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NATIONAL PHYSICAL LABORATORY

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प्राक्कथन

वर्ष 2007–08 के लिए एनपीएल की वार्षिक रिपोर्ट प्रस्तुत करना मेरे लिए हर्ष का विषय है । एनपीएल, भौतिकी के लिए एक प्रमुख प्रयोगशाला है तथा इसके विभिन्न कार्यकलापों में राष्ट्रीय मानक, पदार्थ विज्ञान तथा वायुमंडलीय भौतिकी शामिल हैं ।

एनपीएल का यह हीरक जयंती वर्ष है, एक विशेष स्मारक अंक को 2006–07 में संकलित किया गया था जिसमें एनपीएल के इतिहास, उपलब्धियों तथा भावी दशष्टिकोण का वर्णन करते हुए इसके साठ वर्षों के इतिहास का उल्लेख किया गया है तथा इस पुस्तक का विमोचन हमारे माननीय विज्ञान और प्रौद्योगिकी मंत्री द्वारा 29 अगस्त, 2007 को किया गया था ।

भौतिकी के क्षेत्र में उन्नत अनुसंधान का कार्य विभागीय अवसंरचना के अंतर्गत किया जाता है तथा इस अवसंरचना के अंतर्गत भौतिक यांत्रिक मानक, विद्युत तथा इलेक्ट्रॉनिक मानक, इंजीनियरी पदार्थ, इलेक्ट्रॉनिक पदार्थ, पदार्थ अभिलक्षणन, रेडियो तथा वायुमंडलीय विज्ञान, अतिचालकता तथा निम्नतापिकी नामक सात विभाग शामिल हैं ।

माप के राष्ट्रीय मानकों का अनुरक्षण और उन्नयन एनपीएल का एक संवैधानिक दायित्व है (माप तथा तौल अधिनियम 1956 और 1976 तथा मानक तौल तथा माप अधिनियम 1976 के लिए 1988 के नियमों के अंतर्गत अधिदेशाधीन तथा इसके साथ–साथ भौतिकी के अग्रणी क्षेत्रों में गहन अनुसंधान तथा विकास का कार्य अनेक बाह्य रूप से तथा आंतरिक (इन हाउस) परियोजनाओं के माध्यम से निष्पादित किया जाता है । सीएसआईआर के नेटवर्क–परियोजनाएं कार्यक्रम के आरंभ किए जाने के साथ–साथ, एनपीएल द्वारा इन अनेक परियोजनाओं में महत्वपूर्ण भूमिका का निर्वहन किया जा रहा है जिसे इस प्रतिवेदन में उल्लिखित की गई गतिविधियों के अंतर्गत देखा जा सकता है ।

वर्ष 2007–08 में मानक विभाग के विभिन्न समूहों ने अंतर्तुलना में सफलतापूर्वक भाग लिया । इसके द्वारा 3164 कैलिब्रेशन रिपोर्ट उद्योगों, संस्थाओं तथा प्रत्यायोजित प्रयोगशालाओं को जारी की गई, माप–पद्धति से संबंधित समस्याओं का हल खोजने के लिए 10 निजी/लोक उपक्रमों को सलाह मशविरा प्रदान किया गया तथा प्राथमिक और द्वितीयक मानकों का विकास कार्य भी निष्पादित किया गया । परस्पर सहयोग के आधार पर विभिन्न पैरामीटरों के अनुसार चौदह प्रशिक्षण कार्यक्रम आयोजित किए गए जिसके परिणामस्वरूप देश तथा पड़ोसी देशों में माप–पद्धति के क्षेत्र में कौशलयुक्त मानवशक्ति का विकास संभव हुआ ।

यह बहुत ही गर्व का विषय है कि हमें ''उन्नत मैग्नीशियम एक्स्ट्रूजन एलॉयस का विकास'' करने के लिए 1.00 करोड़ रुपये के कुल वित्त पोषण के साथ विश्व में अग्रणी ऑटोमोबाइल विनिर्माता अर्थात् जनरल मोटर्स की ओर से एक अनुसंधान तथा विकास परियोजना सौंपी गई । इस परियोजना के प्रथम चरण को सफलतापूर्वक निष्पादित कर दिया गया है तथा अंतर्राष्ट्रीय मानकों के अनुसार एक उपलब्धि रेअर अर्थ एलीमैंट के निम्न समावेश से एक्सट्रूडिड मैग्नीशियम एलॉयस की डक्टिलिटी संवर्धन करना रहा है । दूसरा चरण इंजीनियरिंग सामग्री के प्रसंस्करण का विस्तार है, जिसका ऑटोमोबाइल, एरोस्पेस तथा इलेक्ट्रॉनिक उद्योगों में अधिकाधिक अनुप्रयोग किया जा रहा है । हम सभी इस बात से अवगत हैं कि सीएसआईआर का एक प्रमुख अधिदेश निजी उद्योगों से प्राप्त परियोजनाओं पर कार्य करना है तथा मुझे पूरा विश्वास है कि निजी वित्तीय भागीदारी के साथ इस प्रकार की अनेक नई परियोजनाएं भविष्य में उभर कर सामने आएंगी ।

इलेक्ट्रॉनिक प्रदार्थो के अर्न्तगत, प्लाज़्मा डिस्पले पैनल्स के लिए फॉस्फर्स सिंथेसिस का कार्य सैमटैल के साथ किया जा रहा है । सॉलिड स्टेट लाइटिंग अनुप्रयोगों के लिए नए डाउन–कन्वर्जन फास्फर्स का विकास किया जा रहा है । माइनोरिटी करियर लाइफटाइम मापन के लिए फोटोकरंट जेनरेशन तकनीक का विकास किया गया है । श्रेष्ठ इलेक्ट्रोक्रोमिक गुणधर्मों से युक्त पीईडीओटी–एसडीएस के नोवेल पॉलीमर फिल्म का सिंथेसिस प्रगति पर है । एस आई (5512) सतह पर एंटीमोनी आईडी अवसंरचनाओं का सश्जन प्राप्त कर लिया है ।

अभिलक्षणन सुविधाओं के आधुनिकीकरण के एक हिस्से के रूप में, फील्ड उत्सर्जन गन (वोल्टेज को 300 के.वी. तक एक्सीलिरेट करते हुए) सहित ईडीएएक्स अटैचमैंट तथा एसटीईएम के साथ एक अत्याधुनिक एचआरटीईएम को हाल ही में अधिष्ठापित किया गया है । उच्च मैग्नीफिकेशन तथा लैटिस स्केल तक के रिजोल्यूशन पर सामग्रियों के सूक्ष्म अवसंरचनात्मक अभिलक्षणन के लिए यह एक सर्वोत्कर्ष टूल है । फेरोफलयूड का प्रयोग करते हुए चयनात्मक रेंज तापमान सेंसर का भी विकास किया गया है । इस उपस्कर से 5 एम के तक के तापमान के बहुत अधिक कम तापमान का पता लगाया जा सकता है । सीआरएम कार्यक्रमों के एक हिस्से के रूप में इस्पात तथा एल्युमिना पर तीन नए सीआरएम का विकास किया गया है तथा उन्हें प्रस्तुत किया गया है । लीथियम नियोबेट सहित विभिन्न जैविक, अजैविक अर्द्ध–जैविक अरेखीय ऑप्टिकल सामग्रियों का विकास किया गया है तथा अभिलक्षणन किया गया है । अनेक सीयू–सीओ हैट्रोस्ट्रक्चर्स का एसआईएमएस डेप्थ प्रोफाइलिंग कव कार्य भी निष्पादित किया गया है । यह विभाग एनपीएल के अन्य समूहों तथा बाहरी अनुसंधान तथा विकास संस्थानों और उद्योगों के अनुसंधान तथा विकास कार्यकलापों के अभिलक्षणन का कार्य भी करता है ।

रेडियो संप्रेषण, नेवीगेशन तथा भारतीय संदर्भ में अन्य उन्नत अनुप्रयोगों को उन्नत बनाने के उद्देश्य से आयोनाइज्ड तथा नॉन आयोनाइज्ड मीडिया का अभिलक्षणन भी किया गया है । परिवर्तनशील वायुमंडलीय पर्यावरण, प्रक्रियाओं तथा वायुमंडलीय ट्रेस संघटकों के संबंध में प्रभावों, ग्रीन हाउस गैसों, एयरोसोल्स तथा सौर विकिरण जिसमें टेम्पोरल तथा स्पैशियल (अंटार्कटिका तथा आर्कटिक सहित) मापन और मॉडलिंग के संबंधित अध्ययन किए जा रहे हैं ।

थर्मोइलेक्ट्रिक पावर, मैग्नेटो–प्रतिरोधकता तथा मेग्नेटाइजेशन मापन के द्वारा भिन्न डोपेंट्स जैसे ए वन नैनो–सी, नैनो–एसआईसी तथा नैनो–डायमंड्स के साथ डोप्ड एमजीबी 2 बल्क सुपर–कनडक्टर्स में कई आधारभूत अनुसंधान कार्य किए गए।

मानव संसाधन विकास के संदर्भ में, एनपीएल द्वारा विश्वविद्यालयों तथा अन्य शैक्षणिक संस्थानों के छात्रों को परियोजना कार्य और प्रशिक्षण के लिए सुविधाएं उपलब्ध कराई जा रही है। समस्त भारत में स्थित विभिन्न संस्थानों के एम.एस.सी., एम.ई./एम.टेक, एमसीए, बी.ई./बी.टेक आदिका अध्ययन करने वाले 200 से अधिक छात्रों द्वारा अल्पकालिक तथा दीर्घकालिक प्रशिक्षण प्राप्त किया गया है । पांच अनुसंधान छात्रों को उनके द्वारा शोध–प्रबंध को पूरा करने पर पी.एच.डी. की उपाधि प्रदान की गई । चौदह प्रशिक्षण कार्यक्रमों का संचालन किया गया जिनमें उद्योगों, अन्य संस्थानों तथा एन.पी.एल. के भागीदारों सहित अनेक भागीदारों ने हिस्सा लिया । इसके अलावा अनेक शैक्षणिक संस्थाओं/संगठनों द्वारा एनपीएल की यात्राएं की गईं ।

वर्ष 2007–08 के दौरान एससीआई में लगभग 225 वैज्ञानिक तथा तकनीकी दस्तावेजों का प्रकाशन किया गया तथा विभिन्न राष्ट्रीय तथा अंतर्राष्ट्रीय सम्मेलनों में 197 दस्तावेजों को प्रस्तुत किया गया । भारत में तथा विदेशों में पांच–पांच पेटेंट्स को पंजीकरण के लिए प्रस्तुत किया गया । गत वर्ष के दौरान पंजीकरण के लिए प्रस्तुत किए गए पेटेंटों तथा विदेशों में पंजीकरण के लिए प्रस्तुत आठ पेटेंटों को 2007–08 में मंजूरी प्राप्त हुई । 35 नई परियोजनाओं (प्रायोजित तथा परामर्शी) पर कार्य किया गया तथा 3164 केलिब्रेशन रिपोर्टें जारी की गई जिनसे लगभग 494 लाख रुपये का ईसीएफ एकत्र किया गया ।

मैं एनपीएल के वैज्ञानिकों, इंजीनियरों तथा प्रशासनिक, वित्त, भण्डार तथा क्रय स्टॉफ तथा वैज्ञानिक और तकनीकी सेवा स्टॉफ तथा अवसंरचना सेवाओं के सदस्यों का उनकी रुचि तथा सहयोग के लिए आभार व्यक्त करता हूं । इसके साथ मैं प्रकाशन समिति तथा संबद्ध टीम का इस रिपोर्ट के प्रकाशन के लिए भी धन्यवाद करता हूं । श्री प्रेमचंद, श्री एन.के. वधवा तथा श्री आर.जी. मीणा द्वारा किए गए विशेष प्रयासों की भी मैं भूरि–भूरि प्रशंसा करता हूं ।

विक्रम कुमार

(विक्रम कुमार)

निदेशक

Foreword

It is my pleasure to present the NPL Annual Report for the year 2007-08. NPL being a prime laboratory for physics, the spectrum of its activities covers the areas of National Standards, Material Sciences and Atmospheric Physics.

This year being the Diamond Jubilee year, A special commemorative volume, which was compiled in 2006-07, highlighting sixty years of NPL enumerating its history, achievements and future vision, was released by our honorable Minister of Science & Technology on 29th August 2007.

Advanced research in 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, Superconductivity and Cryogenics.

While maintenance and upgradation of National Standards of Measurements remains the statutory responsibility of NPL (as mandated by the standards of weights and measures Act 1956 and 1976 and under the rules of 1988 for the standards weights and measures Act 1976), 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 Report.

In 2007-08 various groups of the Standards Division successfully participated in many inter-comparison, issued 3164 calibration reports to industries, institutions and accredited laboratories, provided consultancy to 10 private/public entrepreneur in solving the metrology related problems, development of primary & secondary standards. Fourteen training programs in various parameters were organized in collaboration, contributing to the development of skilled man power in the field of metrology in the country as well as neighbouring countries.

It is a matter of great pride that we have been awarded R&D project from Global Automobile Manufacturer, General Motors, with a total funding of more than Rs. 1.00 Crore on "Development of Advanced Magnesium Extrusion Alloys". The first phase of this project has since been successfully completed and one of the significant achievements, even by international standards, has been the enhancement of ductility of extruded magnesium alloys with slight addition of rare earth element. The second phase is an extension on the processing of this engineering material, which finds increasing applications in automobile, aerospace and electronic industries. We all are aware that one of the prime mandate of CSIR is to undertake projects from Private Industry and I am sure that many more such projects with private financial participation would emerge in near future.

Under Electronic Materials synthesis of phosphors for Plasma Display Panels is being carried out along with SAMTEL. New down-conversion phosphors for solid state lighting applications are being developed. Photocurrent Generation Technique has been developed for minority carrier lifetime measurement. Synthesis of novel polymer films of PEDOT-SDS having superior electrochromic properties is in progress. Formation of antimony 1D structures on Si (5512) surface has been achieved.

As a part of modernization of characterization facilities, recently a state of the art new HRTEM having field emission gun (accelerating voltage up to 300kV) with EDAX attachment and STEM has been installed at NPL . It is an excellent tool for the microstructural characterization of materials at high magnification and resolution upto lattice scale. A selective range temperature sensor has been developed using ferrofluid. The device is capable of sensing very low temperature upto 5mK. As a part of the CRMs programme, three new CRMs on Steel and Alumina have been developed and released. Various organic, inorganic and semi-organic non linear optical materials including lithium niobate have been grown and characterized. SIMS depth profiling of different Cu-Co hetrostructures have been carried out. The division is also engaged in characterization of R&D activities of other groups of NPL and outside R&D institutes and industries.

Characterization of the ionized and non-ionized media for the purpose of betterment of various types of radio communication, navigation and other advance applications in Indian context is being carried out. Studies related to changing atmospheric environment, processes and impacts in respect of atmospheric trace constituents, green house gases, aerosols and solar radiation involving temporal and spatial (including Antarctica and Arctic) measurements and modeling are being made.

Lot of basic research in doped MgB_2 bulk superconductors with different dopants like Al, nano-C, nano-SiC and nano-diamonds was carried out by thermoelectric power, magneto-resistivity and magnetization measurements

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. Over 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. Five research fellows on completion of their thesis work have been awarded Ph.D. Fourteen training courses were organized where large number of persons including participants from industry, other institutions and NPL participated. Besides number of visits by educational institutes/organization to NPL were arranged.

During 2007-08, about 225 scientific and technical papers were published in SCI journals and 197 papers were presented at various national and international conferences. Five patents were filed in India and five were filed abroad. Ten patents filed in India and eight patents filed abroad in previous years were granted during 2007-08. Thirty five new projects (sponsored and consultancy) were undertaken and 3164 calibration reports were issued, which contributed to generation of an ECF of about Rs.494 lakhs.

I would like to acknowledge the contributions of NPL Scientists, Engineers, and the staff of administration, finance, stores and purchase, the Scientific & technical Services Support staff and the infra-structure services for their interest and co-operation. 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 Prem Chand, Sh. N.K. Wadhwa and Sh. R.G. Meena are also appreciated.

(Vikram Kumar)

Director

Preamble

National Physical Laboratory is one of the first National Laboratories set up under CSIR. Its foundation stone was laid by the first Prime Minister of India, Late Pandit Jawahar Lal Nehru on 4th January 1947. Late Dr. K.S. Krishnan, FRS, was the first Director of the laboratory. The main building was opened by the then Deputy Prime Minister, Late Sardar Vallabhbhai Patel on 21st January 1950.

CHARTER

The main objectives of NPL has been a) to establish, maintain and improve National Standards of Measurements and to realize the Units based on International system, b) to identify and conduct research in areas of Physics, which are most appropriate to the needs of the Nation and for the advancement of the field, c) 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 and d) to keep itself informed of and study critically the status of physics.

CUSTODIAN OF NATIONAL STANDARDS OF MEASUREMENT

National Physical 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; 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 accreditation body in the country (i) its qualified assessors as needed for establishing best measurement capability of the applicant laboratory; (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 estimation of uncertainty in their measurements.

Besides, the laboratory is engaged in development 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 -17025) and of the NABL.

MAJOR ACHIEVEMENTS

National Physical Laboratory has to its credit innumerable number of achievements, a few major achievements are: a) Introduction of Metric system of measurements in India, b) Development of Indelible ink – the indelible contribution to Indian democracy, c) Estimation of methane gas emission from India – a nationwide measurement campaign giving countrywide advantage in environment protection, d) Setting up a pilot plant for development of Electronic components (ferrites), which led to setting up a public sector Unit called Central Electronics Ltd. (CEL) in 1973, e) Development of know-how of the Electrostatic Photocopying machine using indigenous materials and f) Indian Standard Time.

The major thrust areas of R & D are

(A) Metrology

- Calibration & Testing Services to Industries
- Electrical & Electronic Standards
- Physico – Mechanical Standards
- Metrology in Chemistry
- Nano Metrology
- Primary Standards
- Realization of SI units

(B) Materials

- Light weight, high strength metallic materials
- Bulk nano metallic and Nano composite materials
- Carbon & Carbon composites
- Plasma processed materials
- Organic and Inorganic Photovoltaic
- Organic Light emitting diodes
- Conducting Polymers & Composites
- Superconducting materials and Superconductivity
- Fuel cells
- Smart windows
- Sensors (Based on Bio, Gas, Chemicals, MEMS)
- Advanced Characterization Techniques

(C) Radio and Atmospheric Sciences

- Ionosphere & Troposphere
- Atmospheric Environment
- Global Climate charge
- Antarctica and Arctic studies
- Radio- Propagation
- Communications (Fixed, mobile and marine)

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 Secretariat (ii) Administration (iii) Finance & Accounts, (iv) Store & Purchase, (v) Library, (vi) Scientific Support Services, (vii) Technical Support Services, (viii) Workshop and (ix) Central Computer Facility.

R & D GROUPS & MANAGEMENT

NPL Diamond Jubilee Celebration Valedictory Function

August 29, 2007

National Physical Laboratory
'Diamond Jubilee Year' - 2007

Sixty years in the life of an Institution is an important occasion and it always holds a special significance for an Institution like National Physical Laboratory, the largest CSIR laboratory in India. On this important and historic juncture in the life of the laboratory, several conferences and events were organized as part of its Diamond Jubilee Celebrations.

A function was organized at the Physics Department, University of Delhi on 12th April 2007 at 15:30 hrs to commemorate the assumption of office of NPL at this location by the Founder Director of NPL, Sir Dr. K.S. Krishnan. On this occasion, Dr. Vikram Kumar, Director, NPL welcomed the audience comprising of faculty of the University of Delhi, the NPL scientists and other dignitaries. Prof. Deepak Pental, the Vice Chancellor, University of Delhi was the chief Guest at this function. He unveiled a plaque of Sir K S Krishnan, which was installed on the wall outside the room of the Founder Director.

Late Dr. A.P. Mitra, former DGCSIR and also former Director NPL gave the keynote lecture in which he described the exciting era of the late forties and the fifties during which the Radio Science Division of NPL carried out ground, rocket and satellite based ionospheric studies as a part of the International Geophysical Year (IGY). Dr. A.R. Verma, former Director, NPL in his presidential speech, gave a first hand account of the first couple of years that NPL had its office at the Physics Department of the DU.

The Diamond Jubilee celebrations were concluded on 29th August 2007 at a special valedictory ceremony. Shri Kapil Sibal, Honorable Minister for Science & Technology, and Earth Sciences was the Chief Guest while Prof. S.K. Joshi, former DG CSIR and Former Director NPL, presided over the function. Former Directors of NPL and many distinguished dignitaries were also present at the occasion

On this occasion Tree Plantation was done by Honorable Minister Sh. Kapil Sibal, Former Directors, Dr. A.R. Verma, Dr. S.K. Joshi, Dr. Krishan lal and the present Director Dr. Vikram Kumar.

In his welcome remarks, Dr. Vikram Kumar, Director NPL, recalled the valued contributions of his predecessors and the staff in building up the laboratory, bringing it to the present state. Dr. Kumar said that during all these years the laboratory had strived to realize the hopes expressed by its founders by not only fulfilling its primary mandate as a keeper of measurement standards, but also by substantially expanding its research activities in areas of importance to our country and its industrialization. He named several important technologies developed at NPL during the last six decades.

After the presidential remarks by Dr. S.K. Joshi, the Hon'ble Minister released a special Commemorative volume **"*The Legacy Continues*"**, highlighting sixty years of NPL (1947-2007) enumerating its history, achievements and future vision. Mementoes were also given to all the staff members of NPL.

The Hon'ble Minister started his address by thanking for being invited for the special occasion of Diamond Jubilee celebrations of NPL and congratulating the NPL family on the occasion recalling the glorious past of the laboratory. Talking of NPL he said that though he was not a scientist himself but realized the importance of accurate measurements in all walks of life. He said that one could standardize something only if he could measure its physical attributes, which is essential for successful commercialization. He exemplified his statement by quoting Lord Kelvin that if you can measure it, you can improve it, because unless you know what to measure, you do not know what improvements are required.

Further he divided the 60 years of NPL's existence into different eras as the "Formative era", the "Era of consolidation" and the "New millennium Era" Moving from history to the present he said that we must know what we are going to be confronted with. He said that he was told that there was a time when NPL was like a showpiece of country. It was the time when NPL was the Mecca for dignitaries and whosoever came to India or New Delhi visited NPL. He further said that there were many firsts to NPL's credit like, R&D in the areas of carbon, ferrite and solar energy. He asked the scientists and staff to endeavor to bring NPL to greater glory.

भौतिक–यांत्रिक मानक

PHYSICO-MECHANICAL STANDARDS

भौतिक यांत्रिक मानक

भौतिक यांत्रिक मानक प्रभाग राष्ट्रीय भौतिक प्रयोगशाला, भारत की सात अनुसंधान एवं विकास डिवीजनों में से एक है । प्रभाग का गठन यांत्रिक माप के कार्यकलापों के लिए किया गया है जिसमें निम्नलिखित के पैरामीटर शामिल हैं :–

(1) द्रव्यमान, आयतन, घनत्व तथा श्वानता मानक

(2) लम्बाई तथा विमा मानक

(3) तापमान तथा आद्रता मानक

(4) ऑप्टिक रेडिएशन मानक (दश्श्य अवरक्त तथा पराबैंगनी क्षेत्र)

(5) बल, ऐंठन तथा कठोरता मानक

(6) दाब तथा निर्वात मानक

(7) ध्वनिक तथा पराश्रव्य मानक

(8) द्रव्य प्रवाह मानक (केवल जल मीडियम)

(9) प्रघात तथा दोलन संवेदक

प्रभाग ऊपर वर्णित कार्यकलापों से सम्बन्धित मापों के राष्ट्रीय मानकों को स्थापित करने, बनाए रखने तथा सतत् रूप से अपग्रेड करने तथा देश के उद्योग तथा संस्थाओं का शीर्ष स्तर की अंशांकन सेवाएं उपलब्ध कराकर मानकों का प्रसार करने के लिए उत्तरदायी है तथा तत्पश्चात् इनके द्वारा किए गए मापों के लिए अनुरेखणीयता सुनिश्चित होती है । एन पी एल , भारत ने बी आई पी एम के पारस्परिक मान्यता समझौता पर हस्ताक्षर किए हैं तथा अंशांकन तथा माप सक्षमताओं (सी एम सी) के अधिकांश कार्यकलाप बी आई पी एम की वेबसाइट (www.bipm.org) पर उपलब्ध है ।

उपर्युक्त कार्यकलाप ने बी आई पी एम तथा ए पी एम पी (एशिया पेसिफिक मेट्रोलॉजी प्रोग्राम)/आर एम ओ (एशियन क्षेत्र के रीजनल मेट्रोलॉजी आर्गेनाइजेशन) द्वारा नियमित रूप से समन्वित/आयोजित सातवीं अन्तर्राष्ट्रीय अंतः –साम्य (इंटरनेशनल इंटर–कंपेरिजन) में भाग लिया ।

एक नई माप सुविधाओं का सश्जन निम्नलिखित प्राथमिक/संदर्भ मानकों स्थापित करके प्रयोक्ता उद्योगों के लिए उन्नत माप अनिश्चितता के साथ प्रसार करने के लिए किया :–

- एक किलोग्राम का द्रव्य तुलनित्र (कंपेरेटर)
- लेज़र व्यतिकरणमापी वाले फ्लिक मानक की अनुरेणणीयता
- 1000–16000° से. की रेंज में मानक थर्मोकपल विकसित करने के लिए टाइप – एस एण्ड आर धर्मोकपल की माप
- स्पेक्ट्रल दीप्ति के परिवर्ती तापमान काली परत (ब्लैक बॉडी) प्राथमिक मात्रक
- विकर्ज़ कठोरता प्राथमिक मात्रक
- 60 के लीटर/घंटा तक भारात्मक (ग्रेवी मेट्रिक) पद्धति पर आधारित पूर्णतः स्वचालित द्रव्य प्राथमिक मानक

राष्ट्रीय माप पद्धति के नेटवर्क को स्थापित करने की प्रक्रिया को गति देने के लिए इस प्रभाग के वैज्ञानिकों ने बहुत सी प्रयोगशालाओं की तकनीकी सक्षमताओं का मूल्यांकनकर्त्ताओं के रूप में नेशनल एक्रीडिटेशन बोर्ड फॉर टेस्टिंग एण्ड केलिब्रेशन लेबोरेट्रीज़ (एन ए बी एल) की सहायता की है ।

एक समान ही क्षेत्र में कार्यरत विभिन्न उद्योगों की माप सक्षमताओं में एकरूपता बनाए रखने के लिए सुनियामक दक्षता परीक्षण कार्यक्रम का आयोजन एन ए बी एल के साथ सहयोग करके किया गया ।

PHYSICO-MECHANICAL STANDARDS

Physico-Mechanical Standards Division is one of seven R&D Divisions of National Physical Laboratory, India. The division constitutes of mechanical measurement activities involving the parameters of

1. Mass, Volume, Density and Viscosity Standards
2. Length and Dimension Standards
3. Temperature and Humidity Standards
4. Optical Radiation Standard (visible infrared and ultraviolet regions)
5. Force, Torque and Hardness Standards
6. Pressure and Vacuum Standards
7. Acoustic and Ultrasonic Standards
8. Fluid Flow Standards (Water medium only)
9. Shock and Vibration Sensors

The division is responsible to establish, maintain and continually upgrade the National Standards of Measurements related to above said activities and disseminates the standards by providing the apex level calibration services to the industry and institutions of the country and thus ensures the traceability to measurements made by these.

NPL, India is the signatory of the Mutual Recognition Arrangement (MRA) of BIPM and the calibration and measurement capabilities (CMC) of most of the activities are available on BIPM website (www.bipm.org).

The above activities participated in 07 international inter-comparison organized/ coordinated by BIPM and or APMP (Asia Pacific Metrology Program) / RMOs (Regional Metrology Organization of Asian region) regularly.

New measurement facilities were created to disseminate with improved measurement uncertainty to user industries by establishing the following primary/reference standards:

- One kg mass Comparator
- Traceability of the Flick Standard with Laser Interferometer
- Measurement of Type-S & R thermocouples to develop Standards thermocouples in the range 1000-1600 °C
- Variable Temperature blackbody primary standard of spectral radiance
- Vickers Hardness Primary Standard
- Fully automated fluid flow primary standard based on gravimetric method upto 60 K litre/hr.

In order to expedite the process of establishing the network of National Measurement System, the scientists of this division helped National Accreditation Board for Testing and Calibration Laboratories (NABL) as the Lead and Technical Assessors in assessing technical capabilities of several laboratories.

In order to maintain the uniformity in measurement capabilities of different industries operating in the same area, well regulated proficiency testing program was organized in collaboration with NABL.

Mass Standards

Under the Network Project a new one kg mass Comparator from M/s Sartorius AG Germany Model CC-1000S-L has been procured and installed during the year. The comparator has its maximum capacity 1 kg and repeatability of 2 µg. Using this new Mass Comparator, four 1 kg transfer standards have been calibrated against the national prototype kilogram with improved overall measurement uncertainty of 28 µg against existing CMC at 40 µg claimed in our CMCs of Appendix C of BIPM Database.

In continuation of organizing, coordinating and working as a Pilot Laboratory in APMP.M.M.K2 inter-comparison in mass measurements, after completion of the final circulation, the travelling standards have been recalibrated against the check standards and study of their stability for about three months have been carried out. After this study the measurement results were analyzed and Draft A Report of this inter-comparison was prepared and circulated among the participants for their comments, if any. In consultations with the participated laboratories Draft B Report is under preparation.

Under SAARC-PTB Technical Cooperation Programme, one week Training to the staff of National Bureau of Standards & Metrology (NBSM) of Nepal and to the staff of Measurement, Units, Standards & Services Department (MUSSD) of Sri Lanka was given on site.

Length & Dimension Standards

Length & Dimension Standards Group has developed a new methodology using image processing and wavelet transform is developed to measure the size of the wire sieves and their spacing. Wire sieves are used in pharmaceuticals/chemical industries for filtering the grains of chemical powder. Experimental results show that the diameter and spacing of the wire in the sieves can be measured with the accuracy of 1µm and uncertainty of measurement of ± 1 µm at 95% confidence level. The method is also found suitable for detecting any missing wire or any other defect like bending or kink in the wire. In this techniques wavelet transform (Symlet wavelet) analyses the image of sieve in such a way that the discontinuity (cracks, defects, nonuniformity) can be detected more precisely and the spacing/ wire diameter can be measured accurately. Once the image has been acquired and stored in the computer it is available for off line analysis of the sieve sample. Discrete wavelet transform is used to analyze the acquired image as shown in Fig. 1.1. The two-dimensional wavelet transform decomposes the image in horizontal, vertical and diagonal components at different levels of intensities containing mesh information content as shown below.

The Indian patent (Indian Patent 197541) titled "An apparatus for measuring sieve dimensions and a method thereof" has been granted and the copy right (SW-2353) of the software entitled "Gauge Block Interferometry" has also been obtained through CSIR, New Delhi. Technology transfer process is in progress.

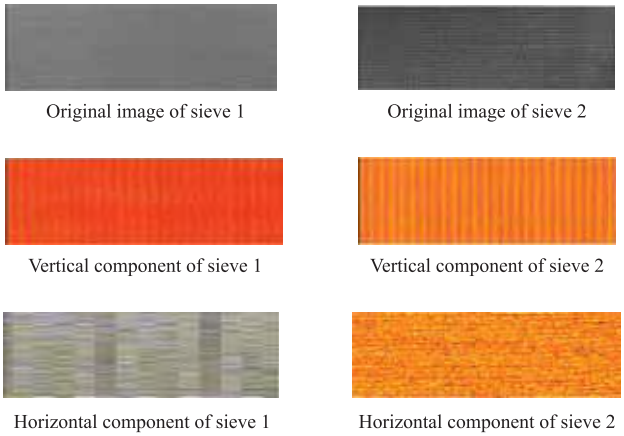


Fig. 1.1 : Original and analysed images of the wire sieves

The Group also participated in the following intercomparisons:

APMP LK 5: Step Gauge Measurement: 620 mm: APMP comparison for the 3 step gauge of length 620 mm has been completed. In this nine NMIs have participated and KRISS Korea was the Pilot lab. Results of the measurements have been submitted to the Pilot lab. The final report is awaited.

APMP LK 3: Angle Gauge Blocks and Polygon measurement: 4 Angle Gauge Blocks of size 5^2, 5¢, 30¢ & 5° and one polygon. Thirteen laboratories are participating.

APMP DEC INTERCOMPARISON: Calibration of Gauge Blocks: (5 steel & 5 tungsten carbide Gauge blocks) completed. Final report is awaited.

SAARC PTB: Calibration of 10 steel gauge blocks: Measurement completed and dispatched to next country in progress. NPL India is the Pilot Lab.

APMP LK 6: Calibration of CMM Ball Plate & Hole Plate (Two D artifact): Measurements completed and the artifacts have been dispatched to NMI Japan that is the pilot laboratory. Final report is awaited.

Temperature & Humidity Standards

A new facility for calibration of high temperature noble metal thermocouples has been created in the range from 1000 ºC to 1600 ºC. Now, standard thermocouples of Type-S, R & B could possibly be calibrated in the overall range from 0 to 1600 ºC. The facility was created for the first time in India to provide apex level calibration and traceability to NABL accredited laboratories all over the country.

Fig. 1.2 (a) : Measurement setup and automation in thermocouple calibration, range 0-1600 ºC

The calibration of thermocouples by inter-comparison method against standard thermocouple has been automated using embedded server technology starting from controlling the HT furnace, data reading of 8-thermocouples at a time, data analysis, evaluating of uncertainty in the calibration for each thermocouple and finally generating the calibration certificate/report in the prescribed format as shown in Fig. 1.2 (a).

A new facility shown in Fig 1.2 (b) for calibration of infrared total radiation pyrometers has been established in the range from 50 ºC to 1300 ºC. The work is under progress to inter-compare the precision measurements with contact as well as with non-contact standard thermometers.

Fig. 1.2 (b) : Calibration set-up for infra-red radiation thermometers, range 50-1200 ºC

The temperature scale from –189.3442 ºC to 961.78 ºC has been established at NPL with all the fixed points as per ITS-90 by realizing triple point of argon with an expanded uncertainty of ± 1.12 m ºC.

Optical Radiation Standards

Source based primary standard of spectral radiance in the form of a variable temperature blackbody has been established. This blackbody works in the temperature range of 1800K – 3200K with temperature stability of ± 0.2K. Its emissivity is 0.999, and exhibits radiance uniformity within 0.1%, in the wavelength range 0.2 μm-2.5 μm. The uncertainty in spectral radiance measurement using this blackbody is 0.3-0.5% in the wavelength range 0.2 μm-0.4 μm, and 0.1-0.3% in the wavelength range 0.4 μm-2.5 μm, respectively. The established facility is shown in Fig. 1.3.

Fig. 1.3 : Set up of the Black Body

The Group has also participated in the APMP Sponsored Key Comparison (CCPR K4.x) on luminous flux with lamps as transfer standards. The transfer standards in the form of three Polaron LF 200 W incandescent lamp having identification nos. as P591, P592 and P593 were procured from NPL, UK. Calibration facilities for the photometric parameters were extended to various lamp and lighting industries, R and D institutions etc. Calibration and Measurement facilities in air UV spectral region were maintained and extended to user industries and institutions.

Basic research on optical coherence for its application on encoding and information processing has been pursued further.

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

Experimental studies were conducted to study the shift of the spectral lines due to dynamic scattering by producing a gaseous medium whose dielectric susceptibility was a function of both space and time. Dopplet-like wavelength shift of the spectral lines emanated from some discharge lamps was observed despite that the source, the scattering medium and the observer were at rest. Results obtained have been published and presented in various forums. The project has been completed successfully and final report has been submitted to DST, New Delhi.

Space Application Sponsored project on "Development of Calibration-Validation (CAL-VAL) site at Kavaratti Island"

In this particular project a laboratory has been developed at the Kavratti island for spectral radiance and spectral irradiance calibration of hyperspectral radiometers procured by SAC, Ahmedabad for ocean color studies. This is one of the achievements of the project. Fundamental research for determination of the immersion factor at various levels of water and various type of water was also carried.

On-line approach to non-contact IR sensor technique for estimation of sugars and its byproducts

In the present work infrared spectroscopic technique is investigated as a rapid and nondestructive alternative of chemical methods for the determination of organic acids and sugars in fruit juices. It allows the simultaneous quantification of glucose, fructose and sucrose in fruit juices to make carbohydrate analysis in fruit juices more amenable to routine measurements. Furthermore, the main organic acids

in fruit juices, citric acid and malic acid have been monitored by this technique. A successful calibration model is developed with one hundred and twenty five synthetic samples that yield good correlation coefficient. The infrared spectroscopy both in mid infrared and near infrared regions allows non-destructive, rapid and accurate analysis of sugars and organic acids in juices and could be applied in quality control of beverages.

Infrared spectroscopic study for tumor diagnosis

Infrared spectra of normal and malignant breast tissues are measured in the 600 cm^{-1} to 4000 cm^{-1} region. The measured spectroscopic features which are the spectroscopic fingerprints of the tissues contain the vital information about the malignant and normal tissues. The novelty of this study is that from the spectroscopic data we could differentiate malignant tissue from the normal one. We analyzed Fourier Transform Infrared (FTIR) data on twenty five cases of infiterating ductal carcinoma of breast with different grades of malignancy from patients of different age groups. Infrared spectra demonstrate significant spectral differences between the normal and the cancerous breast tissues. In particular changes in frequency and intensity in the spectra of protein, nucleic acid and glycogen vibrational modes as well as the band intensity ratios for lipid/proteins, protein/nucleic acids, protein/glycogen are observed. This allows us to make a qualitative and semi quantitative evaluation of the changes in proliferation activity from normal to diseased tissue.

Switching light with light

Theoretical analyses of laser induced nonlinear absorption processes in rhodopsin protein molecules have been performed. The results validate the feasibility of all-optical switching operation '*Switching light with light*', in these protein molecules in very simple pump-probe geometry. The switching speed has been shown to be enhanced from milliseconds to nanoseconds time scale. The performance of the switch in terms of contrast has also been enhanced by optimizing the concentration of molecules.

Force and Hardness Standards

The Dead weight force machine in the range 5-50 N developed earlier was extended to a lower range of 1 N using a specially designed hanger made from aluminium alloy. This fully automated machine has been characterised in the range 1 to 20N using 2N, 3N, 5N, 10N and 20N force transducers and typical calibration results are shown in Fig. 1.4 (a) & 1.4 (b). The observed repeatability and

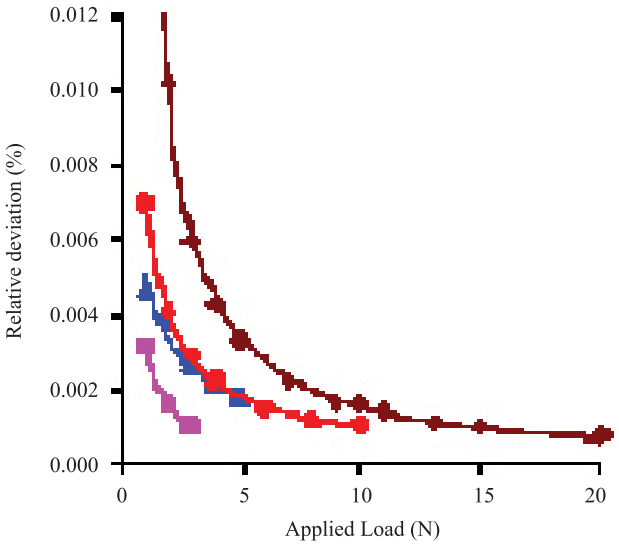


Fig. 1.4 (a) : Relative Repeatability deviation as measured in 50 N dead wt force machine (%)

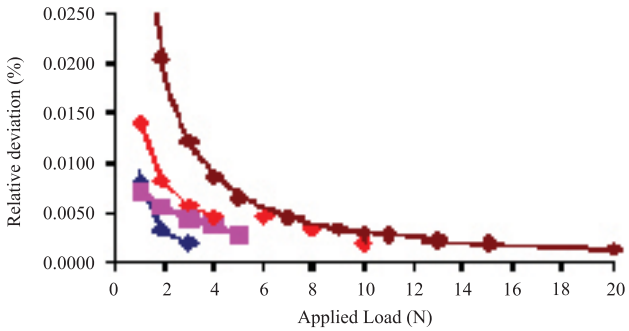


Fig. 1.4 (b) : Relative Reproducibility deviation as measured in 50 N dead weight force machine (%)

reproducibility deviations are below 50 ppm for all the transducers in the range 50% to full scale, thus establishing the suitability of the dead weight force machine as reference force calibration machine in the range 1N to 20 N.

A very **low force measuring system** based on the principle of electromagnetic force compensating balance has been designed and fabricated for calibration of milli-Newton up to few Newton forces (Fig.1.5). The system is a sophisticated mechanical set up comprising of a vibration isolation table, optically flat marble table-top to ensure precision levelling and vertical alignment of the system, double walled temperature stabilized transparent enclosure, sub-micron precision translation stage, etc. The evaluation of the system with low force transducers is in progress including the traceability from the dead weight force machine, mentioned as above in the region 1-20N, by using the results in the overlapping region.

Fig. 1.5 : Low force measuring system

The 2.1 MN build-up system calibrated directly against NPL 1 MN reference standard machine was used to evaluate the metrological performance of the 2 MN hydraulic force calibrating machine. This work has enabled to have the **traceability of the high capacity force hydraulic calibrating machine** in-house up to 1 MN, which was so far based on transfer standard calibrated by PTB.

Calibration of non-conventional flange type torque transducers from industry, belonging to class below 0.5, as per DIN standard No. 51309, was carried out on torque primary standard machine using a newly designed and developed adaptor. Such transducers were so far being calibrated on reference torque standard machine, which is suitable only for class 0.5 and above. Calibration results of a typical commercial transducer showing class 0.1 for all torque values up to full range of 2000 Nm are depicted in Fig. 1.6.

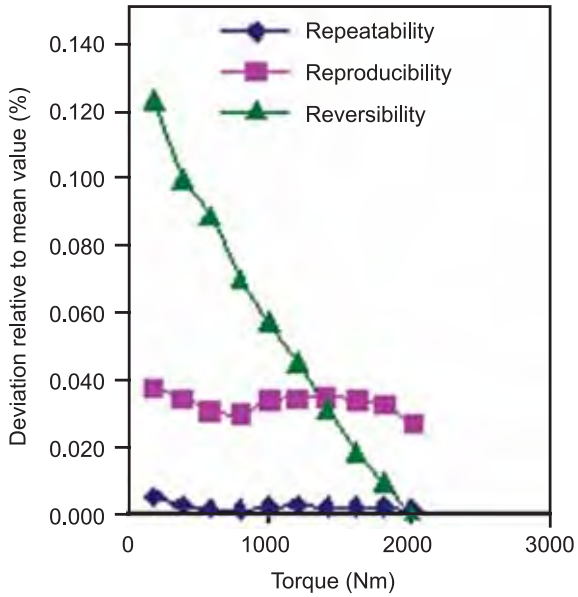


Fig. 1.6 : Metrological characteristics of flange type class 0.1 torque transducer

The proficiency-testing program in torque measurement was initiated. Survey of the interested /participating NABL accredited laboratories was completed and the technical protocol for proficiency testing was finalised. A training program of the participating laboratories in torque wrench calibration is being planned before start of the circulation of the artefacts.

Consultancy projects funded from the Department of Weights and Measures, Ministry of Consumer Affairs, have been undertaken costing approx. more than 3 crores to design, develop and fabricate primary and secondary standard machines, for force as well as torque parameters, to upgrade the calibration capability of Regional Reference Standard Laboratories. It is emphasized here that for verification of UTMs of class I, it is required to use force proving instruments of at least class I. There are no NABL accredited calibration laboratories, except one, in the country, which can undertake calibration of force instruments of class I. NPL is therefore under a lot of pressure to carry out lower level calibration work for such instruments. In order to mitigate this pressure, NPL decided to undertake this project to design, develop and fabricate a simple, portable and user friendly force calibrating machine up to 50 kN, which can be used for calibration of such class I force proving instruments. A prototype of the designed and developed machine is shown in Fig.1.7. This machine works on the principle of force comparison using a double acting hydraulic-piston cylinder applying simultaneously the force on the DUC and the reference force transducer in series.

Fig. 1.7 : Force calibrating machine up to 50 kN based on force comparison principle

This work done will expedite calibration of force proving devices of class I by the force calibrating laboratories and at the same time reduce the calibration work burden of NPL.

The Vickers hardness primary standard, established last year, was evaluated for its calibration and measurement capability to be better than 0.5% for all scales HV1 to HV100 over most of the measurement range. The calibration procedure of Vickers hardness was finalised and calibration of Vickers hardness standard blocks was commenced for jobs from industry to provide traceability in Vickers hardness, which was so far not available to Indian industry.

The force and hardness standards facility is providing national traceability in force, torque and Rockwell hardness through the calibration of force and torque measuring devices and hardness blocks to various users from industries, defence and other government organisations and also from foreign countries including Kuwait, Oman and Nepal. The facilities are being used extensively, which is well reflected in the **ECF** of Rs 53 lakhs (approx.) and the number of calibration reports issued as 513.

Two technical personnel from Afghanistan Standardization Authority were **trained in Force, Torque and Hardness measurement**. A Training program was also conducted for the staff from KIM-LIPI, Indonesia, the NMI of Indonesia, in Force and Torque metrology. The **2nd Indo-Italian Training program in Force, Mass, Pressure, Vacuum and Torque Metrology** was conducted during 18-22 Feb. 2008 at NPL, wherein 59 participants, including 15 from ten developing countries and 44 from India attended.

Pressure and Vacuum Standards

Vacuum Standards

Characterization of Gas Operated Piston Gauge against UIM, the Nation Primary Standard:

We have evaluated of measurement uncertainty using:

(a) Method of Effective Area Estimation of Piston-Cylinder assembly

Preparation of Uncertainty Budget

Determination of Coverage Factor for the required confidence level

Estimation of expanded uncertainty

Q(0.05 Pa, 0.000828 % of reading) at k=2.

(b) Method of Direct Comparison

Preparation of Uncertainty Budget

Determination of Coverage Factor for the required confidence level

Estimation of expanded uncertainty

Q(0.05 Pa, 0.0008 % of reading) at k = 2.

Bilateral Comparison between NIST, USA and NPL, India

The Artefact came from NIST, USA consisted of four numbers of Resonant Silicon Gauges – (RSGs) housed in IGLOU. These four RSGs are : RSG # A : Range: 0 to 10 kPa (abs); RSG # B : Range: 0 to 10 kPa (abs); RSG # C : Range: 0 to 130 kPa (abs) and RSG # D : Range: 0 to 130 kPa (abs). We have collected the data as per the protocol which is agreed upon by both the laboratories. The precise measurements included the collection of minimum ten zero data initially for each set, eight pressure points (RSG # A and RSG # B) in the range 0 to 10 kPa (abs), five data points in each Pressure points, twelve Pressure points (RSG # C and RSG # D) in the range 0 to 130 kPa (abs), five data points in each Pressure points and ten sets of data collection over a period of three months (Jan – Mar, 2008) and finally, five sets required for each RSG (4 Nos). The compilation of collected data and analysis is in progress.

In-house calibration of reference standards

A large numbers of reference standards namely SRGs (NPL-0, NPL-1, NPL-5), CDGs (100 torr abs (2 nos.), 10 torr abs, 10 torr diff, 0.1 torr (abs.)), Resonant silicon gauges, Digital pressure indicator have been carried out for use on our primary standards and for customer gauge calibration. Resuming of calibration service of Standard Leaks for industry. We have fabricated an Igloo package capable of housing our reference gauges at NIST, USA. This package has been given by NIST, USA as a free gift to NPLI.

Studies on the binding energy of H_2O and H_2 on SS surfaces.

Two methods were adopted for this purpose: in the first method, TPD studies were conducted while in the second, actual desorption species of gas evolved during bakeout of a UHV system were monitored at NIST, USA.

Pressure standards

Draft report of key comparison APMP.M.P-K6

The regional key comparison **APMP.M.P-K6** for pressure measurements in gas media and in gauge mode from 20 kPa to 105 kPa was piloted by the Pressure and Vacuum Standards of NPLI,

New Delhi. The transfer standard was a pressure-balance with a piston–cylinder assembly with nominal effective area 335.7 mm^2 (TL-391). Nine laboratories from the APMP region; namely KRISS (Korea), NMI (Australia), NMI (Japan), MSL (New Zealand), SPRING (Singapore), NML-SIRIM (Malaysia), SCL (Hong Kong) and NMI (South Africa) with one specially invited laboratory from the EURAMET region, namely Physikalisch-Technische Bundesanstalt (PTB), Germany, participated in this comparison. The obtained data were compiled and processed under the same program as per the Consultative Committee for Mass and Related Quantities (CCM)/BIPM guidelines and establish a link with CCM.P-K6 through the link laboratory PTB (Germany). Figure 1 shows the degree of equivalence between CCM.P-K6 key comparison participants, namely NMi-VSL(The Neither land), METAS (Sweden), PTB (Germany), NIST (USA), NIM(China), NPL(UK) and NRC(Canada) with the APMP participants mentioned above. These results show an excellent agreement of all participating laboratories within the estimated expanded uncertainties using a coverage factor $k = 2$ (Fig.1.8).

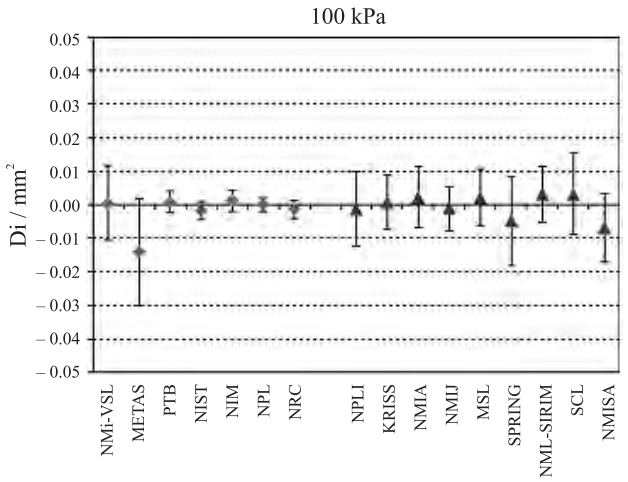


Fig. 1.8 : Summary of results for the degree of equivalence for each NMI with respect to the key comparison reference value for CCM.P-K6 (red mark) and APMP.M.P-K6 (green mark).

The effect of pressure transmitting fluids in the characterization of a controlled clearance piston gauge up to 1.0 GPa

The studies were carried out on the effect of different pressure-transmitting fluids (PTFs) on the systematic characterization of an oil-operated controlled clearance piston gauge (CCPG) (nominal diameter of the piston, 2.5 mm) in the pressure range up to 1000 MPa (1GPa). Pure and mixtures of different PTFs are studied and four will be discussed here; namely, (a) pure normal hydraulic oil (J-13), (b) mixture of J-13 and aviation turbine fuel (ATF), (JATF), (c) pure di-ethyl-hexyl-sebacate oil (BIS) and (d) the mixture of white gasoline (G), J-13 and sebacate (GJBIS).

The characterization is the measurement of the fall-rate of the piston as a function of applied jacket pressure (p_j) with various PTFs using the method of Heydemann and Welch (HW model). The analysis of the results is the determination of the cube root of the piston fall-rate ($v^{1/3}$) with p_j at different loads or measured pressures (p_m). The linear portion of this $v^{1/3} - p_j$ curve is extrapolated towards the null value of fall-rate, and the stall jacket pressure (p_z) at different p_m is obtained. It is observed that reasonably good fall-rate data could be obtained for J-13, JATF and BIS up to maximum pressures of 500 MPa, 700 MPa and 650 MPa, respectively. For GJBIS, this fall-rate data can be obtained up to a maximum pressure of 1 GPa. From the values of p_z at different p_m and also the values of jacket pressure coefficient (d) along with other characteristic parameters in the HW model, we have determined the relative standard uncertainties in the effective area (u(Ae)/Ae) for GJBIS up to 1 GPa for $p_j = 0$ (free deformation mode) and $p_j / p_m = 0.3$. It is interesting to note that for $p_j = 0$, at a p_m of 100 MPa, u(Ae)/Ae is 74×10^{-6},

while at a p_m of 1 GPa, u (Ae)/Ae is 248 x 10^{-6}. However, for p_j/p_m = 0.3, at a p_m of 100 MPa, u(Ae)/Ae is 67 x 10^{-6}, while at a p_m of 1 GPa, u(Ae)/Ae is 125 x 10^{-6}. A comparative study of u(Ae)/Ae has been elaborated with the four PTFs investigated. We have shown that at a p_m of 100 MPa, u(Ae)/Ae is 202 x 10^{-6}, 114 x 10^{-6}, 66 x 10^{-6} and 67 x 10^{-6}, for J-13, JATF, BIS and GJBIS, respectively, while at a p_m of 500 MPa, u(Ae)/Ae is seen to be 97 x 10^{-6}, 57 x 10^{-6}, 46 x 10^{-6} and 56 x 10^{-6} for J13, JATF, BIS and GJBIS, respectively. Our measurements show that GJBIS is a convenient PTF for working up to 1 GPa. Finally, the results of the characterization are compared with the NPLI pressure scale through calibration of a NPLI secondary standard which is traceable to the LNE (France) pressure scale though direct comparison and participation in a recently concluded bilateral comparison with NIST (USA).

