous measurements are first of its kind. It will provide extensive database for understanding the role of aerosols and trace gases for their radiative forcing over northern Indian region and would be very useful for climate modeling. Just before starting of the land campaign during Nov. 28-29, 2004, an inter-comparison of all the equipments was organized by NPL New Delhi for about 15 participating institutions which was inaugurated by the secretary DST Prof. V.S. Ramamurthy on 28th November 2004 (Figure-5.1).

Fig. 5.1 Participants of Teams of LC-2,

A field campaign on aerosols, radiation, boundary layer and trace gases measurements has been done, starting from January 29 to March 20, 2005 in Arunachal Pradesh, under the externally funded ISRO-GBP project on biomass burning in collaboration with NRSA Hyderabad. The measurements at a Jhum cultivation field sites near Itanagar region of Arunachal Pradesh had been done apart from month long background measurements. During this field study various equipments were used viz. O_3, NO_x, CO, CO_2, gas analyzers; Microtops-II for AOD & column ozone, UV-B Biometer, SPM, QCM, Anderson Cascade Impactor for aerosols, SODAR for boundary layer and Ambient air sampling system, etc. from NPL.

EPR & IR Spectroscopy

Electron Paramagnetic Resonance (EPR/ESR

Spectroscopy is one of the major techniques of the Division used for identification and characterization of paramagnetic centres/point defects/impurities in different substances. Such centers produced during different preparation/experimental processes may play important role in controlling the properties of the materials/devices and therefore detailed investigations about them become beneficial for optimizing the process parameters or properties of the materials. FTIR spectroscopy provides information about the vibration and rotation of molecular groups in a material, which is mainly used to determine the concentration of the impurities and their bonding with the host material.

EPR study of microstructure of many ternary oxide glasses depending upon composition was made under collaborative project with Physics Department, M.D. University, Rohtak. Glass systems with composition $xTiO_2$ $(30-x)Na_2O$. $70B_2O_3$ (series I) and $xTiO_2$ $(70-x)B_2O_3$.$30Na_2O$ (Series II) containing 2% V_2O_5 ($0 \leq x \leq 70$ mol%) were prepared by normal melt quenching method. The variation in EPR parameter $\Delta g_{11}/\Delta g_{\perp}$ with increase in TiO_2 content in series I show that the octahedral symmetry of V^{4+} O_6 complex is reduced whereas in series II the octahedral symmetry is improved. The $3d_{xy}$ orbit of the unpaired electron in the VO^{2+} ion expands with increase in TiO_2 content in both the glass series. The degree of covalency of the vanadium oxygen bonds also decreases with increase in TiO_2 content in all these glasses. The dc electrical conductivity was found to increase about 1000 times when temperature was raised from 373 to 523K but contribution of Ti ions in electrical conduction was not observed in glasses prepared with different TiO_2: Na_2O ratio. Results suggest that electrical conductivity is purely dependent on the concentration of mobile Na^+ ions. Therefore, it is concluded that Ti ions are introduced as network former in the form of Ti^{4+} and not as network modifiers in these glasses.

Tetrahedral amorphous carbon (ta-c) films are being studied with considerable interest because of their remarkable properties like extreme hardness, optical transparency over a wide spectral range and wide band gap semiconductor properties. In collaboration with our thin film group, we have monitored the density of spin defect states by EPR in different ta-C films deposited at different bias voltages by using an indigenously developed filtered catholic vacuum arc (FCVA) system. These films were deposited on well cleaned silicon wafers by applying a negative dc bias voltage to the substrate in the range 20-300V at a fixed arc current of 65A. A single narrow line EPR signal obtained in all samples was assigned due to the formation of dangling bonds of tetrahedral bonded carbon atoms of the films, which might have been formed to relieve the strain energy of tetrahedral network of the carbon atoms. The value of spin density of these dangling bonds was found to be 1.5 $\times 10^{19} cm^{-3}$ for ta-C film deposited at –20V substrate bias which has increased continuously to 1.2×10^{20} cm^{-3} with increase of substrate bias upto - 200V. However sample deposited at –300V showed no measurable dangling bond EPR signal. This is an unusual observation and on the basis of several considerations it is suggested that this may be due to the formation of graphitic form of carbon associated with substantial π-electron conjugation. These π-unpaired electrons may pair up with dangling bonds of ta-C atoms to reduce the elastic strain energy of the system. These results support the hypothesis that properties of ta-C films are influenced by the substrate bias voltage applied during growth process and EPR is a very convenient tool to study process parameters required for developing such materials. These results also suggest that ta-C films formed by these methods are not of good quality for electronic applications and further improvements in preparation method are required.

EPR study of conducting polymers was also continued in collaboration with different conducting polymer groups of NPL. Study of electric conduction phenomenon in polyaniline doped with hydrochloric acid (HCl) and para toluene sulphonic acid (PTSA) was made under research training programme for a M.Tech final year student from Birla Institute of Technology, Ranchi. Charge carriers in these samples were identified as polarons and concentration of the polarons was found to depend upon the level of doping and nature of the dopant used. A correlation of EPR and DC conductivity data was made to understand the mechanism of electric conduction. In HCl doped PAN samples, spin concentration have increased

nearly 25 times whereas electrical conductivity has increased about 7 times for increase in doping level from 0.1N to 1.0N. Similarly for PTSA doped samples, spin concentration has increased 3 times only but electrical conductivity has jumped 18 times for same increase in doping level. These results clearly suggest that doping not only increases carrier concentration but also changes the mobility of the carrier due to deformation in the lattice of the polymer during the doping process. In the case of HCl, which is inorganic acid, spin carrier concentration has increased tremendously but electric conductivity has not changed with same pace. It may be due to decrease in mobility of the charge carriers due to increased zig-zag interchain charge transport in HCl doped PAN samples. Further for doping with para toluene sulphonic acid, which is organic acid, electrical conductivity has changed considerably for relatively small increase in spin density suggesting thereby that mobility of the charge carriers has increased considerably with increase in doping level. These results suggest that organic acid has not disturbed the lattice network of interchain charge transport path as in case of HCl doped samples. However more experiments are needed to make such conclusions.

A new form of carbon known as "Nano foam" of carbon cluster has been developed in association with other groups of the NPL. This was synthesised in an electric furnace using graphite electrode in the presence of some metal oxide nanoparticles as catalyst. Characterization of this material by using EPR, X-ray, Electron Microscopy and other techniques is in progress and a patent application is also under process.

Analysis of diffuse reflectance and transmittance spectra of silicon and germanium was undertaken for developing diffuse reflectance standards for the mid IR region of 2.5 to 25 μm. Samples of various surface conditions were studied. These includes (i) both surfaces unpolished (ii) one side polished and other unpolished (iii) one side polished and other texturised and (iv) both sides polished samples. Further work is in progress. In collaboration with Electrochromic Materials and Devices Group, NPL detailed FTIR study of composite gel electrolytes based on poly (methyl metha acrylate) with $LiClO_4$ in propylene carbonate and hydrophilic fumed silica was also made for developing solid state electrochromic smart windows. Results revealed that surface hydroxyl groups of hydrophilic fumed silica linked through hydrogen bonding form a network, which may control transport as well as rheological properties of this material.

Apart from this a large number of samples from various groups of NPL related to various developmental projects were characterized by using EPR and FT-Raman Spectroscopy. Calibration of many IR systems like thermovision camera and IR thermometers from various organisations such as Power Grid Corporation of India, Nagpur, PCI Ltd, New Delhi, Sigma Sales, Jamshedpur, EMC Electronik, New Delhi and Punjab State Council for Science and Technology, Chandigarh was also carried out.

X-ray Analysis

X-ray diffraction from polycrystalline materials is widely used for crystalline phase analysis, structure determination, alongwith other structural information like degree of crystallinity, preferred orientation, mechanical stresses, lattice strains, etc. Crystalline phase analysis can be carried out both qualitatively and quantitatively. X-ray diffraction characterization is very important for development of new materials, fabrication of devices etc. X-ray fluorescence spectrometer is used for elemental analysis of major and minor constituents in materials such as metals, alloys ceramics, glasses, cements, clays, petroleum etc. Investigations on different types of materials from various research groups of NPL and outside organizations were undertaken.

Quantitative analysis of polycrystalline materials of industrial and environmental importance such as fly ash and synthetic diamond powder was carried out by the Rietveld method. The quantitative results obtained by the Rietveld and the chemical methods were correlated to obtain information on the amorphous phase of the samples.

Structural analysis of carbon-ceramic composite developed (by Carbon Technology unit) from coke, silicon and boron carbide was carried out. XRD analysis showed that improved oxidation resistance

is due to in-situ formation of silicon carbide during preparation and formation of protective boron and silicon oxide surface coatings on oxidation.

Structural characterization of ZnO thin films (prepared by IITD using sol-gel method with different precursor materials) was carried out. Single phase, crystalline films of ZnO with hexagonal structure were obtained. The calculated unit cell parameters were in close agreement with the PDF values. Crystallite sizes of films prepared with different precursors were compared. Structural characterization of PLZT thin films (prepared by IITD using RF magnetron sputtering was carried out. XRD phase analysis was used for optimization of various deposition parameters to get a pure perovskite phase of PLZT.

Tin oxide powders (prepared by EMD using different methods) for gas sensors applications were characterized by XRD. a) Powders prepared using solution precipitation technique after adding different surfactants in as-prepared and calcined at different temperatures were analyzed. Average crystallite size increased with calcination temperature. Low angle XRD did not show any mesoporous crystalline structure. Characteristics of tin oxide powders prepared by hydrosol method were compared with those prepared by conventional method of homogeneous precipitation. Crystallite size of powders prepared by hydrosol method was substantially smaller as compared to the conventional method.

Structural characterization of nanowires in alumina templates (prepared by EMD using electrodeposition method) was carried out. The pulse and DC electrodeposited nickel wires showed preferred orientation in different crystal directions. In addition, pulse deposited wires had smaller crystallite size which could be varied with pulse conditions. Structural characterization of chalcogen and chalcogenide nanowires was also carried out.

Structural characterization of ZnS:Mn nanophosphor in silicon oxide gel matrix (prepared by LMD using sol-gel method) was carried out. The samples showed zinc blende structure. On annealing, the crystals grew in size and phase transition from cubic to hexagonal phase was observed at high temperature. Crystallite size of ZnS was estimated to be about 5-7nm. Structural characterization of SnS films (prepared by EMD using electrodeposition) was also carried out. The SnS films showed orthorhombic structure upon annealing in air, the films oxidized to tin oxide.

In continuation of earlier work on Radial Mode Piezoelectric Response of La Modified Lead Zirconate Titanate Morphotropic Phase Boundary Region, further work was done on Chromium Modified (PLZT) in the range of Cr_2O_3; $0 \leq x \leq 0.5$ with $\Delta x = 0.025$. Specimens prepared in various mol% of Cr_2O_3 were characterized for phase boundary analysis before and after annealing. The splitting of reflections (002) and (200) in X-ray diffraction patterns clearly indicates Tetragonal structure.

In the IRM activity under the project of planning, preparation and dissemination of certified reference materials, prepared a -Al_2O_3 powder for the calibration of intensity standard of powder X-ray diffraction equipment. The starting material was electronic grade used for preparation of high tech ceramics. This powder was ball milled and sieved to obtain the particles of sizes $\leq 20\mu m$. The crystallinity of the material was improved by annealing the material at 1400°C for 11 hrs. The XRD pattern was recorded with a step size of 0.005/3 sec with specimen spinning speed of 30 rpm. The entire powder pattern shows the material is well crystalline with FWHM of 0.045° for 113 diffraction peaks. The pattern matches well with PDF file 10-0173 of ICDD which is for orthorhombic unit cell of dimension a =13.1733, b=6.9747, c=5.1099. The repeatability of the powder data result was verified by ten different experiments performed over a period of time. The material is now ready for the round robin testing to various participating laboratories for certification.

Research work was continued on synthesis and characterization of ferrofluid.Aqueous base $CoFe_2O_4$ ferrofluid were synthesized by chemical co-precipitation method under controlled pH. These nanoparticles lies in the range of 5-15 nm. The magnetization of the particles is 40 emu/cc. These particle were utilized for the development of Carbon nano foam in a electric arc furnace at 3600°C. XRD pattern of this material shows a peak at low 2θ value (d=20.22066), which is due to the presence of carbon nanotube. The XRD pattern and electron diffraction

confirm the crystalline phase of nanoparticles used and a peak corresponding to (002) plane of highly crystalline graphitic phase. A narrow EPR signal superimposed on broad base line has also been observed. The electron micrograph shows that nano particles of catalyst used are embedded in the nano foam and these particles are in the range of 5 –30 nm. Ferrofluid conducting polymer films were prepared with different concentration of ferrofluid. The mixture was homogenized by ultra sonification and films were prepared on glass substrate using spinning technique under the influence of with and without magnetic field. Films were characterized by XRD, TEM/SEM and microwave measurements. The study reveals that the polymerization techniques of ferrofluid composite materials have potential for EMI shielding.

Electron Microscopy

Electron Microscopy is an important technique to characterize the materials at nano- and micro-scale. The two major equipments associated with this are scanning electron microscope (SEM) and transmission electron microscope (TEM). The SEM mainly concerns with the surface structure analysis of a given specimen and with the attachment of energy dispersive spectrometer (EDS), the equipment enhances its capability by analyzing elements and compounds present in different areas of the specimen at micro-scale. In contrast the TEM is devoted for internal structure studies of the specimen at higher magnifications and in reciprocal space it characterizes the lattice structure of different phases constituting the material.

The group is involved in characterization of various types of materials including the metallic, semiconductors and amorphous using the SEM and TEM. An extensive work is being carried out on nano-structured materials prepared by different routes available in the form of powders and thin films by different divisions in NPL and outside academic institutes, laboratories and industries. Growth and characterization of various materials like InSbBi thin films, nanostructured ZnO (nanowires and tetrapods along with luminescence measurements) and In_2O_3 is also a significant part of the group activity. Our activity in the field of ZnO has resulted in filing of a patent.

The present SEM is a PC controlled SEM model LEO 440 and fitted with turbo molecular pump for producing clean vacuum. It has secondary & back-scattered electron detectors, cathodoluminescence detector and specimen current monitor to investigate the microstructure of materials under different mode of operations. SEM has an attachment of energy dispersive spectrometer (EDS, Oxford Link ISIS 300) which uses Si(Li) detector to analyze elements from atomic no. 5 to 92 with a resolution of 133 eV. A heat & cold stage (model Gatan C1003) and a tensile stage (model Gatan Microtest 300) are also available as attachments with SEM. These stages are capable of examining the specimen at various heating temperatures (-185 to 400 °C) and at different load conditions (up to 300 N) under the electron beam so the in-situ microstructural changes can be studied.

Various groups in the laboratory working on the development of advanced materials for different applications have extensively used the SEM facility. About 200 samples were characterized with SEM and more than 50 samples were subjected to EDS analysis. Some of the materials characterized by SEM/EDS are CNT's with Ni & Co Catalyst, SiC with B_4C composite, Al_2O_3 pure and Pt coated, B2223 superconducting compound, MEMS structures on Si, nanstructured Si, TiO_2 films on Si, tungsten oxide films, porous silicon.

The SEM/EDS facility has further extensively been used to help the industries located in and around Delhi for the characterization of their samples and giving them input in the form of test report to solve their problems associated with particle size analysis, surface microstructure, failure analysis, chemical composition of their products etc. More than 45 samples were analyzed. A sum of Rs. 4,25,000/- has been realized as testing charges for the same. The products analyzed were broken leaf springs from M/s Maruti, drug samples from M/s Ranbaxy, bitumen samples, clinker samples from M/s Grasim, boiler tubes from M/s NTPC etc.

The TEM (model JEOL JEM 200 CX) is operational and being used for microstructural characterization of variety of materials. The TEM facility is associated with modern techniques of sample preparation including the precision saw, variable speed grinder – polisher, ultrasonic disc cutter, dimple grinder,

dual ion mill etc. The TEM, working at electron accelerating voltage of 200 kV is a central facility, being utilized actively by various groups in NPL and outside R & D organizations. There were about 50 samples characterized and analyzed using TEM facility including the other groups in NPL. The materials are carbon nanotubes, fig. 5.2, whiskers, amorphous & crystallized Si, Ag nanoparticles, ZnO, SnO_2, CdTe. These materials are being prepared for possible applications in various fields such as gas sensors, electrochromic, electronic and nano-phosphors. Around 30 samples were analyzed for I.I.T. Delhi and other outside agencies. These materials were $La_3BaCaCuO_{11.5}$, $La_3BaYCuO_{11.5}$, $Nd_2Ba_2CaCu_5O_{11.5}$, vanadium phosphate of different grades, $PbZrO_3$, $SrTiO_3$, $BaZrO_3$, ZnC_2O_4.

The group is actively involved in various research projects. Among these the development of nano-phosphors sponsored by Department of Science and Technology and custom tailored materials under CSIR network scheme are the main. The materials prepared under these projects are being extensively characterized by SEM/EDS and TEM. Studies carried out on Pt and Pd nano-particles developed Fig. 5.3, under custom tailored materials are quite significant.

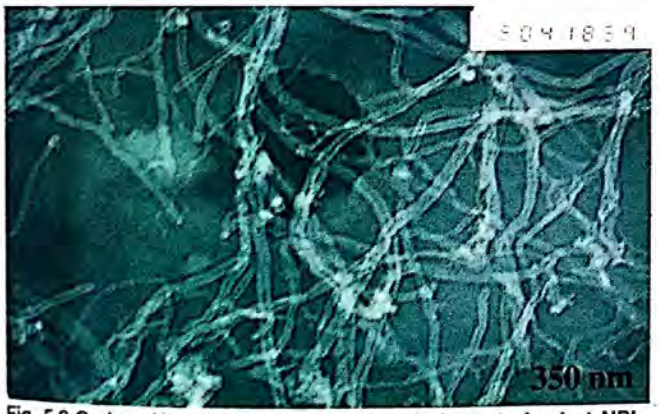


Fig. 5.2:Carbon Nanotubes developed and characterized at NPL

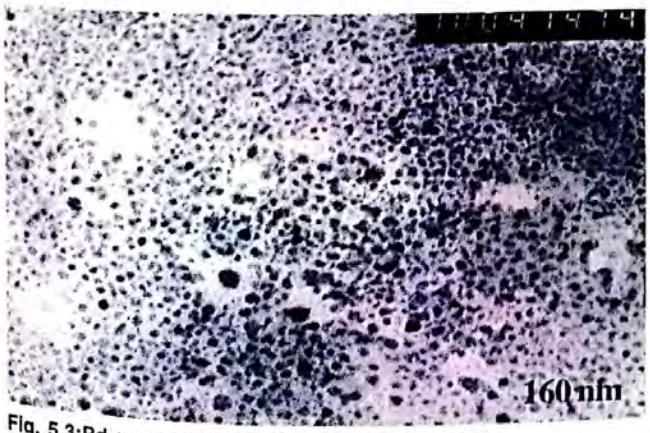


Fig. 5.3:Pd nanoparticles characterized at NPL

Indian Reference Material

Preparation and Dissemination of Certified Reference Materials and Chemical Metrology

Programme on preparation and dissemination of certified reference materials has been included as Task 4 in the CSIR Network project on Upgradation of SI Base Units, National Standards of Measurements & Apex Calibration Facilities and Creation of High Quality Network of Testing and Calibration Laboratories and Preparation & Dissemination of Certified Reference Materials (CMM 0024). Thirty top ranking laboratories including Bhabha Atomic Research Centres, Indian Agricultural Research Institute, R & D Centres of Indian Oil Corporation and National Thermal Power Corporation etc. are participating in the programme. This year work has been initiated for preparation of the CRMs in four new sectors namely Food, Petroleum, Spectroscopy and Geo-chemicals and nominated lead laboratories for their preparation are NGRI Hyderabad, IIP Dehradun, NML Jamshedpur and CFTRI Mysore. Scope in the areas where work is already in progress namely CRMs of elemental solutions, pesticides, gas mixture and silicon powder for X-ray diffraction is also enhanced and several new CRMs are under preparation. New batches of 9 CRMs, released earlier had also been prepared and certified. Following is the details of the work:

A. New CRMs

Work on preparation of following CRMs has been initiated

Geo-chemical	:	Gold Ore
Petroleum	:	Trace elements in fuel oil
Spectroscopy	:	Plain carbon steel
Food	:	Heavy metals in skimmed milk powder
XRD	:	α Alumina
Multi elemental solution	:	Natural Water I and II for cations and anions.
Mono Elemental Solution	:	Cobalt, Magnesium, Barium, Strontium, Sulphate and Chloride,

B. New Batches of Earlier CRMs

Following CRMs of mono elemental solutions had been prepared and certified:

Second Batch		
BND1401.02	Copper Solution	certified concentration 1.00 ± 0.02 mg/L
BND1301.02	Iron Solution	certified concentration 1.00 ± 0.02 mg/L
BND1201.02	Zinc Solution	certified concentration 1.00 ± 0.02 mg/L
Third Batch		
BND402.03	Chromium Solution	certified concentration 2.00 ± 0.02 mg/L
BND401.03	Chromium Solution	certified concentration 1.00 ± 0.02 mg/L
BND301.03	Arsenic Solution	certified concentration 1.00 ± 0.02 mg/L
Fourth Batch		
BND201.04	Cadmium Solution	certified concentration 1.00 ± 0.02 mg/L
BND102.04	Lead Solution	certified concentration 2.00 ± 0.02 mg/L
BND101.04	Lead Solution	certified concentration 2.00 ± 0.02 mg/L

Certified reference materials prepared under this programme had find place in the international database of CRMs known as COMAR. This database is created at BAM Federal Institute for Materials Research and Testing, Berlin, Germany for the benefit/ information of CRM users. CRMs prepared under this programme uploaded to COMAR database and the details of our CRMs could be seen at website http:// www.comar.bam.de

Laboratories of private and public sectors following ISO/IEC 17025, 9000 or any other quality systems are using the certified reference materials prepared under this programme. Some of the important sectors using CRMs are Defence, Power, Petroleum, Bureau of Indian Standards, National Test House, State Pollution Control Boards and Public Health. Nepal Bureau of Standards and Metrology is also using our CRMs. Society is also being benefited by improvement in the quality of life by monitoring and control of quality of water, industrial produces, environmental and health parameters by the use of CRMs directly and indirectly. It also helps the industries in quality assurance and quality control of the industrial and agricultural products to meet the requirement of WTO.

Crystal Growth & Characterization

In-house developed double crystal X-ray diffractometer (DCD) set in (+,-) configuration and a multicrystal X-ray diffractometer (MCD) set in (+,-,-,+) configuration have been employed using $MoK\alpha_1$ radiation originated from a fine focus sealed tube X-ray generator (Philips, 1743; 2kW) for X-ray topography (XRT) and HRXRD studies respectively. The dispersive (+,-,-) configuration for the three Si (111) monochromator crystals of MCD has a special advantage to get a highly monochromatic ($\Delta\lambda/\lambda \leq 10^{-5}$) and collimated (horizontal divergence <3 arc sec) exploring beam. All the diffraction studies were done in the symmetrical Bragg geometry.

Annealing effect on the structural perfection of Fe-doped $LiNbO_3$ single crystals have been studied by high-resolution X-ray diffractometry (HRXRD), X-ray topography (XRT) and Fourier transform infrared (FTIR) spectroscopy. The single crystals prepared by mixing of Li_2CO_3 and Nb_2O_5 powders in the molar ratio of 48.6: 51.4 with 0.05 mol% of iron were grown by Czochralski (CZ) method along [001] direction in air and poled during crystal growth by the application of a d.c. Field. It was observed that the specimens in as-grown state contains low angle and *very low* angle (tilt angle <1 arc min.) boundaries. These grain boundaries were successfully annealed out by post growth thermal annealing at elevated temperatures. FTIR spectra of as grown specimens revealed that these crystals contain OH^- and CO_3^{2-} ionic defects. Due to annealing, the concentration of OH^- ions was

considerably reduced and CO_3^{2-} ionic defects were removed out. $LiNbO_3$ single crystals grown by Czochralski (CZ) method were characterized in their as grown (in-situ poled), post-growth annealed and post-growth poled states by high-resolution X-ray diffractometry (HRXRD), piezometry, UV-Vis. and FTIR spectroscopy methods. From high-resolution diffraction curves, it was found that the as-grown specimens contain low and very low angle boundaries. Post-growth annealing at elevated temperatures results in removing the grain boundaries but leads to decrease in the piezoelectric constant d_{33} to 14 pC/N from its initial value of 17 pC/N showing the misorientation of domains though the structural grain boundaries were removed. Such post-growth annealed samples were re-poled with different poling intensities. Poling leads to enhancement in piezoelectric constant d_{33} upto 23 pC/N. The decrease in half width of the diffraction curve on poling of annealed specimens also indicates improvement in the crystalline perfection. Homogeneity of Li content was studied by UV-Vis. spectra along the crystal boule. Annealing and subsequent poling treatments resulted in decrease of absorption coefficient and shifting of absorption edge. These results indicate the reduction of impurities and antisitic defects. FTIR measurements on post-growth annealed samples show significant reduction in OH^- concentration and almost complete removal of CO_3^{2-} ionic defects, which were otherwise observed in as-grown state.

Crystalline perfection, piezoelectric response and optical transparency of in-situ poled Fe-$LiNbO_3$ a single crystal with 0.02 mol% Fe_2O_3 were studied. Very low angle grain boundaries and the variations in the piezoelectric charge constant d_{33} were observed in the as-grown crystals. Grain boundaries were successfully removed at higher annealing temperatures but the d_{33} value was decreased. Low crystalline perfection and d_{33} were observed after poling the annealed specimen. These parameters improved by low temperature annealing followed by very slow cooling. FTIR spectra revealed that OH^- and CO_3^{2-} ionic defects were present in the as-grown crystals. The OH^- ion concentration reduced, CO_3^{2-} ions removed and optical quality was improved after annealing at higher temperatures.

Amino acid family crystals exhibit excellent nonlinear optical and electro-optical properties. L-alanine single crystal belongs to amino acid group and has been grown by solvent slow evaporation technique at room temperature. These crystals have been characterized by high-resolution X-ray diffractometry (HRXRD), nuclear magnetic resonance (NMR), Fourier transform infrared (FTIR), UV-Vis., Raman spectroscopy, mass spectra analyses and density measurements. The nonlinear response has been tested by using high intensity Nd:YAG laser.

Benzimidazole (BMZ) single crystals were grown by slow evaporation solution technique (SEST) and Vertical Bridgman technique (VBT). From HRXRD studies it was found that though the SEST crystals are small they have better crystalline quality than that of VBT grown. The multiple low angle grain boundaries observed in VBT specimens may be attributed to the thermal stress caused during the post growth cooling cycle. In case of SEST specimen, during its growth, solvent may be entrapped in the crystal lattice and lead to form *very low* angle grain boundary. Functional groups were identified by Fourier transform infrared (FTIR) analysis. Microhardness was measured by Vicker's method. Larger size crystals could be grown by VBT method having better hardness than that of SEST grown. The NLO behaviour for both the specimens have been tested by using Nd-YAG laser and found that the specimens have good SHG properties and their efficiencies are comparable to that of KDP crystals.

Secondary Ion Mass Spectrometry

Formation of cobalt silicides as a buried layer in silicon using high energy heavy ion irradiation.

A Multilayer heterostructure of Si (50nm)/Co (50nm)/Si (50nm)/Si<100> was prepared by e-beam evaporation technique under UHV conditions and it was then subjected to irradiation by 120 MeV Au^+ ions with fluence varying between 10^{13} to 10^{14} ions/cm^2 to investigate and understand the phenomena of swift heavy ion (SHI) induced ion beam mixing (IBM). In cases of metal /semi-conductor systems or metal/metal systems a high temperature spike formation takes place for about a picosecond time, like a transient melt phase due to energy transfer

related to inelastic collisions and this induces intermixing in multi-layer systems. No external thermal treatments were used after the irradiation as a special test case of ion beam induced compound formation. Secondary ion mass spectrometry (SIMS) was used in depth profile mode (Fig.5.4a), which indicated definite changes in sputtering rates near the interface of Si/Co. The sudden change of intensity of Co signal near the first interface, which almost starts decreasing only up to a small depth in Fig.5.4(b) and thereafter increases again, suggests, apriori, the formation of a Cobalt compound due to which the preferential sputtering rate of Co suddenly changes. Such a sudden change in depth profile data at the interface then initiated the further experiments of XRD and Raman spectroscopy to actually determine whether any normal phase of Cobalt silicide has been formed at the interface as a buried layer. A monotonic increase in the mixing width with fluence at the first interface of Si/Co was observed. Further investigation

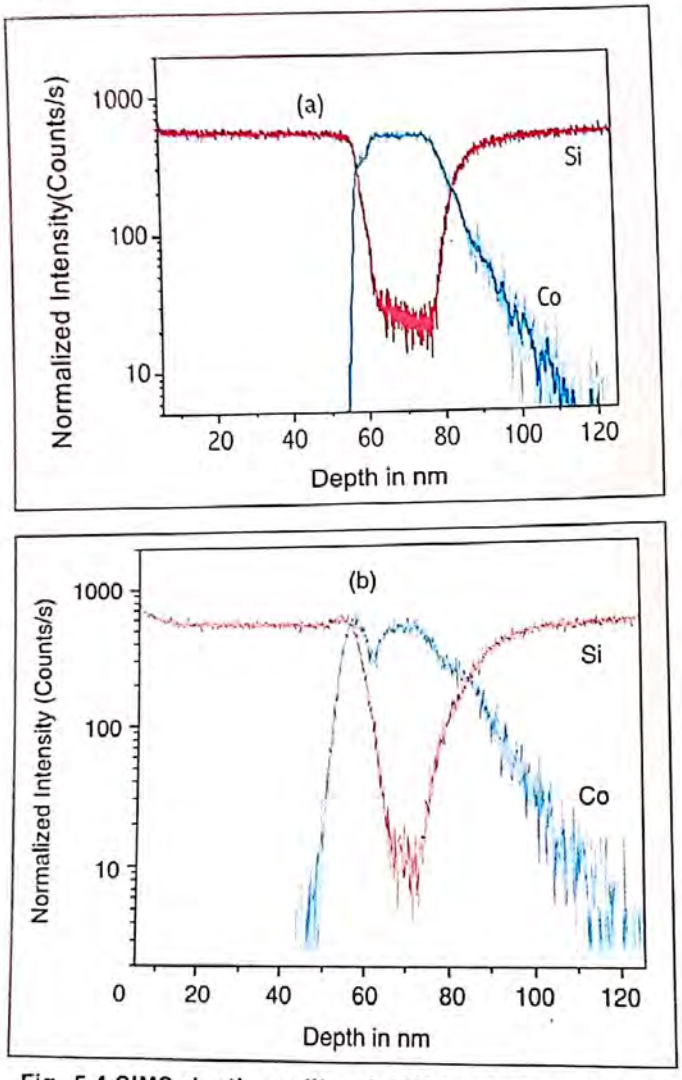


Fig. 5.4.SIMS depth profile of Si/Co interface before irradiation (a) and after irradiation with (b) 1x10^{14}ions/cm^2.

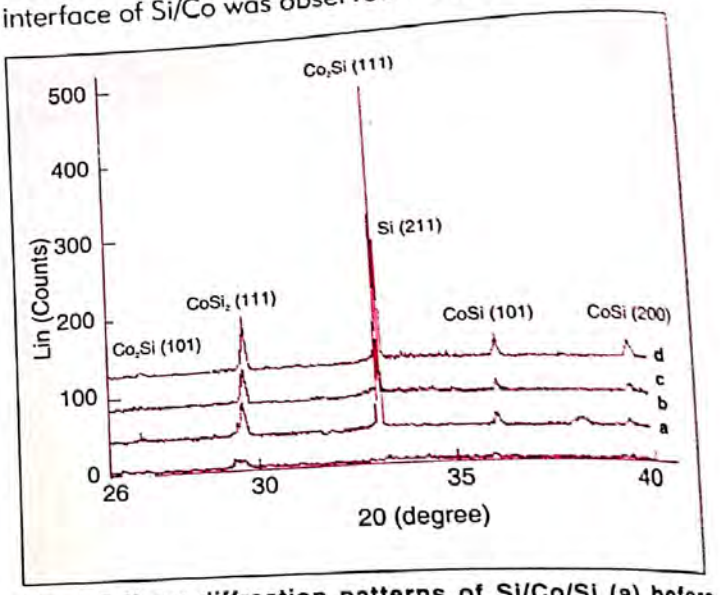


Fig. 5.5 X-ray diffraction patterns of Si/Co/Si (a) before irradiation and after irradiation with 120 MeV Au ions with (b) 1x10^{13}, (c) 5x10^{13}, and (d) 1x10^{14} ions/cm^2. All the three phases of cobalt silicides are observed along with some Si polycrystalline peak from the structure.

by X-ray diffraction (XRD) confirmed formation of different phases of cobalt silicides, $CoSi_2$, CoSi and $CoSi_2$, (Fig.5.5) as a buried layer while the Raman spectroscopy showed broad peaks near 325cm^{-1} and 725 cm^{-1} which are characteristic of $CoSi_2$ phase. The above work suggests that swift heavy ion irradiation can be advantageously used for interconnect related buried layer silicide formation even at room temperature avoiding thermal annealing.

Concluding session of "Users awareness programme on materials characterization" in progress at Seminar Room, NPL, 14th January 2005. Senior scientists of the Division were the faculty members and delivered talks in their specialised fields during this programme. About 50 participants from different institutes were trained during 10-14 January 2005.

L to R : Mr. S.K. Chakladar, Dr. Ram Kishore, Dr. B.R. Chakraborty, Dr. Vikram Kumar, Director, NPL, Dr. S.K. Gupta, Dr. S.K. Halder, Dr. A.K. Agrawal Dr. Rashmi, Dr. G. Bhagvannarayana, Dr. R.K. Garg and Sh. Prabhat K. Gupta.

Research by Emeritus Scientists

Structural Characterization of Bulk Single Crystals, Thin Epitaxial Films and Devices by employing indigenously developed Five Crystal X-ray Diffractometer and utilizing High-resolution X-ray Diffraction Techniques.

Enhancing the life of the filaments of the Rotating Anode X-ray Generator

The Rotating Anode X-ray generator had a serious problem regarding short life of filament of ~ 70 hours. The local representatives of the manufacturers M/s Rigaku, Japan had tried their best. They were in touch with their principals who had suggested several modifications. However, they could not solve this problem. We ourselves modified the filament assembly and the life of the filament has been increased by an order of magnitude, from ~ 70 h to ~ 700 h. The X-ray generator is now being used extensively for high-resolution X-ray diffraction experiments.

Experiments for Observing Zeroth Order X-ray Diffraction

The Five Crystal X-ray Diffractometer had been modified for direct observation of a Zeroth Order X-ray diffraction in silicon single crystals in Laue geometry. A highly collimated Mo Kα1 beam was employed as the exploring X-ray beam. A scintillation counter was employed for measuring small change in X-ray intensity. This study was aimed at understanding dynamical diffraction effects in perfect crystals, observable only under high-resolution conditions. Preliminary experiments have been quite successful.

Progress made under ILTP Project: Structural Characterization of Silicon Monochromators for Synchrotron Radiation

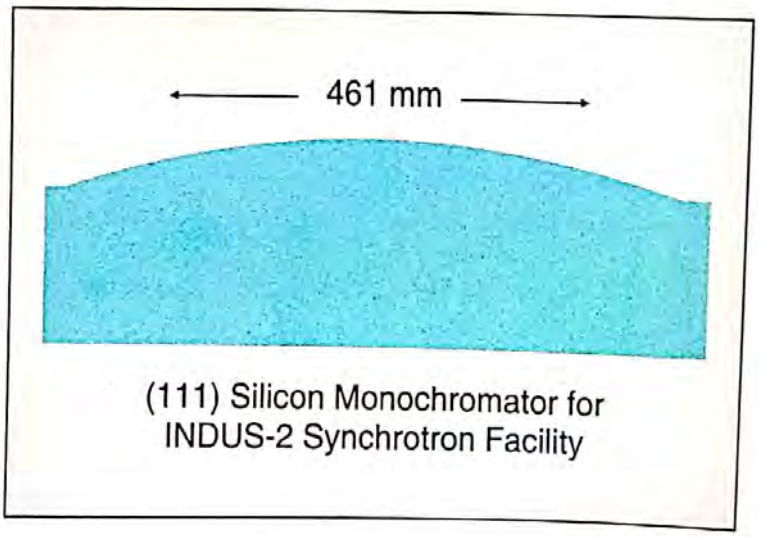
Under this project structural perfection of large size silicon discs, (diameter: ~150 mm; and thickness: ~ 13 mm) was evaluated by using high resolution X-ray diffractometry and topography. The perfection of these as-cut unprepared crystals was quite good. Also, SiCN / Si and BCN / Si thin film-substrate systems for preparing diamond like super hard films for technological applications were subjected to structural characterization. Some of the specimens exhibited high level of crystalline perfection. The level of in-built stress was rather low in some of the specimen.

A new facility for high resolution X-ray reflectometry: imaging mode

A new facility for direct imaging of X-ray beams in grazing incidence reflectometry experiments is being established. This is based on the Five-crystal X-ray diffractometer. First experiments with silicon, GaAs and a few other single crystals have yielded very encouraging results. Different layers on the crystal surfaces, either intentionally deposited or unavoidable could be directly imaged.

Structural characterization for outside institutions

A request was received from Bhabha Atomic Research Centre, Trombay for evaluation of perfection



(111) Silicon Monochromator for INDUS-2 Synchrotron Facility

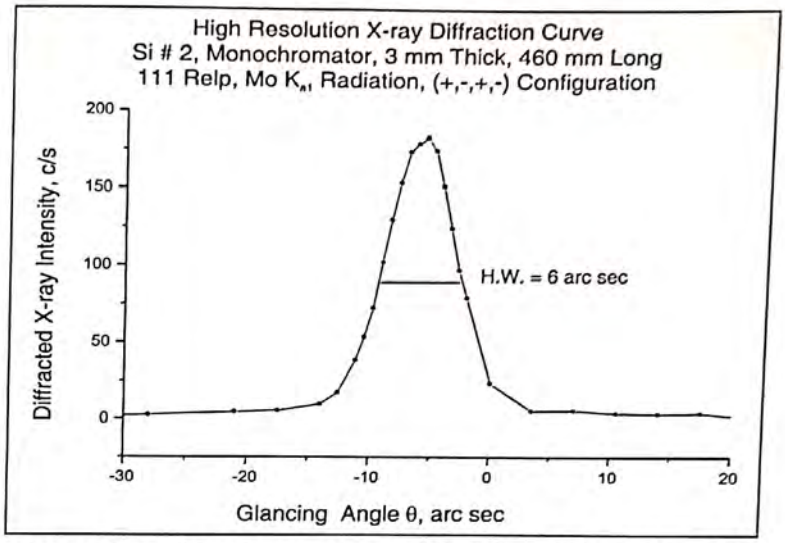
of two large size silicon crystals, which were to be used as monochromators in the synchrotron source INDUS II at Indore. The dimensions of these crystals were 460 mm x 30 mm x 3 mm. A special crystal holder was designed and fabricated at NPL for this purpose.

Structural Characterization of Ortho- and Hexa- Ferrite single crystals was carried out for

Physics Department , Jammu University, Jammu

Network Project: Task Force on MEMS based Sensors

Silicon Single Crystal samples with SiO_2 films from CEERI, Pilani have been characterized for measurement of biaxial stress and degree of crystalline perfection.



A typical X-ray diffraction curve recorded at the middle portion of the silicon monochromator for INDUS –2 Synchrotron Facility by employing the Five Crystal X-ray Diffractometer

रेडियो तथा वायुमण्डलीय विज्ञान

RADIO AND ATMOSPHERIC SCIENCES

jfM;k rFkk ok;e.Myh; foKku

राष्ट्रीय भौतिक प्रयोगशाला का रेडियो एवं वायुमण्डलीय विज्ञान (RASD) कई वर्षों से ग्लोबल चेंज रिसर्च पर विशेष रूप से फोकस करते हुए वायुमण्डलीय विज्ञान के साथ-साथ रेडियो प्रोपेगेशन मीडिया कैराइक्टराइजेशन पर व्यापक अनुसंधान एवं विकास कार्यक्रमों की खोज में लगा हुआ है। दो प्रमुख प्रयोगशाला परियोजनाओं (MLPs) के अन्तर्गत इस वर्ष एक्टिविटीज को पुनः संगठित (Re-organised) किया गया है। इनके उद्देश्य निम्न हैं :-

ifjofrr ok;e.Myh; lk;koj.k] bldh ixfr vkj l?kV (Impacts)

परिवर्तित वायुमण्डलीय पर्यावरण की विशेषता, वायुमण्डलीय अवशेष (Trace) संघटकों के सम्बन्ध में प्रगति और संघट (Impacts), ग्रीन हाउस गैस और पूर्ववर्ती, एअरोसोल और अस्थायी व स्थानिक (अंटार्कटिका सहित) मापन शामिल करते हुए सौर विकिरण, मोडेलिंग, इंस्ट्रुमेंटे ान, निदेशक प्रयोगशाला का स्थापन व विभिन्न डेटा बेस का आविकार/सभी कैम्पेन प्रणाली प्रयोग भी स्थानिक और अस्थायी मापन में सम्मिलित हैं।

jfM;k Hkkfrd ,o vui;kx

भारतीय क्षेत्रों के अन्तर्गत आयनित और अनायनित वायुमण्डलीय मीडिया का अभिलक्षणन और वहां पर विभिन्न प्रकार के रेडियो संचार, संचालन और अन्य विकसित अनुप्रयोगों के और अधिक सुधार के लिए आयन मण्डलीय/क्षोभ मण्डलीय रेडियो संचरण के सम्बन्ध में विभिन्न भौगोलिक प्रक्रियाओं का अध्ययन जिसमें अनुप्रयोज्य संदर्भ माडल्स/डाटा बेसिस के सुधार/विकास सम्मिलित हैं। इसमें सेटेलाइट्स, ग्राउण्ड स्पेस बेस्ड मानटरन पद्धति रेडार, LOS संचार और मोबाइल का प्रयोग कर सम्बन्धित आयन मण्डल/क्षोभ मण्डलीय पैरामीटर का मानिटरन आदि शामिल है जिससे कि उसमें निहित वांछित डाटा बेस उत्पन्न किया जा सके। विभिन्न भौगोलिक प्रक्रियाओं को समझा जा सके और आवश्यक सुधार आदि के आकलन के मानक तैयार किए जो सकें।

प्रभाग द्वारा संचालित विभिन्न वैज्ञानिक गतिविधियों में निम्नलिखित विशेष रूप से उल्लेखनीय हैं :-

वायुमण्डलीय महासागर प्रभाव कार्य करने वाले NIO-NPL-NGRI नेटवर्क प्रोजेक्ट के अन्तर्गत RASD ने सर्दी के मौसम में भारतीय महासागर के निकट वायुमण्डलीय एयरोसोल और ट्रेस गैसों की स्थिति को समझने के लिए 11 अक्टूबर से 18 नवम्बर, 2004 के दौरा एयरोसोल ट्रेस गैसो और UV सोलर विकिरण आन बोर्ड सागर कन्या शिप क्रूज के अध्ययन का संचालन किया जिसमें अरब सागर और बंगाल की खाड़ी भी शामिल थे। यह प्री-मानसून अवधि के दौरान किए गए मापों से अलग था। इसरो के नेतृत्व में राष्ट्रीय एयरोसोल भू-अभियान में 60 से भी अधिक माप संयंत्रों के निष्पादन को बनाए रखने के लिए नवम्बर, 2004 के अन्तिम सप्ताह में राष्ट्रीय स्तर का अन्तर्तुलन प्रयोग आयोजित करने में NPL का महत्वपूर्ण योगदान रहा जो बाद में दिसम्बर, 2004 के पूरे महीने के दौरान लगभग 20 प्रतिभागी संस्थानों द्वारास इंडो जेनेटिक प्लेन के पार फैले 6 क्षेत्रों में फैलाया। फोग अवधि से पहले और बाद में एयरोसोल जलवायु पर अधिग्रहण करना इसका मुख्य केन्द्र बिन्दु था। राष्ट्रीय भौतिक प्रयोशाला ने इस राष्ट्रीय प्रयोग के साथ टानदेम (Tandem) में तीन वर्ष पूर्व आरम्भ किए फॉग मानिटरन कार्यक्रम को जारी रखा। इसने उसी अवधि के दौरान दिल्ली के कॉरिडोर उत्तर से दक्षिण-पश्चिम पर दो मोबाइल भू-अभियान आयोजित किए जो जम्मू और कश्मीर में पटनीटॉप से उत्तर प्रदेश में झांसी और कानपुर तक फैले थे। देशी एयरोसोल प्रकाशीय गहराई माप का इस्तेमाल कर सार्वभौम सोलर फ्लक्स का परिकलन करने के लिए एक सामान्य माडल को विकसित करने का कार्य आरम्भ किया गया।

RADIO AND ATMOSPHERIC SCIENCES

Radio and Atmospheric Sciences Division (RASD) at the National Physical Laboratory has been pursuing comprehensive Research & Development programs on Radio Propagation media characterization as well as in Atmospheric Sciences with a special focus on Global Change Research since many years. This year activities have been reorganized under two Major Laboratory Projects (MLPs). The objectives of these are the following:

Changing Atmospheric Environment, its Processes and Impacts: Characterization of the changing atmospheric environment, processes and impacts in respect of atmospheric trace constituents, green house gases and precursors, aerosols and solar radiation involving temporal and spatial (including Antarctica) measurements, modeling, instrumentation, setting up of referral lab. and creation of various data bases. The spatial and temporal measurements include all the campaign mode experiments also.

Radio Physics and Applications: Characterization of the ionized and non-ionized atmospheric media over the Indian region and studies of various geophysical processes therein, in relation to ionospheric/tropospheric radio propagation for the purpose of betterment of various types of radio communication, navigation and other advance applications, including the Improvements/ development of applicable reference models/data bases. This involves monitoring of related ionospheric / tropospheric parameters using satellites, ground & space based monitoring systems, Radars, LOS communication & mobile links etc. for generation of required data base, understanding the various geophysical processes involved therein and modeling for estimating necessary corrections, etc.

Among the scientific activities conducted by the Division the following are especially notable. Under the NIO-NPL-NGRI Network Project dealing with atmosphere-ocean interactions RASD conducted study of aerosol, trace gases and UV solar radiation onboard Sagar Kanya ship cruise covering parts of both the Arabian Sea and the Bay of Bengal during October 11-November 18, 2004 to understand the state of atmospheric aerosols and trace gases over the Indian Ocean in a winter period. This was in contrast to the measurements done during pre-monsoon periods as a part of INDOEX in the past. In the ISRO led National Aerosol Land Campaign, NPL made a very significant contribution by organizing, in the last week of November 2004 the national level inter-comparison experiment for aligning the performances of more than 60 measuring instruments that were later deployed by about twenty participating institutions over six sites spread across the Indo-Gangetic Plains for the complete month of December 2004. The focus was to capture aerosol climate before and during the fog period. While NPL continued its fog monitoring programme started three years ago in tandem with this national exercise, it also organized two mobile land campaigns in the same period on a north-to-southwest of Delhi corridor stretching from Patnitop in Jammu & Kashmir to Jhansi and Kanpur in Uttar Pradesh. The development of a simple model to calculate global solar flux using indigenous aerosol optical depth measurements has been initiated.

Division's round the year monitoring activities of the lower and middle atmosphere continued. To understand the aerosol size distribution processes including their role in fog and haze formation regular measurements using GRIMM's 15 channel optical aerosol spectrometer have been started. The Division also coordinated a nation wide study on the impact of changing climate on the future scenario of malaria in India.

In Antarctic measurements of columnar ozone, water vapour, methane and carbon monoxide etc continued. The ozone hole strength was found weaker compared to early years because of changed meteorological and dynamical conditions.

Services offered by the Regional Warning Centre (RWC) at NPL, a node of the International Space Environment Services network (ISES), were improved by augmenting the output from RASD developed ionospheric prediction models linked to this. The concept of antenna tilting was investigated theoretically for both fixed and mobile communication to help in designing better link performance by reducing neighbouring cell interference. A very useful design parameter named 'Path Loss Exponent' was deduced for different regions of our country. Use of indigenous database from digital ionosonde and incoherent scatter radar for further validation of IRI model continued.

Design and fabrication of 'Ball Antenna' was completed under the collaborative project with IIG on sensor development for the AC and DC components of the Global Electric Circuit. A virtual instrument to acquire, display and process multi-channel data was successfully developed using the LabVIEW software.

A course on radio meteorology and radio wave propagation was conducted for the Indian Naval Officers on various topics relevant to their day-to-day communication needs.

Atmospheric Environment and Global Change Studies

Trace Gases and Aerosol Studies

Surface Ozone: Observational evidence show that surface ozone level is increasing due to anthropogenic activities on regional as well as global scale. Surface Ozone is toxic gas and elevated ozone concentrations are of concern, because of its impact on human health, crops and vegetation, oxidizing capacity of the atmosphere and climate. The production of troposhperic ozone depends on NOx (NO + NO_2) and VOCs (volatile organic compounds) as well as weather and transport phenomenon. Surface ozone is being measured over New Delhi, an urban site, a region of intensive anthropogenic activity since 1997. Seasonal variation in ozone concentration shows pronounced maximum in the months of summer and autumn seasons and minimum in monsoon and winter seasons. Diurnal pattern in ozone concentration shows daytime in-situ photochemical production through out the year. Elevated ozone concentrations were frequently observed with the highest frequency in the summer and autumn months. The high ozone episode days were associated with meteorological parameters such as sunny and warm weather, stagnant wind pattern and low relative humidity. The monthly average maximum concentration in summer was found in the range of 62 to 95 ppb whereas it was found to be 50 to 82 ppb in autumn (October – November). The analysis of hourly averaged surface ozone data illustrates that on large number of days the surface ozone values at Delhi exceeds the World Health Organization (WHO) ambient air quality standard (Hourly average 80 ppb) for ozone. The daily average surface ozone in 2004 is shown in the

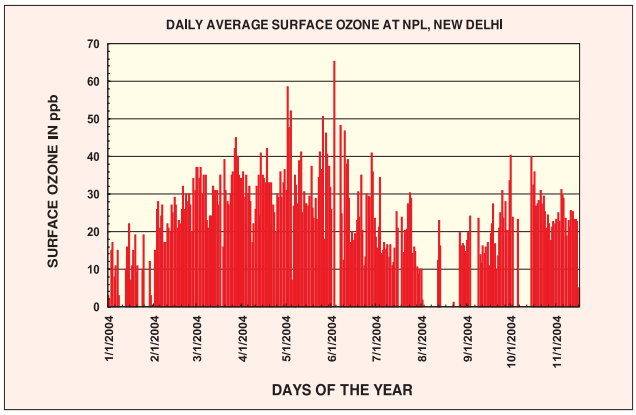


Fig. 6.1 Daily average surface ozone observed at NPL, New Delhi during 2004.

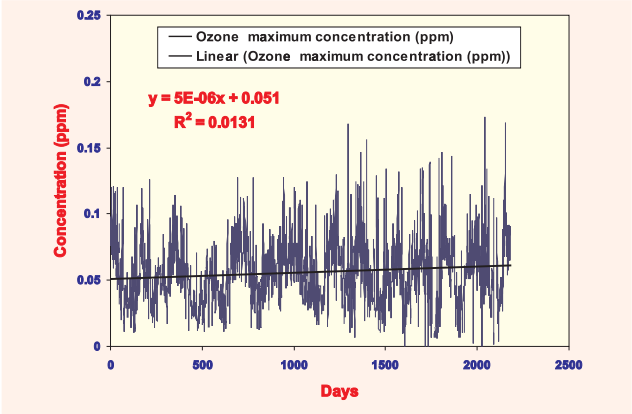


Fig. 6.2 Maximum surface ozone concentration in ppm trend observed at NPL, New Delhi during 1997-2004.

fig.6.1. Daily maximum values of surface ozone during 1997-2004 is defpicted in Fig.6.2. No significant change in the surface ozone values during 1997-2004 has been observed as shown in Fig. 6.2.

