NPL

REPORT
1973-74

NATIONAL PHYSICAL LABORATORY, NEW DELHI

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Chairman, Publications & Library Committee	S R Das
Compilation, Editing & Production	G K Arora
Technical Assistance	S K Kapoor
Secretarial Assistance	I J Taneja
Photographs	R C Dhawan and Amar Nath Khural
Cover Design	S K Das Gupta (PID)

Printed at TARA ART PRESS, Hans Bhawan, New Delhi-110002

CONTENTS

DIVISION OF STANDARDS

1. STANDARDS

One of the important objectives of the Laboratory is the establishment, maintenance and up-dating of national standards of physical measurements at internationally accepted accuracy. This activity, which is a statutory obligation, demands continuous research on standards and on techniques of measurements, utilizing latest techniques, very close to the frontiers of knowledge.

The report presents the activity on the following standards :

(i) Length standards;

(ii) Mass standards;

(iii) Time and frequency standards;

(iv) Electrical and electronic standards;

(v) Photometric and radiometric standards;

(vi) Temperature standards;

(vii) Force standard;

(viii) Low pressure and high pressure standards; and

(ix) Acoustical standards.

2. CALIBRATION & TESTING

Another objective of the Laboratory attended to by this Division is the periodic calibration of standards of measuring instruments and equipment used by various governmental and other testing authorities, industries and Defence etc., against the national standards, and supply of standards to various agencies, to ensure uniform scientific, industrial and commercial measurements. As a corollary to this, the Division also undertakes the calibration of instruments and testing of industrial products and appliances for performance, life, and for effect of environmental conditions.

The report presents this activity under the following categories :

(i) Mass, volume & hydrometers ;

(ii) Length metrology ;

(iii) Photometry, colorimetry and radiometry ;

(iv) Test and Evaluation Centre for electronic & electrical equipment & components ;

(v) A.C. & high frequency ;

(vi) Microwave equipment & components ;

(vii) Heat ;

(viii) Low pressure and high pressure ;

(ix) Engineering materials ; and

(x) Acoustics.

3. DEVELOPMENT OF INSTRUMENTS & SYSTEMS

The competence developed in the establishment of standards and the work of calibration and testing of instruments etc., is also utilized by the Division for undertaking the development of some instruments and systems. Among these, the following deserve a special mention in the report :

(i) Sonic aids for the blind;

(ii) Vacuum instruments and systems; and

(iii) Letter bomb detector.

1. STANDARDS

1.1 LENGTH STANDARDS

Scope

Maintenance and updating of the standard of length and its utilization for standardization and for other precision linear measurements.

The existing standard of length at NPL is the National Prototype Metre which is a copy of the International Prototype Metre.

Objectives

(i) Periodic calibration of NPL laboratory standard metres against the National Prototype Metre ;

(ii) Development and installation of a cryostat for the operation of Kr^{86} standard ;

(iii) Installation of a scanning Fabry-Perot interferometer for monitoring the standard ;

(iv) Development and installation of an interference comparator for standardization of gauges ;

(v) Development of stabilized He-Ne laser and a laser interferometer for measurement of length by electronic fringe counting ;

(vi) Research on laser frequency stabilization for the purpose of using the stabilized laser as the standard ;

(vii) Development of techniques and instruments for measurement of length and related quantities ; and

(viii) Transfer of the know-how for making He-Ne lasers.

Progress

Fabrication of the cryostat for Kr^{86} lamp was completed (*Fig 1*).

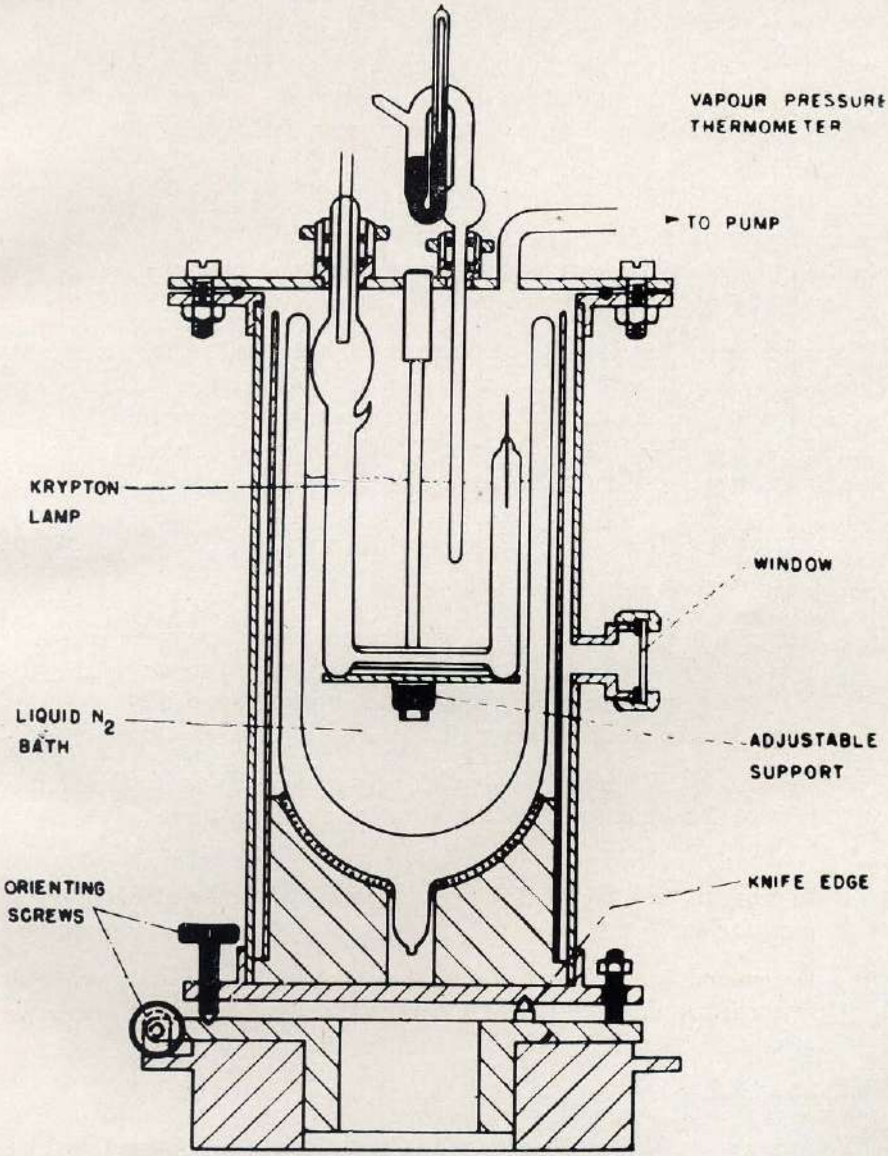

Fig 1 Cryostat for Kr [86] standard lamp designed and fabricated at the Laboratory

The design of the single frequency He-Ne laser was improved by incorporating a PZT modulator for frequency modulation of the laser required for its stabilization.

An investigation was started on the effect of laser radiation on the population distribution of excited levels of Ne in the He-Ne laser plasma and some interesting results were obtained. These measurements are useful for efficient operation of the He-Ne lasers.

Modifications were made to the design of the interference comparator. Fabrication of its optical parts was continued. Work was started on the fabrication of a Fizeau interferometer for testing these optical parts.

Investigations were carried out on an interferometric method of measurement of angular displacements. The method is suitable for calibration of autocollimators and similar devices, and gives the precision of 1 s and 0.1 s respectively for angular displacements upto 1° and 0.2°.