Characterization of a hydraulic Piston Gauge up to 50 MPa

We have evaluated of measurement uncertainty of a newly acquired Piston gauge from 0.1 MPa to 50 MPa using the method of crossfloat with reference to the national secondary standard and determine effective Area of the Piston-Cylinder assembly. Evaluation of measurement uncertainty shows that the relative expanded uncertainty is < 43 x 10^{-6} at k = 2.

Coordinated and completed three proficiency testing

NABL-Pressure-PT005: This PT is organized for the laboratories having measurement capabilities better than 0.25 % and coarse than 0.05% of full scale using digital pressure calibrator as an artifact in the pressure range 7 – 70 MPa. The second phase of the PT is already completed during March 2007. There are total 23 participating laboratories. All the laboratories have performed measurement during and the results are being compiled.

NABL-Pressure-PT006: This PT is already completed. It was organized for the laboratories having measurement capabilities coarse than 0.25 % of full scale using pressure dial gauge as an artifact in the pressure range 10 – 70 MPa. There were total 17 participating laboratories. During the period under report, final report is prepared and submitted to NABL. Out of the total **159** measurement results reported, **135 (84.91 %)** measurement results are found in good agreement with the results of the reference laboratory, NPLI, New Delhi, in the present case.

NABL-Pressure-PT007: This PT is also completed. It was also organized for the laboratories having measurement capabilities coarse than 0.25 % of full scale using pressure dial gauge as an artifact in the pressure range 6 – 60 MPa. There were total 17 participating laboratories. During the period under report, final report is prepared and submitted to NABL. Out of the total **117** measurement results reported, **95 (81.2%)** measurement results are found in good agreement. Overall, the results are considered to be reasonably good, being the first proficiency testing for most of the participating laboratories.

High pressure pneumatic controller installed and tested to 250 bar

For the upgradation of pneumatic pressure facility a pneumatic pressure intensifier along with a high pressure gas controller/calibrator were successfully installed and tested upto 250 bar. These along with our newly procured high pressure piston cylinder assembly would enhance our pneumatic capability.

Basics of ANSYS simulation software utilization

Preliminary ANSYS analysis was carried out for pneumatic piston cylinder assembly wherein Finite Element Meshing was employed to simulate the stress/ strain on the piston cylinder assembly and also the distortion in the cylinder under the influence of pressure upto 8 GPa. Our results showed a close agreement with the effective area calculation when calculated using ANSYS software and simulation method. Further work in underway.

Development of Window-based Software for the calibration of hydraulic pressure measuring instruments

Work for developing the above software started. The starting point was the presently used DOS-based software in Quick Basic, which is monolithic (non-modular) and makes use of files to store data. The new software would be modular, which makes it easier to maintain and upgrade and it also uses RDBMS tables to store data. Moreover, it will have well designed interface screens for user interaction. Software Engineering Methodology of Structured Analysis and Design will be applied for developing the software.

DST sponsored project entitled "High Pressure Raman studies of rare earth sesquioxides"

We have carried out Raman spectroscopic studies on Y_2O_3, Gd_2O_3 and Sm_2O_3 under high pressures in a diamond anvil cell. The results are very interesting and submitted for publication. Presently we are in the process of carrying out high pressure work on other rare earth sesquioxides. Apart from these we have also been collaborating with various institutes for Raman analysis under ambient conditions and have carried out Raman spectroscopy work for Delhi University- Carbon nanotubes, SN Bose Institute- Mg and Cd doped ZnO, and Jamia Millia Islamia- Si etched GaAs samples

Acoustics and Ultrasonics Standards

Acoustics Standard maintains the primary standard of sound pressure level and vibration amplitude. The primary standard of sound pressure level is maintained using the Reciprocity Microphone calibration technique while that of vibration amplitude is maintained using the primary vibration calibration facility. The secondary calibration of accelerometers, vibration meters, sound level meters, sound calibrators, pistonphones and tachometers is carried out for different R&D organizations. Consultancy services are being rendered to industries for Building Acoustics, Noise and Vibration control and its abatement. Apart from this, the Type approval (T.A) and Conformity of Production (C.O.P) is being carried out for the Diesel generating sets as per the CPCB norms.

The Ultrasonic Standards continued to provide services to the industry for calibration of Ultrasonic Non-destructive testing equipment and ultrasonic medical equipments. Calibration procedure was developed for ultrasonic response and dimensional accuracy of test rails as per Euro norms for the on-line ultrasonic inspection of the rails manufactured in India for high-speed trains along with high volume of traffic. In another significant work, ultrasonic velocity has been measured at different pressures in various liquids varying from 0 bar to 7000 bar. A facility has also been created for study of ultrasonic dispersion in liquids at different temperatures (Fig. 1.9).

Fig. 1.9 : Set up for study of ultrasonic dispersion in liquids

An ultrasonic method was developed and used for calibrating the hole flatness and depth in steel block, having FBH holes at non-zero angles.

NABL started a Proficiency testing program in ultrasonic testing. NPL is a nodal laboratory. It has to make the artifact also. Steel blank has been prepared. They have been tested ultrasonically for zero defects. The design of defects has been made. Artificial defects in the form of holes and notches have been made in the artifact. These have been tested for homogeneity test.

The section is involved in acoustic profiling of atmosphere by SODAR. Site specific SODAR observations pertaining to coastal regions of Paradeep Orissa were analyzed in relation to EIA. Similar studies for **Tata Nagar** and **Keonjhar** are in progress.

Three prestigious consultancies were completed successfully for Delhi and Bangalore Metro and one for multipurpose hall design in Lucknow.

Fluid Flow Standards

The performance and evaluation of the upgraded fluid flow primary standards has been completed and the efforts are being made now to make 200 mm dia pipe facility operational. Steps have been taken to have the internal audit of the activity as per ISO 17025.

Shock and Vibration Sensors

A standard reference ultrasonic artifact is designed for International Proficiency Testing Programme.

The first ever indigenous tri-axial piezoelectric accelerometer and ultra miniature, super low noise, charge to voltage converter have been designed, developed and characterized. These will foresee tremendous market potential.

विद्युत तथा इलैक्ट्रॉनिक मानक

ELECTRICAL AND ELECTRONIC STANDARDS

इलेक्ट्रिकल तथा इलेक्ट्रॉनिक मानक

एन पी एल का इलैक्ट्रिकल तथा इलेक्ट्रॉनिक मानक प्रभाग, एस आई यूनिट (SI), प्राइमरी मानक तथा विभिन्न इलेक्ट्रिकल, इलेक्ट्रॉनिक तथा चुम्बकीय पैरामीटरों के राष्ट्रीय मानकों की प्राप्ति, स्थापना, रख–रखाव तथा प्रकीर्णन के कार्य से संबंद्ध है । इन मानकों की अनुरेखणीयता, उद्योगों, प्राधिकश्त प्रयोगशालाओं, अनुसंधान एवं विकास संस्थानों तथा विभिन्न अन्य संगठनों को उपलब्ध करायी जाती है । हाल ही में प्रभाग ने 'वोल्ट' यूनिट के प्रकीर्णन के लिए अंतर्राष्ट्रीय स्तर के समतुल्य की 10 'वोल्ट' स्तर पर स्वचालित जोसेफसन वोल्टेज मानक की स्थापना की है । उच्च परिशुद्धता रेफरेंस पॉवर मानक तथा वाट कनवर्टर के केलिब्रेशन के लिए एक नए पॉवर पद्धति की स्थापना की गयी है ।

प्रभाग ने बी आई पी एम, ए पी एम पी द्वारा स्थापित बहुत सी अन्तर्राष्ट्रीय अनुरेखणीयता स्थापित करने के लिए द्विपार्श्व साम्य किया । प्रभाग ने एन पी एल तथा एन ए बी एल के बीच समझौता ज्ञापन के अन्तर्गत बहुत से दक्षता परीक्षण कार्यक्रम का भी समन्वय किया है ।

ELECTRICAL AND ELECTRONIC STANDARDS

The electrical and electronics standards division of NPLI is involved in the realization, establishment, maintenance and dissemination of SI unit (SI), primary standard, and national standards of various electrical, electronic and magnetic parameters. Traceability of these standards is provided to industries, accredidated laboratories, R& D institutes and various other organizations. Recently the division has established the automatic Josephson voltage standards at 10 volt level at par to international level for the dissemination of unit 'volt'. A new power calibration system for calibration of high precision reference power standards and watt converters has been established.

The division has participated in many international intercomaprison organized by BIPM, APMP and bilateral comparison to establish international traceability. Also it has coordinated various proficiency testing programme under MoU between NPL and NABL.

Time and Frequency Standards

- Time scale of NPL, known as UTC (NPLI) is being maintained with the help of cesium clock. Judicious frequency off set is introduced time to time. During the last one year, the time scale of NPL has been comparable with other leading timing laboratories of the world (Fig. 2.1). The uncertainty of time scale is maintained at 7.6 ns.
- Calibration measurement capabilities (CMC) of time and frequency parameters of NPL have been accepted for entry into Appendix C. These CMCs are now on BIPM website.
- NPLI renders calibration service to industry and others customers for stop watch, timer, and frequency counters etc. Frequency sources like crystal oscillators, Rubidium Clock and Cesium clock at NPLI are also calibrated. The performance of many GPS timing receivers is also evaluated by NPLI. NPLI has designed and developed a new stop-calibrator to improve the uncertainty of its calibration. This is under field test.
- NPLI continues to disseminate standard time and frequency signals (STFS) via geostationary satellite INSAT with an accuracy of 10 ms.
- An innovative time service via telephone line (known as Teleclock service) is in operation by NPL. After successful commissioning this type of service in Nepal and Saudi Arabia, initiation of similar service in SAARC countries are being planned.
- NPLI has the recent plan to procure TWSTFT system to establish a link with Asia Pacific region and Europe. Initial study for implementing this experiment has been done.
- Development of Laser cooled Cs Fountain clock has been undertaken by NPLI. The overall designs of the optical setup and the physics package have been finalized. The system is in process of integration.

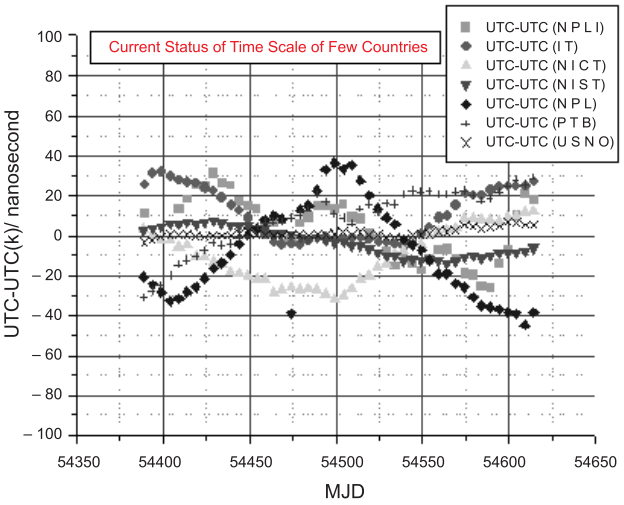


Fig. 2.1 : Status of Time Scale of NPLI vis-a-vis Those of other leading labs.

Josephson Voltage Standard and DC Current, Voltage & Resistance Standards

An automatic 10V Josephson Series Array Voltage Standard (JSAVS) was integrated, characterized and established for the calibration of Zener reference standard which is the secondary standard of DC voltage. This system works at microwave frequency of 76 GHz. The expanded uncertainty of Zener reference standard calibration at 10V is ± 350 nV at k=2 Figure 2.2 and 2.3 show the block diagram and photograph of the automatic 10V JSAVS. The inset in the photographs shows the dc characteristics and the constant voltage steps (Shapiro steps). With the establishment of this standard NPLI is at par at the international level.

The 1 kΩ standard resistor was calibrated against Quantum Hall Resistance Standard and it was

subsequently used to calibrate other standard resistors using automatic DCC bridge. During the above period, total 131 calibration reports were issued. Rs. 11.76 Lakhs as notional value (calibration of instruments of other decision packages to maintain their quality system) and Rs. 7.36 Lakhs as ECF were generated.

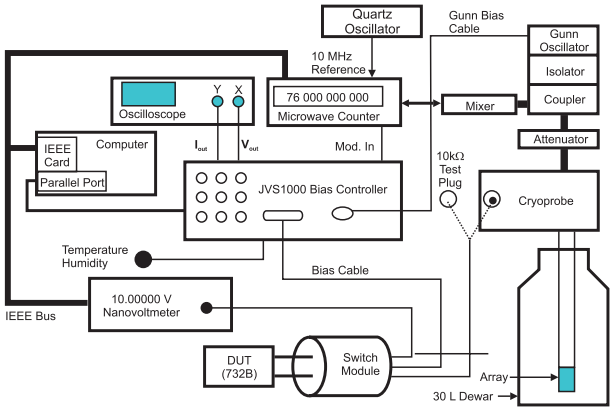


Fig. 2.2 : Block diagram of automated 10V Josephson series array voltage standard system at NPLI

Fig. 2.3 : Photograph of automated 10V Josephson series array voltage standard system at NPLI alongwith characteristics of the array at 76 GHz.

DC High Voltage Standards

This group is providing calibration facility for High Voltage DC equipments *i.e.* DC High Voltage probe, DC High Voltage divider, DC High Voltage Power Supplies and DC Volt meter, upto 100 kV. Primary standard of DC High Voltage is the Resistive Divider, which is traceble to Josephson voltage standard.

The facilities for high current and shunt resistance measurement (at high current) have been established. Shunt resistance can be measured low up to 0.001 Ω at 600 A with an uncertainty of 10 to 15 ppm.

AC Power & Energy Standards

A new Power calibration system has been established for calibration of high precision reference power standards and watt converters for ranges,

10V-576V, 10mA-120A, PF:1 to ±0.01, frequency 40 Hz to 400 Hz.

New Project undertaken

On the basis of study of influence of AC/DC magnetic fields on the performance of energy meters, two old clauses has been amended and three new clauses has been finalized (clauses 5.6.2.1 to 5.6.2.5) and included in the **new version of CBIP specification/manual on Standardization of AC Static Electrical Energy Meters, Publication No. 304 and also some in IS specification IS-13779.** This has helped industries in controlling energy theft to a large extent. This study is setting a land mark for international standardization also.

Fig. 2.4 : Setup for calibration of high precision reference power standards and wattconverters, using Fluke 6100A Electrical Power standard and Fluke 8½ digit Reference multimeter (8508A).

AC High Current & High Voltage Standards

The calibration facilities of AC High Current Ratios from 5A/1A, 5A up to 5000A/1A, 5A and about the calibration of Voltage Transformers of any ratio with 110V and 110/Ö3 V secondary output up to 100kV at 50 Hz at the required burdens.

Principle/Theory

The accurate and precise calibration of Current Transformers (CT) is accomplished by comparison method i.e. by comparing the customer's current transformer to a Reference Standard Current Transformer (RSCT) known as Current Comparator (CC) whose accuracy is so high that the corrections to be applied are negligibly small. The Comparison Method basically relies on a calibrated Current Comparator nominally of the same ratio as that of the current transformer under calibration. A suitable Current Transformer Test Set (CTTS) is used for this purpose to compare the output of the current transformer under calibration to that of the Current Comparator.

Regarding the calibration of Voltage Transformers (VT) it is also accomplished by comparison method i.e. by comparing the customer's Voltage Transformer to a High Voltage Ratio Measuring System (Standard Voltage Divider) which basically comprises the Capacitive Voltage Divider (CVD) C1/C2 and High Precision Electronic Voltage Divider (EVD) whose accuracy is so high that corrections need not to be applied. The Comparison Method basically relies on the calibrated voltage transformer i.e. in our case is a CVD and the Programmable EVD nominally of the same ratio as that of the voltage transformer under calibration. A suitable Voltage Transformer Test Set (VTTS) is used for this purpose to compare the output of the voltage transformer under calibration to that of the Standard Voltage Divider.

Standards Used For Calibration

The standard used for the calibration of current transformer is a Current Comparator having 155 standard ratios right from the lowest 5A/1A, 5A to the highest 5000A/1A, 5A. In order to avoid corrections it is again desirable to have a Current Comparator whose errors are negligibly small. The uncertainty of this reference standard is ± 15ppm and phase displacement uncertainty is ± 0.05 min. The Current Comparator is traceable to PTB, Germany.

For the determination of the errors of the current transformer under calibration, an Automatic Instrument Transformer Test Set (AITTS) is commonly required and is being used as a CTTS. The CTTS shall be capable to operate in the operating range from 1% to 200% of the rated secondary currents of 1A and 5A at 50Hz. The CTTS must indicate the current ratio error in % or ppm and the phase displacement error in minutes or centi-radians. The uncertainty of the CTTS is 10ppm in ratio and ± 0.05 minutes in phase displacement. The AITTS is traceable to PTB, Germany.

Calibration Set-up

The schematic block diagram of the calibration set–up in its simplest forms is shown in Fig. 2.5 for current transformers.

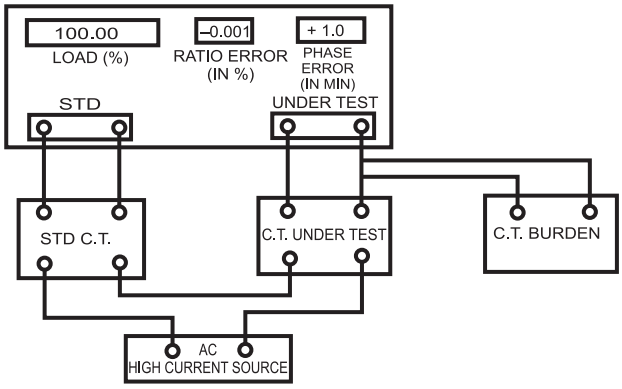


Fig. 2.5 : Calibration of current transformer by comparison technique

The standard used for the calibration of voltage transformer is Standard Voltage Divider. It comprises of a Capacitive Voltage Divider and an Electronic Device. In order to avoid corrections it is desirable to have a Standard Voltage Divider whose errors are negligibly small. The uncertainty of this reference standard is ± 50ppm and phase displacement uncertainty is ± 0.2 minutes. The Standard Voltage Divider is traceable to PTB, Germany.

Calibration Set-up

The schematic block diagram of the calibration set–up in its simplest form is shown in Fig. 2.6 for voltage transformers.

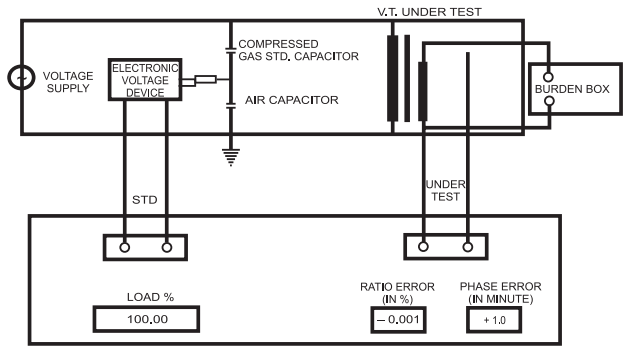


Fig. 2.6 : Voltage transformer calibration by using programmable E.V.D.

A.C. Current Source

The A.C. High Current Source should be able to supply the required current for the accuracy test up to 120% (as per IS 2705, 1992) of the highest rated current. Since the rated primary current includes a range of 5A to 1000A and some times even up to 5000A, therefore, the current source should be provided with tappings to allow the current to be adjusted to the required value. Our lab is equipped with one current source of 5000A, 3V. To connect the current source to the CT and the Current Comparator a bifilar bus bar arrangement has been chosen.

A.C. Voltage Source

The A.C. High Voltage Source should be able to supply the required voltages for the accuracy test up to 120% of the highest rated voltages. Two high voltage sources are available in our lab. One source is up to 50kV; 5000VA with digital indication and the other source is 150kV, 10,000VA with analogue indication.

Clamp Meter

A clamp meter is an instrument up to 1000A which is required in the lab for making measurements of the flowing current in the conductors without breaking the circuit. This instrument as such plays no role in the calibration process.

Current Transformer Burden

Standard burdens are required for the calibration of current transformers as per IS 2705 and IEC 60044-1:1996 The rated burdens which are normally required are 2.5VA, 5VA, 7.5VA, 10VA, 15VA, 20VA, 30VA, 40VA for the rated secondary currents of 1A and 5A at a power factor of 0.8P.F. Lag.

Voltage Transformer Burden

Standard burdens are required for the calibration of voltage transformers as per IS 3156 and IEC 60044-2:1997. The rated burdens, which are normally required, are 2.5VA, 5VA, 7.5VA, 10VA, 15VA, 20VA, 40VA for the rated secondary voltage of 110V and 110/Ö3V at a power factor of 0.8P.F Lag.

Cables

Cables of different sizes are essentially required in the calibration of CTs.

Cables of different sizes and lengths make the CT calibration complete. Proper taut wires are used for making connections to the primary side of

Standard Voltage Divider and VT Under Test from the AC High Voltage Source. Proper flexible cables are used for the secondary side connections to the voltage transformer Test Set.

Environmental Conditions

The temperature of the lab is maintained at (25 ± 2)°C and humidity (50 ± 10)%.

Traceability

In order to ensure that the measurement stability of the equipments being used as Reference Standards and other auxiliary instruments are within the specified limits of uncertainty they must be linked up with higher accuracy standards at the International Level. Our measurement traceability is with PTB, Germany

LF and HF Impedance Standards

This group of electrical and electronic standards is disseminating the traceability for measurement of capacitance, inductance and ac resistance at low and high frequency to calibration laboratories and R & D organizations. The traceability starts from primary standards of capacitance, Calculable Cross Capacitance, based on Lampard-Thompson theorem and traceable to base unit length. The unit of resistance, Ohm, is also realized from capacitance using Quadrature Bridge and other precision ac bridges. The unit of inductance, Henry, is realized from capacitance and ac resistance using Maxwell-Wien Bridge. A set of high precision coaxial reference air lines with traceability to calculable cross capacitor is used as primary standards of HF impedance.

LF & HF Voltage, Current & RF Power Standards

LF Voltage & Current Standards

Traceability of thermal converters covering voltage range 250 mV to 1000 V in the frequency range 10 Hz to 1 MHz has been re-established to the primary standard of LF voltage.

Traceability of thermal current converters covering the current range from 1 mA to 20 A has been re-established to the primary standard of LF current in the frequency range 10 Hz to 10 kHz. Traceability of RF micro-potentiometers, standards of low voltage measurements, covering voltage range 10 mV to 300 mV has been re-established to the primary standard of LF voltage in the frequency range up to 1 MHz.

HF Voltage Standards

Traceability of high frequency thermal converters against the primary standard of HF voltage based on calorimetric principles has been re-established in the voltage range 1V to 50 Volt upto 1000 MHz.

RF Power Standard

The traceability of transfer standard thermistor mounts has been re-established using the microcalorimeter.

Developed three Automated Software Systems in the year 2007-08:

Automation software to establish traceability of thermal transfer standard Fluke 792A and Micro-potentiometer at low voltages to the primary standard has been developed and successfully validated. This is being used for the calibration of ac-dc voltage transfer standards at low voltages (1 mV to 300 mV) in the frequency range 10 Hz to 1 MHz. The block diagram for the measurement setup is shown in Fig 2.7.

Using this automation software: “Key Comparison EUROMET.EM- K11 on ac-dc transfer standards at low voltages”, have been successfully completed. The travelling standard was a Fluke 792A thermal transfer standard. The pilot laboratory for the

comparison is the Swedish National Testing and Research Institute (SP). The report on comparison has been finalized and submitted to the pilot laboratory.

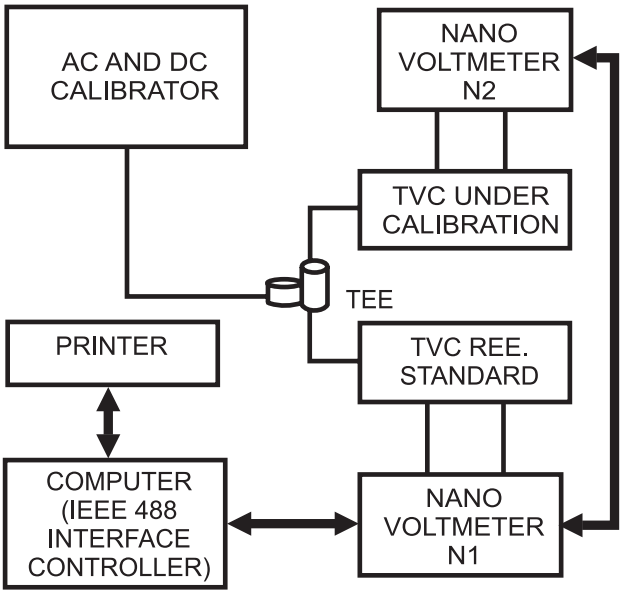


Fig. 2.7 : Block Diagram for Measurement of AC-DC Transfer Difference

Automation software to establish traceability of high frequency thermal converters against the primary standard of RF voltage based on calorimetric principles has been developed. The thermal converters are calibrated using this automated measurement set up.

Radio Frequency (RF) Power is one of the most important quantities in RF metrology. Automation system has been developed for assigning calibration factor to the thermistor mounts and power sensors using direct comparison technique. The measurement setup of Direct Comparison technique is shown in Fig 2.8. The thermistor mounts have been calibrated using these new softwares and the measurement results agree with past results within very close limits.

The automation of these techniques makes calibration faster and more accurate through GPIB cables using IEEE-488 interface card. It also minimizes the human involvement and therefore reduces the chances of errors.

Fig. 2.8 : Direct Comparison Measurement Setup

The need of automation cannot be ignored in the AC-DC transfer measurements, as the calibration procedures are tedious, complicated and requires repetition and regular timing. It reduces the operator skill requirements and substantially reduces measurement time. The results show that due to the automation type A uncertainty has been improved.

RF Attenuation and Impedance Standards

RF Attenuation & Impedance Standards has the responsibility of eestablishment, maintenance & upgradation of RF attenuation & impedance standards and associated calibration facilities.

Bio-medical Measurements

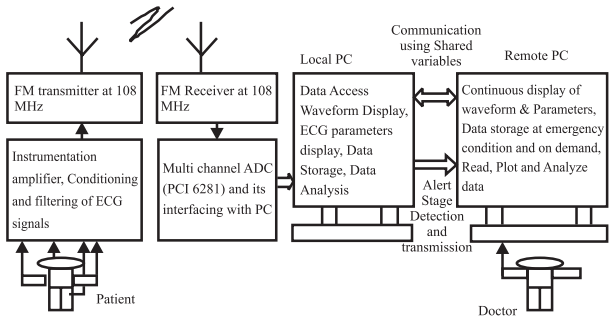
ECG CALIBRATION: Two reports, one at 1mV/10Hz signal source traceable to NPL standards and the other one at 1mV/1Hz signal source (un-calibrated) on the calibration of 12 leads ECG machine were prepared for the uncertainty measurements. The bio-simulator producing sine, square and triangular waveform at 1mV with variable frequencies got calibrated against a primary standard source of 1 mV/10Hz at NPL and subsequently put in use as a secondary standard source for further calibration of ECG machines. To get the report internationally accepted, efforts are being made with NPL UK to get the bio-simulator signal source calibrated at 1mV/1Hz, which is the standard amplitude frequency combination of ECG signal.

Web based real time ultra low value (ecg, eeg) signal transmission for patients monitoring and diagnosis system using lab-view platform

A versatile, cost effective and application oriented web based real time patient monitoring and diagnosis system employing systems and devices like internet, PCs and specially developed graphical user interface (GUIs) in lab-view environment was developed. Biomedical Data of the patient such as body temperature, pulse rate, ECG etc. from different sensors and electrodes put around the patient body are acquired and transmitted using FM transmitter (108 MHz) after proper signal conditioning and amplification. The received signal by FM receiver tuned at the same basic frequency is further acquired by NI lab-view data acquisition card (PCI-6281) and processed to find out vital parameters such as QRS intervals, QT intervals and beat to beat (R-R) intervals. These parameters/ waveform are displayed on local PC (patient side) as well as on remote PC (doctor side) for on line patient monitoring. The automatic emergency condition detection is a new concept in the system's automation, where the software detects an alert stage of the patient and connects patient with the doctor automatically for immediate diagnosis and treatment. The complete system is shown in the following block diagram.

Status

The system is in per-fact working stage and can be demonstrated to outside agencies for further suggestions and improvements. The proposal, in fact has been presented to FICCI committee chaired by DGCSIR a few months ago.



Instrument Development and Electronics

- An electronic circuit was developed for displacement measurement using path sensing detector for setting photo deflection spectroscopy (Plasma Process Materials Group)
- The sensor array data acquisition system (Lab VIEW based) was updated (for Thick film sensor group) in both hardware and software aspects to become more user friendly. Using the developed system the data has been collected and evaluated. Different discrimination techniques are being studied.
- New, improved features has been incorporated into the SODAR system (Lab VIEW based). Off-Line data analysis program has been updated using .net. The new version gives detailed information about the Fax files, mix height calculation etc (SODAR Group).
- A microcontroller system was developed for Fluid Flow Division to interface the voltage levels, to suppress the bouncing problems, and to calculate the elapsed time between pulses
- Expert committee member for finalization of technical specifications for procurement of Vehicular Based Multifunction Pavement Condition Evaluation System (Supra institutional project (CRRI)
- Co- PI of the project titled "Development of Nanostructured metal oxide gas sensor array for detecting chemical warfare agents" (sponsored by DRDO/EP-IPR Division), project has been approved, funding is expected in First week of April 2008.

इंजीनियरिंग पदार्थ

ENGINEERING MATERIALS

इंजीनियरी पदार्थ

इंजीनियरी पदार्थ प्रभाग में मुख्यतः धातु एवं मिश्रधातु (ऐलॉय), उन्नत कार्बन उत्पाद, बहुलक (पॉलीमरिक) एवं मृदु पदार्थ तथा द्रव्य क्रिस्टल समूह शामिल है । इस डिवीजन का उद्देश्य उपर्युक्त वर्णित क्षेत्रों में घटकों, साधनों तथा पद्धतियों के लिए पदार्थ, प्रक्रियाओं तथा प्रौद्योगिकियों का विकास करना है । इस प्रभाग के अनुसंधान एवं विकास उत्पादन में वायु आकाश धात्विक साधनों, कार्बनिक इलेक्ट्रॉनिक साधनों तथा सेंसर आदि का विकास शामिल है । इनमें से कुछ एक पदार्थ का अनुप्रयोग सामरिक तथा औद्योगिक क्षेत्रों में किया जाता है; जनरल मोटर्स ने ऑटोमोबाइल अनुप्रयोगों के लिए एम जी (Mg) मिश्र धातुओं के बहिर्वेधन प्रौद्योगिकी के विकास पर एन. पी. एल. के लिए एक सहयोगात्मक परियोजना को प्रायोजित किया है । भविष्य में, ऐसी और अधिक औद्योगिक सहयोगात्मक परियोजनाएं अन्य उद्योगों जैसे रिलायंस उद्योग राणे ग्रुप ऑफ इंडस्ट्रीज़ के साथ करने पर विचार किया गया है । वस्तुतः इस प्रभाग के अन्तर्गत, बहुत सी विकासात्मक परियोजनाएं जैसे सी. एस. आई. आर. नेटवर्क, प्रायोजित, अनुदान सहायता, सहयोगात्मक तथा परामर्शी का, निजी तथा सरकारी क्षेत्रों दोनों में, विभिन्न अनुसंधान एवं विकास संगठनों के लिए सफलतापूर्वक कार्यान्वित/पूर्ण की जा रही है ।

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 this division is to develop materials, processes and technologies for components, devices and systems in the above mentioned areas. The R & D output of this division includes the development of aerospace metallic devices, organic electronic devices and sensors etc. A few of these materials find applications in strategic and industrial areas; 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 with other industries are envisaged for future. In fact, under this division several developmental 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.

A. METALS & ALLOYS

Development of Light Weight Magnesium (Mg) and Aluminum (Al) based alloys and composites for advanced structural applications in Automobile and Aerospace

R & D efforts were concentrated on development of light-weight Mg and Al alloys and their composites under various sponsored, network, non-network and consultancy projects. The major thrust was on the development of several grades of Mg alloys employing hot extrusion processing technique for their possible automobile and aerospace applications. This work was carried out under a consultancy project entitled "Advanced Magnesium Extrusion Alloys" sponsored by General Motors. Other in-house projects involved synthesis of different grades of Mg alloys and hypereutectic Al-30 Si alloy using Spray Atomization & Deposition (SAAD) technique. Setting-up of a "Center for Nanoscience & Nanotechnology" has been initiated this year, under a non-network project. Diversified activities on nanomaterials development have been planned under this center, including i) synthesis of bulk nanomaterials employing Cryomilling followed by HIPing and Hot Extrusion and also using Equal Channel Angular Pressing (ECAP), ii) Development of metallic and polymeric based nano composites using CNT and Nano-SiC as reinforcements iii) Synthesis of boron nitride nanotubes employing mechanothermal process and iv) Nanomagnetic Particles and Fluids for Device Applications

A. Magnesium alloys

(a) General Motors (GM) Sponsored Project entitled "Advanced Magnesium Extrusion Alloys"

Magnesium alloys have emerged as potential structural materials, in automobiles, due to their low density coupled with high specific strength and specific stiffness. Usage of Mg alloys could result in substantial weight savings and thus reduced fuel consumption and gaseous emissions. However, Mg alloys suffer from an inherent problem of poor ductility and formability at room temperature. Under the "General Motors" sponsored project, an important achievement made was that ductility of pure Mg (about 9%) could be tremendously enhanced (to 31%) by small addition of rare earth (RE) Fig. 3.1. Detailed High Resolution- Transmission Electron Microscopy (HR-TEM) and Electron Back Scattered Diffraction (EBSD) investigations on the extruded samples revealed that manipulation of texture with cerium addition in magnesium resulted in tremendous improvement in ductility. The EBSD analysis had revealed grain orientation favourable to slip planes with cerium addition, which resulted in substantial enhancement of ductility at ambient temperature Fig. 3.2 Shows the Mg-RE extruded tables with good surface finish. These detailed investigations are under progress.

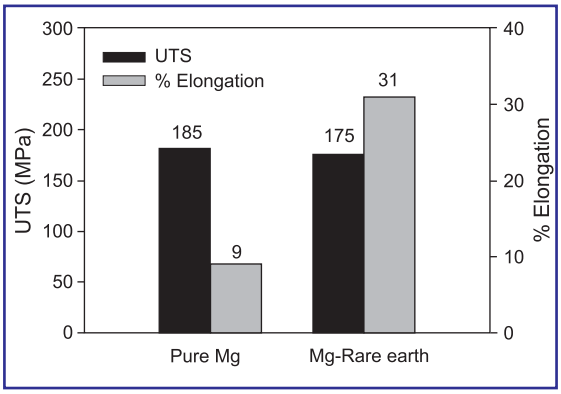


Fig. 3.1 : Mechanical properties of Mg-RE alloy

Fig. 3.2 : Mg-RE alloy extruded tubes

(b) Synthesis of Mg-alloys using rapid solidification and employing spray forming

Magnesium is a lightweight high strength material and automobile industry has realized it to be a futuristic material. Spray atomizing and deposition is a promising route for the synthesis of different grades of Mg alloys. The technology of spray forming of Mg alloys has been successfully developed at NPL. Initial exploratory experiments on AZ31 (Mg-3Al-1Zn) alloy were conducted and optimized process conditions were achieved for low porosity and fine grain size of 25-40 μm. Further experiments involved utilization of metal delivery tubes of varying diameter to optimize Gas-to-Metal Ratio (GMR) and obtain spray deposits with further refinement of grain size for improved mechanical properties. The minimum grain size so far achieved was 5-12 μm employing the metal delivery tube of 3.25 mm dia and at a flight distance of 400 mm. Efforts are currently underway to further reduce the grain size of spray-formed AZ31 deposits by optimizing other spray-forming process parameters.

B. Aluminium alloys

(a) Synthesis of hypereutectic Al-30Si alloys using spray-forming

Al-Si is an important alloy for many commercial automotive applications (piston, cylinder liners, etc) due to its unique properties, such as, high wear resistance, low CTE and good mechanical properties. Presently this material is made by Ingot Metallurgy based routes, which have several limitations, such as, presence of large & coarse primary Si particles in microstructure. Though increasing Si content (>12.5%) could improve the wear resistance as well as lower the CTE, which are desirable for certain applications, however, synthesis of hypereutectic Al-Si alloys not generally possible due to thermodynamic phase diagram considerations. Increasing cooling rates by rapid solidification employing spray forming can make hypereutectic Al-Si alloys to produce uniform microstructure with reduced segregation and also result in fine sized Si particles.

Synthesis of hypereutectic Al-Si alloys was carried out employing spray forming technique. Optimization of spray forming process parameters was carried out to achieve good yield with low porosity and fine size of primary Si particles. Optical microscopy of cast hypereutectic Al-30%Si alloy indicated presence of primary blocky Si, eutectic and Al-Si-Fe-Mn intermetallic phases in the matrix of α - Al (Figure 3.3 (a)). However, under optimized spray forming conditions, large blocky structure of Si was broken and a uniform microstructure was evolved having fine particulate-type morphology of primary Si (Figure 3.3 (b)).

Fig. 3.3 : Microstructures of hypereutectic Al-30%Si (a) cast mother alloy and (b) Spray-formed alloy showing fine primary Si grains

It was observed that the grain size & morphology of primary Si, yield & porosity exhibit a strong dependence on spray-forming processing parameters. Primary Si particulate grain size of 1-4 μm was observed in these spray-formed alloys.

(b) Development of functionally gradient metal matrix composites (MMC)

A vertical centrifuge casting unit facility is available at NPL for the synthesis of functionally gradient metal matrix composites (FG-MMCs). The feed material for these FG-MMCs was prepared in a stir casting unit employing Al alloy as base material and 12% SiCp as reinforcement. Experiments were conducted on the synthesis of Al-12% SiCp functionally gradient MMCs. Detailed

characterization of FG-MMCs developed by the above route is under progress.

C. Centre for Nanoscience & Nanotechnology – new initiative

A new initiative has been taken up for setting-up a Centre of Nanoscience & Nanotechnology under a non-network project. The project involves development activities on the synthesis of nanomaterials such as, carbon nanotubes (CNTs), boron nitride nanotubes (BNNTs), nanostructured Al based metallic powders employing Cryomilling, Al-Si nanomaterials employing High Energy Ball Milling, nano-silicon carbide, nano magnetic particles for ferrofluids etc. These nanomaterials are further aimed to be used for the development of lightweight high strength advanced composites such as CNT reinforced polymeric and metallic composites, ultra fine grained (UFG) lightweight Al-Mg alloys, nano-SiC reinforced polymeric composites, etc. The Al-Mg UFG alloys are proposed to be synthesized by two routes, such as, i) Hot Isostatic Pressing (HIPing) of cryomilled powder followed by its hot extrusion and ii) Equal Channel Angular Pressing (ECAP) of coarse grained bulk materials. Presently experimental infrastructure is being set-up for carrying out above activities in a systematic & focused manner. Several additional equipments for synthesis and processing and characterization of nanomaterials are under procurement. The progress on different activities is briefly described below.

(a) Cryomilling of Al-Mg powders followed by HIPing and hot extrusion

Ultra Fine Grained (UFG) materials are defined as solids having grain size in the range of 200-1000 nm, however, microstructural features such as sub-grains, dislocation cells, X-ray coherent diffraction domains, etc fall below 100 nm. Al and Mg based UFG materials have great potential in automobile/aerospace industries due to their lightweight and high mechanical properties. Synthesis of Al/Mg UFG materials would be carried out employing a novel route that involves large scale synthesis of nanostructured Al-Mg powder employing cryomilling. The synthesized powder would be subjected to consolidation by hot isostatic pressing (HIPing) and hot extrusion. A Cryomill (Make: Union Process, USA) and an Automated Chamber Glove Box (Make: Mbrown, Germany) have been procured and are under commissioning at NPL. These facilities would be used for the synthesis of nanostructured Al/Mg powders. A particle size analyzer is also under procurement that would be employed for determination of particle size distribution. Detailed characterization of cryomilled powder would be carried out using HR-TEM, X-ray diffraction, etc.

(b) Equal Channel Angular Pressing (ECAP)

Another approach for the synthesis of UFG materials is known as Severe Plastic Deformation, which involves several methods, one of which is Equal Channel Angular Pressing (ECAP). ECAP is carried out by pressing of an ingot in multiple passes through a die having two channels of equal cross section, intersecting usually at an angle of 90° to 120°. The process drastically refines the microstructure due to intense shear strains imposed during each pass, without reduction in cross section.

Significant progress has been made in this area and a unique facility has been developed for ECAP of billets in the size of 16 mm 16mm 100 mm. This facility has been designed and developed indigenously. The most significant feature of this facility is that it employs a punch that is almost frictionless. The frictionless conditions could be achieved by designing the set-up such that during pressing, contact of billet and die walls is almost eliminated, though it always remains in contact with the moving punch. Employing this facility, several model materials such as pure aluminum, pure lead and other materials have been successfully ECAPed in multiple passes. The immediate attention is now to make this facility amenable for ECAP of commercial Al & Mg alloys.

(c) Synthesis of Boron Nitride Nanotubes (BNNTs)

Synthesis of boron nitride nanotubes (BNNTs) has been carried out by a mechanothermal process. The process involves ball milling of hexagonal boron nitride (hBN) for a long period in a high-energy ball mill followed by annealing in a protective atmosphere at elevated temperature. Ball milling results in the formation of nanosized disordered BN powder mixed with some metal nanoparticles and annealing leads to the growth of BN nanotubes. Under this activity, BN powder was ball milled for about 100 hrs followed by annealing of milled powder in the temperature range of 950-1300ºC for about 10 hrs. Formation and growth of BNNTs was observed. The BNNTs were characterized using different characterization techniques, such as, HR-TEM, SEM, XRD and Raman spectroscopy. From the detailed study the synthesized BNNTs exhibited a morphology with cylindrical structure. The diameter of nanotubes varied from 20-40 nm (Fig. 3.4), however, their length was significantly affected by the annealing temperature. The length of nanotube was found as 1 μm at higher annealing temperature of 1300ºC as compared to about 50-150 nm at lower annealing temperature of 950ºC. SAD pattern analysis of BNNTs suggested their crystalline nature predominently.

Fig. 3.4 : TEM micrograph of BN nanotubes (BNNTs) (a) BNNTs having dia of 20-40 nm and length upto 1 μm. The inset shows a ring pattern of aggregates of nanotubes, (b) SAD pattern recorded from nanotubes along [0001] axis shows several sharp spots, which indicates that the BNNTs are highly crystalline

(d) Synthesis of Al-Si Nanocomposites

The aim of this activity is to synthesize Al-30 % Si nanocomposites using High Energy Ball Milling (HEBM) to obtain nanocomposites with superior mechanical, tribological and thermal properties. Al and Si powders of median particle size of 100 μm were ball milled for extended time periods at high speeds under inert argon atmosphere. The milling was carried out in a high energy planetary ball mill (Make: Fritsch, Germany, Model: Pulverisette IV). The powder XRD analysis of FWHM (Full Width at Half Maxima) indicated average crystallite size as: Al ~ 15 nm & Si ~ 24 nm. These nanopowders were cold compacted and subsequently subjected to sintering by different routes, such as, pressureless sintering, high pressure rapid sintering and microwave sintering. The aim is to find out a suitable consolidation route to prevent grain growth. The work on process parameters optimization for consolidation of nanopowders is presently underway.

(e) Synthesis of nano-SiC particles

Nano-SiC particles, to be used for carbon ceramic composites, were synthesized by the reaction between silicon and carbon black at 1400°C in argon atmosphere and characterized by SEM and TEM studies. It was found that nano-SiC particles having the diameter in the range of 50-250nm were formed

(f) Development of carbon-nano silicon carbide – boron carbide composites

Carbon ceramic composites (C-nano SiC-B_4C) were prepared through in situ formation of nano-SiC by isostatically moulding the mixture of NPL developed coal tar based green coke fine powder, silicon, carbon black and boron carbide powders and heat treating the moulds at 1400°C in argon atmosphere. The composites showed the in-situ formation nano SiC rods of the size 130nm. The composites were also found to be oxidation resistant at 800°C and 1000°C for about 10 hrs. The X-ray data confirmed the Nano SiC of 56 nm. The SEM and TEM data showed the nanosized SiC in the range of 14-30 nm.

B. Advanced Carbon Products

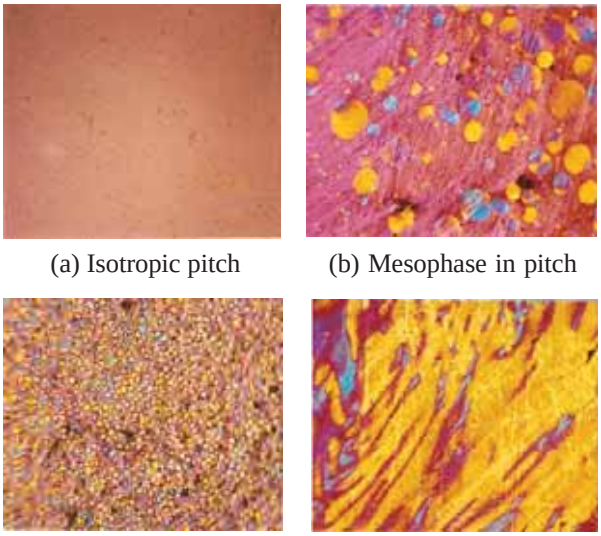
A leading centre in India dedicated to research in both pure and applied science of Carbon with principal motives i) to develop the process technology of newer carbon products which hold strategic importance and are not available to the country at any cost, ii) to develop products which can be made cost-effective by innovative process suitable to available infrastructure, expertise and resources in India, iii) to promote overall growth of carbon science and technology in the country through sustained R&D, research publications, patents, technology transfer, consultancy to industry, national & international conferences and refresher courses etc.

1. Development of carbo-graphite material for aeronautical application

This project is sponsored by Defence Materials and Stores R&D Establishment (DMSRDE), Kanpur. The carbo-graphite material is to be used as a seal for the defence application. This material possesses a high density of 1.90 gcm^{-3}, high shore hardness of 85, high compressive strength of 2000 $kgcm^{-2}$, besides being stable in air at 650°C. The high density carbo-graphite of almost required characteristics using modified NPL green coke has been developed in this project. A high pressure-high temperature impregnation assembly was designed, fabricated and employed for impregnation of high density graphite with suitable boron and phosphorus salts to make it heat stable at 650 °C. Process parameters for impregnation of graphite were optimized. It is interesting to note that high-density graphite without impregnation loses 40% of its weight at 650 °C within four hours, whereas the impregnated graphite does not lose any weight and is stable at 650 °C for periods upto 10 hours. The report of the R&D work done was submitted and presented at DMSRDE, Kanpur. Further work is in progress to develop isostatic moulds of carbo-graphite for supplying to DMSRDE.

2. Development of mesophase pitch for high performance carbon fibers

This project is again sponsored by DMSRDE, Kanpur as a sub-project of their major programme on development of advanced composites and fibres. Mesophase pitches of high softening point were prepared at NPL using QI free pitches (developed by us at NPL) and commercial petroleum pitches by suitable thermal treatment. These pitches were characterized for various parameters including mesophase content (liquid crystal development) using polarizing optical microscope. The samples of mesophase developed in such pitches has been shown in fig. 3.5 (a-d). Further work on the optimization of process parameters and composition of pitches is in progress. Few mesophase pitch samples have been supplied to DMSRDE, Kanpur for spinning into fibres. Two interim reports were prepared and submitted to DMSRDE, Kanpur during the year.



(a) Isotropic pitch (b) Mesophase in pitch

(c) Large conc. of small mesophase spheres (d) Bulk mesophase pitch for HPCF (SP 300°C)

Fig. 3.5 : Mesophase development in pitches during heat treatment.

3. Development of carbon-ceramic composites and influence of oxidation at elevated temperatures

Carbon-ceramic composites were developed by incorporating SiC (through the reaction of Si and carbon or SiC particles as such) and B_4C in the green coke (developed in-house). It was observed that carbon-ceramic composite plates have a density of 1.95 gm/cm^{-3} at HT of 1400 °C and were resistant to oxidation at 800°C - 1200°C for about 10 hours. The bending strength of the composite plates before and after oxidation at 800°C for 10 hrs was found to be the same thereby showing the oxidation of the composite has little effect on the mechanical properties.

4. Development of fuel cells based on hydrogen (CSIR-NMITLI Project)

A batch of 50 numbers of carbon paper samples of size 20cm x 15cm and 30 nos. of carbon composite bipolar plates of similar size were supplied to CECRI to be used in a 1 kW fuel cell stack being assembled at CECRI using all indigenous components. Fig. 3.6 shows the I-V performance of the unit PEM fuel cells assembled at CECRI using Porous carbon paper and the Bipolar plates developed at NPL. The results were highly ecouraging.

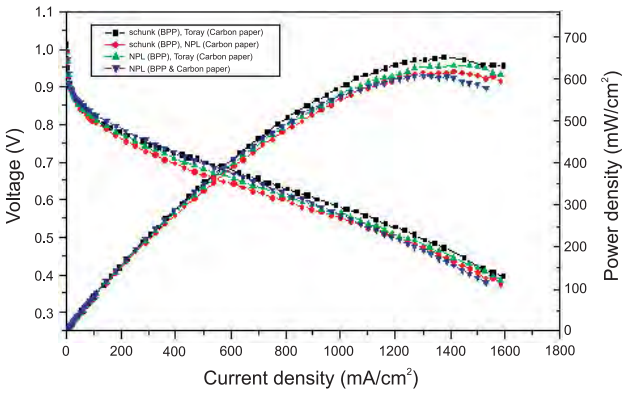


Fig. 3.6 : Comparison of I-V performance of a unit PEM fuel cell using the porous carbon paper and "Schunk, Germany and toray carbon paper compared with commercial carbon paper from Toray, Japan and bipolar plate from Schunk, Germany.

5. Development of speciality carbon materials for novel nuclear reactor

Work under the sponsored project from BARC was continued to develop Carbon/carbon composite tubes for new generation high temperature nuclear reactors (CHT). Prototype tubes with dimensions OD 60mm, ID 20mm and Length 100 mm were fabricated by filament winding technique or using 3-D perform using Hot Isostatic Pressing (HIP) to achieve the desired bulk density of 1.75 to 1.85 g/cc (Fig 3.7). The sample tubes were characterized for physical and mechanical properties and microstructure before supplying to BARC for neutron diffraction studies.

Fig. 3.7 : Densified C/C composite tubes samples with holes

6 Carbon nanotubes based polymer composites

Carbon nanotubes were grown by chemical vapour deposition (CVD) on different carbon fibre substrates namely, unidirectional (UD) carbon fibre tows, Bi-directional(2D) carbon fibre cloth (Fig.3.8) and three-dimensional(3D) carbon fibre felt. These substrates were used as the reinforcement in phenolic resin matrix to develop hybrid CF-CNT composites. The flexural strength (FS) and Flexural modulus(FM) of the CNT-CF cloth hybrid composite improved with

increasing amount of CNT contents. The FS and FM improved by 75% and 54 % respectively as compared to that prepared by neat reinforcements (without CNT growth) under identical conditions with ~ 8% by weight of CNT growth on the substrate(Fig.3.9).

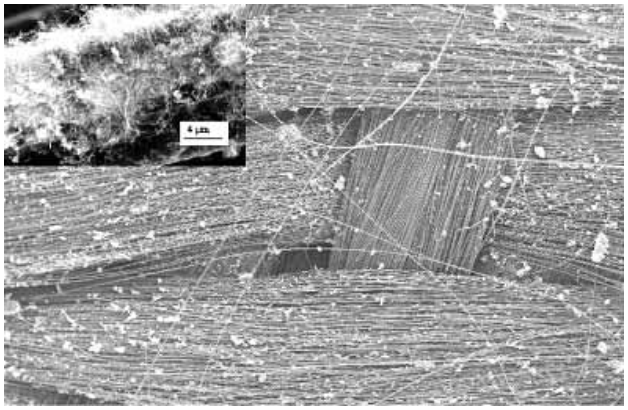


Fig. 3.8 : SEM micrograph of carbon nanotubes grown on the carbon fibre cloth substrate. The inset shows rich growth of carbon nanotubes on a single carbon filament.