NOx: NOx plays a critical role in troposhperic photoxident chemistry by controlling rates of photochemical ozone production and influencing hydroxyl and peroxy radical concentration directly and indirectly. Understanding the physical and chemical process that affect the NOx concentration in different environment is therefore crucial to understand the production of elevated levels of O_3 and the photoxident chemistry that also governs the atmospheric residence time of the trace gases. The NOx are being measured continuously since June 2002 onwards. The Fig. 6.3 shows monthly annual variation of NOx concentration at NPL. Observations

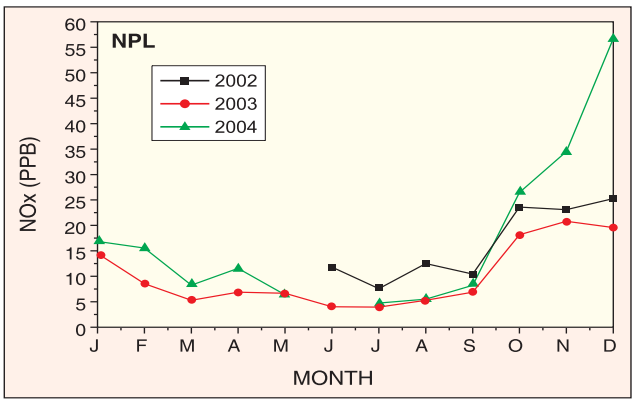


Fig. 6.3 :The monthly mean of NOx in different years at NPL, New Delhi

show that NOx is found more in winter months than in summer due to slow photochemistry in the winter

months. The average concentration of NOx was found more in 2004 as compared to 2002 and 2003.

Aerosols:. In large cities, high population density, industrialization and increase of traffic have led to an increase aerosols mass concentrations. The aerosols are composed of inorganic salts, carbonaceous materials (elemental carbon, semi volatile organic compounds) crystal materials (silicon) and trace metals. Aerosols have adverse impacts on human health and affect optical and chemical properties of the atmosphere and thereby affect climate directly and indirectly. The aerosols generally in a diameter range 0.1- 1.0 micron mostly affect air quality, visibility and climate. The aerosols measurements are being made by haze-dust monitor model EPAM-5000 at National Physical Laboratory, New Delhi. The monthly average mass concentration of PM 2.5 at NPL, New Delhi is found in the range from 60 mg/m^3 to 475 mg/m^3. The concentration varied significantly with season and time of the day and was found highest during winter months. During clear day the particulate matter exhibit minimum level of 50 mg/m^3 or less during midday and increasing to 200 – 300 mg/m^3 in the evening and night. The observations suggest that the daytime minimum value may be resulting from dilution of boundary layer during its vertical expansion in spite of additional injection of aerosols during daytime. The increasing trend in evening and nighttime may be due to inversion. The aerosol number concentration at NPL also measured using GRIMM spectrometer. The diurnal variation in Aerosol number size in three different modes like total i.e, > 0.3µm, sub micron mode i.e., >0.3 to < 1.0 µm and super micron mode >1.0 µm have been shown in the Fig. 6.4 for the month of December 2004. The sub micron mode particles are dominating and are contributing more that 98% for the total number concentration.

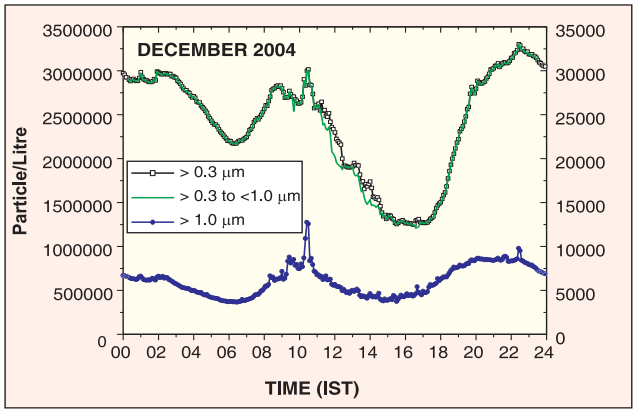


Fig. 6.4 : Diurnal variation of Aerosol number size in three different modes i.e, Total > 0.3µm, sub micron mode i.e., >0.3 to < 1.0 µm and super micron mode >1.0 µm during December 2004 at NPL, New Delhi

Uncertainty estimations in solar UV-B intensities and aerosol optical depth (AOD)

NPL has been running a scientific program for the last so many years to study the solar UV-B radiation reaching the earth surface and the atmospheric aerosol content through measurements of solar radiation at different wavelengths by various instruments such as Erythemal Probe, UV Biometer and Microtop sun photometer. The large uncertainties present in the meteorological parameters and the atmospheric constituents over Delhi during different seasons cause the similar uncertainties in the radiation intensities reaching the earth surface. The data on radiation intensities, Erythemal Dose, MED, AOD, weather condition and wind velocity for the period from March 2003 to February 2004 are analyzed to find out the uncertainties in the different parameters during the different seasons of the year. It is found that the uncertainties due to day to day variability in the global UV-B intensities, Erythemal Dose and MED are 40-50 % for 60^0 solar zenith angle conditions during winter period , 50-60 % during summer periods and 20-30 % during cloud free monsoon periods . These uncertainties are reduced by 5-10 % with the decrease of 10^0 in solar zenith angle. The uncertainties in AOD estimation present a different scenario. Most of times the AODs remain around 0.5 $\pm$ 0.1 but some time, especially during summer periods and the highly hazy periods of February-March, uncertainties become very large.

Development of a model of global solar radiation flux using aerosol optical depth measurements at two wavelengths and its comparison with pyranometer measured flux under clear sky conditions over Delhi.

The modeling of global solar flux (direct-plus-diffuse) is required in many atmospheric applications, such as, in the calculation of time of clearance of fog during the winter months over northen India. To support the NPL fog study program the development of a simple model to calculate global solar flux using

aerosol optical depth measurements under clear sky conditions was undertaken . The aerosol optical depth is an important parameter in the model estimates. A comparison is made between the model estimates of global solar flux with those measured using a pyranometer for three days in the winter months over Delhi. The aerosol optical depth, required in the model, was measured at 0.5 mm and 1.02 mm using a sun photometer. The model values of global solar flux are within 10 % of the measured values.

Estimation of aerosol radiative forcing over Delhi by optical measurements of column aerosol optical depth and radiation flux

The measurement of aerosol optical depth (AOD) and the solar radiation flux can be used to study bulk aerosol radiative properties, their size distribution and loading. An estimate of average direct radiative forcing efficiency at the surface can also be done. The present investigations were carried out for a study of the atmospheric turbidity parameters and estimation of average aerosol radiative forcing over Delhi using the optical measurements.

It is found that a characteristic seasonal variation, during the winter, pre monsoon and post monsoon period, exists in Angstrom alpha and beta parameters. A typical desert aerosol characteristic during April-June desert storm period can be readily seen over Delhi. During this period it is noticed that the high AOD values are associated with extremely low values of the Angstrom alpha and beta parameters where was in the range 0.05 to 0.20. On extremely high sand storm days the α Angstrom coefficient even shows a small negative value ~ -0.06.

The average direct radiative forcing efficiency observed at the surface was also estimated in the UV and total solar radiation range. The preliminary analysis shows that there is considerable decrease in the radiation flux in terms of Wm^{-2} per unit increase in aerosol optical depth.

Road campaign Dec 2004

In order to generate a long-term climatology of atmospheric aerosols and their radiation effect ISRO-GBP has initiated a Land Aerosol Campaign to characterize the atmospheric aerosols during the winter period and to identify the possibilities of transport and transformation across western to eastern Indian region. This would also give opportunity to understand the dynamics of fog formation during the winter period and the possible role of atmospheric aerosols. In connection with this, NPL organized and executed on its campus a complex inter-comparison of about 50 instruments to measure various atmospheric parameters in which about 70 scientists from 20 institutions of the country operated simultaneously for two days, Nov 28-29, 2004. Prof. V.S. Ramamurthy, Secretary, Department of Science and Technology inaugurated the campaign at NPL on 28th Nov. 2004 as shown in photograph.

After the inter comparison at NPL, the teams dispersed for month long observations at eight specified locations at Hisar, Delhi, Agra, Kanpur, Allahabad, Nainital, Jaduguda and Kharagpur.

Fig. 6.5: Acting Director Shri S.C. Garg explaining to Prof. V.S. Ramamurthy, Chairman, NPL's Research Council and Secretary DST, one of the several assemblies of monitoring instruments brought by various institutions as part of the inter-comparison experiment.

Special Land Aerosol Campaign

As a part of the ISRO-GBP sponsored "Special Land Aerosol Campaign Project" in the North Indian corridor, extensive observations of surface ozone, NOx, columnar ozone and number-size distribution of aerosol have been carried out by NPL during 27th November 2004 to 31st January 2005. During the above period NPL has conducted two land campaign and having measurements at different places in the North Indian corridor namely Karnal, Rajpura Town, Hoshiarpur, Jammu, Patnitop Hills, Palampur, Barsar, Nalagarh and Hisar in the first phase. In the second

phase measurements were carried out at Koshi, Gawalior, Jhansi, Kalpi, Kanpur, Fathepur, Allahabad, Lucknow, Barelley and Garh. In the North Indian corridor during the winter period wide variety of aerosol compounds in the atmosphere may enhance stability of aqueous aerosols and thereby degrading visibility and also may alter fog and haze forming processes. In view of the above, measurements of aerosol number concentration using GRIMM spectrometer have been carried out. The levels of variation in number concentration in three different modes like total i.e., >0.3 µm, submicron mode i.e., >0.3 to <1.0 µm and super micron mode i.e., >1.0 µm have been shown in Fig. 6.6 and 6.7.

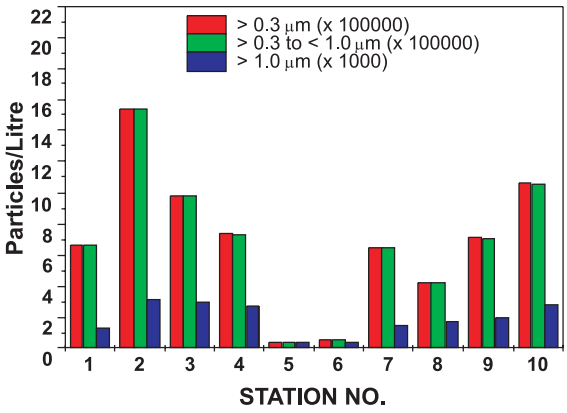


Fig. 6.6 : Variation of number concentration in three different modes at different sites in North Indian corridor during 11-21 December 2004.

1.	Karnal lake	(11-12-2004)
2.	Rajpura town	(12-12-2004)
3.	Hoshiarpur	(13-12-2004)
4.	Jammu rrl	(14-12-2004)
5.	Patnitop hills	(15-12-2004)
6.	Palampur	(16-12-2004)
7.	Barsar	(18-12-2004)
8.	Nalagarh	(19-12-2004)
9.	Nrdi karnal	(20-12-2004)
10.	Hisar	(21-12-2004)

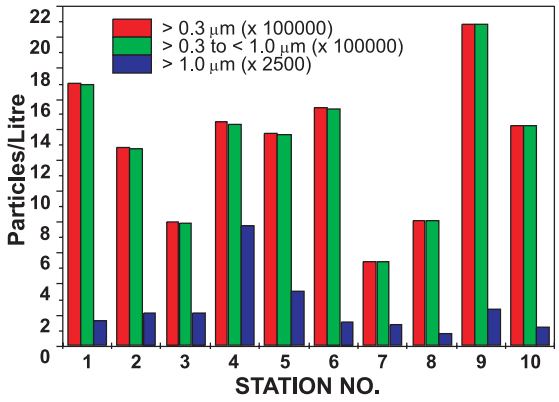


Fig. 6.7: Variation of number concentration in three different modes at different sites in North Indian corridor during 20-29 December 2004.

1.	Koshi	(20-12-2004)
2.	Gawalior	(21-12-2004)
3.	Jhansi	(22-12-2004)
4.	Kalpi	(23-12-2004)
5.	Kanpur	(24-12-2004)
6.	Fathepur	(25-12-2004)
7.	Allahabad	(26-12-2004)
8.	Lucknow	(27-12-2004)
9.	Barelley	(28-12-2004)
10.	Garh	(29-12-2004)
10.	Hisar	(21-12-2004)

The above Figs. 6.6 & 6.7 reveal that submicron mode particles are dominating and are contributing more than 98% for the total number concentration. Figures show that the first phase sites have relatively less number of aerosol particles than the second phase sites. High aerosol (number) concentration, exceeding 15,00,000 Particles/Litre at Rajpura Town, Koshi, Kalpi, Kanpur, Fathepur, Barelley and Garh have been observed and these could be attributed to the higher anthropogenic impact of the regions. Low number concentrations (< 50,000 Particles/Litre) are seen at high altitude stations namely Patnitop Hills and Palampur, which are less inhabited or over vegetated forest regions.

Variability study in UV-B & AOD over Delhi and around during fog campaign

UV-B & AOD measurements were undertaken during the observation campaign in Dec 2004 as part of NPL fog campaign and ISRO-GBP land campaign-2 for aerosol climatology. The observations covered the vast area at different sites in Himachal Pradesh, Punjab, Haryana, Delhi and Uttar Pradesh for foggy as well as non-foggy days. The results have shown very interesting features in different characteristics of UV-B and AOD like high clear sky characteristics at Patnitop in Himachal Pradesh and polluted city environment characteristics near big cities like Delhi, Kanpur, Allahabad and Lucknow.

Ship cruise on board Sagar Kanya

Trace Gases and Aerosol Studies over Indian Ocean

As a part of CSIR Network programme on Global change which commenced in the beginning of this financial year, monitoring of some of the trace gases

Fig. 6.8 : DOD Ship ORV Sagar Kanya used for the cruise

with the existing instruments initiated on continuous basis at NPL. A ship cruise on board Sagar Kanya (shown in Fig. 6.8) was also undertaken from Oct. 11, 2004 to Nov. 18, 2004 to carry out measurements of atmospheric parameters such as surface concentrations of ozone, carbon monoxide, oxides of nitrogen, aerosols size distribution, optical depths, chemical composition and radiations. Besides these, meteorological parameters were also recorded. The area covered for the cruise included both Arabian sea and Bay of Bengal side of Indian ocean close to the equator. Some typical results on the ship route are shown in Figures 6.9 to 6.12 below.

A clear variation has been observed in the mass concentration of PM 2.5 when ship sailed deep into the Sea i.e., away from coastal India. Results reveal that PM 2.5 mass concentrations are generally higher near the coastal India and are varying between 45 to 65 $\mu g/m^3$, whereas the PM 2.5 mass concentration near the equator has been observed low and it is varying below 40 $\mu g/m^3$. Columnar aerosol optical depth at 1.02 µm wavelength is found to be less than 0.12 near coastal India, but it is relatively high at equator and varies between 0.13 to 0.2. We have clearly noticed a variation in Columnar O_3 (254.4 to 280.6 DU) and in columnar water vapour (2.4 to 3.9 cm) during the measurement period.

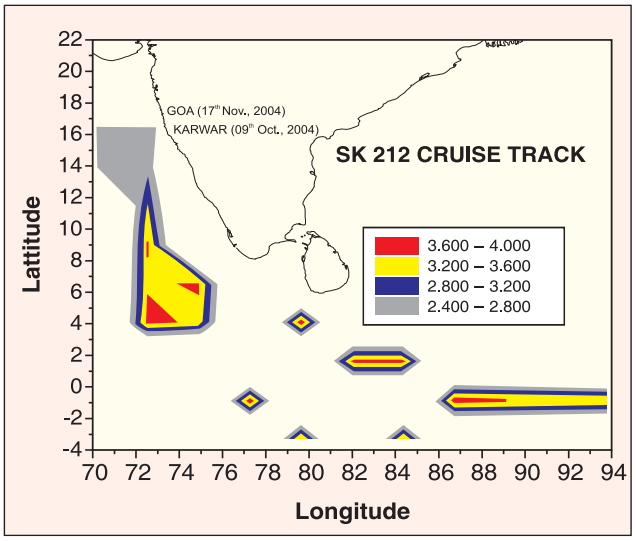


Fig. 6.10 : Spatial variation of AOD at 1.02 µm over Arabian sea and Indian Ocean during 9th Oct. - 17th Nov., 2004.

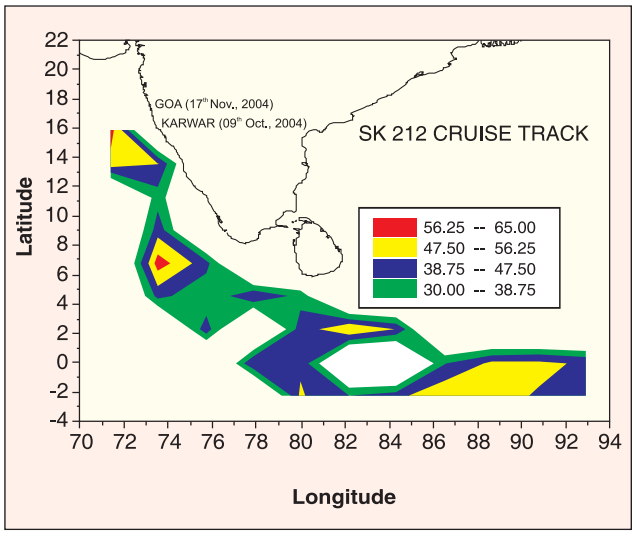


Fig. 6.9 : Spatial variation of PM 2.5 in $\mu g/m^3$ over Arabian sea and Indian Ocean during 9th Oct. - 17th Nov., 2004.

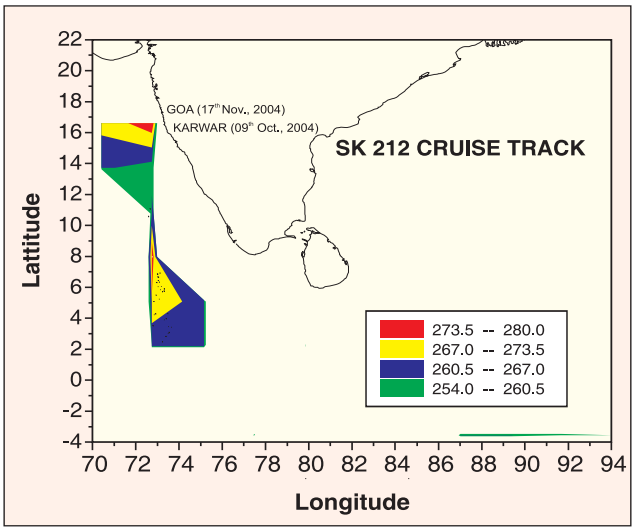


Fig. 6.11 : Spatial variation of Column O_3 in DU over Arabian sea and Indian Ocean during 9th Oct. - 17th Nov., 2004.

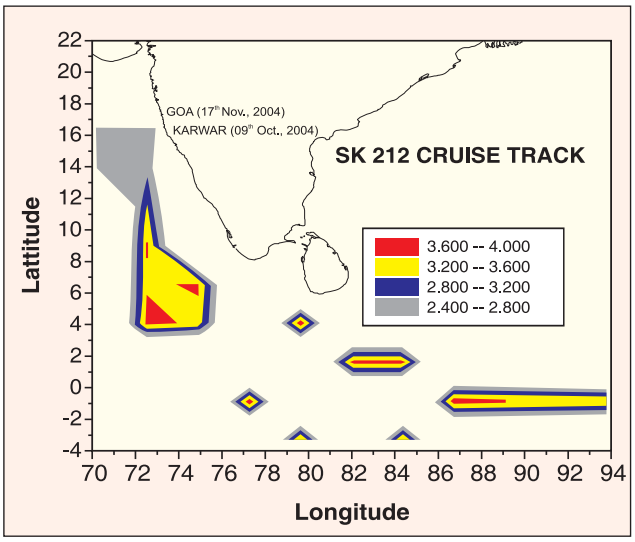


Fig. 6.12 : Spatial variation of Column Water vapour in cm over Arabian sea and Indian Ocean during 9th Oct. - 17th Nov., 2004.

UV-B & AOD Study Over North Indian Ocean

The distribution of aerosol is not uniform globally and is dependent on distribution of their sources and the local, regional and global atmospheric dynamics. The dynamical processes carry the pollution generated over the mainland to the ocean side and vice-versa. An observation campaign was undertaken, over the North Indian Ocean surface to study the flow of pollution from Indian Mainland towards the ocean or vice-versa, during the month of Oct-Nov, 2004 and the solar radiation intensities were measured in UV, visible and near infrared. Sagar Kanya sailed from Karwar on Indian west coast (14° 47' N, 74° 03' E) on 11th Oct 2004 and returned to Goa (15° 29' N, 73° 49' E) on 17th Nov 2004. During the onward journey the ship remained along the west coast of India during 11-14 Oct, 2004, (Lat:14° 47' - 5°19' N) in the deep ocean around equator during 16th Oct.-10th Nov 2004 (Lat: $\pm$ 2° N / S) and again during return journey along west coast during 11-17 Nov 2004 (Lat: 2° -15° N).

The data on AOD at 5 wavelengths during the whole cruise were analysed to find out the relative variations at different locations. It was found that along coast the AOD was higher than those over the deep sea around equator. On coastal side the AOD varied between 0.15 to 0.55 for different wavelengths and being larger at shorter wavelengths and lower at larger wavelengths. At 340 nm it varied between 0.25 to 0.55 and for 1020 nm between 0.10 to 0.15. For other wavelengths it remained in between these values. The AOD values decreased for each wavelength as soon the ship sailed into the deep sea. This reduction was not found to be same for all the wavelengths. The 340 nm radiation experienced the maximum reduction up to one sixth of its coastal values. The next highest reduction was found to be in 675 nm radiation. The AOD values corresponding to the 500 nm, 870 nm and 1020 nm radiations decreased to one fourth, one third and one third respectively.

The data collected by UV-Biometer on MED was analysed to see the relative variations in attenuation due to total column ozone and the pollution levels. It was found that MEDs did not change much between the coastline locations and the equator side locations. It may be because of the reason that the effect of the decrease in the AOD around equator is compensated by the decrease in total ozone content at equator compared to coastline locations.

Climate change and future malaria scenario in India

Current climate trends have shown an increase in maximum temperatures, heavy intense rainfall in some areas and the emergence of intense cyclones. Changes in climate may also alter the distribution of important vector species (e.g., mosquitoes) and may increase the spread of disease to new areas, which lack a strong public-health infrastructure. This work, being carried out under an Indo-UK project at Centre on Global Change, examines the future malaria scenario in India under projected climate change as derived from the HadRM2 regional model.

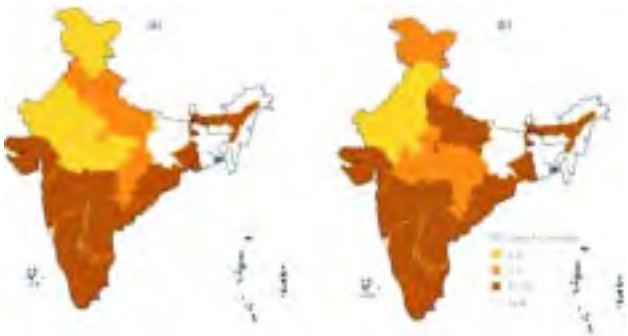


Fig. 6.13 : Transmission Window of Malaria in Different States of India (a) for base case and (b) under projected climate change scenario

The ongoing work has led to the identification of climatic determinants which have pronounced effects on the spread of malaria. Based on these climatic determinants and future climate scenario in India, the transmission windows of malaria in different states of India have been developed (Fig.6.13). Considering an average increase of 3.8°C increase in temperature and a 7% increase in relative humidity by 2080 with respect to the present as shown by HadRM2 model for India, nine states in India will have transmission windows open for all 12 months. The transmission windows in the states of Jammu and Kashmir and Rajasthan may increase by 3 to 5 months as compared to the base year. States like Orissa and some southern states, where the mean temperature is more than 32° C for 4 to 5 months, a further increase in temperature is likely to cut the transmission window by 2 to 3 months. At present the effects of other determinants like socio-economics and ecological are being investigated.

Antarctica studies

NPL is regularly participating in Indian scientific expeditions to Antarctica and conducting experiments at Maitri for global change related atmospheric studies.

Methane: The Monthly mean atmospheric methane measured at Maitri from February 2003 to June 2004 is depicted in Fig 6.14. The day-to-day variation of surface CH_4 concentration was observed to vary small during observational period. The daily average surface methane concentration was found to vary between 1.64 to 1.73 ppm. The annual average CH_4 from Feb. 2003 to June 2004 was found to be 1.69 ppm. No seasonal variation of methane has been observed at Maitri. Mean CH_4 concentration for sixteen-month period has been observed 1.699 ppm with standard deviation of 12 ppb. The observations also illustrate that the baseline CH_4 concentration in the atmosphere is no more increasing.

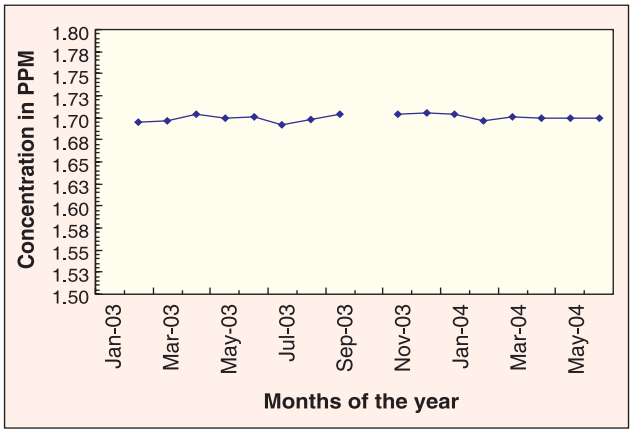


Fig. 6.14 : Monthly mean CH_4 concentration from Feb. 2003 to June 2004

Carbon monoxide: During 22nd Indian Scientific Antarctica expedition a new system has been deployed at Maitri, Antarctica to monitor Carbon-mono-oxide on round the clock basis. The variability in CO concentration has been observed, with hourly mean mixing ratios ranging from 30 ppb to 65 ppb. Diurnal changes in CO concentrations were systematically observed in Antarctic Atmosphere showing higher CO during daytime and relatively low concentration in nighttime. The daily average concentration of CO was found to vary between 30 ppb to 80 ppb during the observational period of January to June 2004. Sometime values show as high as 150 ppb and as low as 10 ppb, which depends upon the local meteorological conditions. The daytime increase of carbon-monoxide is attributed to the photolysis of formaldehyde in Antarctic atmosphere. Recent studies have reported production of formaldehyde in the snow pack. Formaldehyde is rapidly destroyed by sunlight to produce HO_2 and carbon-mono-oxide. The average diurnal variation of CO observed over Maitri is depicted in Fig. 6.15 below.

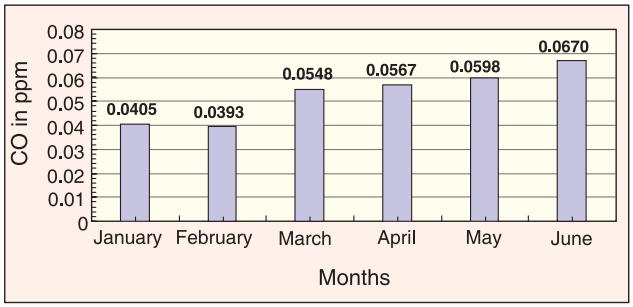


Fig. 6.15 : Monthly mean CO concentration at Maitri Antarctica

Total Column Ozone at Antarctica

Column Water Vapour: Total Water Vapour Column has been measured at Maitri (70° 45'S, 11° 44'E) using Microtop Sun-photometer during 16th, 21st, 22nd and 23rd Indian Scientific Expedition to Antarctica. The observations showed signature of increasing total water vapour column at Maitri, Antarctica.

Measurement also showed signature of increase in the surface temperature and especially found more pronounced in the month of January at Maitri.

Total Column Ozone: The column ozone measurements were carried out during 1997 and again during 2002-2004 at Maitri Antarctica on all clear days. Some times abrupt increase in total ozone column has been observed during ozone hole period. It was also found that the year to year the ozone hole depth as well as its duration is fluctuating depending on dynamics as well as meteorological conditions. The observations showed that the ozone hole in the year 2002 was not as deep as that of the previous few years. The observation also revealed the early recovery of ozone hole during 2002 as compared to 1997. The ozone hole again during 2003 was found to be quite severe and for longer duration in contrast to year 2004 as shown in Fig. 6.16 below. The variability in the ozone hole in different years is attributed to the dynamics and meteorological conditions prevailing over Antarctica.

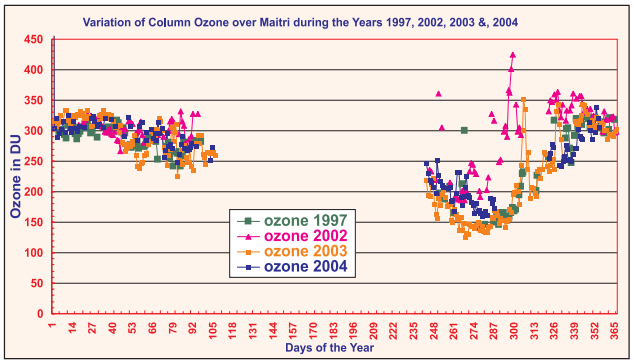


Fig. 6.16: Column ozone over Maitri, Antarctica during 1997-2004

Radio Communications & Space Physics

Atmospheric cloud noise temperature

The total attenuation of a radio wave by cloud is the sum of the absorption and scattering by particles in the cloud. The absorption medium itself radiates power in to radio receiver and contributes to the total system noise temperature. Other contributions to the system noise are the cosmic background, the ground and receiver. For the case of microwave radiation at frequencies below 100 GHz and cloud particles smaller than100 mm, the effect of scattering is small, and absorption is the only contribution to cloud attenuation. Therefore noise temperature of the cloud is too important with cloud attenuation. In view of this atmospheric noise temperature under cloudy condition at 10 GHz, 18 GHz, 32 GHz, 44 GHz and 90 GHz has been determined over Kolkata on the basis of cloud temperature for different cloud thickness. It is seen that atmospheric noise temperature is very significant and varies from 13.35 K to 336.34 K from 10 GHz and 100 GHz respectively in the month of January.

Mobile Communications

Various studies were done to evaluate theoretically the antenna tilting effects on fixed and mobile communications and to reduce the interference in neighbouring cells using the path loss exponents generated from previous data sets. Also some experimental and modeling studies of widely varying urban environments on train mobile communication have been carried out and existing models were modified to suit Indian conditions. A major task of deducing path loss exponents from various data sets spanning northern, western, southern Indian zones including urban, suburban and rural was carried out in the VHF, UHF bands. The experiments included FM, TV measurements in different radials, mobile train measurements etc. This is a very useful design parameter for designing future mobile communications in these regions. These experimentally deduced values as a function of distance were compared with modeled values and the deviations are also brought out.

Course on Radio meteorology and Radio wave propagation for Indian Navy

A course on Radio meteorology and Radio wave propagation was conducted for the Indian Naval Officers during 8-10 December 2004. Fifteen Naval Officers from different Directorates of Indian Navy from various parts of India participated in this course. Various topics such as Radio meteorology and radio wave propagation at low altitudes, characterization of the lower troposphere and radio refractivity climatology, performance assessment of fixed and mobile communication links, climatology of evaporation ducts, radio ray tracing for radar tracking errors, radar propagation, trans-horizon microwave propagation, attenuation of radio waves, anomalous

radar propagation, radar limitations due to anomalous propagation, PC based and tethered and sodar systems for meteorological parameters, radars and its applications and radiosonde measurements were covered.

Validation and Improvement of IRI model for low latitudes

Using NPL prediction model, the peak parameters of the F2-region, (hmF2, foF2), [hmF2 is the height of the maximum electron density in the F2-region and foF2 is the critical frequency of F2-layer] were generated for low and equatorial latitudes over Indian sector for different solar activity at each hour for different months. These parameters (hmF2, foF2) are then used as input to latest IRI-2001 model to obtain the TEC up to 1000 km for the same solar activity periods, as used for generating the peak parameters (hmF2,foF2), at each hour for different months. The TEC values thus obtained were further used to generate the second order coefficients for each station, month and hour by fitting regression curves. Using these coefficients, the TEC, over Indian sector, can be derived for a given solar activity.

Digital Ionosonde observations for the period from 2001 to 2003 were used to examine the seasonal and solar activity variations of bottom side total electron content (BTEC). These observations were then used to evaluate the predictability of the IRI-2001 model. The data from 2001 to 2002 ($82 \leq R12 \leq 114$), a period of high solar activity (HSA) and 2003 ($52 \leq R12 \leq 80$), a moderate solar activity (MSA) were analyzed for this study. The study revealed that during all the seasons for both the levels of solar activity, the BTEC exhibits a large day-to-day variability at any given local time. Seasonally the median BTEC values show equinoctial maximum and presence of winter anomaly during HSA, which is not observed during MSA. The peak content increases by a factor of around 2 during all the seasons from MSA to HSA. Comparison of BTEC with those predicted by the IRI model during MSA show in general good agreement, the percentage deviation of the IRI model with respect to observed values remains less than 20 % during all the seasons except for post-sunset hours and around midnight. The IRI presentation during HSA, although, exhibits diurnal trend similar to observed median BTEC but the model in general, underestimates the BTEC for seasons of equinox and winter at all local times, while the discrepancies are least during summer. Also, no winter anomaly phenomenon is predicted by the IRI model during HSA, while the present observations exhibit winter anomaly

Studies of nighttime plasma drifts using incoherent scatter data

The ionospheric plasma is one of the most important parameter for understanding the dynamics of ionospheric F-region. The incoherent scatter radar at Arecibo (18.4° N, 66.7° W) has the capability of measuring the line of sight (LOS) velocity with a steerable beam swung continuously. A set of LOS ion velocities are combined to give drift vector velocities, which are converted into field parallel ($V_{||}$) and field perpendicular ($V_{\perp N}$, $V_{\perp E}$) components. We have analyzed the nighttime plasma drift components for a period of full solar cycle from 1986 to 1994. We have observed the anti-correlation between $V_{||}$ and $V_{\perp N.}$ The strong anti-correlation between plasma drift are always well developed for most of the night but the height of the F-region peak density (hmF2) sometime correlates with one component of the velocity while at other times it correlates with other velocity components.

Regional Warning Centre and related studies

Prediction of maximum amplitude of the next Solar Cycle 24 using precursor method

National Physical Laboratory, New Delhi operates Indian RWC as a part of International Space Environment Services [ISES] chain and is responsible for collection and dissemination of a wide variety of near-real-time and recent data on solar geophysical conditions to various users in India and neighbouring countries. In addition, the centre is also responsible for providing forecasts on solar and geophysical conditions based on the data collected from other centres located around the globe and also from observatories within India. RWC [Boulder] and RWC [Sydney] are two major sources of near-real-time data and provide a variety of observational information which includes detailed reports on solar active regions, magnetic activity, Coronal Holes, CMEs, X-ray events, Radio bursts, Proton events. etc. Solar activity

predictions both long term and short term is one of the major activity in RWC.

This is the period of solar minimum for the current 11 years solar cycle No. 23, therefore, the long term ionospheric predictions and various other applications such as satellite launching and their life etc., it is essential to predict the maximum amplitude and the time of accurence for the forthcoming solar cycle No. 24 is essential.

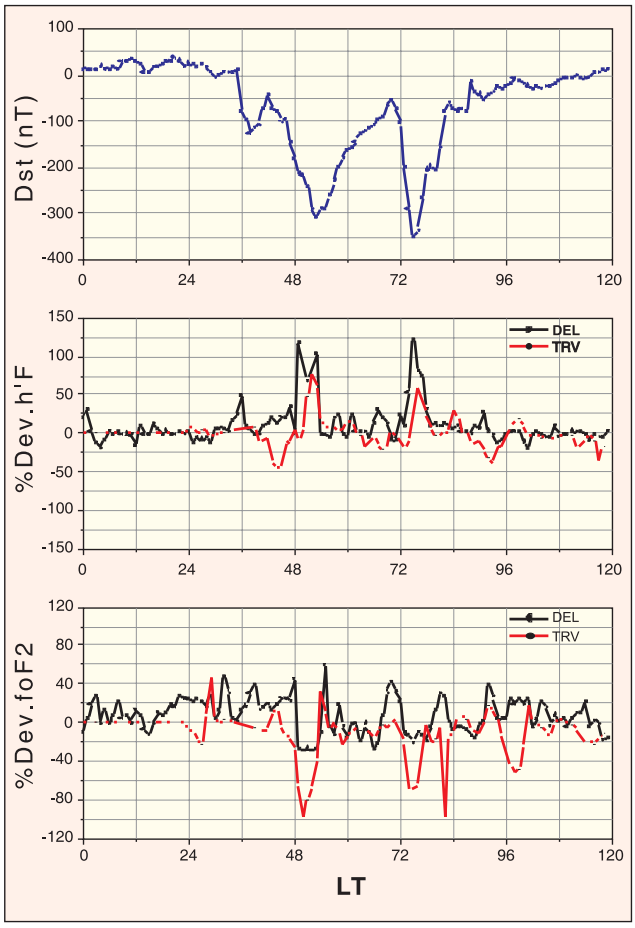
For predicting the maximum amplitude of forthcoming solar cycle number 24, precursor method is used. Precursor technique is based on the correlation of geomagnetic indices (disturbances) prior to the minimum or in the falling part of the sunspot cycle with the magnitude of the ensuing solar cycle maximum. Study was made with, twelve monthly running average sunspot number (R12) and the number of geomagnetic disturbed days in a month (with Ap values more than or equal to 25) for the periods corresponding to last seven solar cycles number 17 to 23 are considered. Geomagnetic disturbance index (DI) is determined using 12 month moving average of the monthly geomagnetic disturbed days. The best first and second-degree correlations, obtained between DI at selected times during the decline part of a solar cycle with the R12 maximum of the ensuing solar cycle are used to predict back the observed R12 peak values for cycles 17-23 and results agree within $\pm$ 5 % & $\pm$ 3% respectively. The technique predicts a maximum amplitude of **R12 ≈139** for the forthcoming solar cycle number 24.

CYCLE	Observed Peak	Average of best three variates (Linear fit) fit)	Average of three variates (Quadratic fit)	% deviation from observed (Linear fit)	% deviation from observed (Quadratic
18	151.9	145.6	150.5	-4.15	-0.92
19	202.7	209.7	203.6	3.45	.444
20	106.4	113.7	108.0	6.86	1.5
21	188.4	181.6	185.7	-3.61	-1.43
22	146.7	146.4	151	-0.20	2.93
23	121.5	120.5	118.1	-0.82	-2.8
24	**Predicted**	**136.3**	**139.3**		

Table 6.1 Hindcast Results

Space weather impact on equatorial and low latitude F-region Ionosphere over India

For detailed study of space weather impact on equatorial and low latitude F-region, the ionospheric response features are analysed during the periods of three recent and most severe magnetic storm events of the present solar cycle occurred in October, November 2003 and November 2004. The F-layer base height (h'F), peak height (hmF2) and critical frequency (foF2) data, from Trivandrum, an equatorial station and Delhi, a low latitude location, are examined during three most severe magnetic storm periods. The results of the analysis clearly show that the height of F-region (both h'F and hmF2), at equator and low latitude, simultaneously increases by 200 to 300 km as shown in Fig. 6.17, in association with maximum negative excursion of Dst values around midnight hours with large depletion of ionization over the equator which is followed by an ionization enhancement at low latitude during recovery phase of the storm. The study shows that during magnetic disturbances, equatorial ionization anomaly (EIA)



6.17 The Effect of Geomagnetic Storm on F-region Ionospheric parameters at equator and low latitude.

expands to much wider latitude than the normal fountain driven by the E/F-layer dynamo electric fields. In addition, at the equator the normal pre-sunset hours enhancement in h'F is considerably suppressed during storm periods. This might be due to changes in magnitude and direction of electric field affecting the upward ExB drift and hence the plasma distribution in the form of decrease of electron density in equatorial region and an increase in low latitude region.

Solar EUV flux during solar cycle 21, 22 and 23

Langmuir probe on the Pioneer Venus Orbiter measured the total solar EUV flux during large portions of sunspot cycles 21 and 22, while CELIAS /Solar EUV Monitor (SEM) on the Solar and Heliospheric Observatory (SOHO) measured this flux in the spectral ranges 26-34 nm and 0.1 - 50 nm during the whole of sunspot cycle 23. We studied the daily values of these EUV fluxes in relation to various often - used proxy indices to identify a single index which has the highest correlation coefficient with the observed values during all the three sunspot cycles. It is observed that no single index exhibits this feature. However, almost all the proxy indices averaged over one - half or more solar rotations show a high degree of correlation with the daily EUV flux. Further, the solar magnetic field is found to exhibit somewhat better correlation and it is recommended that this index averaged over three previous solar rotations may be used for real time prediction.

Indian MST Radar Studies

Detection of echoes from upper E-region

Field aligned radar echoes from the upper E-region have only been observed at the dip equator. However, during one of the experiment on E-region irregularities, a layer of weak echoes, having Signal-to-Noise Ratio (SNR) of the order of -12 to –3 dB was seen drifting downward from 157 km at 09:30 LT to about 148 km at 10:28 LT on July 12. 1997. This constitutes the first observation of daytime 150 km echoes away from the dip-equator and only adds to the mystery regarding the origin of these structures.

Quasi-periodic E-region Echoes: Evidence of K-H billows

Radar studies of field-aligned irregularities in the E-region have revealed the presence of quasi periodic echoes generally at mid latitudes. However, these echoes have also been observed at the low latitude station, Gadanki with the Indian MST radar. Using high temporal (~ 3 sec) resolution experiments, it is observed that the Doppler properties and the spatial distribution of these echoes can be explained in terms of local electrodynamical process that makes ions and electrons move with the vertical neutral wind. It is found that both the wind field and the tilt of the layers are consistent with the presence of Kelvin-Helmholtz billows.

Instrumentation and Facility Development Activities

Virtual instruments for atmospheric research applications

To aid and support Radio and Atmospheric Science experiments an important new development is reported here. This uses the presently available state of the art Virtual Instrument platform, LabVIEW which utilises the power of a modern high performance PC with powerful signal processing tools which are easily amalgamated with the in-built Graphical features for displaying raw-data and/or processed data in real-time. This is normally achieved using the hardware support available in the form of PCI plug and play cards for real-time data acquisition from the real world sensors.

However, in one of the applications a versatile (complete) data acquisition system has been

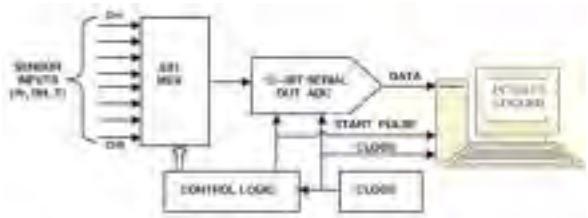


Fig 6.18 Functional Block Diagram of Data Acquisition

Fig. 6.19: LabVIEW Front Panel Display

Time	CH-1	CH-2	CH-3	CH-4	CH-5	CH-6	CH-7	CH-8
12:14:45	4.231	2.161	4.458	4.250	2.158	4.231	0	4.998
12:15:20	4.224	2.163	4.458	4.214	2.158	4.229	0	4.998
12:15:54	4.233	2.161	4.458	4.253	2.163	4.250	0	4.998
12:16:29	4.282	2.163	4.458	4.270	2.168	4.280	0	4.998
12:17:04	4.282	2.180	4.458	4.294	2.183	4.292	0	4.998
12:17:39	4.290	2.185	4.458	4.290	2.187	4.309	0	4.998
12:18:14	4.307	2.185	4.458	4.302	2.187	4.309	0	4.998
12:18:49	4.302	2.190	4.458	4.316	2.187	4.314	0	4.998
12:19:24	4.312	2.190	4.458	4.329	2.192	4.314	0	4.998
12:19:59	4.309	2.195	4.458	4.321	2.195	4.316	0	4.998
12:20:34	4.326	2.200	4.458	4.351	2.197	4.326	0	4.998
12:21:08	4.326	2.202	4.460	4.329	2.202	4.324	0	4.998

Table 6.2: Data in Excel File

developed based on LabVIEW platform which enables Real-time multi-channel data acquisition through the ubiquitous PC printer port.

Two diagrams (Fig.6.18 & 6.19) and a Table 6.2 showing a sample of the data file in Excel format are reproduced.

Developments of atmospheric electricity sensors

The design, development and fabrication of ball antenna sensors and electronic instrumentation for measuring Maxwell current and Schumann resonance electric field were undertaken. For Maxwell current ball antennas of 15 cm diameter size have been designed and fabricated in stainless steel. Current measuring electrometers have also been designed and fabricated. The ball antennas have been designed in such a way as to house their measuring electrometers securely within the balls themselves. Four set of electrometers and ball antennas have since been handed over to IIG for carrying out field test at IIG's experimental site in Tirunelveli. Design and fabrication of ELF voltmeter for Schumann resonance electric field measurements have also been completed.

अतिचालकता तथा निम्नतापिकी

SUPERCONDUCTIVITY AND CRYOGENICS

vfrpkydrk rFkk fuEurkfidh

निम्नतापिकी तकनीकी के क्षेत्र में निम्न तापमापन सुविधाओं के कार्य की अभिकल्पना एवं विकास जारी है। जबकि मूल अनुसंधान के क्षेत्र में उच्च ताप अतिचालकता प्रदर्शित करने वाले क्यूप्रेटस, रूथीनेट्रस और बोराडइस, उच्च ताप वैद्युत शक्ति - कोवाल्टेटस, सी एम आर (CMR) मैंगेनाइटस तथा लौहविद्युत विविध प्रकार के पदार्थों के संश्लेषण सम्बंधीय शोध पत्रों का प्रकाशन ही मुख्य लक्ष्य है। Na_xCoO_2 यौगिक में x परिवर्तित करने से ताप का प्रतिरोधकता एवं तापवैद्युत शक्ति पर आश्रय का विस्तृत अध्ययन किया। चुम्बकीय अतिचालतक $RuSr_2Eu_{1.5}Ce_{0.5}Cu_2O_{10-}$ में चुम्बकीय प्रवृत्ति, एम-एच आलेख, प्रतिरोध और ताप वैद्युत शक्ति का अन्वेषण चुम्बकीय परिवर्तन तापमान, उच्च, क्रान्ति, क्षेत्र रासायनिक विभव एवं विद्युत चालन ऊर्जा के निर्धारण के लिए किया। वैक्यूम अनीलीकृत MgB_2 यौगिक की शुद्ध स्टॉइकियोमीट्री प्रावस्था के संश्लेषण पैरामीटरों को इष्टतमीकृत किया। Mg प्रतिस्थापित Cu1234 में Cu1234 यौगिक की अपेक्षा परस्पर संबंध एवं आंतर रेणुमय की तुलना में सुधार पाया। $Pr_{2/3}M_{1/3}MnO_3$ (M = Ca and Sr) और $Pr_{2/3}(Ba_{1-x}Csx)_{1/3}MnO_3$ सी एम आर (CMR) पदार्थों में विद्युत वहन द्वारा आयनिक माप प्रभाव का अन्वेषण किया। लौह विद्युत $SrBi_2Ta_2O_9$ (SBT) सिरेमिक में टंगस्टन डोपिंग का इसकी संरचना पर प्रभाव, परावैद्युत एवं प्रतिबाधिता गुणधर्मों का अध्ययन किया। विभिन्न सैद्धान्तिक मॉडलों और प्रयोगात्मक परिणामों की तुलना द्वारा शुद्ध एवं डोपड एच टी एस (HTS) क्यूप्रेटस में चालकता की अधिकता को समझने का प्रयास भी किया है।

SUPERCONDUCTIVITY AND CRYOGENICS

In the area of cryo-techniques the design and development work of low temperature measurement facilities continued. Whereas, in the area of basic research the focus has been on publications in a varied class of synthesized materials showing high temperature superconductivity (HTS)- cuprates, ruthenates and borides, high thermoelectric power- cobabltates, CMR- manganites and ferroelectricity. The temperature dependence of resistivity and thermoelectric power of Na_xCoO_2 compounds with varying x was studied in detail. The magnetic superconductor $RuSr_2Eu_{1.5}Ce_{0.5}Cu_2O_{10-}$ were investigated for susceptibility, *M-H* plot, magnetoresistance and thermoelectric power to determine the magnetic transition temperature, superconductivity transition temperature, upper critical field, chemical potential, and energy width for electric conduction. The synthesis parameters for phase pure stoichiometric vacuum annealed MgB_2 compound were optimized. Improvement in inter and intra- granular Jc, in comparison to pure Cu-1234 HTS system, was found in Mg-substituted Cu-1234. Electrical transport measurements on CMR materials like $Pr_{2/3}M_{1/3}MnO_3$ (M = Ca and Sr) and $Pr_{2/3}$ $(Ba_{1-x}Csx)_{1/3}MnO_3$ was carried out to investigate the ionic size effect. Tungsten doping in $SrBi_2Ta_2O_9$ (SBT) ferroelectric ceramics was studied for its effect on the structural, dielectric and impedance properties of the material. Comparison of various theoretical models and experimental results was carried out to understand excess conductivity in pure and doped HTS cuprates.

CRYO-TECHNIQUES

Superconducting Magnet Technology

Design, fabrication and assembly of a universal support system for magnet testing and low temperature experiments (4.2 – 300 K) under high magnetic field has been completed. All the magnets developed at NPL viz. 3 T with 28 mm bore, 7 T with 50 mm bore and 11 T with 50 mm bore can be fitted to this support system.

Two Variable Temperature Insert cryostats (4.2K – 300K) have been designed and fabricated to suit the dimensions of the top flanges of the 3 T, 7 T and the 11 T SC magnets. Assembly is in progress. Probes have been designed and fabricated for TEP and Magneto-resistance measurements.

SUPERCONDUCTIVITY STUDIES

Basic Studies on High Temperature Superconductors

Results of thermo-electric power (S) and electrical resistivity (ρ) measurements are reported on Na_xCoO_2 compounds with x = 1.0, 0.7 and 0.6. These are single-phase compounds crystallizing in the hexagonal structure (space group $P6_3/mmc$) at room temperature. Thermo-electric power values at 300K (S_{300K}) are, @ 80μV/K, 39μV/K and 37μV/K for x = 1.0, 0.7 and 0.6 samples, respectively (Fig.7.1). The samples with x=0.7 and 1.0 are metallic down to 5 K, while the x = 0.6 sample is semi-conducting. The value of ρ_{300K} for x = 1.0 sample is ~0.895 mΩ-cm

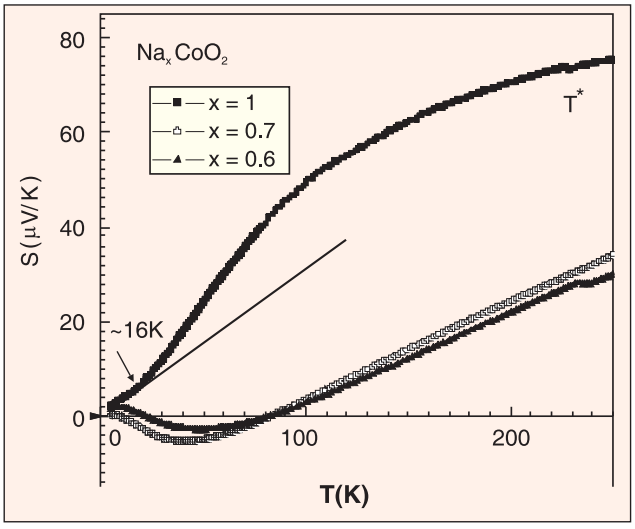


Fig. 7.1 Variation of thermoelectric power with temperature for Na_xCoO_2 compounds witrh x = 1.0,0.7 and 0.6.