Training was given to the technicians of the two licencees of NPL know-how on the methods of fabrication of He-Ne lasers, and help was given to one of them in setting up the equipment for fabrication of He-Ne lasers. A few He-Ne lasers were supplied to other institutions, including the Space Research Centre, Ahmedabad.

1.2 MASS STANDARDS

Scope and Objective

(i) Design and fabrication of 1 kg balances (including interchangeable pan balances) for the comparison of 1 kg standards against the National Prototype with precision commensurate with the internationally accepted accuracies ;

(ii) Design and fabrication of weights in multiples and submultiples of 1 kg and finally to establish their values in terms of National Prototype ;

(iii) Intercomparison of NPL 1 kg standards against standards of other nations ; and

(iv) Design and fabrication of other high precision balances, and to conduct research pertaining to weighing designs and development of standards of unit of mass.

Progress

1 kg Interchangeable Pan Balance : The beam for the 1 kg interchangeable pan balance was completed. The carriage with necessary modifications was refabricated. The pans were recast and machined. In addition, several other parts of the balance were fabricated.

1 kg Modified Balance : A 2 kg capacity Oertling balance, with initial sensitivity of 1 mg per division without lamp and scale, was chosen for modification. The alterations and improvements made include: readjustment of pivots, fitting of lamp and scale arrangement, special pans, and remote control mechanism for weight changing and adjustment of rider.

To eliminate change and gradient of temperature, the balance is placed in thermally lagged but superficially conducting outer case which is housed in a thermally lagged chamber with polished aluminium inner and outer walls *(Fig 2)*. All operations and observations on the balance are made from outside this chamber *(Fig 3)*.

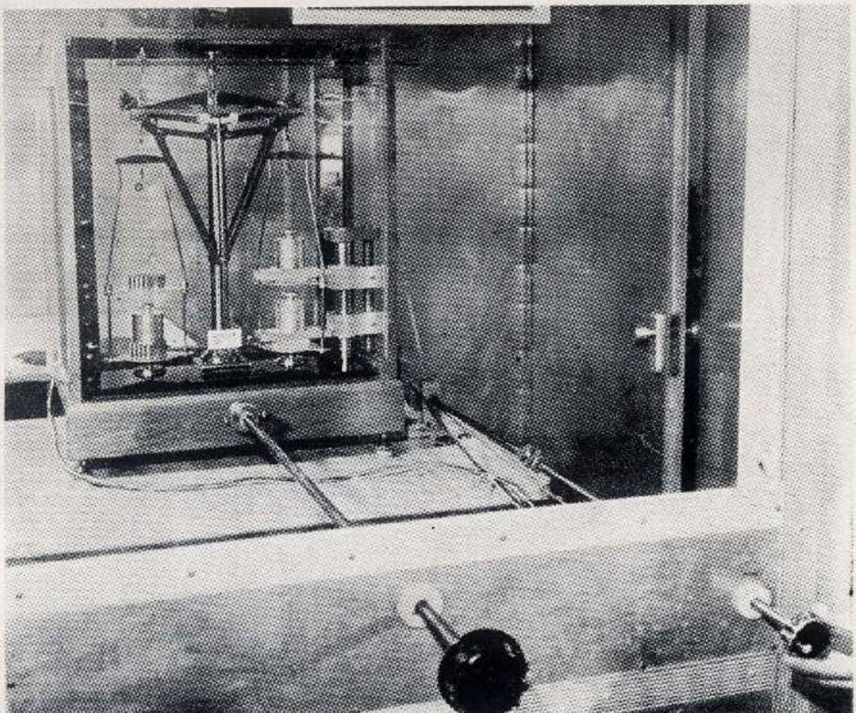

Fig 2 Modified balance for calibrating 1 kg weights with precision of 0.05 mg, placed inside the thermally lagged chamber

The sensitivity figure achieved was 0.05 mg per small division. The observations showed that the consecutive rest points, without affecting the release and arrestments, were fairly constant. However, there was a

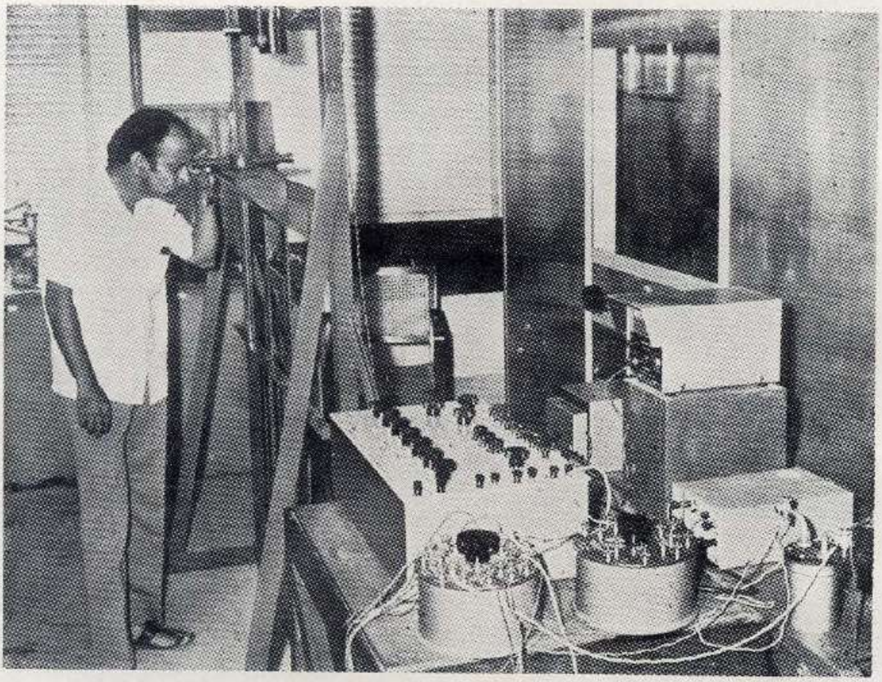

Fig 3 Observations being taken from outside the chamber of the 1 kg modified balance. Equipment in the foreground is for measuring the temperature of the balance chamber with precision of 1 mK

constant drift of rest points, and after 30 consecutive rest points, the shift was of 1 small division which is equivalent to about 0.05 mg. The difference between the consecutive rest points, after releasing and arresting each time, varied from 1 to 3 small divisions. The standard deviation of the set of 10 rest points affecting the release and arrest of the beam every time was less than 1 division, which is equivalent of 0.05 mg, but when weights were interchanged, the difference between the first two consecutive rest points was quite large. Investigations on this behaviour of the balance were undertaken.

The temperature measurements showed, that if outside the chamber the temperature changed by 0.5°C, the temperature inside the balance case remained constant to within 0.02°C. The temperature gradient of the air along the beam was never found to be greater than 0.002°C. Quite often it remained within 0.001°C.

Fabrication of Standard Weights : The samples of Niomonic-75 supplied by DMRL, Hyderabad, were tested for their density, hardness and machinability. The results indicated that the material is good for making the standard weights, and fabrication of some 20 g weights was started.

1.3 TIME AND FREQUENCY STANDARDS

Objective & Scope

Updating and maintaining the base units of time and frequency, and disseminating standard time and frequency signals to the nation and the neighbouring countries.

The aim is to have standard time and frequency broadcast round the clock at two or preferably at three frequencies, 5 MHz, 10 MHz and 15 MHz. It is further aimed to increase the accuracy of transmission by supplementing the present set of quartz oscillators with additional more accurate standards, and also to undertake the development of atomic standards.