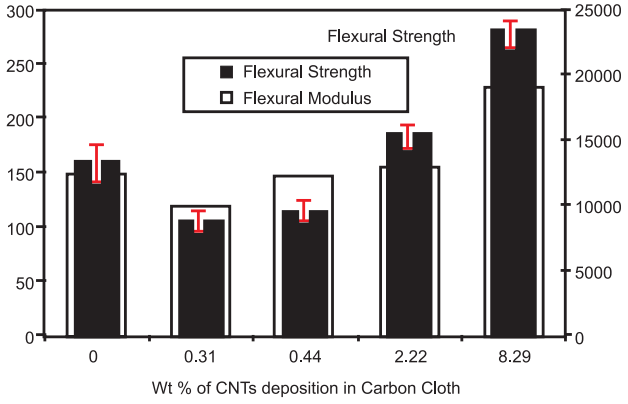


Fig. 3.9 : variation in the mechanical properties of the CNT-Carbon fibre cloth/phenolic hybrid composites with different percentage of CNT loadings. The value at "0" wt.% correspond to the neat carbon fibre cloth/phenolic composite.

7. Development of high quality impregnating grade coal tar pitch

A state of the art process for the production of high quality impregnating pitch was developed by us at NPL and transferred to industry earlier. The industry has now put up an industrial plant shown in Fig.3.10 with a capacity of 2400 MT/p.a. worth about Rs.15 crores. The pitch is used for densification of graphite electrodes for steel industry and C-C composites for defence/other high

Pic-4 Distillation Units – each 22 MT capacity

Fig. 3.10 : View of Impregnating pitch industrial plant developed by M/s Konark Tar Products (P) Ltd., Durgapur based on NPL-Know-how.

technology applications besides having other important applications. A novel process has been recently developed now to produce this pitch with a high coking value of 50-62% compared 42-46% produced from the earlier process. This will reduce the number of impregnation cycles required for the densification of graphite electrodes and C-C composites. A patent for the invention has been applied for during the year.

Specifications of Impregnating Grade Coal Tar Pitch

Characteristics	Old NPL Process	New NPL Process
Softening point	80 – 100 °C	80 – 100 °C
Quinoline insolubles	0 – 3.0 %	0 – 3.0 %
Toluene insolubles	16 – 24 %	16 – 24 %
Coking value	42 – 46 %	50 – 54 %
Specific gravity	1.26 – 1.28	1.26 – 1.29
Ash content	0.05 %	0.05 %

8. Development of high purity - high density - isotropic graphite

R&D work was continued to improve the process of producing high density - high strength - isotropic graphite from green coke. A new technique of coating the green coke powder was done to improve the properties and shelf life of the green coke prepared for the production of high density high strength graphite. A patent application with complete specifications of the process is being drafted. Efforts are continuing to transfer the technology of this high-density graphite to an industry.

9. Development of high-density graphite for multistage depressed collection of electron tubes (XI th Plan Network project)

This is a part of the XI Plan CSIR sponsored network project on Design and fabrication capabilities for very high power microwave tubes with CEERI, Pilani as the nodal agency. The objective in the project is to develop two types of graphites with stringent specifications namely (i) high density graphite, (ii) copper reinforced graphite suitable for multistage depressed collection of electron tubes useful for space applications. Imported samples of both types of graphites, supplied by CEERI, Pilani were characterized and some preliminary R&D work were also initiated.

10. Support of industry

A. Consultancy project

A consultancy project entitled "consultancy for improvement of quinoline insoluble and coking value properties of QI free coal tar pitch" sponsored by a major pitch producing industry in India was undertaken. Suitable experiment was conducted for improving the coking value of the impregnating grade coal tar pitch. The final technical report has been completed for onward transmission to industry.

B. Industrial Testing

The carbon blocks received from different industries / R&D institutes were tested for apparent porosity, Kerosene density, bulk density ,bending strength, shore hardness and thermal conductivity. The test reports were prepared and submitted to parties.

C. Liquid Crystal and Self Assembled Monolayer Section

Design, Development and Fabrication of Array Sensor Chip For Biological Applications

Micropatterning of biological molecules (proteins, immunoglobulins, peptides) onto various surfaces using softlithographic techniques

Development of biomedical microdevices (BioMEMS) has received tremendous attention in recent years as they are more sensitive, accurate, reliable and inexpensive and use very small quantities of expensive reagents and solvents. Consequently, there is a strong need to develop simple microfabrication technology that will be central to the development of miniaturized devices for biological/ biomedical/ biotechnology/ chemical analysis. We have developed a number of techniques to create two-dimensional patterns of different biological sensing elements (proteins, nucleotides, immunoglobulins, cells etc.) with micrometer sizes on different solid substrates, which in turn would be used to develop array-biosensors.

One of the simplest ways to selectively adsorb proteins to the designated regions of a substrate is to create regions with contrasting hydrophobic and hydrophilic properties. Microcontact printing (ìCP) of alkane thiols (HDT) and PEG-thiol on gold coated substrate and alkane silanes and PEG silane on glass/ silicon substrates, respectively has been used to create highly hydrophobic and highly hydrophilic regions with feature sizes ranging from a few tens of microns to a few hundred microns. The hydrophobic regions exhibit strong adsorption of proteins while hydrophilic regions strongly resist the protein adsorption. The proteins selectively adsorb immunoglobulins / cells and act as biosensing elements. It has been found through fluorescence microscopy that selectively adsorbed proteins exhibit strong bioactivity and has been reported in previous year annual report.

Direct patterning of proteins:

Alternatively, we have been able to generate patterns of proteins and functional antibodies by direct µCP on to various solid substrates. The patterned elastomeric stamp is directly incubated with protein solution and the proteins are directly transferred from stamp to the substrate by µCP. The surface properties of the substrate play an important role in transfer of proteins from the stamp to the substrate.

Fig. 3.11 : shows the two-dimensional patterning of BSA_FITC molecules using direct µCP on glass substrate along with the intensity profiling

This technique has been used to create multi-protein patterns on the same substrate and has been tested successfully to sense multi immunoassays using fluorescence microscopy. Micro patterns of human IgG and mouse IgG have been created on functionalized substrates and complimentary anti human IgG-FITC and anti mouse IgG-TRITC attach themselves to human IgG and mouse IgG coated regions only.

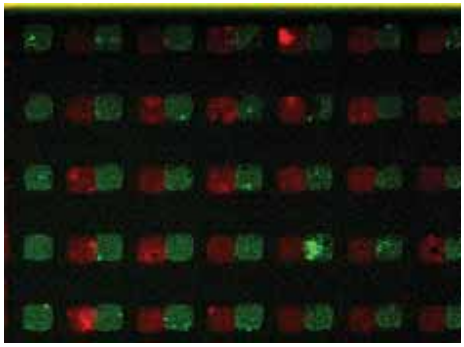


Fig. 3.12 : Shows the fluorescence micrographs of anti human IgGs tagged with FITC and anti mouse IgGs tagged with TRITC selectively attached to patterned primary human IgGs and primary mouse IgGs coated regions (40*40 microns), respectively

Patterning of proteins using chemical selectivity:

As another alternative strategy, two-dimensional protein patterns have been created on patterned-gold-glass substrates. The gold patterns were created by e-beam evaporation of gold through a metal mask. The formation of COOH terminated alkanethiol monolayer was carried out by immersing the gold coated substrate in 20 mM ethanolic solution of mercapto propionic acid & mercapto undeconic acid (10:1 v/v) for 20 hr. These COOH terminated gold substrates were then immersed in aqueous solution of EDAC & NHS to attach the NHS group to the COOH terminus. The bare glass regions were modified with polyethylene glycol (PEG-silane) to provide a highly resistive surface to protein adsorption. The above-modified substrates were further treated with BSA (FITC) protein in PBS. The FITC tagged BSA proteins got selectively & covalently attached to the substrates by replacing NHS group.

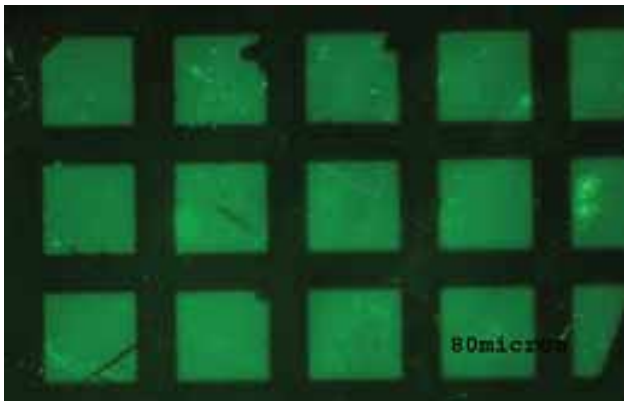


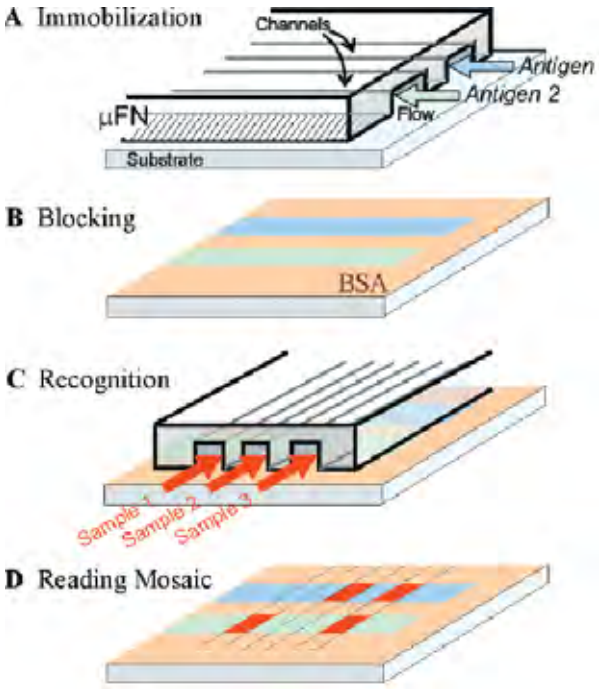
Fig. 3.13 : Shows the fluorescence micrograph of BSA protein tagged with FITC selectively attached to gold-coated square regions(80*80 microns)

We have further investigated the antigen-antibody binding (BSA-anti BSA) by this technique. It has been observed that covalently bound BSA proteins to the gold-coated regions have good bioactivity, which is crucial for the development of biosensors.

Miniaturized Array-Based Immunoglobulins Sensors Using Microfluidic Devices

We have designed, developed and fabricated polymer-based microfluidic chips to realize multi-Immunoglobulins surface assays. The microfluidic chips were

fabricated using micro molding technique. The soft polymer chip containing a number of channels were appropriately functionalized to seal reversibly to the flat glass substrate and to support the aqueous fluid flow inside the microchannels and also to resist the adsorption of biomolecules from the solution to the walls of the channels. The many non-communicating channels were used to deliver different immunoglobulins to the substrate as parallel stripes that act as antigens. The remaining portion of the substrate was coated with BSA to block the adsorption of other biomolecules. Subsequently another microfluidic chip with parallel channels is placed orthogonal to the substrate and flow of anti body (Abs) solutions tagged with fluorescent dyes led to the capture of Abs with antigens resulting in a mosaic structure which could be viewed under a fluorescence microscope. Using the above technique we have been able to develop a biochip which can simultaneously pattern and detect human IgGs, goat IgGs, mouse IgGs and rabbit IgGs.



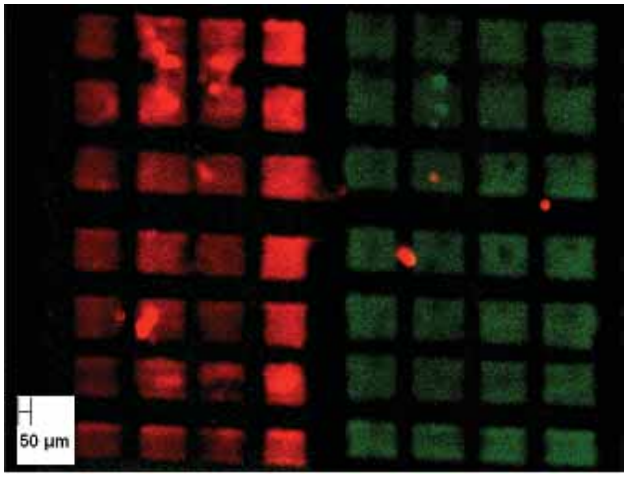


Fig. 3.14 : Micro mosaic immunoassays of Mouse IgGs and human IgGs with anti mouse IgGs conjugated with TRITC and anti human IgGs conjugated with FITC fluorescent dyes using PDMS based Microfluidic Device on APTES (3-Aminopropyltriethoxysilane) and BS3 (Bis(Sulfosuccinimidyl) suberate) modified glass substrate.

Study of Doped and Undoped Nanocrystalline Titania:

The photocatalytic activity of Mn and Ni doped titania was found to increase with dopant concentration up to certain level; at very high dopant concentrations the photocatalytic activity decreases again. The phenomenon has been reported by various workers but varied mechanisms have been suggested for these observations by different researchers. The suggested mechanisms include i) dopant induced particle size reduction enhances the exposed surface area which results increased absorption cross section thereby increased photo catalytic activity ii) decrease in drift time of photogenerated electrons from the interior of the grain to its surface to degrade the dye molecules and reducing the loss by recombination iii) increase in life time of photogenerated carriers by trapping of electrons at the surface states and iv) generation energy states with in the forbidden

gap thereby increasing the possibility of absorption of lower energy radiations.

We have investigated upon all the above reported mechanisms in our samples and despite all the above suggestions we have confirmed, by our experimental observations, that major contribution to increased photocatalytic activity is through the transfer of photo generated electrons to the dopant particle and than to the dye molecule, this route eliminates the possibility destruction of photogenetaed carriers by recombination processes. This process contributes to ~ 80% of the total enhancement in photoactivity rest 20% is contributed by all the other reported mechanisms.

The photodegradation and hydrophilicity arise due to two different mechanisms but in case of titania they are closely related to each other; if one increases the other also increases and vice versa. Both these properties jointly provide the self cleaning property to the windowpane surface which is coated with thin anatase titania film. These results are published in **Applied Catalysis B Environ**

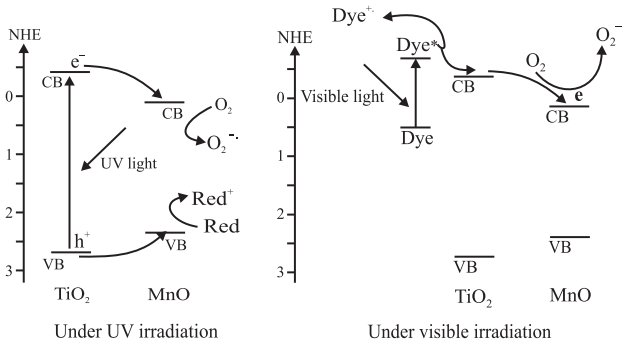


Fig. 3.15 : Proposed mechanism of enhanced photoactivity by dopant under UV and visible irradiation

In case Ni doped TiO_2 films surface of 0.5 mol% Ni ion-doped samples we have observed that the surface contact angle with water reduces to <10° after 20 minutes of UV illumination, while in undoped samples the surface contact angle with water can be reduced to this level only after minimum 1 hour of UV illuminations The contact angle with water of these films was measured by sessile drop method. The enhanced photocatalytic activity in these samples was attributed to prominent decrease in C/Ti and an enhancement of Ti^{3+} states at the film surface in addition to decreases in grain size and increase in life time of electrons & holes due to Ni doping. These results are published in **surface science**

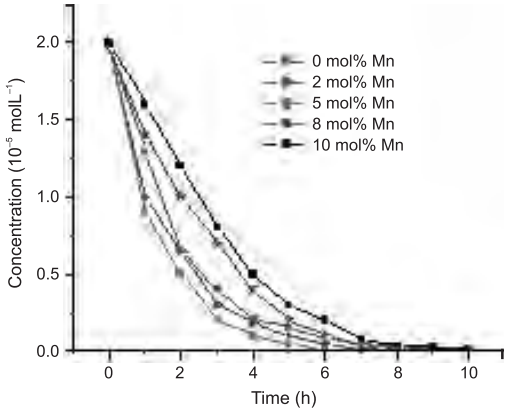


Fig. 3.16 : The photodegradation rate of methylene blue by Mn doped TiO_2 films under UV light

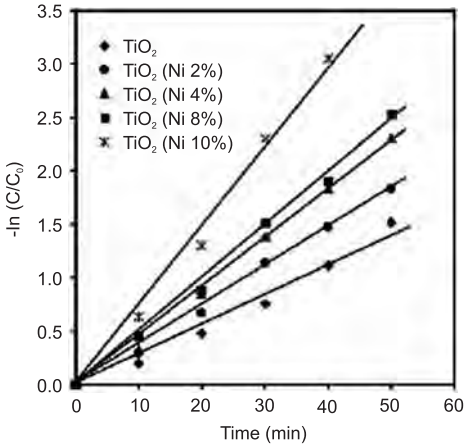


Fig. 3.17 : The photodegradation of eosin by Ni doped TiO_2 films under UV light

TiO_2 is an important commercial material. It is non-toxic, biocompatible and find number of applications in variety of fields. Its latest applications include degradation of pollutants in industrial effluents and self cleaning coatings on window panes which are very much desired in modern high rise architectural designs where cost of cleaning is substantial. But these applications of TiO_2 are restricted due to its limited photoactivity as the band gap of anatase phase of TiO_2 is 3.2eV, therefore it can absorb near the UV edge only whose fraction is very small in the solar spectrum. Intense R & D efforts are desired to enhance the photoactivity of this material so that it can be widely used as a safe effluent purifier and to provide effective self cleaning coating. Our R & D efforts have considerably improved the photoactivity of this material. Also we had made significant breakthrough in understanding the mechanism of enhanced photoactivity in the doped material. We have developed scratch resistant TiO_2 coatings on large area glass sheets by sol-gel technique. The equipment for these coatings has been developed at NPL. Novelty of the technique is that we can obtain uniform film thickness (free from shades) at very small investment on equipment.

D. Ferroelectric Liquid Crystals:

The doping of various types of nanoparticles (NPs) in liquid crystal (LC) material has been extensively investigated since last decade owing to its attractive electro-optical properties and potential applications in electronic industry. The most advantageous thing with these nanoparticles doped liquid crystals is the tunability of electronic and optical properties of nanoparticles with the functional and structural flexibilities of liquid crystals. The nanoparticles doped liquid crystals have been studied by various groups around the world for observing the different aspects such as electro-optical, dielectric, memory effect, phase behaviour etc. Much of the reported work has been focused on nematics liquid crystals. But doping of nanoparticles in ferroelectric liquid crystals (FLCs), which are well known for their good optical contrast, low threshold voltage, memory effect, fast response etc; is rarely reported in literature.

Presently at NPL the enhanced electro-optical properties of Gold nanoparticles (GNPs) doped ferroelectric liquid crystal materials have been studied where the interaction of GNPs with liquid crystal molecules was taken into account. In all parameters of FLCs more emphasis was given on the memory effect or the bistability because of its applications in personal digital assistant, digital cameras etc. and having tremendous potentiality for low cost, large area, high speed and high density memory needed for future computers. The long lasting memory effect, that may be promising for digital nonvolatile memory devices, has been observed for the first time (see Figure 3.18) in the GNPs doped deformed helix ferroelectric liquid crystal (DHFLC) material. This observation of memory effect has been

attributed by electric field induced charge transfer and stabilization of helix deformation of DHFLC respectively. The memory effect has been observed for prolonged time. The work is being carried out to understand the mechanism in detail.

Fig. 3.18 : Memory in gold nanoparticle doped DHFLC (a) indicates the scattered state, i.e. without the application of any external electric field, (b) the switched state on the application of 15 V external bias, and (c) state after removal of bias in which the bright state indicates the presence of memory state for a prolonged time (for few days).

E. Organic photovoltaic devices

To develop eco-friendly and cost effective photovoltaic devices, R & D work has been undertaken in the area of organic photovoltaic devices (OPVDs) at NPL, New Delhi. In the year of 2007-2008, intensive R&D work has been carried out on the basic and applied aspects to improve the efficiency of OPVDs. Poly-(3-hexylethiophene) (P3HT) and copper phthalocyanine (CuPc) are very important organic donor materials for photovoltaic applications. Extensive studies have been carried out on the charge transport phenomenon in P3HT. The Schottky diodes of the polymer were prepared and modeled to extract out the extensive information about the polymer. The modeling has also been carried out on the OPVDs to interpret their characteristics. New device architectures have been employed to enhance the efficiency of OPVDs based on small molecular CuPc.

NPL has developed and demonstrated the OPV devices using polymeric and small molecular organic materials. The small molecular devices consisted of anode/donor/acceptor/exciton blocking layer (EBL)/cathode configuration (the schematic diagram is shown in the inset of Fig.3.19. The incorporation of EBLs has resulted in the improved power conversion efficiency of OPVDs. Studies have been carried out on the application of different EBLs in bilayer and bulk heterojunction OPV devices. Bathophenanthroline (Bphen) has been found to be one of the most suitable exciton blocking materials for organic photovoltaic applications. The power conversion efficiency of ~1.2 % has successfully been achieved in the small molecular bulk heterojunction OPV devices. The current-voltage (*J-V*) characteristics of one of the small molecular OPV devices in dark and under 80 mW/cm^2 irradiance of halogen lamp are shown in Fig. 1. A solar panel (1" x 2" in area) consisting 8 pixels of the active area of ~10 mm^2 each, has been integrated to derive adequate current and voltage to operate an electronic calculator. Fig. 3.20 shows the operation of an electronic calculator under sun light illumination using this device.

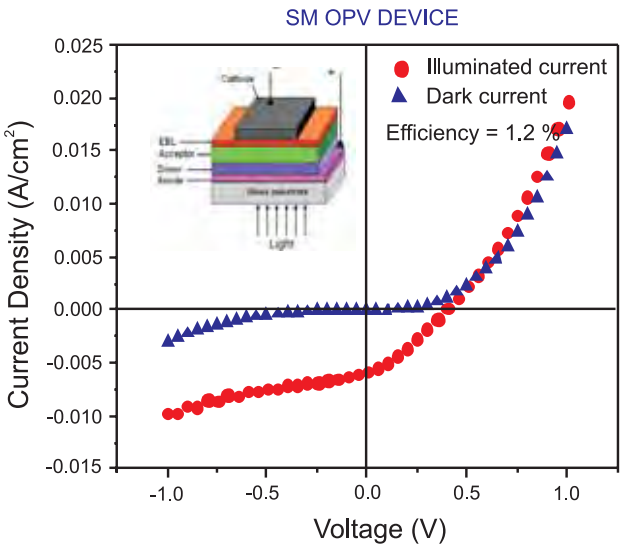
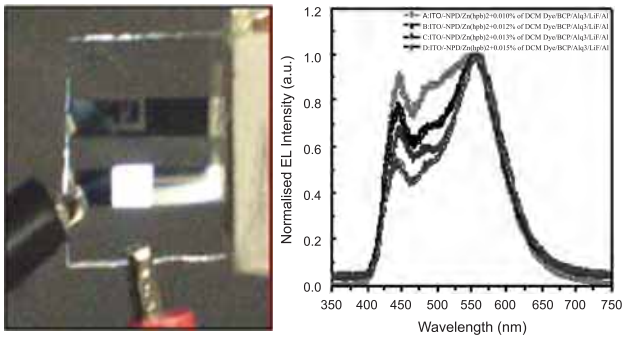


Fig. 3.19 : *J-V* characteristics of small molecular OPV device. Inset shows the schematic diagram of the device.

Fig. 3.20 : Operation of an electronic calculator using the small molecular OPV device under sun light illumination.

F. Development of White Organic Light Emitting Diode

The high power efficiency of Organic Light Emitting Diodes together with the high quality of white light, these LEDs are capable of emitting, is making WOLED an ideal source for white light emission in general lighting applications. In our laboratory we have taken up White Light Emitting Organic Light Emitting Diodes (WOLEDs) as one of the thrust areas of research activity. Recently we have fabricated single layer of $Zn(hpb)_2$ doped with a orange fluorescent dye DCM. The device is made up of multilayer structure consisting of a hole transport layer of N,N diphenyl-N'N'-bis(1-naphthyl)-1,1'-biphenyl-4,4'-diamine (a-NPD), emitting layer $Zn(hpb)_2$ doped with various concentrations of DCM dye, a hole blocking layer 2,9-dimethyl-4,7-diphenyl-1, 10-phenonthroline (BCP), an electron transport layer tris(8-hydroxy)quinoline aluminium (Alq_3) and electron injection layer LiF. We have achieved high quality white light with high current efficiency (1.23 cd/A at 9.5 V) and high power efficiency (0.44 lm/W at 8.5 V).The high efficiency of these white light sources are due to the efficient Förster type energy transfer as well as trap assisted carrier recombination on the DCM guest molecules. The photograph of the device and the spectral response of the WOLED are shown in Fig 3.21 (a)



(a) (b)

Fig. 3.21 : The photograph of WOLED device and EL spectrum of Device.

G. Microwave absorption properties of conducting polymer composite with barium ferrite nanoparticles in 12.4-18 GHz

Conducting polymer nano-composites of polyphenyl amine with barium ferrite nanoparticles 50-70nm, (Fig. 3.22) have been synthesized via emulsion

polymerization. The complex permittivity, permeability and microwave absorption properties of the composite were studied in the 12.4-18 GHz (Ku-band) frequency range. The composite has shown high shielding effectiveness due to absorption (SE_A) of 28.9dB (~ 99.9%), which strongly depends on dielectric loss, magnetic permeability and volume fraction of barium ferrite nano particles. The high value of SE_A suggests that these composites can be used as a promising radar absorbing materials.

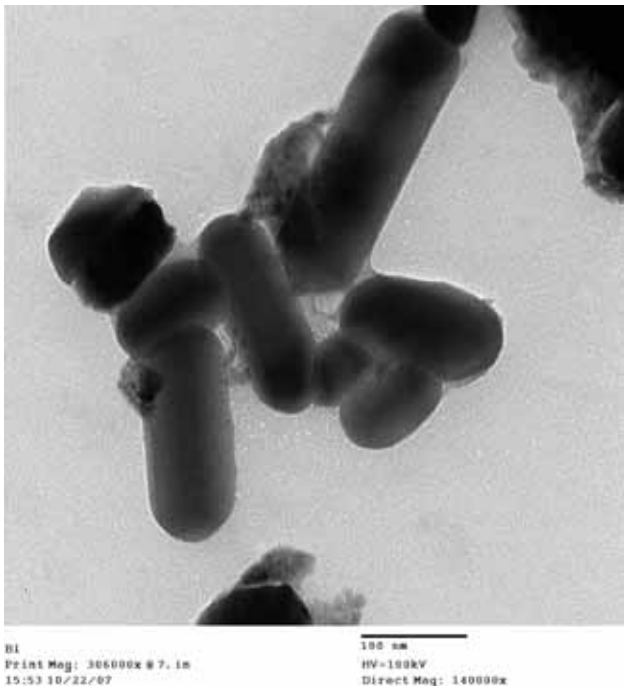


Fig. 3.22 : TEM of composite containing barium ferrite nano particles

Electrochemical Growth behaviour of Polyaniline in the presence of γ - Fe_2O_3 Nanoparticles

The electrochemical polymerization of aniline with DBSA in aqueous medium was carried out using cyclic potential sweep method by switching the potential from - 0.20 V to 0.95 V vs. SCE at a scan rate of 20mV /sec. The rise in current value at 0.78 V in the first cycle corresponds to the oxidation of aniline leading to generation of anilinium radical cations (Fig. 3.23). In the subsequent cycles, new oxidation peaks appear which indicates that these radical cations undergo further coupling to form benzenoid structure and combination of benzenoid and quinoid structure. However when polymerization of aniline was carried out in the presence of γ - Fe_2O_3 particles entrapped in the surfactant medium, electrochemical growth behaviour shows shifting of peak potential values, which indicates the incorporation of γ - Fe_2O_3 in the polymer backbone.

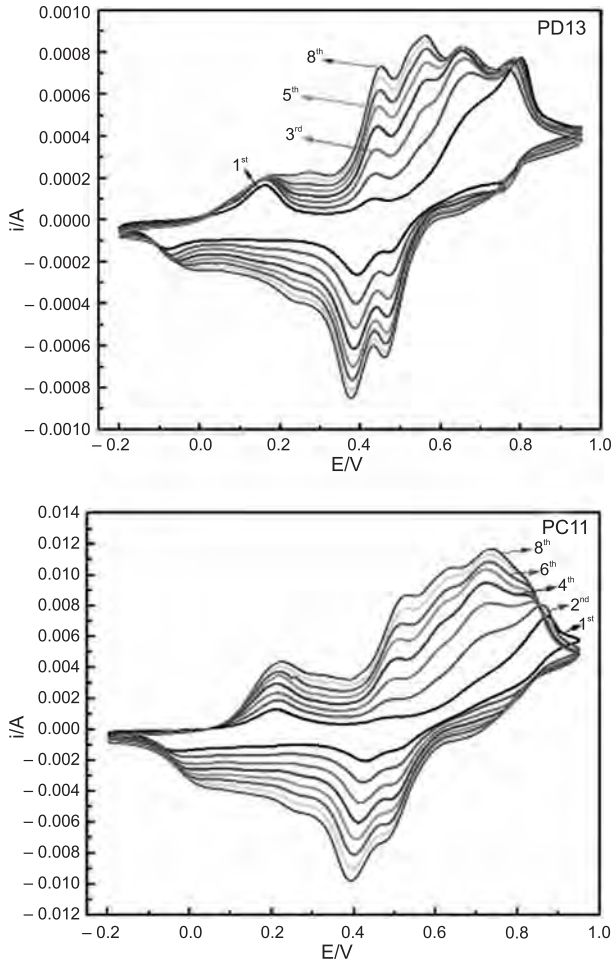


Fig. 3.23 : Electrochemical growth behaviour of conducting polyaniline in ferrite medium

Shielding behaviour of Conducting Polyaniline embedded with barrium ferrite nano particles:

Figure 3.24 shows the variation of the SE with frequency in the 12.4-18 GHz range. It has been observed that conducting ferromagnetic composite of polyaniline with barium ferrite nanoparticles (PBF) have shielding effectiveness (SE) mainly due to absorption and it is found to increase with ferrite concentration and it stabilizes after the threshold loading. The variation of SE_A for the PBF21 was minimum (11.8dB to 13.8dB) and for the PBF13, the SE_A was maximum (19.9dB to 28.9dB) while the SE due to reflection was nominal and contributed very little. The calculated value of SE_R lies between 1.8dB to 3.1dB.

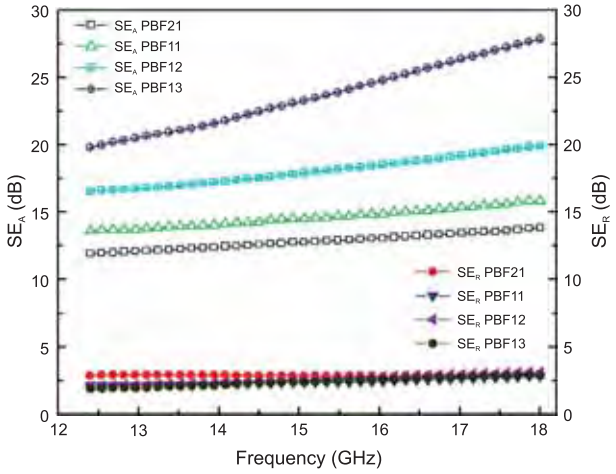


Fig. 3.24 : Shielding Effectiveness of Conducting polymer-barium ferrite composites in the frequency range 12.4-18 GHz

Corrosion inhibition performance:

Tafel polarization curve for iron in 1.0 N HCl with the addition of various concentrations of copolymers of aniline and isopropylaniline is shown in Fig.3.25. The corrosion current value (i_{corr}) at different concentration of the inhibitors obtained are listed in Fig. 3.25 It is clear from the Figure that the corrosion current values (i_{corr}) decreased from 185 micro amp cm^{-2} of that of blank iron electrode to 58 micro amp cm^{-2} with the addition of 80 ppm concentration of ANIPLIS-1 while in the case of ANIPLIS-5, the corrosion current values (i_{corr}) decreased to 58 micro amp cm^{-2} with the addition of 60 ppm concentration and 52 micro amp cm^{-2} with the addition of 80 ppm concentration. Better results has been found with the addition of poly(2-isopropylaniline)-LIS in the system which showed 80% corrosion inhibition efficiency at the 80 ppm concentration.

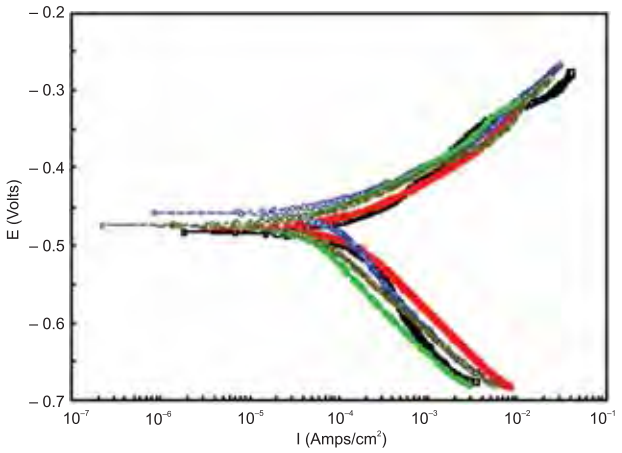


Fig. 3.25 : Tafel Polarization curve of copolymers at different concentrations for studying corrosion inhibition efficiency of iron in 1.0 N HCl

इलेक्ट्रॉनिक पदार्थ

ELECTRONIC MATERIALS

इलेक्ट्रॉनिक पदार्थ प्रभाग

इलेक्ट्रॉनिक पदार्थ प्रभाग ने विभिन्न प्रकार की पदार्थों पर अनुसंधान एवं विकास कार्य किए हैं : – वैद्युत संदीप्ति, फोटोवोल्टीय तथा वैद्युत क्रोमिक पदार्थ, नैनो स्ट्रक्चर पदार्थ, उच्च–तापमान अतिचालकता पदार्थ, उन्नत सिरेमिक पदार्थ तथा पोलीमरिक पदार्थ । तनु तथा मोटी फिल्म के रूप में तथा इसी के साथ बल्क रूप में इन पदार्थों से सम्बन्धित ऐसे साधनों को विकसित करने के प्रयास भी किए जा रहे हैं जिनका उद्देश्य सफलतापूर्वक रूप से विकसित प्रौद्योगिकियों को उद्योग में हस्तांतरित किया जा सके । इसके अतिरिक्त, सतह तथा नैनो स्ट्रक्चरों के अध्ययन तथा अभिलक्षण भी इस प्रभाग के मुख्य कार्यकलाप हैं । प्रभाग में निम्नलिखित ग्रुप शामिल हैं :–

संदीप्तिशील पदार्थ तथा साधन ग्रुप

विभिन्न प्रदर्श साधनों में अनुप्रयोग के लिए विभिन्न संश्लेषित मार्गों द्वारा फॉस्फर्स/नैनोफॉस्फर्स का विकास । ब्लू/यू वी लेड के नज़दीक वाले संयोगी प्रचालन में ठोस अवस्था तड़ित के लिए न्यू डाउन कनवर्जन फॉस्फर्स/नैनो फॉस्फर्स पी–टाइप चालकता प्राप्त करने के लिए विभिन्न पूर्वगामी मार्गों के जरिए डोपेड जेड एन ओ (ZnO) नैनो फास्फर का संश्लेषण।

प्लाज्मा संधाधित पदार्थ, साधन तथा सिस्टम्स ग्रुप

रवाहीन तथा सूक्ष्म/नैनो सिलिकन तथा कार्बन आधारित तनु फिल्में, साधन तथा पद्धतियों पर अनुसंधान एवं विकास कार्य । डायमण्ड जैसी कार्बन फिल्मों पर कार्य किया जा रहा है फिल्टर की हुई कैथोडिक वैक्यूम आर्क तकनीक द्वारा निक्षेप की हुई चतुष्फलकीय रवाहीन कार्बन फिल्में ।

सिलिकन तथा सिलिकन साधन (डिवाइस) ग्रुप

सौर कक्ष फेब्रिकेशन प्रयोगशाला का पुनः सक्रियण तथा 50 मि मी व्यास वेफर्स पर पी+–पी–एन+ (P^+-p-n^+) सिलिकन सौर कक्ष का संसाधन/अल्पांश वाहक जीवनकालिक माप के लिए विकसित किया हुआ फोटोकरेंट जनरेशन तकनीक/सिलिका तथा सिलिकन ऑक्साइड नैनोवायर संसाधन तथा अनुप्रयोग ।

नैनोस्ट्रक्चर पदार्थ, साधन तथा सतह अध्ययन

पी ई डी ओ टी – एस डी एस नोबल पोलिमर फिल्म जिसमें उत्तम वैद्युत क्रोमिक गुणधर्म शामिल होते हैं । गैस संवेदकों के लिए नैनो क्रिस्टलाइन धातु ऑक्साइडों के संश्लेषण । हाईब्रिड जैवे–अजैव नैनोकंपोजिट । जैव इलेक्ट्रॉनिक्स के लिए संयुग्मी पोलिमर । सिलिकन, मैगनीजियम सिलिसाइड आदि पर ऐन्टिमनी का सतह अध्ययन आदि ।

उच्च तापमान अतिचालकता पदार्थ एवं साधन उन्नत सिरेमिक तथा ऑप्टिकल तनु फिल्म ।

[Bi-2223] उच्च करेंट परिवहन के लिए बल्क में ट्यूब/रॉड तथा करेन्ट लीड तथा दीर्घ लम्बाई की टेप । बीटा/अल्युमिना आयनिक चालकता के लिए माइक्रोवेव फरनेन्स । जल प्रदूषण की मॉनीटरिंग करने के लिए ऑप्टिकल बॉयोसंवेदक । फाइबर ऑप्टिक संचार में प्रयोग करने के लिए परिमित बैंडपास फिल्टर कोटिंग । नेत्र अनुप्रयोगों के लिए प्लास्टिक से संबंधित परावर्तन व निरोधी कोटिंग ।

ELECTRONIC MATERIALS

The Division of Electronic Materials has undertaken R & D work on several types of materials : electroluminescent, photovoltaic and electrochromic materials, nanostructured materials, high temperature superconducting materials, advanced ceramic materials and polymeric materials, Efforts have also been made to develop devices involving these materials, in thin and thick film form as well as in bulk form, with the objective of transferring successfully developed technologies to industry. Besides, the study and characterization of surfaces and nanostructures is a major activity in this division. The division includes the following groups :

Luminescent Materials and Devices Group

Development of phosphors/nanophosphors by different synthesis routes for applications in several display devices. New down-conversion phosphors/nanophosphors for solid state lighting in conjunction with blue/ near UV LED. Synthesis of doped ZnO nanophosphor through different precursor routes to obtain p-type conductivity.

Plasma Processed Materials, Devices and Systems Group

R & D on amorphous and micro/nano silicon, and carbon, based thin films, devices and systems. Ongoing work on diamond-like carbon films. Tetrahedral amorphous carbon films deposited by filtered cathodic vacuum arc technique.

Silicon and Silicon Devices Group

Reactivation of solar cell fabrication laboratory and processing of p^+-p-n^+ silicon solar cell on 50 mm diameter wafers. Photocurrent Generation Technique developed for minority carrier lifetime measurement. Silica and silicon oxide nanowire processing and applications.

Nanostructured Materials and Devices and Surface Studies

Novel polymer films of PEDOT-SDS having superior electrochromic properties. Synthesis of nanocrystalline metal oxides for gas sensors. Hybrid organic-inorganic nanocomposites. Conjugated polymers for organic electronics. Surface studies of antimony on silicon, magnesium silicide, etc.

High Temperature Superconducting Materials & Devices, Advanced Ceramics and Optical Thin Films

[Bi-2223] bulk tube/rod and current leads and long lenght tapes for high current transport. Microwave furnace for preparing beta alumina ionic conductors. Optical biosensor for water pollution monitoring. Narrow bandpass filter coatings for use in fibre optic communications. Antireflection coatings on plastics for ophthalmic applications.

The Luminescent Materials and Devices Group

Has been engaged in developing phosphors/ nanophosphors by different synthesis routes for applications in stratogic display devices. As luminescence quantum efficiency of phosphors play a very important role in improving the efficacy of display devices, a new experimental facility using an integrating sphere has been established for absolute quantum efficiency measurement of phosphors. The group has been working on "Synthesis of phosphors for Plasma Display Panels (PDP)" in association with M/s SAMTEL India Ltd, Gaziabad on a collaborative project on "Development of next generation Plasma Display Panel Technology and 50" High Definition (HD) TV Prototype" under NMITLI Program. Red, Green and Blue (RGB) PDP Phosphors have been developed. The developed phosphors were tested under vacuum ultraviolet (VUV) excitation using a VUV Xenon lamp and also under UV excitation attached to Luminescence Spectrometer available at NPL. Quantum efficiency of developed phosphors were measured with our new experimental facility and compared with commercial PDP phosphors used by SAMTEL Colour Lab Ltd. PDP phosphors developed at NPL have high quantum efficiency almost at par with commercial phosphors. Developed RGB phosphors and their luminescence emission spectra under VUV excitation (172 nm) are shown in Fig. 4.1.

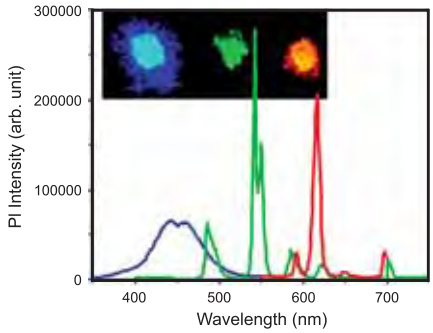


Fig. 4.1 : NPL developed RGB Phosphors for Plasma Display Panel applications and Photoluminescence spectra under VUV excitation (172 nm)

New down conversion phosphors/ nanophosphors have been explored and developed for solid state lighting in conjunction with blue/ near UV LED. The main phosphors developed for this purpose are YAG:Ce codoped with Praseodymium for successful enhancement of red part of resultant white LED spectrum, $SrAl_2O_4$ doped with Praseodymium and $SrAl_{12}O_{19}$ doped with various rare earth activators for excitation by blue LED light. Binary & ternary nanophosphor powder and thin film of ZnO/ ZnMgO were developed which were excitable by near UV (350nm) light (commercial UV-LED) and can produce broadband white emission (Fig. 4.2). Optimum synthesis parameters for producing reliable and high brightness ZnO and $ZnO_{1-x}S_x$ nanophosphors that could be excited efficiently in the near UV region (between 340-480 nm) were identified and established.

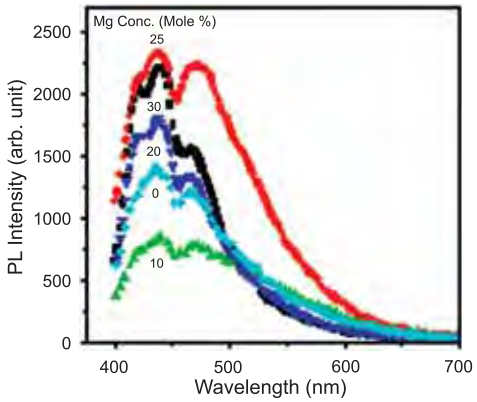


Fig. 4.2 : PL Emission spectra at 350 nm excitation

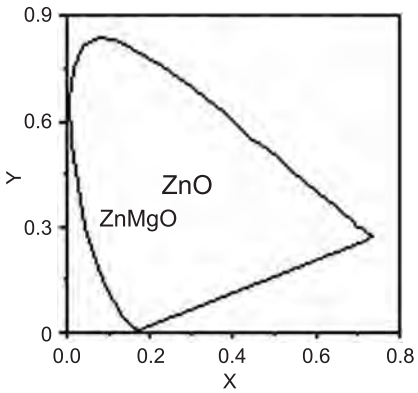


Fig. 4.3 : Photoluminescence emission spectra of ZnMgO thin film and colour coordinate showing near ideal white emission under near UV (350 nm) excitation.

Synthesis of ZnO nanophosphor doped with alkali, alkaline earth and transition metal atoms through different precursor routes was taken up in an effort to obtain p-type conductivity in ZnO which is very difficult to achieve. p-type conduction in alkali doped ZnO and Mg doped ZnO has been achieved (Fig. 4.3). In addition, synthesis of strong green emitting ZnO phosphor, improvements in emission efficiency by doping Mm (misch-metal), Sb and surface passivation of ZnO nanophosphor by capping with inorganic as well as organic material was done for possible electroluminescent, biological and pharmaceutical applications. Production process for high yield ZnO nanorods/tetrapods/nanostructures was optimized for fabrication of futuristic field emission devices. Band gap engineering of ternary $ZnO_{1-x}S_x$ nanophosphor system was successfully carried out using High Pressure Autoclave attached with a high pressure liquid chromatography pump.

The Plasma Processed Materials, Devices and Systems

The Plasma Processed Materials, Devices and Systems group has been engaged in R & D on amorphous and micro/nano silicon, as well as carbon, based thin films, devices and systems.

(a) Amorphous and micro / nano crystalline silicon films

Deposition and characterization of μc / nc-Si:H and a-Si:H thin films using RF (13.56 MHz) plasma enhanced chemical vapour deposition (PECVD) technique with a gaseous mixture of SiH_4+H_2+Ar have been carried out. These films have been grown on 7059 Corning glass and TCO-coated substrates. Our efforts have been to optimize the process for the deposition of uniform μc-Si:H films with high crystalline content and high photosensitivity over 100 cm^2 area. These films have been deposited by varying process parameters such as gas flow, deposition pressure and power density. It has been found that micro/nano-structured and amorphous films are formed in different pressure regions (0.6 - 8 Torr), as confirmed by Raman spectroscopy measurements. The light intensity F and temperature dependent photoconductivity σ_{ph} of these films have been measured in the coplanar geometry configuration, using aluminum electrode contacts with a gap of 0.078 cm. To obtain the light intensity dependence of σ_{ph}, the samples have been stabilized at a given temperature long enough to attain thermal

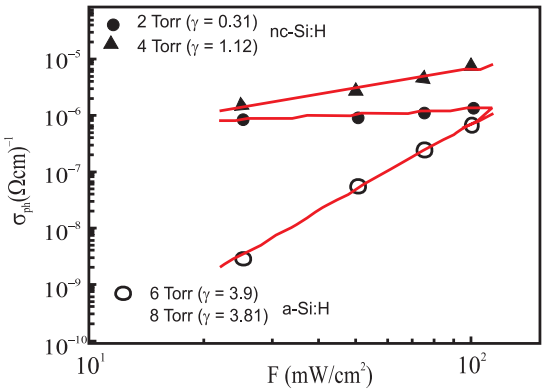


Fig. 4.4 : Dependence of photo-conductivity on light intensity at room temperature.

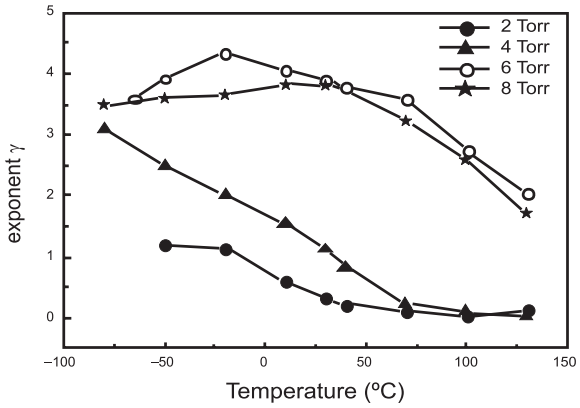


Fig. 4.5 : Dependence of the exponent γ with temperature for samples deposited at various pressures.

equilibrium and thereafter the measurement of σ_{ph} has been carried out by varying the white light intensity F (25 mW/cm^2 – 100 mW/cm^2). The plots of $\log_{10} \sigma_{ph}$ vs F have

been found to be linear for all samples and obey the relation $\sigma_{ph} \propto F^{\gamma}$, where γ is the slope of the line. It has also been observed that the value of γ increases with decreasing temperature. At lower intensities, micro / nanostructured films show higher photoconductivity than amorphous films for a given temperature. It has also been seen that micro/nano-structured films (deposited at 2 and 4 torr pressures) are less sensitive to higher light intensities. Fig. 4.4 & 4.5 show respectively the dependence of photoconductivity on light intensity at room temperature, and variation of the exponent ã with temperature, for samples deposited at various pressures. We plan to translate these results on to large area substrates with high deposition rates of micro/nano-structured silicon thin films, using very high frequency (100 MHz & 2.45 GHz) PECVD technique.

(b) Diamond like carbon films

In continuation of the previous year's work, some more silicon-incorporated diamond like carbon films have been deposited as a function of self bias and pressure, to optimize the process parameters. It has been found that under certain sets of deposition parameters these films were hard, adhesive and scratch-free. These films have been deposited on metallic substrates (which is generally very difficult) with the aim of using them for tribological applications.

(c) Tetrahedral amorphous carbon films deposited by filtered cathodic vacuum arc (FCVA) technique

The newly designed cathodic jet carbon arc (CJCA) source has been fabricated and fitted into the existing filtered cathodic vacuum arc (FCVA) system. Several deposition runs of nitrogen incorporated amorphous carbon (a-C:N) films having nanoparticle inclusions have been carried out using nitrogen as a carrier gas. The measurements of electrical conductivity, SCLC, transmission, stress, hardness, SEM, EDAX, and optical constants on a-C:N films have been made. The effects of various process parameters, such as arc current, magnetic field and substrate bias, on the properties of the deposited films are being studied.

Silicon and Silicon Devices Group

In the Silicon and Silicon Devices Group, the solar cell fabrication laboratory was reactivated and processing of p^+-p-n^+ silicon solar cell on 50 mm diameter wafers was carried out on polished and anisotropically textured silicon wafers. Open circuit voltage >600mV, short circuit current J_{sc} ~24 mA/cm^2 on polished and ~31 mA/cm^2 on textured cells were achieved. The best conversion efficiency of 12.4% (without anti-reflection coating) on 18cm^2 area was achieved.

Minority carrier lifetime was measured using "**Photo Current Generation"** technique, a method developed at NPL. The system was validated by measuring the minority carrier lifetime on the material by microwave PCD system (Semilab, Hungary) available at BARC, Mumbai and Sinton's system at BHEL, Gurgaon. The results were in agreement within ±5%.

A phenomenological model of the generation of photovoltage along the horizontal plane of the obliquely deposited films on transparent substrates was developed. The model is based on the presence of obliquely grown grains separated by parallel grain boundaries (GB) across which GB potential barriers exist. A net photocurrent and hence a photovoltage across each grain boundary due to differential photogeneration of carriers in the front and back side of GBs and the horizontal components of this photovoltage get added up to produce a large photovoltage. An expression has been derived based on this model which shows that for low intensities of illumination the horizontal component $\overline{V}_{och}$ of the

photovoltage increases linearly with electrode separation, resistivity of the film and the incident light intensity. It depends on the angle of deposition and under certain conditions it is expected to be maximum when deposition angle is 45°. The analysis can be applied to study the effect of increase in intensity or decrease in temperature on $\overline{V}_{och}$. It also shows that the photovoltage across the thickness of the obliquely deposited film $\overline{V}_{och}$ is minimum for normal deposition and increases with the increase in the angle of oblique deposition β.

R & D on silicon/silicon oxide nanowires processing and applications was initiated by thermal evaporation of silicon monoxide. Large quantities of SiO_x nanowires were synthesized with diameter in the range of 30-100 nm and hundreds of microns in length. These nanowires have amorphous structure and show blue emission at room temperature. A typical SEM micrograph of silicon dioxide nanowires is shown in Fig. 4.6.

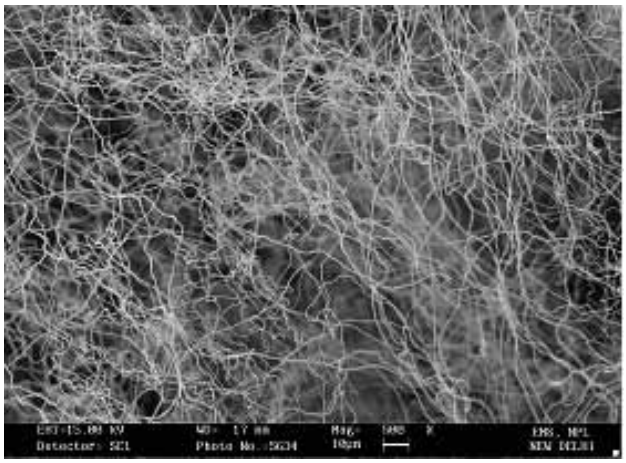


Fig. 4.6 : Typical SEM micrograph of SiO_2 nanowires

In addition, arrays of large area aligned silicon nanowires were successfully prepared at room temperature by electrochemical etching process. These arrays have excellent antireflection surface and could be used for minimizing the optical losses in silicon solar cells. Reflectivity ~1% has been achieved on SiNWs arrays in spectral range 300-600 nm and an average reflectance of ~ 3 % in entire spectral range of 300-1100 nm as shown in reflectivity plot (Fig. 4.7).