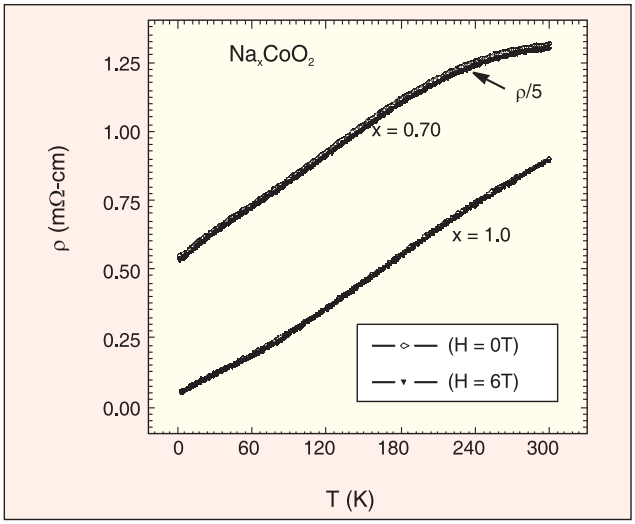


Fig.7.2 Resistivity versus temperature for Na_xCoO_2 with x= 1.0 and 0.7

and the power factor (S^2/ρ) is ~ 7.04 x 10^{-3} W/μK^2 which qualifies it as a good thermo-electric material, please see Fig.7.2. In x =1.0 sample, S(T) is positive throughout 300-5K temperature range and decreases monotonically to zero as temperature T→ 0. In contrast, S(T) of x = 0.7 and 0.6 samples changes sign and shows negative values between 90 K and 16 K before approaching zero as T→ 0. Anomalous S(T) behaviour of x = 0.6 and 0.7 samples, which are coincidentally the precursor materials to the reported superconductivity in this class of materials, indicates a dramatic change in the electronic structure of these compounds on lowering the Na content.

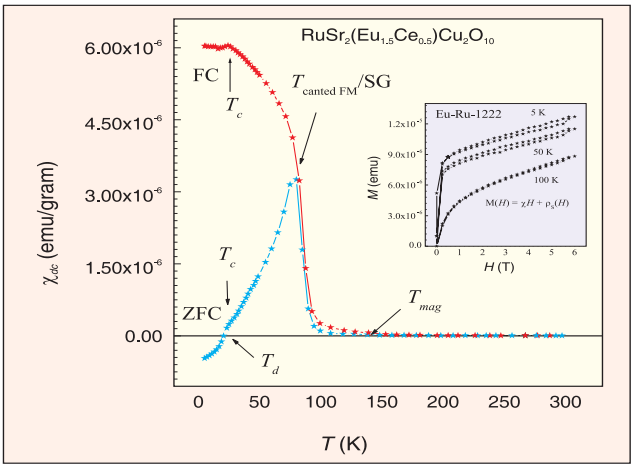


Fig.7.3 Magnetic susceptibilty versus temperature for $RuSr_2$ $Eu_{1..5}$ $Ce_{0.5}Cu_2O_{10-\delta}$

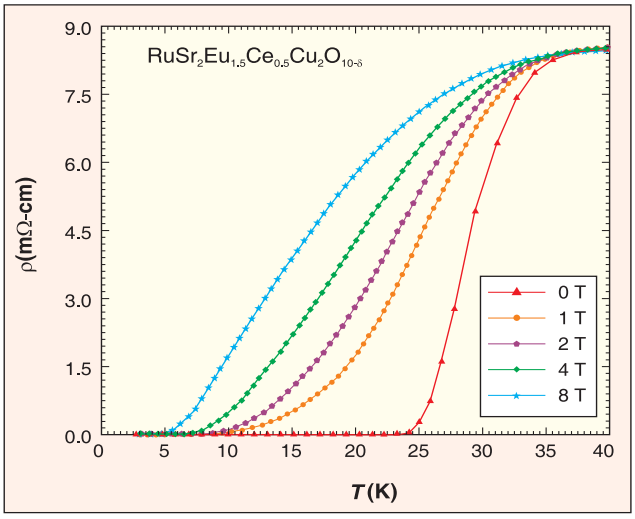


Fig.7.4 Variation of resistance with temperature for $RuSr_2Eu_{1.5}Ce_{0.5}Cu_2O_{10-\delta}$ under different magnetic fields.

Magnetic susceptibility (Fig.7.3), *M-H* plot, magnetoresistance (Fig.7.4) and thermoelectric power of the $RuSr_2Eu_{1.5}Ce_{0.5}Cu_2O_{10-\delta}$ superconductor are measured. Values of the magnetic transition temperature T_{mag} superconductivity transition temperature T_c upper critical field H_{c2} chemical potential μ, and energy width for electric conduction W_σ are obtained from these measurements. It has been found that T_{mag} = 140 K, T_c = 25 K (33 K) from susceptibility (magnetoresistance) measurements, H_{c2} = 55 T, μ = 8 meV, and W_σ = 58.5 meV. These values are compared with other ruthenate superconductors, and resulting physical information is discussed.

Synthesis parameters viz. heating temperature (T^H), and hold time (t^{hold}) for vacuum (10^{-5} torr) annealed and LN_2 (liquid nitrogen) quenched MgB_2 compound are optimized. These are single-phase compounds crystallizing in the hexagonal structure (space group P_6/mmm) at room temperature (Fig.7.5). Our XRD results indicated that for phase-pure MgB_2, the T^H for 10^{-5} torr annealed and LN_2 quenched samples is 750°C. The right stoichiometry i.e., MgB_2 of the compound corresponding to 10^{-5} Torr and T^H of 750°C is found for the hold time (t^{hold}) of 2.30 hours. With varying t^{hold} from 1- 4 hours at fixed T^H (750°C) and vacuum (10^{-5} torr), the *c*-lattice parameter decreases first and later increases with t^{hold} (hours) before a near saturation, while the *a*-lattice parameter first increase and later decreases beyond t^{hold} of 2.30

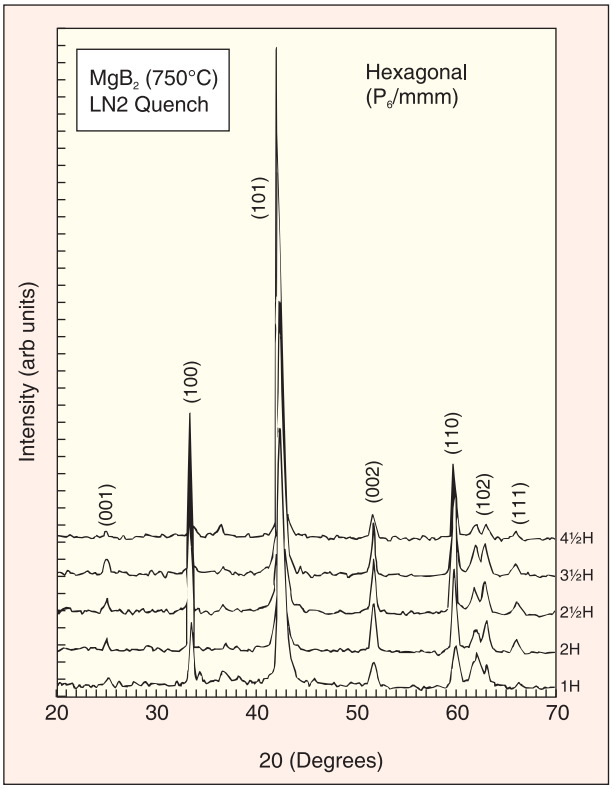


Fig.7.5 XRD of MgB_2

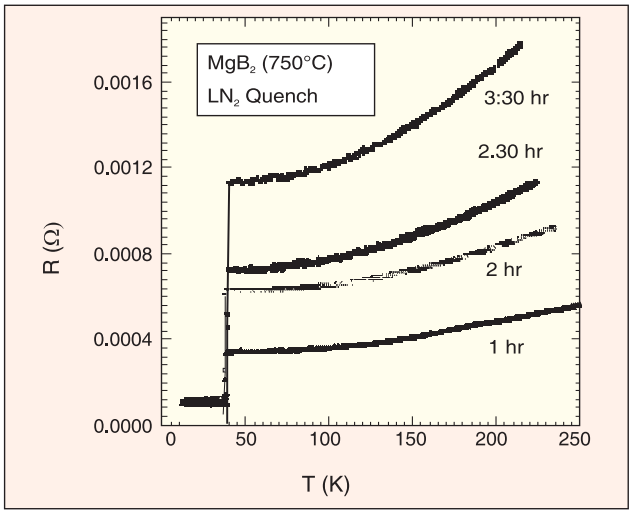


Fig. 7.6 Variation of resistance versus temperature for MgB_2

hours. *c/a* ratio versus t^{hold} plot showed an inverted bell shape curve, touching the lowest value of 1.141 which is reported value for perfect stoichiometry of MgB_2. The optimized stoichimetric MgB_2 compound exhibited superconductivity at 39.2 K with transition width of 0.6 K (Fig.7.6). The compound showed bulk superconductivity (Fig.7.7). In conclusion, the

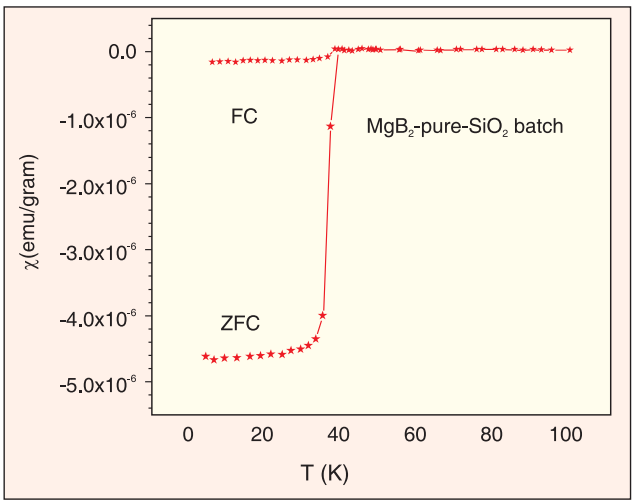


Fig.7.7 Magnetic susceptibility versus temperature for MgB_2.

synthesis parameters for phase pure stoichimetric vacuum annealed MgB_2 compound are optimized and are compared with widely reported Ta tube encapsulated samples.

Field dependent ac susceptibility studies in pure and Mg-substituted Cu-1234 high temperature superconductors reveal the presence of both inter and intra-granular peaks in $\chi''(T)$ curves at different ac field values. Intergranular critical current densities as estimated from the $\chi''(T)$ data are higher for Mg-substituted samples as compared to the pristine sample. Such an improvement in Jc is attributed to the reduction of superconducting anisotropy factor brought about by Mg incorporation, which eventually results in better inter- as well as intra-granular superconducting properties (Figs.7.7-7.10).

Electrical transport measurements on $Pr_{2/3}M_{1/3}MnO_3$ (M = Ca and Sr) colossal magneto-resistive materials have been carried out. With Ca at the Pr-site, $Pr_{2/3}Ca_{1/3}MnO_3$ exhibits only semi-conducting behaviour down to77K, $Pr_{2/3}Sr_{1/3}MnO_3$ shows an insulator-metal (I-M) transition at 288K. Electrical transport (resistivity) on the hitherto unexplored $Pr_{2/3}Ba_{1/3}MnO_3$ manganite, however, exhibits an insulator-metal (I-M) transition at 195K (T_{p1}) accompanied with a resistivity hump at ~160K (T_{p2}) which is ascribed to the lattice strain due to the large ionic size difference between Pr^{+3} and Ba^{+2} (with 9-fold coordination). Such I-M transitions in $Pr_{2/3}Sr_{1/3}MnO_3$ and $Pr_{2/3}Ba_{1/3}MnO_3$ are considered in terms of the larger ion sizes of the 9-fold coordinated Sr^{+2} and Ba^{+2} than of Ca^{+2} in $Pr_{2/3}Ca_{1/3}MnO_3$. The results have been examined in terms of average ionic radii of the substituted ions at Pr-site and from other parameters like variance and tolerance factor. Cs doping at the Ba-site, $Pr_{2/3}(Ba_{1-x}Cs_x)_{1/3}MnO_3$ ($x = 0.10$ and 0.50) increases the resistivity of both the peaks with lowering of T_{p1} and T_{p2} to 183K and 148K for the 10% Cs sample (Fig.7.11) and only the signatures of the I-M transition at T_{p1} ~143K in 50% Cs sample. Owing to its larger than Ba^{+2} ionic size, Cs doping is seen to induce a strain healing effect between Pr^{+3} and Ba^{+2}.

Tungsten doping in $SrBi_2Ta_2O_9$ (SBT) ferroelectric ceramics has been carried out to investigate its effect on the structural, dielectric and impedance properties of the material. $SrBi_2(W_xTa_{1-x})_2O_9$ ($0.0 < x < 0.20$) ceramics were synthesized by solid state reaction method. X-ray diffractograms of the samples reveal the single phase layered perovskite structure formation with tungsten content $x \leq 0.05$. Variation in the lattice parameters has been explained in terms of the limited structural constraint and relaxation imposed by the Bi-O interlayer. Dielectric constant (Σ) and dielectric loss ($\tan\delta$) measurements as a function of the temperature reveal a decrease in the Curie temperature (T_c) from 320°C (for $x = 0.0$) to 291°C (for $x = 0.025$) and an increasing trend over the doping range of $0.05 < x < 0.20$. The observed changes in ε and $\tan\delta$ with frequency and temperature have been considered in the light of oxygen and cationic vacancies in tungsten doped samples. Dielectric constant of the samples increases with tungsten doping at their respective Curie temperatures. Significant reduction in the dielectric loss with tungsten addition is also observed. These have been viewed in terms of a competition between the ionic and electronic polarizations. Bulk conductivity of the samples as deduced through ac impedance investigations indicate an increased electronic conduction beyond the observed solubility limit of 0.05 of tungsten doping.

High quality thin films of $NdNiO_3$ are successfully deposited on $LaAlO_3$ (100) substrates using novel and low cost chemical spray pyrolysis deposition technique. Resistivity (ρ) of the deposited films has been found to be strongly affected by the substrate temperatures (350°C-750°C). A metal-insulator transition (T_{MI}) has

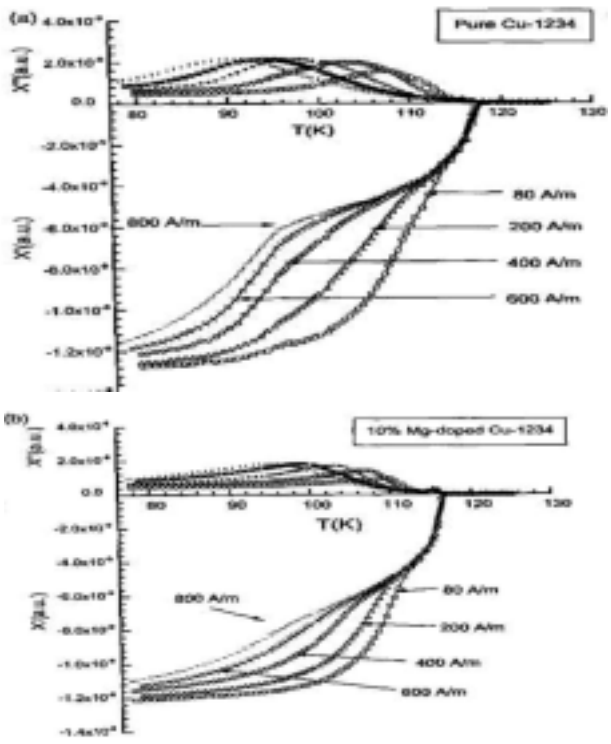
been observed for films deposited at 750°C. Both T_{MI} and the change in R at the transition have been correlated with different parameters such as deposition and annealing conditions, film texture and microstructure. Hysteresis observed in R (T) of these films confirms the presence of first order phase transition obtained without high pressure annealing. XRD and SEM reveal that the best quality films are well textured and highly oriented.

Excess Conductivity Studies

Inadequacy of the comparative studies, in different superconducting systems, which are conducted in the critical regions close to T_c are discussed. Ginzburg point, theoretical as well as experimental critical region widths have been calculated from electrical conductivity fluctuation effects in $YBa_2Cu_4O_8$ (Y-124) superconductor samples and are discussed in the light of both the experimentally observed values of the anisotropy in this system as well as the reported theoretical as well as the observed values in high T_c systems.

The Ginzburg criterion yields theoretical critical region width values for $YBa_2Cu_4O_8$ samples, which in the Fisher criteria (i.e. 25 times GL) yield values such that the experimental critical region widths lie between the theoretical values of Ginzburg and Fisher. Also, we find that, for the lower anisotropy superconducting system the theoretical critical region widths, as calculated from the theoretical formulation without anisotropy factor, are larger than those for higher anisotropy system. This contradicts the observations that critical region width and anisotropy have a direct variation. Also, since this theoretical formulation is very strongly dependent on T_c^{mf} it may give wrong information about the comparative behaviour in the critical regions of different systems. It is seen that a theoretical formulation without anisotropy factor is anomalous for comparing the conclusions from critical region width studies in different systems. It may, therefore, be concluded that for critical region width calculations a theoretical formulation without anisotropy factor does not hold good for any comparison between the behaviour of systems with differing anisotropies.

The influence of planar-site-dopant, Zn, as well as the predominantly chain-site-dopant Fe on the superconducting order parameter fluctuations (SCOPF) in $ErBa_2Cu_{3-x}(Zn,Fe)_xO_{7-\delta}$ polycrystalline bulk samples, due to varying concentrations of Zn occupancies for x=0.02, 0.03, 0.04, 0.05, 0.12, and 0.18; and Fe occupancies for x=0.03, 0.05, 0.09, and 0.18, has been discussed and compared vis-à-vis the mean-field critical temperature (T_c^{mf}), temperature range, lattice parameters, oxygen content and the inter layer coupling. In low concentration Zn doped samples, quantitatively, the order parameter dimensionality (OPD) shows direct variation with Zn content. Beyond a certain Zn concentration the mean-field-region temperature range necessary for obtaining the OPD is almost invariant. With T_c reduction due to Zn concentration increase, this range decreases proportionately with T_c or the T_c^{mf}. It is inferred that higher Zn concentrations cause reversal of the OPD exponent, numerically. The SCOPF are independent of carrier concentration variation in the planes and suggest strong coupling between the two unit-cell planes in pure and Zn doped samples; and are invariant to low concentrations of Fe, and with increasing Fe concentration show marked dimensionality variation and increased dependence



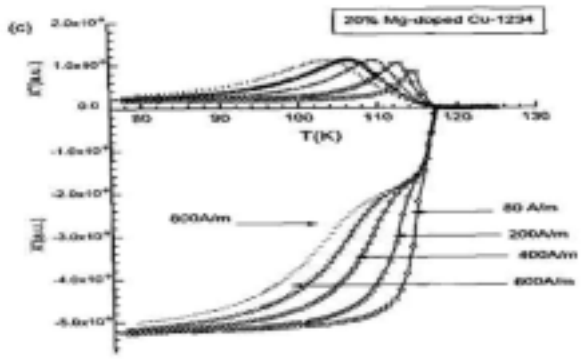


Fig.7.8, (a) Variation of X' and X'' with temperature for the pristine Cu-1234 Superconductor, (b) Variation of X' and X'' 1234 Superconductor. (c) VAriation of X' and X'' wih temperature for 20% Mg-doped Cu-1234 Superconductor.

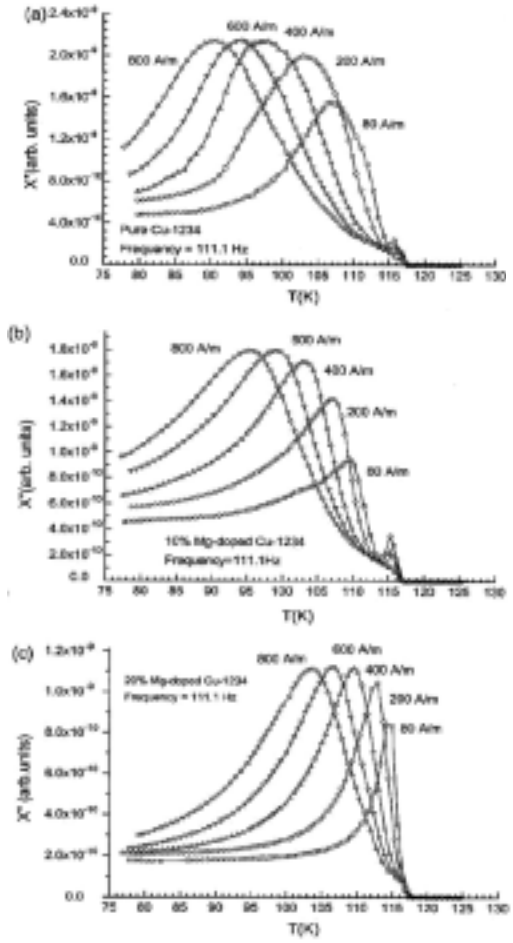


Fig.7.9, (a) Variation of X'' with temperature for the pristine Cu-1234 Superconductor. (b) Variation of X'' with temperature for 10% Mg-doped Cu-1234 Superconductor. (c) Variation of X'' with temperature for 20% Mg-doped Cu-1234 Superconductor.

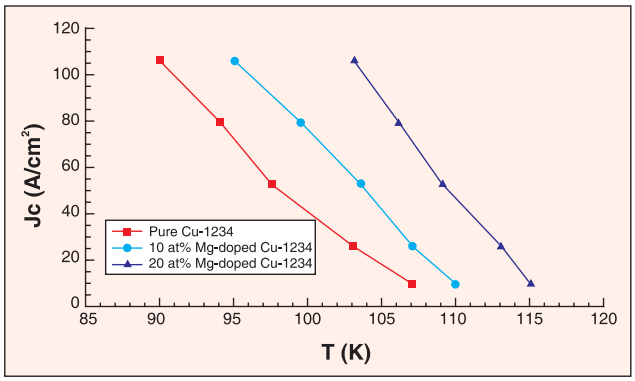


Fig. 7.10. J_c versus T_p behavior for the (a) pristine, (b) 10% Mg-doped and (c) 20% Mg-doped Cu-1234 superconductors. Solid lines drawn are only guide to the eve.

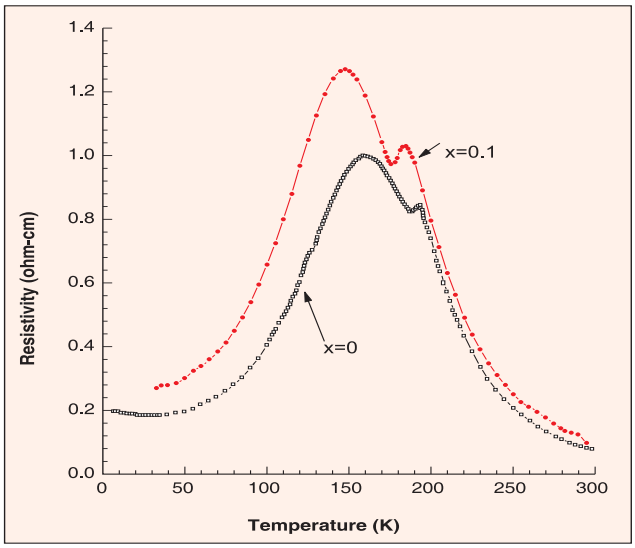


Fig.7.11. Resistivity-Temperature variation in $Pr_{2/3}(Ba_{1-x}Cs_x)_{1/3}MnO_3$.

on oxygen content. Higher Fe concentration promotes dimensionality reversal.

Theoretical work

Theoretical understanding of the role of magnetic field in superconductors is initiated by working out the details of the theory of N.R. Werthemer, E. Helfand and P.C. Hohenberg [Phys. Rev. 147, 295 (1966)] by imaginary time field theoretical methods. Details of the finite size effects are also understood on the basis of the theory of A.D. Zaikin, D.S. Golubev, A. van Otter lo and G.T. Zimanyi [Phys. Rev. Lett. 78, 1552 (1977)]. Various possible ways for the negative curvature and positive curvature of the critical field are learnt.

सहायक सेवाएं

SUPPORT SERVICES

Planning, Monitoring and Evaluation Group

Contract R & D Projects, as Sponsored, Collaborative and Grant-in-Aid Projects are undertaken by the Laboratory with funding from External Agencies.Before submission of the project proposals to the outside agencies they are evaluated by the Group based on various criteria and conditions. Monitoring and developing of complete database for report generation on projects are done and project files are created and maintained. Similarly Major Laboratory Projects and other In-house Projects funded by CSIR & NPL undertaken in NPL are also monitored.Fund allocation and processing of indents is an important activity. The report on completed projects and refund of unspent balance to the funding agencies at the end of project are made by the group PME prepares Annual Plan and Five Year Plan for NPL. It organizes Research Council meetings and coordinates with Management Council meetings organized by administration. Time to time PME disseminates information on projects, performance reports and ECF reports to CSIR. PME is also involved in monitoring of Networking Projects. PME developed manpower data and maintains staff positions and disseminates the information to various authorities. The group also maintains and regulates the appointments of project staff under various externally funded projects.

Industrial Liaison Group

This group handles two major areas viz. Marketing of developed technologies and Consultancy projects. Besides this ILG is responsible for all matter connected with business development, open days function, where few thousand school and college students with their teachers are invited to see the various activities at NPL. Students were shown a film on NPL activities too. A technology day function is also observed where all licencess are invited to delibrate with concerned PI of the technology for any suggestions. This group is also responsible for the dissemination of information, publication in CSIR news and in CSIR annual report. This group also takes care in the Management of S & T outputs with other funding agencies viz DST, CSIR, NRDC etc.

Human Resource Management Group

This group arranges training programmes for the benefit of NPL staff and also organizes NPL sponsored training courses for the benefit of industries in various areas of core competency. It also supports organization of symposia, conferences, etc, at NPL. It also attends to various public relations activities and follows up various MoUs with educational institutions in respect of doctoral, post graduates and summer training on reciprocal basis. In processes induction of JRF's. SRF's, Research Associates for NPL programmes. The group also pursues other schemes of CSIR on EMR and HRD activities.

International Science and Technology Affairs Group

International visits play an important part of scientific R & D Processing of application of the laboratory scientists pertaining to international visits, bilateral exchange programmes, sabbatical study period and deputations abroad are handled by this group. It also arranges important lectures and invited talks. Arranging training programmes for international candidates is also the job of this group.

Library & Technical Information Services 2004-05

NPL Library has been providing library and information support to scientists for R & D pursuits. Over the years it has developed a rich collection of scholarly books and journals for the purpose specifically in the field of physics and related sciences.

During the current year library subscribed to 117 scholarly journals (101 foreign journals + 16 Indian Journals) and added 77 S&T books, 13 Hindi books,104 standard specifications, and 996 bound volumes of journals. The Library uses Library Management package developed in-house, to perform its entire house keeping functions. Library provides library services such as Photocopying service, Electronic document delivery service, Inter-library loan service, reference service and literature search. The Library offers online access to more than 4000 full text journals under the e-journal Consortium Project of CSIR. It facilitates access to journals from various publishers i.e. ScienceDirect (Elsevier), Blackwell, Springer, AIP (American Institute of Physics), APS (American Physical Society Journals), Wiley Interscience (John Wiley & Sons), Oxfor Univ. Press

(OUP) Royal Societyof Chemistry (RSC), Taylor & Francis (T & F)and American Chemical Society (ACS) as well as to their archives going back to 1995 in case of Elsevier Science and 2000 onwards in the case of otherpublishers.

This service was made operational in NPL on 31st July2002 with the access to ScienceDirect (Elsevier group of journals and others w.e.f. February 2005 onwards.

The Library has a KSK Library site on the NPL intranet providing latest information on its activities such as additions to its collection, current subscribed journals, new journals received during the week, links to electronic libraries, publishing houses, library catalogue, and papers published by NPL scientists. The library continued to update this site during the year.

The Library also maintains NPL website (www.nplindia.org) on Internet.It is providing lates information on activities of NPL such as its role,thrust areas of research, facilities, services and achievements. The library continued to update this site.

jkt Hkk"kk dk;kZUo;u

i'kklfud dk;'kkyk

प्रयोगशाला में राजभाषा नीति के प्रभावी कार्यान्वयन हेतु दिनांक 7.4.2004 को एक दिवसीय प्रशासनिक कार्यशाला का आयोजन किया गया। प्रयोगशाला के लगभग 60 अधिकारियों/कर्मचारियों ने इस कार्यशाला में सक्रिय रूप से भाग लिया। इस कार्यशाला के आयोजन का मुख्य उद्देश्य वैज्ञानिक/तकनीकी व प्रशासनिक सभी वर्ग के अधिकारियों/कर्मचारियों को हिन्दी में किए गए कार्य से सम्बन्धित तिमाही प्रगति रिपोर्ट के प्रपत्र को भरने से सम्बन्धित था। इसके अतिरिक्त 1963 की धारा 3(3) के विषय में विस्तृत जानकारी उपलब्ध कराना, छुट्टियों के नियम, रिकार्ड मैनेजमेंट आदि विषयों से अवगत कराना था। श्री एस सी त्यागी, डा. पूरन पाल तथा श्री आर पी शर्मा ने व्याख्यान देकर उक्त विषयों से सम्बन्धित विस्तृत जानकारी से सभी प्रतिभागियों को लाभान्वित किया ।

fof'k"V 0;k[;ku

राजभाषा हिन्दी के कार्यान्वयन, इसके व्यापक प्रचार-प्रसार तथा प्रशासन के साथ-साथ वैज्ञानिक/तकनीकी क्षेत्रों में इसको अधिकाधिक बढ़ावा देने के उद्देश्य से प्रयोगशाला में एक व्याख्यान श्रृंखला आरम्भ की गयी थी। विशिष्ट व्यक्तियों द्वारा व्याख्यानों की इस श्रृंखला के अन्तर्गत दिनांक 6 मई, 2004 को डिपार्टमेंट ऑफ फिजिक्स एण्ड एस्ट्रो फिजिक्स, दिल्ली विश्वविद्यालय के प्रो. आर. पी. टण्डन ने स्मार्ट मैटीरियल पर व्याख्यान दिया।

i'kklfud dk;'kkyk

प्रयोगशाला में प्रशासन विभाग से सम्बन्धित विभिन्न पहलुओं पर प्रत्येक तिमाही में कार्यशालाओं का आयोजन किया जाता है। दिनांक 17 मार्च, 2005 को प्रयोगशाला के अधिकारियों/कर्मचारियों के लिए 'राजभाषा कार्यान्वयन' से सम्बन्धित एक दिवसीय कार्यशाला का आयोजन किया गया। इस कार्यशाला का मुख्य उद्देश्य प्रशासन के सभी अधिकारियों/कर्मचारियों को हिन्दी में किए गए कार्य से सम्बन्धित तिमाही प्रगति रिपोर्ट को प्रपत्र में भरने के सम्बन्ध में जानाकरी उपलब्ध कराना था। इसके अतिरिक्त 1963 की धारा 3(3) के नियम अधिनियमों से अवगत कराना, सी.एस.आई.आर. की क्रय प्रक्रिया, भण्डारण व्यवस्था व रिकार्ड मैनेजमेंट एवं सी सी एस नियम के विषय से विस्तृत जानकारी उपलब्ध कराना था।

कार्यशाला का शुभारंभ निदेशक महोदय ने प्रतिभागियों का स्वागत करके किया। श्री एस सी गर्ग जी ने कार्यशाला के विषय में संक्षिप्त जानकारी दी। डा. एच. एन. दत्ता ने धन्यवाद प्रस्ताव प्रस्तुत किया इसी के साथ कार्यशाला आरंभ हुई।

कार्यशाला को तीन सत्रें में विभक्त किया गया था जिसमें क्रमशः प्रथम सत्र में डा. पूरनपाल जी (मुख्यालय) ने तिमाही प्रगति रिपोर्ट भरने व धारा 3(3) से सम्बन्धित विषय पर चर्चा की उसके प्रश्चात् दूसरे सत्र में श्री कुलदीप कौशिक जी ने सी.एस.आई.आर. की क्रय प्रक्रिया व भण्डारण व्यवस्था पर विस्तार से बताया और अंत में तृतीय सत्र में श्री आर.पी. शर्मा जी ने रिकार्ड मैनेजमेंट एवं सी सी एस नियमों के बारे में बताया। इस कार्यशाला में कुल 58 प्रतिभागियों ने भाग लिया। डा. पूरनपाल, श्री कुलदीप कौशिक, श्री आर.पी. शर्मा ने व्याख्यान देकर उक्त विषयों से सम्बन्धित विस्तृत जानकारी से सभी प्रतिभागियों को लाभान्वित किया। कार्यशाला में भाग लेने वाले प्रतिभागियों को बहुत सी ऐसी जानकारियां प्राप्त हुई जिनसे वे अनभिज्ञ थे। यह कार्यशाला अत्यंत सफल रही।

llnh; jkt Hkk"kk lfefr }kjk fnukd 7-2-2005 dk jk"Vh; Hkkfrd i;kx'kkyk] bfM;u u'kuy lkbl ,dkneh ¼bu lk½] o jk"Vh; ty fodkl vfHkdj.k dk i;kx'kkyk e fujh{k.kA

संसदीय राजभाषा समिति की दूसरी उप समिति राष्ट्रीय भौतिक प्रयोगशाला में हिन्दी के प्रगामी प्रयोग का निरीक्षण करने आई थी। माननीय संसद सदस्य श्री लक्ष्मी नारायण पाण्डेय जी की अध्यक्षता में गठित इस समिति के सदस्यों का डा. विक्रम कुमार, निदेशक, एन. पी.एल., डा. आर. ए. माशेलकर, अध्यक्ष, इंडियन नेशनल साइंस एकादमी (इनसा), एवं श्री आर. के. शर्मा, महानिदेशक, राष्ट्रीय जल विकास अभिकरण ने स्वागत व हार्दिक अभिनन्दन किया।

माननीय समिति सदस्यों व प्रयोगशाला के सदस्यों के आपसी परिचय के पश्चात् बैठक की कार्यवाही आरंभ हुई। निदेशक महोदय ने प्रयोगशाला की भूमिका तथा कार्य-कलापों की संक्षिप्त जानकारी समिति सदस्यों को दी। प्रयोगशाला की वैज्ञानिक गतिविधियों की जानकारी पावर प्वाइंट के माध्यम से दी गयी। प्रयोगशाला में हो रही वैज्ञानिक गतिविधियों व अनुसंधान कार्यों को देखने व समझने में समिति सदस्यों ने अत्यधिक उत्सुकता प्रदर्शित की और उन्हें यह जानकर सुखद आश्चर्य हुआ कि प्रयोगशाला में अन्तर्राष्ट्रीय स्तर के अनुसंधान कार्य होते हैं एवं इसके लिए उन्होंने प्रयोगशाला की सराहना भी की। इसके पश्चात् समिति ने निरीक्षण कार्य आरंभ किया।

निरीक्षण कार्य आरंभ होने पर निदेशक, एन.पी.एल. ने प्रयोगशाला में किए जा रहे हिन्दी कार्यों का संक्षिप्त विवरण प्रस्तुत किया। अन्तर्राष्ट्रीय स्तर व विज्ञान की प्रयोगशाला होने के बावजूद प्रयोगशाला में हिन्दी की प्रगति के लिए उठाए गए कदमों व कार्यों की विस्तृत समीक्षा करने के पश्चात् माननीय संसदीय समिति के सदस्य अत्यन्त प्रभावित हुए। उन्होंने हिन्दी में किए जाने वाले प्रशासनिक व वैज्ञानिक कार्यों की प्रशंसा की लेकिन इसके साथ ही प्रयोगशाला में हिन्दी के उत्तरोत्तर प्रयोग में अपने कुछ अमूल्य सुझाव भी दिए।

भारतीय राष्ट्रीय विज्ञान अकादमी एवं राष्ट्रीय जल विकास अभिकरण जिनके अध्यक्ष क्रमशः डा. आर. ए. माशेलकर एवं श्री आर. के. शर्मा जी थे, का भी संसदीय समिति द्वारा निरीक्षण राष्ट्रीय भौतिक प्रयोगशाला में किया गया।

राष्ट्रीय भौतिक प्रयोगशाला द्वारा समिति सदस्यों के आगमन से सम्बन्धित सभी प्रकार की व्यवस्थाओं की समिति सदस्यों ने प्रशंसा की। निरीक्षण कार्यक्रम समाप्त होने के पश्चात् की गयी श्री एस.सी. गर्ग द्वारा धन्यवाद प्रस्ताव देने के बाद बैठक सम्पन्न हुई।

jk"Vh; dk;'kkyk

राष्ट्रीय भौतिक प्रयोगशाला में पिछले चार-पांच वर्षों से विज्ञान विषय पर हिन्दी में राष्ट्रीय कार्यशालाओं का आयोजन किया जा रहा है। आमतौर पर लोगों की अवधारणा है कि वैज्ञानिक कार्यों में हिन्दी का प्रयोग कठिन है लेकिन यदि किसी कार्य को करने की दृढ़ इच्छा शक्ति हो और निष्ठापूर्वक प्रयत्न किया जाए तो कुछ भी असंभव नहीं है। इसी विचार को केन्द्र में रखकर राष्ट्रीय भौतिक प्रयोगशाला ने प्रतिवर्ष हिन्दी माध्यम से पूर्णरूप से वैज्ञानिक कार्यशालाओं का आयोजन आरंभ किया है। इसके लिए प्रयोगशाला के कार्य क्षेत्र को तीन भागों में विभक्त किया गया है - मानक, पदार्थ विज्ञान तथा रेडियो एवं वायुमण्डलीय विज्ञान। प्रत्येक वर्ष इनमें से एक क्षेत्र में क्रमशः राष्ट्रीय स्तर की कार्यशाला आयोजित की जाती है । इस वर्ष पदार्थ विज्ञान पर कार्यशाला आयोजित की गयी है। इस कार्यशाला में राष्ट्रीय स्तर पर वैज्ञानिकों व युवा शोध छात्रें को अपनी-2 वार्ताएं प्रस्तुत करने के लिए आमंत्रित किया गया जिससे कि सभी एक ही प्लेटफार्म पर एकत्र होकर विचारों का आदान-प्रदान कर सकें।

इस कार्यशाला में लगभग 55 प्रतिभागियों ने अपने-2 क्षेत्र से सम्बन्धित पेपर प्रस्तुत किए जो पूर्णतः वैज्ञानिक थे केवल उनकी भाषा हिन्दी थी। इस कार्यशाला का मुख्य उद्देश्य विज्ञान सम्बन्धी कठिन तथ्यों एवं विचारों को सरल सुबोध हिन्दी में प्रस्तुत करना रहा

जिससे कि वैज्ञानिक शोधों एवं विकास से जुड़ी गतिविधियों को प्रौद्योगिकीय विकास की ओर ले जाकर भारत का सर्वांगीण विकास सुनिश्चित किया जा सके।

इस कार्यशाला में इस वर्ष से एक नई पहल की गयी है। इसमें 35 वर्ष या उससे कम आयु के वैज्ञानिकों/शोध छात्रें द्वारा प्रस्तुत पेपर्स में से दो श्रेष्ठ पेपर्स का चयन करके उन्हें पुरस्कृत किया गया। इस वर्ष दो शोध छात्रें का चयन किया गया। चयन करने के लिए तीन वरिष्ठ वैज्ञानिकों की टीम का भी गठन किया गया। कार्यक्रम के अंत में निदेशक, एन.पी.एल. ने नकद पुरस्कार प्रदान किए।

fof'k"V 0;k[;ku

राजभाषा हिन्दी के प्रभावी कार्यान्वयन इसके व्यापक प्रचार-प्रसार हेतु वैज्ञानिक, तकनीकी, प्रशासनिक क्षेत्रों में अधिक से अधिक बढ़ावा देने के उद्देश्य से राष्ट्रीय भौतिक प्रयोगशाला में पिछले कई वर्षों से व्याख्यान श्रृंखला का आयोजन किया जा रहा है। विशिष्ट व्यक्तियों द्वारा महत्त्वपूर्ण एवं प्रेरणात्मक विषयों पर व्याख्यान आयोजित किए जाते हैं। इसी श्रृंखला के अन्तर्गत दिनांक 8 जून, 2005 को प्रो. रमेश पाण्ड्या, विभागाध्यक्ष, स्टेटिस्टिकल विभाग, रतलाम (मध्य प्रदेश) ने 'ग्रहों का मानव जीवन पर असर : केवल आंकड़ों का समन्वय या यथार्थ?' नामक विषय पर व्याख्यान दिया। इसमें प्रो. पाण्ड्या ने ग्रहों की पूर्ण रूप से जानकारी दी व उन ग्रहों का मानव शरीर पर किस तरह से प्रभाव पड़ता है। इस पर विस्तार से चर्चा की। प्रयोगशाला के सदस्यों ने इसमें अत्यधिक रूचि व जिज्ञासा प्रदर्शित की व अनेक प्रश्न पूछकर उनका समाधान प्राप्त किया।

संलग्न

APPENDICES

Appendix: 1

PUBLICATIONS

Papers Published in Journals

1. Abbott P.J., J.P. Looney, P. Mohan, The effect of ambient temperature on the sensitivity of hot-cathode ionization gauges, *Vacuum (UK),* 77 217-222, 2005.

2. Agarwal A., Seth V.P, P. Gahlot, Goyal D.R., Arora M. and Gupta S.K., Effect of TiO_2 on electron paramagnetic resonance, optical transmission and dc conductivity of vanadyl doped sodium borate glasses, *Spectrochimica Acta Part A,* 60, 3161-3167, 2004.

3. Agarwal Seema, S.B. Samanta and G.L. Sharma, Influence of pH on structural and electrical properties of sol-gel derived (Ba-Sr)TiO_3 thin films under humid conditions, Thin Solid Films 448, 502-508, 2004.

4. Aggarwal R.K., Bhatia G., Saha M., and Mishra A., Effect of compositional parameters on the characteristics of C-SiC-B_4C composites, *Carbon Science*, 5, 164–169, 2004

5. Agnihotry S.A, M.Deepa, S,S, Yadav T. Lal, Viscosity measurement in gel polymeric electrolytes, *SAMIKSHA,* 25, 2, July-Dec., 2004.

6. Agnihotry S.A., Ahmed Shahzada, Gupta Davinder and Ahmad Shrif, Composite gel electrolytes based on poly (methylmethacrylate) and Hydrophilic fumed silica Electrochimica Acta, 49, 2343-2349 2004.

7. Agnihotry S.A., Saxena T.K., Deepa M., Verma A., Swati & Ahmad Shahzada, Smart electrochromic windows (secws) for energy management, *Ionics* 10, 226-232, 2004.

8. Agrawal A., Seth V.P., Gahlot P.S., Khan S., Arora M. and Gupta S.K., Study of electron paramagnetic resonance, optical transmission and d.c. Conductivity of vanadyl doped Bi_2O_3. B_2O_3.Li_2O glasses, *J. Alloys & Compounds,* 377, 225-231, 2004.

9. Ahmad Shahzada, Ahmad Sharif & Agnihotry S.A., Composite polymeric electrolytes based on PMMA-$LiCF_3SO_3$-SiO_2, *Ionics* 10, 268-272, 2004.

10. Ahmad Shahzada, Ahmad Sharif & Agnihotry S.A., Nanocomposite electrolytes with fumed silica in poly(methylmethacrylate) : thermal , rheological and conductivity studies, *J. Power Sources* 140 , 151-156, 2005 .

11. Amit L.Sharma, R.Singhal, A.Kumar, K.K.Pande and B.D.Malhotra, Immobilization of glucose oxidase onto electrochemically prepared polyaniline-co-fluoroaniline films*Journal of Applied Polymer Science*, 91, 3999-4006, 2004.

12. Aruna I, Mehta B.R., Malhotra L.K. & Shivaprasad S.M., A colour-neutral, Gd nanoparticle switchable mirror with improved optical contrast and response time, *Advanced Materials (Wiley)* 16, 169, 2004.

13. Awana V.P.S., Anurag Gupta, H. Kishan, M. Karppinen, H. Yamauchi, A.V. Narlikar, E. Galstyan and I. Felner, Micro-structure and magnetization of the 80-K superconductor, $TbSr_2Cu_{2.7}Mo_{0.3}O_{7+\delta,}$ Physica C 415, 69-73,2004.

14. Awana V.P.S., Anurag Gupta, H. Kishan, S.K. Malik, W.B. Yelon, J. Lindén, M. Karppinen, H. Yamauchi and Darshan C. Kundaliya, Structural and magnetic properties of $MSr_2Y_{1.5}Ce_{0.5}Cu_2O_z$ (M-1222) compounds with M = Fe and Co, J. Appl. Phys 95, 6690-6693, 2004.

15. Awana V.P.S., M.A. Ansari, Anurag Gupta, R.B. Saxena, H. Kishan, Devendra Buddhikot and S. K. Malik, Competition between superconductivity and magnetism in $RuSr_2Gd_{1.5}Ce_{0.5}Cu_2O_{10-\delta}$ (Ru-1222) Rutheno-cuprate compounds, Phys. Rev. B 70, 104520, 2004.

16. Awana V.P.S., M.A. Ansari, Anurag Gupta, R.B. Saxena, H. Kishan, V. Ganesan and A.V. Narlikar, Insulator to metal transition and induction of superconductivity in $Y_{0.4}Pr_{0.6}Ba_{2-x}Sr_xCu_3O_7$ system with $0.0 \leq x \leq 1.0$, Physica C 417, 33-39, 2004.

17. Badrinath K.V.S., K.M. Latha, T.R. Kiran Chand, P.K. Gupta, A.B. Ghosh, S.L. Jain, B.S. Gera, Risal Singh, A.K. Sarkar, Nahar Singh et. al., Characterisation of aerosols from bio-mass burning – A case study from Mizoram (NE), *Chemosphore,* 54,167-175, 2004.

18. Balamurugan B., Aruna I., Mehta B.R. & Shivaprasad S.M., Size-dependent conductivity-type inversion in Cu_2O nanoparticles , *Physical Review B -(Rap.Comm.),* 69, no. 16, 165419, 2004.

19. Balamurugan B., Kruis F.E. & Shivaprasad S.M., Size-induced stability and structural transition in monodispersed indium nanoparticles, *Applied Physics Letters*, 86, 083102, 2005.

20. Banerjee P. K. & Sengupta, A, A Clutter Canceller for Remote Victim Locator, *IETE Technical Review*, 22, 109-116, 2005.

21. Bhagavannarayana G. & Halder S.K., Characterization of $Si_{1-x}Ge_x$/Si layers and depth profile of their hetrobipolar transistor structures by high-resolution X-ray diffractometry and computer simulations, *J. Appl.Phys.* 97, 024509, 2005.

22. Bhagavannarayana G., A. Choubey, Yu.V. Shubin and Krishan Lal, Study of point defects in As grown and annealed bismuth germanate single crystals, *J. Appl. Cryst.* 38 448-454, 2005

23. Bhagavannarayana G., Budakoti G.C., Maurya K.K. & Kumar B., Enhancement of crystalline, piezoelectric and optical quality of $LiNbO_3$ single crystals by post-growth annealing and poling, J. *Cryst. Growth,* 2005.

24. Bhagavannarayana G., Choubey A., Shubin Y.V.& Lal K., Study of point defects in as-grown and annealed bismuth germanate single crystals, *J. Appl. Cryst.* 38, 448, 2005.

25. Cardoso C. A., F.M. Araujo-Moreira, V.P.S. Awana, H. Kishan, E. Takayama-Muromachi, and O.F. de Lima, Magnetic properties of the $RuSr_2Ln_{2-x}Ce_xCu_2O_{10}$ (Ln = Y,Ho and Dy) and $RuSr_2YCu_2O_8$ rutheno-cuprate families: a comparative study., Physica C 405, 212-218, 2004.

26. Chakraborty B.R., Surface & interface characterization by SIMS at NPL, *NPL Technical Bulletin,* p-22-32. Dec., 2004.

27. Chawla Santa and Amitava Sen Gupta, Optical setup of the proposed laser cooled Cs fountain at NPL, India, *MAPAN-JMSI,* 19, pp 139 147, 2004.

28. Choudhary R.K., St.-Maurice J.P. & Mahajan K.K., Observations of coherent echoeswith narrow spectra near 150 km altitude during daytime away from the equator, *Geophys. Res. Lett.,* 31, 2004.

29. Chowdhury M. Pal., Chakraborty B. R. and Pal A. K., Novel electro deposition route for the synthesis of boron nitride films, *Materials Letters,* 58, 3362, 2004.

30. Deepa M., Kar M. & Agnihotry S.A., Electrodeposited tungsten oxide films: annealing effects on structure and electrochromic performance, *Thin Solid Films,* 468, 32-42, 2004.

31. Deepa M., Srivastava A. K., Singh S. and Agnihotry S.A., Structure – property correlation of WO_3 thin films produced by electrodeposition, *J. Mater. Res.,* 19 2576 – 2585, 2004.

32. Dhakate S.R., Aoki T. and Ogasawara T., Effect of silicon infiltration on the mechanical properties of 2D cross-ply carbon-carbon composites, *Carbon Science*, 5 108–112, 2004.

33. Dhakate S.R., Mathur R.B. and Dhami T.L., Strengthening of C/C composites through ceramer matrix, *Carbon Science*, 5 159–163, 2004.

34. Dhakate S.R., Ogasawara T. and Aoki T., Microstructure of Tyranno ZMI fiber reinforced

carbon matrix composites after partial oxidation at different temperature, *Transactions of the Material Research Society of Japan*, 29 3585–3589, 2004.

35. Diva K., Kabiraj D., Chakraborty B. R., Shivaprasad S. M. and Avasthi D.K. Investigation of V/Si mixing induced by swift heavy ions, *Nucl. Ins. Methods in Physics Research* B, 222, p-169, July, 2004.

36. Felner I., E. Galstyan, V.P.S. Awana and E. Takayama-Muromachi, Magnetism and superconductivity in $RuM_{1.5}Ce_{0.5}Sr_2Cu_2O_{10}$ (M=Eu and Y), PhysicaC 408-410, 61-64, 2004.

37. Gahlot P.S., Seth V.P., Agrawal A., Kishore N., Gupta S. K., Arora M. and Goyal D.R., Influence of ZnO on optical properties and dc conductivity of vanadyl doped alkali bismuthate glasses, Radiation Effects & Defects in Solids 159,223-231, 2004.

38. Gajananda K., Kaushik A & Dutta H..N., Thermal Convection over east Antarctica: Potential microorganism dispersal, *International Journal on Aerobiology*, 20, 21-34, 2004.

39. Gajananda K & Dutta H.N., Terrestrial vegetation community structure and biomass of the Schirmacher oasis ecosystem, east Antarctica, *Int. J. Ecology & Dev.*, 3, 39-64,, 2005.

40. Garg Navin, M. Bhattacharya & S.C. Jain, Reducing diesel engine noise, emission & fuel consumption using pilot injection system, *J. Acoustical Society of India,* 32(1-4), 2004.

41. गुप्ता एस के विभिन्न तरल लोहों का इलेक्ट्रान पैराचुम्बकीय अनुनाद तकनीक द्वारा अन्वेषन पुनः अवलोकन भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका 12, 143-145, 2004.

42. Giri Rajiv, H.K. Singh, R. S. Tiwari, O.N. Srivastava, V.P.S. Awana, A Gupta, B.V. Kumaraswamy and H. Kishan, Effect of Ca doping for Y on structural / microstructural and superconducting properties of $YBa_2Cu_3O_{7-\delta}$, *Physica C , 419 10, 2005.*

43. Giri Rajiv, V.P.S. Awana, H.K. Singh, R. S. Tiwari, O.N. Srivastava, Anurag Gupta, B.V. Kumaraswamy and H. Kishan, Effect of Ca doping for Y on structural/ microstructural and superconducting properties of $YBa_2Cu_3O_{7-\delta}$, Physica C 419, 101-108, 2005.

44. Gupta P.K., Sahai Shivraj, Singh Nahar, Dixit C. K., Singh D.P., Sharma C., Tiwari M.K., Gupta Raj K. and Garg S.C., Residue burning in rice-wheat cropping system: Causes and implications, *Current Science*, 87, 1713-1717, 2004.

45. Gupta Prabhat K., Sahai Shivraj, Singh Nahar., Dixit C.K.., Singh D.P.., Sharma C., Tiwari M.K.., Gupta Raj K. and Garg S.C.., Residue burning in rice-wheat cropping system: Causes and implications, *Current Science,* 87(12), 1713-1717, 2004.

46. Gupta S.K., Pant R.P. and Arora Manju, Variable temperature electron paramagnetic resonance investigations of an ionic ferrofluid, I*ndian J. Engineering & Material Science* 11, 305-308, 2004.

47. Gupta S.K., Pant R.P. and Arora Manju. Ferrofluid paper in Hindi, I*nd. J. Scientific & Industrial Research* 143, 2004.