Progress

NPL is disseminating, under code identification ATA, standard time and frequency to the nation at 10 MHz from its transmitter at Kalkaji. Prior to May 1974, these transmissions were based on a set of quartz standards with an accuracy of 1 in 10^8. A major improvement in the time and frequency services was the installation of atomic caesium time and frequency standard in May 1974.

The monitoring system was modified so as to enable all the calibration and standardization work to be done in terms of the caesium standard which has an accuracy of $\pm 7 \times 10^{-12}$ and a stability of $\pm 3 \times 10^{-12}$. A distribution amplifier at 100 kHz was designed and fabricated for distribution of standard 100 kHz frequency. Some preliminary measurements were made to transfer standard 100 kHz signal from NPL to Kalkaji. A 100 kHz signal from caesium standard is divided to 1 kHz and then transferred to Kalkaji over the telephone line (bandwidth of telephone line is about 4 kHz). The signal is then multiplied $\times$ 100 at Kalkaji to a standard 100 kHz signal which can be used to drive the timing system at Kalkaji.

Many instruments connected with time and frequency work received from different organizations were tested and calibrated.

Development work on rubidium atomic standard in collaboration with the Advanced Centre of Electronic Systems, IIT, Kanpur was also taken up.

1.4 ELECTRICAL & ELECTRONIC STANDARDS

1.4.1 STANDARDS OF D.C. VOLTAGE AND RESISTANCE

Objective

Realisation of the national standard of electric current (ampere) by maintaining the national standards of electromotive force (volt) and electrical resistance (ohm), including decimal multiples and sub-multiples of one ohm national standards. This is achieved through :

(i) Mutual inter-comparison of emfs of the national bank of stable Weston cadmium cells by measuring their differences with a vernier potentiometer, to a precision of 1 part in 10^6 ; and

(ii) Mutual inter-comparison of resistances of the national bank of standard resistors by substitution method, and measuring their differences using modified Wheatstone shunt bridge housed in the same oil bath as the one containing the 1 ohm standard resistors, to an accuracy of 5 parts in 10^7.

These standards are internationally cross-checked from time to time to ensure their accuracies.

Progress

Work on mutual inter-comparison of emfs and of resistances of the national banks of standard cells and of standard resistances was continued. The number of the emf standards was augmented by procuring two temperature-controlled air enclosures each containing 12 Muirhead standard cadmium cells. A DC/Current comparator thermometer bridge and constant temperature oil bath were added for better accuracy of measurement. Present uncertainties in measurement of voltage and resistance are 1 part in 10^6.

1.4.2 Realization of the unit of DC Voltage through Josephson Effect

Objective

Following the international trend, work on Josephson Effect, for establishment of the unit of D.C. Voltage standard, has been undertaken.

Progress

Some Josephson junctions were fabricated and their D.C. characteristics at liquid helium temperatures were studied. Feasibility studies on radiating the junction with microwaves, were also carried out.

1.4.3 AC & High Frequency Standards

Objective

Development, maintenance and up-dating of AC and high frequency standards for electrical parameters like voltage, current, power, attenuation, impedance, frequency and noise etc. in the frequency range 30 Hz to 1000 MHz.

This is a ten-year programme of work to be completed in two phases of five years. A modest beginning was made in respect of low frequency and high frequency voltage and power standards.

Progress

An experimental arrangement has been set-up for measurement of A. C. and H.F. voltage (100 mV - 1 V) in the frequency range 100 Hz to 50 MHz. The set-up employs a standard thermal converter, and is based on AC/DC substitution technique. The accuracy of measurement at present varies from 0.5% to 2.0% depending on the voltage range and the frequency of operation.

A bolovac mount based on a preliminary design of the partial H. F. substitution technique for voltage and power measurement has been fabricated. The design for bolometer elements in the form of two split discs is being prepared. The essential requisite of such a design would be to ensure proper impedance matching and isolation of the H.F. source from the biasing source during balancing of the bridge.

While working for establishment of the transfer standard, a laboratory standard for measurement of low powers (10 μW - 10 mW) using a calibrated thermistor mount has been set up in the frequency range 10 MHz - 1000 MHz with an accuracy of $\pm$ 2%.

1.4.4 Microwave Standards

Objective

Development, maintenance and up-dating of the standards of measurement for microwave attenuation, power, impedance, frequency and noise. This is a ten-year programme to be completed in two phases of five years.

Progress

Microwave Attenuation : Prior to the period under report, microwave attenuation measurements were being done in terms of a 30 MHz attenuator incorporated in a microwave receiver. The range extended from 0 to 50 db with an accuracy of $\pm$ 0.1 db in the lower ranges and $\pm$ 0.5 db in the higher ranges. During the period covered by the report, a wave-guide below cut-off attenuator Level II standard for attenuation was procured from NBS, USA, and facilities were established for microwave attenuation measurement with an accuracy of 0.02 db per 10 db upto 60 db in X-band. A frequency-stabilized microwave source with short term stability of 1 in 10^7 was created in the X-band (klystron X-13) with the help of feed back loop and phase lock techniques.

Microwave Power : For microwave power, only a working standard for measurements in the range of 0 to 10 W with an accuracy of $\pm$ 2%

had been established upto 10 GHz. During the period under report, a self-balancing bridge was procured from NBS, USA, for measurement of power with an accuracy of $\pm$ 0.5 to 1.8%. Work was initiated on setting up Level II microwave standard for X-band, using this bridge.

Microwave Impedance Measurements : A method had been developed for measurement of impedance, using directional couplers, tuners and standard movable short circuit. The method was tested for the frequency range 8.2 to 12.4 GHz. The status of accuracy achieved was $\pm$ 0.1 to $\pm$ 0.5 db in the return-loss range of 0.2 to 46 db (VSWR : 80 to 0.01).

Microwave Frequency Measurements : Measurement of microwave frequency was done, using heterodyne frequency meter, which was calibrated in terms of the quartz crystal oscillator maintained by the Laboratory.

A survey was conducted to find out the accuracies of microwave instruments which are available with user organisations like BEL, Bangalore, CIL, Bangalore, TRC, New Delhi, RDSO, Lucknow and HRPU, and a phased programme of improvement of the standards for microwave measurements was drawn out.

1.5 PHOTOMETRIC AND RADIOMETRIC STANDARDS

Objective & Scope

Establishment and maintenance of scales for luminous intensity, luminous flux and colour temperature.

Secondary standards of light in the form of incandescent lamps calibrated by BIPM are maintained and intercompared among themselves as well as against standards from other national laboratories, for luminous intensity (candela) and luminous flux (lumen) to an accuracy of about 2-3%. Another set of lamps maintains the colour temperature scale.

Progress

Work was continued on preparing working standards for a number of miniature types of lamps. Automobile miniature lamps like tail-lamps and dial lamps were also included.

Work was also continued on dependence of spectral distribution and luminous output of fluorescent lamps on voltage and current wave forms, super-incumbent pressures and temperatures etc.

Preparation of working standards and laboratory standards of luminous intensity, luminous flux and colour temperature was undertaken as a recurrent form of activity.

An experiment was initiated for transfer of spectral irradiance from the NBS standard to a reference working standard.

Work was initiated on the establishment of absolute methods so that reflectance standards can be prepared without reference to any material standard.

1.6 TEMPERATURE STANDARDS

1.6.1 PLATINUM RESISTANCE THERMOMETRY (TEMP. RANGE 630°C TO — 183°C)

With the indigenously constructed platinum resistance thermometers, a precision measurement of ± 0.001°C had been achieved prior to the period under report.

Progress

Work has been undertaken to improve the design of the apparatus for determining the B.P. of Water with a view to improving the stability of temperature in the equilibrium state.