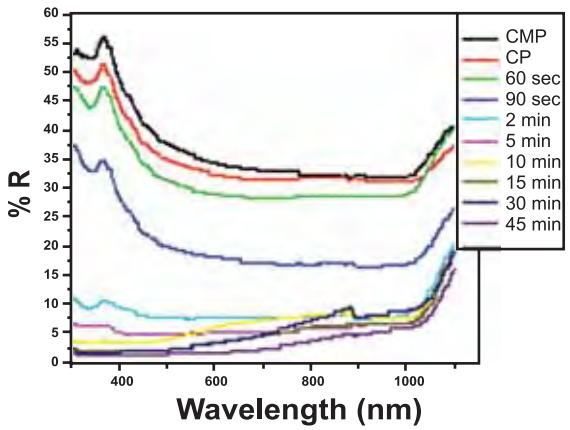


Fig. 4.7 : Reflectance (R) *vs.* wavelength plot of SiNWs arrays of different lengths

In the Electrochromic Materials and Devices

In the Electrochromic Materials and Devices activity, the unequalled potential of aqueous micellar chemistry for synthesizing nanostructured electroactive polymer films of high cosmetic quality has been demonstrated by the remarkably high electrochromic coloring efficiency, fast color-bleach speeds and

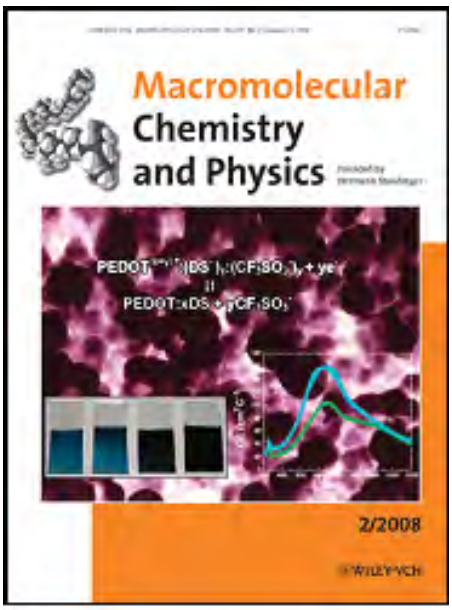


Fig. 4.8 : Electrochormic properties of PEDOT-SDS on the cover page of Macromolecular Chemistry and Physics Vol. 209, No. 2 (2008)

outstanding durability shown by of poly (3, 4 - ethylenedioxythiophene) films and prototype electrochromic windows processed by this method.

Under the Synthesis of Nanocrystalline Metal Oxides for Gas Sensors

Under the Synthesis of Nanocrystalline Metal Oxides for Gas Sensors activity, nanocrystalline / mesoporous tin oxide powders were prepared using chemical techniques. The gas sensitivity of the derived sensors were investigated for various gases ethanol, acetone, TMA, DMA, ammonia, NO_x, CO, LPG and CNG. SnO_2 powder was prepared by precipitation route. Ammonia and NO_x sensors are

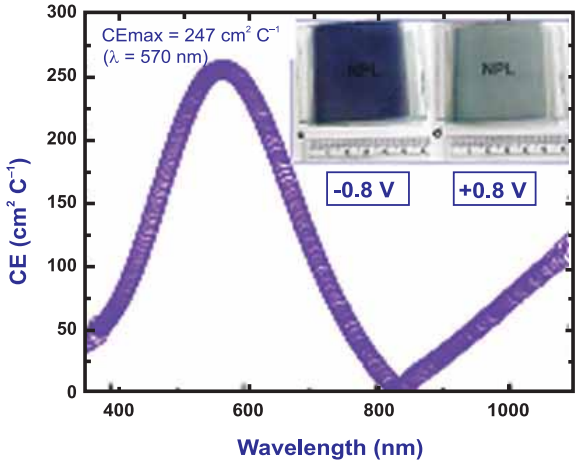


Fig. 4.9 : Coloration efficiency and photograph of elelctrochromic device fabricated using PEDOT:CSA

desired for environmental monitoring and food freshness monitoring. A systematic study was made to improve ammonia and NO_x sensitivity using doped (Pt, Au, Pd) WO_3 as sensitive material. The effect of overlayers such as SiO_2, on response time and gas sensitivity was investigated in detail. A project on Nanostructured metal oxide gas sensor array for detection of chemical warfare agents, was sanctioned by DRDO.

Hybrid Organic - Inorganic Nanocomposites

Under the Hybrid Organic-Inorganic Nanocomposites activity, CdSe nanocrystals (6-10 nm) prepared by chemical route using TOP/ TOPO capping were dispersed in conducting PPV (p-phenylenevinylene) and P3HT (3-hexylthiophene) polymer matrices using a binary solvent mixture (pyridine-chloroform) respectively and tailored by altering the composition and concentration of NC's in CP. Stern-Volmer plots indicate heterogeneous quenching of PL emission for smaller CdSe quantum dots ensuring efficient charge transfer process across polymer-CdSe interface. This heterogeneous quenching could be as a result of insufficient coverage of polymers on the surface of CdSe nanocrystallites due to phase segregation in PPV-CdSe nanocomposites. The superior stability of the surface bonds of P3HT-CdSe nanocomposites as compared to the corresponding PPV-CdSe nanocomposites can be elucidated from absence of PL decay. The smallest size of CdSe nanocrystallites in conjunction with the superior surface morphology of P3HT polymers could be the key for the realization of effective charge separation and transport in hybrid solar cells.

Studies in Conducting Polymers

Under Studies in Conducting Polymers, the chemistry of chemical doping in conjugated polymers has been studied. An evidence for disruption in p-conjugation upon increase in doping was established through various photo-physical, electrical and morphological investigations. The dielectric constant $\varepsilon'(\omega)$, dielectric loss $\varepsilon''(\omega)$ and ac conductivity $\sigma(\omega)$ m of lightly doped poly (3-hexylthiophene) (P3HT) films give the evidence that, both dc conductivity as well as dielectric relaxation originate from the same hopping process. These findings give in-depth understanding of conjugated polymers for application in organic electronics.

Surface Studies and Nanostructures

Under the Surface Studies and Nanostructures activity, the formation of antimony 1D structures on Si (5 5 12) surface was studied. Adsorption of antinomy metal on high index Si (5 5 12) which is composed of (2 2 5) and (3 3 7)

regions with nanoscale widths and row like trenches and provides an unique template for the growth of nanostructures was studied. Various superstructural phases were formed by steering the kinetic parameters and post growth annealing of the surface corresponding to various coverages and substrate temperatures. These were probed in-situ by Low Energy Electron Diffraction (LEED), Auger Electron Spectroscopy (AES), and Electron Energy Loss Spectroscopy (EELS). The growth of Sb at 300°C substrate temperature and annealing to 820°C leads to the formation of low dimensional phases having anisotropy like atomic wires. The results demonstrate the pathways for 1D and 2D nanostructure formation. In **Formation of Magnesium Silicide** studies, the adsorption studies of magnesium on Si (1 1 1) substrate has been performed using AES, LEED and EELS at various substrate temperatures. It is observed that the sticking coefficient of magnesium on the silicide surface is close to zero for temperatures greater than 100°C. Magnesium silicide grows as continuous films on Si substrate at 100–140 °C, while above 170°C it grows in the form of islands.

High Temperature Superconducting Materials & Devices group

In the High Temperature Superconducting Materials & Devices group, the development of $(Bi,Pb)_2Sr_2Ca_2Cu_3O_{10+x}$ [Bi-2223] bulk tube/rod and current leads and long length tapes for high current transport was taken up. A pair of bulk tube (L=430mm, OD=48mm, ID=46mm) joint current leads carrying transport critical current of 85% of that of the individual tube carrying >1KA at 77K in self field has been developed. Optimization of preparation parameters to improve the transport current through the joint is in progress. Multi-filamentary Bi-2223 tapes (> 35 m long) having 7, 13 and 21 filaments carrying I_c ~7-10A at 77K in self-field have been developed. To understand the nature of pairing and in search of effective pinning centers, CESR studies of Bi-2223 samples doped with Pr (0-0.1M%) prepared under optimized conditions have been carried out at RT and 77K. Presence and disappearance of CESR signal along with Platzmann-Wolf lines at RT and 77K respectively confirms further the role of enhanced exchange interaction in this HTS system. Temperature/angular variation studies of this series are in progress. XRD, SEM of these samples have also been carried out. AC susceptibility and RT measurements of these samples showed a slight decrease in T_c from 112K for pure and 110K for 0.10M% Pr doped sample (Fig. 4.10). Transport Jc of bar-shaped samples (L=35mm,W=12mm,t=2mm) is in the range of 10^3 to 10^2A at 77K in self field.

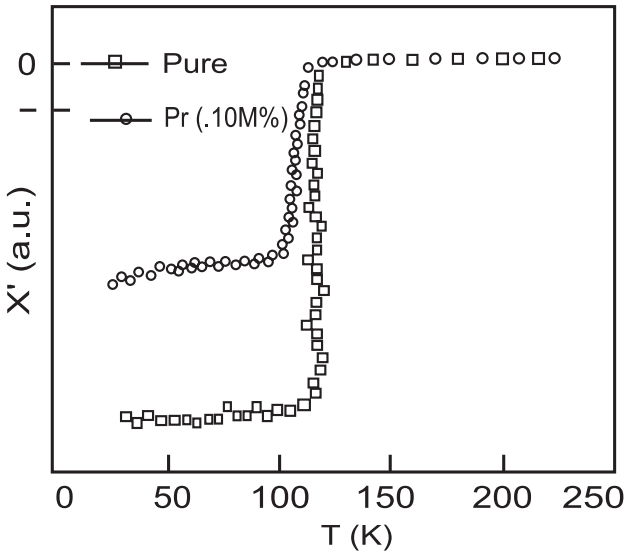


Fig. 4.10 : AC susceptibility and RT measurements on Bi-2223 samples doped with Pr

Advanced Ceramics

Under the Advanced Ceramics activity, for preparing beta alumina ionic conductors, a microwave furnace was designed and fabricated for operation upto 1800 °C. The problem of thermal runaway was solved by modifying the furnace design (Fig. 4.11). For develop-ing optical biosensors, a 0.001 M solution of 3-hydroxy-3-phenyl-1-p-chlorophenyl tria-zene (fluorescent material) was prepared in acetone, pH maintained at 5.6 by ammonium acetate (5% w/v solution in H_2O) and fluorescence was measured with variation of concentration of Malathion. The fluorescence intensity continuously decreased

Fig. 4.11 : Thermal runaway in microwave

with increasing concentration of Malathion. This was not observed with other triazenes. The variation in wavelength as well as fluorescence intensity was observed in pure distilled water and in Malathion solution.

Optical Thin Films

Under the Optical Thin Films activity, narrow bandpass filter coatings with peak transmittances of 60-80 % in the 800-900 nm and 1500-1700 nm regions, for potential use in wavelength division multiplexing (WDM) applications for fibre optic communications, were successfully developed. Using an in-house designed, fabricated and assembled plasma polymerization deposition system, with a argon-oxygen RF plasma at 13.56 MHz and non-toxic liquid organic precursors, processes have been successfully developed to make the surface of polycarbonate (PC) 'wettable', to improve its hardness and to deposit polymeric films of silica, titania and silicon nitride of desired thicknesses. Prototype 4-layer antireflection coatings (ARC) of satisfactory hardness, adhesion and durability have been deposited on PC substrates (Fig. 4.12), and consultancy can be offered for setting up a deposition facility for ARC's on plastic lenses for ophthalmic applications. The deposition of pure rutile- and brookite-phase titania crystals of large surface area, having dimensions in the 300-1200 nm range, has been accomplished by PECVD under different substrate bias voltages, at room temperature (Fig. 4.13).

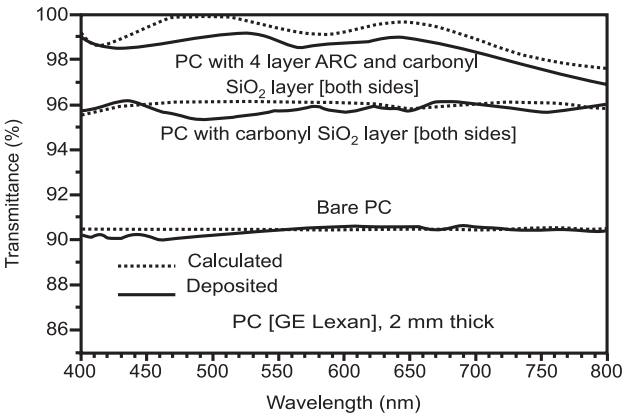


Fig. 4.12 : Measured and calculated transmittance vs wavelength characteristics of a bare, carbonyl silica coated, and 4 layer ARC plus carbonyl silica coated, PC substrate, with both sides coated.

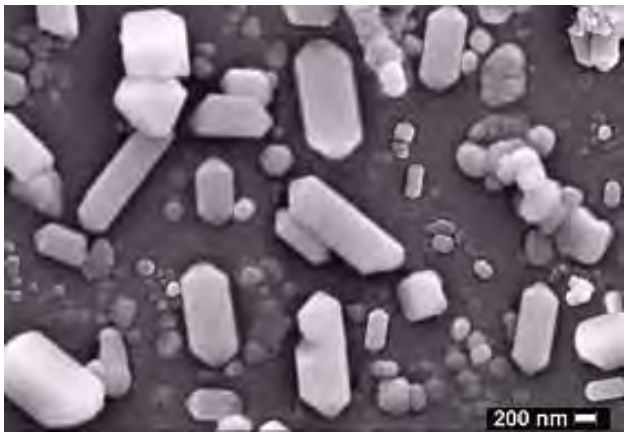


Fig. 4.13 : SEM micrograph of as-deposited brookite titania crystals, deposited by PECVD at – 250 V applied bias, at room temperature.

पदार्थ अभिलक्षणन

MATERIALS CHARACTERIZATION

पदार्थ अभिलक्षणन प्रभाग

राष्ट्रीय भौतिक प्रयोगशाला में विभिन्न पदार्थों के अभिलक्षण विकसित किए जा रहे हैं जैसे तनु परतें, नैनो ट्यूब्स, नैनो रॉड्स नैनो वायर्स, इंजीनियरी अनुप्रयोगों के लिए कंपोजिट पदार्थ, डिवाइस फब्रिकेशन के लिए इलेक्ट्रॉनिक पदार्थ को उनके कंपोजिशन, ट्रेस अशुद्धता, क्रिस्टलीय स्ट्रक्चर, क्रिस्टलीय पूर्णता सतह एवं अंतरापश्ष्ठ के सम्बन्ध में इस प्रभाग में प्रयोगशाला की केन्द्रीय सुविधा के रूप में, नियमित रूप से कार्य किया जा रहा है । प्रभाग प्रयोगशाला की अनुसंधान योजना के अनुरूप निश्चित लक्ष्यों के साथ स्वयं ही अनुसंधान एवं विकास के विभिन्न कार्यकलापों से भी जुड़ा हुआ है । इस अवधि के दौरान डिवीजन द्वारा किए गए कुछ महत्त्वपूर्ण अनुसंधान एवं विकास के कार्य कलापों के बारे में नीचे उल्लेख किया गया है :–

पदार्थों का रासायनिक विश्लेषण जो समाज को सेवा प्रदान करने के कारण राष्ट्रीय महत्त्व का है जैसे :–

(1) पोली एल्युमिनियम क्लोराइड (पी ए सी), एल्युमिनियम फेरिक जिसका प्रयोग जल की शुद्धता एवं उपचार में किया जाता है।

(2) चुनावी प्रक्रिया के लिए अलोप्य स्याही

(3) वी वी आई पी सुरक्षा के लिए गैसे अभिलक्षण ।

10 वीं एशियाई परिशुद्धता फोर्जिंग सम्मेलन के दौरान तीन नए ठोस सी आर एम बी एन डी 3404.01 प्लेन कार्बन स्टील पोजिशन, बी एन डी 3405.01 प्लेन कार्बन स्टील, कंपोजिशन 2 तथा बी एन डी 3301.01 – एल्युमिनियम आंतरिक मानक जारी किए गए । लैब 6 एक्स–रे लाइन पोजिशन तथा लाइन सी आर एम पर कार्य चल रहा है ।

सोल–जेल एवं आर एफ कण क्षेपण द्वारा संश्लेषित नेनो–क्रिस्टलीय जेड एन ओ (ZnO) के विस्तश्त अध्ययन पर विभिन्न अभिलक्षणन तकनीकों का प्रयोग करके किया जा रहा है । ब्राजील तथा अर्कनसस के प्राकशतिक स्फटिक (क्वार्टज) में रेडिएशन प्रेरित पैरा चुम्बकन त्रुटियों पर ई पी आर स्पेक्ट्रोस्कोपी द्वारा अध्ययन किया जा रहा है । इन नमूनों $[AlO_4]^o$ में केन्द्र से संबंधित ई पी आर सिग्नल का अवलोकन किया गया ।

तापमान संवेदक की एक चुनी हुई रेंज का, फेरोफ्लूड का प्रयोग करके विकास किया गया है तथा पेटेन्ट के लिए आवेदन किया गया है । ये साधन तापमान की बहुत कम परिशुद्धता पर भी संवेदन करने में समर्थ हैं अर्थात् लगातार समान वायुमण्डलीय दाब में उत्पन्न हुए एम वी (mV) सिग्नल के सन्दर्भ में 5mK । इस साधन के बहुत से उपयोगी अनुप्रयोग हैं जैसे मानक, तापमापियों का अंशांकन, प्रतिरक्षा, चिकित्सा तथा जैव चिकित्सीय अनुप्रयोग आदि ।

नई एच आर – टी ई एम के संस्थापन से संबंधित कार्य पूरा हो गया है तथा सिस्टम ने काम करना शुरू कर दिया है । नैनो–विमीय कणों, वायर, रॉड, रंध्र तथा डब्ल्यू ओ$_3$ (WO_3) में चैनलों की परिष्कृत सूक्ष्म संरचना को विभिन्न प्रकाशीय तथा विद्युत क्रोमिक गुणधर्म पर उनके प्रभाव को समझने के लिए उन्हें क्रिस्टलोग्राफिक साइमेटरी के साथ किया गया है ।

विभिन्न प्रकार के डोप एवं अनडोप जैव, अर्द्ध जैव, अजैव क्रिस्टल का विकास तथा एच आर–एक्स आर डी तथा अन्य अभिलक्षण तकनीकों द्वारा अभिलक्षित किए गए हैं । क्रोचालस्की तकनीक द्वारा विकसित अनडोप, एम जी डोप तथा एम जी, एन डी को–डोप $LiNbO_3$ सिंगल क्रिस्टल, एच आर एक्स आर डी (HRXRD) द्वारा अभिलक्षित किए गए हैं। एम जी, एन डी को–डोप क्रिस्टल ने क्रिस्टलीय में बेहतर पूर्णता दर्शायी है । ऑप्टिकल ट्रांसमीशन अध्ययन ने एम जी डोप तथा एम जी, एन डी को–डोप एलआईएनबीओ$_3$ ($LiNBO_3$) क्रिस्टल में कट ऑफ फ्रीक्वेन्सी में ब्लू शिफ्ट दर्शाया है।

विभिन्न वैद्युत – रासायनिक रूप से तैयार सीयू–सीओ (Cu-Co) विषम संरचना का सिम (SIMS) गहराई प्रोफाइलिंग का कार्य किया गया है । इस कार्य में सिम के प्रयोग का विचार बहुस्तरीय विषम संरचना के फारमेशन को पुष्ट करने के लिए किया गया । एक अन्य उद्देश्य प्रयुक्त नमूना तैयार करने की वैद्युत रासायनिक विधि के कारण प्रत्येक स्तर में सी यू सी ओ (Cu, CO) का अन्तर्मिश्रण तथा अशुद्धता की सीमा की जांच करना है ।

MATERIALS CHARACTERIZATION

Characterization of various materials being developed at NPL, like thin films, nano tubes, nano rods, nano wires, composite materials for engineering applications, electronic materials for device fabrication etc. are being carried out regarding their composition, trace impurities, crystalline structure, crystalline perfection, surfaces & interfaces, at this division regularly as central facility of the laboratory. The division is also engaged in different R & D activities of its own with definite targets in tune with the research plan of the laboratory as a whole. Some of the important R & D activities of the division persued during this period is listed below:

Chemical analysis of materials which are of national interest giving services to the society, vig. i) Poly aluminium Chloride (PAC), Alumina ferric used in treatment & purifying water ii) indelible ink for electoral process, iii) gas characterization for VVIP security.

Three new solid CRMs BND 3404.01 Plain Carbon Steel composition; BND 3405.01 Plain Carbon Steel, Composition 2 and BND 3301.01 – Alumina internal standard were released during 10th Asian Symposium on Precision Forging. The LaB_6 X-ray line position and line CRM is under preparation.

Detail study of nono-crystalling ZnO synthesized by sol-gel & RF sputtering process were carried out using different characterization techniques. Radiation induced paramagnetic defects in natural quartz from Brazil and Arkansas were studied by EPR spectroscopy. EPR signal pertaining to $[AlO_4]^0$ centre was observed in these samples.

A selective range temperature sensor has been developed using ferrofluid and applied for patent. The device is capable of sensing very low precision temperature i.e. 5mK in terms of mV signal generated at constant atmospheric pressure. This device has many useful applications viz. standard, calibration of thermometers, defense, medical and biomedical applications etc.

Work related to installation of New HR-TEM has been completed and the system is now operational. Fine microstructures of nano-dimensional particles, wires, rods, pores and channels in WO_3 has been interpreted along with their crystallographic symmetries to understand their influence on different optical and electrochromic properties

Various types of doped & undoped organic, semiorganic, inorganic crystals were grown and characterized by HR –XRD and other characterization techniques. Undoped, Mg doped and Mg, Nd codoped $LiNbO_3$ single crystals grown by Czochralski technique were characterized by HRXRD. The Mg, Nd codoped crystals show better crystalline perfection. Optical transmission study shows the blue shift in the cutoff frequency in Mg doped and Mg, Nd codoped $LiNbO_3$ crystals.

SIMS depth profiling of different electro-chemically prepared Cu-Co heterostructures were done. In this work, the idea of using SIMS was to confirm the formation of heterosturcture multi-layers and to confirm the uniformity of the deposited layers. Another objective was to check the extent of impurities and inter-mixing of Cu, Co in each layer due to the electro-chemical method of sample preparation used.

Chemical Metrology

After merger of Indian reference material activity with analytical chemistry, a new activity "Chemical Metrology" has been formed with a focus on Metrology in Chemistry (MiC) for providing traceability in chemical measurements by NPLI by doing R&D in various areas in a well coordinated network mode involving many CSIR and other institutes. It envisages participating in consultative committee on quantity of matter (CCQM)/ Asia pacific metrology program (APMP) and other international comparisons, includes preparation & dissemination of certified reference material (CRM), proficiency testing programme with national accreditation board for testing & calibration laboratories (NABL) accredited laboratories to provide traceability in chemical measurements in the country. The materials characterization for chemical purity/ impurity and composition is the ongoing service given for in-house, public & private sector and for societal needs.

Ministry of environment & forests national communication (NATCOM) projects work started for second national communication for quality assurance for all its national teams. Ongoing project studies in SEI-Swedish sponsored project related to physico-chemical characterization of dry & wet precipitation, apart from Asia pacific network (APN) on global change-health project work, continued including scientific & technical support to our collaborators. Proficiency testing (PT) Phase-I project (code PT-44) for NABL in chemical discipline has been completed for the NABL accredited laboratories. During this period, three new CRMs [BND 3404.01 and 3405.01 for plain carbon steel and BND 3301.01 for □- Alumina internal standard] were released on 5th November 2007 by Mr Ajay Shankar, Secretary, Department of Industrial Policy and Promotion, Ministry of Commerce and industry, Government of India and Mr. Sunil Kant Munjal, Chairman, Hero Corporate Services Ltd, in the 10th Asian Symposium on Precision Forging at India Habitat Centre, New Delhi (Fig. 5.1). Participated in CCQM-P96/ APMP.QM-P11 (Arsenic content in marine swordfish); CCQM-P97/ APMP.QM-P10 (Cadmium and Lead in Herb) (Fig. 5.2); and Inter-laboratory comparison for artificial rainwater under 10th 2007(Wet) EANET (Acid Deposition Monitoring Network in East Asia).

Fig. 5.1 : Release of three new CRMs

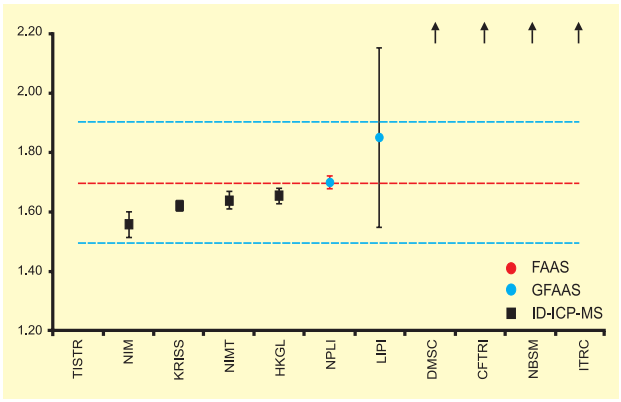


Fig. 5.2 : APMP.QM-P10 comparison results for Cd & Pb in Herb

EPR & IR Spectroscopy

ZnO exhibits a variety of nanostructures. These nanostructures form the basis of next generation electronics, photonics and a variety of other applications related to the field of environment and biotechnolgy. ZnO is a semiconductor with a wide band gap of 3.37 eV and large exciton binding energy of 60 meV. In the present work inexpensive sol-gel technique is used as compared to other expensive techniques such as MBE, MOCVD, PLD etc. The characterization of these films become important in deciding their device worthiness before integrating them in the device for the cost effectiveness, consistency and reliability of the sensor. In this work, nanocrystalline ZnO thin films grown by sol-gel process using zinc acetate as precursor material were studied for their microscopic and paramagnetic properties by high resolution XRD, SEM, TEM and EPR spectroscopic techniques.

XRD diffraction pattern showed polycrystalline nature of these films with preferential orientation of (002) plane. SEM micrographs of this film showed the formation of nanowalls and uniform deposition of films without any cracks etc. These nanowalls have sharp edges which become good candidates for field emission applications. The nanowalls grown are crystalline in nature with a preferred orientation in the *c*-axis direction.

The orientation and faceting of sol-gel derived ZnO thin films were studied as a function of sol strength. These studies revealed that orientation in piezoelectric direction and the faceting of ZnO nanostructures improved from spherical to hexagonal when sol strength was increased from 10% to 25% in stages.

EPR spectroscopy is a very sensitive specialized technique to characterize paramagnetic centres/impurities/defects in any material. In this work, EPR Spectroscopy was used to investigate the oxygen vacancies in ZnO nanocrystalline thin films prepared by sol-gel method by using zinc acetate as precursor material. Different sol-concentrations were used in sol-gel derived ZnO thin films on silicon subastrate. A single narrow line EPR signals with g-values in the range 1.9600-1.9700 was observed in these films. This EPR signal corresponds to the ZnO with wurtzite structure having singly ionized oxygen vacancies with electron. The oxygen vacancies are formed in these films during growth process when oxidation of zinc takes place by the atmospheric air. At that time, under suitable conditions unstable neutral oxygen vacancies are formed which are easily decompsed to singly ionized oxygen vacancy and single electron. This single positively charged oxygen vacancy is occupied by one electron and is of paramagnetic nature due to this EPR signal is observed in these measurements. The appearance of this signal at room temperature confirms the nanocrystalline nature of these films.

Radiation induced paramagnetic defects in natural quartz from Brazil and Arkansas were studied by EPR spectroscopy. EPR signal pertaining to $[AlO_4]^0$ centre was observed in these samples. Ge-doped crystalline quartz has been examined for its thermally stimulated luminescence and has been found to exhibit TL-glow peaks at 100, 200, and 310 °C. While the peaks at 100 and 310 °C have already been noticed in conventionally grown quartz, the new peak at 200 °C, observed in the present studies, appears to be due to the presence of Ge in quartz lattice. The radiation dependence of this peak upon irradiation at 300 K by high energy electrons 1.75 MeV has been presented and the results have been compared and discussed in terms of the hydroxyl defects in natural, cultured, and Ge-doped cultured quartz.

In addition to this work, vibrational and photoluminescence (PL) studies of different para-toluene sulphonic acid (PTSA) doped polyaniline conducting polymers were studied to reveal their structural and optoelectronic properties. Infrared transmittance spectra of these films cconfirmed the formation of PTSA doped polyaniline salt. Four benzenoid and one quinoid chain is the basic oligomeric unit in these polymers whith their ends capped with phenyl rings. A strong photoluminescence (PL) emission peak at 435.74 nm was observed due to singlet excitons. The orderly arrangement of benzenoid and quinoid rings in polymeric chain and their ? conjugation coupling has helped in the formation of singlet excitons. The intensity of this peak varies with change in dopant concentration. the concentration of singlet exciton increases due to increase in conjugation length which is comparable to the delocalization length of singlet exciton.

Calibration of Thermovision Cameras and Polystyrene films from various outside agencies viz,. National Productivity Council, New Delhi, Subros Ltd.-Noida, Matrix Ltd.-Nashik, Maruti Udyog Ltd.-Gurgaon, Chosksi Ltd.-Indore and BeePharmo Ltd.-Mumbai were done. This has helped in ECF generation. Further FT-IR and FT-Raman Spectroscopic testing facilities were provided to various developmental projects of NPL and outside agencies and assistance was also provided in the interpretation of results of a large number of samples. The samples studied are Polymers, Gallium Arsenide Oxide, Annealed micro Crystalline Silicon, TiO_2 and InSb, $MgFe_2O_4$ doped with LiCe, Nano-Crystalline silicon and Fused Silica.

X-ray Analysis

Facilities for Characterization of Materials by XRD and XRF Techniques

Facilities for characterization of materials by XRD/XRF techniques were provided for almost all projects of NPL on development of materials and devices. More than 650 samples were received from various groups of NPL and outside organizations for structural characterization and elemental analysis.

Synthesis and Characterization of Nanocrystalline Zinc Oxide

Preparation of zinc oxide nanoparticles and the study of their microstructure is of extreme importance for understanding their basic material properties. Nanocrystalline zinc oxide powder samples were prepared by wet-chemical method under different growth conditions. The synthesized powder samples were investigated for crystalline phase, microstructural, morphological and luminescent characteristics. Variations in size and shape of particles were obtained under different conditions. These initial results suggest that the size and shape of zinc oxide particles prepared by a simple wet-chemical method may be controlled by growth conditions. Results of microstructure and luminescent characteristics were correlated.

Nanocrystalline Magnetic Alloy

Nano-crystalline magnetic alloy $CoFe_2$ were developed and analyzed for its potential applications. X-ray diffraction peaks and intensity of nano alloy confirmed the stability of the particles. The core to surface ratio of particle is very large which creates negative pressure and forms a CoFe nano – alloy from the initially synthesized mixed ferrite. The particles size varies from 5 - 28 nm on changing the annealing temperature from 373 K to 1173K. On heating, the crystallite size as well as the saturation magnetization (Ms) increases from 20 emu g^{-1} to 110 emu g^{-1}. The material has been utilized for the electromagnetic interference shielding applications. The material was studied in K band region using vector network analyzer shows > 65 d_B microwave absorption with sample thickness of 1.75 mm.

Ferrofluid Based Temperature Sensor

A selective range temperature sensor has been developed using ferrofluid. The principal is

Fig. 5.3 : Experimental set up for ferrofluid based thermometer

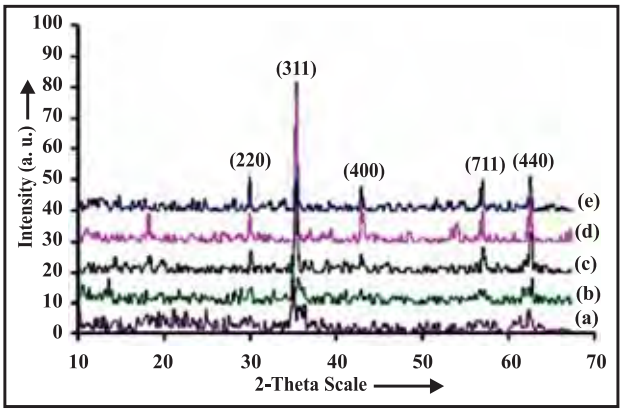


Fig. 5.5 : XRD patterns of nano-crystalline CoFe2O4 particles annealed at (a) 373K, (b) 573K, (c) 773K, (d) 973K and (e) 1173K

based on sensing minute change in air volume due to temperature according to standard gas law (PV=nRT). The device consists of a closed container with very low friction ferrofluid bearing based piston which moves when the temperature changes inside the container. The coefficient of friction of the magnets motion is tremendously reduced using ferrofluid material. This unique property of magnets levitation by ferrofluid is exploited for making the temperature-sensing device. An electrical AC signal has been produced at the output to sense the change in temperature is <1mK. The graph shows the linear variation in the thermometer out put with temperature at varying atmospheric pressure.

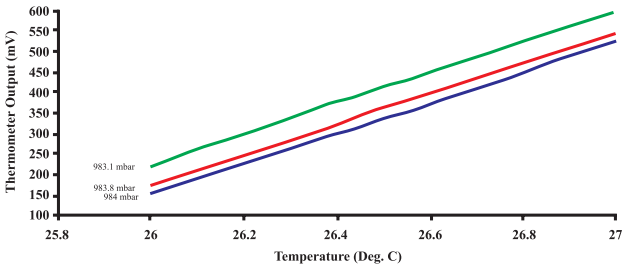


Fig. 5.4 : Thermometer output in millivolt signal

Size-Induced Temperature Effect in Nano Crystalline $CoFe_2O_4$

Studied different size nano-magnetic particles to understand the change in the physical properties because large volume fraction of atoms occupy the grain boundary area. Synthesized nanoparticles were annealed in varying temperature. Crystallinity improves on increasing temperature 373K to 1173K for 2 hrs duration. The material remains single crystalline phase in all the temperature as shown in (Fig. 5.5). At the applied magnetic field of 5000 Oe observed from the magnetization curves is found to increases from 18emu/gm for the sample annealed at 373 K to 74 emu/gm for the sample annealed at 1173 K. Also the corecivity first increases from 0 Oe for the particles annealed at 373K up to a maximum value of 1200 Oe for the particles annealed at 973K, on further annealing the particles at 1173K it is observed that the corecivity decreases to 1000 Oe. The variation of corecivity with particle size is also explained on the basic of domain structure, diameter of particle and crystal anisotropy. The saturation magnetization for the nanocrystalline cobalt ferrite is found lower to their bulk value, which can be attributed to the surface spin canting. Further, the size reduction of magnetic particles leads to several unusual properties like disorder of surface spin (spin canting), surface anisotropy, SP nature and hence it can be tailor for specific applications.

Preparation and Certification of α-Al_2O_3 Reference Material (CRM) for XRD

Prepared α-AL_2O_3 particles of sizes ≤ 20 µm for the certification and dissemination of CRM materials to calibrate powder X-ray diffraction equipment. The crystallinity of the material was improved by annealing at 1400 ^{0}C for 11 hrs. The XRD pattern was recorded with a step size of 0.005^0/3 sec and specimen spinning speed of 30 rpm. The entire powder pattern shows that the material is well crystalline with FWHM of 0.045^0 for the 113 diffraction peak. The diffraction pattern matches well with PDF file 10-0173 of ICDD. The material crystallizes in rhombohedral and the cell parameter calculated as a = 4.7736 ± 0.0034 A^0, c = 12.9930 ± 0.0022 A^0, c/a = 2.72185, Z = 6, D_x = 3.989 A^0. The repeatability of the powder data result was verified by replicate measurements (10 numbers) performed over a period of time. Like this, twelve different laboratories including few foreign labs participated in the certification procedure. The material was released on 5th November 2007 and is now available for its use.

NPL-IITD Joint Work: Characterization of Zinc Oxide Films

Work was continued on analysis of structural characteristics of zinc oxide films (prepared by IITD). The results were further used for correlation with other material characteristics.

Quality System

For Materials Metrology Programme of NPL and implementation of Quality System for Materials Characterization Division, Quality Documents for testing by XRD and XRF techniques have been prepared.

Electron Microscopy

Transmission electron microscope at NPL is utilized as the central facility for the characterization of materials. Different types of samples in the form of thin films and powders prepared by various techniques have been received from different groups of NPL working on the development of new materials. These samples have been characterized for their particles shape, size, distribution of particles, phase identification etc., using transmission electron microscopy technique.

Some of the samples are gold nano particles prepared through chemical route at 4 ^{o}C., 10^{o}C and room temp., Silicon Nanowires on Si and quartz , Te doped InSb thin thin films at Rt and annealed at 200^{o}C, ZnO powder doped with Na (2 and 10 %) and Li 2%, CNT prepared by CVD technique, Fe_3O_4 ferrofluid with different PH values, Fe_2O_3 powder Indian as well as Imported, NiS and MnS powder magnetic materials in nano form, TiO_2 films pure and doped with 1.0 and 1.6% Fe, Cd ferrite, Si/Mn/Si prestine as well as irradiated, Electrochromic Device based on CNT Functionalized poly methylpyrol synthesized in hydrophobic ionic liquid medium. In Figure 5.6 TEM bright field image represents the CNTs functionalized poly (methylpyrrole) films grown by electrodeposition in ionic liquids in which (a-c) shows the regular, smooth (with compact surface having nodules of very low average diameter and (d-f) Poly (methylpyrrole) covered with CNTs giving more mechanical Integrity.

About 110 sample were received from the various groups of NPL working on the development of new and advanced materials. These sample were characterized by using TEM. This facility was also extended to various industries.

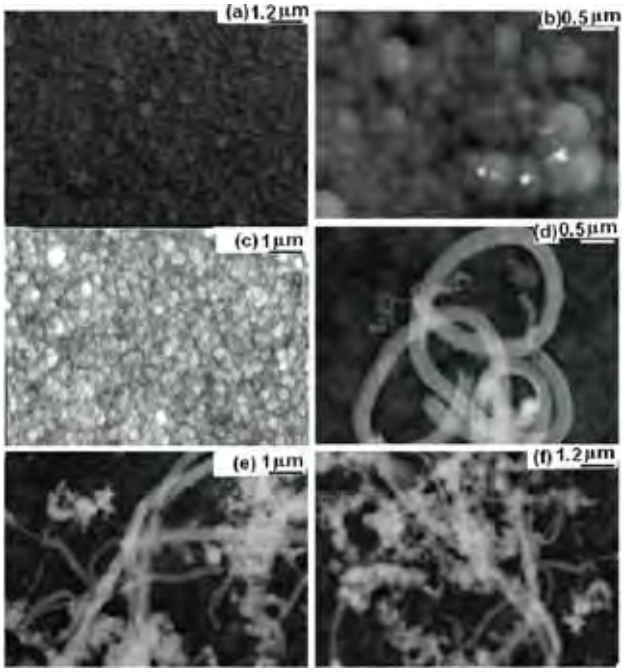


Fig. 5.6 : TEM micrographs of a (a-c) poly (methylpyrrole) (d-f) CNTs functionalized poly (methylpyrrole) films grown by electrodeposition in ionic liquids.

Scanning Electron Microscopy and Energy Dispersive Spectroscopy is another central facility of the laboratory which is extensively used by various R & D groups of NPL, other scientific R & D institutes and Industrial organizations for characterization of materials for surface microstructure and chemical compositional measurement.

Some of the materials characterized by using SEM are Al-Si powder samples, Mg-Al Alloys, Oxidase coatings, metal doped polymer films, polymer powders and films with and without enzyme and DNA, Gold nanoparticles with and without enzymes, High Tc Superconducting Bi2223 multifilaments samples Bi2223 doped with Eu and Tb dopings, Y123 with Pr doping, MgB_2 Pure and with SiC, Mg ferrite and Li-Mg Ferrite samples, Pr-Ba-MnO_3 Composites with different additives, SAM layers with PPY, PNA and DNA, PANI plane, protein immobilized with and without DNA, PANI+CNT composites, LDPE films, CdSeTe Alloys of different ratios and at different temps, Particulate matter/filter paper collected from different locations, Au film/ITO, gold nanoparticles with enzyme and gold nanoparticles with pyrol, Lithium-Ce Ferrite Samples, PECVD grown TiO_2 films/Si, TiO_2 films on different substrates etched with HF and NaOH treated, MgB_2 Pure and with 10% SiC samples annealed at different temperatures, Graphite composites with mixing of Chitosan polymer, Al, Al_2O_3, Al + Al_2O_3 powders ball milled, La-Sr-MnO_3 films/$SrTiO_3$ substrate prepared by DC magnetron sputtering technique, Alkaline and acid texturised micro crystalline Silicon, Porus Silicon samples. Humidity response of Li- substituted magnesium ferrite has been studied in detail. SEM micrograph of Li- substituted magnesium ferrite has been shown in (Fig. 5.7).

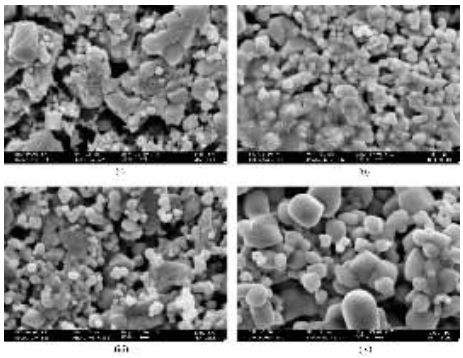


Fig. 5.7 : SEM Micrograph of pure $MgFe_2O_4$, (ii) $Mg_{0.8}Li_{0.2}Fe_2O_4$, (iii) $Mg_{0.6}Li_{0.4}Fe_2O_4$ and (iv) $Mg_{0.4}Li_{0.6}Fe_2O_4$

More than 1000 samples have been examined by SEM and EDS for surface microstructure and compositional analysis.

SEM and EDS facility is also used by the industry for carrying out different type of testing and analysis work. During the period different samples

were received from industry for particle size, shape, surface structure, fracture analysis, thickness and chemical compositional analysis. Some of the industries for which SEM/EDS analysis were carried out are M/s. Oriental Carbon and Chemicals Ltd., New Delhi, M/s. Mindarika Pvt. Ltd., Gurgaon, M/s. MNIT, Jaipur, M/s. Ranbaxy R&D Lab. Gurgaon, M/s. NTPC, R&D centre Noida, Central Road Research Institute New Delhi, M/s. Moser Baer Photovoltaics Ltd., Gautam Budh Nagar, M/s. KPS Consultant & Impex Pvt. Ltd. New Delhi

Crystal Growth and Characterization

Growth and Characterization of Nonlinear Optical (NLO) organic, inorganic and semiorganic single crystals

The recently started R&D activity of growth and characterization of NLO single crystals has been continued in view of (i) growing good quality crystals (ii) growing big size crystals suitable for device applications related to photonics, (iii) to enhance the efficiency of second harmonic generation (SHG) by using different dopants and functional groups, (iv) to search new NLO materials and grow their single crystals, (v) to evaluate their crystalline perfection by high-resolution XRD and (vi) other studies like powder XRD, FTIR, UV-Vis. etc. In this endeavor and with the help of various collaborators working in this upcoming area we have achieved several important R&D results leading to twenty one articles in leading SCI journals and one article in non SCI journal. Some of these important results are briefly described below.

Very recently we have grown and characterized some organic (Benzimidazole), inorganic

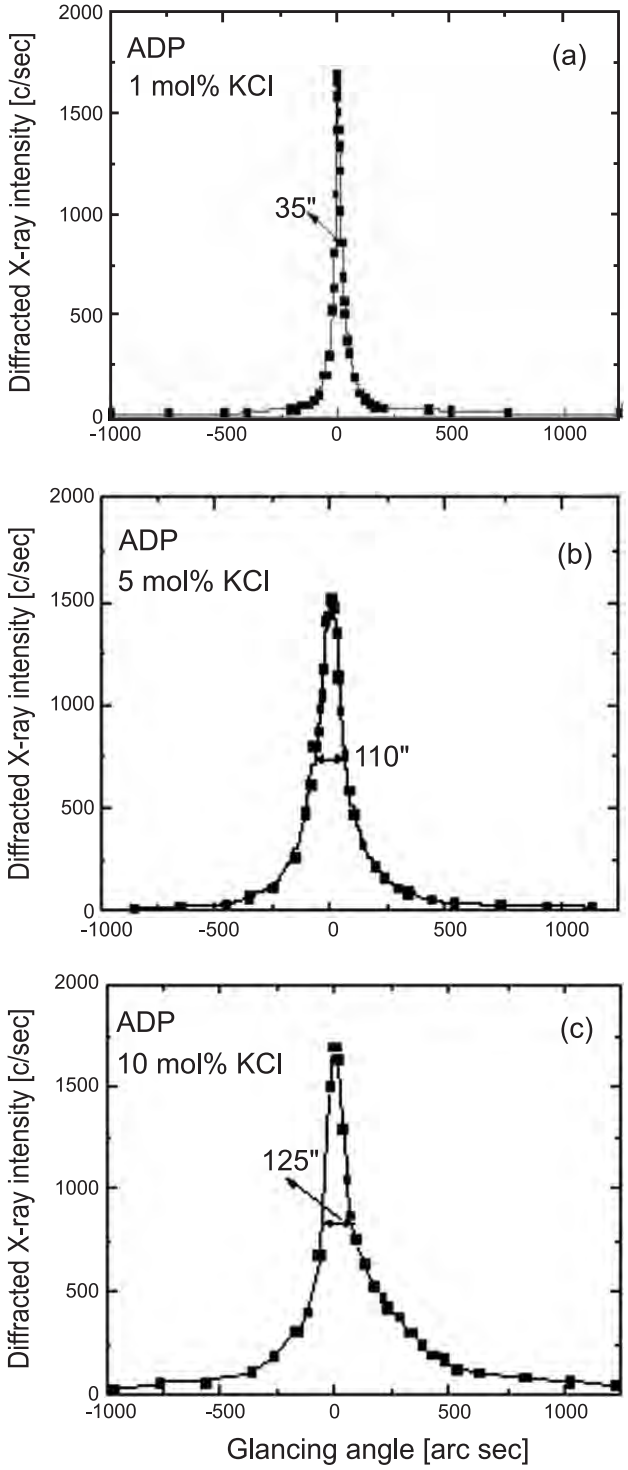


Fig. 5.8 : Diffraction curves (DCs) recorded for KCl doped ADP crystals. Increase in broadness and asymmetry of DCs without splitting shows the accommodation capability of KCl dopants in ADP crystals that lead to increase (up to twice) in the SHG efficiency.

(ADP) and semiorganic (ZTS) crystals doped with non NLO like KCl, Mn, Oxalic acid and NLO like urea and N-methyl urea. Due to these dopants, considerable enhancement in SHG efficiency was observed.

DAST crystal which is one of the high nonlinearity (141 times than that of urea) materials among all the ever known NLO single crystals grown by slope nucleation technique has been characterized.

Growth and Characterization of semiorganic ZTC, a NLO single crystal grown by SEST and unidirectional Sankaranarayanan-Ramasamy (SR) methods have been carried out. Crystals up to 12 mm dia and 40 mm length have been grown. Its crystalline perfection and dielectric properties have been assessed.

Organic NLO single crystal of hippuric acid has been grown and characterized by unidirectional SR method. Its relative nonlinear optical efficiency is 1.54 times better than that of KDP.

Undoped, Mg doped and Mg, Nd codoped $LiNbO_3$ single crystals grown by CZ method (at RRCAT, Indore) were characterized by HRXRD and found better perfection & optical properties due to doping.

Variety of new NLO crystals like Ammonium malate, glycine phosphate, DMAPNP, L-Tartaric acid, cadmium mercury thiocyanate, zinc cadmium thiocyanate etc. have been grown and characterized.

Major technical achievements:

Rectification of Russian make Low thermal gradient Czochralski (LTG-CZ) crystal growth system. This gifted system worth few crores of rupees as per the present rates was not operational from several years due to lack of any help from the firm who gifted the system. It is now rectified successfully for its full operation. Trail experiments to grow BGO crystals are going on.

After procuring and installation of 50 kVA UPS in the recent past, trail experiments to grow 40 to 50 mm dia lithium niobate single crystals are going on. Lot of developmental work in the crucible set up and the RF furnace is going on to get good quality crystals with out cracks.

Surface and Interface analysis by SIMS

Compositional and structural analysis of RF magnetron sputtered La^{3+}-modified PZT thin films

Lanthanum-modified lead zirconate titanate (PLZT) thin films in pure perovskite phase was prepared by RF magnetron sputtering. For this purpose, a 3-in. diameter target of PLZT (8/60/40) was prepared by conventional solid-state reaction route. The chemical composition of PLZT target was determined using gravimetric analysis followed by UV–vis and flame atomic absorption spectrometry. Various deposition parameters such as target-to-substrate spacing, deposition temperature, post-deposition annealing temperature and time have been optimized to obtain PLZT films in pure perovskite phase. The films prepared in pure argon at 100WRF power without external substrate heating exhibited pure perovskite phase after rapid thermal annealing (RTA) as confirmed by X-ray diffraction (XRD). Compositional analysis of the PLZT film was performed by secondary ion mass spectroscopy (SIMS) using PLZT target as standard sample. Depth profile of the film shows very good stoichiometric

uniformity of all elements of PLZT. SIMS analysis, was performed on PLZT thin film prepared without external substrate heating followed by RTA at 700º C for 5min and also on PLZT target. Fig. 5.9 shows the depth profile of PLZT film. Except in the few nanometers region near the upper surface, the stoichiometric uniformity of all elements of PLZT throughout the bulk of the film is evident. The concentration of lead on the surface of the filmwas found to be higher compared to its bulk value. Thus, the wt% of lead inside the film should be close to the expected wt% (59.18). However, the concentration of other elements inside the film is somewhat higher than the corresponding values on the surface. This indicates that the wt% of lanthanum, zirconium, titanium and oxygen in the depth of the film are also close to their expected values 3.45, 16.65, 5.83 and 14.89, respectively. Lead enrichment on the surface of the film can be explained on the basis of the evaporation of lead towards the surface during the annealing process due to its high volatility at higher temperatures. Similar lead enrichment in the near surface region has also been observed on PZT films deposited by sol–gel technique (Watts et al., 2005). Therefore, it can be said that this effect is an intrinsic phenomenon and is not related to a specific deposition process.

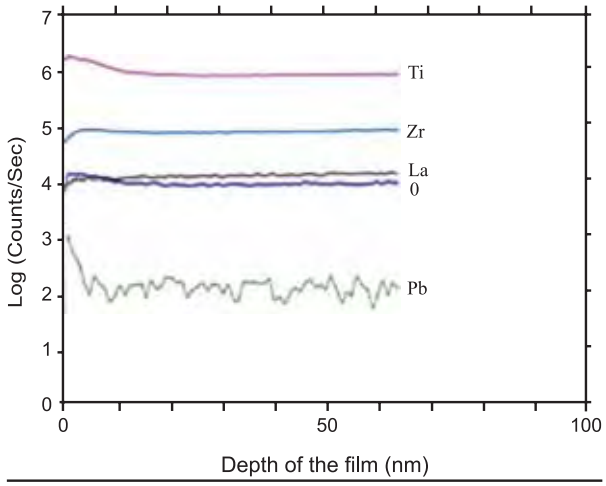


Fig. 5.9 : SIMS depth profile of various elements of PLZT film prepared without external substrate heating and RTA at 700º C for 5min.