48. Haranath D., Bhalla Nitesh, Harish Chander, Rashmi, Kar M. & Ram Kishore, Controlled growth of ZnS:Mn Nanophosphor in porous silica matrix, *Virtual Journal of Nanoscale Science & Technology (AIP)*, Issue 23, 10, 6700-6705 Dec. 6, 2004.

49. Haranath D., Sharma Pooja & Harish Chander, Optimization of Boric Acid Content in Developing Efficient Blue Emitting, Long Persistent Phosphor, *Journal of Physics D: Applied Physics (IOP)*, 38 1-5, 2005.

50. Harish Chander, Haranath D., Virendra Shanker, Sharma Pooja, Synthesis of nanocrystals of long persisting phosphor by modified combustion technique*, Journal of Crystal Growth (Elsevier),* 271, 307-312, 2004.

51. Harish Chander,. Ghosh P. K, Shanker V.,

Haranath D. & Sharma Pooja, *Rashtriya Bhoutik Prayogshala mein Deeptisheel Padharthon va Upakaranon ka Swadeshi Vikas,* Bharatiya Vaignanik Evam Audhyogik Anusandhan Patrika, No. 2, Issue 12 Dec., 213-216, 2004.

52. Hu Y.K, Yoon S.M., Lim J.J., Sankaranarayanan V.K, Kim C.G. &.Kim C.O., Temperature dependence of exchange coupling in $Mn_{75}Ir_{25}$/ $Co_{70}Fe_{30}$/AlO_x/$Co_{70}Fe_{30}$ /$Ni_{80}Fe_{20}$ MTJs, *Physica Status Solidi (a)* 201, 1700, 2004.

53. Jain Kiran, Kumar Vipin, Rashmi, Sood K.N. and Lakshmi Kumar S.T., Preparation of Sb doped SnO_2 transparent conducting oxide coatings by dip coating technique, *Indian J. Physics*, 78A(2), 215-219, 2004.

54. Jain Meena & Kundu N. ,Effect of volcanic aerosols on stratospheric ozone at Kodaikanal, *Ind. J. Radio & Space Phys.*, 33, 170-174, 2004.

55. Jain S.C., Aernout T., Kapoor A.K., Vikram Kumar et. al; I-V Characteristics of Dark and Illuminated PPV-PCBM Blends Solar Cells Synthetic Metal, 148, 245-250, 2005

56. Jain S. L., Ghude S. D., Arya B. C., Signature of early ozone hole recovery during 2002, *Current Science,* 86, 963-965, 2004.

57. Jain S.K, Kamlesh K. Jain and Anil Kumar, Comparison of Calibration Procedures for Force Gauges to Establish Traceability in Force Measurement, *MAPAN-JMSI*, 19(1-2) 53, 2004.

58. Kabiraj K. Diva, Chakraborty B.R., Shivaprasad S.M. & Awasthi D.K., SHI induced mixing at the V/Si interface, *Nuclear Instruments and Methods, (B),* 222, 169, 2004.

59. Kalra N, F Chand, S C Misra, D R Vij, D K Chaturvedi, S Kumar, S Arora and S C K Misra, Electrical and optical non linearity in vacuum deposited thin films of poly [N-(4-benzoil-phenyl)-2 methylacrylamide], *J Nonlinear Optical Physics and Materials*, 13, 65-79, 2004.

60. Kandpal H.C., Ranjana Mehrotra and Swati Raman, Determination of surface flatness by spectral interferometric method, O*ptics and Lasers in Engineering*, 40, 250-255, 2005.

61. Karar N., Harish Chander & Shiva Prasad S. M., Enhancement of luminescent properties of ZnS:Mn nanophosphors by controlled ZnO Capping, *Virtual Journal of Nanoscale Science & Technology (AIP)*, Issue 23, 10, 5058-5060 Dec. 6, 2004, available online at http://www.vjnano.org

62. Karar N., Harish Chander & Shiva Prasad S. M., Enhancement of luminescent properties of ZnS:Mn Nanophosphors by controlled ZnO Capping, *Applied Physics Letters,* No. 21, 85, 5058-5060, 2004.

63. Kaur Amarjeet, Singh Ramadhar, Yadav K.L. & Bhattacharya D., Mechanism of charge transport in polypyrrole-heparin composites, *J. Macromol. Sci. Part A:Pure & Appl. Chem.*, 41, No. 12, 1369-1375, 2004.

64. Kaur S.; Thakur A.K.; Chauhan R.; Bawa S.S. and Biradar A.M., The effect of rotational viscosity on the memory effect in ferroelectric liquid crystal, *Physica B: Condensed matter*, **352**, 337-341, 2004.

65. Kaur S.; Thakur A.K.; Chauhan R.; Bawa S.S. and Biradar A.M.Bistability in deformed helix ferroelectric liquid crystal. *Journal of Applied Physics*, 96, 2547-2551, 2004.

66. Kedar Ashutosh, N. D. Kataria and K.K. Gupta, Characterization and Analysis of HTS Microstrip and Coplanar Resonators using a Spectral Domain Method, *Supercond. Sci. & Technol., 17, pp. 823-827, July, 2004.*

67. Kedar Ashutosh, K.K. Gupta and N. D. Kataria, Spectral Domain Modeling of Superconducting Microstrip Structure: Transmission Lines and Resonators, *Microwave & Optical Technology Letters, MOTL , 41(1), pp. 55-59, April, 2004.*

68. Kedar Ashutosh, K.K. Gupta, G.P. Srivastava and N.D. Kataria, CAD analysis of HTS microstrip patch antennas using spectral domain method,' *J. of Electromagnetics July 7, 2004.*

69. Kedar Ashutosh, N. D. Kataria and K.K. Gupta, Full-Wave Modelling of Non-linear Power Dependence of High-Tc Superconducting Microstrip Resonators, *Electronic Letter, 39 (23), pp 1660-1661, Nov. 2004.*

70. Khare Neeraj, Ajai K. Gupta and G.L. Bhalla,Low field magnetoresistance and conduction noise in layered manganite $La_{1.4}Ca_{1.6}Mn_2O_7$, *Solid State Communications 132, 799, 2004.*

71. Khare Neeraj, Ajai K. Gupta and G.L. Bhalla, Preparation and low field magnetoresistance of double layered manganite $La_{1.4}Ca_{1.6}Mn_2O_7$, *Journal of Physics and Chemistry of Solids, 66, 949, 2005.*

72. Khare Neeraj, D. P. Singh,A. K. Gupta, Shashawati Sen, D. K. Aswal, S. K. Gupta L. C. Gupta, Direct evidence of weak-link grain boundaries in a polycrystalline MgB_2 superconductor, *Journal of Applied Physics 97,* 76103-76105, 2005.

73. Khare Neeraj, D.P. Singh, A.K. Gupta and G.L. Bhalla, Magnetic field dependence of conductance and conduction noise of an artificial grain boun-dary junction in a $La_{0.67}Ba_{0.33}MnO_3$ epitaxial thin film, *Solid State Communications, 132,* 415-419, 2004.

74. Khare Neeraj, D.P. Singh, S.B. Samanta, A.K. Gupta, P.K. Babu, G. Ghosh, R. Nagarajan and L.C. Gupta, Weak link grain boundaries in intermetallic superconductors, Physica C 407, 89-94, 2004.

75. Khare Neeraj, D.P. Singh; A.K. Gupta; D.K. Aswal; Shashawati Sen; S.K. Gupta; L.C. Gupta, Generation of even harmonics in a MgB_2 bulk superconductor: an indication of the presence of weak link grain boundaries, *Superconductor Science & Technology 17,* 13, 2004.

76. Kim Cheol Gi, .Sankaranarayanan V.K, Kim Chong-Oh, Tsunoda M. & Takahashi M., Distribution of interlayer-exchange coupling on MTJ multiplayer, *Physica Status Solidi (a),* 201, 1635, 2004.

77. Kumar, N, Singh, V.R., Kumar, P. and Singh, B., Flow measurement with Intelligent Ultrasonic Flowmeter, *Acta Ciencia Indica* (An International Journal of Physics), XXX, 1, pp 115-119, 2004,.

78. Laffont L., Monthioux M., Serin V., Mathur R.B., Guimon C. and Guimon M.F, An EELS study of the structural and chemical transformation of PAN polymer to solid carbon, *Carbon*, 42 2485–2494, 2004.

79. Latha K. Madhavi, K.V.S. Badrinath, P.K. Gupta A.B. Ghosh, S.L. Jain, B.S. Gera et. al., Impact of bio-mass burning aerosols on UV erythema - A case study from N.E. region of India, A*tmospheric and Solar Physics,* 981-986, 2004.

80. Latha K, Badarinath K.V.S., Gupta P.K., Ghosh A.B., Jain S.L., Gera B.S., Singh R., Sarkar A.K., Singh N., Parmar R.S., Koul S., Kohli R., Nath S, Ojha V.K. & Singh G,. Impact of biomass burning aerosols on UV erythema - A case study from northeast region of India , *J Atmos & Solar Terr. Phys.*, 66, 981-986, 2004.

81. Latha K. Madhvi; Badrinath K.V.S., Kiran Chand T.R.., Gupta Prabhat K., Singh Risal., Tanwer R. S., Nath Shambhu and Singh Nahar., Impact of biomass burning aerosols on UV Erythema-A case study from North East region of India, *J. Atmospheric and Solar Terrestrial Physics* 66, 981-986, 2004.

82. Lochab, J. and Singh, V.R., Acoustic behaviour of plastics for medical applications, *Ind. J. Pure & Appl. Physics,* 42, pp. 49-55. August, 2004,

83. Lokendra Kumar, R. R. Koireng, Aparna Misra, Pankaj Kumar, S. K. Dhawan, M.N. Kamalasanan and Subhas Chandra, Blue organic light emitting diode based on lithium tetra- (8-hydroxy-quinolinato) boron complex, *Indian Journal of Pure and Applied Physics*. 43-56, 2005.

84. Mahajan K.K. & Dwivedi A.K., Ionospheres of Venus and Mars: A comparative study, *Adv.*

Space Res., 33, 145-151, 2004.

85. Mahavir Singh, Omkar Sharma & V. Mohanan, Predicting the sound reduction of building elements from material data, J. *Acoustical Society of India*, 32(1-4), 2004.

86. Mathur Prafull, S C K Misra, Ram Kishore, U C Upreti and J L Pandey, Preparation and characterization of vacuum deposited magnetic polyaniline thin films, *Indian Journal of Engineering and Materials Science*, 11, 353, 2004.

87. Mathur R.B., Bahl O.P, Dhami T.L., Chauhan S.K. Dhakate S.R. and Rand B., Interface and microstructure development in carbon/carbon composites, *Carbon Science*, 5 62–67, 2004.

88. Mehrotra Ranjana, Alka Gupta and R. Nagarajan, NIR spectroscopy and fibre optic probe for determination of alcohol, sugar and tartaric acid in alcoholic beverages, *J. Sc. Ind. Res*. 64, 131-134, 2005.

89. Mishra S C K, Mathur Prafull, Pant R.P. & Gupta Anil K., Nanocrystalline magnetic alloy thin film, *Ind. J. Engg & material Science*, V11, 319, 2004.

90. Misra Aparna, Lokendra Kumar, Pankaj Kumar, S.K. Dhawan, M. N. Kamalasanan and Subhas Chandra, Blue electroluminescence in organic semiconductors, *Indian Journal of Pure and Applied Physics*, 42 793, 2004.

91. Misra Aparna, Pankaj Kumar, S. K. Dhawan, M.N. Kamalasanan and Subhas Chandra, Bright-blue organic electroluminescent device based on bis (2-methyl 8-quinolinolato) (triphenyl Siloxy) aluminium, *Indian Journal of Pure and Applied Physics*. 43 522,. 2005.

92. Misra S C K, Prafull Mathur and B K Srivastava, Polyaniline thin film sensors for detection of carbon monoxide, *Sensors and Actuators A: Physica*, 114, 30-35, 2004.

93. Misra S C K, Prafull Mathur and Maneesha Yadav, M K Tiwari, S C Garg and P Tripathi, Preparation and characterization of vacuum deposited semiconducting nanocrytalline polymeric thin film sensors for detection of HCl, *Polymer*, 45, 8623-8628, 2004.

94. Misra SCK, Prafull Mathur, R P Pant and A K Gupta, Nanocrystalline magnetic alloy thin films, *Indian Journal of Engineering and Materials Science*, 11, 319, 2004.

95. Mohanan V., Omkar Sharma & Mahavir Singh, Absolute calibration of standard condenser microphones, J. *Acoustical Society of India,* 32(1-4), 2004.

96. Moorthy K. Krishna, Babu S. Suresh., Sunil Kumar S.V., Gupta Prabhat K. and B.S. Gera., Altitude profiles of aerosol BC, derived from aircraft measurements over an inland urban location in India, *Geophysical Res. Letters,* 31, L22103, doi: 10.1029/2004GL021336, 2004.

97. Moorthy K. Krishna, S. Suresh Babu, S.V. S. Kumar, P.K. Gupta & B.S. Gera, Altitude profiles of aerosols Bc derived from aircraft measurements over an inland urban location in India, Geo Phy. Letters, Vol. 31, 2004.

98. Narayan H., Gupta Anurag, Narlikar A.V., Sood K.N., Kishore Ram and Kanjilal D., Study of microstructural changes in MgB_2 thin film superconductors irradiated With 200 MeV 10^7 Ag ions, S*uper Conductor Science and Technology* 17, 1072- 1076,2004.

99. Nayar Prabhakan N.S.R., Alexander L.T., Radhika V.N., John T., Subrahmanyam P., Chopra P., Bahl M., Maini H.K., Singh V., Singh D. & Garg S C. Observation of periodic fluctuations in electron and ion temperatures at the low latitude upper ionosphere by SROSS-C2 satellite, *Ann. Geophysicae*, 22, 1665-1674, 2004.

100. Neeraj Khare, D. P. Singh, S. B. Samanta, A. K. Gupta, P. K. Babu, G. Ghosh, R. Nagarajan and L. C. Gupta , Weak link grain boundaries in intermetallic superconductors, *Physica C: Superconductivity, 407,* 89-94, 2004.

101. Nimal T., Vijay Kumar, A. K. Gupta and G. L. Bhalla, Superconducting transition edge

bolometer based on single phase BPSCCO 2223 thick film, Indian J. Pure & Appl. Phys., 42, 257-278, 2004.

102. Ojha V.N., Sudhir Kumar Sharma, S.K. Singhal and G.S. Lamba, insulation resistance measurements of high impedance accelerometer cables, *MAPAN-JMSI,* 19(1-2), pp117-120, 2004.

103. Om Prakash, Measurement of resolving power of convex lenses, *MAPAN-JMSI*,19p 109-115, 2004.

104. Om Prakash, Measurement of square of reflectance using principle of ratios, *J.Instrum. Soc.India*, 34p244-248, 2004.

105. Om Prakash, Moderate accuracy method for measurement of large concave radii of curvature of spherical surfaces, *J.Instrum. Soc.India*, 34 p 83-86, 2004.

106. Paliwal V.K. & Shivaprasad S. M., A phase diagram of the Sb/Si(001) interfacial system, *Surface Science Lett.*, 561/2, L207, 2004.

107. Pant R. P., Dhawan S.K., Suri D. K., Arora Manju Gupta, S.K., Kopcansky M.P. & Timko M., Synthesis and characterization of ferrofluid-conducting polymer composite, *Ind. J. Engg & material Science,* V11, 267,2004.

108. Panwar O. S., Aparna Y., Shivaprasad S. M., Khan Mohd. Alim, Satyanarayana B. S. & Bhattacharyya R., XPS and XAES Studies of as grown and nitrogen incorporated tetrahedral amorphous carbon films deposited by pulsed unfiltered cathodic vacuum arc process, *Appl. Surf. Sci.* 221, 392-401, 2004.

109. Panwar O. S., Deb B., Satyanarayana B. S., Khan Mohd. Alim & Pal A. K., Characterization of as grown and nitrogen incorporated tetrahedral amorphous carbon films deposited by pulsed unfiltered cathodic vacuum arc process, *Thin Solid Films* 472, 180-188, 2005.

110. Panwar O. S., Gupta S. K., Khan Mohd. Alim, Satyanarayana B. S. & Bhattacharyya R., Space charge limited conduction and electron paramagnetic resonance studies of as grown and nitrogen incorporated tetrahedral amorphous carbon films deposited by pulsed unfiltered cathodic vacuum arc process, *Diamond Relat. Mater.* 13, 513-520, 2004.

111. Pawan Kumar, Kumar D., Sharma T. P. & Dixit P.N., Structural and optical properties of vacuum evaporated cadmium zinc sulfide thin films, *Optical Materials* 27, 261-264, 2004.

112. Prabhakaran Nayar S.R., Alexander Lalitha T., Radhika V.N., John Thomas, Subrahmanyam P., Chopra Parvati, Bahl Madhu, Maini H.K., Singh Vishram Singh, Singh Dhan & Garg S.C. Study of the evolution of Te and Ti at the low low – latitude upper ionosphere using SROSS – C2 RPA observations. *J. Atmos. & Solar Terr. Phys.*, 66, 1075-1083, 2004.

113. Prasad M.V.S.N, Rao S.V.B., Rao T. R., Sarkar S. K. & Sharma Suresh., Double knife edge diffraction propagation studies over irregular terrain, *Ind. J. Radio & Space Physics*, 33, 180-184, 2004.

114. Priyanka, Chakravarty B.C., Sinha S.P., Singh P.K., Lal M., Kumar R. , Gandotra R. and Singh S.N., Processing and characterization of silicon photodiodes, *Samiksha*, 25(3), 2004.

115. Rajput S. S. & Jamuar S. S., Low Voltage, High performance current conveyors for low voltage analog and mixed mode signal processing applications, *Analog Integrated Circuits and Signal Processing* 41, issue 1, pp 21-34, Oct., 2004.

116. Raman V., Bhatia G., Bhardwaj S., Srivastava A.K. and Sood K.N., Synthesis of silicon carbide nanofibres by sol-gel and polymer blend techniques, *Journal of Materials Science*, 40, 1521–1527, 2005.

117. Raman V., Bhatia G., Bhardwaj S., Srivastava A.K. and Sood K.N., Synthesis of silicon carbide nanofibres by Sol-gel and polymer blend technique, *J. Material Science Letters*, 40, 1521-1527,2005.

118. Rashmi and Ramchandran R., Estimation of uncertainty of measurement in quantitative analysis of minor constituents of steel, *MAPAN-JMSI,* 19 (1-2), 127-132, 2004.

119. Rashmi, Singh Nahar and Sarkar A.K., Application of the rietveld method to quantitative analysis of impurities in synthetic diamond powder, powder diffraction, 19(2), 141-144,(2004.

120. Sandeep K. Sharma, Rahul Singhal, B.D.Malhotra, Neeta Sehgal and Ashok Kumar, Langmuir-Blodgett based biosensor for estimation of galactose in milk, *Electrochimica Acta*, 49, 2479-2485, 2004.

121. Sandeep K. Sharma, Rahul Singhal, B.D.Malhotra, Neeta Sehgal and Ashok Kumar, Biosensor based on LB Films of poly(3-hexylthiophene) for detection of galactose in human blood, *Biotechnology Letters*, 26 , 645-647, 2004.

122. Sanjid Arif, Singhal R P Chaudhary K P, Kumar Vijay and Sameer, Investigation of hysteresis Loop of Universal Length Measuring Machine and its effect on linear Measurement, *MAPAN-JMSI*, 19(1-2), pp 69-82, 2004.

123. Sankaranarayanan V. K., Yoon S. M., Kim C. G. & Kim C.O., Exchange bias variations of the seed and top NiFe layers in NiFe/FeMn/NiFe trilayer as a function of seed layer thickness, *Journal of Magnetism and Magnetic Materials* 286, 196-199, 2005.

124. Sankaranarayanan V. K., Yoon S.M., Lim J. J., Kim C. G. & Kim C. O., Exchange bias in NiFe/FeMn/NiFe Trilayers, *Journal of Applied Physics* 96, 7428-34, 2004.

125. Sankaranarayanan V.K, Yoon S.M.,.Kim C.G & Kim C.O., Coercivity variations at the top and bottom NiFe layers in NiFe/FeMn/NiFe trilayers, *Physica Status Solidi (b)* 241, 1486, 2004.

126. Sankaranarayanan V.K., Hu Yongkang, Kim Cheol Gi, Kim Chong-Oh, Tsunoda M. & Takahashi M, Development of exchange bias in $IrMn_3$ based tunnel junctions, *Physica Status Solidi (a)* 201, 1688, 2004.

127. Sankaranarayanan V.K., Yongkang Hu, Kim Cheol Gi, Kim Chong-Oh, Tsunoda M. & Takahashi M., Correlation Among Exchange Coupling, Surface Roughness and Junction Size in magnetic Tunnel Junctions, *J. Magn.Magn. Mater.* 272-76,1965, 2004.

128. Sarangi D., Sushil Kumar & Bhattacharyya R., New pattern of stress relief behaviour in diamond like carbon films grown by saddle field fast atom beam source, *Diamond and Related Materials* 13, 1844-1847, 2004.

129. Sarkar S.K., Ahmad Iqbal, Gupta M.M., Prasad M.V.S.N., Das J, De A.K. & Rajesh. Performance deterioration of a communication link at 13 GHz due to rain, *Ind. J. Physics*, 79, 117-121, 2005.

130. Sarkar S.K., Ahmad Iqbal, Das J & De A.K. Cloud height cloud temperature and cloud attenuation in microwave and millimeterwave frequency bands over Indian tropical east coast, *International Journal of Infrared and Millimeter waves*, (USA), 26, 329-340, 2005.

131. Sarkar S.K., Kumar R, Ahmad I., Gupta M.M., Prasad M.V.S.N, Das J. & De A.K. Rain attenuation and performance deterioration of a communication link at Ka band over Indian tropical eastern region, *Ind. J. Radio & Space Physics*, 33, 176-179, 2004.

132. सुधीर कुमार शर्मा एवं विजय नारायण ओझा जेनर अन्तरणीय वोल्ट मानक बैंक की स्थापना एवं उसके द्वारा अंशाकन एवं औद्योगिक प्रकीर्णन. भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका,12(2) pp. 327-329, 2004

133. Sen Gupta A., D.A. Howe, C. W. Nelson, A. Hati, F.L. Walls and J.F. Garcia Nava, High-Spectral-Purity Microwave Oscillator: Design Using Conventional Air-Dielectric Cavity *IEEE Trans. on UFFC*, 51, 10, pp 1225 – 1231, Oct., 2004.

134. Sen Gupta A. & D. A. Howe, Low-noise, high resolution microwave synthesis for atomic frequency standards, Ind. Journ. of Pure Appl. Phys, 43, pp 221-227, Mar 2005.

135. Sen Gupta A. and Fred L. Walls, Investigations of Spurs and PM Noise after Frequency Division, *Meas. Sci. Technol.,* 15, pp 1982-1985, Oct., 2004.

136. Sen Gupta A., High spectral purity cavity stabilized microwave oscillators, Indian Journ. of Pure Appl. Phys, 42, pp 459-464, June, 2004.

137. Sharma D.K., Rai Jagdish, Israel M & Subrahmanyam P. Diurnal, seasonal and latitudinal variations of ionospheric temperatures of the topside F region over Indian region during solar minimum (1995 – 1996), *J. Atmos. & Solar Terr. Phys.,* 67, 269-274, 2005.

138. Sharma J.C., H.C. Kandpal, and Z.H. Zaidi, Effect of spatial coherence on the spectral of electrical signals, *Bulletin of Pure and Applied Sciences*, 23D, 1-8, 2004.

139. Sharma Rina. Ojha V.N., Furuhashi H., Uchida Y. and Chitnis V.T., Analysis of errors for photolithographic mask-wafer alignment using modified moiré technique, *MAPAN-JMSI*, 19(1-2), 83-90, 2004.

140. Sharma S.N., Kohli S. & Rastogi A.C., Quantum confinement effects of CdTe nanocrystals sequestered in TiO_2 matrix: effect of oxygen incorporation, *Physica E-Low-Dimensional Systems & Nanostructures* 25 (4): 554-561, 2005.

141. Sharma, R., Ojha, V.N., Furuhashi, H., Uchida, Y. and Chitnis, V.T. Analysis of errors for photolithographic mask-wafer alignment using modified Moire Technique, *MAPAN-JMSI*, 19 (1-2), pp 83-89, 2004.

142. Shivaprasad S. M., Paliwal V.K. & Chaudhuri A., The evolution of the Sb/Si interface at room-temperature on the Si(111)-(7x7) and the Si(100)-(2x1) reconstructed surfaces, *Applied Surface Science*, 237, 93, 2004.

143. Shukla A.K., Agrawal V. K., Soni N. C., Singh D. P., Singh Janardan and Srivastava S. L, Radial mode piezoelectric response of La modified lead zirconate titanate morphotropic phase boundary region, *Ferroelectrics,* 308) 67-84, 2004.

144. Shukla A.K., Agrawal V.K. , Soni N.C., Singh D.P., Singh Janardan & Srivastava S.L., Radial mode piezoelectric response of La modified lead zirconate titanate in morphotropic phase boundary region, *Ferroelectrics (USA),* 308, 67-84 Aug., 2004.

145. Sian Tarsame. S., Reddy Gade. B. & Shivaprasad Sonnada. M., Study of Mg ion intercalation in polycrystalline MoO_3 thin films, *Jap. Jour. Applied Physics*, 43, 6248, 2004.

146. Singh H K, A K Gupta, P K Siwach, O N Srivastava, The effect of Ba doping on structure and magneto-transport properties of layered manganite $La_{1.4}Ca_{1.6-x}Ba_xMn_2O_{7,}$ *J. Magnetism and Magnetic Materials 292 483, 2005.*

147. Singh Nahar and Gupta Prabhat K., Analysis of Silicates materials: a review, reviews in A*nalytical Chemistry,* 24(1), 1-7, 2005.

148. Singh Nahar., Chauhan R.S. and Gupta Prabhat K.., 3-Hydroxy-3-Phenyl-1-m-chlorophenyl-triazene as spectrophotometric and complexometric reagent in the determination of Iron (III), *Asian J. Chemistry,* 17(1), 265-269, 2005.

149. Singh Sachchidanand & Singh Risal, High-altitude clear sky direct solar ultraviolet irradiance at Leh and Hanle in the Western Himalayas: Observations and model calculations, *J. Geophy. Res*. (USA), 109, D19201, doi:10.1029/2004JD004854, 2004.

150. Singh Vijay Pratap, Das Preeti, Kaur Kuldeep, Billore S.K., Gupta P.K. and Parashar D. C., Nitrous oxide fluxes in a tropical shallow urban pond influencing factors, *Current Science* 88(3) 473-483, 2005.

151. Singh Y P, Nijhawan S K, Singhal R P, Saxena A K and Rao S U M, Inter laboratory proficiency testing: liquid-in-glass thermometer intercomparison-2001/02, *MAPAN-JMSI,*

19(3), pp 169-175, 2004.

152. Singh Y P, Nijhawan S K, Singhal R P, Saxena A K and Rao S U M, Inter laboratory pro-ficiency testing: - thermocouple intercomparison 2001/02, *MAPAN-JMSI*, 19(3), pp 177-184, 2004.

153. Singh, V.R. and Kaur, Palwinder, Surface morphology of gall bladder stones, *Ind.J.Pure & Applied Physics,* 42, pp. 189-194, March, 2004.

154. Singh, V.R. Smart Sensors: physics, technology and applications, I*nd. J. Pur and Applied Physics,* 43, pp. 7-16. Jan .,2005.

155. Singhal K.K., Mohini Madhu., Jha Arvind K. and Gupta Prabhat K., Methane emission estimates from enteric fermentation in Indian livestock: Dry matter intake approach, *Current Science*, 88(1), 119-127, 2005.

156. Singhal Rahul, Asha Chaubey, Keiichi Kaneto, W.Takashima and B.D. Malhotra, Poly-3-hexyl thiophene Langmuir-Blodgett films for application to glucose biosensor, *Biotechnology & Bioengineering*, 85, 277-282 (2004)

157. Srivastava A. K., Deepa M., Singh S., Kishore R. and Agnihotry S.A., Microstructural and electrochromic characteristics of electrodeposited and annealed WO_3 films, *Solid State Ionics,* 176, 1161-1168, 2005.

158. Srivastava A. K., Kishore Ram, Swati and Agnihotry S.A., Electron microscopy and diffraction analysis of nano-structured prussian blue thin films, *Indian J. Eng. Mater. Sci.,* 11, 315-318, 2004.

159. Srivastava A.K., Deepa M., Singh S., Kishore R. & Agnihotry S.A., Microstructural and electrochromic characteristics of electrodeposited and annealed WO_3 films, *Solid State Ionics* 176, 1161-1168, 2005.

160. Srivastava A.K., Ram Kishore, Swati & Agnihotry S.A., Electron microscopy and diffraction analysis of nanostructured Prussian Blue thin films, *Indian J. of Engineering and Materials Science* 11, 315- 318, 2004.

161. Suman Singh, Asha Chaubey and B.D.Malhotra, Preparation and characterization of enzyme electrode based on cholesterol esterase and cholesterol oxidase immobilized onto conducting polypyrrole films, *Journal of Applied Polymer Science*, 91, 3769-73, 2004.

162. Suman Singh, Asha Chaubey and B.D.Malhotra, Amperometerric cholesterol biosensor based on immobilized cholesterol esterase and cholesterol oxidase on conducting polypyrrole films, *Analytica Chimica* Acta, , 502, 229-234, 2004.

163. Sushil Kumar & Godet C., Electronic transport in amorphous carbon nitride (a-C:N:H) and carbon oxide (a-C:O:H) films, *Solid State Communication* 130, 331,2004 .

164. Sushil Kumar, Godet C., Goudovskikh A., Kleider J. P. & Chu V., Nitrogen induced ordering of the localized electronic ð states distribution of a-C:H films, *J. Non Crystalline Solids* 338-340, 349,2004.

165. Thakur A.K.; Biradar A.M.; Singh S.P.; Sharma D.K. and Bawa S.S., Continuous phase transition between Sm C*-Sm A phase in electroclinic liquid crystals. *Japanese Journal of Applied Physics*, 44,1348-1351, 2005.

166. Thakur A.K.; Kaur S.; Bawa S.S. and Biradar A.M. Optical memory effect in deformed helix ferroelectric liquid crystal. *Applied optics*, 43, 5614-5617, 2004.

167. Titus S.S.K., S.K. Jain, Anil Kumar and Kamlesh K. Jain, Hardness and microstructure studies of standard hardness blocks, special issue of *MAPAN-JMS*l, 20(1) 37,2005.

168. Tripurari Lal, M.L.Das and Goutam Mandal, Present status of mass measurement at NPL India and its metrological equivalence in regional and global metrology network, *MAPAN-JMSI,* 19, 1-2, 2004.

169. Uniyal Manish., Bhatt S.C., Bhandari, R. M.S., Rao Ramachandra, Pant R.P. & Semwal B.S., Temperature and frequency dependence of width in sodium potassium niobate mixed system, *Ind.*

J. of Pure and Applied Physics, V 42, 341, 2004.

170. Verma Amita, Kar M., Bakhshi A.K. & Agnihotry S.A., Sol-gel derived CeO_2:TiO_2 coatings for electrochromic devices, *Ionics*, 10, 237-243, 2004.

171. Verma Amita, S.B. Samanta, A.K. Bakshi and S.A. Agnihotry, Optimization of CeO_2 – TiO_2 composition for fast switching kinetics and improved Li ion storage capacity, Solid State Ionics 171, 81-90, 2004.

172. Yadav Sanjay and A. K. Bandyopadhyay, Calibration of electromechanical type direct pressure indicating devices and evaluation of associated uncertainties, *MAPAN-JMSI*, 20, 1, 71-91, 2005.

173. Yadav Sanjay, A.K. Bandyopadhyay, V.K. Gupta and A.C. Gupta, Dravchalit Daab Mapan ke Rashtriya Mankon ki ek Jhhalak, *Journal of CSIR (in Hindi),* V-12, 2, 263-268, 2004.

174. Yoon S.M., Lim J.J., Lee Y.W, Sankaranarayanan V.K., Kim C.G. & Kim C.O., Anomalous exchange bias of the bottom NiFe in NiFe/FeMn/Al/NiFe, *Physica Status Solidi (a)* 201, 1680, 2004.

Papers published in conference / symposium / workshop proceedings

1. Agarwal Ashish and G.M.Saxena, Coherent population trapping based atomic clock at NPL, India XXX OSI, Symp. On Optics and Opto-Electronics, New Delhi , Jan 19-21 2005.
2. Agarwal Ashish, Rubidum Raman Laser, National Laser Symposium, BARC Mumbai, Jan 10-13, 2005.
3. Aggarwal R.K., Bhatia G., Saha M., Mishra A.K. and Sengupta P.R., Effect of moulding pressure on the characteristics of graphites based on self-sintering carbonaceous materials, Proc. of International at NPLI New Delhi, 2005.
4. Ahmad Shahzada, Falodia Tarun, Ahmad Sharif & Agnihotry S.A., A new approach for synthesizing composite polymer electrolytes with a blend of a- PMMA & I-PMMA, International Conference on Electroactive Polymers : Materials and Devices, Dalhousie , Nov 1-5 , 2004 .
5. Anand Y., S. Meena, R. Rathore & S.K. Dhawan, Incorporation of ferromagnetic dopants on the growth behaviour of polyaniline, International Conference on Polymers for Advanced Technologies, Macro, Thiruvananthapuram, India, December 15-17, 2004.
6. Ansari M.A., Anurag Gupta, V.P. S. Awana, R.B. Saxena, H. Kishan, K.N. Sood and Ram Kishore, SEM studies of reactivity of $Y(BaSr)2Cu_3O_{7-\delta}$ superconductors with water, Proceedings of the National Conference on Electron Microscopy (EMSI-2004) pp 60-61, National Physical Laboratory, New Delhi, April 1-3, 2004.
7. Arya B.C., Jain S. L., Kumar Arun & Ghude Sachin D., Measurements of Fine Particulates mass at New Delhi, IASTA-2004 conference to be held at IIT Kanpur during November 15-17, 2004.
8. Arya B.C., Jain S. L., Kumar Arun & Ghude Sachin D., Measurements of fine particulates mass at New Delhi, IASTA-2004 conference to be held at IIT Kanpur during November 15-17, IASTA Bulletin, 16, 50, 2004.
9. Bahadur H., Srivastava A. K., Kishore R., Rashmi and Chandra S., Electron microscopic and X-ray diffraction investigations of nanostructured thin films of ZnO, 14th IEEE International Symposium on Applications of Ferroelectric 185-188, 2004.
10. Bahadur Harish, Kishore Ram, Sood K. N., Rashmi, Sharma R. K., Basu A., Haranath D., Chander Harish, and Chandra Sudhir, Characterization of Thin Films of ZnO Prepared by sol-gel processes, proceedings of the 18th European Frequency and Time Forum, IEE, U.K., 2004.
11. Bahadur Harish, Srivastava A.K., Kar M., Rashmi, Sood K. N, Kishore Ram, Basu A., Sharma R. K., Samanta, S. B.; Bhatt Vivekanand; Pal Prem and Chandra Sudhir, Characterization of thin films of ZnO Ferroelectrics and dielectrics (NSFD-XIII), Editor-in-Chief R. P. Tandon, Allied Publishers, New Delhi, 401-405, 2004.
12. Bahadur Harish; Srivastava A. K., Kishore Ram, Rashmi and Chandra Sudhir, Electron microscopic and X-ray diffraction investigations of nanostructured thin films of ZnO, Proceedings of the 14th IEEE international symposium applications of ferroelectrics (ISAF-04) & 2004 IEEE International Ultrasonics, Ferroelectrics and Frequency Control Joint 50th Anniversary, Montreal, 185-188, 2004.
13. Banerjee P., A.Sen Gupta, G.M.Saxena, A.K.Hanjura, A.Chatterjee, Santa Chawla, Ashish Aggarwal, A.K.Suri, Manish Verma, Current activities of Time and Frequency group

of National Physical Laboratory, Asia Pacific workshop on Time Frequency 2004 (ATF 2004) Proc., Beijing, China pp. 46-53. Oct.18-19, 2004.

14. Basu A., Srivatsa K.M.K., Chakraborty T.K. & Bhattacharya T.K., Design and fabrication of thin film multilayer narrow bandpass filters for CWDM applications, XXX Optical Society of India (OSI) Symposium on Optics and Optoelectronics, National Physical Laboratory, New Delhi, Jan. 19 - 21, 2005.

15. Bauch A., A. Sen Gupta, E. Staliuniene Time Scale prediction using information from external sources -, Proc. EFTF Besancion, France, March, 2005.

16. Bhatia G., Aggarwal R.K., Bhardwaj S., Mishra A.K., and Kaushik N.K., Studies on the development of coal tar pitches with a reduced content of benzo(a)pyrene, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi, 350-357, Nov. 25-26, 2004.

17. Bhatnagar Chhavi, Verma Amita, Sharma Pooja, Agnihotry S.A. & Saxena T.K., Computer controlled set up to assess the performance of electrochromic devices, Advances in Metrology, organized by MSI & NPL, NOPL, 23025, Feb., 2005.

18. Bhuyan P.K., Chamua M, Subrahmanyam P. & Garg S,C. Effect of solar activity on diurnal and seasonal variations of electron temperature measured by SROSS-C2 over Indian low latitudes, 35th COSPAR Scientific Assembly, Paris France, 18-25 July, 2004.

19. Budovsky Ilya, V.K. Rustagi, A.K. Govil, M. Klonz, Hitoshi Sasaki, Hiroyuki Fujiki, Sung-Won Kwon et. al., APMP International Comparison of AC-DC Transfer Standards at the lowest Attainable level of uncertainty, presented in CPEM2004 held in London from June 28 to July 2, 2004 at London by Ilya Budovsky. The paper has been published in IEEE Transactions on Instrumentation & Measurement, April, 2005.

20. Chakravarty B.C., Kumar R., Srivastava R.P., Singh R.P, Tripathy J., Lal M., Kar M., Sood K.N., Samanta S.B.& Singh S.N., A comparative study of the growth kinetics of porous-Si on <100>, <110> and <111> Si substrates for use as an electrochemically formed antireflection coating on terrestrial solar cells, PEMD 2005.

21. Chakravarty B.C., Lal M., Singh S.N. & Gandotra R., Electrochemically formed nanocrystalline porous- si for use as an antireflection coating, Proc. National Conference on VLSI Design and Technology, New Delhi, April 15-16, 2004.

22. Chandra Sudhir, Bhatt V.K., Pal Prem, Bahadur H., Sood K. N., Pant R.P. and Halder S.K, Re-sputtered materials for MEMS based microwave circuit component, Asia Pacific Microwave conference-2004, Delhi Univ, Dec 15-18, 2004.

23. Chauhan S.K., Bahl O.P., Mathur R.B. and Dhami T.L., Single step fabrication of high density carbon/carbon composites, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi, 217-227, Nov. 25-26, 2004.

24. Chawla Santa, Sarika Pugla and A. Sen Gupta, Development of diode lasers as precision spectroscopic tool, Proc. National Conference on Microwave & Optoelectronics, M. D. Shirsat etal Eds, pp 479 - 484 Anamaya Publishers, New Delhi, India, 2004

25. Coondoo Indrani , Jha A.K., Aggrawal S.K. & Soni N.C., Effect of tungsten doping on the structural and dielectric behaviour of Sr $Bi_2Ta_2O_5$ Ferroelectric ceramics, XIII National Seminar on Ferroelectrics & Dielectric (NSFD XIII), Department of Physics and Astrophysics University of Delhi - 110007, 23-25 November, 2004.

26. Coondoo Indrani, A.K.Jha, S.K.Agarwal, N.C.Soni, Effect of Tungsten doping on the structural and dielectric behaviour of $SrBi_2Ta_2O_9$ ferroelectric Ceramics, 13th National Seminar on Ferroelectrics and Dielectrics (NSFD-XIII), Department of Physics, University of Delhi, Delhi, pp. 191-194. Nov 23-25, 2004.

27. Coondoo Indrani, A.K.Jha, S.K.Agarwal, N.C.Soni, Influence of Tungsten doping on the structural and dielectric properties of Aurivillus $SrBi_2Ta_2O_9$ Ceramics National Conference on Advances in Condensed Matter Physics (ACMP-2005), Thapar Institute of Engg. & Tech., Patiala Feb 11- 12, 2005.

28. Dabas R.S., Vohra V.K., Veenadhari B., Garg S.C., Devasia C.V., Subbarao K.S.V, Niranjan K. and Rama Rao P.V.S., Occurrence of spread F irregularities in the Indian Zone and their possible predictions, 35th COSPAR Scientific Asseembly, Paris France , July 18-25, 2004.

29. Dalela P.K., Prasad M.V.S.N. & Mohan Anand., Implementation of remote RF using power line communications:Rural wireless in Indian perspective, IEEE International conf. on personal communications (ICPWC 2005), pp 220-224, New Delhi, India, Jan 23-25, 2005.

30. Das M.L., Goutam Mandal & Tripurari Lal - Improved group weighing technique - 5th International Conference on Advances in Metrology, (AdMet-2005) February 23 to 25, 2005.

31. Dayal P. Babu, Rama Rao N.V., Mehta B.R., Shivaprasad S.M. & Paulson P.D., Structural and optical properties of CdSe, CdTe and CdSeTe nanoparticles dispersed in SiO_2 films, Materials Research Society Symposium Proceedings, Vol. 789, N1.8.1, 2004.

32. Dhakate S.R., Aoki T., and Ogasawara T., High temperature tensile properties of 2D carbon/ carbon composites, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi, Nov. 25-26, 248-258, 2004.

33. Dhakate S.R., Aoki T., Ogasawara T. and Mathur R.B., Silicon infiltrated C/C composites studied by filed emission scanning electron microscope, XXVII Annual meeting of EMSI and conference on Electrom microscopy and Allied fields, New Delhi, April 1-3, 2004.

34. Dhami T.L., Mathur R.B. and Bahl O.P., Carbon-carbon composites for energy applications, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi, Nov. 25-26, 228-237, 2004.

35. Dhawan S.K., Rohit Rathore, M.N. Kamalasannan & S.S. Bawa, Conducting Copolymer of aniline and o-ethoxyaniline as corrosion inhibitor for iron and mild steel, International Conference on Polymers for Advanced Technologies, Macro 2004, December 15-17, 2004.

36. Dilawar Nita, D. Varandani, V. P. Pandey, Mahesh Kumar1, S.M. Shivaprasad1 and A.K. Bandyopadhyay, H. Poswal, S. Karmakar and S.M. Sharma, Raman and XRD studies of Eu_2O_3 under high pressure, Proceedings 42nd European High pressure research group meeting at ecole polytechnic federale de lausanne, lausanne, Switzerland in Sept., 2004.

37. Dixit P. N., Sushil Kumar, Rauthan C. M. S., Khan M. Dilashad, Bhardwaj A. & Rajput S. S., Nano-crystalline silicon films grown by plasma enhanced chemical vapour deposition technique, Electro-2005-Emerging trend in electronics, IT-BHU, Varanasi, Feb. 3-5, 2005.

38. Dixit P.N., Sushil Kumar, Rauthan C.M.S. & Rajput S.S., Growth of silicon and carbon nano particles by plasma, Indo-German Workshop on synthesis and modification of nanostructures by ion beams, Nuclear Science Centre, New Delhi, Feb 20 - 24, 2005.

39. Dutta H.N. & Gera B.S. Presented Invited paper entitled, Low frequency acoustic emission prior to earthquakes, at the brainstorming session on earthquake precursor studies in India, organized by IMD & DST, New Delhi at India Habitat Centre, Lodhi Road, New Delhi, August 12-13, 2004.

40. Dutta H.N., P.K.Sharma, N.C.Dev, J.Singh, B.S.Gera, G.Singh et. al., Ship-borne acoustic sounder observations of thermal convection over East Antarctic ocean, Proceedings of 12th ISARS-2005,DuB15, Clare College, Cambridge, U.K. July 11-16, 2004.

41. Dutta H.N., Sharma K Pawan, Deb N.C., Singh Jaswant, Gera B.S., Singh Gurbir, Bishnoi Laxmi, Singh Bhupender, Lal R.P. & Gajananda, Kh, Shipborne acoustic sounder observations of thermal convection over east Antarctic ocean, Proc. ISARS-2004, Cambridge, UK, July 12-16, 2004.

42. Gandotra R., Chakravarty B.C., Kumar R., Lal M., Singh P.K.& Singh S.N., Effect of back surface field on the performance of silicon pin photodiodes, Proc. 2004 Asia Pasific Microwave Conference (APMC 2004), New Delhi, 15 - 18 Dec, 2004.

43. Garg S.C., Das U.N., Subrahmanyam P., Bahl M., Maini H.K, Chopra P, Thomas J, Singh D, & Singh V. Indian aeronomy satellite SROSS C-2 mission: some technical aspects and significant results, 35th COSPAR Scientific Assembly , Paris France, 18-25 July, 2004.

44. Garg S.C., H.K.Meni, J. Thomas, M.K.Tiwari, Vishnu Singh, Dharam Singh,Madhu Bahl, R.M.Khanna, B.S.Gera et. al., A new temperature inversion layer close to ground in polluted atmospheric environment, Proceedings of 12th ISARS-2005,63-66, Clare College, Cambridge, U.K. July 11-16, 2004.

45. Garg S.C., Maini H.K., Thomas John, Tiwari M.K., Singh Vishram, Singh Dhan, Bahl Madhu, Khanna R.M. and Gera B.S., A new temperature inversion layer close to ground in polluted atmospheric environment, Paper presented in International Conference on Atmospheric Remote Sensing held in Cambridge, UK from July 12-16 , 2004.

46. Garg S.C., Subrahmanyam P., Jain A.R., Chopra P., Thomas J., Singh D., Singh V. Contribution of neutral winds and storm time electric fields to the low latitude ionization distribution following major solar weather events: in situ measurements by the Indian Satellite SROSS-C2 , 35th COSPAR Scientific Assembly, Paris France, 18-25 July, 2004.

47. Gera B.S., An approach towards global sodar networking, Proceedings of 12th International Symposium on Acoustics Remote Sensing and Associated Techniques of the Atmospheric & Oceans ISARS-2004 , Clare College, Cambridge, U.K. July 11-16, 2004.

48. Gera Neha, Mohanan V., Gera B.S., Singh G., Ojha V.K., Gupta P.K., and Dutta H.N. Wind profile measurements using Doppler sodar, presented in the 5th International Conference on Advances in Metrology Admet 2005, NPL, New Delhi, February 23-25, 2005.

49. Gera Neha, P. Goyal, B.S. Gera et. al., Sodar studies of foggy boundary layer in relation to air pollution management, Proceedings of 12th ISARS-2005,67-70, Clare College, Cambridge, U.K. July 11-16, 2004.

50. Gera.Neha, Goyal P., Gera B.S., Pasricha P.K., Singh G., Ojha V.K. & Dutta H. N., Solar studies of foggy boundary layer in relation to air pollution management, Proc. ISARS-2004, Cambridge, UK July 12-16, 2004.

51. Alka Gupta, K.P. Singh, Ranjana Mehrotra and H. C. Kandpal, Infrared characterization of acetylenic compounds used as building blocks in nanomaterials, National Conference on perspective in optics and Spectroscopy held in CCS University, Meerut, Meerut, April 6-8, 2005.

52. Golia Santosh & Arora M., Bismuth telluride and selenium doped bismuth telluride thin films for thermoelectric generators in automobile Industry, MRSI Symposium, NCL, Pune, Feb. 9-11, 2005.

53. Golia Santosh & Arora M., Electrochemically deposited transition metal doped cadmium telluride thin films for optoelectronics devices, XXX Optical Society of India (OSI) Symposium on Optics and Optoelectronics, National Physical Laboratory, New Delhi, Jan. 19 - 21, 2005.

54. Golia Santosh & Arora M., Study of electrochemically deposited antimony doped cadmium thin film, XXVII Annual meeting of EMSI and Conference on Electron microscopy and Allied fields, Apr. 1-4, 2004.

55. Govil A.K., V.K. Rustagi, Bijendra Pal & R.

Aggarwal, Investigation of thermocouple power sensor as RF-DC voltage transfer standard for precise measurement of RF voltage, presented in International Conference on Advances in Metrology AdMet - 2005 held at NPL, New Delhi from Feb. 23 to 25, 2005.

56. Gupta Alka, Ranjana Mehrotra, H.C. Kandpal and R.N. Verma, Differentiation of normal and malignant breast tissues using fourier transform mid- infrared spectroscopy, National Conference on perspective in optics and Spectroscopy Held in CCS University, Meerut April 6-8, 2005.

57. Gupta Prabhat K., Gupta Vandana, Sharma Pratul, Pradhan Vaishali, Singh Nahar, Koul S., Singh Khem, Sharma C., Johri P., Das S.N., Adhya T.K., Pathak H., Ramesh R., Purkait N., Baruah K.K., Venkatratnam L., Singh Gulab Iyer, C.S.P. and Mitra A. P.; in Greenhouse Gas Emission Uncertainty reduction in indian agriculture sector: rice cultivation, proceedings of the workshop on uncertainty reduction in green house gas inventories, National Physical Laboratory, New Delhi, 4-5 March 2003, (Eds) Mitra A.P., Sharma Subodh K; & Bhattacharya Sumana a, MoEF-GoI-NATCOM, , pp. 89-102, June, 2004.

58. Gupta Prabhat K., Jha Arvind K., Singh Nahar, Swami M., Singhal K.K. and Mitra A.P., Green house gas emission uncertainty reduction in indian agriculture sector: livestock, "proceedings of the workshop on uncertainty reduction in green house gas inventories", National Physical Laboratory, New Delhi, 4-5 March 2003, (Eds) Mitra A.P., Sharma Subodh K. & Bhattacharya Sumana, MoEF-GoI-NATCOM, pp. 139-146 June, 2004.

59. Gupta Prabhat K., Sahai Shivraj, Dixit C.K, Singh D.P., Singh Nahar, Singh, Khem Koul S., Johri P., Sharma C; Garg S.C and Mitra A. P.; Greenhouse gas emission uncertainty reduction in indian agriculture sector: field burning of agricultural crop residue, "proceedings of the workshop on uncertainty reduction in green house gas inventories", National Physical Laboratory, New Delhi, 4-5 March 2003, (Eds) Mitra A.P., Sharma Subodh K. & Bhattacharya Sumana, MoEF-GoI-NATCOM, pp. 157-164 June, 2004.

60. Gupta S. K., Singh Ramadhar, Arora Manju, Kumar Jitendra & Kaur Amarjeet, Correlation of ESR and electrical conductivity properties of ferric chloride doped poly 3-methylthiophene, 4th Asia Pacific EPR/ESR Symposium, IISc Bangalore, India, November 21-25, 2004.

61. Gupta S.K., Arora Manju, Panwar O.S., Khan Mohd. Alim, Dixit P.N., Husain M., ESR study of tetrahedral amorphous carbon films grown using an indigenously developed filtered cathodic vacuum arc system, Asia Pacific EPR/ ESR Symposium, IISc., Bangalore, Nov., 22-25, 2004.

62. Hanjura A. K. and A. Sen Gupta, Precise Time Transfer for Power Sector, Admet, 2005.

63. Hanjura A. K., and A. Sen Gupta, Satellite position prediction for precise time transfer - microwaves & optoelectronics, M. D. Shirsat et al Eds., pp 204-209, Anamaya Publishers, New Delhi, India, 2004.

64. Haranath D., Chander H. & Sharma Pooja, Synthesis of long decay $SrAl_2O_4:Eu^{2+},Dy^{3+}$ Phosphor in nanocrysatlline phase, international conference on luminescence and its applications (ICLA-2004), BARC, Mumbai, Page 166, 9-12 Feb., 2004.

65. Haranath D., Chander H., Nitesh & Sharma Pooja, Luminescence of ZnS:Mn nanophosphors embeded in porous silica matrix using sol-gel method, national conference on materials and their applications (NCMA-2004), Kurukshetra University, Kurukshetra, Page 41, 11-13 March, 2004.