A new tin-point apparatus was set up for realizing the melting point of tin, and measuring the resistance of stem-type platinum resistance thermometers at this equilibrium state.

Several new triple-point cells were completed for realizing the primary fixed point of triple-point of water. By the method of intercomparison, defective triple-point cells were identified and isolated.

Several stem-type platinum resistance thermometers were periodically re-calibrated at several fixed points to study the stability of R_0 values.

1.6.2 THERMOCOUPLE THERMOMETRY (TEMP. RANGE 630°C TO 1064°C)

With the indigenously constructed thermocouples (Pt—Pt 10% Rh) a precision measurement of ± 0.1°C had been achieved earlier.

Progress

Preliminary experiments on freezing point of copper in black body, conducted during the period, showed, that :

With argon purge and sufficient graphite diaphragms, copper does not oxidise appreciably ;

The thermocouple could monitor freezing, melting, as well as supercooling of the metal in the black body ; and

The freezing point in two of the freezes agreed to within 0.1 μV i.e., 0.01°C.

Studies on the facilities for calibration of standard thermocouples at the freezing point of silver by ingot method were carried out. No argon was used. Reproducibility of temperature measurement was 0.1°C.

1.6.3 Optical Pyrometry (Temp. Range 1064°C to 1800°C)

With the locally assembled pyrometer, reproducibility of temperature measurement of $\pm$ 0.5°C at 1064°C and $\pm$ 2°C at 1800°C is available.

Fabrication of the optical system of a standard photo-electric pyrometer was started.

Help to other Industries

Two stem-type platinum resistance thermometers, for the temperature range — 183°C to +630°C were supplied to NAL, Bangalore.

Technique of constructing industrial type ceramic/glass enclosed sensors of $R_0 = 100$ ohm for platinum resistance thermometers was developed. Five such sensors were sent to Vikram Sarabhai Space Centre, Thumba.

Work of constructing ceramic enclosed sensors of 200 ohm, for the Power Project Engineering Division, Department of Atomic Energy, Bombay, was taken up.

1.7 FORCE STANDARD

In order to verify material testing machines, force measuring instruments are required. These proving devices are to be calibrated at regular intervals. This work was hitherto being done to an accuracy of 4 in 10^5 for devices upto 3,000 kgf, using the dead weight machine designed and fabricated at the Laboratory.

With the growing requirement from the industry for calibration of proving devices of higher capacities, as a first step, one universal testing machine was modified for calibration of devices at various steps of load upto 15,000 kgf with an accuracy of 0.1%.

1.8 LOW PRESSURE AND HIGH PRESSURE STANDARDS

The emphasis, for the present, has mainly been on the establishment of standards for low pressures, and a standard McLeod gauge using variable compression techniques used as a primary standard of pressure in the range 10^{-3} to 10^{-6} torr with an accuracy of 2–3% has been established.

Progress

During the period under report, a set-up was fabricated which recorded a pressure of 3×10^{-9} torr. A bakeable glass-metal system for obtaining pressure of the order of 10^{-11} torr was also designed and its fabrication and assembly was undertaken.

1.9 ACOUSTICAL STANDARDS

Status prior to the period under report

Standards of sound pressure had been established in terms of laboratory standard condenser microphones calibrated by the reciprocity method in a coupler cavity. The microphones had also been compared with the laboratory standard microphones maintained at PTB, West Germany.

Standards for threshold of hearing by air conduction were established in terms of a calibrated laboratory standard condenser microphone working in an artificial ear cavity of specified volume and of an internationally accepted earphone.

Standards of acceleration/displacement were maintained in terms of a calibrated accelerometer checked on a vibrating table at 50 Hz only at 1g.

Progress

Working standard microphones were calibrated by comparison with laboratory standard microphones in a coupler cavity.

Standard of magnetic recording tape was established in terms of a standard reference magnetic tape reproduce system for calibration of magnetic recording tapes.

A reverberation room, completed according to internationally specified requirements for measurement of noise power output of small machines and sound absorbing properties of materials, was commissioned.

Work on fitting the frame-work supporting the absorbent wedges in the anechoic room was taken up.

2. CALIBRATION & TESTING

2.1 MASS, VOLUME & HYDROMETERS

Scope and Objectives

(i) Testing and Calibration of (a) Precision weights including standards for Weights & Measures Enforcement Departments of the country, (b) Volumetric glassware, (c) Hydrometers of various types, and (d) Butyrometers;

(ii) Testing of balances and weighing machines ;

(iii) Supply of authenticated copies of standards of mass to the industry, research institutions, and to the Departments of Legal Metrology ; and pressure of the order of 10^{-11} torr was also designed and its fabrication and assembly was undertaken.

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(iii) Supply of authenticated copies of standards of mass to the industry, research institutions, and to the Departments of Legal Metrology ; and

(iv) Supply of standardised measures of capacity to the State Departments for Enforcement of Weights and Measures.

Progress

About 1,000 test reports were issued during the period under report, and about Rs. 60,000/- were realised as the test charges.

2.2 LENGTH METROLOGY

Scope and Objectives

(i) Calibration of precision gauges for linear thread and angle measurement ;

(ii) Testing of instruments, equipments, tools and materials for linear dimensions, including prototype testing ; and

(iii) Calibration and certification of secondary standard length measures for the Directorate of Weights and Measures.

Facilities exist for making linear measurements to the accuracies detailed below :

(a) Line standards upto 1 metre length with precision of 1 μm.

(b) End standards upto 4 metre length with precision of 1 μm per metre.

(c) Length of smaller gauges upto 100 mm (slip gauges) in terms of wavelength of Hg^{198} radiations with accuracies ranging from $\pm$ 0.1 μm to $\pm$ 0.03 μm.

(d) Testing of surface plates and straight edges for flatness in sizes of 100 $\times$ 100 mm^2 to 1000 $\times$ 1000 mm^2 as per standard specifications.

(e) Various dimensional measurements including thread measurements involving precision finer than 0.01 mm.

(f) Angle measurement with precision of 5″.

Progress

About 800 test reports were issued to outside parties. Special mention may be made of calibration of slip gauge sets, other high precision end gauges, vernier calipers, and of secondary standard length measures.

A new procedure was developed for calibration of secondary standard metre bars. The procedure gives better precision and the standard deviation of the measurement of each interval.

Ruling of scales and graticules was continued but the required precision could not be obtained.

2.3 PHOTOMETRY, COLORIMETRY, AND RADIOMETRY

Scope and Objectives

(i) Testing and calibration of lamps, lighting fittings, materials for light and colour control, optical instruments, systems and components, photometric instruments etc. ;

(ii) Measurement of optical properties of materials, viz., colour, spectral reflectance and transmittance, optical density, opacity etc. ; and

(iii) Supply of NPL-made integrating spheres.

New items added for testing were photo control switches for use in street lighting or series lighting which may be switched off at scheduled times without manual control.

Progress

About 160 test reports were issued to outside parties. Besides, substantial testing work for other activities of the Laboratory was also done.

The following consultancy service was also rendered :

M/s. Toshiba Anand Lamps, Cochin	Quality control of electric lamps
M/s. Jain Lamps and Allied Industries (P) Ltd., Kanpur	Miniature lamp production.
M/s. Anand Lamps Ltd., Dehradun.	Design and quality control laboratory for auto and other miniature lamps.