रेडियो तथा वायुमण्डलीय विज्ञान

RADIO AND ATMOSPHERIC SCIENCE DIVISION

रेडियो तथा वायुमण्डलीय विज्ञान

रेडियो तथा वायुमण्डलीय विज्ञान डिवीजन के कार्य कलापों में प्रयोगशाला की दो मुख्य प्रयोगशाला परियोजनाएं शामिल है । पहली परियोजना का शीर्षक 'रेडियो भौतिकी तथा अनुप्रयोग' है । यह आयनमंडली तथा ट्रोपोस्फरिक संचार पद्धति को सहायता देने के लिए आयनित तथा गैर आयनित माध्यम के अभिलक्षण से संबंध रखती है । आयनमंडली संचार कार्य में वृद्धि मुख्यतः अंतरिक्ष भौतिकी, एच एफ संचार तथा नेवीगेशनल अनुप्रयोग में होती है, जबकि ट्रोपोस्फरिक संचार के संबंध में यह पार्थिव तथा भू–अंतरिक्ष मार्ग पर रेडियो तंरगों के संचार के सभी पहलुओं तथा मोबाइल के साथ–साथ समुद्री संचार को शामिल करता है जिसमें वी एच एफ से लेकर रेडियो फ्रीक्वेंसी स्पेक्ट्रम के गीगा डर्ट्स तक की फ्रीक्वेंसी शामिल होती है । अंतरिक्ष भौतिकी के क्षेत्र में मुख्य उपलब्धियों में शामिल है : आयरन मॉडल विकसित करने के लिए भारतीय जोन के लिए विभिन्न प्रकार की लम्बी सीरीज के आयनमंडली डाटा का संग्रहण, अंतराष्ट्रीय संदर्भ आयनमंडली (आई आर आई) मॉडल का मान्यकरण, भारतीय जोन के ऊपर टोमोग्रफिक इमेज के लिए रेडियो संचार तथा नेवीगेशन तथा साफ्टवेयर विकास के लिए भारतीय जोन के लिए प्रयोक्ता अनुकूलन पाइंट से पाइंट एच एफ सम्पर्क पूर्वानुमान का विकास अंतरिक्ष मौसम सेवाओं को उपलब्ध कराने के लिए आर डब्ल्यू सी इंडिया के कार्यकलाप, प्रयोक्ता के लिए एच एफ सम्पर्क पूर्वानुमान का विकास, अंतरिक्ष मौसम सेवाओं को उपलब्ध कराने के लिए आर डब्ल्यू सी इंडिया के कार्यकलाप, प्रयोक्ता के लिए एच एफ सम्पर्क पूर्वानुमान, दिल्ली के ऊपर तूफान के समय का आयनमंडली एच एफ पूर्वानुमान, भूकम्प के वास्तविक रूप से आने से कुछ दिन पहले आयनमण्डली क्षोभ के रूप में अवलोकित भूकम्प आने के पूर्व से सम्बन्धित नए अध्ययन को शुरू करना, आयन मंडली पूर्वानुमान सहित विभिन्न अनुप्रयोगों के लिए आगामी सौर चक्र 24 का पूर्वानुमान सेटलाइट प्रक्षेपण तथा ट्रैकिंग आदि निम्न आयनमण्डली कार्यकलाप तूफान के लिए संचालित कुछ समय के तूफान का अध्ययन, पृथ्वी के नजदीक अंतरिक्ष पर्यावरण सेंस (SENSC) प्रयोग से संबंधित सेटलाइट के लिए आयन एवं इलेक्ट्रॉन आर पी ए दोनों के लिए इलेक्ट्रोमीटर डिजाइन तथा शरदकालीन कार्यक्रम के एक हिस्से के रूप में अंटार्कटिका को भेजे वी एल एफ रिसीवर सिस्टम । ट्रोपोस्फरिक संचार में किए गए कार्य में बहुत से बादल पैरामीटर के पूर्वानुमान जैसे राडार प्रतिबिंबता, बादलों की सघनता, बादल की ऊंचाई, ऊर्ध्वाधर एकीकृत द्रव जल मात्रा, वर्षा दर वितरण, वर्णन संचयन तथा रेडियो संचार अनुप्रयोग के लिए कोलकाता के ऊपर भारतीय मौसम विज्ञान विभाग से संबंधित सी बैण्ड में प्रचालित डाप्लर राडार द्वारा लिए गए बादल पैरामीटरों के माप से बारिश होने की तीव्रता आदि, साफ वायु, बादलों तथा बारिश वाले मौसम में मानसून महीनों से संबंधित कैरियर तीव्रता प्रेक्षण के आधार पर 12 गीगाहर्ट्ज GH_2 में डायरेक्ट टू होम सेवाओं के लिए भू–अंतरिक्ष मार्ग पर सैटललाइट संचार का कार्य–निष्पादन, ग्रामीण क्षेत्रों पर तथा भारतीय रेल रोड सहित मार्ग से भटकने के पूर्वानुमान के लिए रेडियो प्लानिंग टूल का अनुप्रयोग पश्चिमी भारत में मोबाइल संचार पर रेलवे सुरंगों का प्रभाव, उड़ीस तथा झारखण्ड क्षेत्रों के दुर्गम क्षेत्रों में ग्रामीण संचार पर शुरूआती कार्य तथा एयर कॉम इंटरनेशनल के सहयोग के साथ एन सी आर क्षेत्र में 900 मेगा हर्टस में अनुभव 400 मीटर की ऊंचाई तक बाउण्ड्री लेयर के थर्मल स्ट्रक्चर पैरामीटर के अध्ययन के लिए डोपलर सोडार का कनफिग्रेशन तथा रेडियो सिस्टम कनफिग्रेशन की योजना शामिल है ।

प्रयोगशाला की दूसरी मुख्य परियोजना का शीर्षक 'वायुमण्डलीय वातावरण तथा भूमण्डल में परिवर्तन (ग्लोबल चेंज)' इस परियोजना में मुख्य उपलब्धियां ऐरोसोल तथा बादलों के सतत् माप के लिए माइक्रो पल्स लिडर का प्रचालन दिल्ली, पुणे तथा त्रिवेन्द्रम के ऊपर ओजन के क्षैतिज विभाजन का पूर्वानुमान जिससे जनवरी फरवरी माह के दौरान अत्यधिक उच्च ट्रोपोस्फेरिक ओजोन के बारे में पता लगा है दिल्ली में जिलावार नमूना लेने से बायोईंधन से कार्बनयुक्त ऐरोसोल के बजट का पूर्वानुमान, उष्णकटिबंधी क्षोभसीमा क्षेत्र पर मेसोस्केल संवहन सिस्टम से संबंद्ध मानसून के प्रभाव का पता लगाना, मानसून से पहले कानपुर के ऊपर एरोसोल रेडिएशन असर का पूर्वानुमान सिंगल स्केटिग एलबिडो तथा पांच वर्षों (2002–06) के लिए दिल्ली पर एरोसोल रेडिएशन असर का पूर्वानुमान, ऐरोसोल ब्लैक कार्बन का ऋतुओं में परिवर्तन तथा दिल्ली में रेडिएशन प्रवाह पर इसका प्रभाव, मारस ग्लोबल सर्वेचर डाटा का प्रयोग करते हुए मार्टियन आयनमंडली में कुछ असंगबतिपूर्ण विशेषताओं की जांच, ध्रंवीय क्षेत्रों में हिम पैक से सी ओ पर नए रूचिपूर्ण डाटा सैट, जी आर आई एम एम स्पैक्ट्रोमीटर का प्रयोग करते हुए 2007 में सतह ऐरोसोल के बीच आकार का विभाजन सतह ओजोन से संबंधित नियमित परिवेक्षी प्रेक्षण को जारी रखना, एन ओ एक्स (NO_X), सी ओ (CO), एन एम एच सी (NMHC) ओजोन की कॉलम कंटेन्ट, जल वाष्प ए ओ डी तथा यू वी रेडिएशन तथा साथ ही साथ भारतीय उपमहाद्वीप के ऊपर निम्न स्ट्रेटोस्फियर का सैद्धांतिक स्पष्टीकरण तथा कोहरा साफ होने के स्थानीय समय के पूर्वानुमान के लिए मॉडल से संबंधित कार्य । द सेंट ऑफ ग्लोबल चेंज तथा आई सी एस यू के साउथ एशियन रिजीनल रिसर्च सेंटर के भू–मण्डलीय परिवर्तन के क्षेत्रीय अध्ययनों के लिए स्टार्ट (START) कार्यक्रम जो समन्वित बहु–एजेंसी बहुत विषयक राष्ट्रीय तथा अन्तर्राष्ट्रीय कार्यक्रमों के लिए भारतीय क्षेत्र में क्षमता निर्माण को संबंद्ध करता है वह अभी भी मुख्य प्रयोगशाला परियोजना के एक हिस्से के रूप में कार्य कर रही है ।

रेडियो तथा वायुमण्डलीय विज्ञान डिवीजन में स्वर्गीय डा. ए पी मित्रा, एफ आर एस की अगुआई में रेडियो विज्ञान से संबंधित एक क्षेत्रीय सुविधा शुरू की गयी है जिसका मुख्य उद्देश्य क्षमता निर्माण विशेषकर रेडियो विज्ञान के क्षेत्र में मानव संसाधन तथा विशेषज्ञता विकास को संबद्धित करने तथा सूचना का प्रसार करने तथा भारत तथा इसके आस–पास रेडियो विज्ञान से संबंद्ध कार्यकलापों के समन्वय का कार्य भी किया जा रहा है ।

RADIO AND ATMOSPHERIC SCIENCES

The activities of the Radio and Atmospheric Sciences Division comprise with two Major Laboratory projects of the laboratory. The first project is entitled "Radio Physics and Applications". It deals with the characterization of ionized and non ionized media to aid ionospheric and tropospheric communication systems. Incase of ionospheric communication the work are mainly on space physics, HF communication and navigational application while for tropospheric communication, it covers all aspects of radio wave propagation over both terrestrial and earth space paths and mobile as well as marine communication covering the frequency from VHF up to many giga hertz of radio frequency spectrum. The main achievements in the area of space physics include collection of different types of long series of ionospheric data for Indian zone for developing ionospheric models, validation of international reference ionosphere (IRI) model, development of user friendly point to-point HF-link prediction and TEC models for Indian zone for radio cmmunication and navigation and software development for tomographic images over Indian zone, activities of RWC-India for providing Space Weather Services, HF-link predictions etc to the users, storm time ionospheric HF predictions model over Delhi, initiated new study related to earthquake precursor observed as ionospheric perturbations few days before the actual occurrence of an earthquake, prediction of next solar cycle 24 for various applications including ionospheric predictions, satellite launching and tracking .etc., some storm time studies conducted for low ionospheric activity storm, the design of electrometer for both Ion & Electron RPA for Satellite for Earth's Near Space Environment (SENSE) experiment and a VLF receiver system sent to Antarctica as part of winter programme. The work carried out in tropospheric communication include estimation of several cloud parameters viz. radar reflectivity, cloud thickness, cloud height, vertical integrated liquid water content, rain rate distribution, precipitation accumulation and rain fall drop velocity etc. , from the measurements of cloud parameters taken by the Doppler radar operating in C-band belonging to the India Meteorological Department over Kolkata for radio communication application, the performance of satellite communication over earth space path for direct to home (DTH) services at 12 GHz on the basis of carrier intensity observations pertaining to the monsoon months under clear air, cloudy and rainy condition, application of radio planning tool to predict path loss along Indian rail road and over rural zones, effect of railway tunnels on mobile communications in western India, preliminary work on rural communications in difficult terrains of Orissa and Jharkhand Regions and experiments in 900 MHz band in NCR region using in collaboration with Aircom International, planned the radio system configuration and configuration of a Doppler Sodar for the study of Thermal structure Parameter of the boundary layer up to a height of 400m.

The second Major Laboratory Project is entitled "Atmospheric Environment and Global Change". The main achievements in this project are the operation of a micro pulse lidar for continuous measurements of aerosols and clouds, estimation of vertical distribution of ozone over Delhi, Pune and Trivandrum revealing significantly high tropospheric ozone during January-February, estimation of budget of carbonaceous aerosols

from biofuels from the district wide sampling in Delhi, detecting influence of monsoon associated mesoscale convection systems on tropical tropopause region, estimation of aerosol radiation forcing over Kanpur during pre monsoon, single scattering Albedo and aerosol radiation forcing estimation over Delhi for five years (2002-06), seasonal variation of aerosol black carbon and its impact over radiation flux over Delhi, investigation of some anomalous features in the Martian ionosphere using Mars global surveyor data, interesting new data sets on CO from snow pack in polar regions, size distribution among surface aerosols in 2007 using GRIMM spectrometer, continuation of regular ambient observations related to surface ozone, NOx, CO, NMHC, column content of Ozone, water vapour AOD and UV radiation as well as theoretical explanation of low stratospheric ozone over Indian subcontinent and the work related to the model for forecasting the local time of clearance of fog. The Centre of global change and the South Asian Regional Research Centre of ICSU's START programme for regional studies of global change which promote capacity building in the Indian region for coordinated multi-agency multi-disciplinary national and international programmes are still operated as a part of this Major Laboratory Project.

A Regional Facility on Radio Science (RFRS) started under the leadership of Late Dr.A.P.Mitra, FRS in Radio and Atmospheric Sciences Division with the objectives mainly to promote capacity building, particularly human resource and expertise development in the field of Radio Science and to disseminate information and coordinate the Radio Science related activities in India and around is also in operation.

Prediction of maximum amplitude and shape of Sunspot Cycle number 24 for different applications - Revised and updated

The characteristics of the 11-year solar cycle were of mere academic curiosity; but in the present satellite age, the strength of the solar cycle makes a huge difference to satellite operators, who plan their launches many years in advance. Each solar peak heats and expands the outer atmosphere, which in turn increases the drag on satellites, especially those in low-Earth orbits. Hence, satellite planners decide their missions and adjust orbital heights to take advantage of weak solar activity, if possible. Occurrence of a solar peak earlier or later or of unexpectedly large magnitude could alter the expected useful life of the satellite. Predictions of the solar activity are also useful for other purposes, such as operation of power grids on Earth and satellite communication systems. Solar activity forecasting is an important topic for various scientific and technological areas, like space activities related to operations of low-Earth orbiting satellites, electric power transmission lines, high frequency radio communications and geophysical applications. Therefore, the prediction of sunspot cycle is one of the important activities of Regional Warning Center (RWC-India), operated by NPL since last more than 30 years, as part of International Space Environment Services (ISES) which run 12 RWCs all over the globe.

Based on cycles 17-23, linear correlations are obtained between 12-month moving averages of the number of disturbed days when Ap is greater than or equal to 25, called the disturbance index, DI, at thirteen selected times (called variate blocks 1, 2, …each of them in six-month duration) during the declining portion of the ongoing sunspot cycle and the maximum amplitude of the following sunspot cycle. In particular, variate block 9, which occurs just prior to subsequent cycle minimum, gives the best correlation (0.94) with a minimum standard error of estimation of ±13, and hind casting shows agreement between predicted and observed maximum amplitudes to about 10 percent. As applied to cycle 24, the modified precursor technique yields maximum amplitude of about 124 ± 23 occurring about 45 ± 4 months after its minimum amplitude occurrence, probably in mid- to- late 2011 as shown in Fig. 6.1.

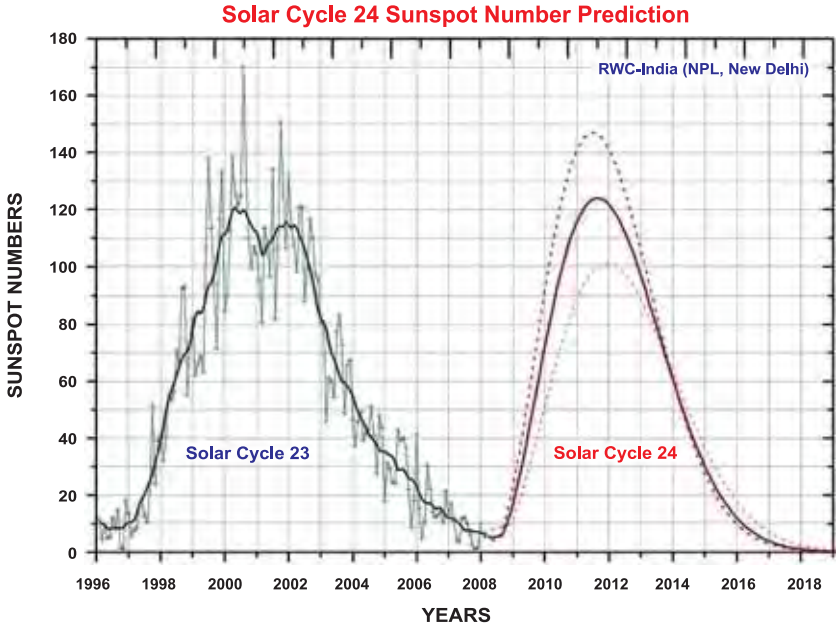


Fig. 6.1 : Shape and length of predicted solar cycle number 24 having peak amplitude 124 ± 23 occurring about 45 ± 4 months from the minimum of solar cycle number 24 i.e., sometimes about mid-to-late 2011.

Network of Digital Ionosonde System, GPS and Tomographic Receivers

A network as shown in Fig. 6.2 of Digital Ionosonde Systems (Delhi & Bhopal), dual frequency GPS receivers (Delhi, Trivandrum) and NWRA Tomographic Receivers (Delhi and Bhopal) for having extensive measurements of foF2, hmF2, TEC and VHF, UHF & L-band Scintillation for developing Ionospheric models has been established. The GPS receivers are for TEC and L-band Scintillation monitoring, Tomographic Receivers for 150 and 400 MHz scintillation, latitudinal TEC profile for producing Tomographic Images and Digital ionosonde for continuous monitoring of different ionospheric layers etc. The main objective of all these is to produce near real time forecasting of TEC, foF2, Scintillation etc for various applications. Details of above NPL network are given below:

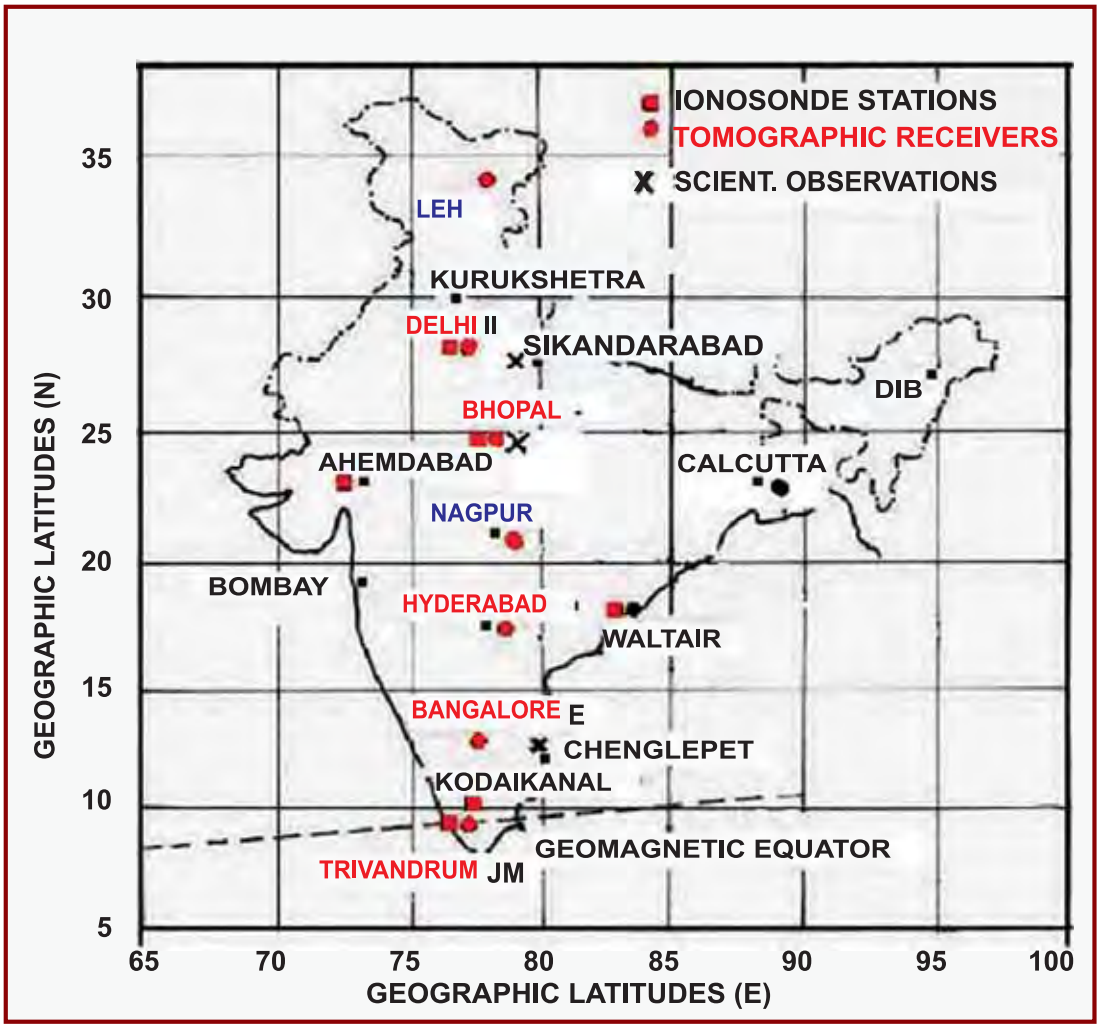


Fig. 6.2 : Network of Digital Ionosonde, GPS and Tomographic Receivers in India set-up under CSIR Network Project with NAL, Bangalore

In addition to Delhi Ionosonde, which is operational since July 2000, one more Digital Ionodonde System (KEL IPS-71) was installed at Bhopal, near the equatorial ionization anomaly crest, in October 2006. As compared to old Ionosonde systems (IPS-41) operational in the country (Trivandrum, Waltair and Ahmedabad), these are the most modern and fully automated which give a variety of information, which were not possible with older models. These operate in the vertical as well as in oblique incidence mode and provide HF spectrum surveillance, amplitude and Doppler Ionograms and 24 hour summaries of Ionograms. Apart from information on ionospheric layer parameters, information on Doppler shifts, True height versus Electron Density, Ionospheric Irregularities (Spread F and Sporadic E) are also available on this system. Photograph of IPS-71 Digital Ionosonde System along with the types of Ionograms obtained, is shown in Fig. 6.3.

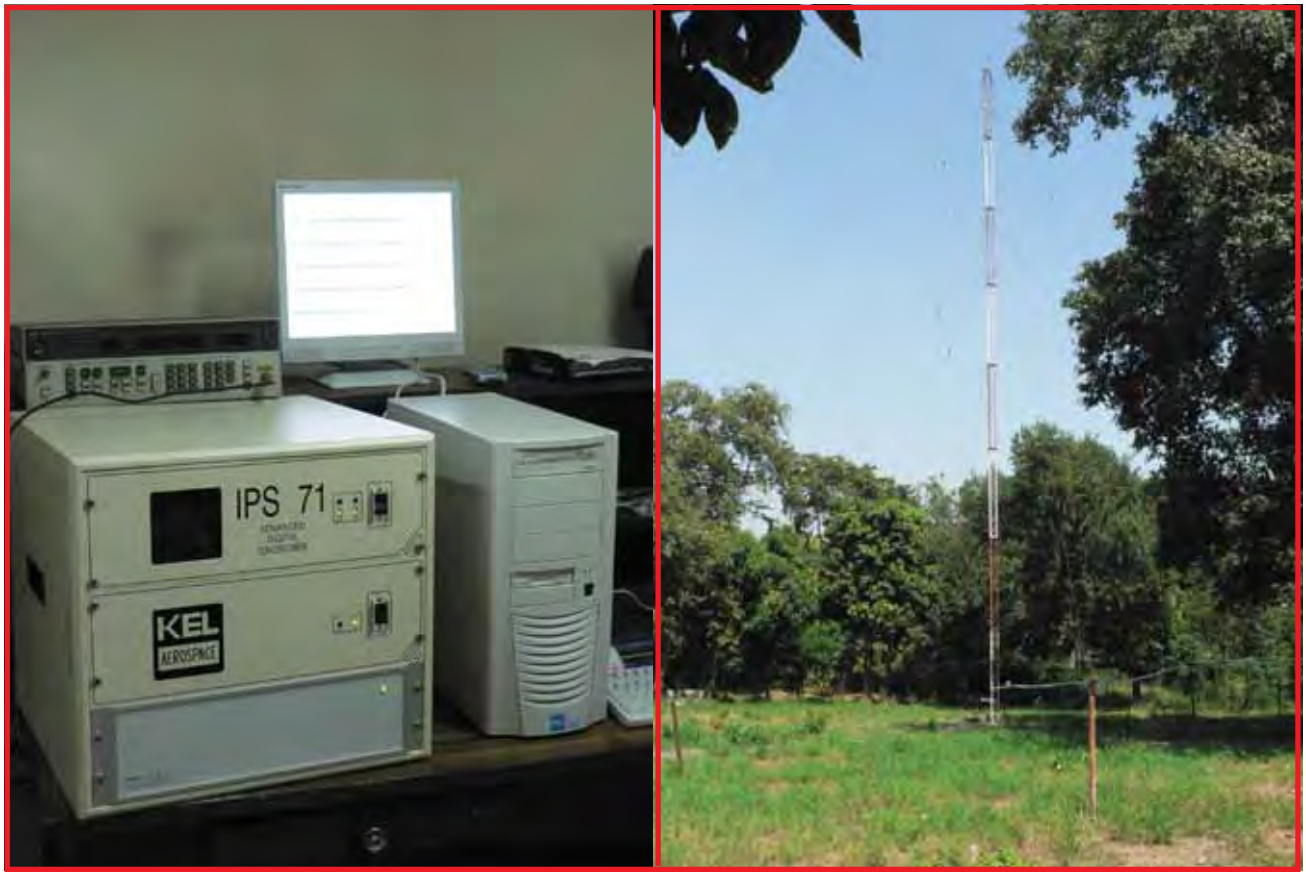


Fig. 6.3 : Photograph of IPS-71 Digital Ionosonde System along with the types of Ionograms obtained.

Two dual frequency GPS receivers - one at NPL New Delhi and other one at Equatorial location, Thumba, in collaboration with Space Physical Laboratory (ISRO), Trivandrum, providing TEC and L-band scintillation data has been installed.

In order to strengthen the ongoing CRABEX program, two NWRA ITS20S COHERENT RECEIVERS, one system is installed in NPL and operated by NPL and other one is installed at ISRO master control facility at Bhopal which is operated by SPL. These two (along with the one of SPL which is installed at Thumba) are most advanced systems replacing the earlier Indian systems installed by SPL under CRABEX program.

Ionospheric pre-cursors observed over low latitudes during some of the recent major earthquakes

Earthquakes still occupy first place in the list of natural disasters causing fatal incidences and loss of human lives and to minimize these losses researchers are trying to find a reliable precursor. Work has been carried out on ionospheric perturbations, if any, observed over a low latitude station, Delhi, prior to occurrences of eleven major earthquakes (magnitude greater than 6 on Richter Scale) during last couple of years. Initially, foF2 data is analyzed with upper and lower bound of inter-quartile range (IRQ) and the observed anomalous changes related to geomagnetic disturbances are filtered out. Then the remaining perturbations are analyzed in relation to the occurrence of seismic activities. The results of the study show some unusual perturbations observed in foF2 values, 1 to 25 days before and 2-3 days after the main shock of every earthquake indicating a clear seismo-ionospheric link and may be used as earthquake precursors.

Ionospheric variations were examined before and after all the eleven earthquakes, occurred between January 2003 to December 2005. For better understanding the results are also divided into two parts namely when the anomalous ionospheric perturbations are observed before the main shock, which are defined as pre-cursors and those observed after the main shock of the earthquake. A major earthquake, of magnitude 7.6, occurred on Oct. 8, 2005 at India – Pakistan border, shocks of which were also felt at the observation site. To study the ionospheric perturbations in this case, Delhi ionosonde data during Sept. - Oct. 2005 is analyzed as above and the results are shown in Fig. 6.4. As noted from the Dst variations (Fig. 6.4) that the month of September is full of geomagnetic disturbances therefore, it is difficult to be correlated ionospheric effects with seismic activity due to highly fluctuating behaviour of Dst index. Whereas some major variation in foF2 values of around 20% from the upper bound of IRQ is recorded 2 to 3 days before the main shock (Fig. 6.4c). Some continuous enhancements of 10 to 20% higher than upper bound of IRQ are also observed just a day prior to main shock of the earthquake. These enhancements might be related to the pre-seismic activities before the Pakistan earthquake because the geomagnetic conditions are very quiet during these days.

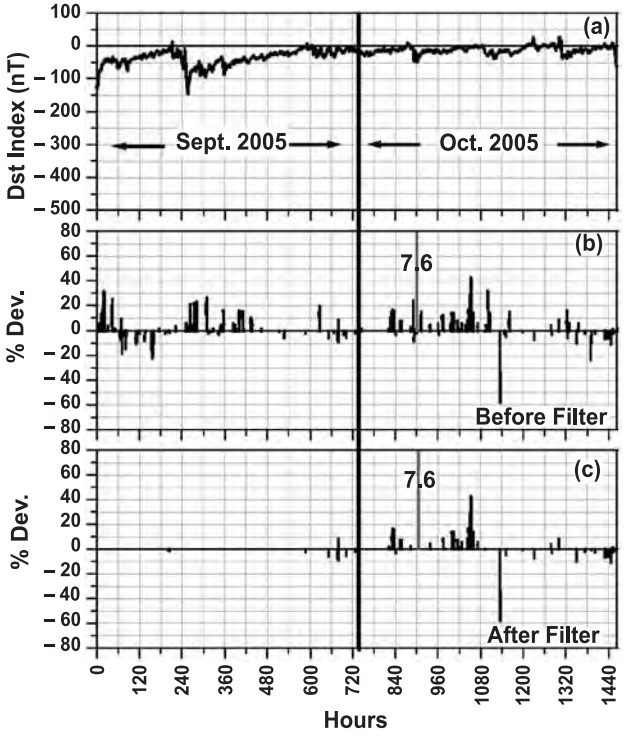


Fig. 6.4 : The figure shows the F-region ionospheric parameter foF2 along with the Dst index value during the month of Sept. and Oct. 2005. Dst index value is shown in (a). In (b) positive values show % deviation of foF2 from the upper bound of IRQ and negative values show % deviation from the lower bound of IRQ. Percentage deviation observed when Dst index value is in between ±15 is shown in (c). The gray line shows the time of occurrences of main shock of the earthquake.

Comparison between IRI predictions and digital ionosonde measurements of hmF2 at New Delhi during low and moderate solar activity

The diurnal and seasonal variations of height of the peak electron density of the F2-layer (hmF2) derived from digital ionosonde measurements at a low–middle-latitude station, New Delhi have been derived. Diurnal and seasonal variations of hmF2 are examined and comparisons of the observations are made with the predictions of the International Reference Ionosphere (IRI-2001) model. It is seen that during both the moderate and low solar activity periods, the diurnal pattern of median hmF2 reveals a more or less similar trend during all the seasons with presunrise and daytime peaks during winter and equinox except during summer, where the pre-sunrise peak is absent. Comparison of observed median hmF2 values with the IRI during moderate and low solar activity periods, in general, reveals an IRI overestimation in hmF2 during all the seasons for local times from about 06 LT till midnight hours except during summer for low solar activity, while outside this time period, the observed hmF2 values are close to the IRI predictions. The hmF2 representation in the IRI model does not reproduce pre-sunrise peaks occurring at about 05LT during winter and equinox as seen in the observations during both the solar activity periods. The noontime observed median hmF2 values increase by about 10–25% from low (2004–2005) to high solar activity (2001–2002) during winter and equinox, while the IRI in the same time period and seasons shows an increase of about 10–20%. During summer, however, the observed noontime median hmF2 values show a little increase with the solar activity, as compared to the IRI with an increase of about 12%.

Seasonal and solar cycle variations of the height of the peak density of the F2-layer (hmF2)

The diurnal and seasonal variations of the height of the peak density of the F2-layer (hmF2) during low (2004-2005), and moderate (2003) solar activity periods have been examined. Hourly monthly scaled values of foE (Critical frequency of the E-layer) , foF2 (critical frequency of the F2-layer) and M(3000)F2 (propagation factor) obtained from modern digital ionosonde, installed at NPL, New Delhi, are used to derive hmF2 using empirical formulations during different seasons for various levels of solar activity. Our studies reveal that during both the solar activity periods, the diurnal pattern of observed median hmF2 values reveal more or less similar trend during all the seasons with the pre-sunrise and daytime peaks, during winter and equinox except during summer. On the other hand, the International Reference Ionosphere (IRI) predictions too show similar trend except for a few discrepancies, where IRI does not reproduce pre-sunrise peaks in any of the solar activity period and in any season. The daytime observed median hmF2 values increase by about 5 to 25 % from low to high solar activity (2001-2002) depending upon local time and season, while during summer, the increase is a little. Overall, the percentage deviation of the observed median hmF2 values with respect to the IRI model, in general, remains within 10 to 15 % in all the seasons for both the solar activity periods. The diurnal variation of hmF2 along the median values and IRI predicted values during moderate solar activity are shown are shown in Fig. 6.5 for summer and winter seasons.

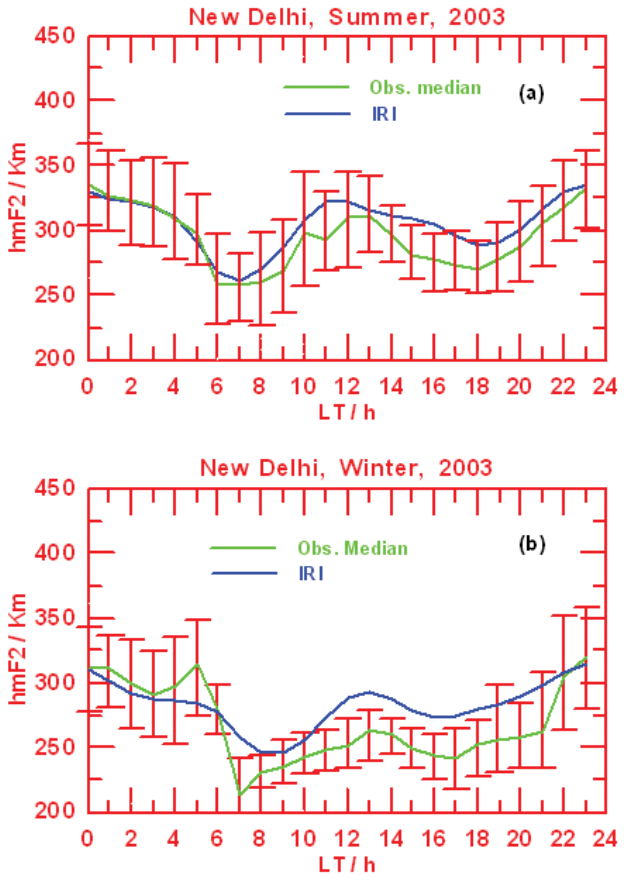


Fig. 6.5 : Diurnal variation of height of the peak density of the F2-layer (hmF2) derived from modern digital ionosonde measurements at NPL, along with their standard deviation, median and IRI-2001 predicted values during moderate solar activity for (a) summer, (b) winter.

Midday electron density profiles during moderate solar activity

Bottomside electron density (Ne-h) profiles below the F2-peak, during midday (10-14 h) are analyzed using modern digital ionosonde observations at New Delhi, for the period from January 2003 to December 2003, pertaining to moderate solar activity (MSA). Each individual profile is normalized with respect to the peak height and density (hmF2, NmF2) of the F2-region. These profiles are compared with those obtained from the International Reference Ionosphere (IRI-2001) model. using both the options namely: Gulyaeva's model and B0 Tab. option. The study reveals that during summer and equinox, the IRI model with B0 Tab. option in general, produces better agreement with the observed median profiles, while the IRI predictions using Gulyaeva's option, overestimate the electron density distribution at all the heights below the F2-peak, the IRI (Gulyaeva) model predicted electron densities are larger by about 100 to 125 % at heights around 100 km below the F2-peak. However, during winter, in general, the IRI model, using both the options, reveals shows fairly good agreement with the observed median profiles. The said discrepancies are examined in terms of profile shape parameters, in particular for Gulyaeva option, which uses height of the half peak electron density of the F2-layer (h0.5) for building up of the bottomside profile in the IRI model.

Although, the recommended option in IRI for low latitude is that of Gulyaeva, but it does not reproduce observed profiles well, rather, the profiles predicted by IRI with Gulyaeva's option are too thick especially during summer and equinox (Fig.6.6). Examining the h0.5 parameter from the observed and IRI model, it is concluded that the h0.5 parameter, is not well suited particularly during summer and equinox for daytime conditions.

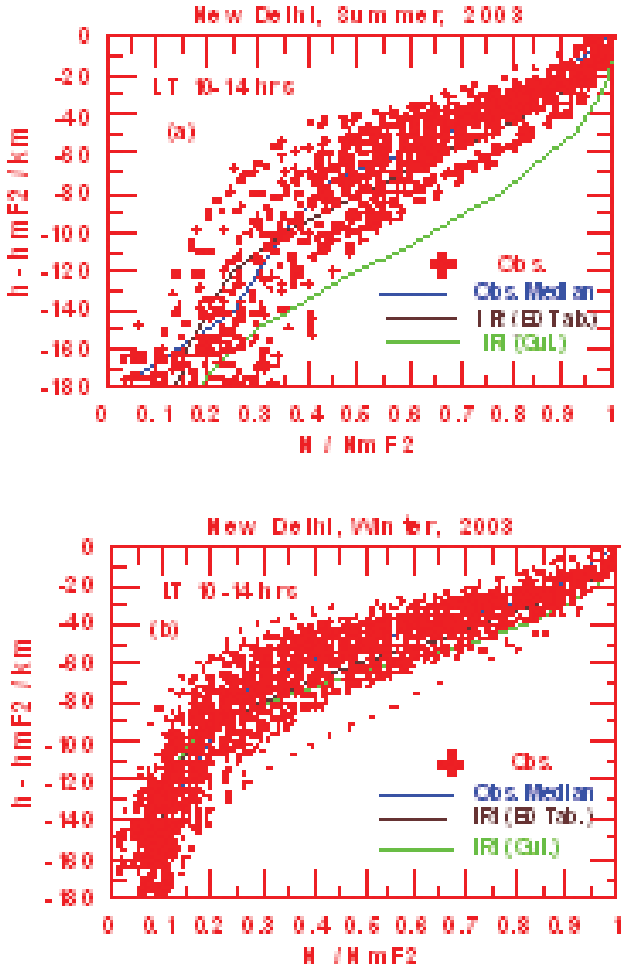


Fig. 6.6 : Seasonal variation of observed midday normalized electron density profiles using modern digital ionosonde measurements at New Delhi, against (h-hmF2) along with the median profile and IRI predicted normalized profiles using IRI (B0 Tab.) and IRI (Gul.) options for (a) summer and (b) winter

Satellite for Earth's Near Space Environment (SENSE)

Plasma diagnostic experiment consisting of Electron and Ion Retarding Potential Analyzers (RPA) and Ion drift meter (IDM) for the study of equatorial and low latitude ionosphere in the height region of 450 km over Indian region has been undertaken. It has been included as one of the payloads in SENSE satellite mission. This satellite will be flown as a piggy back on one of the PSLV missions during the time frame of 2011-12.

Scientific objectives of the SENSE satellite mission and also technical details of different experiments have already been framed. The first stage laboratory model will come up by the end of year 2008. Designs of circuits of electronic subsystems are being finalized and the fabrication of sensors is also being initiated.

Rain attenuation over earth space path for direct to home (DTH) service over Delhi

The carrier intensity over earth space path of satellite communication at Ku band affected by three atmospheric conditions viz., clear air, cloud and rain are investigated. The signal amplitude variations were measured during the monsoon months over earth space path by utilizing the DTH (direct to home) service of 2005. Though the signal is found to lie in Ku band but the exact frequency of operation is around 12 GHz. Under clear sky condition the signal level was found to vary from -66 dBm to -69 dBm. The maximum fade of 3 dB was observed. However for 52 % of the time signal was of -67.5 dBm to -69 dBm and for 48 % of time the signal level was found to vary between -66 dBm to 67.5 dBm under clear sky condition. It has been observed that the satellite signal over the earth space path is attenuated even due to cloud. Such attenuation is due to the absorption of the signal by the liquid water content which is present in the cloud. It has been seen that the attenuation of radio wave due to cloud is between 1 dB and 7 dB. The signal level from -67.5 dBm exceeds for 50% of time while the signal level from -66.5 dBm exceeds for 7.8 % of the time under cloudy condition (Fig. 6.7). The analysis suggests that even under cloudy condition signal level becomes of

low order for considerable time. The probability distribution of the satellite signal indicates that signal level varied from -66 dBm to -78 dBm under rainy situation (Fig. 6.8). The maximum attenuation of the order of 12 dB was observed. The signal level was found to vary from -67.5 dBm to -78 dBm for 56 % of time while signal was found to vary for 44% of time from -66 dBm to -67.5 dBm. It has also been reported that DTH services affected severely during rain over Delhi. The services may be improved by increasing the gain of the receiving system. The extra gain is to be provided either in form of antenna gain or by introducing extra LNA in the system.

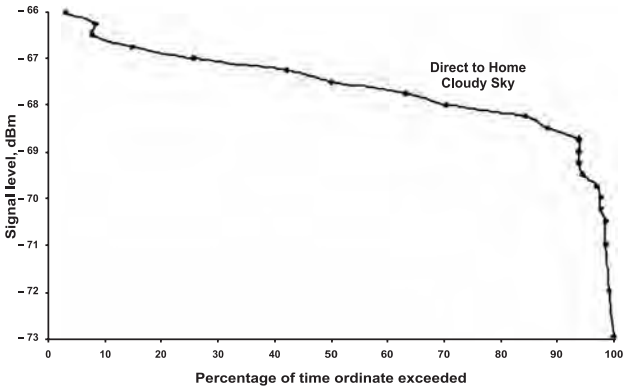


Fig. 6.7 : Probability distribution of carrier intensity measured over satellite path under cloudy sky situation

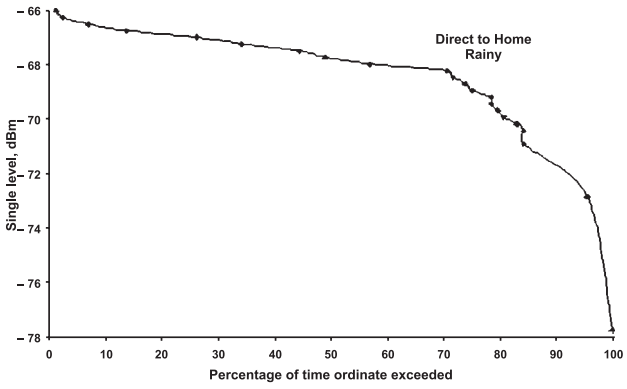


Fig. 6.8 : Probability distribution of carrier intensity measured over satellite path under rainy situation

Rain bearing cloud/rain height distribution over the Indian subcontinent

Rain bearing cloud height/Rain height is an important input parameter, which is needed for estimation performance of satellite communication and remote sensing applications. The rain height is estimated from the results of 0^{o}C isotherm-height. One of the best ways to estimate 0^{o}C isotherm height is from radiosonde observations. The range of variation of rain height/rain bearing cloud height in relation to 0^{o}C isotherm height, H_i over different stations in India during different seasons has been deduced. It has been observed that H_i decreases in the months of winter as latitude increases. It is well known that before the rainy situation, we have cloudy conditions in our tropical stations in India. Some times it is observed that the sky is fully covered with heavy dark cloud just before rain over Indian stations. It is a well-established fact that the clouds, which are present before rainy situation, are nothing but rain bearing clouds. And such rain bearing clouds have maximum cloud water particle density. It is therefore necessary and useful to estimate attenuation of the radio wave due to cloud over the region when the cloud water particle density is maximum as such attenuation results are only important to the radio engineers for satellite communication systems. Cloud height is also required to estimate temperature of the cloud. Some results on rain/ rain bearing cloud height in relation to 0^{o}C isotherm height over various stations are presented in Table: 1.

Table: 1 Rain/ rain bearing cloud height over various locations

Station	Range of rain/rain bearing cloud height in km
Mumbai	2.98 – 5.85
Nagpur	3.46 – 5.40
Ahmadabad	2.70 – 5.95
Hyderabad	2.90 – 5.95
Kolkata	3.20– 4.70
Chennai	2.90 – 6.20
Visakhapatnam	2.95 – 6.20

The 0°C isotherm height is associated with melting layer and bright band. Recently, bright band height (melting layer height) has been deduced from tropical rain measuring mission (TRMM) observations. It has been seen that the bright band height deduced from TRMM results underestimate the rain height in relation to 0°C isotherm height when it is compared with the results deduced from radiosonde observations over the Indian stations (Fig. 6.9). The year-to-year variation of bright band height over different Indian latitudes and stations were also deduced and it has been found that the year to year variation of bright band height is quite significant in the latitude range from 20° to 35° while there is not variation of bright band from year to year for latitude from 5° to 20°.

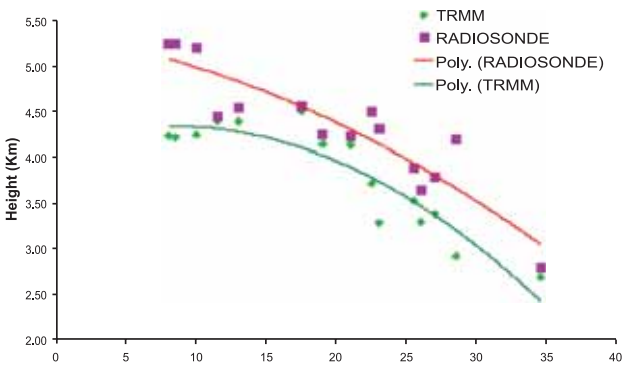


Fig. 6.9 : Rain height deduced from Radiosonde and TRMM observation

Mobile communication

In order to improve the rural cellular communication an attempt is made to characterize the radio channel over rural zones along rail roads. This involved development of various prediction tools requiring the comparison of radio measurements with models. For a country like India where diverse terrain conditions exist, same prediction method might not hold well in all the regions. To identify the methods suitable to rural zones an attempt is made to compare the measured results over selected north and West Indian base stations with classical two- ray, Hata and ITM models. Their efficacies have been evaluated in terms of statistical parameters like error distribution functions etc., apart from traditional parameters.

Aircom's asset radio planning tool has been utilized to predict the signal levels along rail roads utilizing the digital terrain data. Clutter maps, terrain variations have been developed and these have been used in selecting the appropriate models. These have been compared with the observed results along rural zones of northern and western India. The model parameters of Aircom's tool has been tuned based on the observed values since default values of the radio planning tool were not tallying with the observed results. This is the major contribution and can act as input for designing radio planning tools over this region.

Based on the data collected by us in the past over southern, northern, western and eastern regions of the country at 150, 320 & 440 MHz model parameters of well known Hata model were tuned and the coefficients over various regions have been brought out. The model parameters for various regions of our country have been tabulated and can

go into the inputs for designing future cellular systems in these regions.

The technology development over the country prompted us to start the field on Wimax which has got application to rural communication in fixed wireless broadband leading to internet and other services over rural zones. Several models at 2.5 and 3.5 GHz have been identified and evaluated over Indian conditions.

Work on effect of railway tunnels on mobile communications has been carried out in the year in down line direction and up line direction in western rail tracks and attenuation observed due to tunnel dimensions have been deduced. These studies will be useful for setting up base stations and deciding handoffs when the trains pass through the tunnels.

An experiment in collaboration with Aircom International has been conducted at 900MHz and valuable data utilizing various base stations in National capital region in urban, suburban environments has been raised.

Model for forecasting the local time of clearance of fog using ground-based remote atmospheric measurements

A model for computing the local time of clearance of radiative fog, due to the evaporation of liquid water droplets by solar radiation, using ground-based remote atmospheric measurements has been developed. The parameters that need to be measured or estimated are surface air-temperature, temperature inversion-layer thickness, temperature gradient across inversion-layer, aerosol optical depth and liquid water content in fog. Additional parameters that have been input (from models elsewhere) are soil albedo for solar radiation and the reflectance of liquid water droplets for solar radiation. The model has been applied to three case studies of dense fog conditions, with varied meteorological conditions in the surface-layer, in January 2001, January 2002 and January 2003, over Delhi. The model forecasts of the local time of clearance of fog have been compared with corresponding visual observations and remote sodar observations of the disappearance of the temperature inversion-layer. It is inferred that the present model, using routine ground-based atmospheric measurements, is useful for forecasting the time of clearance of radiative fog to within half an hour.

Studies on trace gases and aerosols at NPL, New Delhi

The trace gases and aerosols play a major role in at least two important areas: climate and air quality. Continuous monitoring for surface ozone, oxides of nitrogen, PM1, PM2.5 and PM10, Methane and Non-methane hydrocarbons, carbon monoxide and aerosols size distribution in 0.3-20 μm spectral range were carried out and a reliable and systemic observations data set has been generated. The data set will be helpful to validate regional scale dispersion model and predicating tools to help us build scenarios for future, so that adverse environment effects can be minimized.

The temporal variation of surface ozone at NPL, New Delhi during July, 1997 to December, 2007 is shown in Fig. 6.10. In all year's winter and monsoon months showing low values of ozone than the critical value (NAAQS – 1 Hour average -120 ppbv). Where as during summer and post monsoon months ozone values attain critical value, which is alarming for poor air quality in these seasons, and could be potential threat to terrestrial ecosystems and

to agricultural productivity. Preliminary evaluation of possible damage to crop yield by ozone has been carried out using exposure plant response index. Continuous measurements of NOx ($NO+NO_2$) since June 2002 onwards showed increasing trends.

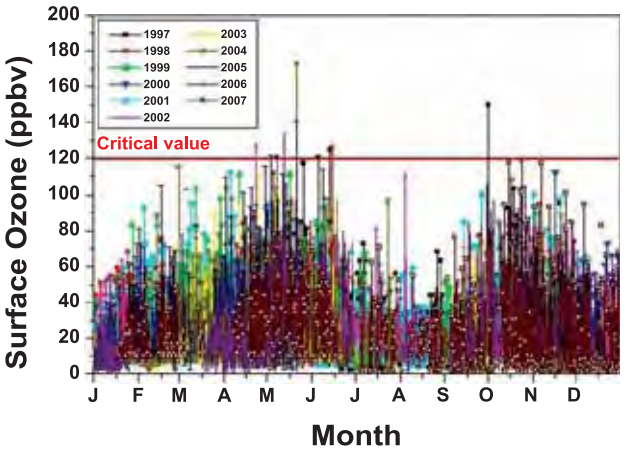


Fig. 6.10 : 1-Hour average values of surface ozone in ppb at NPL, New Delhi during 1997-2007.

It is seen in Fig. 6.11 that most of the days in summer during the measurement period at NPL, New Delhi an Ambient air quality is poor and 8-hours average concentration of ozone exceed to its critical value (NAAQS – 8 Hour average - 80 ppbv). During the post monsoon months also ozone values are above critical value.

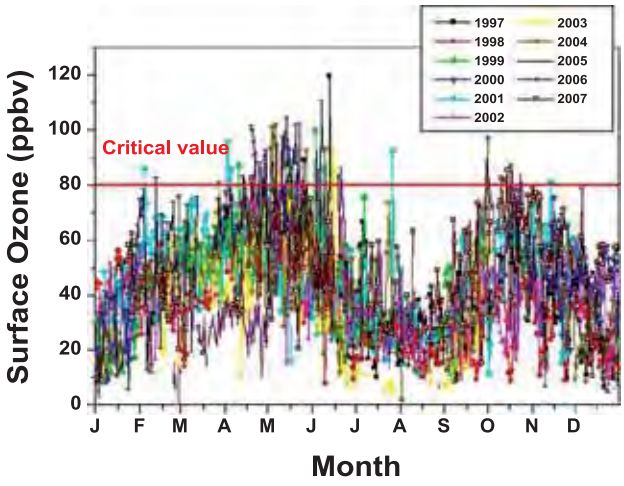


Fig. 6.11 : 8-Hour average (10:00-17:00 LT) values of surface ozone in ppb at NPL, New Delhi during 1997-2007.

Micro Pulse Lidar (MPL) for Atmospheric studies at NPL, New Delhi

Lidar measurements have been proved to be promising tools to enhance our understanding regarding impact of aerosols and clouds on precipitation, radiative processes and climate study. A polarization micro pulse lidar system has been set up and operational (Fig. 6.12) since August 2007 at National Physical Laboratory, New Delhi to perform continuous measurements of aerosols and clouds. The MPL has a capability to monitor range – resolve back-scattered signals from aerosols and clouds at polarizations parallel and perpendicular to the polarization of laser beam. The lidar employs a diode pump Nd: YAG laser, which emits secondary harmonics at 532 nm. A Schmidt – cassegrain telescope of aperture of 200 mm is used as the transmitter and the receiver in coaxial configuration. Photon counting technique is used to detect signals on both the channels.

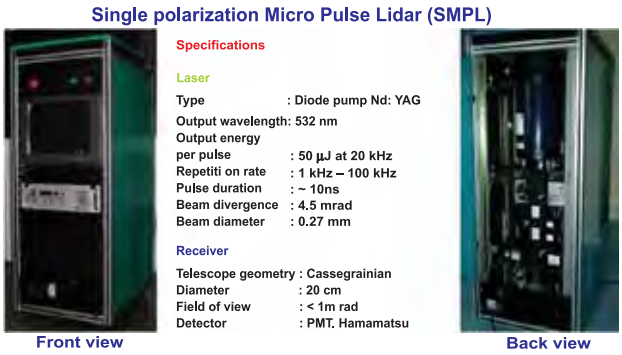


Fig. 6.12 : Micro pulse lidar

Analysis of the data reveals that during the observational period extinction coefficient varies between 0.1 km^{-1} to 0.45 km^{-1} while during the night, the atmospheric boundary layer height varies between 120 m and 250 m.

Aerosol radiation forcing (ARF) over Delhi

The aerosol optical depth (AOD) measurement at 500 nm using MICROTOPS have

been compared with the AOD retrieved at 550nm from the MODIS terra satellite measurements and the AOD values were used to model the aerosol radiation forcing (ARF) over Delhi (Fig. 6.13). ARF has been estimated during 2002-2006 using the Santa Barbara DISORT Atmospheric Radiative Transfer model (SBDART). The single scattering albedo (SSA) and the asymmetry parameter used as input in this model have been estimated using the Optical Properties of Aerosol and Cloud (OPAC) model. The results show that the average monthly AOD peaks every year in the month of June and has a minimum during February or September. It is found that the average monthly clear-sky ARF at the surface decreases by about 15 Wm-2 during pre-monsoon months of April-June as compared to that during January-March. The (ToA) Top of Atmosphere forcing is also found to reduce by about 2-5 Wm-2 due to dust aerosols.