66. Haranath D., Chander Harish, Basu A., Rashmi, Bahadur Harish, Bhatt Vivekanand and Chandra Sudhir Photoluminescence characteristics of thin films of silicon nitiride, ferroelectrics and dielectrics (NSFD-XIII), Editor-in-Chief Tandon R. P., Allied Publishers, New Delhi, 152-154, 2004.

67. Haranath D., Harish Chander & Harish Bahadur, Photoluminescence characteristics of thin films of silicon nitride, XIII National Seminar on Ferroelectrics and Dielectrics (NSFD-XIII), Department of Physics & Astrophysics, University of Delhi, 23-25 Nov., 2004.

68. Harish Bahadur, Srivastava A. K., Kar M., Rashmi, Sood K.N., Kishore R., Basu A., Sharma R.K., Samanta S. B., Bhatt V., Lal P., Chandra S., Characterization of thin films of ZnO, Ferroelectrics and Dielectrics NSFD-XIII (eds. R.P.Tandon, V.Gupta, K.Sreenivas, S.Prakash, A.K.Arora), Publisher Allied Publisher Pvt. Ltd, New Delhi, India, 401-405, 2004.

69. Harish Chander, R & D Activities of Luminescent materials and devices group at NPL, National Conference on Materials and Their Applications (NCMA-2004), Kurukshetra University, Kurukshetra, Page 4, 11-13 March, 2004.

70. Haranath D., Harish Chander, Sharma Pooja, Sood K. N., Surface distribution studies and improved pl characteristics of silica coated ZnS:Mn Nanophosphor Layers, national conference on luminescence and its applications (NCLA-2005), Department of Physics, Bangalore University, Bangalore, 2-4 Feb., 2005.

71. Jain Kiran & Rashmi, Fabrication of Nanocrystalline CdS thin films by electrochemical process, XXX Optical Society of India (OSI) Symposium on Optics and Optoelectronics, National Physical Laboratory, New Delhi, Jan. 19 - 21, 2005.

72. Jain Kiran & Sood K.N., Morphology and FTIR property of polyaniline array confined in alumina template, international conference on recent advances on composite materials, BHU, Varanasi, India, Dec. 17-19, 2004.

73. Jain Kiran, K.N. Sood, Rashmi, S.B. Samanta and S.T. Lakshmikumar, Preparation and micro-structural studies of highly ordered CdSe nanowires in porous alumina templates, Proceedings of the National Conference on Electron Microscopy (EMSI-2004) pp166-167, National Physical Laboratory, New Delhi, April 1-3, 2004.

74. Jain Kiran, Kara N. & Chandra H., CdSe thin films preparation by unipolar current pulse electrodeposition technique, MRS Spring meeting 2005, San Francisco, CA, USA, March 28- 1 April, 2005.

75. Jain Kiran, Rashmi & LakshmiKumar S.T.,Preparation of Nanocrystalline Tin oxide powder for gas sensor applications, international conference on soft matter, Jadavpur University, Kolkata, India, Nov 18-20, 2004.

76. Jain Kiran, Rashmi & Sood K.N., Preparation of one dimensional nanostructures of Chalcogens and Chalcogenides using nanoporous templates, Indo German Workshop on Synthesis and Modification of Nanostructured Materials by Energetic Ion Beams, NSC, New Delhi, India, Feb 20-24, 2005.

77. Jain Kiran, Rashmi & Sood K.N., Preparation of semiconductor nanowires in porous alumina templates for optoelectronic applications, XXX Optical Society of India (OSI) Symposium on Optics and Optoelectronics, National Physical Laboratory, New Delhi, Jan. 19 - 21, 2005.

78. Jain Kiran, Rashmi,.Sood K.N & LakshmiKumar S.T., Preparation of Ni nanowires in porous alumina template using unipolar pulse electrodeposition technique, International Conference on Soft Matter, Jadavpur University, Kolkata, India, Nov 18-20, 2004.

79. Jain Kiran, Sharma Himani, Sood H.N., Rashmi & LakshmiKumar S.T., Growth and microstructure of SnS films prepared by electrodeposition technique, 31st PVSC conference, Florida, USA, Jan 3-7, 2005

80. Jain Kiran, Sood K.N., Rashmi & LakshmiKumar S.T., CdSe thin films and nanowires synthesis using pulse electrodeposition techniques, 31st PVSC conference, Florida, USA, , Jan 3-7, 2005.

81. Jain Kiran, Sood K.N., Rashmi, Samanta B.S. & Lakshmikumar S.T., Preparation and

microstructural studies of highly ordered CdSe nanowires in porous alumina templates, XXVII Annual meeting of EMSI and conference on electron microscopy and allied fields, NPL, New Delhi, April 1-3, 2004.

82. Jain Kiran,.Srivastava A.K,. Saxena R.K & Ramesh K., Gas sensing properties of tin oxide powder synthesized in presence of surfactants, MRS spring meeting 2005, San Fransisco, CA, USA, March 28-1 April, 2005.

83. Jain S.L, Arya B. C., Ghude Sachin D., Arora A. K. & Sinha Randhir, Surface Ozone Measurements using Differential Absorption Lidar, Proc. Fourth International Asia-Pacific Environmental Remote Sensing Symposium 2004: Remote Sensing of the Atmosphere, Ocean, Environment, and Space" held from 8-12 November 2004 at the Waikiki Beach Marriott Resort in Honolulu, HI USA. SPIE Paper No. 5653-38

84. Jain S.L, Ghude Sachin D., Kumar Ashok, Arya B.C. & Bajaj M.M., Carbon monoxide measurement at Maitri, Antarctica, INCON-2004, conference held at Pune during December, 2004.

85. Jain S.L, Ghude Sachin D., Kumar Ashok, Kulkarni Pavan S., Arya B.C., & Bajaj M.M., Online CO_2 and CH_4 measurement using automated gas chromatograph at Indian Research Station, Antarctica INCON-2004, conference to be held at Pune during December, 2004.

86. Jain S.L. & Arya B.C., Column ozone, water vapour and AOD measurements at very high altitudeobservatory, Proc. Quadrennial ozone symposium Kos. Athens, June 1-8 , 363-364, 2004.

87. Jain S.L. & Arya B.C., Column ozone, water vapour and AOD measurements at very high altitude observatory, Proc. Quadrennial ozone symposium held at Kos. Athens during June 1-8, 2004.

88. Jain S.L.& Arya B.C. Measurements of solar radiation at New Delhi, high altitude observatory, Hanle and Maitri Antarctica , Accepted for 35th COSPAR Scientific Assembly held at Paris, France during 18-25 July, 2004.

89. Jain S.L., Sachin D. Ghude, Ashok Kumar, B.C. Arya and M.M. Bajaj, Carbon monoxide measurement at Maitri, Antarctica, INCON-2004, conference to be held at Pune. December, 2004.

90. Jain S.L., Arya B.C. & Ghude Sachin. Water vapor measurements: Comparison for New Delhi, Hanle & Maitri , Antarctica. Joint AOGS 1st Annual meeting & APHW second conference 2004 held at Singapore during 5-9 July, 2004.

91. Jain S.L., Arya B.C. & Kumar Arun, Measurements of surface ozone , CO and NOx at NPL,New Delhi, Proc. Quadrennial ozone symposium, Kos. Athens, June 1-8 , 884- 885, 2004.

92. Jain S.L., Arya B.C. & Kumar Arun. Differential Absorption Lidar for atmospheric probingAccepted for 12th International symposium on Acoustic remote sensing held at Cambridge, UK , during 11-16 July, 2004.

93. Jain S.L., Arya B.C. & Kumar Arun. Measurements of surface ozone , CO and NOx at NPL, New Delhi. Proc. Quadrennial ozone symposium held at Kos. Athens, during 1-8 , 2004.

94. Jain S.L., Arya B.C., Ghude S.D. Arun Kumar & P.C.. Pandey, Measurement of Green House Gases and Ozone at Maitri, Antarctica Accepted XXVIII SCAR Open Science Conference to be at Congress Centre, Bremen, Germany S16/O05 during 26-28 July, 2004.

95. Jain S.L., Arya B.C., Kumar Ashok & Kumar Arun. Measurements of water vapor , AOD , UV-B, and NIR radiation using Total Solar Eclipse on 23rd November 2003 at Maitri, Antarctica, Proc.. Quadrennial ozone symposium Kos. Athens, 1095-1096, June 1-8 , 2004.

96. Jain S.L., Ghude Sachin D., Kumar Ashok, Kulkarni Pavan S., Arya B.C. & Bajaij M.M., Online CO_2 and CH_4 measurement using automated gas chromatograph at Indian Research Station, Antarctica INCON-2004, conference held at Pune during December, 2004.

97. Jain S.L., Sachin D. Ghude, Kumar Arun, Kumar Ashoka & Arya B.C. Ozone measurement during ozone hole at Maitri Antarctica. Proc. Quadrennial ozone symposium, Kos. Athens, June, 1-8 361-362, 2004.

98. Jain Sohan Lal, Arya Bhuvan Chandra, & Kumar Arun, Differetial absorption lidar for the measurements of atmospheric minor constituents . Proc. The 22nd International Laser Radar Conference, Matera , Italy, 713-716, (2004).

99. Jain, S.L.; Ghude, S.D.; Arya, B.C, Green House Gases Measurement at Maitri, Antarctica accepted for 35th COSPAR Scientific Assembly held in Paris, France, 18 - 25 July 2004.

100. Jaiswal S.K. and Ojha V.N. , Precision calibration and estimation of uncertainty in measurement of DC high current source upto 100A. 5th International Conferences in Advances in Metrology at NPL, New Delhi pp. 80. on 23-25 Feb., 2005.

101. Johri Prabha, Microscopic approach in understanding cyclic ductile fracture behaviour of sa 333 steel, published in proceedings of the "XXVII annual meeting of EMSI and conference on Electron Microscopy and allied field (EMSI-2004)", NPL New Delhi, , pp. 62-63, April 1-3, 2004.

102. Kalita Bulumoni, Gogoi Purabi, Sushil Kumar, Dixit P.N. and Agarwal Pratima, Transport studies on high band gap a-Si:H thin films, 49 Solid State Physics Symposium, Amritsar, Dec. 2004.Kanpur during November 15-17, 2004 IASTA Bulletin, 16, 79-83, (2004).

103. Kataria N D and H.K. Singh, Microwave characterization of superconducting and dielectric Materials Kataria N D, Vijay Kumar, Sandeep Kohar and R R Raheja, Automated microwave measurement system for characterization of dielectric resonators at cryogenic temperatures, National Seminar on Cryogenics and its frontier Applications, held at Calcutta, April 26-28, 2004.

104. .Kumar, S.K. Dhawan & M.N. Kamalasannan, Synthesis of Poly-p-phenylenes for fabrication of Polymer light emitting diodes International Conference on Polymers for Advanced Technologies, December 15-17, 2004, Macro Thiruvananthapuram, India (2004)

105. Kataria N. D., M. T. Sebastian and S. Kohar,Frequency-temperature compensation using a stack resonator, Asian Pacific Microwave Conference, Dec15-18, 2004

106. Kaur. S.; Thakur A.K.; Choudhary A.; Bawa S.S. and Biradar A.M., Electro-optic memory effect in deformed helix ferroelectric liquid crystal, XXX Symposium on optics and opto electronics, Jan 19-21, National Physical Laboratory, New Delhi, 217 (2005).

107. Khanna R., Bahl M., Gupta B., Singh D. and Garg S.C., A new attempt to accurately profile the thermal structure of the boundary layer, Paper presented in International Conference on Atmospheric Remote Sensing held in Cambridge, UK from July 12-16 , 2004.

108. Kumar Ashok, Gupta V.B., Ghude Sachin D., Jain S.L. & Arya B.C., Study of Ozone Hole over Maitri at Fringe Region of Antarctica during 2003. IASTA-2004 conference held at IIT Kanpur during November 15-17, 2004.

109. Kumar Jitendra, Rastogi R. C. & Singh Ramadhar, Effect of annealing and doping level on conductivity and surface morphology of poly(3-octylthiophene) films, International Conference on Electroactive Polymers: Materials and Devices, Dalhousie, India, November 1-5, 2004.

110. Kumar Jitendra, Singh Ramadhar, Sood K. N. & Kaur A, Investigation of surface morphology

of poly(3-octylthiophene), XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, NPL, New Delhi, April 1-3, 2004.

111. Kumar Narendra, Kumar, Parmod, Singh V.R. and Singh Bhim, Sensitivity analysis of Ultrasonic fluid flow measurement", 5th Int. Conf on Advances in Metrology (AdMet-2005), New Delhi, February 23-25, 2005.

112. Kundu Namita, Peshin S.K., and Singh Sachchidanand., Variation of Ozone chemopause and tropopause height difference with tropospheric temperature, Quadrennial Ozone symposium, June 1-8, 2004, Kos, Greece.

113. Lahiri Debdutta, Sharma S. N., Zeena S., Kamat Prashant V. & Bunker Bruce A., Evidence For the chemical nature of capping in CdSe nanoparticles, Proceedings of ICSM (International Conference on Soft Matter), 124, organized by Centre for Surface Science, Dept. of Chemistry, Jadavpur University, Kolkata, Nov. 18-20, 2004.

114. Lal M., Priyanka & Singh S.N., Effect of silicon nitride film on the performance of screen printed silicon solar cell, proc.national workshop on advances in materials science and applications, National Physical Laboratory, New Delhi, India, May 3-4, 2005.

115. Lal R.P., Dutta H N., Lagun Victor E., Study of Atmospheric boundary layer dynamics over Schirmacher Oasis, Queens Maud Land, East Antarctica during local summer, Proc. ISARS-2004, Cambridge, UK, July 12-16, 2004.

116. Mahajan S K and K B Ravat, Traceability of 100 kV DC high voltage measurements at NPLI 5th International Conference on Advances in Metrology (AdMet-2005) Feb., 23-25, 2005.

117. Mathur R.B., Chhotey Lal, Rao A.M., Dhami T.L., Sarita Seth, Seth R.K. and Rao R., Investigations on the preparation and purification of Single walled and Proc. of Multiwalled Carbon Nanotubes, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi, Nov. 25-26, 92-102 2004

118. Mehrotra Ranjana, Alka Gupta and H.C.Kandpal, Quantitative determination of pol value in sugar cane juice using NIR spectroscopy and fiber optic probe, National Conference on perspective in optics and Spectroscopy Held in CCS University, Meerut April 6-8, 2005

119. Mishra A., Saha M., Bhatia G., Aggarwal R.K., Raman V., and Sengupta P.R., Effect of composition on the characteristics of C-SiC-B4C composites, Proc. of International Conference on Carbon CARBON 2004, Providence, USA, July 11-16, 2004

120. Misra Aparna, Lokendra Kumar, R. R. Koireng, Pankaj Kumar, S. K. Dhawan, M. N. Kamalasanan and Subhas Chandra, Blue colour electroluminescence device based on para-hexaphenyl oligomer National Conference on Materials and Their Applications (March 11-13,2004) Deptt. of Physics, Kurukshetra University, Kurukshetra.

121. Misra Aparna, Pankaj Kumar, S. K. Dhawan, M.N. Kamalasanan and Subhas Chandra, Greenish- blue organic light emitting diode based on lithiumtetra (2-methyl 8- hydroxy-quinolinato) boron complex, 7th International Conference on Optoelectronics, Fiber optics & Photonics. Photonics 2004 Cochin India. Dec. 9-11,2004.

122. Mittal M.K., J.C.Biswas, Bilateral comparison of watt converter c-1/2 in ac power and energy between NPL, India and PTB, Germany at NPLI. 5th International Conferences in Advances in Metrology at NPL, New Delhi on 23-25 Feb., 2005.

123. Mohan P., Current status of vacuum and pressure standards at NPL, India, 2nd APMP workshop on pressure and vacuum, KRISS, Korea, 13 -17 Sep. 2004.

124. Mohan P., Current Status of ISO TC 112 (Vacuum Technology) in India, 2nd APMP

workshop on pressure and vacuum, KRISS, Korea, 13 -17 Sep. 2004.

125. Mohan P., Metrological characteristics of a capacitance diaphragm gauge, 2nd APMP Workshop on Pressure and Vacuum, KRISS, Korea, 13 -17 Sep. 2004.

126. Mohd. Dilshad, Bharadwaj A., Parashar A., Sushil Kumar, Rauthan C. M. S., Dixit P. N. & Rajput S. S., Langmuir Probe as a plasma diagnostic tool in plasma enhanced chemical vapour deposition, ADMet 2005, Feb 23-25, 2005.

127. Mohd. Dilshad, Bhardwaj A., Parashar A., Sushil Kumar, Rauthan C. M. S., Dixit P. N. & Rajput S. S., Neural vision through amorphous silicon, XXX Optical Society of India (OSI) Symposium on Optics and Opto-Electronics (SOOP-05), National Physical Laboratory, New Delhi, Jan. 19-21, 2005.

128. Moodley S.S., M. Saleem and A.K. Saxena, The development of a four-terminal pair coaxial ratio bridge for the realization of the capacitance scale at CSIR-NML, Presented in Conference on Precision Electromagnetic Measurements (CPEM-04) to be held in London from 27 June to 2 July 2004

129. Nagarajan R., Alka Gupta, Ranjana Mehrotra and H.C.Kandpal, Attenuated total reflectance (ATR) technique for quantification of constituents in alcoholic beverages, National Conference on perspective in optics and Spectroscopy held in CCS University, Meerut, Meerut April 6-8, 2005.

130. Nigam Rashmi, Sharma Rashmi, Srivastava Piyush, Chaubey Avanish, Agnihotry S.A. &.Saxena T.K, Computer controlled set up for cyclic voltammetric studies : Electrochromic Devices, Advances in Metrology , organized by MSI & NPL , NOPL, 23025, Feb., 2005.

131. Ojha V.N. and Singh, Ajeet, Traceability of DC resistance standard at NPLI. 5th International Conferences in Advances in Metrology at NPL, New Delhi pp. 78. on 23-25 Feb., 2005.

132. Om Prakash, Sanjay Yadav, V.K. Gupta and A.K. Bandyopadhyay, Studies on the stabilities of various type of industrial pressure measuring devices, Proc. INCON-2004 (In CD), Paper No. 327, Pune, Dec. 19-21,2004.

133. Padam G.K., Ekbote S.N., Sharma M., Tripathy M.R., Srivastava G.P. & Das B.K., Effect of electromagnetic interactions on the undulatory temperature dependent behaviour of non-resonant microwave absorption (NRMA) signal amplitude in Bi-2212 (5 wt.% Ag) sintered pellets, Asia Pacific Microwave Conference 2004 (APMC '04), p.949, Dec. 15-18,2004.

134. Pant R.P., Arora Manju Sood, K.N., Kishore Ram, Halder S.K. and Gupta S.K., Investigations on nanophase of magnetite based ferrofluid in polymer matrix, XXVII Annual Meet of EMSI and Conference on Electron Microscopy & Allied Fields, NPL, New Delhi, p.224-225 April 1-3, 2004.

135. Panwar Neeraj, Vikram Sen, Ajay Kumar and S.K. Agarwal, Colosal Magneto-resistance in Manganite Perovskites, NPL Tech. Bull, pp 13-25, Sept. 2004.

136. Panwar Neeraj, Vikram Sen, D.Kaur, D.K.Pandya and S.K. Agarwal, Effect of Ba and Cs on the resistivity behaviour of Pr-based Manganites DAE Solid State Physics symposium, GND University, Amritsar pp.116. Dec. 26-30, 2004.

137. Parameshwaran T.K., M.B.Das and Tripurari Lal - Present status of measurement of density of liquids at NPLI, 5th International Conference on Advances in Metrology (AdMet-2005) February 23 - 25, 2005.

138. Parashar A., Mohd. Dilshad, Bharadwaj A., Sushil Kumar, Rauthan C.M.S., Singhal S. K., Rajput S. S. & B. P. Singh, Optically transparent cubic boron nitride film grown by PECVD technique, XXX Optical Society of India (OSI) Symposium on Optics and Opto-Electronics (SOOP-05), National Physical Laboratory, New Delhi, Jan. 19-21, 2005.

139. Pasricha P.K., Singh Risal, Tanwar R.S., Singh

Sachchidanand & Nath Shambu. A Model of global Flux of solar radiation using aerosol optical depth measurements at two wavelengths and its comparison with Pyranometer measured flux under clear sky conditions over Delhi IASTA Bulletin, 16, 23-26, 2004.

140. Pawan Kumar, Kumar D., Dixit P.N., Sharma T. P., Optical and electrical properties of cadmium sulfide vacuum evaporated thin films, electro-2005-emerging trend in electronics, IT-BHU, Varanasi, Feb. 3-5, 2005.

141. Prasad M.V.S.N., Dalela P.K. & Rajendra Singh, A comparison of land mobile radio prediction methods for Indian rural zones, IEEE International conference on personal communications (ICPWC 2005), pp 217-219, New Delhi, India, January 23-25, 2005.

142. Priyanka, Gandotra R., Lal M. & Singh Sukhvir, Preparation of different size silicon nanoparticle by electrochemical etching, Proc. XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, National Physical Laboratory, New Delhi-110012, India, pp-246-247.,April 1- 3, 2004.

143. Priyanka, Lal M,.Singh S.N. & Shivaprasad S.M, Depth profiling of PECVD silicon nitride layers on silicon solar cell, proc. indo-german workshop on synthesis and modification of nano-structured materials by energetic ion beams, jointly organized by Nuclear Science Centre, New Delhi and Universidad Stuttgart, Germany February 20- 24, 2005.

144. Priyanka, Lal M. & Singh S.N, Optimum hydrogen passivation by PECVD Si_3N_4 deposited on crystalline silicon solar cells, 31st ieee photovoltaic specialists conference, Florida, January 1-5, 2005.

145. Priyanka, Lal M. & Singh S.N., Ellipsometry measurement for the optical properties of PECVD silicon nitride film deposited on silicon solar cells, Proc.5th International Conference on Advances in Metrology, National Physical Laboratory, New Delhi, India February 23-25, 2005.

146. Priyanka,.Lal M. and Singh S.N, Hydrogen annealing effects in crystalline silicon solar cell processing, Proc. XXX Optical Society of India (OSI) Symposium on Optics and Opto-Electronics (SOOP-05), National Physical Laboratory, New Delhi, India, January 19-21, 2005.

147. Rai Radheshyam, Senguttuvan T. D. & Lakshmikumar S. T., Study of the electronic and optical bonding properties of doped SnO2, 14th International Workshop on Computational Mechanics of Materials (IWCMM14), Goa, India, 23-25 September, 2004.

148. Rai Radhey Shayam ,Soni N.C., Sharma Seema & Choudhary R.N.P. Study of structural and dielectric properties of al doped PLZT ceramics, XIII national seminar on ferroelectrics & dielectric (NSFD XIII), Department of Physics and Astrophysics University of Delhi, 23-25 November, 2004.

149. Rajput S. S. & Jamuar S. S., Advanced current mirrors for low voltage analog designs, Proc. ICSE 2004, Kuala Lampur, Malaysia.
Raman V., Bhatia G., Mishra A., Saha M. and Rashmi, Oxidation resistance of C-SiC-B_4C composites developed through in-situ formation of silicon carbide, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi, 311-318, Nov. 25-26, 2004.

150. Raman V., Bhatia G., Mishra A., Sengupta P.R, Saha M. and Rashmi, Development of carbon-ceramic composites, Proc. of International Conference on Recent Advances in Composite Materials, BHU, India 16-17 Dec., 2004.

151. Raman V., Bhatia G., Mishra A.K., Sood K.N. and Kaushik N.K., Synthesis of silicon carbide nanofibres from pitch blended with sol-gel silica, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi147-152 , 25-26 Nov, 2004.

152. Raman V., Bhatia G., Sengupta P.R., Bhardwaj S. and Sood K.N., Synthesis of silicon carbide nanofibres from mixture of polymer and sol-gel

silica, Proc. of International Workshop on Carbon Materials for Energy Applications, NPL, New Delhi, 133-137, Nov. 25-26, 2004.

153. Rathore Rohit & S.K. Dhawan, Thermal & electrical stability of polyaniline in the presence of mixed dopants - Characterization and Applications, International Conference on Polymers for Advanced Technologies, Macro Thiruvananthapuram, India December 15-17, 2004.

154. Rauthan C. M. S., Sushil Kumar, Rajput S. S. & Dixit P. N., Nano-crystalline diamond films at room temperature by plasma enhanced chemical vapour deposition technique, Electro-2005-Emerging trend in electronics, IT-BHU, Varanasi Feb. , 3-5, 2005.

155. Ravat K B and S K Mahajan, Practical aspects which affect an electrical measurement 5th international conference on advances in metrology (AdMet-2005) page 83, Feb., 23-25, 2005.

156. Reddi B.V., Nahar Singh and K.N. Sood, TiO_2 - based nano tapes and tubes, Proceedings of the National Conference on Electron Microscopy (EMSI-2004) pp 214-215, National Physical Laboratory, New Delhi, April 1-3, 2004.

157. Reddi B.V., Nahar Singh, R.P. Pant and K.N. Sood, Cages, shells and polyhedral shapes from selfassembly of Zinc Oxide nanocrystals, Proceedings of the National Conference on Electron Microscopy (EMSI-2004) pp 216-217, National Physical Laboratory, New Delhi, April 1-3, 2004.

158. Roy Somnath C., G.L. Sharma, M.C. Bhatnagar and S.B. Samanta, Effect of processing parameters on the surface morphologies of sol-gel derived (Bs,Sr)TiO_3 thin films-an Atomic Force Microscopy, Proceedings of the National Conference on Electron Microscopy (EMSI-2004) pp176-177, National Physical Laboratory, New Delhi, April 1-3, 2004.

159. Rustagi V.K., A.K. Govil & Bijendra Pal, Results of bilateral comparison of AC-DC voltage transfer standard between NPL, India and PTB, Germany at 10 volt, presented in International Conference on Advances in Metrology (AdMet - 2005) held at NPL, New Delhi from Feb. 23 - 25, 2005.

160. Rustagi V.K., R. Aggarwal & Bijendra Pal, Evaluation of coaxial micro-calorimeter for RF power standards and its comparison with another calorimetric power standard in the lower frequency range of 1 MHz to 50 MHz, presented in International Conference on Advances in Metrology (AdMet - 2005) held at NPL, New Delhi from Feb. 23 -25, 2005.

161. Rustagi V.K., Uncertainty in AC voltage, AC current and RF power measurements:Case studies, was presented in the Training Course on uncertainty in measurement: case studies, organised at NPL for participants from NABL and NPL, during 30th April to 1st May 2004.

162. S.C. Jain, Vikash Sharma, V. K. Tanwar and P.K. Singh, Rapid fabrication of Micro and Nano structures in polymers and metals using soft lithographic techniques, Seventh International. Conf. on Optoelectronics, Fiber Optics and Photonics "Photonics-2004", Cochin. 9-11 Dec., 2004.

163. Saini K.K., Chander Kant, Sunil Dutta Sharma, C.P. Sharma, R.K. Sharma, K. N. Sood and S.S. Bawa, Effect of Ag doping on Optical Properties of TiO_2 films, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields

164. Sankaranarayanan V.K., Om Prakash & Lakshmikumar S.T., Investigation of Co/Ag discontinuous multilayers prepared by UHV electron beam evaporation, International Conference of Soft Matter 'ICSM 2004', Jadavpur University, Kolkata , Nov.18-20, 2004.

165. Sarah Rizvi and V.R. Singh, Output characteristics of silicon devices on loading with biological fluids, 5th Int. Conference on Advances in Metrology (AdMet-2005), New Delhi, February 23-25, 2005.

166. Saxena A.K., Naib Singh and Mohd. Saleem Uncertainty in capacitance measurements: case studies, presented in training course on uncertainty organized by NPLI for NABL accreditation officer on 30 April to 1 May, 2004.

167. Saxena G.M., Squeezed and phase operators in terms of inverse of annihilation and creation operators, Proc. VIIth Int'l conf. Opto-electronics, Fibre Optics and Photonics, Cochin, Dec 9-11, 2004.

168. Saxena A. K. , Mohd. Saleem, Naib Singh, S. U. M. Rao and R. P. Singhal Interlaboratory proficiency testing in capacitance measurement for NABL accredited laboratories - 2003/04 presented in 5th International conference on Advances on Metrology 2005, AdMet-2005at NPL, New Delhi. held on 23 - 25 Feb, 2005.

169. Sen Vikram,Neeraj Panwar,G.L.Bhalla and S.K.Agarwal, Resistivity Behaviour of $Pr_{2/3}M_{1/3}MnO_3$ (M=Ca,Sr,Ba) Manganite Perovskites DAE Solid State Physics symposium, GND University, Amritsar pp.116, Dec. 26-30, 2004,

170. Senguttuvan T. D., Samanta. S. B. & Sood K. N., Phases in copper stabilized Zirconia solid oxide fuel cells anode materials, EMSI-2004, National Physical Laboratory, New Delhi, Apri1-3 l, 2004.

171. Senguttuvan T. D., Singh Sukhvir, Lakshmikumar S. T. & Ram Kishore, TEM studies of SnO_2 nanoparticale synthesized by inorganic sol-gel method, EMSI-2004, National Physical Laboratory, New Delhi, April 1-3, 2004.

172. Senguttuvan T. D., Srivastava A. K. & Ram Kishore, Microstructural characterization of ZrO_2 nanoparticles synthesized by sol-gel method, EMSI-2004, National Physical Laboratory, New Delhi, April 1- 3, 2004.

173. Senguttuvan T.D., S.B. Samanta and K.N. Sood, Phases in Copper-Stabilized Zirconia Solid Oxide Fuel Cells Anode Material Proceedings of the National Conference on Electron Microscopy (EMSI-2004) pp 68-69, National Physical Laboratory, New Delhi, April 1-3, 2004.

174. Senguttvan T.D., Sood K.N., Soni N.C., Rai Radhey Shayam & Singh D.P. , Sintering studies on ZST microwave ceramics by Scanning Electron Microscopy, EMSI-2004, NPL, New Delhi, April 1-3, 2005.

175. Sharma Shally, A.K.Saxena and Mohd. Saleem, Development of an automated setup for Measurement of temperature coefficient of s tandard inductors, presented in 5th International conference on Advances on Metrology, (AdMet-2005) held on 23 to 25 Feb, 2005.

176. Sharma C.P., Chander Kant, K.K. Saini, Sunil Dutta Sharma, R.K. Sharma, Ram Kishore and S.S. Bawa, Optical properties and surface morphology of Au/TiO_2 thin film by sol-gel process XXVII annual meeting of EMSI and conference on electron microscopy and allied fields.

177. Sharma Himani, Jain Kiran, Sood K.N., Rashmi & Lakshmikumar S.T, Microstructural studies on SnS thin films prepared by electrochemical deposition technique, XXVII Annual meeting of EMSI and conference on electron microscopy and allied fields, NPL, New Delhi, April 1-3, 2004.

178. Sharma Himani, Sharma Shailesh N., Singh Gurmeet &. Shivaprasad SM, Role of amines in the surface modification of TOPO-capped CdSe nanocrystals, Proceedings of 16th AGM-MRSI, organized by NCL, Pune, Feb.10-12, 2005.

179. Sharma Pooja, Ali Anwar, Haranath D. & Harish Chander, Effect of Boric Acid on synthesis and properties of Calcium Aluminate Phosphor, national conference on luminescence and its applications (NCLA-2005), Department of Physics, Bangalore University, Bangalore, Feb., 2-4,2005.

180. Sharma Pooja, Chander H. & Haranath D., Alumina dependent luminescence in Calcium Aluminate Phosphor, international conference on luminescence and its applications (ICLA-

2004), BARC, Mumbai, Page 135Feb., 9-12, 2004.

181. Sharma Pooja, Haranath D., Harish Chander, Ali Anwar, Singh Sukhvir &. Sood K. N., Optical properties of blue emitting phosphor nanowires, XXX Optical Society of India (OSI) Symposium on Optics and Opto-Electronics (SOOP-05), NPL, New Delhi, Jan. 19-21, 2005.

182. Sharma Rashmi & Agnihotry S.A. , Effect of TiO_2 addition on the durability of sol-gel derived amorphous WO_3 films, 6th National Conference on Solid State Ionics, Kolkata, October 5-7, 2004 .

183. Sharma Rina, An Introduction to uncertainty in measurements, national seminar on audit requirements for traceability in measurement process, organized by CII, Hotel Taj Mahal, New Delhi, PP 5.0-5.16, April 10, 2004.

184. Sharma Rina, Vijay T. Chitnis and Yoshiyuki Uchida, Modified moiré technique and its application to mask alignment, Materials for 21st Century, Aichi Institute of Technology, Toyota, Japan, October 14-16, 2004.

185. Sharma S.K. and Ojha V.N. Role of statistical process control in maintaining the National Standard of DC voltage. 5th International Conferences in Advances in Metrology, pp. 35 at NPL, New Delhi on Feb., 23-25, 2005.

186. Sharma S.K. and Ojha V.N., Performance evaluation and validation of software of newly established automatic bank of DC reference standard. 5th International Conferences in Advances in Metrology, pp. 81, at NPL, New Delhi on Feb., 23-25, 2005.

187. Sharma S N, Sharma R.K., Bhagavannarayana G., Samanta S.B., Sood K.N. & Lakshmikumar S.T., Demonstration of the formation of porous silicon films with superior mechanical properties, morphology and stability, Procedings of 14th International Workshop on Computational Mechanics of Materials (IWCMM 14), 26-32, organized by IIT Mumbai, held in Goa, Sept. 22-24, 2004.

188. Sharma S.N., Sharma RK, Shivaprasad SM & Lakshmikumar ST, Effect of electrolyte and current density on the oxidation process of porous silicon, proceedings of ISAMAP2K4 (International Symposium on Advanced Materials and Processing 2004), 756, organized by Materials Science Centre, IIT Kharagpur, Dec. 6-8, 2004.

189. Sharma Shailesh N., Sharma Himani, Singh Gurmeet & Shivaprasad SM., Low energy ion induced XPS depth profiling of monodispersed cdse nanocrystals, proceedings of Indo German Workshop on Synthesis and Modification of Nano-structured Materials by Energetic Ion Beams, p. 49, organized by Nuclear Science Centre, New Delhi, Feb. 20-24, 2005.

190. Sharma Susheel, Rajput S. S., Magotra L. K. & Jamuar S S., Floating gate transistor modeling for circuit applications, Proc. MTECS-05/IETE, Aligarh, India 2005.

191. Shukla A.K, Agarawal V.K.I, Soni N.C., Singh Janardan & Srivastava S.L., The effect of lanthanum oxide on the electromechanical properties of lead zirconate titanate at room temperature, international symposium on advance materials and processing (ISAMAP-2K4), at Indian Institute of Technology, Kharagpur, December 6-8, 2004.

192. Singh Sachchidanand, Nath Shambhu , Tanwar R.S. & Risal Singh, Study of Aerosol Optical Depth and Angstrom coefficients over Delhi during sand storm period and its impact on total solar radiation flux. IASTA Bulletin, 16, 20-22.

193. Singh Ravindra, Singh Nahar, Rashmi, Goel T.C. and Chandra Sudhir, Preparation and properties of RF Sputtered PLZT thin films, ferroelectrics and dielectrics (NSFD-XIII), Editor-in-Chief R. P. Tandon, Allied Publishers, New Delhi, 397-400, 2004.

194. Singh Risal, Dutta H.N., Gera B.S., Mandal A., Vijayakumar A. & Singh Jaswant. Physical & chemical characterization of aerosols in the Antarctic marine boundary layer, presented at

the National Workshop on Indian Antarctic Research Programme: Achievements of .23rd & Planning for 24th Antarctic Expedition, organized by NCAOR, Goa, July 19-20, 2004.

195. Singh S. and Singh, V.R., Ultrasonic and micro-hardness study of renal calculi, Proc. Second IASTED International Conference on Biomedical Engineering, Innsbruck, Austria, pp, 417-815, BioMed 2004.

196. Singh Sachchidanand , Nath S, Tanwar R.S. & Singh R., Enhanced aerosol optical depth and radiation flux reduction over Delhi during the sand storm period, 35th COSPAR Scientific Assembly, Paris, France, July 18-25, 2004.

197. Singh Sachchidanand, Singh Risal, Nath Shambhu & Tanwar R.S., Estimation of aerosol radiative forcing over Delhi by optical measurements of column aerosol optical depth and radiation flux, Presented at XXX Optical Society of India Symposium on Optics and Opto-Electronics , NPL New Delhi, January 19-21, 2005 .

198. Singh Santosh and Arora M., Electrochemically deposited CdMnTe thin films for solar cell, ISAMAP -2K4, IIT Kharaghpur, Dec. 6-8. 2004, Proc. Inter. Symp. Adv. Mater. & Processing, Ed. B. Adhikari, Vol. 1, 334 - 341, 2004.

199. Singh Swati , Kaur Harsimran and Singh Risal., Uncertainty Estimation in Solar UV_B radiation flux and Aerosol Optical Depth measurements in different seasons over Delhi, presented at 5th International conference on Advances in Metrology, NPL, Feb. 23-25, 2005.

200. Singh V.R., A new semiconductor lithotripsy sensor, Proc. 26th Ann Int Conf IEEE-EMBS (EMBC-2004), San Francisco, California, USA, ppr 568. Sept., 1-5, 2004.

201. Singh V.R., A smart lithotripsy sensor for the calibration of disintegrators , proc. annie-04: smart engg system design: Neurral Networks, Fuzzy Logic, evolutionary programming, complex systems and data mining, held at Missouri-Rolla (USA), November 7-10, 2004.

202. Singh V.R., Advances in diagnosis of biological tissues, Proc. 2nd Int. Conf. on Diagnostic Procedures & Techniques, IIT-Madras, Chennai, April 1-3, 2004.

203. Singh V.R., Bansal, Vakul, Gehlot, S. and Saini, S., IR and SEM analysis of the teeth, Proc. Second IASTED International Conference on Biomedical Engineering BioMed 2004, Innsbruck, Austria, pp 417-816.

204. Singh V.R., Mathematical correlation between disruption efficiency and stress wave effect on kidney stones in ultrasonic lithotripsy, Proc. 10th Ann Conf on Math Modelling, Bhopal, May 16-18, 2004.

205. Singh V.R., Nano-bioinstrumentation systems for bioinformatics research, Proc. IETE 35th Mid Term Technical Symposium, Nagpur, April 3-4, 2004.

206. Singh V.R., Recent Trends in Nano-biomedical sensors, proc. national conference on Biomedical Engg (NCBME), GITAM, Visakhapatnam, Dec 23-24, 2004.

207. Singh V.R., Role of R & D Institutes in the Promotion of Higher Technical Education, Proc. Conf on Forecast in Higher Technical Education, Patiala, Feb, 2004.

208. Singh V.R., Role of sensors in monitoring and control of pollution due to solid waste materials, National Conf on Solid and Hazardous Waste Management Problems and Solutions, New Delhi, April 28-29, 2005.

209. Singh V.R., Smart biomedical sensing devices, Int Conf on Instrumentation (INCON-2004), Dec 16-19, 2004

210. Singh V.R., Smart lithotripsy sensor, proc. second IASTED International Conference on Biomedical Engineering BioMed-2004, Innsbruck, Austria, ppr no. 417-812. .

211. Singh Ajeet and Ojha V.N., Validation of the software of automatic DCC bridge. 5th

International Conferences in Advances in Metrology at NPL, New Delhi, pp. 79. on Feb., 23-25, 2005

212. Singh, V.R., Modelling of thermal profile in brain tumour under focussed ultrasound, Proc. Int. Conf. on Mathematical Biology, Kanpur, Feb. 19-21, 2004.

213. Singh, V.R., National status of metrology for manufacturing of sophisticated health care systems, Proc. All India Seminar on Advances in Metrology for Manufacturing Technology, Durgapur, pp. i-ix, February 7-8, 2004.

214. Singhal R P and Rina Sharma, Traceability in measurements, national seminar on audit requirements for traceability in measurement process, organized by CII, Hotel Taj Mahal, New Delhi, PP 1.0-1.10, April 10, 2004.

215. Sinha Sanjeev, Goutam Mandal and Tripurari Lal - Calibration of reference grade hydrometers using solid density standards, 5th International Conference on Advances in Metrology (AdMet-2005) February 23 -25, 2005.

216. Srivastava Abhilasha, Jain Kiran, Rashmi, .Srivastava A.K & Lakshmikumar S.T., Preparation of nanocrystalline SnO_2 powder for gas sensor applications through microwave treatment, XXVII Annual meeting of EMSI and conference on electron microscopy and allied fields, NPL, New Delhi, April 1-3, 2004.

217. Srivastava Abhilasha, Jain Kiran, Rashmi, Srivastava A.K. &.LakshmiKumar S.T., Study of structural and microstructural properties of SnO_2 powder for LPG and CNG gas sensors, IWCMM-14, 14th International workshop on Computational Mechanics of Materials, GOA, India, September 23-25, 2004.

218. Srivastava Abhilasha, Jain Kiran,.Srivastava A.K, Rashmi & LakshmiKumar S.T., Preparation of nanocrystalline tin oxide by hydrosol method, international conference on soft matter, Jadavpur University, Kolkata, India, Nov 18-20, 2004.

219. Srivatsa K.M.K., Basu A., Bhattacharya T.K., Chakraborty T.K. & Bera Mrinmoyee, Deposition and characterisation of polymeric optical thin films for ophthalmic applications, using plasma polymerisation deposition process, XXX Optical Society of India (OSI) Symposium on Optics and Optoelectronics, National Physical Laboratory, New Delhi, Jan. 19 - 21, 2005.

220. Sunil Dutta Sharma, K.K. Saini, C.P. Sharma, Chander Kant, R.K. Sharma,R. P. Pant and S.S. Bawa, Characterization and Optical Properties of Sol-Gel TiO_2 Films, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Field.

221. Suresh Chand, Arti Dwivedi, Jitender Kumar, Rajiv K Singh, G D Sharma, S Dwivedi and Ramadhar Singh, Interface barrier lowering charge transport in solution grown poly (vinyledene chloride-acrylonitrile) films, International Conference on electro-active polymers: materialsand.

222. Suresh Chand, Dwivedi A., Kumar Jitendra, Singh Rajiv K., Sharma G. D., Dwivedi S. & Singh Ramadhar, Interface barrier lowering transport in solution grown P(VDC-ACN) films, International Conference on Electroactive Polymers: Materials and Devices, Dalhousie, India, November 1-5, 2004.

223. Suresh Chand, G D Sharma and S Dwivedi , Charge storage mechanism in solution grown poly (vinyledene chloride-acrylonitrile) films, International Conference on electro-active polymers: materials and devices, Dalhousie, India, Nov, 1-5 2004.

224. Sushil Kumar, Dixit P. N., Rauthan C. M. S. & Rajput S. S., Diamond like as anti reflection coating for germanium optics, XXX Optical Society of India (OSI) Symposium on Optics and Opto-Electronics (SOOP-05), National Physical Laboratory, New Delhi, Jan. 19-21, 2005.

225. Sushil Kumar, Rauthan C. M. S., Rajput S. S. & Dixit P. N., Thick Silicon dioxide films grown using plasma enhanced chemical vapour deposition technique for optical waveguide applications, Electro-2005-Emerging trend in electronics, IT-BHU, Varanasi, Feb. 3-5, 2005.

226. Thakur A.K.; Bawa S.S.; Biradar A. M.; Kaur S. and Annapoorni S. Role of dipolar interaction on the memory effect in deformed helix ferroelectric liquid crystals, 11th National Conference on liquid crystals, Allahabad, 6, Nov. 1-3, 2004.

227. Tripurari Lal - Guide for the Calibration of measuring devices used to determine mass and volume in medical reference measurement laboratories, 5th International Conference on Advances in Metrology AdMet-2005, February 23 -25, 2005.

228. Tripurari Lal, Goutam Mandal & M.L.Das - Re-establishment of National Standards of Mass at NPL India and potential economic impact of its metrological equivalence under CIPM-MRA, 5th International Conference on Advances in Metrology (AdMet-2005) February 23 -25, 2005.

229. Upadhyay P.L. and K.N. Sood, Phase-formation and superconductivity of Gd-substituted Bi(Pb)SrCaCuO system, Proceedings of the National Conference on Electron Microscopy (EMSI-2004) pp 230-231, National Physical Laboratory, New Delhi, April 1-3, 2004.

230. वृहत चुम्बकीय प्रतिरोधक पदार्थों में प्रतिस्थापन का धात्विक-अधात्विक संक्रमण पर प्रभाव विक्रम सेन, नीरज पवार, अजय कुमार, एस.के. अग्रवाल एवं डी.के. पंडया भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका अंक 2, पृ0 236-238 दिसम्बर 2004

231. वृहत चुम्बकीय पदार्थों में अधात्विक संक्रमण पर बाह्य एवं रासायनिक दवाब का प्रभाव विक्रम सेन, नीरज पवार, एस.के. सिंघल, बी.पी. सिंह एवं एस.के. अग्रवाल भारतीय वैज्ञानिक एवं औद्योगिक अनुसंधान पत्रिका अंक 2, पृ0 247-248 दिसम्बर 2004

232. Verma Amita,.Bakhshi A.K & Agnihotry S.A., Citric acid induced improved homogeneity of CeO2 coatings for electrochromic device applications , 6th National Conference on Solid State Ionics , Kolkata, October 5-7, 2004 .

233. Vijay Kumar and N D Kataria, Low Phase noise sapphire/rutile composite dielectric resonator oscillator, Asian Pacific Microwave Conference, Dec15-18, 2004.

234. Vijaya kumar D. Arun, D. R. Sharma and A. C. Gupta, Evaluation of measurement uncertainty of secondary pressure standards in the barometric pressure range, proceedings of the international conference on instrumentation (incon 2004), organized at department of instrumentation & control, pune institute of engineering & technology, Shivaji Nagar, Pune during Dec. 19-21, 2004.

235. Yadav Sanjay and A.K. Bandyopadhyay, reassurance of national hydraulic pressure standards, their traceability and dissemination system, Proc. INCON-2004 (In CD), Paper No. 623, Pune, Dec. 19-21, 2004.

236. Yadav Sanjay, V.K. Gupta, A.K. Bandyopadhyay and A.C. Gupta, Evaluation of measurement uncertainty with direct pressure indicating devices, Proc. INCON-2004 (In CD), Paper No. 624, Pune, Dec. 19-21, 2004.

Papers presented in Conferences/Symposium/Seminars/ Workshop but not covered in proceedings.

1. Abbott P.J., P. Mohan, A Study of the Variation of Sensitivity of Hot Cathode Ionization Gauges as a Function of Gas Adsorption, 51st AVS International Symposium, , Anaheim, Calif., USA,. Nov. 14-19, 2004.
2. Agrawal A. K, The Indian National programme on preparation and dissemination of Certified Reference Materials, 5th International Conference on Advances of Metrology, New Delhi, February 23-25, 2005.
3. Ajeet Kumar Kaushik, Parul, Shubhra Goel, Nepal Singh and Ranjana Mehrotra, Determination of moisture content in raw tobacco using diffuse reflectance near infrared spectroscopy, AdMet-05, National Physical Laboratory, New Delhi Feb 23-25, 2005.
4. Ajeet Kumar Kaushik, Ranjana Mehrotra and H.C.Kandpal, Vibrational spectroscopic studies of cellulosic materials, International Conference on Spectrophysics, Chennai Tamilnadu 9-12 Feb, 2005.
5. Arora Manju and Gupta S.K., Estimation of overall uncertainty in spin concentration measurement of paramagnetic centers in different materials by EPR spectroscopy,5th International Workshop on Advances in metrology (Admet-05), NPL, New Delhi, Feb.22-25, 2005.
6. Ashok Kumar, Deepa Bhatnagar, Reeta Gupta and Yudhisther Kumar, A new technique for the measurement of acoustic impedance of liquids, International Conference on Advances in Metrology (AdMet-2005), New Delhi, Feb. 23-25, 2005.
7. Ashok Kumar, Reeta Gupta and Yudhisther Kumar, Direct measurement of acoustic impedance, 13th National Symposium on Ultrasonics (NSU-XIII), Jhansi, Dec. 21-23, 2004.
8. Ashok Kumar, Reeta Gupta and Yudhisther Kumar, Estimation of vertical linearity for the calibration of ultrasonic flaw detector, 13th National Symposium on Ultrasonics (NSU-XIII), Jhansi, Dec. 21-23, 2004.
9. Ashok Kumar, Yudhisther Kumar and Reeta Gupta, A comparative study of anechoic water tanks, National Symposium on Acoustics, Mysore, Nov. 25- 27, 2004.
10. Ashok Kumar, Yudhisther Kumar and Reeta Gupta, Development of method for the quality check of ultrasonic beam calibrator using microbalance, International Conference on Advances in Metrology (AdMet-2005), New Delhi, Feb. 23-25, 2005.
11. Bahadur H., Srivastava A.K., Kishore R., Rashmi and Chandra S., Microstructural and X-ray diffraction investigations of nano-structured thin films of ZnO, IEEE International Ultrasonics, Ferroelectrics and Frequency Control, Montréal, August 23-27, 2004.
12. Bahuguna D.P., B.K. Yadav, Jai Bhagwan, R.K. Garg and H.C. Kandpal, Uncertainty in measurement of luminous intensity and traceability of other photometric units through this base unit, AdMet-05, National Physical Laboratory, New Delhi Feb 23-25, 2005.
13. Balaram V., Charan S.N., Agrawal A.K., Patil M.L., Subba Rao D.V., Kapilavastu K., Sangurmath P., Sarma D.S. and M. Sankara Gowda, Preparation of gold geochemical reference material - preliminary results, 5th international conference on advances of metrology, New Delhi, February 23-25, 2005.

14. Basavaraju K.N., R.K. Garg, Jai Bhagwan, Sudama and H.C. Kandpal, Establishment of luminous flux and color coordinate standards in the form tubular fluorescent lamps by spectroradiometry, AdMet-05, National Physical Laboratory, New Delhi, Feb 23-25, 2005.

15. Bhagavannarayana G., Budakoti G.C., Anantha Murthy R.V., Kumar B. & Bartwal K.S., High resolution XRD, XRT and FTIR studies on as-grown and annealed Fe doped $LiNbO_3$ single crystals, presented in the Conference on Electron Microscopy and Allied Fields held at NPL during April 1-3, pp. 196, 2004.

16. Bhagavannarayana G., Characterization of single crystals and epitaxial films by high-resolution X-ray diffraction methods, Invited talk delivered in the symposium on nonlinear optical crystals and modeling in crystal growth, held at Chennai pp. during 28th Feb. and 1st March, 2, 2005.

17. Bhagavannarayana G., Growth and Characterization of non-linear optical single crystals, invited talk delivered at tenth national seminar on crystal growth, held at Kongu Engg. College, Erode, Tamil Nadu, pp. during Jan 27-29, 29.G, 2005.

18. Bhagavannarayana G., High-resolution X-ray diffraction methods to characterize single crystals and their films Invited talk delivered at Madurai Kamraj University, Madurai on 14th March, 2005.

19. Bhagavannarayana G., Maurya K.K., Budakoti G.C., & Kumar B., High resolution X-ray diffractometric, piezoelectric and spectroscopic studies of $LiNbO_3$ single crystals grown by Czochralski method, presented in the XIII National Seminar on Ferroelectrics and Dielectrics (NSFD-XIII) held at Dept. of Physics and Astrophysics, Univ. of Delhi pp. 47 during Nov. 23-25, 2004.

20. Budakoti G.C. & Bhagavannarayana G., Defect studies of pure and Fe-doped single crystals grown by CZ method, presented in the tenth national seminar on crystal growth, held at Kongu Engg. College, Erode, Tamil Nadu, pp. 122 during Jan 27-29, 2005.

21. Chakraborty B.R., Kabiraj D., Diva K. and Avasthi D.K., Mixing behaviour of buried transition metal layer in silicon due to SHI irradiation, Paper presented at the Indo-German workshop on Synthesis and modification of Nano-structured materials by energetic ion beams held at Nuclear Science Centre, New Delhi, during Feb. 20-24, 2005.

22. Chakravarty B.C., Kumar R., Srivastava R.P. , Singh R.R. , Tripathi J. Lal M., Kar M., Sood K.N., Samanta S.B., & Singh S.N., A comparative study of the growth kinetics of Boron -Si on <100> , <110> and <111> Si substrate for use as electrochemically formed Anti -reflection Coating on Terrestrial Solar Cell, Proc. Nat. Conf. Phys. Electronic Materials and Devices (PEMD-2005), Sambalpur University, Orissa, Feb, 10 - 12, 2005.