2.4 TEST AND EVALUATION CENTRE FOR ELECTRONIC AND ELECTRICAL EQUIPMENT AND COMPONENTS

Background

The Laboratory has been operating a nucleus of an environmental testing laboratory to study the performance of electronic components and materials on a limited scale. On the recommendation and with the support of the Electronics Commission these facilities have been greatly enhanced to encourage the growth of the electronics industry at a rapid pace and to meet the growing demands for developmental and type testing. A Test and Evaluation Centre to act as a national facility for the northern zone, on lines similar to two other centres — one at the Bhabha Atomic Research Centre (BARC), Bombay, and the other at the Chief Inspectorate of Electronics (CIL), Bangalore — has been set up.

Scope

To act as a national laboratory facility for environmental testing, calibration and evaluation of electronic and electrical products; and

To operate field exposure stations and to carry out studies in tropicalization.

Objectives

(i) To provide quick and efficient test facilities to electronic and electrical industry and other user organisations such as Defence, Civil Aviation, DGS & D, ISI etc.;

(ii) To carry out primarily developmental and type testing according to the Indian Standards Institution (ISI) specifications or any other national specifications required by the user;

(iii) To analyse the performance of the components and equipments to acquire failure-rate data and to carry out failure analysis studies to evaluate the reliability in order to advise the industry to improve its products and the users in the planning of systems ;

(iv) To carry out correlation studies between the accelerated laboratory tests and the performance of the products under actual environmental conditions, through setting up of several field stations representing different climatic and other environmental conditions, and to make this information available to all interested parties — both national and international ;

(v) To carry out systematic studies in tropicalization of components and equipments ;

(vi) Based on the test data, studies and experience, to suggest and advise revision and/or updating of the ISI specifications ;

(vii) To offer calibration facilities with established traceability to the national standards of physical measurement of the NPL ; and

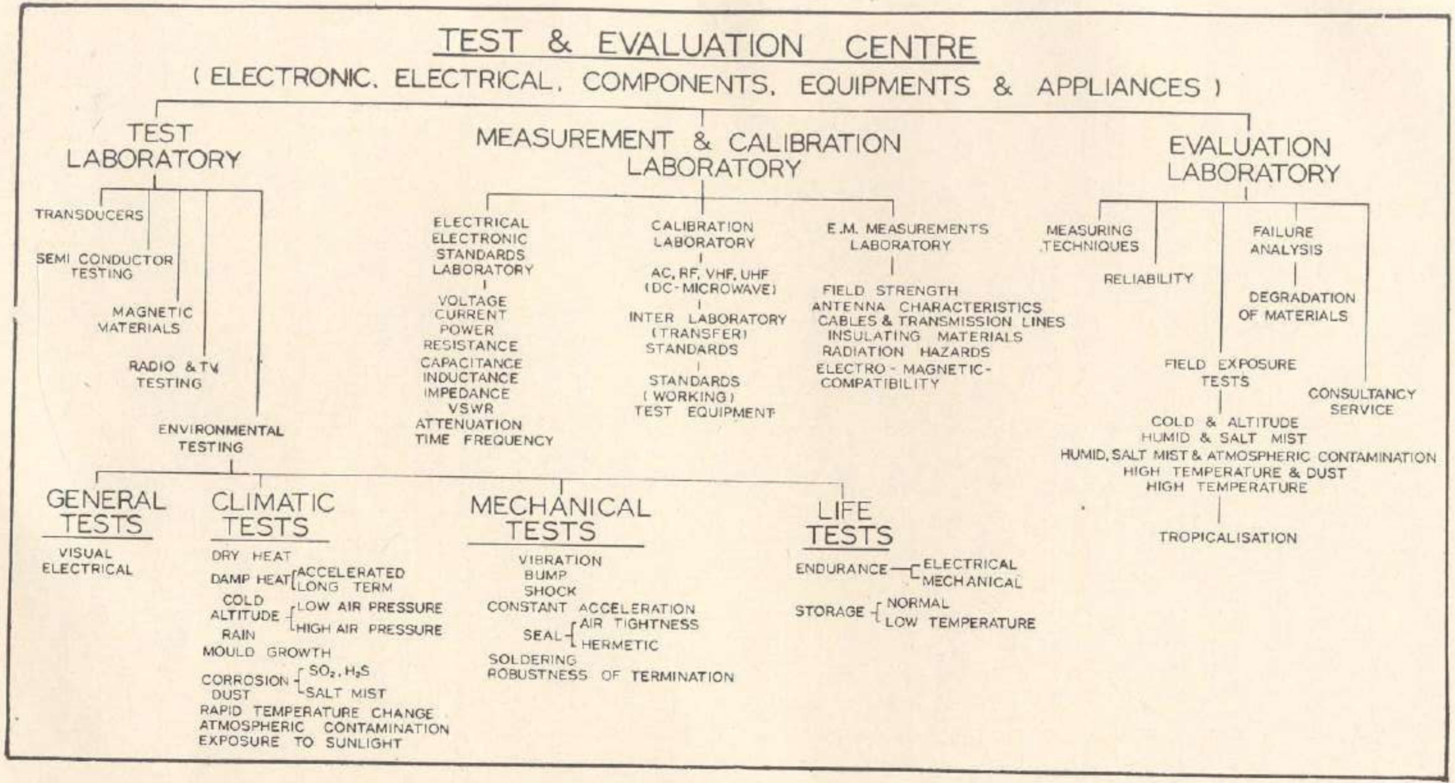
(viii) To perform such other specialized services or render advice, as may be required from time to time.

Programme

The programme had been drawn up into two phases — the first phase to cover mainly the environmental testing and evaluation of components and equipment, and the second phase to cover measurement and calibration laboratory, reliability and field exposure stations.

Enlarging the environmental test facilities by the addition of equipments to cover the complete test facilities for electronic equipments and for a few additional facilities for components, which could not be taken care of in the first phase, is also envisaged in the second phase.

The chart reflects the envisaged set-up of this Centre.


TEST & EVALUATION CENTRE
(ELECTRONIC. ELECTRICAL. COMPONENTS. EQUIPMENTS & APPLIANCES)
TEST LABORATORY
TRANSDUCERS
SEMI CONDUCTOR TESTING
MAGNETIC MATERIALS
RADIO & TV TESTING
ENVIRONMENTAL TESTING
GENERAL TESTS
VISUAL
ELECTRICAL
CLIMATIC TESTS
DRY HEAT
DAMP HEAT ACCELERATED
LONG TERM
COLD
ALTITUDE LOW AIR PRESSURE
HIGH AIR PRESSURE
RAIN
MOULD GROWTH
CORROSION SO₂, H₂S
SALT MIST
DUST
RAPID TEMPERATURE CHANGE
ATMOSPHERIC CONTAMINATION
EXPOSURE TO SUNLIGHT
MECHANICAL TESTS
VIBRATION
BUMP
SHOCK
CONSTANT ACCELERATION
SEAL AIR TIGHTNESS
HERMETIC
SOLDERING
ROBUSTNESS OF TERMINATION
LIFE TESTS
ENDURANCE ELECTRICAL
MECHANICAL
STORAGE NORMAL
LOW TEMPERATURE
MEASUREMENT & CALIBRATION LABORATORY
ELECTRICAL ELECTRONIC STANDARDS LABORATORY
VOLTAGE
CURRENT
POWER
RESISTANCE
CAPACITANCE
INDUCTANCE
IMPEDANCE
VSWR
ATTENUATION
TIME FREQUENCY
CALIBRATION LABORATORY
AC, RF, VHF, UHF (DC-MICROWAVE)
INTER LABORATORY (TRANSFER) STANDARDS
STANDARDS (WORKING) TEST EQUIPMENT
E.M. MEASUREMENTS LABORATORY
FIELD STRENGTH
ANTENNA CHARACTERISTICS
CABLES & TRANSMISSION LINES
INSULATING MATERIALS
RADIATION HAZARDS
ELECTRO - MAGNETIC- COMPATIBILITY
EVALUATION LABORATORY
MEASURING TECHNIQUES
RELIABILITY
FAILURE ANALYSIS
DEGRADATION OF MATERIALS
FIELD EXPOSURE TESTS
COLD & ALTITUDE
HUMID & SALT MIST
HUMID, SALT MIST & ATMOSPHERIC CONTAMINATION
HIGH TEMPERATURE & DUST
HIGH TEMPERATURE
TROPICALISATION
CONSULTANCY SERVICE

Progress

The Test and Evaluation Centre was shifted from the temporary sheds to a new building to house and commission the equipment received during the first phase of the programme.