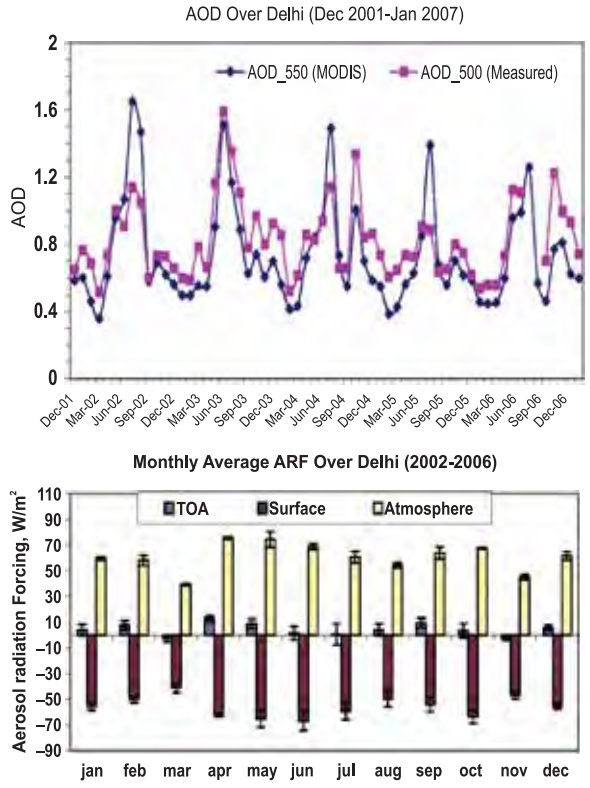


Fig. 6.13 : AOD and ARF over Delhi

Polar Atmospheric studies

Photochemical reactions in snow have recently witnessed an unprecedented surge of interest. In recent investigations, it is seen that production and significant release of CO flux is from snow covered region. On the basis of measurements made at Maitri, Antarctica, it has been observed a systematical diurnal cycle coinciding with the diurnal cycle of solar actinic radiation. This variation implies that photochemical production of CO is active in the snow covered region of Antarctica. It is expected that organic matter is trapped in snow and especially photochemical destruction of formaldehyde (HCHO) is probably the major substrate of the photochemical formation of CO when exposes to sunlight. The study shows that Polar regions may act as one of the strong source of carbon-monoxide. The measurements of CO over Antarctica support the finding of earlier investigators that substantial abundance of HCHO is produced by a flux from the snow.

Similar type of CO measurements over Arctic were carried out to study snow-pack production of carbon monoxide and its diurnal variability during First Indian Arctic Winter phase Expedition (2nd – 31st March, 2008). Along with these measurements studies were carried out on Black Carbon, aerosol number-size distribution, AOD, water vapour and collected air samples over Arctic region. The variation of CO in ppbv over Arctic is presented in Fig. 6.14.

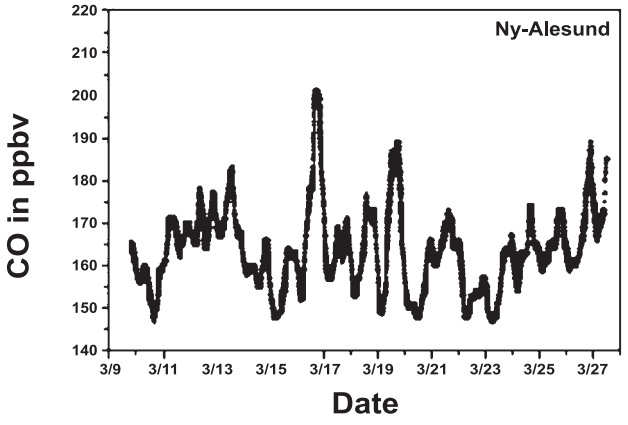


Fig. 6.14 : Temporal variation of Carbon monoxide (CO) in ppbv at Ny-Alesund, Arctic during 9^{th} – 27^{th} March, 2008.

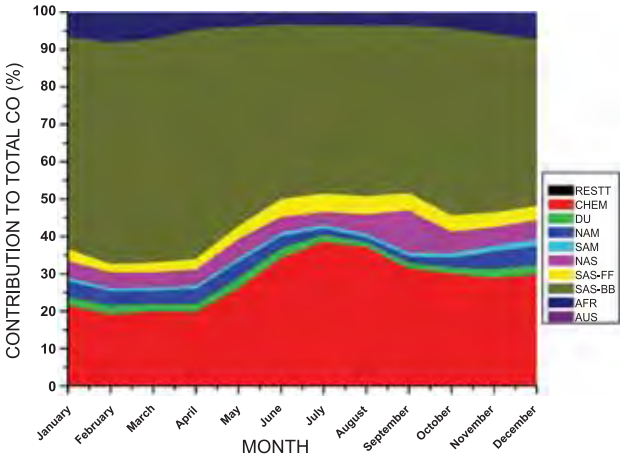


Fig. 6.15 : Simulated variations of the monthly mean contributions (percent) of the CO tracers to the total CO. Abbreviations are follows: AFR: CO from Africa; EU: CO from Europe; NAM: CO from North America; SAM: CO from South America; SAS-FF: CO from South Asia Fossil Fuel burning; SAS-BF: CO from South Asia Biomass Burning; AUS: CO from Australia; CHEM: CO from chemistry and RESTT: CO from rest of the equation respectively.

Long range transport of pollutants

The impact of long range transport of pollutant at several remote sites (Darjeeling, Hanle, Port Blair and Sunderban etc) was studied. To start with, the long term measurement of trace gases at Goa is being initiated, whereas, similar measurement is being started at Darjeeling in collaboration with Bose Institute, Kolkata. Measurement of surface ozone at Hanle and Port Blair is continuing in collaboration with Indian Institute of Astrophysics and India Meteorological Department respectively. The results deduced from campaign measurements show the indication of long range transport from south-east Asia as well as from west Asia. Figure-6.15 shows monthly variation of relative contribution of different sources in contributing the CO concentration at Darjeeling.

Emissions of trace gases and aerosol from biofuels

The linkages between sources and concentration of atmospheric trace gases and aerosol are to be established to understand budget of trace gases and aerosol. Moreover, role of long range transport of pollutants over India could be quantified provided quantification of the emission/contribution of pollutants from India itself is available. Sampling of biofuels was performed almost in district level over Delhi to determine emission factors of carbonaceous aerosol (Organic carbon and elemental carbon). The biomass collection sites in and around is shown in Fig. 6.16. The emission factors of some of the carbonaceous aerosol and other aerosols and concerned gases are presented in Table: 2 and Table: 3.

Fig. 6.16 : Details of location of the Biomass sampling sites

Table-2 Emission factors of some of the concerned carbonaceous aerosol

Fuel	EC(g/Kg)	OC(g/Kg)
Fuel wood		
(a) shahtoot	0.5	0.5
(b) keekar	0.07	1.07
Dung cake	0.07	5.1

Table-3 Emission factors of some of the concerned aerosols and gases

Emission Factors for NOx and PM from Biofuels (Delhi)		
Species	**NOx EF(g/kg)**	**PM EF (g/kg)**
Cow dung	1.35 ± 0.75	18.9 ± 8.70
Shahtoot	4.82 ± 0.56	2.3±0.57
Keekar	4.79 ± 1.13	2.1 ± 1.30
Mustard stem	2.04 ± 1.30	12.1 ± 9.13
Kabli keekar	0.87 ± 0.50	1.5 ± 0.47
Ber	0.15 ± 0.12	3.9 ± 3.14
Nagpan	2.87 ± 1.06	4.0 ± 1.79
Sheersh	0.83 ± 0.36	11.5 ± 6.35

Long term and short variation in vertical distribution of ozone and temperature over India and South East Asia

Focus on research on stratospheric ozone and total ozone has shifted recently to research on tropospheric ozone, in particular, surface ozone and its precursor gases due to its impact on regional air quality and climate.

(a) Long term variation in tropospheric ozone

Vertical distribution of ozone over Delhi (Fig. 6.17), Pune and Trivandrum has been analyzed for the period 1984 to 2005 using ozonesonde data available from India Meteorological Department. Using those data various results, viz.,: (1) Long term monthly trend on Delhi, Pune and Trivandrum, (2) Long term overall trend on Delhi, Pune and Trivandrum for the same period fitting a multiple regression model including the variation of Quasi Binneal Oscillation (QBO), El Nino Southern Oscillation (ENSO), and Solar Flux, (3) Calculation of correlation of ozone with QBO, ENSO and Solar Flux and (4) Calculation of vertical distribution of periodicity of QBO, ENSO and Solar cycle in ozone over three stations have been deduced. It has been observed that there is significant increase in tropospheric ozone particularly around 500 hPa and 200-300 hPa during the period of January-March. Role of biomass burning and stratosphere-troposphere exchange is evident at these two layers. There is also prominent increase in ozone at the layer of tropopause (~100 hPa) during June and July (monsoon month). It has its own implications.

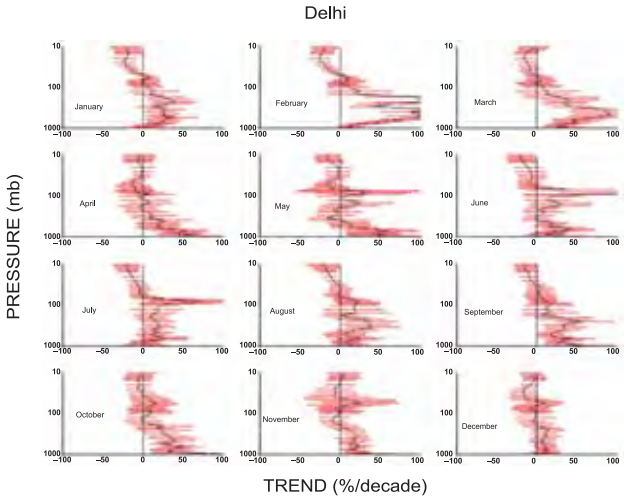


Fig. 6.17 : Monthly trend (%/decade) in vertical distribution of ozone over the period 1984-2005 at Delhi. 2 sigma plot shows the standard deviation of trend

(b) Role of stratospheric-tropospheric exchange (STE) on tropospheric/ stratospheric ozone in relation with tropopause variation over Asian region

The variation of tropical tropopause determines stratospheric-tropospheric exchange which controls concentration of many of minor constituents in tropical region. Because of fast economic growth of Asia, where, anthropogenic activity is more, changes in tropospheric ozone over this region is of great importance. To study the variation of tropospheric/stratospheric ozone in relation with tropopause variation, we have used ozonesonde data taken over three Indian stations (Delhi, Pune and Trivandrum). For wider perspective of this analysis on spatial scale, this study was extended to Asian region covered by two SHADOZ (Southern Hemispheric Additional Ozonesondes) stations. Although ozonesonde data over three Indian stations are available for the period of 1970-2005, the analysis of the data has been restricted for the period of seven years (1998-2005) to keep uniformity with SHADOZ data. Preliminary analysis over the period of 1970-2005 shows that tropospheric ozone has made e-fold increase during 70's with simultaneous decrease in stratospheric ozone over three Indian stations. However, over last ten years (1995-2005), a decreasing trend in tropospheric ozone is noticed over three Indian stations while the tropospheric over SHADOZ stations shows increasing trend.

Study of longterm variation of stratospheric ozone over Indian subcontinent

Version 8 SBUV on Nimbus 7 and SBUV/2 data on NOAA 9, 11, and 16 are used to find trend in stratospheric ozone. Vertical profiles of ozone over Delhi, Pune and Varanasi are obtained in mixing ratio on 15 pressure surfaces by averaging data within a grid of $\pm 2^0$ latitude and $\pm 10^0$ longitude around the respective station. A depletion in upper stratospheric ozone is found when SBUV + SBUV/ 2 data for the period 1978-2003 is analysed. Short term trend analysis for the periods 1978-92, 1992-99 and 1999-03 have also been done. The existing regressive model which includes QBO, 6 monthly, annually and solar cycle oscillations is modified to include ENSO, tropopause temperature as regressive coefficient. It is further generalized to take any periodicity. The observations of minor constituents like water vapour and methane have been obtained by Halogen Occultation Experiment (HALOE Ver V18 data) for the period 1992 to 2001. The values for sunrise data only are taken for the sake of symmetry and they are averaged for the latitude range of $+2^0$, longitude range of $\pm 10^0$ around a respective station. The profiles are averaged for vertical resolution of 2 km. The data as a function of day is used in the regressive model to calculate trend over Delhi, Pune and Varanasi. Anticorrelation between ozone and water vapour is seen in stratosphere An anticorrelation between water vapour and ozone is seen at stratospheric heights.

अतिचालकता तथा निम्नतापिकी

SUPERCONDUCTIVITY AND CRYOGENICS

अतिचालकता तथा निम्नतापिकी

डिवीजन का मुख्य कार्य डोप्ड एमजीबी$_2$ (MgB_2) में मूल अनुसंधान का लगातार किया जाना है । विभिन्न डोपेन्ट जैसे ए एल, नैनो–सी, नैनो एस आई सी (SiC) तथा नैनो डायमण्ड वाले एमजीबी$_2$ (MgB_2) के बल्क नमूनों को संश्लेषित करके थर्मो वैद्युत पॉवर एस (टी) चुम्बकीय प्रतिरोधकता [(P(T,H)] तथा उच्च क्षेत्रों में चुंबकन एम (एच) द्वारा अभिलक्षित किया गया है । एक अनूठे परिघटनात्मक अन्तर्वेशन फार्मूले को $Mg_{1-x}Al_xB_2$ में ए एल (Al) संकेन्द्रण के एक कार्य के रूप में अवलोकित धनात्मक तथा ऋणात्मक एस टी निर्भरता दोनों के अनुकूलन के लिए विकसित किया गया था नैनो–सी, नैनो–एस आई सी (SiC) तथा नैनो डायमण्ड की डोपिंग को ऊपरी महत्त्वपूर्ण फील्ड Hc(T), अनुत्क्रमणीयता फील्ड $H_{irr}(T)$ तथा MgB_2 बल्क सामग्री में महत्त्वपूर्ण मौजूदा घनत्व Jc(B,T) की उल्लेखनीय वशद्धि के लिए दर्शाया गया है ।

SUPERCONDUCTIVITY AND CRYOGENICS

A major activity of the division has been continuation of basic research in doped MgB_2 superconductors. Bulk samples of MgB_2 with different dopants like Al, nano-C, nano-SiC and nano-diamonds were synthesized and characterized by thermoelectric power S(T), magneto-resistivity [r(T,H)] and magnetization M(H) in high fields. A unique phenomenological interpolation formula was evolved to fit both positive and negative S(T) dependence observed as a function of Al concentration in $Mg_{1-x}Al_xB_2$. The doping of nano-C, nano-SiC and nano-diamonds were shown to significantly enhance the upper critical field $H_c(T)$, the irreversibility field $H_{irr}(T)$ and the critical current density $J_c(B,T)$ in the MgB_2 bulk material.

(I) Anomalous thermoelectric power of $Mg_{1-x}Al_xB_2$ system with x = 0.0 to 1.0

Thermoelectric power, S(T) of the $Mg_{1-x}Al_xB_2$ system has been measured for x = 0.0, 0.1, 0.2, 0.4, 0.6, 0.8 and 1.0. XRD, resistivity and magnetization measurements are also presented. It has been found that the thermoelectric power is positive for $x \leq 0.4$ and is negative for $x \geq 0.6$ over the entire temperature range studied up to 300 K, see Fig.7.1. The thermoelectric power of $x \leq 0.4$ samples vanishes discontinuously below a certain temperature, implying existence of superconductivity. In general, the magnitude of the thermoelectric power increases with temperature up to a certain temperature, and then it starts to decrease towards zero base line. In order to explain the observed behaviour of the thermoelectric power, we have used a model in which both diffusion and phonon drag processes are combined by using a phenomenological interpolation between the low and high temperature behaviours of the thermoelectric power. The considered model provides an excellent fit to the observed data. It is further found that Al doping enhances the Debye temperature.

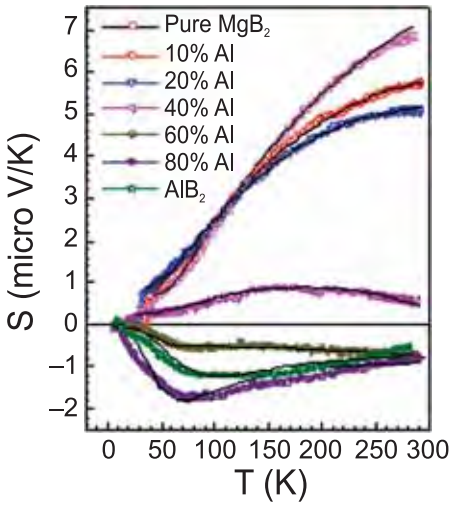


Fig. 7.1 : Thermopower vs temperature plots in the temperature range 0 to 300 K for all samples of series $Mg_{1-x}Al_xB_2$ (x = 0.0 to 1.0). The experimental data points are shown by different symbol and the theoretical fits are shown by the solid lines.

(II) Significant improvement of flux pinning and irreversibility field in *nano*-Carbon doped MgB_2 superconductor

Synthesis and study was done on the variation of superconductivity parameters such as transition temperature T_c, upper critical field H_c, critical current density J_c, irreversibility field H_{irr} and flux pinning parameter (F_p) for the $MgB_{2-x}C_x$ system with *nano*-Carbon doping up to x=0.20. Carbon substitutes successfully on boron site and results in significant enhancement of H_{irr} and $J_c(H)$. Resistivity measurements reveal a continuous decrease in T_c under zero applied field, while the same improves remarkably at higher fields with an increase in *nano*-C content for $MgB_{2-x}C_x$ system. The irreversibility field value is 7.6 & 6.6 Tesla at 5 and 10K respectively for the pristine sample, which is enhanced to 13.4 and 11.0 Tesla for x = .08 sample at same temperatures, see Fig.7.2. Compared to undoped sample, critical current density for the x=0.08 *nano*-Carbon doped sample is increased by a factor of 24 at 10K at 6 Tesla field.

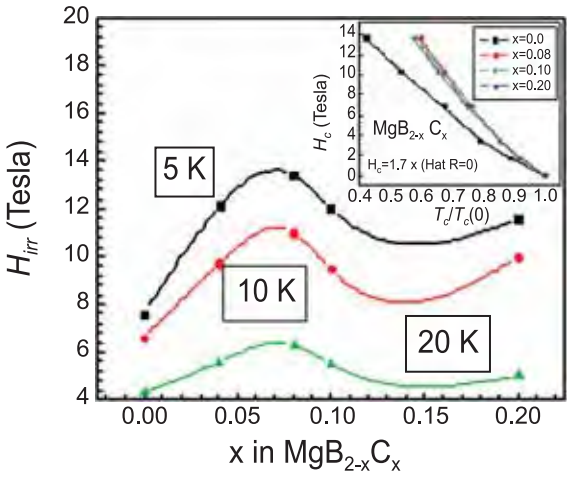


Fig. 7.2 : Irreversibility field H_{irr} versus Carbon content plots at 5, 10 & 20K for $MgB_{2-x}C_x$ samples. The inset shows the upper critical field (H_c) vs Normalized temperature plots for $MgB_{2-x}C_x$ samples (x=0.0, 0.08, 0.10 & 0.20)

(III) Superconductivity of bulk MgB_2+*nano*(*n*)-SiC composite system: A high field magnetization study

A study was conducted on the effect of n-SiC addition on the crystal structure, critical temperature, critical current density and flux pinning in MgB_2 superconductor. X-ray diffraction patterns show that all the samples have MgB_2 as the main phase with very small amount of MgO, further with *n*-SiC addition the presence of Mg_2Si is also noted and confirmed by SEM & EDS. The T_c value for the pure MgB_2 is 18.9K under 8 Tesla applied field, while is 20.8K for the 10-wt % *n*-SiC doped sample under the same field. This points towards the increment in upper-critical field value with *n*-SiC addition. The irreversibility field for the 5% *n*-SiC added sample reached 11.3, 10 and 5.8 Tesla, compared to 7.5, 6.5, and 4.2 Tesla for the pure MgB_2 at 5, 10 and 20K respectively (Fig.7.3). The critical current density for the 5-wt % *n*-SiC added sample is increased by a factor of 35 at 10K and 6.5 Tesla field and by a factor 20 at 20K and 4.2 Tesla field. These results are understood on the basis of superconducting condensate (sigma band) disorder and ensuing intrinsic pining due to B site C substitution clubbed with further external pinning due to available *n*-SiC/ Mg_2Si pins in the composite system.

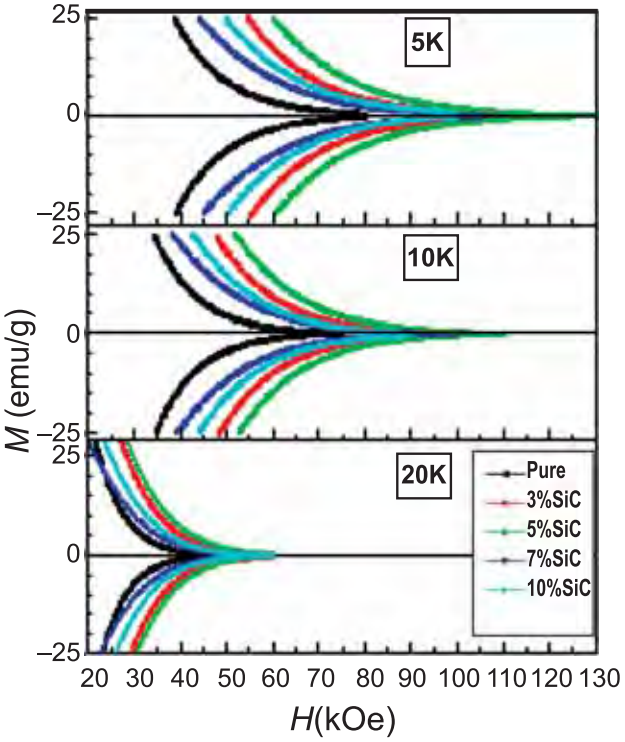


Fig. 7.3 : Magnetization loop *M(H)* for MgB_2+*n*-SiCx (x=0%, 3%, 5%, 7% & 10%) up to 13 Tesla field at 5, 10 & 20K

(IV) High field performance of nano-Diamond doped MgB_2 superconductor

Polycrystalline MgB_2-nD_x (x= 0 to 0.1) samples are synthesized by solid-state route with ingredients of Mg, B and n-Diamond. The results from magneto-transport and magnetization of nano-

diamond doped MgB_2-nD_x are reported. Superconducting transition temperature is not affected significantly by x up to x = 0.05 and latter decreases slightly for higher x > 0.05. R(T) vs H measurements show higher T_c values under same applied magnetic fields for the nano-diamond added samples, resulting in higher estimated H_{c2} values. From the magnetization measurements it was found that irreversibility field value for the pristine sample is 7.5 Tesla at 4 K and the same is increased to 13.5 Tesla for 3-wt% nD added sample at the same temperature. The $J_c(H)$ plots at all temperatures show that J_c value is lowest at all applied fields for pristine MgB_2 and the sample doped with 3-wt% nD gives the best J_c values at all fields. For the pure sample the value of J_c is of the order of 10^5 A/cm^2 at lower fields but it decreases very fast as the magnetic field is applied and becomes negligible above 7 Tesla. The J_c is 40 times higher than pure MgB_2 at 10 K at 6 Tesla field in case of 3%nD doped sample and its value is still of the order of 10^3 A/cm^2 at 10 Tesla for the same sample. On the other hand at 20K the 5%nD sample shows the best performance at higher fields (Fig.7.4). These results are discussed in terms of extrinsic pinning due to dispersed n-Diamond in the host MgB_2 matrix along with the intrinsic pinning due to possible substitution of C at Boron site and increased inter-band scattering for highly doped samples resulting in extraordinary performance of the doped system.

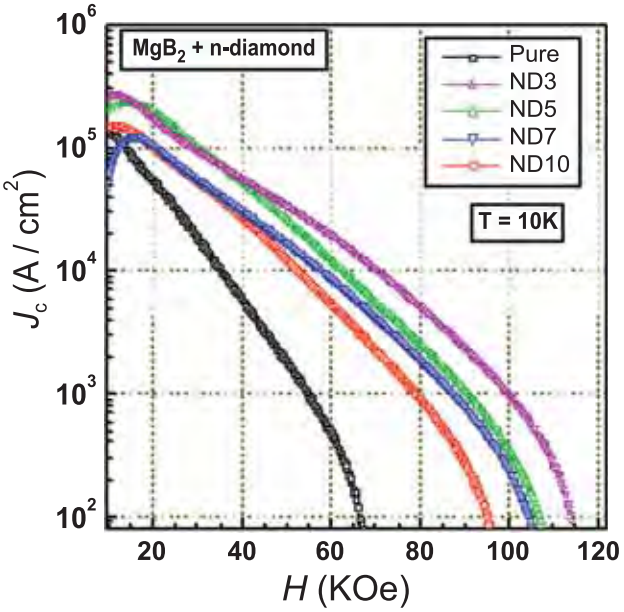


Fig. 7.4 : Critical current density (J_c) variation with respect to applied magnetic field (H) at 10K for nano-Diamond added MgB_2 superconductor.

सहायक सेवाएं
SUPPORT SERVICES

Planning, Monitoring and Evaluation Group (PME)

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 develops 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.

PME has the additional responsibility of getting feed back on degree of customer satisfaction in a prescribed format from funding agencies who are funding the different contract research projects in NPL. The process is done at the end of each project. This function has been initiated by CSIR under the supervision of Customer Satisfaction Evaluation Unit (CSEU) at CSIR Headquarter, Rafi Marg, New Delhi – 110 001. The feed-back received from the funding agencies are sent to CSEU, CSIR.

PME prepares many types of reports on Manpower in different formats as required from time-to-time and also does different type of Analysis for manpower planning of the laboratory.

Publication of Annual Report is another important activity of PME. On receiving inputs from various DUs', DPs' & other concerned groups, Text and Appendices of Annual Report are compiled, corrected and published in the form of annual Report each year.

Industrial Liaison Group (ILG)

This group undertakes two major areas viz marketing of developed technologies and consultancy and technical services. Besides this, the group is responsible for all matters connected with business development, open day function, wherein few thousand schools and college students with their teachers are invited to see the various scientific activities at NPL. Students are shown a film on NPL activities too. A technology day function is also observed where all licences are invited to deliberate with concerned PI of the technology for any suggestions. This group is also responsible for the dissemination of science through publication in CSIR news and in CSIR annual report, business and industrial magazines and their websites and through advertisements in news papers, conferences, symposiums, various other events and their souvenirs and also through participation in exhibitions Processes applications for the awards pertaining to technology or consultancy services rendered. Informs industries and licences for any new schemes. This group also takes care in the management of S & T outputs with other funding agencies viz. DST, CSIR, NRDC, AIMA,CDC, etc.. This group has recently initiated its efforts in setting-up an incubation Centre and possible knowledge Alliane with Moser Baer Photovoltaic Limited in Solar Energy area.

Human Resource Development Group (HRDG)

This Group organises Training Programmes for the benefit of NPL staff members as well as for the personnel belonging to Testing & Calibration Laboratories, S & T institutions and industries in various areas of core competence. 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. Besides this, the Group also organizes the placement of JRFs, SRFs, Research Associates, etc., in suitable sections/ divisions of the laboratory, and pursues other schemes of CSIR on EMR and HRD activities.

International Science and Technology Affairs Group (ISTAG)

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 leave / study leave for 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. It also organize the visit of foreign delegation at NPL. International collaborative projects, Bilateral International cooperation porgrammes & MoUs of NPL are also the areas of this group.

Library and Technical Information Services

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 109 scholarly journals (90 foreign journals and 19 Indian journals) and added 167 S & T books, 54 Hindi books. 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 4500+ full text journals under the e-consortium project of CSIR. It facilitate access to journals from various publishers i.e. Science Direct (Elsevier), Blackwell, Springer, AIP, APS (American Physical Society), Wiley Inter science, John Wiley and sons, Oxford University Press, Royal Society of Chemistry, American Chemical Society as well as to their archives going back to 1995 in case of Elsevier science and 2000 onwards in the case of other publishers. From this year, the Library has started providing access to intranet edition of Indian Standards.

This Service was made operational in NPL on 31st July 2002 with the access to Science Direct (Elsevier) group of journals and others w.e.f. February 2005 onwards.

This year, library has also installed 7 (Seven) dedicated computers in the library reading hall to provide access to electronic journals for walk-in users (Who are mostly from the various educational & research institutes). Library Reading hall is also having the high-speed wireless internet area (hot spot) where one can have wireless connectivity for their wi-fi enabled laptops.

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, and papers published by NPL scientists. The library continued to update this site throughout the year.

The Library also maintains NPL website (http://www.nplindia.org) on Internet. It is provides latest information on activities of NPL such as its role; thrust areas of research, facilities, services and achievements.

Central Workshop:

Different types of machining facilities have been established in NPL's Central workshop to

extend support to laboratorys R&D needs and to undertake external contract jobs. In addition to normal milling, lathe and welding machines etc. for normal fabrication jobs, work-shop is also under-taking a wide varieties of jobs of die making, sheet metals, plating and polishing and high quality carpentry works etc. The NPL workshop also has CNC milling facilities backed up by a CAD / CAM facility comprising a high precision German 'DECKEL FP4A' universal milling machine, with CNC rotary table and a GLIDEMESTER CT-200 CNC lathe machine capable of producing turned components. The workshop is also having a Auto CAD based drawing and tracing facilities. During the year the central workshop has completed more than 1095 jobs of in- house machining and fulfilled most of the requirements of high precision jobs of various Divisions/Sections. Total cost of work done during the year at Workshop was approx. Rupees. One crore thirty eight lacs thirty six thousand two hundred eighty eight only).

In addition to design, development and fabrication jobs, work-shop also undertakes a large number of maintenance jobs comprising different precision machines, pumps, compressors, gear boxes, machines of the Glass Technology Unit etc.

Glass Technology Unit:

This unit is having excellent facilities and expertise for design, development, fabrication and repair of scientific glass and quartz glass apparatus and equipments. It undertakes scientific glass instrumentation work for in-house as well as other institutions, industries and organisations. During the year Glass Technology Unit completed 176 jobs for NPL and 15 jobs for outside agencies and earned Rs 97898/- (Rs. Ninety seven thousand eight hundred and ninety eight only) as ECF. GTU has also provided a comprehensive technical training for various skills to one Technical Officer from University of MORATOWA Sri Lanka for two months and charged a sum of US $ 2000/-

Cryogenic Plants & Facilities:

NPL has excellent liquid Nitrogen & liquid Helium producing units. It is also having a 6000 litres capacity liquid Nitrogen storage vessel, making the availability of liquid Nitrogen round the clock for NPL's scientific work. We are also maintaining and producing liquid Helium at NPL. Till 31st Dec, 2007, we have produced approximately 31200 litres of LN_2 & supplied approximately 2400 litres of liquid Helium and Helium gas. Efforts are being made to improve the productivity further.

The Central Computer Facility at NPL

The Central Computer Facility (CCF)

(a) offers several network, computing and user-support facilities to NPL scientists and staff,

(b) is involved in software development for use at NPL and development of biomedical instruments, and

(c) conducts research in the areas of pattern formation and nonlinear physics and evolving networks and

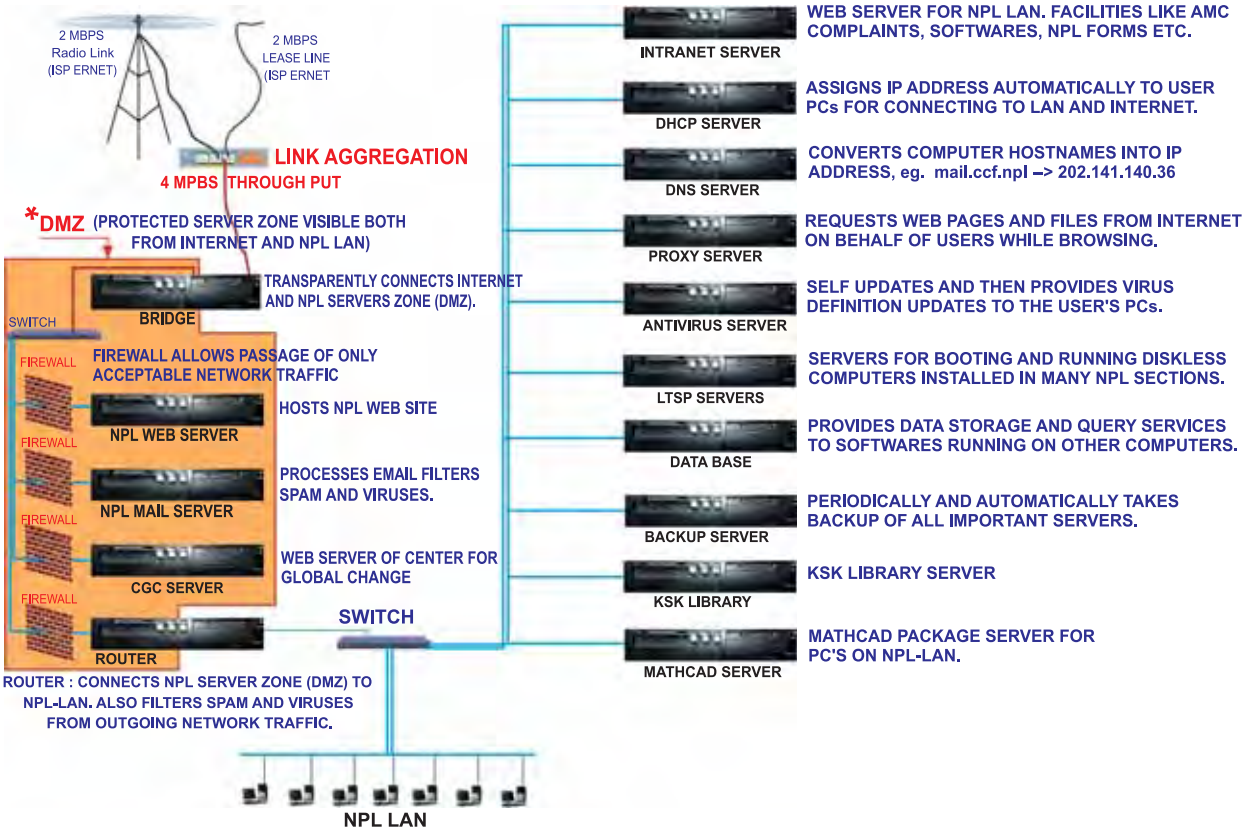
(d) provides consultancy to other instutions and industry in the area of IT infrastructure and networking and automation and instrumentation.

IT Infrastructure and Facilities at NPL

A campus LAN (Local Area Network) has been set which connects together approximately 850 computers spread over the NPL campus. The network utilises a mixture of optical fibre, UTP cables and switches. The internet access is provided through a gateway to the external world via a 2 Mbps radio link and 2 Mbps leased line to the ERNET at the department of Electronics. Email and Internet services are thus brought to the user's desktops.

CCF has established and is actively maintaining various servers namely Mail, Web, LTSP, Intranet, DHCP, DNS, Router, Bridge, Anti-virus, Backup, Database and Other Dept.

servers for providing networking, mailing and backup services. A schematic of the set up is shown in the figure below.



CCF has started the initiative to establish a new Data Center facility. Migration to improved infrastructure, with new servers to improve of the quality of service has been already completed. Multi-layered firewall, anti-spam engine, antivirus solution have been implemented to enhance the overall network security.

Developmental Activities

- Development of Personnel Inventory System (PIR) to enable the employees to retrieve their PIR records. Its purpose is to help store personnels for maintaining and updating the PIR records online.
- CCF has developed the NPL intranet site (http://nplnet.ccf.npl) and is maintaining the same for providing information about latest circulars, notices, announcements etc. User friendly interfaces are also provided on the site for lodging PC/printer AMC related complaints and checking the status, to browse through the list of experts, personal inventory records, telephone directory, commonly used forms and open source softwares etc.

Research and Educational Activities

- Development of biomedical instruments like blood oxygenation monitor, ECG machine and brain oxymeter.
- Experimental, theoretical, and computer simulation research on formation of patterns in a layer of a solid at the melting transition.
- Research on models for prebiotic evolution using numerical methods.

राजभाषा कार्यान्वयन

RAJBHASHA

द्विभाषी टेलिफोन डायरेक्टरी का प्रकाशन

पिछले कई वर्षों से प्रयोगशाला में द्विभाषी टेलिफोन डायरेक्टरी का प्रकाशन किया जा रहा है जिसमें अधिकारियों से संबंधित सूचना दी जाती थी किन्तु अप्रैल, 2007 में प्रकाशित इस बार की टेलिफोन डायरेक्टरी में स्थायी रूप से कार्यरत प्रयोगशाला के सभी स्टाफ सदस्यों के नाम व उनके टेलीफोन नम्बर दिए जाने का प्रथम प्रयास किया गया । इस डायरेक्टरी में समस्त स्टाफ के नाम सम्मिलित होने के कारण अब सभी अधिकारी/कर्मचारी बड़ी आसानी से एक–दूसरे से सम्पर्क कर सकते हैं।

''मापिकी व गुणवत्ता प्रबंधन'' पर राष्ट्रीय संगोष्ठी

मापिकी, मापविज्ञान औद्योगीकृत देशों की तकनीकी अवसरंचना का एक अनिवार्य हिस्सा बन गई है और गुणवत्ता प्रबंधन तथा गुणवत्ता नियंत्रण के लिए अहम् भूमिका निभाती है । समस्त विश्व में ''राष्ट्रीय मापिकी संस्थाएं'' बी आई पी एम के सहयोग से एस आई मात्रकों का निर्धारण, अनुरक्षण व प्रचार करती है । राष्ट्रीय भौतिक प्रयोगशाला वर्ष 2001 से हिंदी में विभिन्न कार्यशालाओं और संगोष्ठियों का आयोजन कर रही है । प्रयोगशाला में 11–13 जुलाई, 2007 में आयोजित मापिकी और गुणवत्ता प्रबंधन पर राष्ट्रीय संगोष्ठी इस श्रृंखला की सातवीं संगोष्ठी थी । इस संगोष्ठी का मुख्य उद्देश्य हिंदी में माप विज्ञान संबंधी जानकारी, आम जनता की भाषा तथा मापिकी और गुणवत्ता आश्वासन के विभिन्न विषयों से संबंधित विचारों का आदान प्रदान करना तथा मापिकी के क्षेत्र को नियंत्रित करने के लिए देश में उपलब्ध अंशांकन और परीक्षण सुविधाओं से संबंधित सूचना का प्रचार करना एवं इन सुविधाओं के प्रयोग की आवश्यकता से संबंधित जानकारी का प्रचार–प्रसार करना था ।

इस संगोष्ठी का शुभारंभ दिनांक 11 जुलाई, 2007 को प्रयोगशाला के सभागार में प्रातः 09.30 बजे किया गया ।

इस संगोष्ठी में मुख्यतः जो क्षेत्र सम्मिलित किए गए थे वे हैं – मापिकी में प्रगति, नैनो मापिकी, निर्देशक सामग्री, प्रमाणित निर्देशक सामग्री, पदार्थ मापिकी, पर्यावरणीय माप, औद्योगिक माप तथा गुणवत्ता आश्वासन, रासायनिक मापिकी, प्रत्यायन, स्वचालन, अनिश्चितता, विधिक मापिकी, अनुमार्गणीयता और जैव तकनीकी माप ।

इस संगोष्ठी में राष्ट्रीय भौतिक प्रयोगशाला के अतिरिक्त दुर्गापुर, इलाहाबाद, गाजियाबाद, चण्डीगढ़, देहरादून, पटियाला आदि क्षेत्रों की विभिन्न संस्थाओं/विश्वविद्यालयों ने सक्रिय रूप से भाग लिया । संगोष्ठी में 82 वक्ताओं ने अपने प्रपत्र प्रस्तुत किए जिनमें 18 आमंत्रित वार्त्ताएं, 32 मौखिक प्रस्तुतीकरण तथा 32 पोस्टर प्रस्तुतीकरण सम्मिलित थे ।

राष्ट्रीय भौतिक प्रयोगशाला, मेट्रोलॉजी सोसायिटी ऑफ इण्डिया तथा एन.ए.बी.एल. द्वारा पूर्णतः हिंदी माध्यम से संयुक्त रूप से आयोजित यह संगोष्ठी अत्यंत सफल रही ।

संगोष्ठी की महत्वपूर्ण बात यह रही कि इस बार सारांश पुस्तिका के साथ–साथ इसकी प्रोसीडिंग्स भी छपवाई गई जो प्रयोगशाला के लिए एक बहुत बड़ी उपलब्धि रही । वरिष्ठ वैज्ञानिकों का सहयोग व उनका योगदान विशेष प्रेरणादायक रहा ।

व्याख्यान

राजभाषा हिंदी के कार्यान्वयन, इसके व्यापक प्रचार–प्रसार तथा प्रशासन के साथ वैज्ञानिक/तकनीकी क्षेत्रों में इसे और अधिक बढ़ावा देने के लिए दिनांक 28 सितम्बर, 2007 को डा. अश्विनी मेहता, डिपार्टमेंट ऑफ कोर्डियोलॉजी, सर गंगा राम अस्पताल, नई दिल्ली ने ''दिल से संबंधित बीमारियों की रोकथाम'' (Prevention of Heart Disease) नामक विषय पर व्याख्यान दिया ।

हिंदी पखवाड़ा आयोजन

राष्ट्रीय भौतिक प्रयोगशाला में दिनांक 1 सितम्बर से 14 सितम्बर, 2007 तक हिंदी पखवाड़ा मनाया गया । पखवाड़े के दौरान विभिन्न प्रतियोगिताओं का आयोजन किया गया और 14 सितम्बर, 2007 को पखवाड़े का समापन समारोह आयोजित किया गया । हिंदी पखवाड़े के दौरान जो विभिन्न प्रतियोगिताएं आयोजित की गई उन सभी के लिए अलग–अलग समितियों का गठन किया गया जिससे कि आयोजन में किसी प्रकार की असुविधा न हो । निबंध, काव्य पाठ, साइंस क्विज, नोटिंग ड्राफ्टिंग व डिक्टेशन प्रतियोगिता आयोजन के दौरान पूरी प्रयोगशाला में पूर्णतः हिंदी का माहौल होने से ऐसा लगा जैसे प्रयोगशाला में शत–प्रतिशत कार्य हिंदी में ही होता है । इस प्रकार के आयोजनों से लोगों में, हिंदी के प्रति गहरी आस्था व रुचि देखने को मिली और इसी कारण निदेशक, एन पी एल के सुझावानुसार अब इस प्रकार के आयोजन पूरे वर्ष करने का निर्णय लिया गया ।

उपर्युक्त प्रतियोगिताओं में भाग लेने वाले प्रतियोगियों में से कुल 74 प्रतिभागियों को पुरस्कार के लिए चुना गया ।

14 सितम्बर, 2007 को समापन समारोह का उद्घाटन डा. पी सी कोठारी ने किया । उन्होंने अपने स्वागत भाषण में उपस्थित सभी स्टाफ सदस्यों को हिंदी में हो रही उत्तरोत्तर प्रगति व इसमें स्टाफ सदस्यों के सहयोग की भूरी–भूरी प्रशंसा की । उन्होंने विभिन्न प्रतियोगिताओं में बढ़ चढ़ कर भाग लेने पर बधाई दी । उन्होंने बताया कि हिंदी पूर्ण भाषा है । हमें अपनी भाषा से जुड़े रहना चाहिए किन्तु भाषा के प्रचार–प्रसार के लिए हमें अपने दिन प्रतिदिन के कार्यों में क्लिष्ट भाषा का प्रयोग नहीं करना चाहिए, सरल भाषा का ही प्रयोग करना चाहिए जिसे सभी सरलतापूर्वक समझ सकें ।

इस अवसर पर मुख्य अतिथि के रूप में सुश्री प्रभाकिरण जैन को आमंत्रित किया गया । उन्होंने अपने अध्यक्षीय भाषण में कहा कि हमें हिंदी भाषा का प्रयोग करते समय गर्व महसूस करना चाहिए क्योंकि एक हिंदी ही ऐसी भाषा है जो हमें एक सूत्र में बांधे रखती है । इस अवसर पर उन्होंने अपनी व्यंग्य व हास्य से भरपूर कविताएं सुनाई ।

इस अवसर पर मुख्य अतिथि व कार्यकारी निदेशक ने सभी विजेताओं को पुरस्कार प्रदान किए ।

अंत में डा. वी एन ओझा ने निदेशक, मुख्य अतिथि सभी आयोजकों, प्रतिभागियों व विशेष रूप से सभागार में उपस्थित सभी सदस्यों को धन्यवाद दिया और हिंदी के कार्यान्वयन में और अधिक प्रगति करने का आह्वान करते हुए कहा कि यदि सभी सरकारी कर्मचारी ईमानदारी से तथा बेहिचक हिंदी में कार्य करना आरम्भ कर दे तो हिंदी के कार्यान्वयन में यथा प्रगति निश्चित है ।

जलपान के साथ समारोह का समापन किया गया ।

संलग्न
APPENDICES

APPENDIX - 1

PUBLICATIONS

Papers Published by NPL Scientists During April 2007 – March 2008

Publication in SCI Journals

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APPENDIX - 2

PATENTS

Patents Granted in India

Sr. No.	Title	Patent No.	Grant Date	Inventors
1.	An appratus for measuring sieve dimensions and a method therefore	197541	18/09/2007	K P Chaudhary, S Singh and C Shakher
2.	A process for the preparation of conducting polymeric membrane and a conducting polymeric membrane prepared thereby useful as a filter for capturing viruses in potable liquids	215049	20/02/2008	Ramadhar Singh, Subhas Chandra, Hawa Singh, Amarjeet Kaur Narula, and Shobha Broor
3.	A process for the preparation of silica glass	215136	21/02/2008	Virender Kumar Parashar, Vasantha Raman and Om Prakash Bahl
4.	A novel method of fabricating improved standard platinum resistance thermometers and improved standard platinum resistance thermometers made thereby	215497	27/02/2008	V P Sharma, J K Gupta, K L Nagarwal, R K Luthra and R G Sharma
5.	An improved process for the production of modified green coke useful for making high density monolithic graphite products and a process for making products therefrom	215804	03/03/2008	Gopal Bhatia, Rajendra Kumar Aggarwal, Jagpal Singh Mathur and Om Prakash Bahl
6.	An apparatus useful for measuring particle size of a powder sample	215480	27/02/2008	P K Ghosh
7.	A device useful for the enhancement of resolution of an autocollimator and an autocollimator incorporating the device	215718	03/03/2008	Lakhan Singh Tanwar and Parvinder Pal Singh Virdy
8.	A novel composition useful for removing organic coatings from solid surfaces and a process for preparing the said composition	215794	03/03/2008	Ajit Kumar Sarkar and Niranjan Singh
9.	An improved process for the preparation of thin films useful for electronic optical tribiological application	216815	04/03/2008	C Anandan, P N Dixit, R Bhattacharyya, C Mukherjee and T Seth
10.	A composition useful for the preparation of an improved long decay luminescent powder and a process for the preparation of an improved long decay luminescent powder there from	215878	05/03/2008	Pradeep Kumar Ghosh, Harish Chander, Virendra Shanker and Parmanand

Patents Filed in India

Sr. No.	Title	Application No.	Filing Date	Inventors
1.	A process for the preparation of photo luminescent nanostructured silicon thin films	2750DEL2007	28/12/2007	Sushil Kumar, P N Sixit and CMS Rauthan
2.	A process for the preparation of oxide superconducting rods	0209DEL2008	25/01/2008	Narinder Kumar Arora, Gursharan Kaur Padam, Ramesh Sethi, Mukul Sharma, Shri Kant Narayan Ekbote
3.	A process for preparation of nanowires of metal oxides with dopants in lower valence states	2372DEL2007	13/11/2007	Harish Chander, Virendra Shanker, Divi Harnath and Pooja Sharma
4.	Combustible gas sensor	0062DEL2008	07/01/2008	Vipin Kumar, Kiran Jain, S T Lakshmikumar and T Raghavendra
5.	A novel process to produce high quality impregnating grade pitch	531DEL2008	05/03/2008	G Bhatia, V Raman, P R Sengupta, Archana Mishra, T S Negi and R S Bisht

Patents Granted Abroad

Sr. No.	Title	Patent No.	Country	Grant Date	Inventors
1.	Conducting polymer membrane and a process for the preparation of the same membrane	120690	Romania	28/09/2007	Ramadhar Singh, Subhas Chandra, Hawa Singh, A K Narula and Shobha Broor
2.	Simulated circuit layout for low voltage, low paper and high performance type II current conveyor for analog signal processing applications	0763038	Korea	21/09/2007	Sher Singh Rajput and Sudhanshu Shekhar Jamuar
3.	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	696502	China	13/07/2007	A K Rastogi, K Jain, H P Gupta and Vipin Kumar
4.	Lactate biosensing strip with two electrodes	7319018	United States of America	15/01/2008	Manoj Kumar Pandey, Asha chaubey, Krishan Kant Pande, Rajendra Kumar Sharma, Krishan Kumar saini, Bansi Dhar Malhotra and Rajesh
5.	Reusable heat pack, method of manufacture thereof, mixture for use in a reusable heatpack and process for the preparation thereof	2380664	Canada	15/01/2008	C P Sharma, R K Sharma, C Kant and A K Sarkar
6.	Enzyme electrode and process for preparation thereof	7267837	United States of America	11/09/2007	Arun Kumar, Rajesh and Bansi Dhar Malhotra
7.	A lactate biosensing strip	1578985	Europe	31/10/2007	Krishan Kant Pande, Rajendra Kumar Sharma, Krishan Kumar saini, Bansi Dhar Malhotra, Manoj Kumar Pandey, Asha Chaubey and Rajesh
8.	A sensitive fast responsive thin film ethanol sensor and a process for the preparaton of a sensitive, fast response thin film ethanol sensor and a process for the preparation of a precursor solution for ethanol sensor	2002216358	Australia	20/12/2007	A K Rastogi, K Jain, H P Gupta and Vipin Kumar

Patents Filed Abroad

Sr. No.	Title	NF No.	Appl. No.	Country	Filing	Inventors Date
1.	A process for the simultaneous and selective growth single-walled and multi-walled carbon nanotubes	0133NF2006/US	11/934816	United States of America	05/11/2007	R B Mathur, Chottey Lal, T L Dhami, B P Singh and A K Gupta
2.	An automated dead weight machine useful for calibrating strain gauge load cells	0014NF2006/IT	MI2007 A001712	Italy	31/08/2007	Kamlesh Kumar Jain, Hari Prasad Poddar and Raghunandan Prasad Singhal
3.	An automated dead weight machine useful for calibrating strain gauge load cells	00114NF2006/DE	10-2007-036214.7	Denmark	02/08/2007	Kamlesh Kumar Jain, Hari Prasad Poddar and Raghunandan Prasad Singhal
4.	An improved sol-gel process for the preparation of nanocrystalline $CeTi_2O_6$ Powder	0010NF2007/WO	PCT/IN 2008/ 000020	World Intellectual Property Org.	Yet to file	Amita Verma and S A Agnihotri
5.	A process for the preparation of a low contact resistance contact on a high transition temperature superconductors	163NF2004/EP	PCT/04724 669.9	Europe	30/11/2007	S N Ekbote, G K Padam, N K Arora, Mukul Sharma, Ramesh Sethi and M K Banerjee

APPENDIX - 3

TECHNOLOGIES MARKETED

Sr. No	Technology Developed	Licensee	Date of Transfer
1.	Software developed for pressure measurement/computation and estimation of measurement uncertainity using dead weight tester	M/s Regional Testing Centre Okhla , New Delhi-110020	24.04.2007
2.	Dead Weight Force Machine	M/s DVG Laboratories and Consultants Private Limited, Gurgaon – 122 011	05.09.2007
3.	A software for calibration of pressure measuring instruments using dead weight tester as pressure standard	M/s Sushma Industries Calibration Centre, Bangalore	19.11.2007

APPENDIX - 4

R & D COLLABORATIONS

Collaborating Institute	Area
Generic development of nanometrology for nanotechnology at NPLI (inter division,)	Nano metrology
National Institute of Standards and Technology (NIST), 100 Bureau Drive, Gaithersburg, MD 20899-8364 USA, Phone: 301-975-2956; FAX: 301-208-6962.	Pressure standards
National Institute of Standards and Technology (NIST), 100 Bureau Drive, Gaithersburg, MD 20899-8364 USA, Phone: 301-975-2956; FAX: 301-208-6962.	Vacuum Standards
High Pressure Laboratory, Department of Physics, University of Jaipur, Jaipur	Raman Spectroscopy
Department of Physics, Barakatullah Vishwavidyalaya, Bhopal, MP	
S.N. Bose Institute, Kolkata	
Space Applications Centre, Ahmedabad	Spectroradiometry
PTB, Germany,	
NPL,	
UK,	
NIST,	
USA,	
DIT,	
DST	
Various Universities.	
General Motors DMSRDE,Kanpur DMSRDE,Kanpur CEERI, CSIO	Advanced Magnesium Extrusion Alloys Caro-graphite seals Mesophase carbon fibres High density graphite
Aparna Carbons, Bhilai NMRL,(DRDO) BARC NCL, CECRI	High coking value impregnating pitch Porous conducting carbon paper Carbon/carbon composite tubes Development of fuel cell based on hydrogen