23. Chandra Mukesh & Ashok Kumar, A new method for measurement of parameter of nonlinearity of liquids using underwater parametric acoustic arrays, International Conference on Advances in Metrology (AdMet-2005), New Delhi, Feb. 23-25, 2005.

24. Chandra Mukesh and Ashok Kumar, Design criteria for parametric acoustic sources for underwater and airborne applications, 13th National Symposium on Ultrasonics (NSU-XIII), Jhansi, Dec 21-23, 2004.

25. Chaudhary K.P., M.L.Mangal*, Arif Sanjid M, R P Singhal, A new approach for calibration of caliper checker, step gauge using electronic probe and standard gauge block and evaluation of uncertainty of measurement, 5th International Conference on Advances In Metrology (AdMet-2005) NPL, New Delhi 23-25 February, 2005.

26. Deepa M., Srivastava A.K., Singh S. and Agnihotry S.A., Effect of annealing on structure - property of electrodeposited nanostructured WO_3 Thin Films, XXVII annual meeting of EMSI and conference on electron microscopy and

allied fields, New Delhi, India, pp.76-77 April 1-3, 2004.

27. Gahlot P.S., Khasa S., Agarwal A., Seth V.P. and Gupta S.K. Effect of alkali ions on the electron paramagnetic resonance in vanadyl doped $ZnO.Li_2O.B_2O_3$ glasses, Asia Pacific EPR/ESR symposium, IISc. Bangalore, Nov. 22-25, 2004.

28. Gandotra Priyanka, Raghav, Lal M. and Singh Sukhvir, Preparation of different size silicon nanoparticles by electrochemical etching, XXVII annual meeting of EMSI and conference on electron microscopy and allied fields, , pp 246-247 April 1-3, 2004.

29. Garg R.K., B. K. Yadav and H.C. Kandpal, Absolute measurement of UV content in GLS lamps of different wattage-a spectroradiometric approach, AdMet-05, National Physical Laboratory, New Delhi Feb 23-25, 2005.

30. Gera B.S., An approach towards global sodar networking, 12th International symposium on acoustics remote sensing and associated technique of the atmospheric & oceans (ISARS-2004) July 11-16, 2004.

31. Gera Neha, P. Goyal, B.S. Gera et. Al., Sodar studies of foggy boundary layer in relation to air pollution management, 12th ISARS-2005, , Clare College, Cambridge, U.K. July 11-16, 2004.

32. Gera Neha, V.Mohanan, B.S.Gera et. al., Wind profile measurements using Doppler Sodar, Admet - 2005, NPL, New Delhi, Feb. 23-25, 2005.

33. Goel Shubhra, Alka Gupta, K.P. Singh Ranjana Mehrotra and H.C. Kandpal, A comparative study of nanstructured organic polymers with their macroscopic counterparts using Fourier Transform Infrared Spectroscopy, International Conference on Spectrophysics, Chennai Tamilnadu, 9-12 Feb. 2005.

34. Gupta Alka, Shubhra Goel, K.P. Singh Ranjana Mehrotra, and H.C. Kandpal, Optical properties of polyaniline nanotubes fabricated on a ground glass surface, International Conference on Spectrophysics, Chennai Tamilnadu, 9-12 Feb. 2005.

35. Gupta Prabhat K. and Sahai Shivraj, Residue open burning in rice-wheat cropping system in india: an agenda for conservation of environment & agricultural resources, paper presented in national conference on 'conservation agriculture-conserving resources: enhancing productivity', NASC Complex, PUSA, New Delhi, Sept. 22-23,2004.

36. Gupta Prabhat K., Gupta Vandana, Sharma Pratul, Koul S., Singh Nahar, Singh Khem, Sharma C. and Johri P., Methane and nitrous oxide emissions from rice-wheat cropping system during 2002-03, Paper presented in 5th international conference on advances in metrology (AdMet-05), NPL, New Delhi, Feb. 23-25, 2005.

37. Gupta Prabhat K., Jain Meena, Singh Nahar and Singh Khem, Wet & dry deposition studies over Delhi, paper presented in 5th international conference on advances in metrology (AdMet-05), NPL, New Delhi, Feb. 23-25, 2005.

38. Gupta Prabhat K., Jha Arvind K., Koul S., Sharma Pratul, Johri P., Purvaja R. and Ramesh R., Measurement of greenhouse gas emissions from landfill sites of chennai: a coastal mega city, paper presented in 5th international conference on advances in metrology (AdMet-05), NPL, New Delhi, Feb. 23-25,2005.

39. Gupta Prabhat K., Sahai Shivraj, Dixit C.K., Singh D.P., Singh Nahar, Singh Khem, Sharma Pratul, Koul S., Johri P., Sharma C. and Garg S.C., Addressing uncertainty in trace gas emission from agricultural crop residue burning in India, paper presented in 5th international conference on advances in metrology (AdMet-05), NPL, New Delhi, Feb. 23-25, 2005.

40. Gupta Prabhat K., Singh Khem, Singh Dharam Pal, Dixit C.K., Jain Meena K, Gupta Vandana, Sharma C. and Singh Nahar, Variation of respirable suspended particulate matter, SO_2 and NO_2 during Diwali period in the ambient air of Delhi, Paper presented in 5th international

conference on advances in metrology (AdMet-05), NPL, New Delhi, Feb. 23-25, 2005.

41. Gupta S.K., Arora M., Panwar O.S., Khan Mohd.K., Dixit P.N. and Hussain M., ESR study of tetrahedral amorphous carbon films grown using an indigenously developed FC vacuum arc system, Asia Pacific EPR/ESR symposium, IISc.Bangalore, Nov.22-25,2004.

42. Gupta S.K., Singh R., Arora Manju Kumar, J. and Kaur A., Correlation of esr and electrical conductivity properties of ferric chloride doped poly-3 methyl thiophene, Asia Pacific EPR/ESR Symposium, IISc., Bangalore, Nov.22-25, 2004.

43. Harnath D., Chander Harish, Nitesh, Sood K.N., Singh Sukhvir and Kishore Ram, Morphological investigations of ZnS: Mn nanophosphor developed in transparent silica Gel, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, , pp 236-237 April 1-3, 2004.

44. Jai Bhagwan, D.P. Bhahuguna,B.K. Yadav,K.N. Basavaraju, R.K. Garg and H.C. Kandpal, Absolute measurement of luminous flux and color coordinates of compact fluorescent lamps by spectroradiometry, AdMet-05, National Physical Laboratory, New Delhi, Feb 23-25, 2005.

45. Jain Kamlesh K., J. K. Dhawan, A low cost high efficiency transfer Standards upto 700 kN, AdMet 2005, NPL, New Delhi, February 23-25, 2005.

46. Jain Kiran and Rashmi, Fabrication of nanocrystalline CdS thin films by electrochemical process,XXX Optical Society of India Symposium on Optics and Opto-Electronics, NPL, New Delhi, January 19-21,2005.

47. Jain Kiran, and Sood K. N., Morphology and FTIR property of polyaniline array confined in alumina template, int. conf. on recent advances in composite materials, book of abstracts Jain Kiran, Rashmi and Lakshmi Kumar S.T., Preparation of nanocrystalline tin oxide powder for gas sensor applications, international conference on soft matter (ICSM 2004), Jadavpur University, Kolkata. November 18-20, 2004.

48. Jain Kiran, Rashmi and Sood K. N., Preparation of one dimensional nanostructures of chalcogens and chalcogenides using nanoporous templates,indo german workshop on synthesis and modification of nano-structured materials by energetic ion beams, , NSC, New Delhi. February 20-24, 2005.

49. Jain Kiran, Rashmi and Sood K.N., Preparation of semiconductor nanowires in porous alumina templates for optoelectronic applications,XXX Optical Society of India Symposium on Optics and Opto-Electronics, NPL, New Delhi. January 19-21 2005.

50. Jain Kiran, Rashmi, Sood K.N. and Lakshmi Kumar S.T., Preparation of Ni nanowires in porous alumina template using unipolar electrodeposition technique,international conference on soft matter (ICSM 2004), Jadavpur University, Kolkata November 18-20, 2004.

51. Kandpal H.C. and Ranjana Mehrotra, Estimation of uncertainty in the measurement of color coordinates, AdMet-05, National Physical Laboratory, New Delhi Feb 23-25, 2005.

52. Kandpal H.C., Construction of spatial-coherence spectral filters, XXX Optical Society of India Symposiumon Optics and Optoelectronics National Physical Laboratory, New Delhi Jan 19-21, 2005.

53. Kandpal H.C., Swati Raman and Ranjana Mehrotra, Observation of Gouy phase anomaly with an interferometer, XXX Optical Society of India Symposiumon Optics and Optoelectronics National Physical Laboratory, New Delhi Jan 19-21, 2005.

54. Karar N., Chander Harish, Harnath D., Singh Sukhvir, Kishore Ram and Singh Fauran, Luminescence properties of Ag doped ZnS nano particles correlated using TEM, XXVII Annual

Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, , pp 184-185 April 1-3,2004.

55. Khanna Ravi, K.P Chaudhary, R.P Singhal, Calibration & uncertainty evaluation using length measuring machine-a new facility at NPL for the measurement of long gauge blocks, 5th international conference on advances in Metrology (AdMet-2005), NPL, New Delhi 23-25 February, 2005.

56. Kumar Mahesh, Paliwal V. K., Joshi Amish G. & Shivaprasad S. M., Epitaxial growth of submonolayer Sb on high index Si (5 5 12) single crystal surface, 49th DAE Solid State Physics Symposium, 64, 26-30th December, 2004.

57. Kumar Mahesh, Paliwal Vinod Kumar, Joshi Amish G., Shivaprasad S. M., Evidence for 1D Zigzag Sb nanowires formation on the atomically trenched Si (5 5 12) surface, MRSI Symposium 2005, 10-12th February, 2005.

58. Lal Kasturi, Singh Sukhvir Sood, K.N., Prasad Vinod and Kishore Ram, Microstructural investigations on InSb thin films synthesized by electron beam and thermal evaporation technique, XXVII annual meeting of EMSI and Conference on Electron Microscopy and Allied Fields, pp 244-245. April 1-3, 2004.

59. Mahavir Singh, Omkar Sharma & V. Mohanan, New approach for determining sound absorption coefficients, Admet -2005, NPL, New Delhi, Feb. 23-25, 2005.

60. Mehrotra Ranjana, D.P. Bahuguna, Swati Raman, B.K. Yadav and H.C. Kandpal, Light emitting diodes - evaluation of performance by spectroradiometry, AdMet-05, National Physical Laboratory, New Delhi Feb 23-25, 2005.

61. Mohan P., A study of some metrological characteristics of capacitance diaphragm gauges, 51st AVS International Symposium, Anaheim, Calif., USA. , Nov. 14-19, 2004.

62. Mohanan V., Omkar Sharma & Mahavir Singh , Vibration criteria for laboratory environments, 5th International Conference on Advances in Metrology (Admet -2005), NPL, New Delhi ,Feb. 23-25, 2005.

63. Murali K., Rai K.N., Srivastava A.K., Kishore R., Electric and dielectric properties of strontium bismuth niobate vanadates (SBVN), XIII National Seminar on Ferroelectrics and Dielectrics, New Delhi, p. 40 November 23-25, 2004.

64. Nagarajan R., Parul, Ranjana Mehrotra and M. M. Bajaj, Moisture analysis by near infrared diffuse reflectance spectroscopy in commercial milk powder, International Conference on Spectrophysics, Chennai Tamilnadu, 9-12 Feb., 2005.

65. Om Prakash Measurement of optical parameters of optical components presented in the national conference on precision manufacturing held at the Department of Mechanical Engineering, Sant Longowal Institute of Engineering & Technology, Sangrur, Punjab(India), during Dec.,2004.

66. Om Prakash Measurement of radii of curvature of convex reference test plates presented in the 5th International Conference on Advances in Metrology (AdMet-2005), organized by the Metrology Society of India (MSI) and the National Physical Laboratory, New Delhi, during February, 2005.

67. Om Prakash Simulation of the experiment to study the effect of sun light on visibility through glass windscreen of a vehicle Presented in the XXX Optical Society of India (OSI) Symposium on Optics and Opto-Electronics (SOOP-05), organized jointly by Optical Society of India and National Physical Laboratory, New Delhi, during, January, 2005.

68. Pant R.P., Arora Manju, Sood K.N., Kishore Ram, Halder S.K. and Gupta S.K., Investigations on nanophase of magnetite base ferrofluid in polymer matrix, XXVI EMSI Conference on Electron Microscopy and Allied fields, NPL New Delhi April 1-3,2004.

69. Pant R.P., Halder S.K, Singh D.P, Agrawal A.K. and Lal Krishan, - Al_2O_3 certified reference materials for calibration of powder X-ray diffraction equipment,5th Int. Conf. on Advances in Metrology (Admet-2005)NPL, New Delhi, Feb 23-25,2005.

70. Pant R.P., Parkash Om, Singh Sukhvir, Sankarnarayana V.K., Haldar S.K., Maurya K.K. and Kumar Vijay, Cobalt ferrite nanoparticles relevance to ferrfluid formation,XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, pp 222-223 April 1-3, 2004.

71. Pardeep Mohan and Harish Kumar, Short-term Stability of the Calibration Factor of a 1000 torr Capacitance Diaphragm Gauge, 5th Intern. Conf. on Adv. In Metrology, AdMet-05, NPL, New Delhi, 23-25 Feb., 2005.

72. Pardeep Mohan, A new determination of the volume ratio of the NPLI static expansion system, 5th intern. conf. on adv. in Metrology, AdMet-05, NPL, New Delhi, 23-25 Feb., 2005.

73. Pardeep Mohan, Characterization of two spinning rotor gauges using the NPLI static expansion system, 5th Intern. Conf. on Adv. In Metrology, AdMet-05, NPL, New Delhi, 23-25 Feb., 2005.

74. Parul, Alka Gupta and Ranjana Mehrotra, Moisture determination in aspirin drug formulation by near infrared Spectroscopy, International Conference on Spectrophysics, Chennai Tamilnadu, 9-12 Feb. 2005.

75. Raman Swati, Ranjana Mehrotra, D.P. Bahuguna, Sudama and H.C. Kandpal, White LEDs - their usage as sources of different characteristics, AdMet-05, National Physical Laboratory, New Delhi Feb 23-25, 2005.

76. Raman V., Bhatia G., Misra A.K., Bhardwaj S., Sood K.N. and Kaushik N.K., Synthesis of silicon carbide nanofibres from pitch blended with sol-gel derived silica int. workshop on carbon materials for energy applications, IWCMEA- 2004.

77. Raman V., Bhatia G., Sengupta P. R., Bhardwaj S. and Sood, K. N. Synthesis of silicon carbide nanofibres from mixture of polymer and sol-gel silica with sol-gel silica, proc. Int. workshop on Carbon materials for Energy Applications, IWCMEA, 2004.

78. Raman V., Bhatia, G, Bhardwaj S., Sood K.N. and Srivastava A. K., Synthesis of silicon carbide nanofibers (SiCnf) from polymer blended with sol-gel silica, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, New Delhi, India, Pp.86-87 April 1-3, 2004.

79. Rashmi and Singh Nahar, Quantitative analysis of polycrystalline materials by X-ray diffraction using rietveld method,5th international conference on advances in metrology: metrology for manufacturing sector and global competitiveness AdMet 2005, NPL New Delhi, 23-25 February, 2005.

80. Reddi B.V, Singh Nahar and Sood K. N., TiO_2 - Based Nano tapes and tubes, published in proceedings of the XXVII annual meeting of EMSI and conference on Electron Microscopy and allied field (EMSI-2004), NPL New Delhi, April 1-3, pp. 214-215,2004.

81. Reddy B.V., Singh Nahar, Pant R.P. and Sood K.N. XXVI EMSI Cages, Shells and polyhedral shapes from self assembly of zinc oxide nanocrystals, conference on electron microscopy and allied fields, p 216, NPL, New Delhi April 1-3, 2004.

82. Reddy Vilas, A.L.Vyas, Mukesh Chandra, Ashok Kumar, I.P.Singh, Dynamic rain fall assessment using artificial neural network, National Symposium on Acoustics, Mysore, Nov. 25- 27, 2004.

83. Sanjid Arif M, Niveen Farid, Digital Processing of speckle patterns and its applications to study length and surface deformation, 5th International Conference on Advances In Metrology (AdMet-2005), NPL, New Delhi, 23-25 February, 2005.

84. Sanjid Arif, K.P. Chaudhary, R.P. Singhal, Nanometer range proficiency in measurement of gauge blocks using automatic phase stepping gauge block interferometer at NPL I, 5th International Conference on Advances In Metrology AdMet-2005, NPL, New Delhi, 23-25 February, 2005.

85. Satish Kumar, Jai Bhagwan, Sudama, K.N. Basavaraju and H.C. Kandpal, Integrating sphere coating - how frequent should it be?, AdMet-05, National Physical Laboratory, New Delhi Feb, 23-25, 2005.

86. Senguttuvan T. D., Sood K. N., N. C. Soni, Radheshyam Rai and Singh D. P., Sintering studies on ZST microwave ceramics by Scanning Electro Microscopy, XXVII Annual Meeting of EMSI and conference on Electron Microscopy, and Allied Fields at National Physical Laboratory, New Delhi, April 1-3, 2004.

87. Senguttuvan T.D, Singh Sukhvir, Lakshmikumar S.T. and Kishore Ram, TEM Studies of SnO_2 Nanoparticles Synthesized by Inorganic Sol Gel Method, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, pp 84-85 April 1-3, 2004.

88. Senguttuvan T.D., Srivastava A.K. and Kishore R., Microstructural Characterization of ZrO_2 Nanoparticles Synthesized by Sol-Gel Method, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, New Delhi, India, pp.108-09 April 1-3, 2004.

89. Sharma Bhawna, R.P. Singhal, Rina Sharma, Quality assurance of software through testing-a case study, 5th international conference on advances in Metrology (AdMet-2005), NPL, New Delhi, 23-25 February, 2005.

90. Sharma D. R., D. Arun Vijayakumar and A. C. Gupta, Present status of low pressure measurement in barometric pressure region at NPL India and its Global Metrological Equivalence, is presented during the international conference on advances in metrology (ADMET-2005), organized at NPL, India during February, 23-25, 2005.

91. Sharma Pooja, Chander Harish, Harnath D., Nitesh, Singh Sukhvir and Kishore Ram, Structure and Phtoluminscence of Nano-$SrAl_2O_4$:Eu^{2+}, Dy^{3+} Phospphor, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, pp 208-209, April 1-3, 2004.

92. Sharma Pooja, Haranath D, Chander Harish, Ali Anwar, Singh Sukhvir and Sood K.N., Optical Properties of Blue Emitting Phosphor Nanowires,XXX Optical Society of India (OSI) Symposium on Optics and Opto-Electronic (SOOP-05), Book of Abstracts, 2005.

93. Sharma Rina , An introduction to uncertainty in measurements, national seminar on audit requirements for traceability in measurement process. organized by Confederation of Indian industry (CII) and QCI Hotel Taj Mahal, New Delhi, April 10, 2004.

94. Sharma Rina, N.K. Aggarwal and R.P. Singhal, Proficiency testing in calibration of gauge blocks among accredited laboratories in India, 5th International Conference on Advances In Metrology (AdMet-2005), NPL, New Delhi, 23-25 February, 2005.

95. Sharma Rina, B.K. Roy and R.P. Singhal, Study of thermal expansivity of gauge block, 5th international conference on advances in Metrology (AdMet-2005), NPL, New Delhi, 23-25 February, 2005.

96. Sharma S.D., Saini K.K., Sharma C.P., Kant Chander, Sharma R.K., Pant R.P. and Bawa S.S., Characterization and optical properties of sol-gel TiO_2 film, XXVI EMSI Conference on Electron Microscopy and Allied fields, NPL New Delhi, April 1-3, 2004.

97. Shivaprasad S.M., Kumar Mahesh, Joshi A. G., Paliwal V.K., Formation of antimony 1D-nanostructures on Si (5 5 12) surface, Spring MRS 2005, Paper No. A8.8, 124714), 28-31st March, 2005.

98. Singh Nahar, Kayal *Nijhuma, Gupta Prabhat K. and Agrawal A.K., Determination of zinc, iron

and cadmium in rice using, flame atomic absorption spectrometer and inductively coupled plasma atomic emission spectrometer, Accepted in 5th international conference on advances in metrology (AdMet-05), Feb.23-25, 2005.

99. Singh Niranjan and Sarkar Ajit K., Determination of Trace impurities in high purity graphite using electrothermal atomization - Atomic Absorption Spectrophotometer (ETA-AAS), Paper presented in MRSI Symposium on Materials for Automotive Industries, NCL, Pune, 10-12 Feb.,2005.

100. Singh Niranjan and Sarkar Ajit K., Uncertainty measurements of silver nitrate content in indelible ink, paper presented in 5th international conference on advances in metrology (AdMet-05), NPL, New Delhi, Feb. 23-25 2005.

101. Singh Ravindra, Singh Nahar, Gupta Prabhat K., Rashmi, Sood K.N., Kishore Ram, Bahadur Harish Goel T.C and Chandra Sudhir, Compositional and structural analysis of RF sputtered PLZT thin films,Presented in international conference on smart materials (smart Mat-04), Chiang Mai, Thailand, 1-3 December (2004).

102. Singh Ravindra, Singh Nahar, Rashmi, Goel T.C. and Chandra Sudhir, Preparation and properties of rf sputtered PLZT thin films, presented in national seminar on ferroelectric and dielectric materials NSFD-13th, University of Delhi, 23-25 Nov., 2004.

103. Singh S., Srivastava A.K., Lal Kasturi and Kishore R., Evidences of imperfections in thermally evaporated InSb Thin Fims, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, New Delhi, India, Pp.218-19, April 1-3, 2004.

104. Singh Sukhvir, Lal Kasturi, Sood K.N. and Kishore Ram, Growth and microstructural characterization of InSbBi compound and its thin films, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, pp 242-243 April 1-3,2004.

105. Singhal RP, Rina Sharma, traceability in measurements, national seminar on audit requirements for traceability in measurements processorganized by Confederation of Indian Industry (CII) and QCI Hotel Taj Mahal, New Delhi, April 10, 2004.

106. Som J, N., Virendra Babu, Raj Singh, and I. S. Taak, New water flow testing facility installed at National Physical Laboratory, New Delhi, and its use for testing the domestic water meters, 5th international conference on advances in metrology (AdMet-2005), NPL, New Delhi, February 23-25, 2005.

107. Som J. N., Virendra Babu, Raj Singh, and I. S. Taak, Development of ultrasonic method for flow measurement, 13th National Symposium on Ultrasonics 2004 (XIII-NSU 2004) Department of Physics, Bundelkhand University, Jhansi.

108. U.P. Soni Daya, Gupta Prabhat K. and Verma K. K., Study on the hydrolytic behaviour and antibacterial activity of some unsymmetrical diorganyltellurium(IV) dichlorides, Paper presented in 5th international conference on advances in metrology (AdMet-05), NPL, New Delhi, Feb. 23-25, 2005.

108. Srivastava A.K. and Kishore R., Electron Energy Loss Spectroscopy: A technique for nano - dimensional imaging with analytical measurements, 5th international conference on advances in metrology, New Delhi, pp.44, February 23-25, 2005.

109. Srivastava A.K., Colliex C. and Haberland H., High resolution electron microscopy and electron energy loss spectroscopy of the interface between deposited TiNx nanoclusters and the Si Substrate,XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, New Delhi, India, Pp.202-03, April 1-3, 2004.

110. Srivastava A.K., Deepa M., Singh S., Kishore R. and Agnihotry S.A., Microstructure dependent electrochromic performance of electrodeposited WO_3 Films,XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied

Fields, New Delhi, India, Pp.124-25,April 1-3, 2004.

111. Srivastava A.K., Lal K., Sood K.N., Kishore R., Electron microscopy and spectroscopy studies of nano-structured materials including interfaces, Indo-US materials research workshop on collaborations and networking, Pune, pp.75, December 19-21,2004.

112. Srivastava A.K., Sood K.N. and Kishore R., Electron microscopy and spectroscopy of ZnO tetrapods and nanowires, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, New Delhi, India, Pp.188-89, April 1-3, 2004.

113. Srivastava Abhilasha, Jain Kiran, Rashmi, Srivastava A.K. and Lakshmikumar S.T., Preparation of nanocrystalline SnO_2 powder for gas sensor applications through microwave treatment, XXVII Annual Meeting of EMSI and Conference on Electron Microscopy and Allied Fields, New Delhi, India, Pp.162-63 April 1-3, 2004.

114. Srivastava Abhilasha, Jain Kiran, Srivastava A.K., Rashmi and Lakshmi Kumar S.T., Preparation of Nanocrystalline Tin Oxide by Hydrosol Method, International Conference on Soft Matter (ICSM 2004), Jadavpur University, Kolkata. November 18-20, 2004.

115. Subba Rao D.V., Balram V., Agrawal A.K., Charn1S.N., Patil M.L., Gnaneshwar Rao T., Kapilavastu K., Sarma D.Srinivasa, Sridhar D.N., Trace and REE Characteristics in gold geochemical reference material in hutti gold mines, Southern India, 5th international conference on advances of metrology, New Delhi, February 23-25, 2005.

116. Sudama, D.P. Bahuguna, Jai Bhagwan, Ranjana Mehrotra and H.C. Kandpal, Luminance measurement of phosphorescent material and its decay with time, (AdMet-05), National Physical Laboratory, New Delhi Feb 23-25, 2005.

117. Titus S.S.K., S.K. Jain and Kamlesh K. Jain, A Comparative Study of Standard Hardness Blocks, Presented at (ADMET 2005), New Delhi , February 23-25, 2005.

118. Vijayakumar D. Arun, D. R. Sharma and A. C. Gupta, Evaluation of uncertainty contributions of correlated parameters of a calibration process employed in barometric pressure measurements, is presented during the international conference on Advances in Metrology (ADMET-2005), organized at NPL, India during February 23-25, 2005.

119. Vijayan N., Bhagavannarayana G., Balamurugan N., Ramesh Babu R., Gopalakrishnan R., Maurya K.K. & Ramasamy P., A comparative study on the solution and melt grown single crystals of benzimidazole: a nonlinear optical material, presented in the XXX Optical Society of India (OSI) Symposium on Optics and Opto Electronics (SOOP-05) held at NPL, PP. 162, during Jan. 19-21, 2005.

120. Vijayan N., Bhagavannarayana G., Balamurugan N., Ramesh Babu R., Gopalakrishnan R., Maurya K.K. & Ramasamy P., Growth and characterization of solution and melt grown single crystals of benzimidazole: a nonlinear optical material, presented in the Tenth National Seminar on Crystal Growth, held at Kongu Engg. College, Erode, Tamil Nadu, pp. 84, during Jan 27-29, 2005.

121. Vijayan N., Bhagavannarayana G., Ramesh Babu R., Gopalakrishnan R. & Ramasamy P., Growth and characterization of nonlinear optical single crystals of L-alanine, presented in the XXX Optical Society of India (OSI) Symposium on Optics and Opto Electronics (SOOP-05), held at NPL, , pp. 165 during Jan. 19-21, 2005.

122. Vijayan N., Bhagavannarayana G., Ramesh Babu R., Maurya K.K., Gopalakrishnan R. & Ramasamy P., Studies on the growth and characterization of some organic NLO crystals Invited talk delivered in the Symposium on Nonlinear Optical Crystals and modeling in crystal growth, held at Chennai pp. 2 during 28th Feb. and 1st March, 2005.

123. Yadav B.K., D.P. Bahuguna, Ranjana Mehrotra and H.C. Kandpal, Illuminance responsivity calibration of photodetectors, (AdMet-05), NPL, New Delhi Feb 23-25, 2005.

124. Yadav Sanjay, V.K. Gupta and A. K. Bandyopadhyay, Interlaboratory comparison in the pressure range up to 70 MPa using dead weight tester as an artifact, presented during international conference on advances in Metrology (AdMet-2005), NPL New Delhi, Feb. 23-25, 2005.

125. Yadav Sanjay, V.K. Gupta, Om Prakash and A. K. Bandyopadhyay, Reestablishment of measurement uncertainty of the national primary pressure standard up to 500 MPa Presented during International Conference on Advances in Metrology (AdMet-2005) NPL New Delhi, Feb., 23-25,2005.

Book Chapters

1. "Alkaline Earth Sulphides", Virendra Shanker and Harish Chander, "The Handbook of Electroluminescent Materials", edited by Prof. D. R. Vij, published by Institute of Physics Publishing, U. K. pp 193-216. Feb, 2004.
2. "Carbon Materials for Energy Applications"-Proc. of International Workshop on Carbon Materials for Energy Applications-Edited by R.K. Aggarwal, T.L. Dhami and O.P. Bahl Ideal Impressions Pvt. Ltd., New Delhi.
3. "Electroluminescence - An Introduction", D. Haranath, Virendra Shanker, D. R. Vij, "The Handbook of Electroluminescent Materials", edited by Prof. D. R. Vij, published by the Institute of Physics Publishing, U. K. pp 1-23. Feb, 2004.
4. Awana V.P.S., Magneto-superconductivity of rutheno-cuprates, review chapter in 'frontiers in magnetic materials', Ed. By A.V. Narlikar, Springer-Verlag Publishing, Germany page no531-572,2005.
5. Experimental verification of Doppler-like wavelength shift due to dynamic multiple scattering of light by a plasma medium H.C. Kandpal and Ranjana Mehrotra, Perspective in Engineering Optics, Ed. Kehar Singh and V.K. Rastogi pp136-150, 2004.
6. Gupta Anurag, V.P.S. Awana S.B. Samanta, H. Kishan and A.V. Narlikar "Disordered uperconductors" frontiers in superconducting materials springer-verlag publishing, Germany page no. 499-554, 2005.
7. Gupta Prabhat K., Das S.N., Adhya T.K; Pathak .H., Ramesh R., Purkait N;. Baruah K.K., Venkatratnam L., Singh Gulab, Iyer C.S. P., Gupta Vandana, Sharma C., Sharma Pratul, Pradhan Vaishali, Singh Nahar, Koul S., Singh Khem, Johri P., Garg S.C. and Mitra A. P., Reducing uncertainties in methane emission from rice cultivation, published in "climate change and India-Uncertainty Reduction in Greenhouse Gas Inventory Estimates", (Eds.) Mitra A.P., Sharma Subodh, Bhattacharya Sumana, Garg Amit, Devotta Sukumar, and Sen Kalyan, Universities Press (India) Pvt. Ltd., pp. 171-222, 2004.
8. Gupta Prabhat K., Sahai Shivraj, Singh Nahar, Dixit C.K., Singh D.P., Singh Khem; Koul S., Sharma C., Garg S.C. and Mitra A.P., GHG emissions from biomass burning: field burning of agricultural crop residue, published in "climate change and india-uncertainty reduction in greenhouse gas inventory estimates", (Eds.) Mitra A.P., Sharma Subodh, Bhattacharya Sumana, Garg Amit, Devotta Sukumar, and Sen Kalyan, Universities Press (India) Pvt. Ltd., pp. 258-279, 2004.
9. Optical Coherence Anurag Sharma, A.K. Ghatak and H.C. Kandpal Encyclopedia in Modern Optics, Eds. R.D. Guenther, D.G. Steel and L.Bayvel, Elsevier, Oxford.Vol 1, pp 84-99, 2004.
10. Pathak H; Gupta Prabhat K., Bhatia A., Sharma C., Kalra N. and Mitra A.P., Nitrous Oxide Emission from Soil Plant System, published, in "Climate Change and India-Uncertainty Reduction in Greenhouse Gas Inventory Estimates", (Eds.) Mitra A.P., Sharma Subodh, Bhattacharya Sumana, Garg Amit, Devotta Sukumar, and Sen Kalyan, Universities Press (India) Pvt. Ltd., pp. 244-257, 2004.
11. H.C. Kandpal and Ranjana Mehrotra, Physical photometry and its industrial applications Lighting Engineering Ed P. Barzatia pp36-70, 2004.
12. Singh V.R., Chaudhary, M. and Bhatnagar, I.K., Investigative Techniques for the Damage Assessment of the Monuments, Studies in Art

and Archaeology Conservation (eds. A.S.Bisht and S.P.Singh), Agam Kala Prakashan, chapter 17, pp. 197-234, New Delhi, 2004.

13. Singh V.R., Recent Advances and Future Directions in Ultrasonic Diagnosis of Tissues, in book, 'Advances in Medical Diagnostic Techniques and Procedures' (eds. M.Singh and S. Radhakrishnan), Anamaya Publishers, pp 7-11, New Delhi, 2004.

14. Swamy Mahadeswara, Singhal K.K., Gupta Prabhat K., Mohini Madhu, Jha Arvind K. and Singh Nahar; Reduction in Uncertainties from Livestock Emissions, published, in "Climate Change and India-Uncertainty Reduction in Greenhouse Gas Inventory Estimates", (Eds.) Mitra A.P., Sharma Subodh, Bhattacharya Sumana, Garg Amit, Devotta Sukumar, and Sen Kalyan; Universities Press (India) Pvt. Ltd., pp. 223-243,2004.

Appendix-2

PATENTS

Patents Filed in India

S.No.	Title	NF No.	Application No.	Filing Date	Inventors
1.	Thin film ethanol sensor and a process for the preparation	0346NF2001/IN	0837DEL2004	06/05/2004	Rastogi A K, Jain K, Gupta H P, Kumar V
2.	A phased array acoustic atmospheric profiling radar	0300NF2003/IN	1096DEL2003	02/06/2004	Ravi Mohan Khanna, Satish Chand Garg, Madhu Bahl, Beena Gupta, Dhann Singh, Omkar Sharma, Vellur Mohanan, Vivekanand Jha, Sushma Roy, Gautam Chakraborty
3.	Copolymer of benzene and substituted benzene	0198NF2003/IN	03246DELNP2004	20/10/2004	Sandeep Kumar Dhawan, Kamalasasan Narayanan Modeeparampu, Sukhwant Singh Bawa
4.	A single step process for the preparation of high density carbon-carbon composite material	0029NF2005/IN	56/DEL2005	16/03/2005	Bahl Om Prakash, Mathur Raesh Behari, Dhami Tersem Lal, Chauhan Sippy Kalra
5.	A process for manufacturing nano-structured zinc oxide tetrapods	0111NF2005/IN	0773 DEL 2005	31/03/2005	Dr. A.K.Srivastava Mr. K.N.Sood Mr. Kasturi Lal

Patents Granted in India

S No.	Title	Patent No	Grant Date	Inventors
1.	An improved device useful for calibrating hydraulic pressure gauges	191691	26/08/2004	Jain K K, Poddar H N P
2.	An improved process for the preparation of photoreceptors	191288	24/05/2004	Chand S, Bhatheja R C, Sharma G D, Singh J K, Chandra S

Patents Filed Abroad

S.No.	Title	Appl. No.	Country	Filing Date	Inventors
1.	A sensitive, fast responsive thin film ethanol sensor and a process for the preparation of a sensitive, fast response thin film ethanol sensor and a process for the preparation of a precursor solution for ethanol sensor	2002216358 10.2004.700706	0346NF2001/AU 0346NF2001/KR	07/05/2004 08/05/2004	Rastogi A K, Jain K, Gupta H P, Kumar V
2.	An improved process for the preparation of doped lead iron tungstate relaxor material for wide range pressure measurement and a capacitive pressure transducer made thereby	PCT/IN02/00078 028NF2001/SU	0282NF2001/CN 0282NF2001/CA 028NF2001/JP 0282NF2001/IL	28/09/2004	Dr. K.K.Jain Mr.Viney Kumar Prof.S.C.Kashyap

Patents Granted Abroad

S.No.	Title	Patent No.	Country	Grant Date	Inventors
1.	Reusable heat pack	771018 1245207 B1	AU EP	24/06/2004 24/11/2004	Sharma C P, Sharma R K, Kant C, Sarkar A K
2.	Compensated sulphonated polyaniline and a process for the preparation thereof	3592991	JP	03/09/2004	Saraswati Koul, Sandeep Kumar Dhawan, Subhas Chandra, Ramesh Chandra
3.	A process for the preparation of highly stable solid precursor material useful for tungsten oxide electrochromic coatings.	GB2359304A	GB	21/04/2004	S.A.Agnihotri, R. Ramachandran, P Varshney, N Sharma and M.Deepa.

Appendix-3

TECHNOLOGIES MARKETED

(Rs. In lakhs)

Licensee	Date of Transfer	Technologies Transferred	Premia
M/s J Ragrau Instruments, New Delhi	11/05/2004	Force Transducer	106000.00
M/s Konark Tar Products Pvt Ltd, Durgapur	31/11/2004	Impregnating Grade Coal Tar Pitch	220400.00
		Total	**326400.00**

INFORMATION ABOUT TECHNOLOGIES

1. Force Transducer

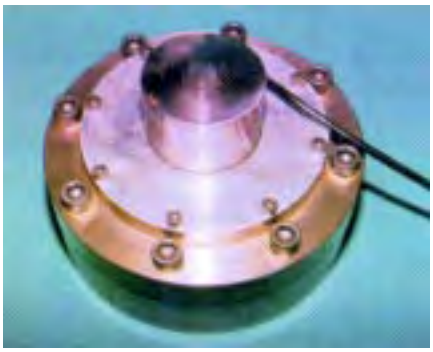
Force Proving rings are presently in use effectively as force measuring/force proving instruments but their use is limited due to their inherent disadvantages like cumbersome to use (in most cases for specific forces only) temperature sensitive and are unable to measure the low forces with accuracy. These can not be used for automation of the processes and a number of proving rings are required to measure the forces over a wide range and need a strict temperature control during measurements and are subjected to the operators technical competency being analogue.

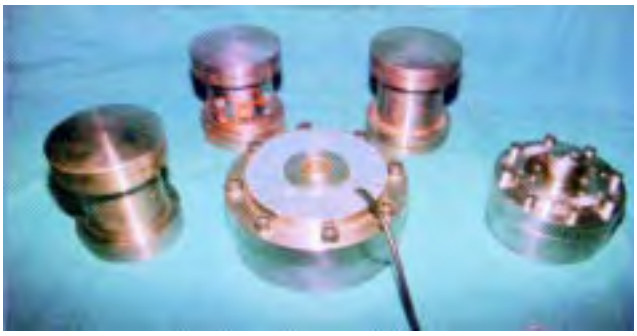
The strain gauge force transducer to measure the applied forces up to 3MN are available in the international market having an over all uncertainty of ±0.02% with a digital display system of 1000000 (ten lakhs count).

The force transducers are available within country which are capable to measure forces in mid region with a repeatability and an over all uncertainty in the measurement not better than ±0.05% and ±0.1% respectively.

The present development would provide a reliable accurate temperature compensated user friendly force transducer for wide range of forces. This would meet the aspiration of the user industries and the quality control laboratories to produce the quality product in case of the former and to have the national traceability and upgrade the quality of the product they manufacture in the later case.

Strain gauge force transducer having an accuracy and repeatability better than ±0.04% and ± 0.005% respectively to measure applied forces up to 500 kN would be available through this development.





2. Impregnating-grade Coal Tar Pitch

Coal tar pitch is an extremely important material used in large quantities as binder and impregnant in the manufacture of conventional carbon products, such as graphite electrodes for the production of steel in electric arc furnaces, and prebaked anodes and soderberg paste for the production of aluminium.

Impregnating-Grade Coal Tar Pitch

The basic difference in the behaviour of the binder-grade and impregnating-grade coal tar pitches is with respect to their characteristics, particularly the quinoline and toluene insolubles contents. Thus, whereas the quinoline insolubles (QI) and toluene insolubles (TI) contents for the binder-grade pitch usually lie in the range of 8-14% and 28-40%, respectively, the same for the impregnating-grade pitch are 4% (max.) and 16-24%, respectively.

Appendix-4

R & D COLLABORATIONS

Institute	Area
National Accreditation Board for Testing and Calibration Laboratories, Department of Science and Technology, Government of India	Proficiency Testing Accreditation, Laboratory Assessment Quality Awareness & Training Programmes
SASO, Saudi Arabia	HRD and establishment of calibration facilities
Industry	Calibration, Consultancy, Training
Aichi Institute of Technology, Toyota, Japan	Moiré techniques in measurement
12 CSIR Laboratories Central Food Technological Research Institute, Mysore Central Fuel Research Institute, Dhanbad Central Mechanical Engineering Research Institute, Durgapur Central Scientific Instruments Organization, Chandigarh Indian Institute of Petroleum, Dehradun Industrial Toxicology Research Center, Lucknow National Aerospace Laboratories, Bangalore National Environmental Engineering Research Institute, Nagpur National Institute of Oceanography, Goa National Metallurgical Laboratory, Jamshedpur Regional Research Laboratory, Jorhat Structural Engineering Research Centre, Chennai Indian Statistical Institute, Kolkata Birla Management Corporation Limited, Bombay Dyal Singh Collage, Delhi University	CSIR Network Project No CMM 24 entitled,. Upgradation of SI Base Units, National Standards of Measurements & Apex calibration and Creation of High Quality Network of Testing and Calibration Laboratories and preparation & Dissemination of Certified Reference Materials
Indian Institute of Technology, Delhi	Studies on etched GaAs system, CdTe, InN systems
University of Rajasthan, Jaipur	High pressure Raman studies on $LaSrMnFeO_3$ systems.
Barkhatulla University, Bhopal Central Pollution Control Board, New Delhi Central Public Works Department, New Delhi Indian Institute of Technology, New Delhi Department of Science & Technology, New Delhi HACE India Ltd., New Delhi	Rare earth actimonides e.g. LaSb, CeSb etc.

Institute	Area
G.B.Pant Institute, Gangtok Delhi Metro Rail Corporation Ltd., New Delhi. 3 CSIR Laboratories Central Scientific Instruments Organisation, Chandigarh Central Electronics Engineering Research Institute, Pilani Central Building Research Institute, Roorkee	CSIR Network Project No. COR 007 on Electronics for Societal Purpose entitled: Development of Seismic Alert System to avert colossal losses during occurrence of major earthquakes
Cooperation on International Traceability in Analytical Chemistry (CITAC), Brazil.	Cooperation for Chemical Traceability in Measurements with in member countries and others.
The International Database for Certified Reference Materials on the Internet (COMAR), BAM Federal Institute for Materials Research and Testing, Berlin, Germany	Registration of CRMs developed in India and their uploading to COMAR Database.
Central Building Research Institute Roorkee	Preparation and dissemination of certified reference materials of elemental solutions and milk powder.
Central Food Techn. Research Institute Mysore	Preparation and dissemination of certified reference materials of elemental solutions, pesticides and milk powder.
Central Salt & Marine Chemical Research Institute, Bhavnagar	Preparation and dissemination of certified reference materials of elemental solutions, pesticides and milk powder.
Indian Institute of Chemical Technology Hyderabad	Preparation and dissemination of certified reference materials of elemental solutions, pesticides and milk powder.
Indian Institute of Petroleum Dehradun	Preparation and dissemination of certified reference materials of elemental solutions, gas mixtures, milk powder, petroleum, and XRD.
Industrial Toxicology Research Centre Lucknow	Preparation and dissemination of certified reference materials of elemental solutions, pesticides, milk powder, petroleum and metals & alloys.
National Environmental Engineering Research Institute, Nagpur	Preparation and dissemination of certified reference materials of elemental solutions, gas mixtures, pesticides and milk powder
National Geophysical Research Institute Hyderabad	Preparation and dissemination of certified reference materials of elemental solutions, milk powder, petroleum, metals & alloys and geochemicals.

Institute	Area
National Institute of Oceanography, Goa	Preparation and dissemination of certified reference materials of elemental solutions
National Metallurgical Laboratory Jamshedpur	Preparation and dissemination of certified reference materials of elemental solutions and metals & alloys.
Regional Research Laboratory Bhubaneswar	Preparation and dissemination of certified reference materials of elemental solutions and gas mixtures
Central Fuel Research Institute Dhanbad	Preparation and dissemination of certified reference materials of elemental solutions and gas mixtures
National Botanical Research Institute Lucknow	Preparation and dissemination of certified reference materials of elemental solutions and gas mixtures
Indian Agricultural Research Institute New Delhi	Preparation and dissemination of certified reference materials of gas mixtures and pesticides
Indian Oil Corporation R & D Centre, Faridabad	Preparation and dissemination of certified reference materials of elemental solutions, gas mixtures and XRD.
Bhabha Atomic Research Centre, Mumbai	Preparation and dissemination of certified reference materials of elemental solutions and milk powder
Regional Research Laboratory, Jorhat	Preparation and dissemination of certified reference materials of elemental solutions
National Centre for Compositional Characterization of Materials (NCCCM), Hyderabad	Preparation and dissemination of certified reference materials of elemental solutions
National Thermal Power Corporation R & D Centre, NOIDA	Preparation and dissemination of certified reference materials of elemental solutions, gas mixtures and XRD.
National Dairy Research Institute Karnal	Preparation and dissemination of certified reference materials of gas mixtures.
National Remote Sensing Agency (NRSA) Hyderabad	Preparation and dissemination of certified reference materials of gas mixtures.
Physical Research Institute Ahemdabad	Preparation and dissemination of certified reference materials of gas mixtures.
Central Rice Research Institute (CRRI) Cuttak	Preparation and dissemination of certified reference materials of gas mixtures.
Tezpur University, Napaam, Tezpur, Assam	Atmospheric Chemistry
Arunachal University, Itanagar, Arunachal Pradesh	Atmospheric Chemistry
Indian Institute of Technology, Delhi	Characterization of Materials

Institute	Area
Thapar Instt. of Engg. & Tech., Patiala	Atmospheric Chemistry
RARS, SKUAST-K, Leh-194101, Ladakh, J&K	Atmospheric Chemistry
Physics Department M.D. University, Rohtak	Characterization of Materials
Maruti Udyog Ltd,	Characterization of Materials by SEM
Indian Institute of Technology, New Delhi	Characterization of Materials by TEM
Department of Physics, Anna University, Chennai	Crystal growth and characterization
Nuclear Science Centre, New Delhi.	Swift heavy ion beam induced interface mixing
Indian Association for the Cultivation of Science, Kolkata	GaN, BN based nano-structured material characterization
Solid State Physics Laboratory, Delhi	Quantum well structure depth profile
Center for Advanced studies, Indore	High K-dielectric material characterization
Indian Institute of Technology, Delhi	PLZT based material characterization
Central Electronics and Electrical Research Institute, Pilani	AES/ELS equipment re-activation
Shriram Institute for Industrial Research, Delhi	Advanced Carbon Products
Kurukshetra University	Structural Optical Electric, Dielectric Properties af doped and undoped TiO_2 thin films
IIT Kanpur	Studies on nanocrystalline silicon for making devices.
IIT Guwahati	Preparation and study of high quality hydrogenated amorphous silicon (a-Si:H) and silicon germanium (a-SiGe:H) alloys for photovoltaic applications Structural characterization technique for evaluation of starting crystal, stress distribution in sensor element and long term stability for sensor components as a central facility
Dept. of Physics, Indian Institute of Technology, New Delhi	Surface Physics and Nanostructures
DOD/NCAOR	Antarctica studies
ISRO-GBP	Aerosol, trace gases, radiation
CPCB, New Delhi	Fog Studies
IARI, New Delhi	FACE studies
National MST Radar Facility	Lower Atmosphere, F-region studies
ISRO, Bangalore	RPA, Aeronomy Payload onboard SROSS-C2 satellite
IMD, New Delhi	Rain effects on microwave Communications

Institute	Area
SV University, Tirupati ISI, Kolkata Bose Institute, Darjeeling;University of Kolkata; Jadavpur University;CRRI, New Delhi; WBPCB, West Bengal	Mobile communications. Estimation of rain characteristics using X band radar Atmospheric chemistry

Appendix -5

Sponsored & Supported R & D Projects

New Projects

(Rs. in Lakhs)

Sr. No.	Title of the Project	Agency / Client	Amount Received
1	Design and development of urea-biosensor	DST	8.000
2	Fabrication and characterization of organic light emitting diodes	DST (Women Scientist Scheme-A)	8.250
3	Optical phase singularity and its applications	DST (Women Scientist Scheme-A)	6.120
4	Interaction with universities/labs in the area of superconductivity	UGC	26.000
5	Coherent Radio Beacon Experiment (CRABEX) for tomographic studies of the ionosphere on board GSAT-II satellite	VSSC, Thiruvananthapuram	1.854
6	Development of bandpass interference filters for course wavelength division multiplexing (CWDM)	DST	12.000
7	Cloud and precipitation phenomenan estimation by using different systems for propagation characteristics in micro wave and millimetre wave and millimetre wave frequency BA	DST	5.000
8	Metal induced crystallization behaviour on thin film of amorphous silicon	INDO-US	1.785
9	Development of plasma polymerization process and deposition system for thin film optical coatings on plastic substrates, conducting polymeric barrier membrane coatings	DST	24.000
	(A) Total of New Project		**93.009**

Continuing Projects

Sr. No.	Title of the Project	Agency / Client	Amount Received
1	Synthesis of carbon nanotubes and their applications in composites and hydrogen storage	Indo-Belarussian	1.000
2	Development of injection solar cells utilizing dye sensitised nano-crystalline TiO_2 films	MNES	0.000
3	Studies on the effect of dynamic multiple scattering on frequency shift of spectral lince and applications	DST	0.000

4	Study of atmospheric aerosols radiation and trace gases under ISRO-GBP road campaign during February 2003: Delhi-Hyderabad-Delhi Corridor	Physical Research Lab.(PRRL) Navrangpura	7.100
5	Development of organic light emitting diodes	DIT, CGO Complex	10.488
6	Smart electro-chromic windows for energy conservation	MNES	5.000
7	Development of spray forming technology of magnesium alloys	VSSC, Thiruvanthapuram	0.000
8	Development of ultrasonic method to evaluate moisture in composite materials	ARDB	2.965
9	Measurement of CH_4 & N_2O emissions from rice/wheat ecosystem in relation to reducing uncertainties in emission factor for enabling activities for intial communication to UNFCCC	ME&F (Winrock)	0.000
10	Reducing uncertainties in emission of CH_4 and N_2O from livestock in india in relation to the enabling activities for intial communication to UNFCCC	ME&F (Winrock)	0.000
11	Development of nonophosphors for industrial application	DST	0.000
12	Growth of nearly perfect single crystal of oxide materials with technological applications	INDO-Russia (ILTP)	0.000
13	Agriculture sector inventory	ME&F (Winrock)	0.000
14	Reducing uncertainties in Emissions CO_2,CH_4 and N_2O from biomass burning in india in relation to the enabling activities for intial cummunication to UNFCCC	ME&F (Winrock)	2.173
15	Carrying capacity studies of teesta basin in sikkim	IIT, Delhi	0.000
16	Design, development and fabrication of sensors and electrometers for the study of maxwell current density and schumann resonances	IIG	0.000
17	Semiconductor silicon for applications in solar energy microelectronics and power electronics	Indo-Russia (ILTP)	0.000
18	Plasma assisted deposition of hydrogenated amorphous silicon films at high rates at VHF frequencies (CW and pulsed)	DST	8.000
19	Development of DNA biosensor	DST	16.000
20	Micro-patterining of solid surfaces for technological application in the field of microelectronics, sensors and displays	DST	5.000
21	Setting up of test and calibration facility for ceramic sensors	DST	4.000
22	Design & development of ceramic based oxide sensor	DST	

23	Development of transducer elements for acoustic emission (ae) sensor	BARC	3.000
24	Spin effects and interactions in the quantum dots	DST	0.000
25	Assessment of impacts of climate change on human health	ME&F (Winrock)	0.000
26	A study of metal oxide coatings on glass substrated by sol-gel technique	DST	0.000
27	Pressure induced phase transitions and metrological applications	DST	2.500
28	Setting up of facilities for dissemination of Indian Standard Time in north-eastern states	DST	0.000
29	A study of the formation of delta-doped silicon structures by surface phase control and solid phase epitaxy	DST	0.000
30	Development of hard coating of cubic boron nitride for industrial applications	DST	2.000
31	SROSS-C2 satellite RPA aeronomy payload data management	ISRO	
32	Studies on bio-mass burning and related trace gas emissions using IRS-P3 satellite data	NRSA	3.000
33	Surface order and structure studies of polymer solid interfaces	Indo-US	
34	Design development and fabrication of 500 kg dead weight machine to calibrate the load cell used for weighing purposes	RRSL, Min. (CAF&Pub Jakkur, Bangalore)	6.49600
35	Photoinduced superconductivity and non-equilibrium states	DST	0.000
36	Studies on fog ocurrence in Delhi	CPCB	0.000
37	Operation of the south asian regional research centre (SAS-RRC) for study of global change under SASCOM	Int.Start Secr.	10.401
38	Planning preperation and dissemination of certified reference materials for quality assurance in analytical measurements	DST (NABL)	0.000
39	To develop 10 PF capacitor using ule quartz for use by accredited calibration laboratory	DST	0.000
40	Development of polymeric sensors for detection of environmentally hazardous gases and micro-organisms	ME&F	0.549
41	Development of cholesterol biosensors	DBT	5.500
42	R & D in non-invasive optical fibre probe based near-infrared spectroscopy (NIRS) for accessing brain activity	DST	1.800
43	A new approach for memory effect in ferro-electric liquid crystal materials based on charge accumulation phenomenon	DST	3.000

44	Development of new formulation of indelible ink	Election Commission of India	2.690
45	Application of carbon nanotubes in composites-alignment and adhesion problems	DST/NSF	0.000
46	NIR spectroscopy techniques for cellulosic materials	Birla Management Corporation Limited	0.000
47	Growing by MBE method of epitanial structure on the basis of compound A"B" GaAs, Al In GaAs of different composition for various applications	Indo-Russia	0.000
48	Application of some conducting polymers films	Indo-Japan (DST)	0.000
49	To conduct inter-laboratory proficiency testing amongst the NABL accredited calibration laboratories in india	DST (NABL)	36.000
50	Self assembled layers of conducting polymers for molecular devices	DST	0.000
	(B) Total of New Project		**138.664**

Completed Projects

Sr. No.	Title of the Project	Agency / Client	Amount Received
1	Studies on critical current and vortex dynamics in high Tc superconducting bulk samples and tapes	Indo-Japan	0.000
2	Studies on humidity standards	Indo-Japan	0.000
3	Impact of climate change on human health	ME&F	5.156
4	Development of piezo electric accelerometers for general purpose applications	DRDO, Hyderabad	0.000
5	Development of a coal tar pitch with a reduced content of polycyclic aromatic hydrocarbons	ME&F	4.460
6	Studies on spatial-coherence spectral filters and their applications	DST	0.000
7	Monitoring of green house gases at maitri-Antarctica	DOD, Goa	0.000
8	Study of Initial stage of formation of Metal-Semiconductor Interface	DST	0.000
	(C) Total of Completed Projects		**9.616**
	GRAND TOTAL (A)+(B)+(C)		**241.289**

Appendix-6

RECEIPTS THROUGH CONSULTANCY

Consultancy Projects

(Rs. In lakhs)

S.No.	Client	Project Title	Amount
1	NIC, New Delhi	STFS Master Clock Model TS 2100	6.99
2	AEW, Jallandhar	Augumentation of Water Meter test facilities at Jallandhar	3.93
3	GM Motors, Bangalore	Advanced Magnetic Extrusion Alloys	3.78
4	ERDA, Baroda	To Design, Develop & Supply One unit of Piezoelectric Acceleratometer as per Specification	0.29
5	RRSL, Bhubhneswar	Supply and Installation of Load Cell Testing Instruments of Range 50-500 kg in RRSL, Bhubneswar	11.69
6	RRSL, Faridabad	Supply and Installation of Load Cell Testing Instruments of Range 50-500 kg in RRSL, Faridabad	11.69
7	GE BEL, Pvt Ltd, Bangalore	Calibration of Penning Gauge	1.10
8	DMRC, New Delhi	Noise and Vibration Study in Metro Stations	4.73
		Total	**44.20**

Appendix-7

EARNINGS FROM CALIBRATION & TESTING

Physico - Mechnical Standards

Activity	DP No.	No.of Reports (N)	Charges (Rs.)
Dimension	1.02	460 (62)	3487736.04
Mass	1.01	874 (24)	4289311.95
Force	1.05	445 (0)	4348269.20
Pres. & Vacuum	1.06	88 (38)	1839867.00
Temperature	1.03	311 (58)	1569481.80
Optical Radiation	1.04	444 (9)	5475374.70
Accoustic	1.07	206 (19)	2665352.50
Ultrasonic	1.09	32 (4)	340531.00
Humidity	1.10	33 (62)	220066.00
Fluid Flow	1.08	17 (0)	103146.00
Total (A)		**2906 (276)**	**24339136.19**

Electrical & Electronics Standards

Activity	DP No.	No.of Reports (N)	Charges (Rs.)
Power & Energy	2.05	187 (1)	2028971.00
AC & LF (CT/PT)	2.06	28 (4)	825284.00
DC Standards	2.03/04	42 (38)	352554.00
HF & MW Atte.	2.09	15 (0)	244525.00
LF & HF Impedence	2.07	62 (21)	47386.00
HF & MW	2.08	15 (8)	598616.00
Magnetic	2.10	23 (11)	473091.00
Time & Freq.	2.01	34 (4)	214325.00
Quantam Hall	2.02	05 (8)	13500.00
Total (B)		**411 (94)**	**4798252.00**

Testing & Job Work

Activity	DP No.	No.of Reports	Charges (Rs.)
Material	30	--- (0)	13280.00
Chem.Analysis	5.01	72 (0)	1254348.00
IRM	5.05	06 (0)	233759.00
Electron Microscope	5.04	25 0)	605820.00
EPR Analysis	5.02	02 (0)	52876.00
Carbon Technology	3.01	05 (0)	82018.00
Electrical Engg.	45	02 (0)	2160.00
Piezoelectric Accelar.	1.11	20 (0)	117803.80
Thin Film	4.04	01 (0)	14183.00
Total (C)		**131 (0)**	**2376247.80**
TR. Entry Unknown GR Code			1633570.00
Grand Total A+B+C+TR		**3635 (370) =4005**	**33147205.99**
S.T. 10.2%			**3068071.70**

Following is the information regarding revenue earned by Testing and Calibration services for year 2004-2005.