Due to the dislocation of work and the lack of special facilities for commissioning a number of the new equipment, the Centre could undertake only limited testing work for outside agencies. However, special service for testing of magnetic materials and components was rendered to the Electronic Components Production Unit (ECPU) of the Laboratory, and also to the Central Electronics Ltd — a Government of India Undertaking, under the Department of Science and Technology — into which the ECPU has grown during the period under report.

2.5 A.C. & HIGH FREQUENCY

The group working on the establishment of standards for A. C. and high frequency measurements, undertook testing and calibration work also.

The group made use of the following existing facilities for rendering testing and calibration service to outside parties and in particular to Hindustan Aeronautics Ltd., and Air India :

(i) Calibration of R.F. power meters from 10 μW to 10 mW.

(ii) Calibration of audio and R.F. signal generators (frequency range extending upto 100 MHz) in the voltage range 10 mV to 10V.

(iii) Calibration of VTVMs, power meter calibrators, voltage calibrators, and low-power attenuators, in frequency ranges extending from power frequencies to several hundred MHz.

(iv) Measurement of characteristic impedance of coaxial cables upto 250 MHz.

(v) Measurement of various parameters of transistors and diodes upto several hundred MHz.

2.6 MICROWAVE EQUIPMENT & COMPONENTS

The group working on the establishment of standards for microwave measurements undertook testing and calibration work also.

M/s. K L B Electronics, Delhi, and M/s. Scientific Instruments Co. Ltd., Allahabad, who are the licensees of the NPL know-how for microwave components in waveguide configuration, and also for some microwave instruments, were the main users of this facility. This alone amounted to an earning of a test fee of more than Rs. 50,000 during the period under report.

2.7 HEAT

Scope

(i) Testing and calibration of platinum resistance thermometers, thermocouples, optical pyrometers, and mercury-in-glass thermometers ;

(ii) Study of the thermal properties of materials; and

(iii) Testing of domestic refrigerators and refrigeration appliances.

Progress

During the period under report, about 200 test reports were issued.

Special mention may be made about the following :

(a) Two platinum resistance thermometers from M/s. Instrumentation Ltd. Kota, were calibrated.

(b) One long-stem portable liquid-oxygen vapour pressure thermometer for the temperature range 90 K to 60 K was completed.

(c) A cryostat suitable for operating krypton lamp at low temperatures was made for the length standards work of the Laboratory.

(d) An indicating potentiometer and a probe for detecting levels of low boiling (cryogenic) liquids were fabricated.

(e) Medical thermometer capillary tubes were tested as per IS specifications, for the Director (Ceramic & Glass), Small Scale Industries, for evaluating the indigenous capillary tubes in comparison with the foreign-made ones.

(f) Work on fabrication, studies and modifications of a fluidized bed-bath was taken up for calibration of thermometers above 300°C.

(g) Provision was made for testing of bottle coolers.

2.8 LOW PRESSURE AND HIGH PRESSURE

Objectives

(i) To set up calibration facilities for various types of pressure/vacuum gauges for the ranges (i) 760 torr to 1 torr, (ii) 1 torr to 10^{-2} torr, and (iii) 10^{-2} torr to 10^{-6} torr ; and

(ii) To test the performance characteristics of vapour diffusion pumps and oil rotary pumps according to ISO and ISI specifications.

Status achieved

The set-ups required for achieving the first objective had been designed and the required components had been fabricated. A system for calibrating Bayerd Alpert ionization gauges against the primary standard, was also set up.

An apparatus for measuring speed, ultimate vacuum, and other characteristics for vapour diffusion pumps had been constructed and used to test some samples received from the industry. The equipment for vapour diffusion pumps is being modified in accordance with the ISO and ISI specifications.

Assembly of the equipment for testing of characteristics of rotary pumps as per ISO and ISI specifications was started. A special three-way metal valve was designed and is being incorporated in the system, so that the same Mcleod gauge, manometer and flowmeter could be used for rotary pumps with capacities ranging from 50 l/min to 500 l/min and more.

2.9 ENGINEERING MATERIALS

The following testing facilities for engineering materials exist at the Laboratory :

(i) Tensile strength measurement (upto 700°C), compression tests on metals and concrete cubes, plotting stress strain curves. (Maximum load — 100t).

(ii) Hardness tests — Rockwell, Brinell & Vickers Pyramid—on metals.

(iii) Bend test.

(iv) Izod and Charpy impact test.

(v) Torsion test on wires upto about 4 mm diameter.

(vi) Transverse tests.

(vii) Load tests on material handling machines, e.g., jacks, hoists, chain pulley blocks etc.

(viii) Calibration of proving rings, universal testing machines, impact testing machines and hardness testing machines.

Progress

More than 500 test reports were issued to outside parties.

2.10 ACOUSTICS

Scope and Objective

(i) Periodic calibration of acoustic and electro-acoustic equipment ;

(ii) Testing of acoustic and electro-acoustic devices and materials for their performance characteristics and properties, and to check complete electro-acoustic systems and performance characteristics of auditoria ; and

(iii) Rendering advice on problems of noise reduction, acoustic design and treatment of auditoria, hearing protection etc.

Facilities exist for testing items like, motion picture projectors, magnetic recording tapes, audiometers, hearing aids, ear defenders, automobile horns, electric sirens, sound absorbing materials, sound insulating materials, tuning forks, vibration generators, sound level indicators, tachometers, ultrasonic therapy units, loudspeakers, microphones, amplifiers, sound reproducing equipment, etc.

Progress

About 70 test reports were issued during the period under report. Another about 20 consultancy cases were handled. These latter included design and acoustic treatment of auditoria, sound insulation and optimum reverberation in sound recording studies, reduction of noise from an industrial shed, suppression of noise emanating from an aeroengine test-bed etc.

Statement of Receipts on account of Calibration and Testing Work done by the Division of Standards during 1973-74 and 1974-75.

The receipts on account of developmental and type testing and calibration of instruments are given below :

Activity	*No. of Test Reports*		*Test fee in Rs.*	
	1973-74	*1974-75*	*1973-74*	*1974-75*
Mass, Volume and Hydrometers	554	471	24,601.00	35,727.00
Length Metrology	562	529	41,805.01	30,645.40
Photometry, Calorimetry & Radiometry	107	82	33,925.19	27,060.34
Test and Evaluation Centre for Electronic & Electrical Equipment and Components	263	184	28,330.01	28,331.67
*A.C. & High Frequency	28	38	7,012.00	12,511.67
Microwave Equipment and Components	909	505	40,550.00	15,370.00
Heat	109	120	5,453.04	11,891.67
Low Pressure and High Pressure	8	—	2,095.00	—
Engineering Materials	374	292	46,295.00	42,115.00
Acoustics	50	36	13,190.00	14,795.00
Materials	20	7	4,250.00	2,055.00
Total	2984	2264	2,47,506.25	2,20,502.75

*Represents the receipts of the erstwhile Electronics Division.