Appendix - 4, R & D Collaborations

Collaborating Institute	Area
SAMTEL Colour Lab Ltd.; NAC, Allahabad; CGCRI, Kolkata; IIT,Kanpur	LMD Group, NMITLI Project
Tezpur University, Naapam, Tezpur, Assam Thapar University, Patiala, Punjab Stockholm University, Stockholm, Sweden Institute of low temperature Science, Hokkaido University, Sapporo, Japan	Environment: Greenhouse Gases Environment: Aerosols & Health Environment: Rain Chemistry Environment: Aerosol Chemistry
Elektrochemie Group, PTB, Germany NMI-VSL, Netherland Instt. of Experimental Physics, Kosice, Slovak.	MiC: Primary pH Measurement MiC: Gas Metrology Magnetic fluid
C-DOT, New Delhi New Delhi NERTU, Osmania University, University College of Engineering, Hyderabad	Mobile Communication Fixed and Mobile Communication
Rajdhani College, Univ. of Delhi New Delhi	Stratosphere – Troposphere Exchange
Indira Gandhi Institute of .Technology, Indrastha Univ. New Delhi.	Air Pollutants – Emission of PAH from Biofuel
Space Physics Laboratory, (Thiruvanantapuram) Barkatullah University, Bhopal	Ionospheric Tomography
ISRO, Bangalore	Satellite in-situ measurements
National Institute of Oceanography, Goa	Global Change
Bose Institute, Kolkata	Air pollutants at Darjeeling
India Meteorology Department, New Delhi	Air pollutants at Port Blair
• BHU, Varanasi	Superconductivity
• University of Delhi	
• IIT, Delhi	
• IIT, Kanpur	
• JNU, New Delhi	
• Unicamp, Brazil	
• DY Patil University, Kohlapur	
• Missouri University, USA	
• Univ. Notredame, USA	
• Univ. of Wollongong, Australia	
• University of Rajasthan, Jaipur	
• Delhi College of Engineering, Univ. of Delhi, Delhi	

Appendix - 4, R & D Collaborations

Collaborating Institute	Area
• Inst. fur Festkorperphysik, Karlsruhe, Germany	Superconductivity
• TIFR, Mumbai	Superconductivity & Magnetisium
• IUAC, Indore	
• NIMS, Japan	
• Racah Institute of Physics, Jerusalem, Israel	
• MPI, Stuttgart, Germany	CMR Materials
• National Dong-Hwa University, Taiwan	
• Manipal Institute of Technology, Manipal	

APPENDIX - 5

SPONSORED/SUPPORTED R & D PROJECTS

(Rs. In lakhs)

Sr. No.	Title	Agency/Client	Amount Received
New Projects			
01	Bio-sequestration and bio-impregnation of heavy metals leading to nanomaterials synthesis and decontamination of industrial effluent	DST	2.00
02	Application of new functional conducting polymers in Nio-sensor and Nano electronic	DST (Indo-Japan Co-operative Science Programm)	2.00
03	Melt/Solution processable conducting polyaniline based magnetic films	DST	2.50
04	Growth and structural characterization of nearly perfect single crystals of oxide materials for scintillation applications	DST (Indo-Russian Joint Project)	3.67
05	Determination of country specific emission factor for methane from land fills and estimation of its emission inventry under the aegis of the NATCOM-SNC	Winrock International India (A facilitating agency for Ministry of Environment & forest)	6.26
06	QA/QC support for GHG (CO_2, CH_4 and N_2O) emission measurements undertaken by different national teams under the aegis of NATCOM-SNC	Winrock International India (A facilitating agency for Ministry of Environment & forest)	6.38
07	Formation of Alkali Metal nanostructures on reconstructed low and high index Silicon Surfaces (under SERC FAST TRACK Proposals)	DST	7.23
08	Development of TiO_2 nanocatalyst for environmental purification (Under SERC FAST Track Scheme)	DST	11.00
09	Ferro fluid based electric power generator	DRDO (Defence Research & Development Organization)	11.11
10	Studies on rare earth substituted magnesium ferrite thin films and the effect of humidity on its performance	DRDO (Defence Research & Development Organization	11.81
11	Physico-Chemical studies of metal and metal oxide nonoparticles (under SERC FAST TRACK Prposals)	DST	12.00

Appendix - 5, Sponsored/Supported R & D Projects

Sr. No.	Title	Agency/Client	Amount Received
12	High pressure Raman studies of rare earth sesquioxides (Ln_2O_3(Ln=La,Ce,Pr,Nd,Sm,Eu,Gd,Tb,Dy,Ho,Er,Yb,Y)	DST	14.00
13	Development of DNA Biosensor for detection of Neisseria Gonorrhea in clinical sample	DST	16.53
14	On-line approach to non-contact IR Sensor technique for estimation of sugar and its byproducts	DBT	16.92
15	Amorphous carbon thin film having nanoparticle inclusions deposited by the modified vacuum plasma arc techniques	DST	28.00
16	Infrared spectroscopic study for tumor diagnosis	DST	29.00
17	Development of white organic light emitting diodes (WOLEDs) for general lighting applications	DST	36.00
Continuing Projects			
01	Metal Induced Crystallization Behaviour on Thin Film of Amorphous Silicon	DST (Indo-US)	0.50
02	Development of Nanostructured electrochromic films with improved performance characteristics by wet chemical techniques for smart windows	DST	1.00
03	Coherent Radio Beacon Experiment (CRABEX) for Tomographic Studies of the Ionosphere on Board GSAT-II Satellite	VSSC, Thiruvananthapuram	1.74
04	Synthesis and characterization of nano size granins of Ruthenocuparates MGB_2 Superconductors	DST (Indo-Israel)	2.20
05	Physico-Chemical characterization of wet deposition at NPL, New Delhi and Pantnagar in Uttaranchal	SEI, Sweden	2.23
06	Synthesis of organic and inorganic Nanocomposites for sensor applications	DST	5.00
07	Ionospheres of Venus and Mars: Chemistry, Dynamic Thermal Structure and Solar Wind Interaction	Physical Research Laboratory, Ahmedabad	5.12
08	Synthesis and characterization of carbon nono tubes/polymer network composites	DST	7.00
09	High rate deposition of the microcrystalline silicon films using high density microwave plasma and its application efficient large area thin film solar cells	DST	7.50
10	Operation of the South Asian Regional Research Centre (SAS-RRC) for Study of Global Change Under SASCOM	Int. START Sect.	0.00
11	Studies on Fog Ocurrence on Delhi	CPCB	0.00
12	To Conduct Inter-Laboratory Proficiency Testing Amongst the NABL Accredited Calibration Laboratories in India	DST (NABL)	0.00

Appendix - 5, Sponsored/Supported R & D Projects

Sr. No.	Title	Agency/Client	Amount Received
13	Development of Ultrasonic Method to Evaluate Moisture in Composite Materials	ARDB, Bangalore	0.00
14	Setting up of Facilities for dissemination of Indian Standard Time in North-Eastern States	DST	0.00
15	Semiconductor Silicon for Applications in Solar Energy Microelectronics and Power Electronics	Indo-Russia (ILTP)	0.00
16	Development of injection solar cells utilizing dye sensitised nono-crystalline TiO_2 films	MNES	0.00
17	Development of Nanophosphors for Industrial Applications	DST	0.00
18	Interaction with Universities/Lab in the Area of Superconductivity	UGC	0.00
19	Investigation Study on Microwave Sintering of Beta Alumina Tubes	DST	0.00
20	Development of speciality carbon materials for novel nuclear rectors	BARC, (Central Complex Trombay, Mumbai)	0.00
21	Low cost technology for High efficiency Silicon Solar Cell	DST (Indo-Bulgarian Inter Govt. Prog.)	0.00
22	Establishment of primary standards for Vickers & Brinell Hardness Scales	DST	0.00
23	Development of Calibration-Validation (CAL-VAL) Sites at Kavaratti Island	DSAC, Space Application (ISRO, Ahmedabad)	0.00
24	Assessment of Effects of High Particulate on Pulmonary Health Status in Selected Magacities of South Asia	APN-Japan	0.00
25	Generic Development of Nanometrology for Nanotechnology	DIT, New Delhi	0.00
26	Integrated campaign for aerosols, gases & radiation budget	VSSC, Thiruvanthapuram	0.00
27	Dynamics studies at the phase transition region of SmC*-Sm-A phase in electroline liquid crystal materials	DST	0.00
28	Development of carbo-graphite material for aeronautical application	Defence Material & Store Estb. (DRDO, DMSRDE)	0.00
29	Sol-gel derived Optical Biosensor for Water Pollution Monitoring	DST	0.00

Appendix - 5, Sponsored/Supported R & D Projects

Sr. No.	Title	Agency/Client	Amount Received
30	High Stability Atomic Fountain Clocks	DST-DAAD (German Academic Exchange Serv.)	0.00
31	Modeling of organic Opto-electronic devices LEDs and Solar Cells	DST	0.00
32	Study of the mechanisms involved in enhancement of electroluminescene properties of inorganic nanophosphors	DST (Under SERC FAST Proposals)	0.00
33	Studies and formulations for upscailing the process for making porous conducting carb paper and establish pilot plant scale facilities at NMRL	NMRL, Navel Materials Research Laboratory	0.00
34	Development of Mesophase Pitch for High Performance Carbon Fibres	Defence Material & Store R&D Estb. (DRDO, DMSRDE)	0.00
35	Proficiency Testing (PT) among National Accreditation Board for Testing and Calibration Laboratories (NABL) Accredited Laboraories in Chemical Discipline	DST (NABL)	0.00
36	SAARC-PTB Cooperation Programme	PTB-Germany	0.00
37	Molecular and biochemical sensor for identification of cells and diagnosis of diseases	DST	0.00
38	Study on the effects of atmospheric dynamical activity in the tropical tropopause region: Implications on the stratosphere-Troposphere exchange of the minor constituents	DOS, Department of Space	0.00
39	A novel development of lab-on-chip biosensor for determination of mycotoxins in food (mainly cereals) - under SERC Fast Track Scheme	DST	0.00
40	Development of Carbon-Ceramic composites and the influence of oxidation at elevated temperatures on their properties	DST	0.00
41	Evaluation of emission factors and budgets of gases and particulate matter of relevance to climate change emitted by fuels particularly biomass used in India by the rural sector & small scale industries	DST	0.00
Completed Projects			
01	Cloud and Precipitation Phenomena estimation by using different Systems for Propagation Characteristics in Micro Wave and Millimetre Wave and Millimetre Wave Frequency bands	DST	0.00
02	Development of Plasma Polymerization Process and Deposition System for Thin Film Optical Coatings on Plastic Substrates, Conducting Polymeric Barrier Membrane Coatings	DST	0.00

Appendix - 5, Sponsored/Supported R & D Projects

Sr. No.	Title	Agency/Client	Amount Received
03	Development of Bandpass Interference Filters for Course Wavelength Division Multiplexing (CWDM) Fibre Optic Communication System	DST	0.00
04	Fabrication and Characterization of Organic Light Emitting Diodes	DST (Women Scientist Scheme-A)	1.50
05	Studies on the Effect of Dynamic Multiple Scattering on Frequency Shift of Spectral Lines and Applications	DST	1.00
06	Optical Phase Singularity and its Applications	DST (Women Scientist Scheme-A)	0.75
07	Design & Fabrication of Filter Transmission Meter	DST	0.00
08	Design and Development of Urea-Biosensor	DST	3.00
New/Completed			
01	$Melt blending of PET with doped PANI to generate data based on thermal and electrical properties	Reliance Industries Limited, Mumbai	1.99
	Note: $Project started & completed in 2007-08 (completed Nov 09, 2007)		
01	#Development of Transducer Elements for Acoustic Emission (AE) Sensor	BARC	1.20
	Note: #Project Completed in 2005-06 but amount received in (2007-08)		
		Grand Total	**258.15**

CSIR Network Projects

Sr. No.	Name of the Project	Project Code	Nodal Officer	Name of the Laboratory
1	Advancement in Metrology	NWP 0045	Dr P Banerjee/ Dr Prabhat Kr Gupta	NPL as Nodal Lab
2	Fabrication of LED Devices and Systems for Solid State Lighting Applications	NWP 0025	Dr. S T Lakshmikumar	NPL as Nodal Lab
3	R&D on Photovoltaics and other Solar Energy Applications **(Supra-Institutional Project)**	SIP 0017	Dr P K Singh	NPL as Nodal Lab
4	Advance Light Weight Metallic Materials for Engineering Applications	NWP0028	Dr Anil Kr Gupta	NPL as Partner Lab RRL, Bhopal as Nodal Lab
5	New Screening Technologies and Effect on Human Health-Megacity Pollution precursor prediction & Impact alert system	NWP 0017	Dr M K Tiwari	NPL as Partner Lab NEERI as Nodal Lab
6	Surface analysis of Dispensor Cathodes for High Power MWT	NWP 0024	Dr Mahesh	NPL as Partner Lab CEERI, Pilani as Nodal Lab
7	Design and Fabrication Capabilities for very High Power Microwave Tubes	NWP0024	Dr G Bhatia	NPL as Partner Lab CEERI, Pilani as Nodal Lab
8	Development of Ultrasonic Technique for measurement of Residual Stress in Bulk Materials	NWP 0027	Dr Ashok Kumar	NPL as Partner Lab NML, Jamshedpur as Nodal Lab
9	Technology for Assessment and Refurbishment of Engineering Materials and Components	NWP 0027	Dr Sushil Kumar	NPL as Partner Lab NML, Jamshedpur as Nodal Lab
10	Conducting Polymer paints and coatings for corrosion protection and sheilding of concrete structures in strategic areas	NWP 0012	Dr S K Dhawan	NPL as Partner Lab NCL, Pune as Nodal Lab

APPENDIX - 6

CONSULTANCY PROJECTS

(Rs. In lakhs)

Sr. No.	Client	Title	Contact Value	Amount Received 2007-08
NEW				
01	RRSL, Bhubaneswar	Design and fabrication of transfer standards confirming to class A	2.23	2.23
02	CSIO, Chandigarh	Calibration facility-guidance for quality manual	0.00	0.00
03	RRSL Guwahati	Setting up of torque standards machine.	11.40	11.40
04	RRSL, Faridabad	Design, fabrication and installation of primary torque measurement machine.	31.00	24.85
05	Bangalore Metro Rail Corporation Ltd (BMRCL), Bangalore	Noise and vibration study in and around proposed Bangalore Metro Train/Stations.	11.24	11.24
06	Aeronautical development agency (ADA), Bangalore	Certification of reference blocks of various materials as per 1.2 mm EBH standard of VSTM 127-PV3/PV3	9.36	3.51
07	RRSL, Bangalore	Setting up of torque standard machine.	31.00	24.85
08	RRSL, Bangalore	Design, erection and commissioning of dead weight force machine.	101.25	81.10
09	RRSL, Ahmedabad	Design, primary and secondary torque measuring facility.	14.29	11.45
10	RRSL, Bhubaneswar	Supply of one number of secondary torque measurement facility.	14.29	14.29
11	Aparna Carbon Pvt Ltd, Kolkata	General consultancy to improve the QI free coal tar-pitch	2.00	2.00
12	MN Dastur & Co. Pvt Ltd, Kolkata	Mixing height determination at Keonjhar, Orissa	5.90	3.70
13	General Motors India Pvt Ltd, Bangalore	Recrystallization and grain refinement mechanism during extrusion of magnesium alloys	65.97	15.00
14	HEG Ltd, Noida	To check feasibility/suitability of HEG Ltd works, mandideep to manufacture nuclear grade graphite	1.00	0.99

Appendix - 6, Consultancy Projects

Sr. No.	Client	Title	Contact Value	Amount Received 2007-08
15	Tata Steel, Jamshedpur	Inversion study for Tata steel plant.	4.10	4.10
16	Jindal Steel & Power Ltd, Raigarh (MP)	Ultrasonic response from hall and notches in reference test rails and theirs correlation with dimensions	5.46	4.84
NEW & COMPLETED				
01	ERTL, New Delhi	Characterization of dead weight tester	2.47	2.47
02	Urban Waste Management Ltd, New Delhi	Performance checking of high pressure hose	0.34	0.34
COMPLETED				
01	Jadavpur University Kolkatta	Setting up-lab for calibration parameters : dimension and force in a limited range as per IS 17025	3.14	0.00
02	RRSL, Bhubaneswar	Supply and installation of load Cell testing instruments of range 50-500 kg	14.29	0.00
03	RRSL, Faridabad	Supply and installation of load cell testing instruments of range 50-500 kg	14.29	0.00
CONTINUING				
01	RRSL, Ahmadabad	Fabrication and installation of load cell testing machine	16.43	0.00
02	NTPC,Gautam Budh Nagar, Noida	Purchase of low noise convertor	2.24	0.00
03	Coal Chem, Bhilai	QI free coal tar pitch from coal tar	0.80	0.00
04	CPCB, AGRA, Lucknow Zone	Inversion/mixing height studies at CPCB, Agra	9.99	0.00
05	DMRCL, Delhi	Consultancy services for studying noise impact of Delhi Metro Operation	5.32	0.00
06	MN Datur & Co. Ltd, Kolkatta	Mixing height determination at Paradeep,Orissa	2.76	0.77
		Total	**382.56**	**219.13**

APPENDIX - 7

EARNING FROM CALIBRATION & TESTING

Physico-Mechanical Standards

Sr. No.	Activity	DP No.	No. of Reports	Calibration Charges
1	Mass	1.01	686	64.89
2	Length & Dimension	1.02	503	55.43
3	Temperature & Humidity	1.03A	51	10.29
4	Temperature & Humidity	1.03B	68	08.69
5	Temperature & Humidity	1.03C	43	05.17
6	Optical Radiation	1.04	399	82.12
7	Force & Hardness	1.05	493	61.47
8	Pressure & Vacuum	1.06	107	30.75
9	Acoustic	1.07	294	75.98
10	Fluid Flow	1.08	9	1.04
11	Ultrasonic	1.09	31	3.88
12	Shock & Vibration	1.11	21	1.84
		Sub-Total (A)	**2705**	**401.55**

Electrical & Electronic Standards

Sr. No.	Activity	DP No.	No. of Reports	Calibration Charges
1	Time & Frequency	2.01	24	2.64
2	Josephson Voltage Standards DCI, V & R	2.03	69	9.53
3	DC High Voltage	2.04	15	2.35
4	AC Power & Energy	2.05	97	18.38
5	AC High Current * High Voltage (CT/PT)	2.06	35	15.53
6	LF & HF Impedance	2.07	20	4.39
7	LF & HF Voltage, Current & RF Power	2.08	20	14.46
8	RF Attenuation & Impedance	2.09	21	5.74
9	Magnetic	2.10	19	1.26
		Sub-Total (B)	**320**	**74.28**

Engineering Materials

Sr. No.	Activity	DP No.	No. of Reports	Calibration Charges
1	Metal & Alloys	3.01	4	0.31
2	Advanced Carbon Product	3.02	11	0.28
		Sub-Total (C)	**15**	**0.59**

Material Characterization

Sr. No.	Activity	DP No.	No. of Reports	Calibration Charges
1	Chemical Analysis	5.01	84	5.92
2	EPR & IR	5.02	7	1.23
3	X-Ray	5.03	2	0.22
4	Electron Microscope	5.04	22	3.33
5	Indian Reference Materials	5.05	6	0.44
6	Crystal Growth	5.06	0	0.00
7	SIMS Standards	5.07	2	0.19
		Sub-Total (D)	**123**	**11.33**

Superconductivity & Cryogenics

Sr. No.	Activity	DP No.	No. of Reports	Job Work Charges
1	Superconductivity	7.01	1	5.78
		Sub-Total (E)	**1**	**5.78**
		GRAND TOTAL (A+B+C+D+E)	**3164**	**494.12**

APPENDIX - 8

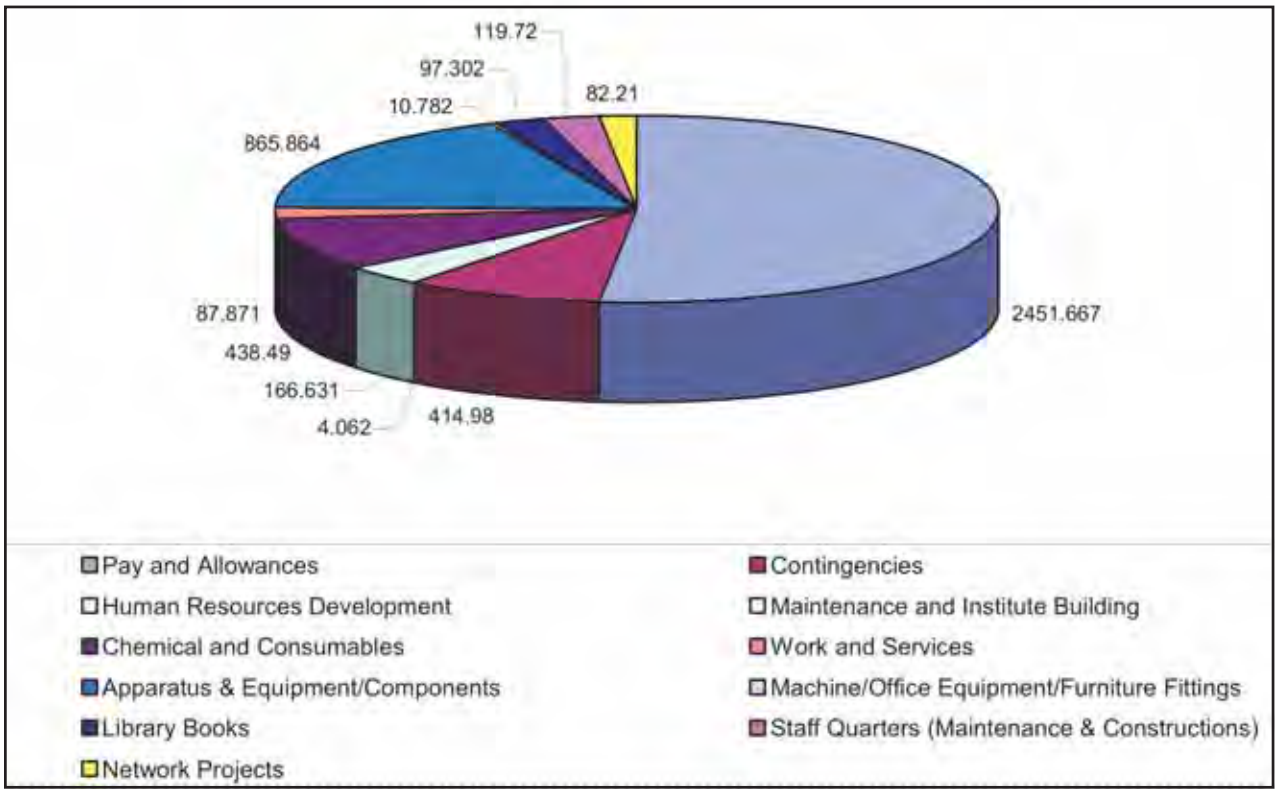
ACTUAL EXPENDITURE 2007 - 08

(Rs in lakhs)

Sr. No.	Budget Heads	Expenditure
1	Pay and Allowances	2451.667
2	Contingencies	414.980
3	Human Resources Development	4.062
4	Maintenance and Institute Building	166.631
5	Chemical and Consumables	438.490
6	Work and Services	87.871
7	Apparatus & Equipment/Components*	865.864
8	Machine/Office Equipment/Furniture Fittings	10.782
9	Library Books**	97.302
10	Staff Quarters (Maintenance & Constructions)	119.720
11	Network Projects	82.210
	Total	**4739.579**

* including Computers

** including Library Journals



APPENDIX - 9

RECOGNITIONS, HONOURS AND AWARDS

Awards:

Vikram Kumar

ISSS Award for Special Recognition

N. Vijayan

a) CSIR Young Scientist Award

b) Prof. P. Ramasamy National Award for Crystal Growth.

C. Sharma

Received a certificate from Hon'ble Prime Minister of India recognizing the contribution made to the efforts of United Nations Intergovernmental Panel on Climate Change (IPCC), which co-shared the Nobel Peace Prize 2007.

P.K. Siwach

Young scientist award of the UP Council of Science & technology

B.D. Malhotra

Fellow of the National Academy of Sciences, India

Best Poster/paper award:

Harish Bahadur

Best Poster Award (Int. Conf. Luminesecence ICLA 2008, Feb. 2008), NPL, New Delhi,.

R Mehrotra, S Raman, Sudama, D P Bahuguna and H C Kandpal

Best Poster Award**:** "LED measurements and applications", National Symposium on Metrology and Quality Management, NPL, New Delhi (India), July 11-13, 2007.

Manju Arora

Best Poster Award (Workshop on Metrology in Hindi, Jul. 2007), NPL, New Delhi

Recognitions:

Vikram Kumar

Chairman of the BIS Sectional Committee MTD-33 on Nanometrology

Tripurari Lal

Member

CCM WGM Task Group 1 (TG-1)

Mass metrology under vacuum for a miseen pratique.

CCM WGM Task Group I1 (TG-I1)

Uncertainty components due to traceability to the international prototype kilogram)

Re-nominated member of CCM Working Group in Viscosity

A.K. Bandyopadhyay

Chairman, TCM, APMP extended for another two years term up to 2009

Prabhat Kumar Gupta

Chaired, BIS sectional committee on gases (CHD-6), Manak Bhavan, New Delhi,

A.K. Agrawal

Chaired, BIS sectional committee on glass and laboratory wares (CHD 10), Mumbai,

Leader of Indian Delegation in the meetings of ISO TC-48 and SC-6 at Mumbai

Anil K. Gupta

Distinguished Visiting Professorship, (AICTE-INAE) at Institute of Technology (**IT**),Banaras Hindu University with Dept. of Metallurgical Engineering –2007- tilldate.

Research Council (RC) Member of Central Glass & Ceramic Research Institute (CGCRI), Kolkata for a period of three years since April, 2007

Chairman, Alloy Steel & Forging Sectional Committee (MTDC-16), Bureau of Indian Standards (BIS).

Management Council Member (2007-09) of NPL; CEERI, Pilani,; AMPRI (RRL), Bhopal; NISCAIR, New Delhi and NIIST (RRL), Thiruvanathpuram

APPENDIX - 10

VISITS ABROAD

Sr. No.	Name & Designation	Country Visited	Duration	Purpose
1	Dr. B.C. Arya, Sc. F	Japan	16.04.2007 18.04.2007	To attend 3rd Asia Pacific Network (APN) workshop on Asia Ozone Pollution in Eurasian
2	Dr. T.K. Mandal, Sc. C	Japan	16.04.2007 18.04.2007	To attend 3rd Asia Pacific Network (APN)workshop on Asia Ozone Pollution in Eurasian
3	Dr. R.S. Dabas, Sc. F	USA	21.04.2007 27.04.2007	To attend "International Space Environment Services (ISES) and Space weather Week Meeting"
4	Dr. Govind, Sc. C	USA	08.06.2007 07.06.2008	To visit Department of Physics & To visit Department of Physics & Astronomy, The State University of New Jersey, on BOYSCAST Fellowship awarded by DST for the year 2006-2007 to perform research at Rutgers University under Dr. T.E. Madey
5	Dr. A.Sen Gupta, Sc.G	Germany, Switzerland	27.05.2007 01.06.2007	(i) To design and develop Cs frequency synthesis techniques and construction and evaluation of a laser cooled Cs foundation clock under the DST-DAAD project from 1st May to 27th May,2007 at PTB,DAAD Germany (ii) a workshop on primary Frequency Control Symposium and Presentation at EFTF-IFCS,2007 at Geneva,Switzerl and from 28th May to 1st June,2007.
6	Dr. R.B. Mathur, Sc. F	Australia	07.05.2007 06.09.2007	To work in the Department of Functional Nanomaterial, University of Queensland, Brisban, Australia to develop Collaborative programme of mutual interest and to foster enduring linkage between the two institutes under the award entitled "Endeavour India Executive Award" sponsored by the Department of Education & Training, Australia
7	Dr. Y P. Singh, Sc. F	Nepal	07.05.2007 12.05.2007	To visit Nepal Bureau of Standards and Metrology (NBSM).
8	Dr.Tripurari Lal, Sc.F	Nepal	07.05.2007 12.052007	To visit Nepal Bureau of Standards and Metrology (NBSM).
9	Dr A.K. Bandyopadhyay, Sc.F	China	09.05.2007 12.05.2007	To attend the APMP meetings and MIC symposium /workshop

Appendix - 10, Visits Abroad

Sr. No.	Name & Designation	Country Visited	Duration	Purpose
10	Sh.Bijendra Pal, Tech Ofcr B	Taiwan	16.05.2007 18.05.2007	To attend a Workshop on AC Metrology sponsored by APMP
11	Dr. Vikram Kumar, Director	Germany	03.05.2007 05.052007	To visit as a member of Indian delegation for attending the 2nd Meeting of Joint Working Group for discussion with the German side for devising concept paper for proposed Indo-German Science,Researach and Technology Centre.
12	Dr. R.P. Singhal, Sc. G	Mangolia	19.05.2007 28.05.2007	For the assessment of Mangolian Agency for Standardization and Metrology (MASM) at Ulan Bator, Mangolia
13	Dr. Sanjeev Sinha, Sc. E-I	Thailand	04.06.2007 08.06.2007	To attend the Joint Training on Measurement Standards at National Institute of Metrology (NIMT)/ JICA,
14	Sh. Rajesh Kumar, Sc. C	Thailand	04.06.2007 08.06.2007	To attend the Joint Training on Measurement Standards at National Institute of Metrology (NIMT)/ JICA,
15	Sh.Virendra Kr Gupta, STA	Thailand	04.06.2007 08.06.2007	To attend the Joint Training on Measurement Standards at National Institute of Metrology (NIMT)/ JICA,
16	Dr. Vikram Kumar, Director	China	09.06.2007 15.06.2007	To attend Developing Economics Committee (DEC) Workshop as a member of Executive Committee
17	Dr. Tripurari Lal, Sc. F	Vietnam	06.06.2007 08.06.2007	To attend "Evaluation Workshop for APMP.M.M.K6 Inter-comparison in Mass
18	Dr. H.R. Singh, Sc.E-II	Netherland	07.06.2007 12.06.2007	To attend and present a paper in "ICMCC-2007,International Conference on Medical Care and Compunetics
19	Dr. R.P. Singhal, Sc. G	China	09.06.2007 15.06.2007	To attend the APMP EC (Executive Committee) , APMP TC chairs & Developing Economies Committee (DEC) Workshop, MIC Symposium & Workshop
20	Dr. Prabha Johri, Sc. C	China	13.06.2007 15.06.2007	To attend the 2nd International Symposium and Workshop on metrology in chemistry (MIC-2007) under APMP meeting programme
21	Dr. Vikram Kumar, Director	Germany	19.06.2007 21.06.2007	For participation in the 1st Project Advisory Committee(PAC) and also to participate in the Euro Nano Forum 2007
22	Dr. R.P. Pant, Sc. E-I	Slovak	23.07.2007 27.07.2007	To attend the 11th International Conference on Magnetic Fluids(11th ICMF) held at Institute of Experimental Physics (KOSICE)·at Slovak Academy of Sciences (SAS).

Appendix - 10, Visits Abroad

Sr. No.	Name & Designation	Country Visited	Duration	Purpose
23	Dr. Sanjay Srivastva, Sc. B	Japan	29.07.2007 11.08.2007	For attending the Summer School on " Data Science of Materials".
24	Dr. S.C. Jain, Sc. G	China	04.08.2007 07.08.2007	To attend the 2nd Chinese India Workshop on MEMS & MENS and delivered an invited lecture as the Co-Chairman at China Resources Hotel.
25	Dr.Vikram Kumar, Director	China	04.08.2007 07.08.2007	To attend 2nd China-India Workshop on MEMS & MENS as a Chairman of Steering Committee
26	Dr. (Ms.) Rina Sharma, Sc.EII	China	06.08.2007 11.08.2008	For APLAC Peer of CANAS, China
27	Dr..M.N. Kamlasanan, Sc.F	Singapore	02.08.2007 03.08.2007	To attend 10th Asian Symp. On Information Display at orchard.
28	Dr.S.N. Sharma, Sc.C	Singapore	01.07.2007 06.07.2007	To attend Int. Conference on Materials Technologies (ICMAT-2007).
29	Dr.V.P.S. Awana, Sc.C	Israel	06.09.2007 25.09.2007	To work under Prof. I. Felner at Raach .Institute. of Physics ,Hebrew University,Jerusalam under DST funded collaborative project " Synthesis & Characterization of Nano-Size grains of Ruthenocupretters & MgB_2 Superconductors"
30	Dr. Y.P. Singh, Sc. F	Sri Lanka	20.08.2007 25.08.2007	Under SAARC –PTB cooperation programme to provide training to the scientists of MUSSD in Temp. Mass & Length Standards
31	Sh.Tripurari Lal, Sc. F	Sri Lanka	20.08.2007 25.08.2007	Under SAARC –PTB cooperation programme to provide training to the scientists of MUSSD in Temp. Mass & Length Standards
32	Dr.K.P. Chaudhary, Sc.F	Sri Lanka	20.08.2007 25.08.2007	Under SAARC–PTB cooperation programme to provide training to the scientists of MUSSD in Temp. Mass & Length Standards
33	Dr. Mahavir Singh, Sc.EI	Spain	02.09.2007 06.09.2007	To attend the Triennial International Conf. On Acoustics(19th ICA 2007 Material) for oral paper presentation validity for calculation Method for Sound Triennial Loss
34	Dr.B.D. Malhotra, Sc.F	Korea	01.10.2007 06.10.2007	To deliver seminars on Recent advances on self assembled motolayer based Biosensors on conducting polymers based Biosensors under mutual research .and academic programme "NPL and Korea"
35	Dr.H.C. Kandpal, Sc.F	France	24.09.2007 27.09.2007	To attend a seminar on optics and photonics 2007 " OPTO-2007"
36	Dr.M.K. Tiwari, Sc.F	Canada	17.09.2007 19.09.2007	To attend the 20th START Scientific Committee meeting and CIDA/START Workshop on climate change .Risk Management

Appendix - 10, Visits Abroad

Sr. No.	Name & Designation	Country Visited	Duration	Purpose
37	Mr..S.P. Singh, Sc.C	Japan	01.10.2007 15.10.2007	To visit Kyushu Inst.of Technology under Indo-Japan Joint Project. Application of new Fundamental Polymers in Biosensor and nano-electronics.
38	Dr.Vikram Kumar, Director	Australia	28.10.2007 02.11.2007	As a member of the executive council APMP and Chairman of Developing Economy Committee(DEC) in 23rd APMP General Assembly and related activity.
39	Dr.A.K. Bandyopadhyay, Sc.G	Australia Malayasia	29.10.2007 07.11.2007	1)To attend the 23rd APMP meeting at Menzki,hotel, Sydney 2) To attend a workshop in Kualalampur
40	Dr.P.C. Kothari, Sc.G	Australia	28.10.2007 29.10.2007	To attend the 23rd APMP meeting at Menzki,hotel, Sydney.
41	Dr.P. Banerjee, Sc.G	Australia	28.10.2007 31.10.2007	To attend the 23rd APMP meeting at Menzki,hotel, Sydney.
42	Dr.A.K. Hanjura, Sc G	Australia	28.10.2007 31.10.2007	To attend the 23rd APMP meeting at Menzki,hotel, Sydney.
43	Dr.Prabhat Kr. Gupta, Sc.F	Australia	28.10.2007 31.10.2007	To attend the 23rd APMP meeting at Menzki,hotel, Sydney
44	Dr.Ranjana Mehrotra, Sc.F	Germany	12.10.2007 11.02.2008	To visit PTB Germany under INSA-DFG Exchange Programme
45	Dr.Vikram Kumar, Director	France	12.11.2007 16.11.2007	To attend 23rd General conference on Weights & Measures of National Metrology Instt. Directors.
46	Dr.Naveen Garg, Sc.B	Indonesia	19.11.2007 21.11.2007	To attend Workshop on "Microplane Pressure reciprocity calibration and its uncertainty analysis.
47	Mr. Saood Ahmad, Sc.C	Thailand	11.12.2007 14.12.2007	To attend Asia Pacific Microwave Conference for poster presentation
48	Dr.S.K. Titus, Sc.EI	Maxico	27.11.2007 01.12.2007	To attend the 1MEKO 20th TC3 3rd TC16 & 1st TC16 & 1st TC22 Int.Conf.2007 at Maxico
49	Dr.Anil Kr. Gupta, Sc.G	Singapore	17.12.2007 19.12.2007	To attend 16th Int.Conference on Processing and Fabrication of Advanced Materials (PFAM)
50	Dr.T.K .Mandal, Sc.C	China	20.11.2007 22.11.2007	To attend 2nd Joint CSIR-GSPC workshop on Ocean Processes in relation to changing climate in Asia Oceania.
51	Dr.Y.Nazeer Ahmmad	China	20.11.2007 22.11.2007	To attend 2nd Joint CSIR-GSPC workshop on Ocean Processes in relation to changing climate in Asia Oceania.
52	Dr.V.N. Ojha, Sc.F	Singapore	01.12.2007 05.12.2007	To attend 2nd PAC meeting of Nano – stand project TC-229

Appendix - 10, Visits Abroad

Sr. No.	Name & Designation	Country Visited	Duration	Purpose
53	Sh.Bharat Kumar Yadav, T.O.A	Singapore	10.12.2007 13.12.2007	To attend the 6th Int. Conference on Information, communication and signal processing(ICICS-227)
54	Dr. S.K. Dhawan , Sc. E-II	Taiwan	17.12.2007 21.12.2007	On the invitation of Prof.Ten-Chin Wen of National Cheng Kung , University for discussion and to deliver a talk in the area of Conducting Polymers.
55	Dr.M.N. Kamalasanan, Sc.F	China	26.12.2007 28.12.2007	To attend 2nd Joint Workshop on " Designing Materials through Nano technology" under the CSIR-NSFC S&T Cooperation .
56	Dr.V.N. Ojha , Sc.'F'	USA	26.02.2008 05.03.2008	To participate in the International Workshop on "Documentary Standards for Measurement and Characterization in Nanotechnologies at NIST,USA from 26th Feb to 28th Feb.2008.and 2) to visit NIST,USA laboratories from 29th to 5th March,2008
57	Dr.V.P.S. Awana, Sc.'C'	Japan	11.03.2008 02.04.2008	To visit NIMS, Japan from 11th March 2008 to 2nd April 2008 to present his work report in ICYS workshop (11th March 2008 -13th March 2008) and to do some experimental work related to high field magnetization of superconductors in Prof. Muromachi laboratory, NIMS for three weeks (14th March to 2nd April,2008)
58	Dr. Ram Kishore, Sc.F,	USA	01.03.2008 31.03.2008	To visit USA to visit Prof. Hammed A. Naseem, Professor of Electrical Engineering, Director, Arkansas Photovoltaic Research Centre, University of Arkansa, to work on Metal Induced Crystallisation Behaviour on Thin Films of Amorphous Silicon under DST-INSF collaborative project
59	Dr.Hari Kishan, Sc.F .	Israel	22.03.2008 30.03.2008	To work Prof. Felner's Laboratory at Racah Institute of Physics , Hebrew University, Jerusalam, Israel under Indo-Israel joint project entitled "Synthesis and Characterization of Nano Size Grains of Tuthenocuprates and MgB_2 Superconductors".
60	Dr Chhemendra Sharma, Sc.E-II	China	17.03.2008 20.03.2008	To China to participate as an SASCOM/SASRC representative in the "International Workshop on Anthropogenic Impact on Asian Monsoon"

Appendix - 10, Visits Abroad

Sr. No.	Name & Designation	Country Visited	Duration	Purpose
61	Dr.A.Sen Gupta , Sc.G.	Germany	30.03.2008 13.04.2008	To visit PTB, Germany to design and develop Cs frequency synthesis techniques and construction and evaluation of a laser cooled Cs foundation clock under the DST-DAAD project at PTB,DAAD, Braunschweig.
62	Sh.Prabhat K. Gupta , Sc.F	France	30.03.2008 04.04.2008	To visit BIPMP,France to attend CCQM-Working Group meeting on Gas Analysis(GAWG) at BIPM, Paris , excluding travel time.
63	Dr. Harish Bahadur, Sc.F	Korea	30.03.2008 15.05.2008	Under INSA-KOSEF Exchange programme

APPENDIX - 11

PhDs BASED ON THE RESEARCH WORK DONE AT NPL

Sr. No.	Title	Awardee	University/ Institute	Guide(s)
1.	Investigations of some optical techniques for Dimensional Measurements	K P Chaudhary	IIT Delhi	Prof. Chander Shekhar (IIT, DelhI) Prof. L. S. Tanwar (NSIT, N. Delhi)
2.	Modification of coal tar pitch for a reduced content of benzo-a-pyrene and preparation of fusible thermosetting composition from the modified pitch	Ms Sapna Kaushik	Delhi University	Dr. G. Bhatia (NPL), Dr. R.K.Khandal (SRI) Dr. G.L.Verma (DCE, DU).
3.	Memory Effect in Deformed Helix Ferroelectric and Electroclinic Liquid Crystal materials	Ms Sarabjot Kaur	Delhi University	Dr. A.M. Biradar (NPL) Prof. S. Annapurni (Delhi Univ.)
4.	Study of Interface Mixing by Swift Heavy Ions	Ms Diva	Dr. B.R. Ambedkar Univ. Agra , India	Dr. Ram Kishore (NPL) Dr. B.R. Awasthi (NSC, N. Delhi) Dr. R.S. Chauhan (B.R. Ambedkar Univ. Agra)
5.	Study of fluctuation induced conductivity and magnetic properties of nano-metal oxide doped MgB_2 superconductors	Intikhab Aalam Ansari	Jamia Millia Islamia, New Delhi	Dr. Hari Kishan (NPL) Dr. M. Shahabuddin (J.M.I., N. Delhi) Prof. M. Husain (J.M.I., N. Delhi)

APPENDIX - 12

HUMAN RESOURCE DEVELOPMENT ACTIVITIES

1. Organisation of External Training Courses

An important activity of the HRD Group is to organise Training Courses on various physical parameters in the area of Metrology / Standards, as well as on other specialised topics, and are primarily meant for personnel belonging to various industries, Testing & Calibration laboratories and other S & T organisations.

Fourteen (14) Training Courses on diverse topics of 'Force, Temperature, Pressure and Energy', 'AC & DC Electrical Measurements & Calibrations', 'Pressure & Vacuum Metrology', 'Photometry & Colorimetry', 'Dimensional Metrology', 'Mass Metrology', 'ISO-17025', etc., were organised by NPL, which were attended by a large number of personnel belonging to various national & international organisations, including a few from NPL also. This activity led to an ECF generation of Rs. 9.26 Lacs.

2. Formulation and Organisation of Internal Training Programmes

Besides the external training courses, efforts were also made to formulate new training programmes for the exclusive benefit and welfare of the NPL staff members. The basic objective was to provide the staff members good training in the area of relevance to their duties, so that they could perform in a more competent, productive and useful manner. Accordingly, 3 new training programmes were properly designed and executed also.

3. Dissemination of HRD-Related Information to NPL Staff Members

Dissemination of HRD-related information to the NPL staff members is another important task performed by the HRD Group.

More than 200 different types of HRD-related papers were displayed at 4-5 prominent places of the laboratory each, during the year 2007-2008.

4. Deputation of NPL Staff Members to Attend Conferences

NPL encourages and supports its staff members, including the floating members like JRFs, SRFs, PAs, RIs, RAs, SRAs, etc., to attend and present papers at national / international conferences / symposia / seminars / workshops, organised by different agencies in areas relevant to research activities being carried out at NPL. This is primarily meant to enable the staff members to put forward their views and research results before the leading national / international experts and interact with them on the latest developments in their research areas.

A large number of NPL scientists and other staff members (~400 cases) were deputed to participate in various conferences or similar events held in the country.

5. Placement, Ph.D. Registration and Other Support to Research Fellows

One of the most prominent activities of the HRD Group is to provide help and support to Research Fellows (JRFs / SRFs), starting from the time they join NPL till the time they leave NPL. This includes their placement in aparticular Division / Group and helping them in getting Hostel accommodation, if required. This also includes their Ph.D. registration, assessment for continuance / upgradation, deputation to attend conferences, etc. Seventeen (17) fresh Research Fellows were inspired to join NPL during the year 2007-2008.

6. Organisation of Students' Training at NPL

NPL provides both Short Term (Minimum Six Weeks to Six Months or so) and Long Term One Year or so) training to students pursuing M.Sc. / B.Tech. / M.Tech. / MCA, or their equivalent degree programmes, at different educational institutions spread all over the country. During the year 2007-2008, over 200 students were provided training, oriented towards the fulfillment of their academic degree requirements, in different areas of research.

7. Organisation of Institutional Visits to NPL

Organisation of institutional visits involving students / teachers / faculty members / personnel belonging to schools / colleges / universities / technical institutes / S&T organisations is an important activity of the HRD Group. The basic objective is to provide the visitors a glimpse of the activities and achievements of NPL, and thus enhance its visibility in the society. During the year 2007-2008, nine (9) institutional visits were organised by the HRD Group, which involved 247 persons and included prestigious institutions like IIT-Delhi, IILM-Ranchi, NITS-Noida and BHU-Varanasi.

8. Placement of Newly-Recruited Scientists 'B'/'C'

Co-ordination was done towards the placement of newly-recruited Scientists 'B'/'C' in a particular Division/Section. These scientists were made to undergo a 2-week Orientation Programme consisting of meeting senior scientists, including all DU / DP Leaders, and interacting with them on their research activities. This programme could be very helpful in their proper placement by the authorities as well as in their pursuit of research activities in the future.

9. Formulation of NPL Training Calendar 2008-2009

The formulation of 'NPL Training Calendar' and its communication to the prospective industries / laboratories / scientific institutions is the very first step towards the organization of Training Courses by the NPL. The NPL Training Calendar for the year 2008-2009 was formulated by the HRD Group in consultation with the concerned DU / DP Leaders, and sent to all the relevant parties.

10. Maintenance of NPL Human Resource Record

An important responsibility of the NPL's HRD Group is to maintain a record of its Human Resource in terms of Group I, Group II, Group III, Group IV and Administrative staff members w.r.t. their age & average age, highest qualification, gender, religion, caste, category, relative seniority and things like that. Besides this, the record of floating staff members, such as JRFs, SRFs, RAs, PAs, RIs, Emeritus Scientists, etc., is also maintained. In line with this responsibility, the record of NPL Human Resource was maintained, which was updated on monthly basis.

11. CSIR Foundation Day Celebrations - 2007 (NPL Open Day)

Efforts were made towards the updation and publication of NPL Brochures (NPL at a Glance) at the occasion of CSIR Foundation Day Celebrations - 2007 in the form of NPL Open Day on 26-September-2007.

12. Organisation of CSIR Programme on Youth for Leadership in Science (CPYLS) - 2007

The CPYLS programme for the year 2007 was organised by NPL at its premises on 23-24 January,

2008 with the joint efforts of the HRD Group and the Chairman, Academic Committee. It was attended by 29 bright young school children, and involved the inaugural lecture by Dr. B.R. Mehta, Professor of Physics, IIT-Delhi, in the emerging and fascinating area of Nano-Science & Nano-Technology, and the valedictory lecture by Mr. Anjali Rai Mehta, a prominent science journalist, on the topic "What Science is all about", besides various other lectures by the learned scientists of NPL on different topics.

13. Organisation of National Science Day - 2008 (Poster Presentation Symposium)

A Poster Presentation Symposium comprising poster presentation of the work carried out by the Research Fellows (JRFs/SRFs) was organised by NPL on 22nd February, 2008 as a novel way of celebrating the National Science Day - 2008. To make this symposium lively and attractive, 3 Best Poster Presentation Awards were instituted, which were later given to the Research Fellows selected for this purpose.

APPENDIX - 13

CONFERENCES, SYMPOSIA, WORKSHOPS AND EVENTS ORGANISED BY NPL

May 17, 2007

First Discussion meeting on Global Change CSIR Network Projects.

May 18, 2007

World Metrology Day and National Technology Day

May 28-29, 2007

First meeting of the Joint Working Group on R&D between NPL India and Immetre Brazil

July 13, 2007

मापिकी व गुणवत्ता प्रबंधन पर राश्ट्रीय संगोश्ठी

July 13, 2007

Workshop on Application of D.M.I. for Dimension Metrology

August 09, 2007

Seminar on Patent Search Analysis & Management

August 29, 2007

Diamond Jubilee Celebration at NPL with Mr Kapil Sibal, Minister of Science & Technology as Chief Guest.

Sept 26, 2007

CSIR Foundation Day Celebrations

Nov 14-16, 2007

IASTA – 2007 Conference

Jan 23-24, 2008

Organisation of CPYLS Programme - 2007

February 12, 2008

One day school on 'Science and Applications of Luminescent Materials' (SALM – 2008)

Feb 12-16, 2008

International Conference on Luminescence and its Applications (ICLA-2008)

Feb 18, 2008

Indo-Italian Workshop on Force

Feb 22, 2008

Organisation of Poster Presentation Symposium on the National Science Day - 2008

APPENDIX - 14

LECTURES ORGANIZED UNDER NPL SEMINAR SERIES

S.No.	Date	Speaker	Affiliation	Title of the talk
1.	31-08-07	Wlodzimierz Lewandowski	Time, frequency and gravimetry section BIPM	Satellite time-transfer: Recent developments and projects
2.	11-09-07	Pardeep Mohan	National Physical Laboratory, Dr. K. S. Krishnan Road, New Delhi- 110 012	Study of outgassing-related measurements in UHV system
3.	30-10-07	S.M. Shivaprasad	JNCASR, Bangalore	A new approach to the formation of compatible substrates for GaN growth
4.	21-11-07	Rajendra Bordia	Dept. of Material Science and Engg, University of Washington, Seattle, USA	Polymer derived nanostructured composite ceramics
5.	29-11-07	Mukunda P. Das	Department of Theoretical Physics, RSPhysSE Institute of Advanced Studies The Australian National University Canberra, ACT 0200Australia	Mesoscopic electron transport: Facts and fantasies
6.	12-12-07	Mitja Rosina	Professor Emeritus at the University of Ljubljana	Some curiosities of nature
7.	14-12-07	S T Lakshmikumar	National Physical Laboratory, Dr. K. S. Krishnan Road, New Delhi- 110 012	Nobel Prizes (2007) in Science : An Appreciation
8.	20-12-07	Jagdish Narayan	Fan Family Distinguished Chair Professor Department of Material Science and Eng.North Carolina State University Raleigh, NC 27695-7916, USA	Frontiers in nanomaterials and nanotechnology
9.	23-12-07	Mitsumasa Iwamoto	Department of Physical Electronics, Tokyo Institute of Technology2-12-1 o-Okayama, Meguro-ku, Tokyo 152-8552, Japan	Probing of carrier motion in pentacene films by optical second harmonic generation measurements

Appendix - 14, Lectures Organized Under NPL Seminar Series

S.No.	Date	Speaker	Affiliation	Title of the talk
10.	24-12-07	Mitsuyoshi Onoda	Department of Electrical Engineering and Computer Sciences, Graduate School of Engineering, University of Hyogo, 2167 Shosha, Himeji, Hyogo 671-2280, Japan	A proposal of molecularly doping methods for polymer devices: maskless dye diffusion technique
11.	24-12-07	Keiichi Kaneto	LSSE, Kyushu Institute of Technology, Kitakyushu, 808-0196, Japan	Field effect transistors and the light effects based on composite films of conducting polymers and fullerene derivatives
12.	14-02-08	Peter Kopcansky	Director, Institute of Experimental Physics, Slovak Academy of Sciences, Slovak	Magnetic Nano-fluids and their technical and Bio-medical applications

APPENDIX - 15

INVITED TALKS, LECTURES BY NPL SCIENTISTS

S.No.	Speaker's Name	Topic	Event and Venue
1.	A.K. Agrawal	i) Evaluation of Uncertainty in Chemical Measurements	National Symposium on Recent Advances in Analytical Sciences and Applications, Shimla, April 9-11, 2007
		ii) Precise and Accurate Measurement of Pollutants in Water	National conference on Environmental Pollution and Health: Problems and Solutions, New Delhi, April 19-20, 2007
		iii) Inductively Coupled Plasma Emission Spectrometer (ICPES)	User Awareness Programme on Materials Characterization Techniques, NPL, New Delhi, July 16-20, 2007
		iv) Quality System in Measurements and Certified reference Materials	Workshop on Technologies and Recent Advances in Residue Estimation of Pesticides, IPFT, Gurgaon, Haryana, September 25, 2007
		v) Importance and Requirements of Laboratory Accreditation System	Management Development Programme on Orientation, Maintenance & Repair of Analytical Equipment Sponsored by Ministry of External Affairs, Govt. of India at CSIO Regional Center, New Delhi & Chandigarh, March 03, 2008
2.	A.K. Srivastava	i) Advance techniques of electron microscopy for nanoanalysis including interfaces	National Conference on Electron Microscopy & Allied Fields and XXIX Annual Meeting of EMSI, New Delhi, India, November 26-28, 2007
		ii) Imaging and Spectroscopic Investigations of Nanoclusters Employing HRTEM, STEM and EELS	10th International Conference on Advanced Materials (IUMRS-ICAM 2007), Indian Institute of Science, Bangalore, India October 8-13, 2007
3.	Amish G. Joshi	Surface Science – A powerful technique for Nanotechnology	S. Venkateshwara. College, New Delhi, on 7th Nov.2007
4.	Anil K. Gupta	i) Overview of Nanoscience & Nanotechnology at NPL with special reference to Structural Applications	Theme Meeting on "Nanostructured Advanced Materials" National Metallurgical Laboratory, Jamshedpur, March 27- 29, 2008
		ii) Resurgence of Magnesium and its Alloys for Transport Applications	APAM (Asia Pacific Association for Materials) 19th Annual General Meeting (AGM) of Materials Research Society of India (MRSI, Trivandrum, February, 14-16, 2008

S.No.	Speaker's Name	Topic	Event and Venue
		iii) Mg & Al – based alloys for Automotive & Aerospace applications – R&D activities at NPL	National Conference on Advanced Materials for Aerospace and Defence applications at AMRITA Vishwa Vidyapeetham University, Coimbatore, January 7–9, 2008
		iv) Light Weight Metallic materials for automobile applications – Opportunities & Challenges	16th International Conference on: Processing and Fabrication of Advanced Materials, National University of Singapore (NUS), Singapore, December 17–19, 2007
		v) Journey to Materials	Indian National Science Academy, New Delhi, December 14, 2007.
		vi) Processing of Light-Weight Alloys with Special Reference to Mg-Alloys	International Conference on Advanced Materials and Composites (ICAMC-2007) held at NIIST (RRL), Thrivadrum, October 24–26, 2007
		vii) Novel Composite Development Activity at NPL for Strategic applications	10th International Conference on Advanced Materials (IUMRS-ICAM), IISc Bangalore, October 8-13, 2007
5.	Anil Kumar	Calibration of Universal Testing Machines	Presented at 2nd Indo-Italian Training Program in Force, Mass & Pressure, Feb. 18-22, 2008, NPL, New Delhi
6.	B.R.Chakraborty	i) Surface and Interface Analysis using Secondary Ion. Mass Spectrometry (SIMS) : Static SIMS	Lecture delivered at SSPL on 24.8.07 under the CEP Programme
		ii) Characterization of various Nanophosphors for doping distribution by TOF – SIMS and Laser SNMS	Invited talk delivered at the National Conf. On Nanomaterials & Nano-technology (NATCON NAMTECH 2007) 08-10 Dec. 2007, Lucknow University, Lucknow.
		iii) Application of TOF – SIMS and Laser SNMS for study of doping distribution in Nanophosphors.	Invited talk delivered in the Tenth Conference of International Academy of Physical Sciences (CONIAPS – X), Jan.12-14, 2008 at Guru Ghasidas University, Bilaspur, Chhattisgarh.
		iv) Secondary Ion Mass Spectrometry– Tool for characterizing Surfaces & Interfaces	Lecture delivered at the University of Delhi, Physics Deptt. under the Centre for Professional Development in Higher Education (UGC – ASC) Programme, on 16th January, 2008.
		v) Ion Solid interaction and use of SIMS for characterization of swift heavy ion induced mixing	Invited talk delivered at the 13th ISMAS Workshop cum Symposium held during 26-31st January, 2008 at BARC, Mumbai.