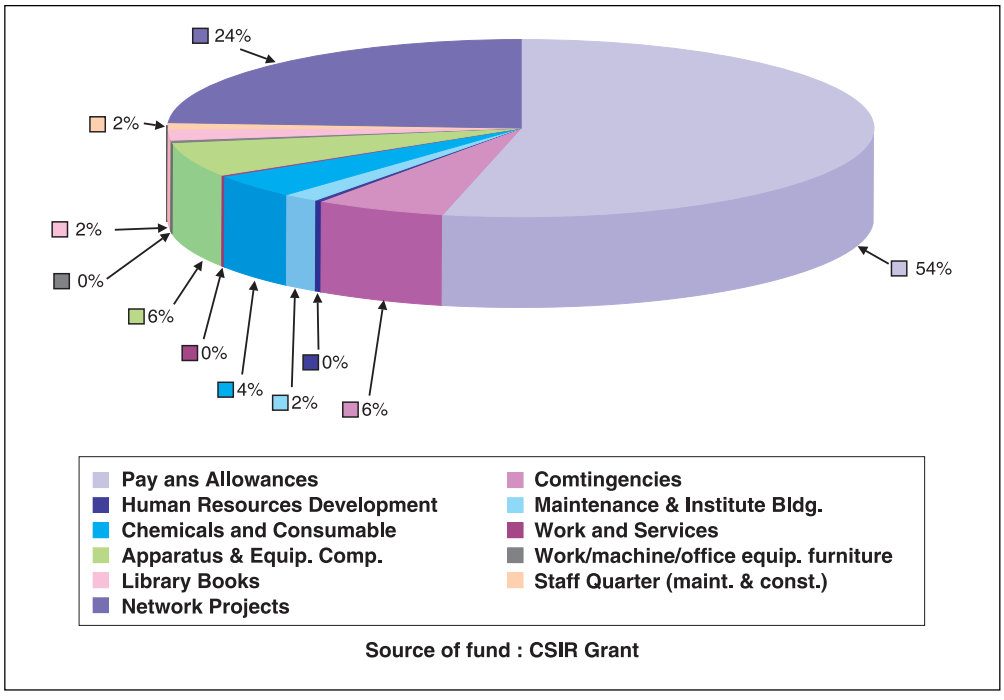
Calibration & Testing charges	30079134.29
Services Tax @ 10.2%	3068071.70
Total ECF	33147205.99

Appendix-8

ACTUAL EXPENDITURE

(Rs. In Lakhs)

Sr. No.	Budget Head	Expenditure
1	Pay and Allowances	2127.839
2	Contingencies	242.000
3	Human Resources Development	13.000
4	Maintenance & Institute Bldg.	61.000
5	Chemicals and Consumables	160.173
6	Work and Services	17.669
7	Apparatus & Equipment Component	257.260
8	Work/machine/office equipment furniture fittings	4.000
9	Library Books	72.800
10	Staff Quarters (maintenance & constuction)	64.000
11	Network Projects	942.488
	Total	**3962.229**



Source of fund : CSIR Grant

HONOURS AND AWARDS

Dr. Vikram Kumar, Director

Chairman: Device development, National Programme on Smart Materials; Working Group on Nanotechnology, Deptt. Of Information Technology; Governing Council, National Accreditation Board for Laboratories; CSIR Steering Committee on Antartic Research (CSIR-SCAR).

President: Metrology Society of India (MSI).

Member: Science and Engineering Research Council (SERC-DST); Nanoscience Technology Initiative (DST); Governing Council/Executive Committee, Bureau of Indian Standards (BIS); Governing Council, Quality Council of India (QCI).

Distinguished Visiting Professor (INAE): Deptt. Of ECE, IISc, Bangalore.

Editorial Board: Bulletin of Material Science; J.IETE; IETE Tech Reviews; Indian J. of Engineering and Material Sciences.

Delivered 8th B.N. Singh Memorial Lecture, Delhi University

R.P. Singhal, Sc'G'

Vice Chairman, APMP Technical Committee for Length (TCL)

APMP Reviewer, for reviewing CMCs under CIPM MRA, Appendix C for National Measurement Institutes (NMI) of APMP and other Regional Metrology Organizations (RMO).

Rina Sharma, Sc 'E-I'

APMP Reviewer, for reviewing CMCs under CIPM MRA, Appendix C for National Measurement Institutes (NMI) of other Regional Metrology Organization (RMO)

Member of APLAC review team.

Dr. H.C. Kandpal, Sc 'F'

Appointed as Chairman of the Committee for Formation of Specifications for Metal -Halide lamps of the Bureau of Indian Standards , New Delhi.

Elected as the Joint Secretary of Optical Society of America (Delhi Chapter)

Nominated as a member of the Editorial Board of the Journals/Magazines Science Encyclopedia-Wealth of India and Indian Scientist and Industrial Research published by NISCAIR, New Delhi

Dr. Ranjana Mehrotra, Sc 'E-II'

Appointed as National Advisory Committee member for the International conference on Spectrophysics.

Appointed as the Editorial Board member for Journal of Pure and Applied Spectrophysics.

Dr. Nita Dilawar, Sc 'C'

Received the Asia-Pacific Metrology Programs Iizuka Award for 2004, for contributions in the field of Metrology.

Mr. A. C. Gupta, Sc 'G'

Appointed as Vice-Chair of Technical Committee on Quality System (TCQS), APMP.

Dr. A.K. Bandyopadhyay, Sc 'F'

Selected as the member of the International Advisory Committee of the 4th CCM International Conference on Pressure Metrology 19-21 April, 2005, London, IOP and NPL (UK).

Dr. Sanjay Yadav, Dr, D. Arun Vijayakumar and DR. A.C. Gupta

Appreciation Certificate : Appreciation Certificate awarded to Sanjay Yadav, D. Arun Vijayakumar and A.C. Gupta in recognition of registration of Copy Right - L19605 for the software entitled, "A Complete Software Package for the Calibration of Pressure Measuring Instruments" NPL, New Delhi, 2004.

Dr.V.Mohanan, Sc 'G'

Elected as President, Acoustical Society of India for the term 2005-2006

Dr. Ashok Kumar, Sc 'F'

Convenor, 5th International Conference on Advances on Metrology

Om Prakash, Sc 'F'

Honoured as a "Guest of Honour" in the Inaugural Function of the conference "National Conference on Precision Manufacturing NCPM-2004", organized jointly by the Mechanical Engg. Department, SHSL-Central Institute of Engineering and Technology, Longowal (Punjab), and National Institute of Technology, Hamirpur (Himachal Pradesh), at Longowal, Sangrur, Punjab (India), during 11-12, December,2004.

Dr S. K. Singhal, Sc. 'F'

Appreciation Certificate awarded for meritorious contribution to the IPR portfolio of NPL

General Secretary, Ultrasonic Society of India

Dr. B. R. Chakraborty , Sc 'E-II'

Appointed as a Member, all India selection committee and chairman of Physical sciences committee, DAAD (German Academic Exchange Service) fellowship award committee, 2005-06.

Dr.A.K. Agrawal, Sc 'F'

Nominated as a member in the International Database for Certified Reference Materials on the Internet (COMAR), BAM Federal Institute for Materials Research and Testing, Berlin, Germany.

Nominated as Principle member of the Glass, glassware and Laboratoryware sectional committee of the Bureau of Indian Standards, New Delhi.

Dr.V.R. Singh, Sc 'G'

Member of IPC (International Programme Committee) and Paper Reviewer in IASTED Int. Conf. on Biomedical Engg (BioMED- 2005), Innsbrug, Austria.

Chairman of Fellowship & Awards Comm., IEEE-Delhi.

Invited for Faculty Selection in Tel-Aviv University, Israel.

Served as a Member of Programme Committee of Second Int. Conf. on Computing : Communication and Control Technologies (CCCT-04), Austin, Texas (USA), August 14-17, 2004.

Dr. D. Haranath, Sc. B,

Received CSIR Young Scientist Award 2004.

Dr. Divi Haranath conferred with the CSIR young Scientist Award for the year 2004 by Shri Kapil Sibal, VP, CSIR & Hon'ble Minister of State, S & T and Ocean Development & Dr. R.A. Mashelkar, DG, CSIR & Secretary DSIR

Received Young Scientist of The Year 2003-2004 Award of NPL.

Dr. Haranath has done very good research work on silica aerogels. His work on hydrophobic aerogels has potential for applications. His ressearch and developmental work on long afterglow phosphors is of significant industrial importance.

Dr.S.M. Shivaprasad

Received Outstanding Scientist of the year award of NPL.

Dr. S.L.Jain, Sc. F

Member of Project Management Board (PAB) for 84 cm LIDAR system at ARIES Aryabhatta Research Institute of Observational Sciences, Manora Peak, Nainital, Uttaranchal , India.

Member of SPIE -The International Society for Optical Engineering.

Member of Special Committee of School of Environmental Sciences, Jawahar Lal Nehru University, New Delhi

Member Programme committee SPIE-The International Society for Optical Engineering International Asia-Pacific Symposium for (AE102) Lidar Remote Sensing For Industry And Environmental Monitoring V held during 8-12 November 2004 at Waikiki Beach Marriott Resort Honolulu, Hawaii USA And chaired two sessions in the above Symposium

Member of the Research Board of Advisors, American Biographical institute Inc, USA

Dr. H.N. Dutta, Sc. F

Co-Convener CSIR - Steering Committee on Antarctic Research.

Life member of Academy of Environmental Biology, Lucknow.

Honoured by the Staff and Students of Department of Environmental Science, CCS Univ., Meerut ;UP Association for Science & Technology Advancement & CDRI; Department of Environmental Science, HN Bahuguna University, Garhwal, Srinagar; Principal & Staff of Dronacharya College, Gurgaon; IIT Roorkee for contributions to Antarctic Science

Dr. M.K.Goel, Sc. F

Nominated as Associate Program Co-ordinator for the URSI General Assembly to be held in New Delhi in October, 2005.

Outstanding R & D Team Award for year 2003-2004 has been conferred to "Four groups of Electrical & Electronic Standards namely JVS & DC Standards; LF & HF voltage, Current & RF Power Standards; LF Impedance Standards and AC high Current & High Voltage Standards" for successfully completing the International Peer Review of 387 CMCs, highest in Asia-Pacific Region, thus calibration certificates issued by NPL are globally acceptable.

Appendix-10

VISITS ABROAD

S.N.	Name & Designation	Country Visited	Duration	Purpose
1.	Dr. K. Lal Dir. Gr. Sci.	France	02.04.04 to 04.04.2004	To participate in the meeting of CODATA Task Group.
2.	Dr. Mahavir Singh Sci. C	Japan	04.04.2004 to 06.04.2004	To attend the18th Int. Congress on Acoustics (ICAS2004) & visit to Akita University.
3.	Dr. Vikram Kumar Director	Malaysia	12.04.2004	To attend 8th DEC meeting
4.	Dr. K. Lal Dir. Gr. Sci.	Poland	16.04.2004 to 19.04.2004	To attend the annual executive board meeting of CODATA
5.	Dr. K. Lal Dir. Gr. Sci	Switzerland	12.05.2004 to 13.05.2004	To attend the MAX Plank Society meeting
6.	Dr. Neeraj Khare Sci. E-I	Malaysia & Singapore	10.05.2004 to 15.05.2004 & 16.05.2004 to 17.05.2004	To attend the Workshop, Chracterization & Spl. purpose
7.	Dr. Vikram Kumar Director	Belgium	13.05.2004 to 15.05.2004	To attend Annual Board Meeting & meeting of Coordinating Committee
8.	Dr. Shiv Kumar Jaiswal Sci.B	Singapore	07.06.2004 to 08.06.2004	To participate in the advanced Precision Measurement Equipment Training
9.	Dr. S.L. Jain, Sci.F	Greece	01.06.2004 to 08.06.2004	Presented four papers at XX Quadrennial Ozone Symp.
10.	Dr. K. Lal Dir. Gr. Sci.	Russia	04.07.2004 to 19.07.2004	Visits under ILTP Programme
11.	Dr. S.C. Garg Sci.G	U.K. & France	11.07.2004 to 16.07.2004 & 18.07.2004 to 25.07.2004	ISAR-2004 Conf, CLP-001732
12.	Dr. S.L. Jain Sci.F	Italy	12.07.2004 to 16.07.2004	XX International laser Radar Conference

S.N.	Name & Designation	Country Visited	Duration	Purpose
13.	Dr. R.S. Dabas Sci.F	France	18.07.2004 to 24.07.2004	Int.Space Environment Science Meeting
14.	Dr. Neeraj Khare Sci.EI	U.K.	16.08.2004 to 25.10.2004	On Sabbatical Leave as EPSRE fellowships
15.	Dr. Krishan Lal Dir. Gr. Sci.	Indonesia	19.07.2004 to 21.07.2004	CODATA meeting and workshop on shairing data resources for Research,Science & Technology
16.	Dr. B.S. Gera Sci.F	U.K.	13.07.2004 to 27.07.2004	To attend International Conference ISARS-2004
17.	Dr. Ram Kishore Sci.EII	Japan	13.09.2004 0I.12.2004	For R&D work at Kyshu University, Japan on EOL
18.	Dr. P. Banerjee Sci.G	China	24.08.2004 to 27.08.2004	To attend Asia Pacific Radio Science Conf. (APSRAS 2005), Quingdan
19.	Dr. Harish Bahadur Sci.EII	USA & Canada	19.08.2004 to 22.08.2004 & 23.08.2004 to 27.08.2004	To attend the 2004 IEEE Int.Ultrasonic Ferroelectric & Freq.Control 50 Anniversary Conf. at Canada & to visit Michigan Technological Univ.USA
20.	Dr. P. Banerjee Sci.G	Nepal	05.09.2004 to 10.09.2004	To install time service via telephone
21.	Mr. A.K. Suri T.O.C	Nepal	01.09.2004 to 10.09.2004	To install time service via telephone
22.	Dr. Tuhin Mandal Sci.EI	Newzealand	04.09.2004 to 09.09.2004	To attend 8 IGAC Int.Conf.
23.	Dr. Nita Dilawar Sci.C	Switzerland	01.09.2004 to 04.09.2004	To attend 42nd European High Pressure Research Group meeting
24.	Dr. V.R. Singh Sci.G	USA	01.09.2004 to 10.09.2004	To attend the 26th Annual Int. IEEE-EMBS Conference
25.	Dr. Pradeep Mohan, Sci. F	South Korea & Singapore	14.09.2004 to 19.09.2004	To attend the APMP Workshop
26.	Dr. Vikram Kumar, Director	France	30.09.2004 to 01.10.2004	To attend the meeting of Directors of NMIs Member of states of the metre convention
27.	Dr. A. Sen Gupta Sci. F	Germany	14.10.2004 to 13.03.2005	To work on the Cessium Foundation Frequency Std. & Galileo Ground Segment timing aspects on Leave due admissible

S.N.	Name & Designation	Country Visited	Duration	Purpose
28.	Dr (Mrs) Rashmi Sci. E-II	Japan	03.10.2004 to 09.10.2004	To attend the fourth south-west asia and middle east scholars alumni meeting
29.	Dr. (Mrs) Rina Sharma Sci.E-I	Japan	13.10.2004 to 19.10.2004	To attend the for 21st century - material development for environment, energy and information
30.	Dr V T Chitnis Scientist G	Japan	13.10.2004 to 19.10.2004	To attend the for 21st century - material development for environment, energy and information
31.	Dr. Krishan Lal Dir. Gr. Sci.	Belarus	12.10.2004 to 19.10.2004	Indo Belarus Progg.of Cooperation in S & T
32.	Dr.H.C. Kandpal Sci.F	China	18.10.2004 to 19.10.2004	To attend 20th APMP General Assembly and related activities
33.	Dr.A. K. Bandhyopadhyay Sci.F	Netherland & China	14.10.2004 to 15.10.2004 18.10.2004 to 19.10.2004	To visit NIMT
34.	Dr. Arun Kumar Agarwal Sci.F	China	17.10.2004 to 19.10.2004	To visit NIMT
35.	Dr. A.C. Gupta Sci.G	China	18.10.2004 to 19.10.2004	To visit NIMT
36.	Dr P.C. Kothari Sci.G	China	18.10.2004 to 19.10.2004	To visit APMP General Assembly activities
37.	Dr. P. Banerjee Scientist G	China	18.10.2004 to 19.10.2004	To visit APMP General Assembly activities
38.	Dr R.P. Singhal Sci.G	China	18.10.2004 to 22.10.2004	To visit APMP General Assembly activities
39.	Dr. Vikram Kumar Director	China	20.10.2004 to 22.10.2004	To visit APMP General Assembly activities
40.	Mr A.K. Suri T O C	Nepal	13.10.2004 to 14.10.2004	To participate on use of teleclock service (digital time data in telephone)
41.	Dr S.C. Jain Sci.G	USA	25.10.2004 to 02.11.2004	For NPL-US Project on surface order and structural studies of polymer
42.	Dr. Lakha Singh Sci.F	Italy	18.10.2004 to 22.10.2004	To present a paper in the Beacon Satelite Symp.2004(BSS 2004)

S.N.	Name & Designation	Country Visited	Duration	Purpose
43.	Mrs N. Goswami Sci.EI	Russia	25.10.2004 to 24.12.2004	Under ILTP Program
44.	Dr. Vikram Kumar Director	USA	01.11.2004 to 31.12.2004	As visting Research Scholar at Rensselear Polytechnic Institute, to collaborate in the area of semi conductor engineering
45.	Dr. R.S. Dabas Sci.F	Italy	06.11.2004 to 15.11.2004	To attend the school of Radion science for South Asian Scientists, co-sponsored by URSI
46.	Dr. P. Banerjee Sci G	Italy	06.11.2004 to 09.11.2004	To deliver a lecture on Radio Science for South Asian Sci.at Abu Salam Int.Centre for the(ICTP)Trieste
47.	Dr S.L. Jain Sci.F	USA	08.11.2004 to 12.11.2004	To attend 9th Asia Pacific Environmental Sensing Symp.04 on remote sensing of the atmosphere ocean environment and space
48.	Dr. Neeraj Khare Sci.EI	UK	08.11.2004 to 07.09.2005	As visiting scientist EPSRC fellowship, Deptt.of Materials science and Metallurgy, Univ.of Cambridge, U.K. on sabbatical leave
49.	Dr. K. Lal Dir.Gr. Sci.	France	18.11.2004 to 19.11.2004	To attend IAP workshop on the Access to scientific information and meeting for discussion in UNESCO
50.	Dr. R. P. Singhal Scientist G	UK	28.11.2004 to 04.12.2004	To discuss the concept design of the building and related issues.
51.	Dr. (Mrs) Rina Sharma, Sc. E-I	USA	23.01.2005 to 28.01.2005	As a member of to evaluate the quality system policies & practices of IAS.
52.	Dr. A.K. Bandyopadhyay, Sc.F	USA	15.02.2004 to 14.08.2005	On sabbatical leave to visit NIST to work on a project
54.	Dr. Ram Kishore, Sci.F	USA	26.03.2005 to 29.05.2005	Under DST-NSF project on " Metal Induced Crystallization Behaviour on Thin Films of Amorphous Silicon

Appendix-11

Ph.D awards based on the research work done at NPL

	Title	Awardee	University/ institute	Guide(s)
1.	Pressure Induced Phase Transitions of some advanced materials	Vipul Srivastava	Barkatulla University	Dr A K Bandyopadhyay (NPL) Dr. SP Sanyal (Barkatulla Univ.)
2.	Ultrasonic Studies in Cancer Hyperthermia	Kirti Gandhi Bhatia	CCS University, Meerut	Singh, V R (NPL) and Bansal, M C (CCS Univ.)
3.	Ultrasonic Study of Hospital Engineering Materials	Jyoti Lachab	CCS University, Meerut	Singh, V R (NPL) and Bansal, M C (CCS Univ.)
4.	Microscopic and Acoustic Studies of Dental Materials	Sandeep Kumar	CCS University, Meerut	Singh, V R (NPL) and Bansal, Vakul (CCS Univ.)
5.	Preparation and characterisation of Bi-based high-Tc superconducting films and bolometers	A. T. Nimal	University of Delhi	Dr A K Gupta (NPL) Prof G L Bhalla (DU)
6.	Studies on polymeric sol-gel electrolytes	M. Deepa	University of Delhi	Dr. S.A. Agnihotry(NPL) Prof Omesh Chandra (DU)
7.	Heteroepitaxial growth of Antimony on reconstructed Silicon Surfaces: Si(111)-(7x7), Si(001)-DD(2x1), Si(001)-c(4x4)	V.K. Paliwal	University of Delhi	Dr. S.M. Shivaprasad (NPL) Dr A G Videshwar (DU)
8.	Synthesis, Characterization and Properties of Modified Lead Zirconate Titanate Ceramics	V.K. Hans	CCS University, Meerut	Dr. S.M. Shivaprasad (NPL) Prof R P Tandon (DU)

Appendix-12

HUMAN RESOURCE DEVELOPMENT ACTIVITIES

1. Participation of NPL Personnel in Various Events

Financial support towards registration and travel cost is provided to scientists / technical staff for attending and presentation of papers at national / international seminars / symposia / conferences / workshop organized elsewhere in India in areas relevent to research activities being carried out at the institute. This is primarily to enable them to put forward views on their research results and interact with the leading national / international experts on the current development in their research areas.

194 personnel were deputed to participate and present technical papers in various seminars / symposia / conferences / workshops.

2. Training Programme Organised at NPL

The objective of these training programmes is to impart training through class room lectures, demonstration and hands on training in the lab to participants from industrial houses as per training calendar. The internal candidates are nominated by their divisional heads.

Ten (10) training courses related to Standards, Calibration, Uncertainty in Measurements, Radiometrology, Material Characterization Techniques etc. were conducted. 175 persons participated.

3. Programme Attended

Several scientists were nominated to attend training programme organized by HRDC,Ghaziabad and other institutes.

4. Students Training

NPL provided training, short term (six weeks plus) and long term (three months plus), to students of various disciplines from Colleges / Universities / Engineering Colleges from all over India mainly during Summer and Winter Semesters. They got acquainted with emerging research areas / techniques.

184 students pursuing postgraduation/ engineering/MCA etc. from various educational institutions undertook training/carried out project work under the guidance of several senior scientists working in different areas towards the fulfillment of their academic course work.

5. Research Fellow

Research followship (JRF /SRF) as per the CSIR-UGC and any other departmental norms are provided for a period of five years (max.) Several new research fellows were inducted. R & D facilities at NPL thus were made available to Young Researchers to help them carry out research in emerging areas leading to Ph.D awards and fulfilling the need of developing highly skilled human resource required for the industry as well as academic institutes.

6. Functions Organised

Schrodinger Lecture delivered by Prof. A.G.MacDiarmid, Nobel Laureate, USA on 10th December, 2004.

K.S.Krishnan Memorial Lecture delivered by Prof. H.Shirakawa,Nobel Laureate,Japan on 7th February, 2005.

Invited Lecture delivered by Prof. Alan J. Heeger, Noble Laureate on 1st March, 2005

7. Visits to NPL

567 visitors comprising of students from various colleges, training institutes, polytechnics & engineering institutes, P.G.T. Teachers through Kendriya Vidyalaya Sangathan, trainee officers from Indian Institute of Legal Metrology, Young student researchers from different institutions etc. visited selected R & D activities at NPL.

CONFERENCES, SYMPOSIA, WORKSHOPS AND EVENTS ORGANISED BY NPL

Total 182 numbers of events were organized by Seminar Complex. Some Important Seminars-workshops are as follows:

April 1 - 3, 2004

XXVII Annual Meeting of EMSI and Conference of Electron Microscopy and allied fields (EMSI-2004)

April 27, 2004

The DST expert committee meeting for sensors

May 11, 2004

Technology day celebration

August 02 - 27, 2004

Four weeks training in Mass and Volume metrology to two participants from SASO. Map -Taul Saptah, December 28, 2004, Weigh India, New Delhi-110092

September 1, 3, 8, 14, 2004

Hindi Pakhwara

September 13, 2004

Bhatnagar award function and CSIR foundation day celebration

October 08 - 09, 2004

Equipment Inter-comparison Meeting Nov.27-30, 2004 under ISRO-GBP Composition of acid Deposition Workshop,

October 08 - 09, 2004

Two days Workshop on Composition of Acid Deposition, NPL, New Delhi.

October 15 - 16, 2004

Training Programme in Dimension Metrology for staff of M/s Mitutoyo South Asia India Ltd.

November 25 - 29, 2004

International workshop on Carbon Materials for energy application

December 10, 2004

Schrodinger Lecture delivered by Prof. A.G. MacDiarmid, Nobel Laureate, USA

January 06 - 07, 2005

Organized seminar on Inter Laboratory Programme on Indian reference materials and HGML-NGRI-NPL Collaborative Project on Gold Geo-chemical Reference Materials at National Geophysical Research Institute, Hyderabad. 50 scientists from various organizations and representatives of different CSIR and Non-CSIR organizations participated in BND programme, namely NGRI, Hyderabad; NPL-New Delhi; CFTRI-Mysore, NML-Jamshedpur; NIO-Goa; CBRI-Roorkee; IIP-Dehra Dun; NBRI-Lucknow; IICT-Hyderabad; NEERI-Nagpur; HGML-Hutti, Bangalore; NCCCM, Hyderabad; DMRL-Hyderabad; CIMET-Hyderabad; Nagaland University-Kohima; Department of Mines and Geology- Hyderabad had participated in this seminar. Status of the IRM programme, collaborative project on Gold Geo-chemical Reference Materials and future programme of this project had been discussed in the seminar.

January 19 - 21, 2005

National Conference of Optical Society of India. XXX Optical Society of India Symposium on Optics and Optoelectronics

January 31 - February 4, 2005

Training course on calibration of RTDs & Thermocouples

February 7, 2005

K S Krishnan Memorial Lecture delivered by Prof. H. Shirakawa, Nobel Laureate, Japan

February 8 - 9, 2005

Photovoltaics Experts Meeting was organised at NPL to help MNES identify the Thrust Areas of Research in Solar Photovoltaics.

February 22, 2005

Organized a Workshop on Chemical Metrology in collaboration with Metrology Society of India at NPL, New Delhi. 50 scientists and technical persons had attended this workshop from the 16 organizations of the country. Topics on BIPM MRA, Chemical Metrology, Traceability, Certified Reference Materials and Uncertainty in Measurements had been covered in the workshop.

February 22, 2005

Workshop on Fluid Flow Measurement, National Physical Laboratory, New Delhi.

February 23 - 25, 2005

5th International Conference on Advances in Metrology (AdMet-2005)

February 26 - 27, 2005

Workshop-training programme on Mass and Dimensional Technology

March 1, 2005

Invited Lecture delivered by Prof. Alan. J. Heeger, Nobel Laureate-2000

March 2 - 4, 2005

Training course in Calibration/ Verification/Testing of Hardness Testing, Impact Testing and Universal Testing Machines, jointly, organized by NPL and NABL, New Delhi.

LECTURES BY EMINENT SCIENTISTS

Sr No	Name and Address	Date	Topic
1.	Dr. Ashok Kumar of NPL, New Delhi.	16.04.2004	Desktop Nuclear Fusion the Ultrasonic Approach
2.	Prof. Ajit Rohatgi of Georgia Institute of Technoloy USA.	15.06.2004	Opportunities & challenges in making Si-physic voltaics: A cost effective energy option
3.	Dr. A. Basu of NPL, New Delhi.	02.07.2004	Ellipsometry: A versatile technology for determination of optical constants and thickness of thin-films and much more.
4.	Prof. A.M. Rao of Clemson University USA	08.07.2004	Carbon Nanotubes: Synthesis, Characterization and Applications.
5.	Prof. P.V. Ashrit of Moncton University Canada	21.07.2004	Structural Dependence of Electrochromic Behaviour in WO_3.
6.	Dr. Praveen Chaddah of CAT Indore	04.08.2004	Studies on Supercooled Metastable States in Vortex Matter and in Ordered Magnetic Systems.
7.	Prof.T.P. Singh of Deptt. Bio-physics AIIMS, New Delhi.	26.09.2004	Drug Development: Rational Structure-based approach and Indian Challenge.
8.	Dr. Nick Brown of National Metallurgy Lab., Australia	11.10.2004	Laser Interferometry
9.	Prof. Ursula Bilitweski of Dept. of Natural Product Biology, GBF, Braunschweig, Germany	13.10.2004	Protein Sensing Devices
10.	Prof. K.L.Chopra, President, Society for Scientific Values, New Delhi.	27.10.2004	Ethical Concern
11.	Prof. Peter Samuely of Institute of Experimental Physics, Slovak Academy of Sciences, Slovakia	02.12.2004	Mi;tonamd / multigap super conducting in MgB_2 and related materials
12.	Prof. Karol Flachbart of Institute of Experimental Physics, Slovak Academy of Sciences, Slovakia	02.12.2004	Intricate magnetic properties of some rare earth dodecaborides.
13.	Prof. Keiichi Kaneto Kyushu Institute of Technology. Kitakyushu, Japan	09.12.2004	Recent Progreses in Artificial Muscles Based on Conducting Polymers

Sr No	Name and Address	Date	Topic
14.	Prof. M. Onoda, University of Hyogo, Japan	09.12.2004	Fabrication of Nano-structure Thin Films based on Conjugated Polymers and their Device applications
15.	Prof. M. Iwamoto, Tokyo, Institute of Technology, Tokyo, Japan.	09.12.2004	Detection of Surface Polarization in Organic Films by MDC-SHG Measurements of Control of Current-Voltage Characteristics
16.	Prof. Alan Mac Diarmid of University of Texas Dallas (UTD)	10.12.2004	Electronic Polymer & Nanoscience.
17.	Dr. Tamio Endo of Mie University, Mie, Japan	16.12.2004	Microwave Absorption and Dynamics in a-Oriented Superconducting YBCO Thin Film.
18.	Dr. Kazuhiro Endo of Mie University, Mie, Japan	16.12.2004	Reentrant Phase and Vortex Dynamics
19.	Dr. M. Tokomoto, Molecular Nanophysics, AIST, Tsukuba, Japan	24.12.2004	Observation of Three-dimensional Fermi Surfaces in a Single-component Molecular Metal
20.	Prof. Joseph Shinar, Physicist of Ames Laboratory and Professor, Deptt. Of Physics and Astronomy	29.12.2004	Pi conjugated organic system
21.	Prof. J.N Dahiya, Chauge	04.01.2005	Lecture
22.	Prof. S. Kurinec of RIT, USA	05.01.2005	Lecture
23.	Prof. Pradeep K. Rohatgi of University of Wisconsin, Milwaukee, USA	14.01.2005	Advances in Nano Composites
24.	Prof. G. Donaldson of University of Strathclyde Glasgow, Scotland, UK	14.01.2005	Superconducting Quantum Interference Devices and its Applications.
25.	Prof. Vikram Dalal of IOWA University Ames, USA.	14.01.2005	Nanocrystalline Silicon: Material properties, structure and a photovoltaic devices.
26.	Prof. H. Sirakawa Noble Laureate & Professor Emeritus, University of Tsukuba, Japan	07.02.2005	Discovery of Conducting Polymer-Polyacetylene Fortuity and inevitability.
27.	Prof. H.M.Hiese of ISAS-Institute for Analytical Sciences, University of Dortmund, Germany.	15.02.2005	Novel Instrumental tools for medical diagnostics using near and mid-infrared spectroscopy.
28.	Prof. R.M.Mehra of Delhi University, Delhi.	15.02.2005	EMI Compatibility
29.	Dr. Arunav Kundu of Michigan State University, USA.	25-28.02.2005	Probing towards formation of galaxies.

Sr No	Name and Address	Date	Topic
30.	Prof Alan J Heiger, Noble Laureate University of California, Santa Barbara USA.	01.03.2005	Plastic Electronics and Optoelectronics
31.	Dr. Bernd Schumacher of PTB-Braunschweig, Germany.	07.03.2005	Quantum Hall Effects and its Application as Resistance Standard.

INVITED TALKS, LECTURES BY NPL SCIENTISTS

S.No.	Speaker's Name	Topic	Event and Venue
1.	T Lal	Uncertainty Evaluation in Mass Measurements	Training Course on Uncertainty Evaluation organized by NPL 30th April, & 1st May, 2004 at NPL
2.	T Lal	Techniques for Mass Calibration	Specialized Training Program on Calibration at RTC Okhla, New Delhi
3.	T Lal	Uncertainty Evaluation in Calibration of Weights and Balances	Specialized Training Program on Calibration at RTC Okhla New Delhi.
4.	T Lal	General Guidelines for Calibration of Weights Maap Taul Saptah	Weigh India in Collaboration with NPL during 28 Dec., 2004 to 3 Jan., 2005
5.	R P Singhal	Recent Developments at NPL: Development of Technique for Measurement of Taper Bore of Large Flywheel at BHEL	TCL Workshop, 20th APMP General Assembly, 18-22 October, 2004, Beijing, China, Organized by Asia Pacific Metrology Programme (APMP) and NIM.
6.	Rina Sharma	Evaluation of Uncertainty	Dimensional Measurements and an example of Gauge Block calibration Dec 2004, IIQM Jaipur
7.	R P Singhal	Dimensional Metrology,	National Pressure and Temperature Measurements for Process Industry as per Norms 29-30 April,2004 FCRI, Palghat
8.	R P Singhal and Rina Sharma	Application of ISO Guidelines on Uncertainty in Measurements to Calibration of Ring Gauges.	Training Course on Uncertainty in Measurements. April 30-May - 1, 2004 at NPL, New Delhi.
9.	R P Singhal	Physico Mechanical Standards at NPL.	Training Course on Uncertainty in Measurements. April 30-May 1, 2004 at NPL, New Delhi
10.	R P Singhal and Rina Sharma	Application of ISO Guidelines on Uncertainty in Measurements to Calibration of Ring Gauges.	Training Course on ISO-IEC 17025, Basic Metrology and Uncertainty in Measurements. Aug 31-Sept., 03, 2004 NPL, New Delhi.

S.No.	Speaker's Name	Topic	Event and Venue
11.	R P Singhal and Rina Sharma	Traceability of Measurements.	Training Course on ISO-IEC 17025, Basic Metrology and Uncertainty in Measurements. Aug 31-Sept. 3, 2004, NPL, New Delhi.
12.	Rina Sharma and R P Singhal	Preparing for Laboratory Accreditation.	Training Course on ISO-IEC 17025, Basic Metrology and Uncertainty in Measurements. Aug 31-Sept 03, 2004, NPL, New Delhi
13.	Rina Sharma and R P Singhal	Human Aspects of Auditee,	Training Course on ISO-IEC 17025, Basic Metrology and Uncertainty in Measurements. Aug 31-Sept 03, 2004, NPL, New Delhi
14.	K P Chaudhary	Measurements with CMM & Evaluation of Uncertainty in Measurements -A Case Study.	Training Course on ISO-IEC 17025, Basic Metrology and Uncertainty in Measurements. Aug 31-Sept 03, 2004, NPL, New Delhi
15.	Rina Sharma	An Introduction to Evaluation and Expression of Uncertainty in Measurements.	Training Course on Mass and Dimensional Metrology. NPL & MSI, February 26-27, 2005, NPL, New Delhi
16.	Rina Sharma & R P Singhal	Calibration of Artifacts of Dimensional Metrology by Comparison: Evaluation of Uncertainty.	Training Course on Mass and Dimensional Metrology. NPL & MSI, February 26-27, 2005, NPL, New Delhi
17.	R P Singhal, Rina Sharma & K P Chaudhary	Surface Texture: Terms, Definitions and Evaluation.	Training Course on Mass and Dimensional Metrology. NPL & MSI, February 26-27, 2005, NPL, New Delhi
18.	K P Chaudhary	Calibration of Length Measuring Machine using Laser Interferometer and Evaluation of Uncertainty in Measurements.	Training Course on Mass and Dimensional Metrology. NPL & MSI, February 26-27, 2005, NPL, New Delhi
19.	K P Chaudhary	Calibration and Uncertainty Evaluation of Dimensional Parameters.	Training Course on Dimensional Metrology. Hema Engineering Industries Ltd, Gurgaon , April 12-13, 2004.
20.	K P Chaudhary	Basic Metrology.	Training Program on Dimensional Metrology. Mitutoyo south Asia India Ltd, New Delhi during, October 15-16, 2004.
21.	K P Chaudhary	ISO 17025 Accreditation Process.	Training Program on Dimensional Metrology. Mitutoyo south Asia India Ltd, New Delhi during, October 15-16, 2004.

S.No.	Speaker's Name	Topic	Event and Venue
22.	R P Singhal	Traceability in Measurements.	Training Program on Dimensional Metrology. Mitutoyo south Asia India Ltd, New Delhi during, October 15-16, 2004.
23.	K P Chaudhary	Laser applications in Bio-Medical Instrumentation.	Training Program on Repair maintenance and calibration of Bio Medical instruments for Hospital Doctors. CSIO Delhi centre Organized by DST & CSIO, June 26, 2004.
24.	K P Chaudhary	Optical Methods for Dimensional Calibration-their Importance and Accuracy.	Specialized Training on Calibration RTC, Okhla Delhi during, September 20-22, 2004.
25.	H C Kandpal	Experimental Verification of Doppler-like Wavelength Shift due to Dynamic Multiple Scattering of Light by Plasma Medium.	Indian Statistical Institute. Kolkata April 1, 2004
26.	H C Kandpal	National Conference on Perspective in Optics and Spectroscopy	CCS ,University, Meerut, April 6-8, 2005
27.	H C Kandpal	National Seminar on light measurements	Society for Lighting Engineers Held at Central Institute for Road Transport, Pune May 9-10, 2004
28.	H C Kandpal	Expression and Estimation of Measurement Uncertainty in photometric measurements. Photometry Measurements and calibrations in NPLI and the CMCs. Expression and Evaluation of Uncertainty in the Measurement of Photometric units	20th APMP conference on Photometry and Radiometry. Beijing China Oct 18-20, 2004
29.	H C Kandpal	Doppler-like Wavelength shift due to Dynamic Multiple Scattering of Light-- a Possible Explanation to Redshift Riddle.	Seminar on recent advances in optics and photonics. IIT Delhi December 20-21, 2004
30.	R K Garg	User Awareness Programme on Materials Characterization	FTIR Spectrometer and its advantages over the conventional spectrometers,

S.No.	Speaker's Name	Topic	Event and Venue
		Techniques	National Physical Laboratory during Jan. 10-14, 2005
31.	R Mehrotra	Applications of NIR spectroscopy	CSIO Complex, New Delhi
32.	R Mehrotra	Infrared Spectroscopy	CSIO Complex, New Delhi
33.	R Mehrotra	Near Infrared Spectroscopy in Sugar Process Monitoring,	International conference on Spectrophysics.
34.	Ashok Kumar	Desktop Nuclear Fusion - The ultrasonic approach	National Physical Laboratory, Delhi, April 16, (2004)
35.	Ashok Kumar	Nuclear Fusion Based on Ultrasonics.	13th National Symposium on Ultrasonics. Jhansi, Dec. 21-23 (2004)
36.	Yudhisther Kumar	NDT of Materials by Ultrasonic Methods.	13th National Symposium on Ultrasonics. Jhansi, Dec. 21-23 (2004)
37.	J K Gupta	Calibration & Evaluation of Uncertainty in Measurement in Digital Thermometer using PRT	NPL from workshop on "Uncertainty in Measurement- Case Studies"April 30, 2004 to May 1, 2004 for assessors and accreditation officers of NABL at NPL, New Delhi.
38.	J K Gupta	Evaluation of Uncertainty in Temperature Measurement- A Case Study	Training Course on ISO-IEC 17025, Basic Metrology & uncertainty in Measurement held at NPL, New Delhi from August 31-September 3, 2004.
39.	J K Gupta	Calibration of Platinum Resistance Thermometers	Training Programme on " Calibration of liquid- in- glass thermometers and thermocouples" organized by NPL at NPL, New Delhi, on Aug.04, 2004
40.	J.K Dhawan	Calibration of UTM -Precaution, Recording the Data and Analysis	Training course in Force & Hardness Metrology, March 2-4, 2005, New Delhi.
41.	Anil Kumar	Calibration/Verification of Impact Testing Machines, Precautions, Recording the Data and Analysis	Training course in Force & Hardness Metrology, March 2-4, 2005, New Delhi.
42.	S S K Titus	Calibration /Verification of Hardness Testing Machines, precautions, recording the data and analysis	Training course in Force & Hardness Metrology, March 2-4, 2005, New Delhi.
43.	P Banerjee	Time and GPS Time	Integrated Test Range, DRDO,

S.No.	Speaker's Name	Topic	Event and Venue
			Chandipur, Balasore on 18th & 19th Jan. 2004
44.	P Banerjee	Time and Time Transfer	Academy of Technology, Bandel on 21st January, 2005
45.	P Banerjee	Concept Time and Time Transfer Series of 4 lectures	ICTP Trieste during Nov. 2004
46.	G M Saxena	Atomic Clocks based on Coherent population Trapping (CPT)	Lecture under the NPL Seminar Series on 8th April 04.
47.	Ashish Agarwal	Atomic Clock - Recent Developments.	Invited Talk in National Seminar on Perspectives in Engineering Optics;Indraprastha Engineering College, Ghaziabad; 27th April, 2005
48.	A Sen Gupta	GPS Signal Structure and Characteristics	SERC School, NERTU, Hyderabad, Aug 9, 2004
49.	A Sen Gupta	Basics of GPS Signal Reception including Correlation Techniques	SERC School, NERTU, Hyderabad, Aug 9, 2004
50.	A Sen Gupta	Time Transfer and Dissemination using GPS - SERC School	NERTU, Hyderabad, Aug 9, 2004
51.	N D Kataria	Dielectric Resonator: Frequency - Temperature Compensation	National Seminar on Electromagnetic Waves & Applications JNU, 21st Feb, 2005
52.	N D Kataria	Microwave Resonators	Guru Prem Sukh Memorial College of Engineering, (GGSIP University)Feb 16, 2005
53.	N D Kataria	Quantum Hall Resistance Measurement using Direct Current Comparator and Cryogenic Current Comparator	Thirteenth National Symposium on Cryogenics-Surat, Feb 26, 2005
54.	N D Kataria	Dielectric Resonator and its Applications as Stable Frequency Reference	National Conference on Ferroelectrics & Dielectrics, Nov. 2004, Delhi University
55.	V N Ojha, Rina Sharma and R P Singhal	Generic development of nano-metrology for nano-technology	Two days workshop on Applications of nano-technology in manufacturing sector, by Department of Industrial Policy and Promotion under the ministry of Commerce and industry, held at "Central Manufacturing Technology Institute (CMTI)", Bangalore, 2nd & 3rd April 2004 at NPL.

S.No.	Speaker's Name	Topic	Event and Venue
56.	V N Ojha	Uncertainty in Measurement: Calibration, Traceability and Related Metrological Terms	Workshop on Preparation for Final Audit, held at Gas Authority of India (GAIL) Training Centre, Noida (23rd - 25th July 2004).
57.	V N Ojha	Uncertainty in Measurement : Its Evaluation and Expression as per the Requirement of ISO/IEC : 17025	Training course on Uncertainty in measurement: Case studies, April 30 - May 1, 2004, held at National Physical Laboratory, New Delhi.
58.	V N Ojha	Uncertainty in Measurement : Calibration, Traceability and Related Metrological Terms	Training on Uncertainty in measurement: held at National Physical Laboratory, Case studies, April 30 - May 1, 2004, New Delhi.
59.	V N Ojha	Uncertainty in DC Measurements: A Case study	Training course on Uncertainty in measurement: Case studies, April 30 - May 1, 2004, held at National Physical Laboratory, New Delhi.
60.	V N Ojha	Uncertainty in Measurement : Its Evaluation and Expression as per the Requirement of ISO/IEC : 17025 Part -I	Training course on ISO-IEC 17025 and Uncertainty in measurement, August 31 - September 3, 2004, held at National Physical Laboratory, New Delhi.
61.	V N Ojha	Uncertainty in Measurement : Its Evaluation and Expression as per the Requirement of ISO/IEC : 17025 Part -I	Training course on ISO-IEC 17025 and Uncertainty in measurement, August 31 - September 3, 2004, held at National Physical Laboratory, New Delhi.
62.	V N Ojha	Uncertainty in Measurement	Training Programme in Dimension Metrology 15-16 October, 2004 Venue : Hotel Crown Plaza Surya, New Delhi
63.	V N Ojha	Design and Fabrication of Josephson Tunnel Junctions and Series Arrays	Physics Seminar at Government College for PG students of Physics on 16th October, 2004. Ajmer under the UGC extension activities
64.	V N Ojha	Applications of Josephson tunnel junctions and series arrays as digital and analog circuits	Physics Seminar at Government College Ajmer under the UGC extension activities for PG students of Physics on 16th October, 2004.
65.	V N Ojha	Uncertainty in Measurement : Its Evaluation and Expression as per the requirement of ISO/IEC : 17025	IIQM course on ISO/IEC 17025 and uncertainty in measurement - Electrical & electronics and Physico-mechanical metrology, 9-11 Dec. 2004, held at Indian Institute of Quality Management, Jaipur

S.No.	Speaker's Name	Topic	Event and Venue
66.	V N Ojha	Uncertainty in Measurement : Calibration, Traceability and Related Metrological Terms	IIQM course on ISO/IEC 17025 and uncertainty in measurement- Electrical & electronics and Physico-mechanical metrology, 9-11 Dec. 2004, held at Indian Institute of Quality Management, Jaipur
67.	V N Ojha	Uncertainty in DC Measurements: A Case Study	IIQM course on ISO/IEC 17025 and uncertainty in measurement - Electrical & electronics and Physico-mechanical metrology, 9-11 Dec. 2004, held at Indian Institute of Quality Management, Jaipur
68.	V N Ojha	Uncertainty in Measurement : Its Evaluation and Expression	Uncertainty in measurement- Chemical metrology, 20-22 Dec. 2004, held at Indian Institute of Quality Management, Jaipur
69.	V N Ojha	Uncertainty in Measurement : Calibration, Traceability and Related Metrological Terms	"Uncertainty in measurement - Chemical metrology", 20-22 Dec. 2004, held at Indian Institute of Quality Management, Jaipur
70.	V N Ojha	Evaluation of Uncertainty in Measurement Traceability and Related Metrological Terms	Workshop on Chemical Metrology , Feb. 22, 2005 , organised by Metrology Society of India, held at National Physical Laboratory, New Delhi.
71.	V R Singh	Advances in Diagnosis of Biological Tissues	2nd Int. Conf. on Diagnostic Procedures & Techniques, IIT-Madras, Chennai, April 1-3, 2004.
72.	V R Singh	MEMS-based Biomedical Instrumentation Systems:	Int. Conf. on Trends in Industrial Measurements and Automation (TIMA-2004), Chennai, Dec 15-18, 2004.
73.	V R Singh	Nano-Sensors for Hypert-hermia Applications	Shanghai Int Conf on Physiological Biophysics (IPCPB'04), Shanghai (China), November 9-13, 2004.
74.	V R Singh	Recent Trends in Nano-biomedical Sensors	National Conference on Biomedical Engg (NCBME), GITAM, Vishakhapatnam, Dec 23-24, 2004.
75.	V R Singh	Ultrasonics in Cancer Research: Future Directions in Diagnostic and Treatment Techniques	Indian Science Congress (Physical Sciences Section), Jan 3-7, 2005.