3. DEVELOPMENT OF INSTRUMENTS & SYSTEMS

3.1 SONIC AIDS FOR THE BLIND

A sonic walking aid for the blind was developed and batch-produced. Two units of the size of a torch were sent to the Department of Social Welfare, for trials at the National Centre for the Blind, Dehradun and Blind Relief Association, Delhi, in June 1974 (*Fig 4*). Need was felt to incorporate the following modifications for better handling of the unit by the blind :

(i) Change in housing to provide safety to the transducers and to give a better grip;

(ii) To provide increased life to the unit by decreasing the battery drain; and

(iii) To raise the operating frequency of the unit from 25-45 kHz to 60-100 kHz for obtaining more information about the ground surface.

These modifications were made, and miniaturisation of the aid was also attempted.

Work was also initiated on tactile mobility aid and reading aid for the blind.

Fig 4 Dr. G. S. Pathak, Vice President of India, taking keen interest in the sonic mobility aid for the blind

3.2 VACUUM INSTRUMENTS AND SYSTEMS

The competence developed in the establishment of standards for low pressure measurement and the associated testing and calibration activity is also utilised for undertaking development of vacuum instruments and systems. The major items engaging attention in this direction were :

(i) Development of Penning and Pirani type of gauges ;

(ii) Development of thermal conductivity type vacuum leak detector ;

(iii) Development of a field ion microscope;

(iv) Development of silver-impregnated graphite contacts for relays ;

(v) Ultra-high vacuum systems for ion implantation and for scanning electron microscope.

Status achieved

Penning and Pirani gauges measuring pressures from 10^{-6} torr, and Pirani type leak detector, had been developed and their know-how had been commercially exploited.

A glass type field-ion microscope capable of operating at liquid nitrogen and with helium as the image gas had been designed in collaboration with the Metallurgy Department, Banaras Hindu University. Significant progress had been made in fabricating and assembling other accessories viz., a vacuum system consisting of a rotary pump, diffusion pump and a cold trap having a vacuum of better than 10^{-8} torr, a charcoal trap and gas supply lines and a furnace to bake the entire system to achieve ultra-high vacuum. The assembly of the components was on hand.

An all-metal impregnation apparatus for batch production of silver-impregnated graphite contacts for relays had been designed and fabricated. The development of these contacts had been undertaken at the instance of the Research. Designs & Standards Organisation (RDSO), Lucknow. Samples had been sent to RDSO for laboratory tests and also for life tests. The reports of these tests were highly encouraging. The contacts had successfully undergone 3,47,000 operations till the period under report. The rated life of these contacts is taken as 10^{6} cycles @ 250 cycles per day.

Preliminary work on the design of UHV systems for the two inter-laboratory projects on (i) Ion Implantation, and (ii) Scanning Electron Microscope had been initiated. These projects have been identified by the Coordination Council for the Physical & Earth Sciences Group of CSIR Laboratories.

3.3 LETTER BOMB DETECTOR

A new metal detector was designed to detect the presence of small metallic objects contained in a non-metallic medium. It is particularly suited for the detection of bombs which are sent in the form of letters through post offices as part of the regular mail. The instrument comprises a radio frequency generator (45 to 65 kHz), a sensing device, and an electronic detector unit. It operates on 230 V A.C. mains.

When a letter containing a bomb or any metallic object is passed through the sensing device, a warning is given out by the detector in the form of deflection of a moving coil meter, the glow of a lamp, and an aural signal through the built-in loadspeaker or through a pair of ear-phones.

The equipment was developed for the Posts & Telegraphs Department who have been supplied some units of it.

DIVISION OF SPECIALIZED TECHNIQUES

The activities of the Division of Specialized Techniques are organized into two groups, viz.,

1. Specialized Techniques Group ; and
2. Cryogenics Group.

The Specialized Techniques Group not only undertakes the testing of materials for purity, crystallinity and perfection, but also undertakes the precise measurement of some of the physical properties of materials.

The Cryogenics Group directs its attention to the study of the peculiar phenomena that occur at low temperatures, e.g., Josephson Effect, Kondo Effect etc., development of cryogenic plants, study of superconducting materials and systems, cryo-chemical method of small powder preparation, etc. It also renders cryo-technical services.

1. SPECIALIZED TECHNIQUES GROUP

Introduction

In the second industrial revolution through which we are passing, and which is sometimes referred to as automation, increasing demands are being made on scientists and technologists to tailor materials to required specifications. In this endeavour, increasing efforts are being put in to study why materials behave as they do, and whether we can tailor materials to required specifications. These efforts have convincingly shown that any reliable and reproducible use of a device requires extremely well characterized materials for purity, perfection and their relevant physical properties. In some of the sophisticated industries, the stringency of material characterization is great, and indeed, as industry becomes more and more science-based, it requires extremely well characterized materials.

The Specialized Techniques Group not only undertakes the testing of materials for purity, crystallinity and perfection, but also undertakes the precise measurement of the physical properties of materials.

Objectives

The main objectives of this Group are :

(i) To cater to the needs of the various scientists in the laboratory for the testing of materials for purity, perfection, crystallinity and physical properties ;

(ii) To extend its services to other research institutions and to the industry in the region, for characterization of materials ; and

(iii) To undertake specific programmes for understanding the relationship between composition, structure, imperfection and their relevant physical properties.

1.1 ANALYTICAL CHEMISTRY SECTION

In the Analytical Chemistry Section, about 600 samples were analysed. These samples included ferrous and non-ferrous metals and alloys, ores, cement, water, quartz, transformer oil etc. Purification of trichlorobenzene was also done to meet the requirements of the Cryogenics Group.

Some of the highlights of the Section, leading to the development of new test procedures, are indicated below :

Composition of Superconducting Alloys : The Section was called upon to determine the exact composition of superconducting alloys niobium-tin and niobium-titanium. The determination of the relative proportion in a given sample is quite cumbersome as the chemical behaviour of these elements is similar. The conventional method of hydrolysis of niobium in the solution did not work as the precipitation was not found to be quantitative. Tartaric acid was used as a complexing agent to hold titanium in solution, and niobium was precipitated out at a controlled pH. In the case of niobium-tin alloys, tin was separated as sulphide and in the resulting solution niobium was precipitated as niobium oxinate.

Determination of Silica Content in Boiler Feed Water : Badarpur Thermal Power Station referred the problem of determining silica content of the boiler feed water. The silica content in the boiler feed water should not exceed 0.02 ppm. Normally, determination of silica in water at this level of concentration presents problems. A method for this was standardized. Silica was determined as reduced molybdosilicic acid by spectro-photometric method. With this method it is possible to determine silica content as low as 0.002 ppm.

Determination of Trace Quantity of Lithium : Trace quantity of lithium was determined by flame photometric method using oxyhydrogen flame. Lithium of the order of 0.1 ppm could be determined. These methods were standardized for the Central Water and Power Commission.

Analysis of Alloy Steel : In the determination of tungsten, cobalt and chromium in an alloy steel, the Section had to develop new test methods. The conventional method of separation of other metals by zinc oxide precipitation and then estimation of cobalt by nitroso β naphthol method did not work. Estimation of cobalt was carried out by potentiometric titration using potassium ferrocyanide solution. The coprecipitation of tungstic acid was prevented by using sodium fluoride. The disolution was done with perchloric acid. The method yielded a granular precipitate of tungstic acid, and thus simultaneous determination of tungsten and chromium could be possible in the same solution.