S.No.	Speaker's Name	Topic	Event and Venue
		vi) Use of Secondary Ion Mass Spectrometry for the Characterization of various Nanomaterials	Talk delivered at the National Seminar on Recent Advances in material science – RAM S08, during February 15-17, 2008 at the Indian School of Mines University, Dhanbad
7.	Bipin Kumar Gupta	i) Development of New phosphor Materials for Energy Saving Devices	National conference on Nano-materials and Nano-technology, 8-10 Dec.2007, Deptt. Of Physics, Lucknow University, Lucknow.
		ii) Applications of Carbon Nano-materials and Technology	- d o -
		iii) Hydrogen Energy – Alternate Solutions for India's Needs	National Conference on the Application of Material Science in Service of Society, 5th and 6th February 2008, C.M.P. Degree College, University of Allahabad.
8.	C Sharma	i) Preparation of national GHG inventories from Industrial Processes and Product Use (IPPU) Sector	invited talk and training provided to the participants of NATCOM-CII Training Meeting on IPPU Sector organized by the Confederation of Indian Industries (CII) at New Delhi on 25 January 2008
		ii) India's National Communication (NATCOM) Project	International Workshop on Climate Change & Its Impact on Flora in the South Asia Region, March 9-12, 2008 organized by the National Botanical Research Institute, Lucknow and South Asia Co-operative Environment Programme, Colombo, Sri Lanka at NBRI, Lucknow.
9.	C. Lal	Carbon Products for Electric Sliding Applications	National workshop on Modern Carbon products and processing, NPL, New-Delhi, 3rd March 2008
10.	D. Haranath	i) Band gap Engineering and Doping of ZnO and ZnOS Nanocrystals	International Conference on Luminescence and its Applications (ICLA-2008) held at National Physical Laboratory, New Delhi, India from February 13-16, 2008
		ii) Effect of Refractive Index of the Medium on the Luminescence of ZnO:Li Quantum Dot	International Conference on Advanced Materials and Applications (ICAMA-2007) held at Shivaji University Kolhapur, Maharashtra during November 15-17, 2007
		iii) Phosphors and Nanophosphors – Synthesis, Characterization and Applications	Michigan Technological University (MTU), Houghton, Michigan, USA on June 08, 2007.
11.	G. Bhagavannarayana	i) An introduction to high-resolution X-ray diffraction (HRXRD) methods to characterize as-grown & processed single crystals and epitaxial films	Invited talk delivered at a special seminar organized by Nesamony Memorial Christian College, Marthandam, Kanya Kumari, Tamil Nadu on 3-1-2008.

S.No.	Speaker's Name	Topic	Event and Venue
		ii) Characterization of single crystals, epitaxial films, quantum wells and porous silicon by high-resolution X-ray diffraction methods	Invited talk organized by Phys. Dept., Madurai Kamaraj University, Madurai, Tamil Nadu on 4-1-2008 under the UGC DRS programme.
		iii) Interesting correlations between crystalline perfection and SHG efficiency depending upon the size, concentration and nature of defects in NLO crystals	Invited talk delivered in National Conference on Advanced Materials, Devices and Technologies held at Dept. of Phys., Sri Venkateswara University, Tirupati during Feb. 20-22, 2008.
		iv) Characterization of as-grown and processed single crystals and epitaxial films by high-resolution X-ray diffraction methods	Invited talk delivered in "6th National Conference on Emerging Trends in Crystal Growth and Nano Materials" held at Dept. of Phys., Loyola College, Chennai during Feb. 28 & 29, 2008.
		v) Characterization of Epitaxial Films and Quantum Wells by High-resolution XRD, Raman and DXS measurement techniques	12th National Seminar on Crystal Growth held at Centre for Crystal Growth, SSN College of Engineering, SSN Nagar, Tamil Nadu during Dec. 21-23, 2007, Pg. 8.
12.	G. Bhagavannarayana S.K. Kushwaha, S. Parthiban and Subbiah Meenakshisundaram	Effect of dopants and complexating additives on crystalline perfection and SHG efficiency in NLO crystals	Seminar on Crystal Growth and Nanoscience held at Dept. of Phys., Aditanar College of Arts and Science, Tiruchendur, Tamil Nadu during 30th Aug. to 1st Sep., 2007,
13.	G. Bhatia	Carbon-ceramics composites for high temperature applications	6th International conference on high temperature ceramic matrix composites (HTCMC-6) and advanced ceramic materials and technologies for 21st century at India Habitat Center, New Delhi
14.	Govind	Adsorbate induced faceting of Rh (210) surface	American Physical Society, March meeting, New Orleans, Louisiana, USA, 10-14 March, 2008
15.	H. C. Kandpal	i) Optical Radiation Measurements	Defense Laboratory, Jodhpur, April 20, 2007.
		ii) Photometric Measurements and Problems	Central Inst. for Road Trans., Pune May 21, 2007.
		iii) Uncertainty in Photometric Measurements	VRDE, Ahmednagar, August 17, 2007
		iv) Photometric Measurements Problems and solution	GE, Apar, June 3,2007
		v) Measurements of focal length and uncertainty in measurement	OLF, Dehradun, June16, 2007
		vi) 8 lectures: Course on Photometry and Colorimetry	ARAI, Pune September 25-26, 2007

S.No.	Speaker's Name	Topic	Event and Venue
		vii) 10 lectures: Wave optics, Ray optics and experimental demonstrations of the optical phenomena by simple and very cost effective experiments	3 day Course to the Teachers of the Higher Secondary from South India at Navodaya Vidyalaya, Hyderabad, Sept 9-12, 2007
		viii) Coherence and intreferometry	Rajasthan University, April 12, 2007
		ix) Parametric fluorescence and its application in quantum metrology	Sopra, Paris, France
16.	Harish Bahadur	i) Nanostructural characteristics of thin films of ZnO: Structural property coorelationship"	International Conference on Advanced Materials and Applications (ICAMA - 2007), Shivaji Univ., Kolhapur, Nov. 2007.
		ii) ZnO structural property correlationship"	10th Conference of International Academy of Physical Sciences CONIAPS - X, Interdisciplinary approaches in Physical Sciences : growing Trends and Recent Advances, Dept. Pure & Appl. Phys., Guru Ghasidas Univ., Bilaspur Chattisgarh, Jan. 2008
17.	K. Nagarajan, C.K Shashidharan Nair and G. Bhagavannarayana	High-resolution X-ray diffraction, dielectric and birefringence studies on ZTS, NaAP and RbAP single crystals	12th National Seminar on Crystal Growth held at Centre for Crystal Growth, SSN College of Engineering, SSN Nagar, Tamil Nadu during Dec. 21-23, 2007,
18.	M.N. Kamalasanan	i) White Organic Light-Emitting Diodes Based on DCM Doped Zinc Complex	ASID Symposium, Singapore, 2-4 August 2007
		ii) Energy Transfer Processes in Polymer Light Emitting Diodes	India-China workshop of "Designing Materials through Nano-technology, Beijing, 27-28 December 2007
		iii) Tuning the Spectral Response of $Zn(hpb)_2$ by Optimal Doping of DCM Dye for White Organic Light Emitting Diodes	International Conf. For Luminescence and its Applications-2008, 13-16 February 2008, NPL, New Delhi
		iv) Some Recent Advances in Flexible Organic Electronic Devices	National Seminar on Photonic Polymers: Materials, Devices and Applications, BITS, Pilani, 3-4 April 2008
19.	Mahesh Kumar	Metal-semiconductor surfaces and interfaces	Seminar on Developments in Materials, High Energy and Nuclear Physics, on 20-21 February, 2008. JMI University Delhi
20.	N. Vijayan and G. Bhagavannarayana	i) Synthesis, growth and characterization analyses of L- threonine sodium nitrate	Regional level Seminar on Crystal Growth and Nanoscience held at Dept. of Physics, Aditanar College of Arts and Science, Tiruchendur, during 30, 31st August–1st September 2007

S.No.	Speaker's Name	Topic	Event and Venue
		ii) Studies on the electrical, thermal, structural and optical properties of glycine hydrofluoride and L-histidine bromide single crystals	12th National Seminar on Crystal Growth held at Centre for Crystal Growth, SSN College of Engineering, Kalavakkam during December 21-23, 2007
		iii) Growth and characterization analyses of some technologically important nonlinear optical single crystals by SEST, VBT and SR methods	National seminar on Crystal Growth of Nonlinear Optical Materials held at Dept. of Physics, National College, Tiruchirappalli during March 03-04, 2008
21.	P.K. Singh	i) Multi-crystalline Silicon Ingot Growth: Indian and the World Status	International Conference on Solar Cells, IC-SOLACE-2008, Cochin 21-23 January, 2008.
		ii) Photovoltaic: A Prospective	Seminar on Energy Materials and Systems, Anna University, Chennai 10-11 Jan 2008
22.	Prabhat K. Gupta	i) AAS	AAS: UAPMAT-07, July 16, 2007; NPL New Delhi
		ii) Gas Analysis	Gas Analysis: UAPMAT-07, July 17, 2007; NPL, New Delhi
		iii) Livestock GHG & environment,	Livestock GHG & environment, TROPNUTRICON07, Oct. 6, 2007, NDRI, Karnal
		iv) MiC and Indian scenario for trace gases & aerosols	MiC and Indian scenario for trace gases & aerosols, IASTA conf., Nov. 15-17, 2007, NPL, New Delhi
		v) Climate change and MiC issues	Climate change and MiC issues, NBRI, March 10, 2008, NBRI, Lucknow
23.	R S Dabas	Space Weather Predictions at NPL for Strategic Applications	National seminar on "Emerging Trends in Space and Aviation Meteorology" held on 18 – 19 February 2008 at Air Force auditorium, Subroto Park, New Delhi
24.	R.B. Mathur	i) Carbon components for fuel cell-their applications	National workshop on Modern Carbon products and processing, NPL, New-Delhi, 3rd March 2008
		ii) Fuel cell: Future source of clean energy	Refresher course in Physics and electronics; Centre for professional development in higher education, Delhi, University, 16th January, 2008
		iii) Development of Advanced Carbon products for Industrial and Energy Applications	Plasma Research group at Australian National University (ANU), Canberra, August 21, 2007
25.	Ranjana Mehrotra	i) Radiometric and Photometric Activities at NPL	PTB, Germany
		ii) Infrared Spectroscopy	CSIO, New Delhi, Sept. 2007

S.No.	Speaker's Name	Topic	Event and Venue
26.	Rashmi	X-ray Fluorescence Spectrometry in Characterization of Materials	User awareness programme on material characterization techniques, NPL, New Delhi, July 16- 20, 2007
27.	S K Sarkar	i) Characterization of non ionized media for radio wave propagation over the Indian subcontinent	Seminar on Recent advances on Planetary studies on 27 July, 07, held at Department of Physics, M C College, Barpeta, Assam
		ii) Precipitation phenomena in relation to radio wave propagation over India	Seminar on Recent advances on Planetary studies on 28 July, 07, held at Department of Physics, M C College, Barpeta, Assam
		iii) Radio climatology over India	Workshop on Radio Occultation Sounder Atmosphere held during 11-12 January, 08 at NARL, Gadanki, AP.
		iv) Radio environment in relation to clear air and its effects on radio wave propagation over India	Inst Radio Physics and Electronics, Kolkata during 10-16 March, 08
		v) Precipitation phenomena and its effects on microwave communication over India	-do-
28.	S.K. Dhawan	Designing of Conducting Polymers for Electrical/Electronic Industries	International Conf. On Advances in Polymer Science & Technology, Poly 2008, India Habitat Center, New Delhi, 28-30 January 2008
29.	S.K. Jain	i) Developments in resonant transducer technique for measurement of force and related quantities	Presented at XVI National symposium on Ultrasonics, Cochin University of Science & Technology, Kochi, Dec. 17-19, 2007
		ii) Tracability of force calibration at National Physical Laboratory	Presented at 2nd Indo-Italian Training Program in Force, Mass, Pressure, Feb. 18-22, 2008, NPL, New Delhi
30.	S.K.Halder	Characterization of Materials by Powder X-ray Diffraction Technique	User awareness programme on material characterization techniques, N.P.L., New Delhi, July 16- 20, 2007
31.	S.S.K. Titus	Calibration of Torque Wrenches	Presented at 2nd Indo-Italian Training Program in Force, Mass & Pressure, Feb. 18-22, 2008, NPL, New Delhi
32.	Sachchidanand Singh	Aggregating aerosols radiative forcing: Approaches and issues	IASTA-2007, conference at Delhi during November 14-16, 2007.
33.	Santa Chawla	Development of phosphors for white LED	International Conference on Luminescence and its Applications (ICLA-2008) held at National Physical Laboratory, New Delhi, India from February 13-16, 2008
34.	Shailesh N. Sharma	Towards Greener Nanosynthesis Of Core-Shell CdSe-ZnSe Quantum Dots	ICONTOX 2008, International Conference held at Lucknow during Feb 5-7th, 2008.

S.No.	Speaker's Name	Topic	Event and Venue
35.	T. Balakrishnan, G. Bhagavannarayana and K. Ramamurthi	Growth, structural, optical, thermal and mechanical properties of ammonium pentaborate single crystal	National seminar on recent advances in Materials Science held at Dept. of Physics, Cauvery College for Women, Tiruchirappalli during Feb. 15-16, 2008,
36.	T.L.Dhami	i) Carbon/Carbon Composites and their Applications"	Refresher Course in Physics and Electronics, Center for Professional Development in Higher Education, Delhi University, 10th January, 2008.
		ii) Thermal Management through Ceramic Materials	Sixth International Conference on High Temperature Ceramic Material Composites (HTCMC – 6) and Advanced Ceramic Materials and Technologies for 21st Century. Sep.4 – 7, 2007, New Delhi
		iii) Carbon-Carbon Composites as High Temperature Materials	Indo – Japan Workshop on Microstructural Performance of High Temperature Composites, Jan.15 – 17, 2007, BHU
		iv) Nuclear Energy – Role of Carbon Materials	op on "Modern Carbon Products and Processing" 3rd March, 2008, ICS, NPL, N Delhi.
37.	Tripurari Lal	i) Calibration of Volumetric Measurement Apparatus.	In Seminar on "Calibration & Testing for Quality Assurance of the Products" organized by CGCRI Khurja Centre under WWCD Project - 5th September 2007
		ii) Balances & Their Operation, Maintenace & Calibration	During Management Development Program on Operation, Maintenance & Repair of Analytical Equipment under ITEC/SCAAP Program sponsored by Ministry of External Affairs, New Delhi organized by CSIO New Delhi, 13th Feb. to 8th April 2008.
38.	V.P.S. Awana	i) Superconductivity of various Borides	Invited talk at IUAC-New Delhi, 4th Feb. 2008
		ii) Magnetic structure of Rutheno-cuprates	Invited talk at ICYS-NIMS-JAPAN, 11th Mar. 2008
39.	Vikram Kumar	i) Inaugural address	IETE seminar at IETE, New Delhi on 7th May 2007
		ii) Importance of Calibration and Testing & its impact on Quality in our country and effect on our daily life	Defence Institute of Physiology and allied Sciences (DIPAS), New Delhi on 14th May 2007
		iii) Nanometrology	मापिकी व गुणवत्ता प्रबंधन पर राश्ट्रीय संगोश्ठी National Physical Laboratory, New Delhi on 11th July 2007
		iv) Nanometrology for the new world of Nanotechnology	User Awareness Programme of Material Characterization National Physical Laboratory, New Delhi on 16th July 2007

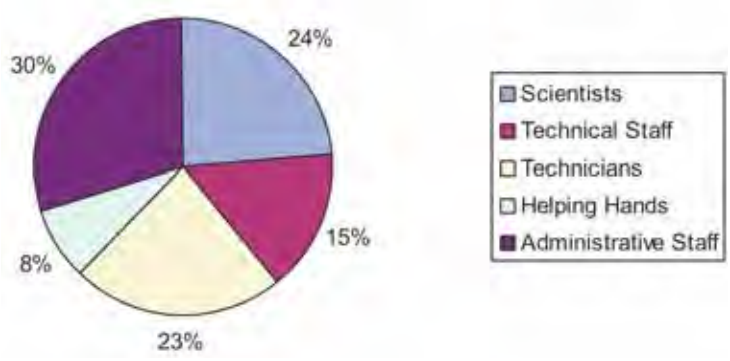
S.No.	Speaker's Name	Topic	Event and Venue
		v) MEMS & Microsensors	2nd Chinese – India workshop on Microelectro-Mechanical system at North China University, China Resources Hotel, Beijing on 5th August 2007
		vi) Overview of MEMS in India	International Symposium on Test & Measurements North China University, China Resources Hotel, Beijing on 6th August 2007
		vii) Nanotechnology – An overview	Sri Venkateshwara College, New Delhi on 15th September 2007
		viii) Nanotechnology and Nanometrology @ NPLI	International Workshop on Nanometrology, National Physical Laboratory, New Delhi on 19th October 2007
		ix) Role of Standardization in Nanotechnology	Bangalore Nano 2007 conference held on 6th December 2007
		x) Inaugural address	National conference on Nanomaterials & Nanotechnologies University of Lucknow, Lucknow on 8th December 2007
		xi) Inaugural address	International Conference on Sensors, signal processing, communication control & Instrumentation, Vishwakarma Institute of Technology, Pune on 3rd January 2008
		xii) Inaugural address	National seminar on Nanomaterials and Devices Jamia Milia Islamia, New Delhi on 30th January 2008

APPENDIX - 16

HUMAN RESOURCE

As on March 31, 2008

GROUP IV			**GROUP II**	**Sub-Total**	**195**
Director		1			
Scientist G		10	**GROUP I**	**Sub-Total**	**68**
Scientist F		78			
Scientist EII		36	ADMN-A		8
Scientist EI		24	ADMN-B		83
Scientist C		32	ADMN-C		55
Scientist B		29	ADMN-C (Cafeteria Staff)		11
	Sub-Total :	**210**	ADMN-D		99
			ADMN-D (Cafeteria Staff)		11
GROUP III				**Sub-Total :**	**267**
Tech. Ofcr (E-II)		5		**GRAND TOTAL**	**866**
Tech. Ofcr (E-I)		18			
Supt. Engineer		1			
Tech. Ofcr (C)		34			
Tech. Ofcr (B)		14			
Tech. Ofcr (A)		8			
Sr. Tech. Asst.		10			
Tech.. Asst. VIII		35			
Junior Engineer		1			
	Sub-Total :	**126**			



SCIENTISTS AND OFFICERS AS ON 31.03.2008

Director
Dr Vikram Kumar

Name	Designation
Physico-Mechanical Standards	
Head : Dr Kamlesh Kumar Jain	
Dr Kamlesh Kumar Jain	Scientist G
Dr Ashis Kumar Bandhyopadhyay	Scientist G
Dr Ashok Kumar	Scientist F
Sh H N P Poddar	Scientist F
Dr Bhim Sain Gera	Scientist F
Dr Desh Raj Sharma	Scientist F
Dr Sushil Kumar Jain	Scientist F
Dr Pardeep Mohan	Scientist F
Dr Hem Chandra Kandpal	Scientist F
Sh Tripurari Lal	Scientist F
Sh B V Kumaraswamy	Scientist F
Sh Omkar Sharma	Scientist F
Dr Rakesh Kumar Garg	Scientist F
Sh Subodh Kumar Singhal	Scientist F
Sh K P Chaudhary	Scientist F
Dr Yesh Pal Singh	Scientist F
Sh Anil Kumar	Scientist F
Dr (Ms) Ranjana Mehrotra	Scientist F
Dr Mukesh Chandra	Scientist EII
Sh Navin Kumar Srivastava	Scientist EII
Sh Raj Singh	Scientist EII
Dr Sanjeev Sinha	Scientist EI
Dr Mahavir Singh	Scientist EI
Dr (Ms) Rina Sharma	Scientist EI
Sh D Arun Vijayakumar	Scientist EI

Appendix - 16, Human Resource

Name	Designation
Dr Sanjay Yadav	Scientist EI
Dr (Ms) Nita Dilawar	Scientist EI
Dr S Seela Kumar Titus	Scientist EI
Sh Rajesh Kumar	Scientist C
Sh Gautam Mandal	Scientist C
Sh Naveen Garg	Scientist B
Ms Sumitra Singh	Scientist B
Sh C K Gopan	Scientist B
Dr Parag Sharma	Scientist B
Sh Harish Kumar	Scientist B
Sh Virendra Babu	Tech Ofcr (EII)
Sh Ravi Khanna	Tech Ofcr (EII)
Sh Jagdish Kumar Gupta	Tech Ofcr (EII)
Sh Jai Bhagwan	Tech Ofcr (EI)
Sh Gurbir Singh	Tech Ofcr (EI)
Mrs Reeta Gupta	Tech Ofcr (EI)
Dr Yudhisther Kumar Yadav	Tech Ofcr (EI)
Sh T K Parameshwaran	Tech Ofcr (C)
Sh Gurcharanjit Singh	Tech Ofcr (C)
Sh V K Ojha	Tech Ofcr (C)
Sh Ishwar Singh Taak	Tech Ofcr (C)
Sh Gurdeep Singh Lamba	Tech Ofcr (C)
Sh Bhikham Singh	Tech Ofcr (C)
Sh Mukesh Kumar	Tech Ofcr (B)
Sh K N Basavaraju	Tech Ofcr (B)
Sh Sudama	Tech Ofcr (B)
Sh Mahargha Baran Das	Tech Ofcr (B)
Sh Bharat Kumar Yadav	Tech Ofcr (A)
Sh Harish Kumar	Tech Ofcr (A)

Electrical & Electronic Standards
Head: Dr Prafulla Chandra Kothari

Name	Designation
Dr Prafulla Chandra Kothari	Scientist G
Dr P Banerjee	Scientist G
Dr Amitava Sengupta	Scientist G
Dr G M Saxena	Scientist F
Dr Ashok Kumar Hanjura	Scientist F
Dr Vijay Narain Ojha	Scientist F
Dr Sita Ram Gupta	Scientist F
Sh Anil Kumar Govil	Scientist F
Sh Mukesh Kumar Mittal	Scientist F
Sh T Raghvendra	Scientist F
Sh Anil Kishore Saxena	Scientist F
Dr R K Kotnala	Scientist F
Sh Pramendra Singh Negi	Scientist F
Sh Ritander Aggarwal	Scientist EII
Dr. Vijay Kumar Gumber	Scientist EII
Mrs Arundhati Chatterjee	Scientist EII
Dr Neeraj Khare	Scientist EII
Sh Kavindra Pant	Scientist EII
Sh M P Singh	Scientist EII
Sh H R Singh	Scientist EII
Sh Ajeet Singh	Scientist EI
Sh Joges Chandra Biswas	Scientist EI
Sh Rajbeer Singh	Scientist EI
Dr Hari Krishna Singh	Scientist EI
Sh Shiv Kumar Jaiswal	Scientist C
Ms Manju Singh	Scientist C
Dr Ashish Agarwal	Scientist C
Dr R P Aloysius	Scientist C

Name	Designation
Sh Saood Ahmed	Scientist C
Sh Chockalingam Sreekumar	Scientist B
Sh Kamlesh Kumar Patel	Scientist B
Sh Mukesh Kumar Alaria	Scientist B
Ms Pranalee Premdas	Scientist B
Sh Anil Kumar Suri	Tech Ofcr (EI)
Sh Kul Bhushan Ravat	Tech Ofcr (EI)
Sh Mohammad Saleem	Tech Ofcr (C)
Sh Avdhesh Kumar Goel	Tech Ofcr (C)
Sh Bijendra Pal	Tech Ofcr (B)
Sh Sridhar Lingam	Tech Ofcr (A)
Ms Poonam Sethi Bist	Tech Ofcr (A)

Engineering Materials
Head: Dr Anil Kumar Gupta

Name	Designation
Dr Anil Kumar Gupta	Scientist G
Dr Sukhmal Chand Jain	Scientist G
Dr Sukhwant Singh Bawa	Scientist G
Dr Gopal Bhatia	Scientist G
Dr Rakesh Behari Mathur	Scientist F
Dr M N Kamalasanan	Scientist F
Dr Ashok Manikrao Biradar	Scientist F
Dr Suresh Chand	Scientist F
Dr Tarsem Lal Dhami	Scientist F
Dr Bansi Dhar Malhotra	Scientist F
Sh Ramesh Chandra Anandani	Scientist F
Dr Sunil Kumar Singhal	Scientist F
Dr Chhotey Lal	Scientist F
Dr Rajeev Chopra	Scientist F

Appendix - 16, Human Resource

Name	Designation
Dr Krishan Kumar Saini	Scientist F
Dr Tushya Kumar Saxena	Scientist EII
Dr Ajay Dhar	Scientist EII
Dr S K Dhawan	Scientist EII
Dr R K Sharma	Scientist EII
Sh Sudhanshu Dwivedi	Scientist EII
Sh Sanjay Rangnate Dhakate	Scientist EI
Dr(Ms) Ritu Srivastava	Scientist C
Sh Vipin Jain	Scientist C
Dr Surendra Pal Singh	Scientist C
Dr (Ms) G Sumana Gajala	Scientist C
Sh Ashok Kumar	Scientist B
Dr R G Mathur	Scientist B
Sh. Bhanu Pratap Singh	Scientist B
Sh Pankaj Kumar	Scientist B
Sh Bathula Sivaiah	Scientist B
Sh M Sarvanan	Scientist B
Ms Priunka Heda Maheshwari	Scientist B
Sh Rajiv Sikand	Tech Ofcr (EI)
Sh Pinaki Ranjan Sengupta	Tech Ofcr (EI)
Sh Gauri Datt Sharma	Tech Ofcr (C)
Sh Rakesh Khanna	Tech Ofcr (C)
Sh Chander Kant	Tech Ofcr (C)
Sh Jokhan Ram	Tech Ofcr (C)
Sh Rajesh Kumar Seth	Tech Ofcr (B)
Sh Vinod Kumar Tanwar	Tech Ofcr (A)

Electronic Materials
Head: Dr S T Lakshmikumar

Name	Designation
Dr S T Lakshmikumar	Scientist F
Dr Amitabha Basu	Scientist F
Dr Virendra Shanker	Scientist F
Dr Ramadhar Singh	Scientist F
Dr Bidhan Chandra Chakravarty	Scientist F
Dr Parakram Kumar Singh	Scientist F
Dr Omvir Singh Panwar	Scientist F
Dr S M Shivaprasad	Scientist F
Dr Sher Singh Rajput	Scientist F
Dr (Ms) Meenakshi Kar	Scientist EII
Dr (Ms) Kiran Jain	Scientist EII
Dr (Ms) Santa Chawla	Scientist EII
Sh C M S Rauthan	Scientist EII
Dr K M K Srivatsa	Scientist EII
Dr Abdul Mobin	Scientist EII
Dr Narinder Kumar Arora	Scientist EI
Dr T D Senguttuvan	Scientist EI
Mrs Santosh Singh	Scientist C
Dr Shailesh Narayan Sharma	Scientist C
Dr Amish G Joshi	Scientist C
Dr(Ms) Gurusharan Kaur Padam	Scientist C
Dr Sushil Kumar	Scientist C
Dr Divi Haranath	Scientist C
Dr Govind	Scientist C
Dr(Ms)M Deepa	Scientist C
Sh Mahesh Kumar	Scientist B
Sh Sanjay Kumar Srivastava	Scientist B
Dr Bipin Kumar Gupta	Scientist B

Materials Characterization
Head: Dr Bibhash Ranjan Chakraborty

Name	Designation
Dr Bibhash Ranjan Chakraborty	Scientist F
Dr Sujit Kumar Halder	Scientist F
Dr Godavarthi Bhagavannarayana	Scientist F
Dr Ram Kishore	Scientist F
Sh Prabhat Kumar Gupta	Scientist F
Dr Harish Bahadur	Scientist F
Dr (Ms) Rashmi	Scientist F
Dr Devinder Gupta	Scientist EII
Dr Rajendra Prasad Pant	Scientist EII
Dr Sukhvir Singh	Scientist EI
Dr Avanish K Srivastava	Scientist EI
Ms Renu Pasricha	Scientist EI
Dr Kamlesh Kumar Maurya	Scientist C
Dr (Ms) Prabha Johri	Scientist C
Dr Nirmalya Karar	Scientist C
Dr Nahar Singh	Scientist B
Sh.Parveen Saini	Scientist B
Sh N Vijayan	Scientist B
Dr (Ms) Sushree Swarupa Tripathy	Scientist B
Dr (Ms) Daya Soni	Scientist B
Sh Niranjan Singh	Tech Ofcr (EI)
Dr (Ms) Manju Arora	Tech Ofcr (EI)
Dr Dharam Pal Singh	Tech Ofcr (EI)
Sh Kedar Nath Sood	Tech Ofcr (C)
Sh Rajiv Kumar Saxena	Tech Ofcr (C)
Ms Abha Bhatnagar	Tech Ofcr (B)

Radio & Atmospheric Sciences
Head: Dr M K Tiwari

Name	Designation
Dr M K Tiwari	Scientist F
Dr P K Banerjee	Scientist F
Dr Swapan Kumar Sarkar	Scientist F
Dr Pradeep Kumar Pasricha	Scientist F
Dr P N Vijayakumar	Scientist F
Dr Raj Singh Dabas	Scientist F
Dr Mahendra Kumar Goel	Scientist F
Dr Bhuwan Chandra Arya	Scientist F
Dr M S V N Prasad	Scientist F
Sh Pattamatta Subrahmanyam	Scientist F
Ms Madhu Bahl	Scientist F
Sh Narendra Kumar Sethi	Scientist F
Sh H K Maini	Scientist F
Sh Thomas John	Scientist F
Sh Deo Raj Nakra	Scientist F
Ms Parvati Chopra	Scientist EII
Dr (Ms) Meena Jain	Scientist EII
Dr Chhemendra Sharma	Scientist EII
Sh Randhir Singh Tanwar	Scientist EI
Ms Anuradha Sengar	Scientist EI
Dr Tuhin Mandal	Scientist EI
Dr Sachidanand Singh	Scientist EI
Dr Y Nazeer Ahammed	Scientist C
Dr Arun Kumar Upadhyay	Scientist C
Dr Kirti Soni	Scientist B
Dr Sudhir Kumar Sharma	Scientist B
Sh K G M Pillai	Tech Ofcr (EI)
Sh Iqbal Ahmed	Tech Ofcr (EI)

Appendix - 16, Human Resource

Name	Designation
Ms Shiv Kumari Bhatia	Tech Ofcr (C)
Sh Arun Kumar Ghoghar	Tech Ofcr (C)
Sh Shambhu Nath	Tech Ofcr (C)
Ms Beena Gupta	Tech Ofcr (C)
Sh Vinod Kumar Sharma	Tech Ofcr (C)
Sh Man Mohan Gupta	Tech Ofcr (C)
Ms K Ratnamala	Tech Ofcr (B)
Sh Alok Mukherjee	Tech Ofcr (A)

Superconductivity & Cryogenics
Head: Dr Hari Kishan

Name	Designation
Dr Hari Kishan	Scientist F
Dr Ratan Lal	Scientist EII
Dr S K Agarwal	Scientist EII
Dr (Ms) P L Upadhyay	Scientist EII
Dr Anurag Gupta	Scientist EI
Sh M A Ansari	Scientist EI
Sh Man Mohan Krishna	Scientist C
Dr Veerpal Singh Awana	Scientist C
Sh Rajendra Singh Meena	Scientist C
Sh S B Samanta	Tech Ofcr (EII)
Sh Mohan Chandra Singh	Tech Ofcr (C)
Sh Jai Pal Singh	Tech Ofcr (B)

Director's Office
Head: Dr Vikram Kumar

Name	Designation
Dr Vikram Kumar	Director
Sh Rajan Babu Saxena	Scientist F
Ms Shikha Mandal	Scientist F
Dr (Ms) S Niranjana N Goswami	Scientist EII
Sh Virendra Kumar Jaiswal	Scientist C
Sh Vishwa Deepak Arora	Tech Ofcr (EI)

Library
Head: Sh Deepak Kumar Tewari

Name	Designation
Sh Deepak Kumar Tewari	Scientist F
Sh N K Wadhwa	Scientist EI
Sh Hasan Haider	Tech Ofcr (EI)
Sh Jagdish Prasad	Tech Ofcr (C)
Sh Rajpal Zamaji Walke	Tech Ofcr (B)

Scientific Support Services
Head: Dr V T Chitnis

Name	Designation
Dr V T Chitnis	Scientist G
Dr R K Aggarwal	Scientist F
Sh S Uma Maheshwar Rao	Scientist F
Sh Narinder Kumar Babbar	Scientist F
Sh P L Pasricha	Scientist EII
Sh Ganga Prasad	Scientist EII
Dr (Ms) Jyoti Lata Pandey	Scientist EII
Sh Sushil Kumar Sharma	Scientist EII
Ms Indra Tiwari	Scientist EII
Dr D P Bhatt	Scientist EII
Ms Shashi Lekha Bhatnagar	Tech Ofcr (EI)
Sh S K Rastogi	Tech Ofcr (C)
Sh Ashwani Kumar Suri	Tech Ofcr (C)
Sh Jagan Nath Prasad	Tech Ofcr (C)
Sh Lalit Jain	Tech Ofcr (C)
Sh Amar Singh	Tech Ofcr (A)

Technical Support Services
Head: Dr Jagdish Chandra Sharma

Name	Designation
Dr Jagdish Chandra Sharma	Scientist F
Sh Dharam Jit Singh	Supt. Engnr.(Civil)
Sh J B Soni	Tech Ofcr (EI)
Sh Deepak Bansal	Tech Ofcr (C)
Sh Prabhu Shankar Tripathi	Tech Ofcr (C)
Sh Rambir Singh	Tech Ofcr (A)

Workshop & GTU
Head: Sh Surendra Singh Verma

Name	Designation
Sh Surendra Singh Verma	Scientist F
Sh P Srinivasan	Scientist C

Head: Dr Ravi Mehrotra
Central Computer Facility

Name	Designation
Dr Ravi Mehrotra	Scientist F
Ms Deepti Chaddha	Scientist C
Sh Ashish Ranjan	Scientist C
Sh Nitin Sharma	Scientist C
Sh Trilok Bhardwaj	Scientist B
Sh Ashok Kumar	Tech Ofcr (C)
Sh Vijay Sharma	Tech Ofcr (C)
Sh Kanwaljit Singh	Tech Ofcr (B)

Head: Sh R P Sharma
Administration & House Keeping

Name	Designation
Sh R P Sharma	COA
Sh S K Mehta	F & A O
Sh Sudipto Chaterjee	F & A O
Sh Prem Singh	SPO
Sh Mukesh Khanna	SPO
Dr (Ms) Shakuntala Sharma	Sr Hindi Officer
Ms Veena Jain	Admn. Ofcr
Sh Vijay Kumar	Sr Security Ofcr
Sh Surendra Kumar	S O (str & pur)
Sh Bhag Singh	S O (str & pur)
Sh S K Thakur	SO (F&A)
Sh Upendra Kumar	SO (F&A)
Sh Umesh Gupta	SO(G)
Sh Balraj Singh	SO(G)
Sh Rajiv Sharma	SO(G)
Sh M C Meena	SO(G)
Sh Vikram Singh	SO(G)

Sh Mange Ram	PS
Ms Paramjit Kaur	PS
Sh Inder Jeet Taneja	PS
Ms Gulshan Arora	PS
Ms Santosh Sharma	PS
Sh Amar Singh	PS
Sh Ram Gopal Meena	PS
Sh Indrajeet	PS

Retired Persons

Sh Satish Kumar Nijhawan, Tech Ofcr (EI)

Dr Harish Chander, Scientist F

Dr (Ms) Vasantha Raman, Scientist F

Sh Lakhpat Singh, Sr Security Ofcr

Sh Ved Prakash, Gr II(4)

Sh Subhash Chandra Gera, Scientist F

Sh Gyan Chand, SO (F&A)

Sh J Thankappan, Gr II(4)

Dr Vijay Kumar Pandey, Scientist F

Sh Nathu Ram Balmiki, Daftry (ACP)

Sh Rai Singh, Gr II(4)

Sh P Uma Maheshwar Reddy, Gr II(4)

Dr Mahendra Mohan (Srivastava), Scientist F

Sh Vishram Sing Yadav, Tech Ofcr (C)

Dr Vellur Mohanan, Scientist G

Dr Raghunandan Prasad Singhal, Scientist G

Dr Prakash Narain Dixit, Scientist F

Dr S K Gupta, Scientist F

Sh Gabar Singh, Workshop Asstt VII

Dr Radhe Shyam Arora, Scientist F

Dr Mohan Lal, Scientist F

Sh Jagdish Prasad, Gr II(4)

Sh P S Gaira, Asstt. (G) Grade-1

Dr S D Sharma, Scientist F

Sh Vinod Kumar Oberoi, GrII(4)

Sh Pritam Singh, Gr II(4)

Mrs Swatantra Bahl, Asst (G) Grade II

Sh Ashwani Kumar, Gr II(4)

Sh Vijay Kumar Rustagi, Scientist F

Sh Ram Phal (II), Sec Grd

Sh Sher Singh Bhandari, Sr Mech Asstt

Sh Kartar Singh, Workshop Asstt VII

Sh M K Banerjee, Tech Ofcr (EI)

Dr Arun Kumar Agrawal, Scientist F

Sh Mahavir Singh, Jr Sec Grd (ACP)

Sh Mohinder Kr. Chhibber, Tech Ofcr (EI)

Sh M P Nagrath, Gr II(4)

Sh Banwari Lal, Security Asstt Gr I

Dr Shiv Nath Singh, Scientist G

Sh V P Sharma, Gr II(4)

Sh Tushar Kanti Chakravarty, Scientist EII

Sh Daulat Ram, Sec Grd

Sh Dhan Singh Chaunal, Tech Ofcr (C)

Sh Naib Singh, Scientist EII

Sh Ram Kishan I, Workshop Asstt VII

Sh Jai Bhagwan, Gr II(4)

Obituaries

Sh Gauri Shankar Giri, Gr II(4)

Sh Ramesh Kohli, Tech Ofcr (B)

Ms Jagnit Kaur Sahani, Asstt (G) Grade 1

Sh Bhim Singh Yadav, Gr II(4)

Sh Dharmendra Kr., Asstt (Str & Pur) Grad 1

Ms Manjulika Mathur, Asstt (Str & Pur) Grad 1

Scientists Fellow & Emeritus Scientists

Dr Ashok Kumar Gupta, Emeritus Sci

Dr B S Mathur, Emeritus Sci

Dr O P Bahl, Emeritus Sci

Dr P K Ghosh, Emeritus Sci

Dr U N Sinha, Emeritus Sci

Dr Subhash Chandra, Emeritus Sci

Sh S C Garg, Emeritus Sci

Dr R Bhattachryya, Emeritus Sci

Dr S L Jain, Emeritus Sci

Dr Lakha Singh, Emeritus Sci

Dr Vinod Kumar Jain, Emeritus Sci

Dr V Mohanan, Emeritus Sci

Dr S K Joshi, Platinum Jub. Emr. Sci

Dr A R Varma, INSA Hony Sci

Dr K K Mahajan, INSA Sr Sci

Dr Krishan Lal, INSA Sr Sci

Sh Dharam Pal Singh, Rajiv Gandhi Fellow

Dr Marshal, Scientist Fellow

Sh Joseph Sunday Ojo, CSIR TWAS Fellow

Dr Vikram Soni, Research Sci C

Research Associates/Fellows/ Interns

Sh Vinod Kumar Chahar, JRF (CSIR, NPL)

Sh Annveer, JRF (CSIR,NPL)

Sh Feroz Khan, JRF (CSIR-UGC)

Ms Zimple Matharu, JRF (CSIR-UGC)

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Sh Dinesh Kumar, JRF (CSIR-UGC)

Ms Chetna Dhand, JRF (CSIR-UGC)

Ms Sweta Bhandari, JRF (CSIR-UGC)

Sh Bikash Ghosal, JRF (GATE)

Sh Deepak Kumar Jangir, JRF (ICMR)

Sh Jitesh K, JRF (UGC-NPL)

Sh Ajay Kumar, JRF (UGC-NPL)

Sh Vibhav Pandey, JRF (CSIR)

Sh Manoj Kesaria, JRF (CSIR)

Sh Hemant Kumar, JRF (CSIR)

Ms Monika, JRF (CSIR)

Sh Nandan Singh, JRF (CSIR)

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Sh Arunandan Kumar, JRF (CSIR)

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Dr Sushri Pratima, Sr. Res. Assoc.
Dr Manoj Kumar Srivastava, Sr Res Assoc.
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Dr(Ms) Nupur Bahadur, Young Scientist-P.I.
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Sh Ravinder Singh Parmar, RA
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Sh Sunil Dutta Sharma, RA
Ms Amita Verma, RA
Ms Vibha Srivastava, RA
Dr Ashok Kumar, RA
Ms Puja Goel, RA
Ms Suman Sharma, RA
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Dr Anees Ahmad, RA
Dr (Ms) Punita Singh, RA
Ms Sonal, Res. Intern
Ms Jyoti Shah, Res. Intern
Mohd. Imran Ansari, Res. Intern
Ms Manisha, Res. Intern
Ms Anu Rana, Res. Intern
Sh Virendra K. Rai, Res. Intern
Sh Anand Dev Tewari, Res. Intern
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Sh Amrendra Anand, Res. Intern
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Sh Neeraj Dwivedi, Res. Intern
Sh Deepak Chhikra, Res. Intern
Sh Mahesh Chand, Res. Intern
Sh Dalip Sharma, Res. Intern
Sh Suresh Kumar Patel, Res. Intern
Ms Gunjan Mittal, Res. Intern
Ms Vasudha Agarwal, Res. Intern
Ms Anjali Sharma, Res. Intern
Ms Tanvi Vats, Res. Intern
Ms Priyanka, SRF
Sh Sanjay Kumar, SRF
Sh Neeraj Panwar, SRF
Sh Bhaskar Gahtori, SRF
Ms Taranuum Bano, SRF (CSIR)
Ms Vandana Gupta, SRF (CSIR)
Sh Pavan S Kulkarni, SRF (CSIR)
Ms Kavita Arora, SRF (CSIR)
Sh Bhupendra Singh, SRF (CSIR)
Ms Diva, SRF (CSIR)
Sh Vivek Kumar Varma, SRF (CSIR-UGC)
Ms Hema Bhandari, SRF (CSIR-UGC)
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Sh Vikram Sen, SRF (NET)
Sh Anil Ohlan, SRF (NET)-CSIR
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Sh Sunil Kumar Arya, SRF (CSIR)
Sh Shivraj Sahay, SRF (CSIR)

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Sh Arindam Datta, SRF (CSIR)	Sh Trailokya Saud, SRF (NPL)
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Ms Swati Raman, SRF (CSIR)	Ms Monu Dahuja, SRF (NPL)
Sh Atif Khan, SRF (CSIR)	Ms Nirmal Prabhakar, SRF-NET (UGC)
Sh Rajesh Kumar, SRF(CSIR)	Sh Rahul Tripathi, SRF-UGC

APPENDIX - 17

RESEARCH AND MANAGEMENT COUNCILS

Research Council
(01.04.2007 - 31.03.2008)

01.	Prof Ajay Kumar Sood … … … … Chairman, Division of Physical and Mathematical Sciences, Department of Physics, Indian Institute of Science, BANGALORE - 560 012	Chairman,
02.	Prof S S Jha … … … … Distinguished G. Professor Department of Physics Indian Institute of Technology Powai MUMBAI - 400 076	Member (External)
03.	Dr V C Sahni … … ... … Director Raja Ramanna Centre for Advanced Technology Department of Atomic Energy Govt. of India INDORE – 452 013 **And** Director Physics Group Bhabha Atomic Research Centre (BARC) MUMBAI – 400 085	Member
04.	Prof G K Mehta … … … … Distinguished Honorary Professor IIT-K Inter University Accelerator Centre, Aruna Asaf Ali Marg, NEW DELHI - 110 067	Member
05.	Prof B M Arora … … … … Professor Tata Institute of Fundamental Research (TIFR) Homi Bhabha Road, Colaba MUMBAI - 400 005	Member

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08.	Dr B Hari Gopal Director National Accrediation Board for Testing Calibration Laboratories 3rd Floor, NISCAIR Building 14, Satsang Vihar Marg New Mehrauli Road NEW DELHI – 110 067	Member (Agency Representative)
09.	Dr S K Bhadra Scientist Central Glass and Ceramic Research Institute (CGCRI) 196, Raja S C Mullick Road KOLKATA – 700 032	Member (DG's Nominee)
10.	Dr Chandrashekhar Director Central Electronics Engineering Research Institute (CEERI) PILANI – 333 031	Member (Sister Laboratory)
11.	Dr Naresh Kumar Head, (RDPD) Council of Scientific & Industrial Research, Anusandhan Bhawan, 2 Rafi Marg, NEW DELHI - 110 001	Member (Permanent Invitee)
12.	Dr Vikram Kumar Director National Physical Laboratory Dr K S Krishnan Marg NEW DELHI - 110 012	Member
13.	Sh R B Saxena Scientist 'F' & Head, Planning Monitoring & Evaluation Group National Physical Laboratory Dr K S Krishnan Marg NEW DELHI - 110 012	Non-Member Secretary

Management Council
(01.07.2005 –30.06.2007)

01.	Dr Vikram Kumar, Director … … …	Chairman
02.	Dr Anil Kumar Gupta, Scientist Gr IV(6) …	Member
03.	Dr Hari Kishan, Scientist Gr IV(5) … …	Member
04.	Dr M S V N Prasad, Scientist Gr IV(5) …	Member
05.	Dr R P Aloysius, Scientist Gr IV(2) …	Member
06.	Dr(Ms) Rina Sharma, Scientist Gr IV(3) …	Member
07.	Sh K N Sood, Tech Ofcr Gr III(5) …	Member
08.	Head PME … … …	Member
09.	Sr CFA/CFA/F&AO … … …	Member
10.	Sr COA/COA/AO … … …	Member Secretary

Management Council
(01.07.2007 – 30.06.2009)

01.	Dr Vikram Kumar, Director … … …	Chairman
02.	Dr A Sengupta, Scientist Gr IV(6) …	Member
03.	Dr Hari Kishan, Scientist Gr IV(5) …	Member
04.	Dr(Ms) Rajana Mehrotra, Scientist Gr IV(4) …	Member
05.	Dr(Ms) Rina Sharma, Scientist Gr IV(3) …	Member
06.	Dr D Harnath, Scientist Gr IV(1) …	Member
07.	Dr(Ms) Manju Arora,Tech Ofcr Gr III(4) …	Member
08.	Head, PME … … …	Member
09.	Sr F&AO(SG)/Sr F&AO/F&AO … …	Member
10.	Sr COA/COA/AO … … …	Member Secretary

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Important nearby landmark

- ❖ Sidharth Hotel
- ❖ Pusa Campus

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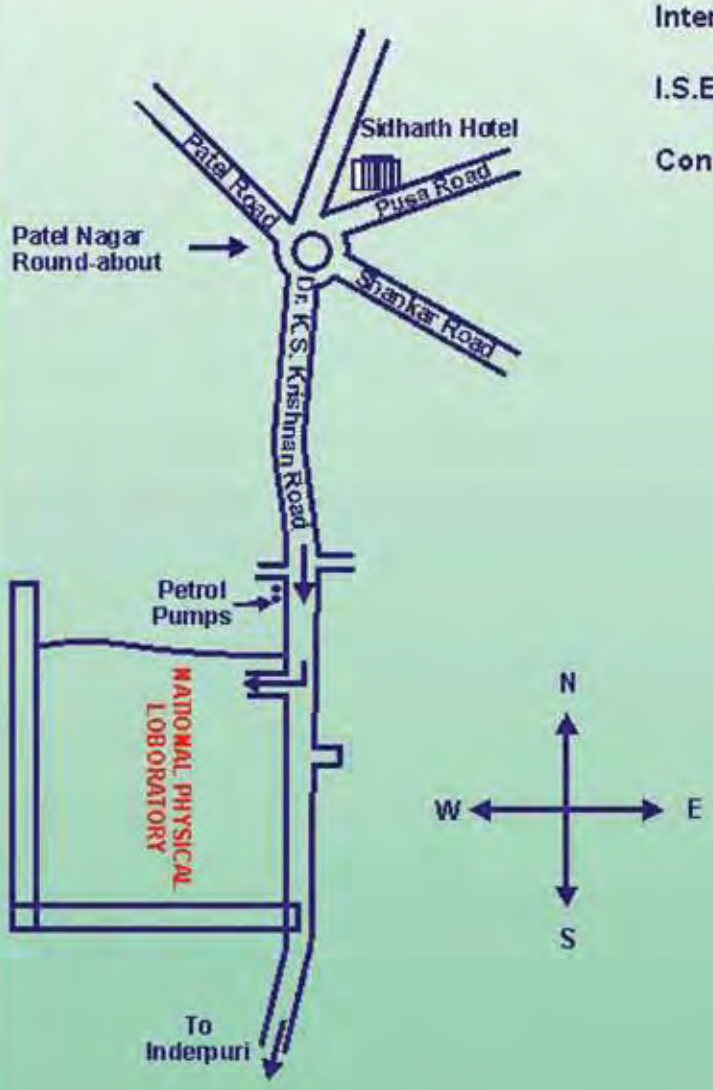
Delhi Railway Station	:	09 km
Indira Gandhi International Airport	:	
Domestic (Terminal)	:	11 km
International (Terminal)	:	19 km
I.S.B.T.	:	08 km
Connaught Place	:	05 km



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Working Hours :

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