S.No.	Speaker's Name	Topic	Event and Venue
76.	V R Singh	Nano-Biomedical Sensors	'Workshop on Bioinformatics Tools in Biology Research AMU, Aligarh, March 9-10, 2004.
77.	V R Singh	Advances in Nano-Bioinstrumentation Systems for Bioinformatics Research	IETE 35th Mid Term Technical Symposium, Nagpur, April 3-4, 2004.
78.	V R Singh	Future of Instrumentation	At the time of launching of M.Tech (Instrm & Control Engg) at Apeejay College of Engg, Sohna, October 25, 2004.
79.	V R Singh	Standardisation and Calibration of Biomedical Equipment	Seminar organised by Metrology Soc of India and Weigh India, New Delhi, Dec 27, 2004.
80.	V R Singh	Smart Sensors and Nano-Piezoelectric Devices.	13th Nat. Symp. on Ultrasonics. Jhansi, Dec 21-23, 2004.
81.	V.R. Singh	Nano-bio-composites	Workshop on Nano-Composites, Amity School of Engg & Tech, New Delhi, March, 2005.
82.	G Bhatia	Development of Advanced Carbon Products	Department of Polymers Science & Applied Chemistry, Delhi College of Engineering, Bawana, Delhi, 01.04.2004.
83.	S C Jain	Imaps India National conference 2004	"IINC-2004", 26-28 Nov. 2004 Bangalore
84.	S C Jain	Soft Lithographic Techniques for Rapid Fabrication Of Micro And Nano Structures In Polymers And Metals	Symposium mesoscopic Physics, JNU, 18-19 March 2005
85.	A M Biradar	Dynamics of Electroclinic Liquid Crystal Material by Dielectric Relaxation Material	11th National Conference on liquid crystals, Nov. 1-3, 2004, Allahabad, India.
86.	B D Malhotra	Biosensors for Clinical Diagnostic Industry.	National Science Day. Jaypee Institute of Information Technology (Deemed University). Noida, 28 Feb. 2005
87.	B D Malhotra	Prospects of Conducting Materials.	Brain storming Session on advanced Polymers in Biosensors. Institute of Materials Science. Govt. of Orissa. Bhubneshwar, Orissa. 20-21 January. 2005.

S.No.	Speaker's Name	Topic	Event and Venue
88.	B D Malhotra	Nano-Biomaterials for clinical diagnostics industry.	Brain -Storming session on Nanotechnology in the manufacturing centre. CMTI, Bangalore. 2-3 April 2004.
89.	B D Malhotra	Biosensors	DST Workshop on 'Prospects of biosensors in modern biology and biotechnological application. Department of Botany, Punjab University. Chandigarh 26 October 2004.
90.	B D Malhotra	Current Trends in Biosensors. Sensors for Agricultural and Industrial Applications.	Department of Physics. Dibrugarh University, Dibrugarh. 20 Sept.-10 October 2004.
91.	B D Malhotra	Langmuir-Blodgett films based biosensors.	BioTech 2004. India International Centre, New Delhi, 11-15 October 2004.
92.	B D Malhotra	Nano-Materials in Biosensors.	International Symposium on 'Advanced Materials & Processing. Indian Institute of Technology. Kharagpur. 6-8 December, 2004.
93.	A Basu	Optical Thin film Multilayer Narrow Bandpass Interference Filters for WDM Applications	Workshop on Thin Film Coatings. IRDE Dehradun, 11 - 12 March 2005.
94.	S A Agnihotry	Practical Applications of Solid State Ionic Materials, A Case Study: Electrochromic Devices,	Sixth National Conference on Solid State Ionics , Kolkata , 5-7 October 2004
95.	S A Agnihotry	Nanocomposite Polymer Electrolytes.	Seminar on Nanocomposites and Technology. Amity School of Engineering & Technology (ASET), 26-27 Feb., 2005
96.	V.K.Sankaranarayanan	Exchange Bias In Nanostructured GMR Multilayers.	International symposium on Advanced Materials and Processing. ISAMAP-2K4, 1327-34, I.I.T Kharagpur, India, 6-8 Dec. 2004.
97.	Harish Chander	Development of Nanophosphors for Industrial Applications.	First National Conference on Nanoscience and Technology (NSTI-2005). National Chemical Laboratory, Pune, 7-8 March 2005.
98.	Harish Chander	Nanophosphors Synthesis - A Review.	National Conference on Luminescent Materials and its Applications (NCLA-2005) Bangalore University, Bangalore, 2-4 Feb., 2005.

S.No.	Speaker's Name	Topic	Event and Venue
99.	P N Dixit	Development of Diamond like Carbon and some Nano-structures of Carbon at NPL.	Workshop on Thin Film Coatings. IRDE, Dehradun, 11 - 12 March 2005.
100.	P N Dixit	Amorphous Silicon to Nano-Crystalline Silicon Thin films by Plasma Enhanced Chemical Vapour Deposition Technique.	Workshop Amity, 27 Feb., 2005.
101.	P N Dixit	Hydrogenated Amorphous & Microcrystalline Silicon Based activities at NPL.	Annual meeting of experts on condensed matter. IIT Kanpur, 5 Feb. 2005.
102.	S S Rajput	Low Voltage Circuits and Their Applications.	Keynote address at SV College of Computer Studies. Kadi, Ahemedabad in National Level Technical Paper Presentation Competition on 9-1-2005.
103.	S S Rajput	Low Voltage Design Practices in VLSI	AMU/IETE sponsored MITECS 05 Conference Aligarh, UP, 5-6 March 2005.
104.	S S Rajput	Low voltage analog VLSI	Continuing Education Program on Technology Enabled managerial skills Course. IIT Roorkee, held between June 15 and July 31, 2004.
105.	S M Shivaprasad	Surfaces of Nanostructures	Rai Univeristy, Gurgaon, 18th Feb. 2005.
106.	S M Shivaprasad	Surfing Solid Surfaces	Jamia Millia Islamia, Physics Deptt., 12th Oct. 2004.
107.	S M Shivaprasad	Research in Surface Science	Karnataka Rajya Vigyana Samiti and Tumkur Science Club, Tumkur, 15th June, 2004.
108.	S M Shivaprasad	Initial Stages of Heteroepitaxy: A surface science approach.	Solid State Physics Laboratory. DRDO, Delhi, Wednesday Seminar, 18th April, 2004.
109.	S M Shivaprasad	Applications of Surface Science to Nanostructures,	Central Electronics Engineering Research Institute, Pilani, 4th April, 2004.
110.	B C Chakravarty	Materials for Terrestrial Solar Photovoltaics.	Nat.Conf.Phys. Electronic Materials and Devices (PEMD-2005). Sambalpur University , Orissa, Feb, 10 - 12, 2005.
111.	Mohan Lal	Silicon Nitride Layers by Plasma Enhanced CVD for Large Area High Efficiency mc-Si Solar cells.	19th National symposium on plasma and technology (Plasma-2004). Plasma Society of India, 7-10, 2004.

S.No.	Speaker's Name	Topic	Event and Venue
112.	Mohan Lal	Deep level Transient Spectroscopy (DLTS) Studies in Cz Silicon Solar cells.	National Conference on Physics of Electronic Materials and Devices PEMD -2005. Sambalpur University, February 10-12, 2005.
113.	Mohan Lal	Critical Issues of Industrial Silicon Solar cells of achieving Higher Efficiency.	National Symposium on Advances in Material Science, D.D.U. Gorakhpur University, Gorakhpur, March 17 - 19, 2005.
114.	S N Singh	Application of Photoconducting decay and photocurrent generation method for determination of minority carrier life time in silicon.	International Symposium on ultra pure materials. CMET, Hyderabad, Nov. 22- 23 , 2004.
115.	S N Singh	Photoresponse and Dark reverse I - V Characteristics of Silicon Photodiodes.	National Seminar on Current Trends in Condensed Matter Physics, D. B.S. College, Kanpur, Nov. 19-20, 2004.
116.	A K Agrawal	Chemical Metrology, Traceability, and Certified Reference Materials.	Workshop on Chemical Metrology, NPL New Delhi, February 22, 2005.
117.	A K Agrawal	Evaluation of Uncertainty in Chemical Measurements	Workshop on Chemical Metrology, NPL, New Delhi, February 22, 2005
118.	A K Agrawal	ICP Emission Spectrometer: A Novel Technique for Characterization of Materials	Management Development Programme on Operation, Maintenance and repair of Analytical Equipment, CSIO, Delhi Centre, New Delhi, February 10, 2005.
119.	A K Agrawal	ICP Emission Spectrometer and its Applications	User Awareness Programme on Materials Characterization Techniques, NPL, New Delhi, January 10-21, 2005.
120.	A K Agrawal	Certified Reference Materials	Seminar on Inter Laboratory Programme on Indian Reference Materials (Bharatiya Nirdeshak Dravyas) and HGML-NGRI-NPL Collaborating Project on Gold Geochemical Reference Materials, NGRI, Hyderabad, January 6-7, 2005.
121.	A K Agrawal	Measurement of Uncertainty in Chemical Measurements	Training Course on Measurement of Uncertainty in Chemical Testing, IIQM, Jaipur, December 20-22, 2004.

S.No.	Speaker's Name	Topic	Event and Venue
122.	A K Agrawal	Chemical Metrology, Traceability, and certified reference materials.	Workshop on Chemical Metrology, NPL New Delhi, February 22, 2005.
123.	A K Agrawal	Need of Certified Reference Materials for Assessment of Drinking Water Quality	National Symposium on Pesticides: Myths, Realities and remedies and Pesticide Expo-2004, IARI, New Delhi, December 1-3, 2004.
124.	A K Agrawal	Certified Reference Materials of Trace Elements in Water	International Symposium on Ultrapure Materials: Processing, Characterization, and Applications (ISUPM), CIMET, Hyderabad, November 22-23, 2004.
125.	A K Agrawal	Status of Certified Reference Materials and Chemical Metrology in India	Technical Committee on Amount of Substance (TCQM) of Asian Pacific Metrology Programme (APMP), NCCRM, Bejing, China, October 18-19, 2004
126.	A. K. Agrawal	Evaluation of Uncertainty in Chemical Testing.	Training Course on Uncertainty in Measurement, NPL, New Delhi, April 30-May1, 2004.
127.	Prabhat K. Gupta	Invited talk	Indo- EU workshop during Sept.6-10, 2004, at Univ. of Hyderabad
128.	Prabhat K. Gupta	Atomic absorption Spectrophotometer	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
129.	Prabhat K. Gupta	Spectrophotometer	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
130.	Prabha Johri	GCMS	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
131.	S.K. Gupta	Advanced Techniques for Materials Characterization	CII -NPL interaction meeting held at CII Auditorium, Gurgaon, 2nd June, 2004
132.	S.K. Gupta	Characterization of Advanced Materials by EPR Spectroscopy	National Conference on Advanced Materials and Technology held at DAV College, Amritsar during Sept.24-26, 2004

S.No.	Speaker's Name	Topic	Event and Venue
133.	S.K. Gupta	Electron Paramagnetic Resonance - Underlying Principle & its Applications	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
134.	Sukhvir Singh	Characterization of Materials using Transmission Electron Microscopy technique	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
135.	Rashmi	XRF Technique for materials characterization.	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
136.	Ram Kishore	XRF Technique for materials characterization.	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
137.	S K Halder	XRD Technique for materials characterization.	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
138.	A K Agrawal	Chemical Metrology, Traceability, and certified reference materials.	Workshop on Chemical Metrology, NPL New Delhi, February 22, 2005.
139.	B R Chakraborty	SIMS Technique for materials characterization.	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
140.	G. Bhagavannarayana	Characterization of crystals by HRXRD	Users awareness programme on Materials Characterization Techniques, held at NPL, New Delhi, January 10-14, 2005.
141.	Krishan Lal	Effective Science -Administration Partnership.	Training Programme for Controllers of Administration / Administrative Officers, IMT Chandigarh, August 2004
142.	Krishan Lal	High Resolution X-ray Diffraction and Characterization of Single Crystals.	Seminar, Physics Department, IIT Kanpur, Sep 2004.
143.	Krishan Lal	Recent Advances in Structural Characterization of Semiconductor Crystals, Thin Films and Devices,	National Conference on Advanced Materials and Technology, D. A. V. College, Amritsar, Sep 2004

S.No.	Speaker's Name	Topic	Event and Venue
144.	Krishan Lal	Ultrasonics and Material Science.	Inaugural Lecture, National Symposium on Ultrasonics, Bundelkhand Univ., Jhansi, Dec 2004
145.	Krishan Lal	Precision Measurements: Vital for Scientific, Industrial, Economic, and Societal Development.	Inaugural Lecture, Maap Taul Saptah, Weigh India, New Delhi Dec 2004
146.	Krishan Lal	Recent Advances in Structural Characterization of Materials.	Regional Research Laboratory, Bhubaneswar, Jan 2005
147.	Krishan Lal	Precision Measurements for Materials Evaluation.	Invited Talk: ADMET-2005, New Delhi, Feb 2005.
148.	Krishan Lal	Fascinating World of Crystals.	Science Day Lecture, Indian Agricultural Research Institute, New Delhi, Feb 2005,
149.	Krishan Lal	Crystal Defects and Crystal Growth: A Lifelong Fascination.	Keynote Lecture, Workshop on Structural Characterization of Materials, New Delhi, March 2005.
150.	Krishan Lal	High Resolution X-ray Diffraction and Structural Characterization of Bulk Crystals, Thin Films and Devices,	Keynote Address, National Seminar on Materials Processing and Characterization, Shivaji University, Kolhapur, March 2005.
151.	Krishan Lal	High Resolution X-ray Diffraction Studies of Semiconductor Single Crystals, Thin Films and Devices.	Presentation for Silicon 2004, Irkutsk, Russia, July 2004.
152.	Krishan Lal	Indian R & D Activities on Natural Gas Hydrates.	CODATA Gas Hydrate Task Group Meeting 2004, GFZ Potsdam, Nov 2004
153.	S L Jain	Atmospheric Probing with Laser systems and Antarctica activities	Organized by LASTEC Metcalfe House, New Delhi April, 7, 2004.
154.	S L Jain	Indian Contributions in Atmospheric Studies over Antarctica during last two decades	Workshop at NCAOR, October 27-29, 2004
155.	S L Jain	Lidars for atmospheric probing	(NCLBAS-2005) held at Deptt.of Physics, Visva-Bharati, Santiniketan January 10-13, 2005.
156.	H N Dutta	Antarctica, A divine Environment	CCS University, Merrut June 5, 2004.
157.	H N Dutta	Earthquake Precursors	CCS University, Merrut June 5, 2004.
158.	H N Dutta	Antarctica: Endless opportunities	CDRI Lucknow, June 25, 2004.

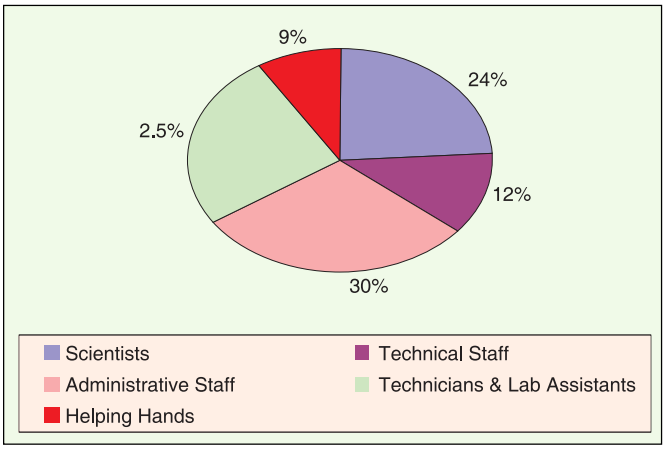
S.No.	Speaker's Name	Topic	Event and Venue
159.	H N Dutta	Low frequency acoustic emission prior to an earth-quake	Workshop on Precursors of earthquakes. India Habitat Center, New Delhi. August 12-13, 2004.
160.	H N Dutta	Antarctic-Environment	H N Bahuguna Garhwal University, Srinagar-Garhwal, September 7, 2004.
161.	H N Dutta	Eearthquake Precursors	H N Bahuguna Garhwal University, Srinagar - Garhwal September 8, 2004
162.	H N Dutta	Antarctic Environment	Dronacharya College, Gurgaon, September 25,2004
163.	H N Dutta	Earthquake Precursors: Role of Physics	Deptt of App. Physics, Guru Jambheshwar Uni. Hisar, October 16, 2004.
164.	H N Dutta	Measurement of Turbulent Structure of the Lower Atmosphere using Ship-borne Acoustic Sounder	Course on Radio Meteorology and radio wave propagation at low altitudes, N.P.L Delhi. December 8-10, 2004.
165.	H N Dutta	Earthquake Precursors	Dronacharya College, Gurgaon January 19, 2005.
166.	H N Dutta	Antarctica: Present perspective	Science Day, IIT Roorkee, February 28, 2005.
167.	H N Dutta	Earthquake Precursors	Shardhanand College Uni. of Delhi, Delhi, March 7, 2005.
168.	H K Maini	A PC based System for the Measurement of Vertical Temperature Gradient	Course on Radio Meteorology and radio wave propagation conducted for officers of Indian Navy at NPL New Delhi. December 8-10, 2004.
169.	Thomas John	Tethered ballonsonde for the Measurement of Meteor-ological Parameters.	Course on Radio Meteorology and radio wave propagation conducted for officers of Indian Navy at NPL New Delhi. December 8-10, 2004.
170.	S K Agarwal	Superconductivity in Pr-123 - Situation Revisited in the National Seminar on The impact of Condensed Matter Physics on Technology - some recent trends	At Sikkim Manipal Institute of Technology, Majitar Rangpo, Sikkim, 4 - 5 March 2005
171.	R B Saxena	Cryogenics and its Applications	Pusa Polytechnic, Pusa Campus, New Delhi in April 2004

S.No.	Speaker's Name	Topic	Event and Venue
172.	R B Saxena	Recent Research & Development in the area of Cryogenics and Superconducting Magnets	Twentieth National Symposium on Cryogenics held at Surat in February 2005
173.	V P S Awana.	Magneto Superconductivity of Ruthenocuprates	10th International Vortex Workshop, January 9-14, 2005, Tata Institute of Fundamental Research, Mumbai
174.	Vikram Kumar	Polymers for Future Electronics	8th B N Singh Memorial Lecture, Delhi University, April 16, 2004
175.	Vikram Kumar	Current Transport in Conducting Polymers	Jack Welch Centre, General Electric, Bangalore, July 23, 2004
176.	Vikram Kumar	Nanotechnology for Devices - A Review	DST Course for Young Scientists, Sept. 22, 2004
177.	Vikram Kumar	Polymers in Electronics -A Review	National Conference on Advanced Materials and Technology, D.A.V. College, Amritsar, Sept. 24, 2004
178.	Vikram Kumar	Polymers in Electronics -A Review	IIT Delhi Physics Department Oct. 4, 2004
179.	Vikram Kumar	Organic Solar Cells	Georgia Institute of Technology, Atlanta, USA, Dec. 8, 2004
180.	Vikram Kumar	Recent Developments in Organic Electronics	Rensellaer Polytechnic Institute, Troy, NY, USA, Dec. 15, 2004
181.	Vikram Kumar	Future Electronic Devices	Special Lecture, IEEE Delhi Centre Jan. 16, 2005
182.	Vikram Kumar	National Initiative for the Development of MEMS in India	Componex Exhibition and Seminar, Pragati Maidan, Delhi, Feb 3, 2005
183.	Vikram Kumar	Organic Electronic and Opto Electronic Devices	Aligarh Muslim University, Physics Department, March 12, 2005

HUMAN RESOURCE

S. No.	Category	Grade	Number
(A)	*Scientific & Technical Staff*		
1	Scientific Staff	Group IV	220
2	Technical Staff	Group III	111
Sub Total 1 + 2			**331**
3	Supporting Technical Staff	Group II	234
4	Helping Hands	Group I	83
Total S & T Staff			**648**
(B)	*Administrative & Non-Technical Staff*		
5	Administrative (Gazetted)	Group A	9
6	Administrative (Gazetted)	Group B	90
7	Administrative (Non-Gazetted)	Group C	57
8	Non-Technical Staff	Group D	121
Total Administrative & Non-Technical Staff			**277**
GRAND TOTAL			**925**

Scientists	220
Technical	111
Administrative	277
Technician	234
Helping Hands	83



SCIENTISTS AND OFFICERS AS ON 31.03.2005

NAME	CURRENT DESIGN.	PROJECT CODE
Dr Vikram Kumar	Director	INFRA
PHYSICO-MECHANICAL STANDARDS		
Mass, Volume & Viscosity		
Sh Tripurari Lal	Scientist F	OLP0001
Sh Mati Lal Das	Scientist EII	OLP0001
Sh Ganga Prasad	Scientist EII	OLP0001
Dr Sanjeev Sinha	Scientist EI	OLP0001
Sh Gautam Mandal	Scientist B	OLP0001
Sh T K Parameshwaran	Tech Ofcr (B)	OLP0001
Sh Mahargha Baran Das	Tech Ofcr (A)	OLP0001
Length & Dimensional Metrology		
Dr Raghunandan Prasad Singhal	Scientist G	OLP0002
Sh S Uma Maheshwar Rao	Scientist F	OLP0002
Dr V G Kulkarni	Scientist F	OLP0002
Sh K P Chaudhary	Scientist F	OLP0002
Dr Mrs Rina Sharma	Scientist EI	OLP0002
Sh B K Roy	Tech Ofcr (EI)	OLP0002
Sh Ravi Khanna	Tech Ofcr (EI)	OLP0002
Sh S L Thind	Tech Ofcr (C)	OLP0002
Sh Mukesh Kumar	Tech Ofcr (A)	OLP0002

Temperature Standards

Dr Yesh Pal Singh	Scientist EII	OLP0003
Sh Navin Kumar Srivastava	Scientist EII	OLP0003
Sh Satish Kumar Nijhawan	Tech Ofcr (EI)	OLP0003
Sh Jagdish Kumar Gupta	Tech Ofcr (EI)	OLP0003
Sh Gurcharanjit Singh	Tech Ofcr (B)	OLP0003

Optical Radiation Standards

Dr Hem Chandra Kandpal	Scientist F	OLP0004
Dr Rakesh Kumar Garg	Scientist F	OLP0004
Dr Om Prakash	Scientist F	OLP0004
Dr Devinder Gupta	Scientist EII	OLP0004
Dr (Miss) Ranjana Mehrotra	Scientist EII	OLP0004
Sh Jai Bhagwan	Tech Ofcr (C)	OLP0004
Sh K N Basavaraju	Tech Ofcr (A)	OLP0004
Sh Sudama	Tech Ofcr (A)	OLP0004

Force & Hardness Standards

Dr Kamlesh Kumar Jain	Scientist F	OLP0005
Dr Sushil Kumar Jain	Scientist F	OLP0005
Sh Jagdish Kumar Dhawan	Scientist F	OLP0005
Sh Anil Kumar	Scientist EII	OLP0005
Dr S Seela Kumar Titus	Scientist C	OLP0005
Sh Rajesh Kumar	Scientist C	OLP0005

Pressure & Vacuum Standards

Sh Akhilesh Chandra Gupta	Scientist G	OLP0006
Dr Ashis Kumar Bandhyopadhyay	Scientist F	OLP0006
Dr Desh Raj Sharma	Scientist F	OLP0006
Dr Pardeep Mohan	Scientist F	OLP0006
Sh B V Kumaraswamy	Scientist F	OLP0006
Dr Bibhash Ranjan Chakraborty	Scientist F	OLP0055
Sh D Arun Vijayakumar	Scientist C	OLP0006
Dr (Miss) Nita Dilawar	Scientist C	OLP0006
Dr Sanjay Yadav	Scientist C	OLP0006

Acoustics Standards

Dr Vellur Mohanan	Scientist G	OLP0007

Dr Bhim Sain Gera	Scientist F	OLP0007
Sh Omkar Sharma	Scientist F	OLP0007
Dr Mahavir Singh	Scientist EI	OLP0007
Sh Naveen Garg	Scientist B	OLP0007
Sh V K Ojha	Tech Ofcr (B)	OLP0007
Sh Gurbir Singh	Tech Ofcr (B)	OLP0007

Fluid Flow Measurement

Dr Jnanendra Nath Som	Scientist F	OLP0008
Sh Raj Singh	Scientist EII	OLP0008
Sh Virendra Babu	Tech Ofcr (EII)	OLP0008
Sh Ishwar Singh Taak	Tech Ofcr (B)	OLP0008

Ultrasonic Standards

Dr Ashok Kumar	Scientist F	OLP0009
Dr. Mukesh Chandra	Scientist EII	OLP0009
Mrs Reeta Gupta	Tech Ofcr (B)	OLP0009
Dr Yudhisther Kumar Yadav	Tech Ofcr (B)	OLP0009

Shock & Vibration Sensors

Sh Subodh Kumar Singhal	Scientist F	OLP0011
Sh Gurdeep Singh Lamba	Tech Ofcr (A)	OLP0011

ELECTRICAL & ELECTRONIC STANDARDS

Time & Frequency

Dr P Banerjee	Scientist G	OLP0012
Dr Amitava Sengupta	Scientist G	OLP0012
Dr G M Saxena	Scientist F	OLP0012
Dr Ashok Kumar Hanjura	Scientist F	OLP0012
Mrs Arundhati Chatterjee	Scientist EII	OLP0012
Dr (Mrs) Santa Chawla	Scientist EII	OLP0012
Sh Chockalingam Sreekumar	Scientist B	OLP0012
Dr Ashish Agarwal	Scientist B	OLP0012
Sh Anil Kumar Suri	Tech Ofcr (C)	OLP0012

Quantum Hall Resistance Standards & Superconducting Devices

Dr N D Kataria	Scientist F	OLP0013
Sh Vijay Kumar	Scientist EII	OLP0013

Dr Neeraj Khare	Scientist EII	OLP0013
Sh Man Mohan Krishna	Scientist C	OLP0013
Dr Harikrishna Singh	Scientist C	OLP0013

Josephson Voltage DC Current, Voltage & Resistance

Dr Vijay Narain Ojha	Scientist F	OLP0015
Sh Ajeet Singh	Scientist EI	OLP0015

AC Power & Energy

Sh Mukesh Kumar Mittal	Scientist F	OLP0016
Sh Joges Chandra Biswas	Scientist EI	OLP0016

AC High Voltage & High Current

Dr Sita Ram Gupta	Scientist F	OLP0017
Sh Shiv Kumar Jaiswal	Scientist B	OLP0017

LF & HF Impedance

Dr Omkar Nath	Scientist F	OLP0018
Sh Anil Kishore Saxena	Scientist EII	OLP0018
Sh Naib Singh	Scientist EII	OLP0018
Sh Mohammad Saleem	Tech Ofcr (B)	OLP0018
Sh Avdhesh Kumar Goel	Tech Ofcr (B)	OLP0018

LF & HF Voltage, Current & RF Power

Sh Vijay Kumar Rustagi	Scientist F	OLP0019
Sh Anil Kumar Govil	Scientist F	OLP0019
Sh Ritander Aggarwal	Scientist EII	OLP0019
Sh Bijendra Pal	Tech Ofcr (A)	OLP0019

RF Attenuation & Impedance

Sh Pramendra Singh Negi	Scientist EII	OLP0020
Sh Kamlesh Kumar Patel	Scientist B	OLP0020

Magnetic Standards

Dr Prafulla Chandra Kothari	Scientist G	OLP0021
Dr R K Kotnala	Scientist EII	OLP0021

DC High Voltage Standards

Dr Surender Kumar Mahajan	Scientist F	OLP0022
Sh Kul Bhushan Ravat	Tech Ofcr (C)	OLP0022

Bio-Medical Measurement & Standards

Dr Ved Ram Singh	Scientist G	OLP0023
Dr Ramesh Babu Tripathi	Scientist EII	OLP0023

CFCT

Dr V T Chitnis	Scientist G	OLP0024
Mrs Indra Tiwari	Scientist EII	OLP0024
Dr D P Bhatt	Scientist EII	OLP0024
Dr Mansha Ram	Scientist EI	OLP0024
Sh G K Kapoor	Tech Ofcr (B)	OLP0024
Sh S K Rastogi	Tech Ofcr (B)	OLP0024
Mrs Shashi Lekha Bhatnagar	Tech Ofcr (B)	OLP0024
Sh Jagan Nath Prasad	Tech Ofcr (A)	OLP0024

ENGINEERING MATERIALS

Metals & Alloys

Dr Anil Kumar Gupta	Scientist G	OLP0025
Dr Bhanu Pratap Singh	Scientist F	OLP0025
Dr Sunil Kumar Singhal	Scientist F	OLP0025
Sh Ramesh Chandra Anandani	Scientist F	OLP0025
Sh H N P Poddar	Scientist F	STS0016
Dr Rajeev Chopra	Scientist EII	OLP0025
Dr Ajay Dhar	Scientist EII	OLP0025
Sh Vipin Jain	Scientist C	OLP0025
Dr R G Mathur	Scientist B	OLP0025
Sh Islamuddin Anwar Malik	Tech Ofcr (EII)	OLP0025
Sh Rajiv Sikand	Tech Ofcr (C)	OLP0025
Sh K D Sharda	Tech Ofcr (C)	OLP0025
Sh Rakesh Khanna	Tech Ofcr (B)	OLP0025

Advanced Carbon Products

Dr Gopal Bhatia	Scientist F	OLP0026
Dr Rakesh Behari Mathur	Scientist F	OLP0026
Dr R K Aggarwal	Scientist F	OLP0026
Dr Tarsem Lal Dhami	Scientist F	OLP0026
Dr (Mrs) Vasantha Raman	Scientist F	OLP0026
Dr Chhotey Lal	Scientist EII	OLP0026

Sh Sanjay Rangnate Dhakate	Scientist EI	OLP0026
Sh. Bhanu Pratap Singh	Scientist B	OLP0026
Sh Pinaki Ranjan Sengupta	Tech Ofcr (C)	OLP0026
Sh Rajesh Kumar Seth	Tech Ofcr (A)	OLP0026

Polymeric & Soft Materials

Dr Sukhwant Singh Bawa	Scientist G	OLP0028
Dr M N Kamalasanan	Scientist F	OLP0028
Dr Satish Chandra Kant Mishra	Scientist F	OLP0028
Dr Ashok Manikrao Biradar	Scientist F	OLP0028
Dr Chhatra Pal Sharma	Scientist F	OLP0028
Dr Suresh Chand	Scientist F	OLP0028
Dr Bansi Dhar Malhotra	Scientist F	OLP0028
Dr Harish Bahadur	Scientist EII	OLP0028
Dr Krishan Kumar Saini	Scientist EII	OLP0028
Dr S K Dhawan	Scientist EII	OLP0028
Dr R K Sharma	Scientist EII	OLP0028
Sh Sudhanshu Dwivedi	Scientist EII	OLP0028
Dr Tushya Kumar Saxena	Scientist EI	OLP0028
Dr (Ms) Ritu Srivastava	Scientist C	OLP0028
Sh Gauri Datt Sharma	Tech Ofcr (C)	OLP0028
Sh Chander Kant	Tech Ofcr (B)	OLP0028

Liquid Crystalline Materials & Devices

Dr Sukhmal Chand Jain	Scientist G	OLP0029

Cryogenic Plant & Facilities

Sh Subhash Chandra Gera	Scientist F	OLP0052
Sh Ashok Kumar	Scientist B	OLP0052

ELECTRONIC MATERIALS

Luminescent Materials

Dr Virendra Shanker	Scientist F	OLP0030
Dr Harish Chander	Scientist F	OLP0030
Dr Divi Haranath	Scientist B	OLP0030

Thin Film Technology

Dr Prakash Narain Dixit	Scientist F	OLP0031

Sh Sher Singh Rajput	Scientist EII	OLP0031
Dr Omvir Singh Panwar	Scientist EII	OLP0031
Dr K M K Srivatsa	Scientist EI	OLP0031
Sh C M S Rauthan	Scientist EI	OLP0031
Dr Sushil Kumar	Scientist C	OLP0031
Sh Jagdish Chand	Tech Ofcr (A)	OLP0031

Silicon & Silicon Devices

Dr Shiv Nath Singh	Scientist F	OLP0032
Dr Mohan Lal	Scientist F	OLP0032
Dr Bidhan Chandra Chakravarty	Scientist F	OLP0032
Dr Parakram Kumar Singh	Scientist F	OLP0032
Sh Ravi Kumar	Tech Ofcr (EI)	OLP0032

Microstructure Devices

Dr Amitabha Basu	Scientist F	OLP0033
Dr S T Lakshmikumar	Scientist F	OLP0033
Dr (Mrs) S A Agnihotry	Scientist F	OLP0033
Dr Ramadhar Singh	Scientist F	OLP0033
Dr (Mrs) Meenakshi Kar	Scientist EII	OLP0033
Dr (Mrs) Kiran Jain	Scientist EII	OLP0033
Mrs Santosh Singh	Scientist C	OLP0033
Dr Shailesh Narayan Sharma	Scientist C	OLP0033
Dr V K Sankaranarayanan	Scientist C	OLP0033
Dr (Ms) Deepa	Scientist C	OLP0033
Sh Tarun Kumar Chakraborty	Tech Ofcr (C)	OLP0033
Sh T K Bhattacharya	Tech Ofcr (C)	OLP0033
Sh Murari Lal Sharma	Tech Ofcr (B)	OLP0033
Sh Vipin Kumar Singhal	Tech Ofcr (A)	OLP0033
Sh Om Prakash	Tech Ofcr (A)	OLP0033

Superconducting and Ceramic Materials

Dr Srikant N Ekbote	Scientist F	OLP0034
Dr Narinder Kumar Arora	Scientist EI	OLP0034
Dr T D Senguttuvan	Scientist C	OLP0034
Dr (Ms) Gurusharan Kaur Padam	Scientist C	OLP0034
Sh M K Banerjee	Tech Ofcr (C)	OLP0034
Sh N C Soni	Tech Ofcr (C)	OLP0034

Sh Mukul Sharma	Tech Ofcr (C)	OLP0034

Surface Physics and Nanostructure Devices

Dr S M Shivaprasad	Scientist EII	OLP0043
Dr Amish G Joshi	Scientist C	OLP0043
Dr Govind	Scientist C	OLP0043
Sh V K Hans	Tech Ofcr (B)	OLP0043

MATERIALS CHARACTERIZATION

Characterization of Materials by Chemical Methods

Sh Prabhat Kumar Gupta	Scientist F	OLP0037
Dr Nahar Singh	Scientist B	OLP0037
Dr (Mrs) Prabha Johri	Scientist B	OLP0037
Sh Niranjan Singh	Tech Ofcr (C)	OLP0037
Sh M K Dasgupta	Tech Ofcr (C)	OLP0037

Characterization of Materials by EPR Spectroscopy

Dr S K Gupta	Scientist F	OLP0038
Dr (Miss) Manju Arora	Tech Ofcr (B)	OLP0038

Characterization of Materials by XRD/XRF Techniques

Dr Sujit Kumar Halder	Scientist F	OLP0039
Dr (Miss) Rashmi	Scientist EII	OLP0039
Dr Rajendra Prasad Pant	Scientist EII	OLP0039
Dr Dharam Pal Singh	Tech Ofcr (B)	OLP0039

Characterization of Materials by Electron Microscopy

Dr Ram Kishore	Scientist F	OLP0040
Sh Kasturi Lal	Scientist EII	OLP0040
Sh Sukhvir Singh	Scientist EI	OLP0040
Dr Avanish K Srivastava	Scientist C	OLP0040
Sh Keadr Nath Sood	Tech Ofcr (B)	OLP0040

Indian Reference Materials

Dr Arun Kumar Agrawal	Scientist F	OLP0041
Sh Rajiv Kumar Saxena	Tech Ofcr (B)	OLP0041
Mrs Abha Bhatnagar	Tech Ofcr (A)	OLP0041

Growth & Structural Characterization of Single Crystals

Dr Godavarthi Bhagavannarayana	Scientist F	OLP0042
Dr Kamlesh Kumar Maurya	Scientist C	OLP0042
Sh Parveen Saini	Scientist B	OLP0042
Sh N Vijayan	Scientist B	OLP0042

RADIO & ATMOSPHERIC SCIENCES

Radio & Atmospheric Environmental Monitoring

Sh Satish Chand Garg	Scientist G	OLP0047
Dr P K Banerjee	Scientist F	OLP0047
Dr P N Vijayakumar	Scientist F	OLP0047
Dr S D Sharma	Scientist F	OLP0047
Mrs Madhu Bahl	Scientist F	OLP0047
Sh H K Maini	Scientist EII	OLP0047
Sh Thomas John	Scientist EII	OLP0047
Sh Vijay Kumar Vohra	Scientist EII	OLP0047
Dr Sachidanand Singh	Scientist C	OLP0047
Sh Sher Singh	Scientist B	OLP0047
Sh Vishram Sing Yadav	Tech Ofcr (C)	OLP0047
Sh K G M Pillai	Tech Ofcr (C)	OLP0047
Sh Iqbal Ahmed	Tech Ofcr (C)	OLP0047
Sh Ramesh Kohli	Tech Ofcr (B)	OLP0047
Sh Dhan Singh Chaunal	Tech Ofcr (B)	OLP0047
Mrs Beena Gupta	Tech Ofcr (B)	OLP0047
Sh Man Mohan Gupta	Tech Ofcr (B)	OLP0047

Radio Communication & Space Physics

Dr Lakha Singh	Scientist F	OLP0045
Dr Swapan Kumar Sarkar	Scientist F	OLP0045
Dr Raj Singh Dabas	Scientist F	OLP0045
Dr Mahendra Kumar Goel	Scientist F	OLP0045
Dr M S V N Prasad	Scientist F	OLP0045
Sh Pattamatta Subrahmanyam	Scientist F	OLP0045
Sh Narendra Kumar Sethi	Scientist EII	OLP0045
Dr Vijay Kumar Pandey	Scientist EII	OLP0045
Mrs Parvati Chopra	Scientist EII	OLP0045

Sh Dharam Bir Sharma	Tech Ofcr (C)	OLP0045
Mrs Shiv Kumari Bhatia	Tech Ofcr (B)	OLP0045

Atmospheric Environment and Global Change Studies

Dr M K Tiwari	Scientist F	OLP0046
Dr Sohan Lal Jain	Scientist F	OLP0046
Dr Hirday Nath Dutta	Scientist F	OLP0046
Dr Pradeep Kumar Pasricha	Scientist F	OLP0046
Dr Bhuwan Chandra Arya	Scientist F	OLP0046
Dr Kanwar Sushil Zalpuri	Scientist F	OLP0048
Dr Mahendra Mohan	Scientist EII	OLP0046
Sh Deo Raj Nakra	Scientist EII	OLP0046
Dr Radhe Shyam Arora	Scientist EII	OLP0046
Dr Risal Singh	Scientist EII	OLP0046
Dr (Mrs)Meena Jain	Scientist EII	OLP0046
Sh Randhir Singh Tanwar	Scientist EI	OLP0046
Dr Tuhin Mandal	Scientist C	OLP0046
Dr Y Zaheer	Scientist C	OLP0046
Sh Arun Kumar Ghoghar	Tech Ofcr (B)	OLP0046
Sh Shambhu Nath	Tech Ofcr (B)	OLP0046

SUPERCONDUCTIVITY & CRYOGENICS

Superconducting Magnets

Sh Rajan Babu Saxena	Scientist F	OLP0051
Sh M A Ansari	Scientist C	OLP0051

Basic Superconductivity

Dr Hari Kishan	Scientist F	OLP0010
Dr B V Reddi	Scientist EII	OLP0049
Dr (Mrs) S Niranjana N Goswami	Scientist EII	Infrastructure/8.04
Sh Pratim K Dutta	Scientist EII	OLP0049
Dr Ratan Lal	Scientist EII	OLP0049
Sh Umesh Chandra Upreti	Scientist EII	OLP0049
Dr S K Agarwal	Scientist EII	OLP0049
Dr (Miss) P L Upadhyay	Scientist EII	OLP0049
Dr Veerpal Singh Awana	Scientist C	OLP0049
Dr Anurag Gupta	Scientist C	OLP0049

Sh S B Samanta	Tech Ofcr (EI)	OLP0049
Sh Mohan Chandra Singh	Tech Ofcr (B)	OLP0049
Sh Jai Pal Singh	Tech Ofcr (A)	OLP0049
Sh Jokhan Ram	Tech Ofcr (A)	OLP0049
Sh Bhikham Singh	Tech Ofcr (B)	OLP0010
Sh Rama Shankar Singh	Tech Ofcr (EI)	Infrastructure

Library

Sh Deepak Kumar Tewari	Scientist EII	STS0001
Sh N K Wadhwa	Scientist C	STS0001
Sh Hasan Haider	Tech Ofcr (C)	STS0001
Sh Jagdish Prasad	Tech Ofcr (B)	STS0001

SCIENTIFIC SUPPORT SERVICES

Planning, Monitoring & Evaluation Group

Sh C S Prasannakumar	Scientist G	STS0004
Sh Tushar Kanti Chakravarty	Scientist EI	STS0004

Human Resource Management Group

Sh S K Chakladar	Scientist F	STS0008
Mrs Shikha Mandal	Scientist EII	STS0008
Sh V D Arora	Tech Ofcr (B)	STS0008
Sh Vinod Kumar Sharma	Tech Ofcr (A)	STS0008

Industrial Liason Group

Sh Narinder Kumar Babbar	Scientist EII	STS0005
Dr Miss Jyoti Lata Pandey	Scientist EII	STS0005
Sh Mohinder Kumar Chhibber	Tech Ofcr (EI)	STS0005

International Science and Technology Affairs Group

Sh Sushil Kumar Sharma	Scientist EII	STS0009
Sh Ashwani Kumar Suri	Tech Ofcr (B)	STS0009

TECHNICAL SUPPORT SERVICES

Electrical, Air Conditioning & Pumping

Sh Jagdish Chandra Sharma	Scientist EII	STS0010
Sh Deepak Bansal	Tech Ofcr (B)	STS0010

Sh Prabhu Shankar Tripathi	Tech Ofcr (B)	STS0010

Civil Engineering

Sh I P Singh	Exe. Engg.	STS0013
Sh Dharam jit Singh	Asst. Exe. Engnr.(Civil)	STS0013
Sh V K Singh	Asst. Exe.Engnr.(Civil)	STS0013
Sh Anuj Gaur	Astt. Exe. Engg.	STS0013

Seminar Complex

Sh Subhash Chandra	Tech Ofcr (EI)	STS0015

Workshop

Sh Surendra Singh Verma	Scientist F	STS0016
Sh Ram Sarup	Tech Ofcr (C)	STS0016

Central Computer Facility

Dr Ravi Mehrotra	Scientist F	STS0018
Sh V Sakthivel Samy	Scientist C	STS0018
Ms Deepti Chaddha	Scientist B	STS0018
Sh Ashok Kumar	Tech Ofcr (B)	STS0018
Sh Kanwaljit Singh	Tech Ofcr (B)	STS0018
Sh Vijay Sharma	Tech Ofcr (B)	STS0018

Not Reporting

Sh V K Gogia	Scientist C
Sh S K Gupta	Scientist C

ADMINISTRATION & HOUSE KEEPING

Sh R P Sharma	COA	Infrastructure
Sh B S Rawat	Controller Fin & Acon	Infrastructure
Mrs Saroj Dhingra	F & A O	Infrastructure
Sh Brijesh Sharma	SPO Gr. I	Infrastructure
Dr (Mrs) Shakuntala Sharma	Sr Hindi Officer	Infrastructure
Sh Dhirender Kumar	Admn. Ofcr	
Sh Sudershan Sharma	SPO	Infrastructure
Sh Vijay Kumar	Sr Security Ofcr	Infrastructure
Sh Lakhpat Singh	Sr Security Ofcr	STS0019
Sh Kuldeep Kaushik	S O (str & pur)	Infrastructure

Sh S N Gupta	S O (str & pur)	Infrastructure
Sh Surender Kumar	S O (str & pur)	Infrastructure
Sh Bhag Singh	S O (str & pur)	Infrastructure
Sh Indrajeet	PS	Infrastructure
Mrs Paramjit Kaur	PS	OLP0002
Sh R K Bhasin	PS	OLP0046
Sh Mange Ram	PS	OLP0051
Sh Hankolin Chongloi	SO (F&A)	Infrastructure
Sh Satish Kumar	SO (F&A)	Infrastructure
Sh S K Thakur	SO (F&A)	Infrastructure
Sh Naveen Pavithran	SO (str. & pur)	Infrastructure
Sh Subhash Chander	SO(G)	Infrastructure
Sh Bal Krishna	SO(G)	Infrastructure
Sh D K Salone	SO(G)	Infrastructure
Sh B K Singh	SO(G)	Infrastructure
Sh Chhering Tobden	SO(G)	Infrastructure
Ms Beena Anupa Kullu	SO(G)	Infrastructure
Sh Umesh Gupta	SO (G)	Infrastructure

Retired Persons

Dr (FNA) Krishan Lal, Sci (Dir Grd)

Sh Har Prakash Narang, Scientist F

Dr Janardan Singh, Scientist F

Mrs Mithlesh Saxena, Scientist EII

Sh Mitthan Lal (Sharma), Scientist EII

Mrs Veena Roonwal, Tech Ofcr (EI)

Sh N K Aggarwal, Tech Ofcr (EI)

Mrs Asha Rani Kaushik,Tech Ofcr (C)

Sh Bhupinder Singh

Sh Arjun Lal Dhingra

Sh Manohar Lal (Gulati), Sr Mech Asstt

Sh Om Prakash Arora, Sr Mech Asstt

Sh Jaspal Singh, Sr Mech Asstt

Sh Dal Chand, Sr Mech Asstt

Sh Mool Chand, Sr Mech Asstt

Sh Jagdish Chand, Sr Mech Asstt

Sh Amrit Pal Singh, Sr Mech Asstt

Sh Jagdish Chander, Sr Mech Asstt

Sh Satendra Pal Kharbanda, Sr Mech Asstt

Sh Ramesh Chand, Sr Mech Asstt

Sh Jagdev Singh, Workshop Asstt VII

Sh Ram Phal, Security Asstt Gr 1

Mrs S A Joseph, PS

Mrs Santosh Khanna, PS

Sh J K Setia, Asstt (G) Grade -1

Obituaries

Sh Shish Ram, PS

Mrs Hardai, Safaiwala

Sh S K Ghosh, Gr II(5)

Sh Jeevan Narain, SMA

Scientist Fellow & Emeritus Scientists

Dr A V Narlikar, Emeritus Scientist

Dr Ashok Kumar Gupta, Emeritus Scientist

Dr B S Mathur, Emeritus Scientist

Dr K K Mahajan, Emeritus Scientist

Dr O P Bahl, Emeritus Scientist

Dr P K Ghosh, Emeritus Scientist

Dr U N Sinha, Emeritus Scientist

Dr Subhash Chandra, Emeritus Scientist

Dr A P Mitra, Hony Secientist

Dr A R Verma, INSA Hony Scientist

Mohd Dilshad, Research Scientist

Dr Vikram Soni, Research Scientist

Research Associates

Sh Rahul Singhal, Prov Res Associates

Dr Dayal Soni, RA

Dr Mitali Shah, RA

Dr S P Singh, RA

Dr Sippy Calra Chauhan, RA

Dr Umendra Kumar, RA

Dr Nirmalaya Karar, RA

Sh Anand Kumar Dwidi, RA

Sh Raj Kishore Sharma, RA

Sh Ravinder Pratap Singh, RA

Dr Sushri Pratima, RA

Km Aparna Mishra, RA

Dr Anil Kumar, RA

Km Punita Singh, RA

RESEARCH AND MANAGEMENT COUNCILS

RESEARCH COUNCIL
(01.01.2004 - 31.12.2006)

S. No.	Name	Status
1	**Prof V S Ramamurthy** Secretary, Department of Science & Technology, Technology Bhawan, New Mehrauli Road, NEW DELHI - 110 016	**Chairman**
2	**Prof Ajay Kumar Sood,** Chairman, Division of Physical and Mathematical Sciences, Dept of Physics, Indian Institute of Science, BANGALORE - 560 012	**Member**
3	**Prof G K Mehta** Nuclear Science Centre, A A Marg, NEW DELHI - 110 067	**Member**
4	**Prof S Dattagupta,** Director, S N Bose National Centre for Basic Sciences, Block - JD, Sector III, Salt Lake, KOLKATA - 700 098 (WB)	**Member**
5	**Dr M J Zarabi** Chairman & M D, Semiconductor Complex Ltd., Sector 72, S A S Nagar - 160 071 (Punjab) Near Chandigarh	**Member**

S. No.	Name	Status
6	**Dr Satish Kaura** Chairman & Managing Director, SAMTEL Colour Ltd., 52, Community Centre, New Friends Colony, NEW DELHI - 110 065	**Member**
7	**Prof S Bhattacharya** Director, Tata Institute of Fundamental Research, (TIFR) Homi Bhabha Road, Colaba, MUMBAI - 400 005	**Member**
8	**Prof N Kumar** Director & Professor of Physics, Raman Research Institute, C V Raman Avenue, Sadashivanagar, BANGALORE - 560 080	**Member**
9	**Sh B A Mylar Rao** Chairman & Managing Director, Central Electronics Ltd., 4, Industrial Area, SAHIBABAD - 201 010	**Member**
10	**Prof S Bhattacharya** Director, Tata Institute of Fundamental Research, (TIFR) Homi Bhabha Road, Colaba, MUMBAI - 400 005	**Member**
11	**Dr H S Maiti** Director, Central Glass & Ceramic Research Institute, 196 Raja S C Mullick Road, KOLKATA - 700 032	**Member** Sister Lab

S. No.	Name	Status
12	**Dr O P Agarwal** Head, (RDPD), Council of Scientific & Industrial Research, Anusandhan Bhawan, 2 Rafi Marg, NEW DELHI - 110 001	**Member** DG's Nominee
13	**Dr Vikram Kumar** Director, National Physical Laboratory, Dr K S Krishnan Marg, NEW DELHI - 110 012	**Member**
14	**Sh C S Prasanna Kumar** Scientist 'G' & Head, PME National Physical Laboratory, Dr K S Krishnan Marg, NEW DELHI - 110 012	**Secretary**

MANAGEMENT COUNCIL
(01.07.2003 - 31.06.2005)

S. No.	Name	Status
1.	Dr Vikram Kumar, Director	Chairman
2.	Dr Anil Kumar Gupta, Sc G	Member
3.	Dr M K Tiwari, Sc F	Member
4.	Dr V N Ojha, Sc F	Member
5.	Dr (Ms) Nita Dilawar, Sc C	Member
6.	Ms Deepti Chadha, Sc B	Member
7.	Sh K G M Pillai, Tech Ofcr 'C'	Member
8.	Sh C S Prasanna Kumar, Sc G, Head, PME	Member
9.	Sh B S Rawat, Dy F & A O	Member
10.	Sh R P Sharma, COA	Member-Secretary