Determination of Boron in Silicon : Silicon for use in electronics industry is characterized by the boron content. The Section applied itself to develop quicker method for determination of boron in silicon. Boron forms a blue coloured complex with dianthrimide in sulphuric acid medium. The colour is very sensitive and it is possible to estimate micro quantities of boron in pure solutions. The method is being extended for determination of boron in high purity silicon. Silicon is removed after fixing boron as borofluoride. Boron is released afterwards and reacted with dianthrimide. The absorption maximum has been found to be at 620 $m\mu$ by using U.V. spectrophotometer.

D.T.A. and T.G.A. Studies : Thermogravimetric behaviour of various precursor materials like polyacrylonitrile, its oxidised form and viscose rayon, used for making carbon fibres, were studied under different conditions. The information regarding the temperature at which the decomposition of these materials takes place is important in the making of carbon fibres from them. The rate of carbonisation of these materials can be suitably programmed in case their thermal behaviour is known.

DTA and TGA studies were also carried out on samples of iron compounds for gamma ferric oxide, and some organometallic compounds.

Preparation of Polycrystalline Silicon using Trichlorosilane Process : Rods of polycrystalline silicon using trichlorosilane process were prepared. The purity corresponded to 10-50 ohm cm. These rods were made by depositing silicon over silicon filament. 30 mm rods of uniform diameter, weighing nearly 800 g, were made. A series of rods were made by this technique. The method of depositing silicon over silicon has many advantages over the earlier method of depositing on tantalum wire, as it eliminates the possibility of contamination by the use of different etchants and is economical also.

1.2. SPECTRO-CHEMICAL ANALYSIS SECTION

The spectrochemical analysis Section tested samples which included phosphors, superconducting materials, carbon products, ferrites etc.

A new method was evolved for taking time-resolved spectra to achieve lower detection limit, using the phenomenon of selective volatalization. A model of this device was fabricated and initial trials were made with good results.

1.3 INFRARED SECTION

Apart from testing samples using infrared spectroscopy, the Infrared Section did considerable work on the development of infrared detectors and infrared spectrophotometer.

Far Infrared Spectrophotometer : A far infrared spectrophotometer useful in the range 200 to 400 microns, using wire mesh Fabry-Perot interferometer, has been made. In the process, a detailed analysis of single and multiple wiremesh systems and their complementary structures has been carried out. With this study, it is possible to make infrared filters, infrared Fabry-Perot etalons etc.

Pyroelectric Infrared Detectors : Pyroelectric infrared detectors were made using single crystals of triglycine sulphate and ceramics of (Pb, Zr) TiO_3. These pyroelectric infrared detectors are quite sensitive, have no spectral resonance, and are cheap to make. These detectors are so sensitive that it is possible to detect a change of 10^{-4} °C in the temperature of the detecting crystals. In view of the remarkable sensitivity, these detectors can be used for remote sensing and night photography.

An apparatus for growing single crystals of triglycine sulphate (TGS) was also designed and fabricated. It has an arrangement to rotate the crystal seed alternately in two directions for a period of 30 s in a constant temperature bath.

Interference Filters : Theoretical equations giving the optical properties of five-grid and six-grid interference filters were derived. Theoretical expressions for three-grid and four-grid systems using different grids, were also obtained.

1.4 X-RAY DIFFRACTION AND SPECTROSCOPY SECTION

This Section carried out X-ray analysis for identification of phases in a wide variety of materials such as battery grade manganese dioxide samples, clay samples, natural garnets, synthetic diamond grits, superconducting materials, gamma ferric oxide for magnetic tapes, Manganese-Zinc ferrite single crystals, crystals labelled as plant insulin etc.

Mn-Zn Ferrites : The work in connection with Mn-Zn ferrite powders has been very extensive involving diffractometer runs to estimate the unreacted α Fe_2O_3 in the ferrite matrix. This information is vital in determining the final sintering conditions. For proper ferrite formation, it is necessary that there should be 3-5% unreacted Fe_2O_3 in the pre-fired ferrite. A large number of samples were examined and this helped in determining the final firing conditions.

Diamond Grits : Extensive work was carried out on behalf of the Customs Department of the Govt. of India, on the nature of diamond grits. This investigation has yielded a unique method of determining whether the grit is from natural diamond or from artificial diamond. During the course of this investigation a very unusually fine grained diamond powder was extensively studied due to the broadness of the usually sharp diamond lines. The line profiles of these diffractions have been analysed for the average crystallite size determination, which was found to be of the order of about 80 Å.

This result led to a search for the method of production of such a fine size, because the normal method of powdering cannot be employed due to the extreme hardness of diamond. Literature survey showed that the size range of artificial diamond powder could only be produced by shock-explosion method.

Battery-grade MnO_2 : Testing of MnO_2 samples from Geep Flash Light Industries, Allahabad, was quite frequent. The X-ray data are most valuable to distinguish between the different allotropic varieties of pure MnO_2. A continuous series of compounds exist intermediate between ramsdellite (an orthorhombic MnO_2) and tetragonal pyrolusite. There is a gradual change from well crystallised ramsdellite through poorly crystallized gamma MnO_2 to well crystallised pyrolusite. The number of intermediate pattern types is therefore, unlimited. Ramsdellite shows much sharper diffraction lines than pyrolusite. Gamma MnO_2 is a synthetic preparation and its natural analog is called N sulite MnO_2. X-ray diffraction patterns of N sulite MnO_2 and gamma MnO_2 resemble remarkably, except that the 4.36Å reflection occurs as a weak reflection in N sulite but is absent in gamma MnO_2. Also the 2.59Å line is very weak in N sulite but fairly strong in gamma MnO_2. Gamma MnO_2 is considered as the best for dry cell manufacture.

Structure and Phase Transformations in Semi-conductor Chalcogenide Materials : The work on chalcogenides was continued and the findings are reported below :

(i) Earlier results on the transformation of $\beta\, In_2S_3$ to the high temperature form $\gamma\, In_2S_3$, have been extended. Single crystals, sealed in evacuated fused quartz capillaries and kept at about 850°C have been studied for symmetry changes, using the Laue method. On the basis of the 3-fold symmetry axis perpendicular to the tetragonal (013) plane, it has been concluded that the reversible β to γ phase change involves small, co-related atomic position changes in the sulphur atoms due to the mobile indium ions in the tetrahedral and octahedral positions in the 'doublet layer'.

(ii) The structure of InSe is based on a rhombohedral cell with space group R3m. The atomic positions and accurate lattice parameters have been determined and the nature of extended defects has been found to be due to the presence of the obverse and the reverse orientation of the rhombohedral cell in the thin lamellae parallel to the basal plane. This gives rise to the sets of sharp and diffuse reflections for h-k=3n and h-k/3n respectively. Structure factors and intensities have been calculated and compared with the observed intensities. The agreement is very satisfactory, and structure has thus finally been solved.

(iii) The products of air-oxidation of Bi_2Te_3 and Bi_2SeTe_2 have been studied after heating the powders in air at successively higher temperatures upto about 900°C. Mass loss/gain and X-ray fluorescence analysis has also been carried out. The results of investigation are as follows :

1. The air-oxidation of Bi_2Te_3 reaches completion at about 600°C with almost no loss of bismuth or tellurium. One of the phases is face centred cubic, and the second phase is tetragonal.

2. The air oxidation of Bi_2SeTe_2 proceeds with loss of Se and the final phase is orthorhombic.

(iv) X-ray studies on Ga_2Se_3 were initiated as this material is characterised by sets of sharp and diffuse X-ray reflections, indexible on a face-centred cubic cell. Those with h, k and l even, are sharp, whereas all reflections with h, k and l odd, are diffuse. In addition to obtaining single crystal data, annealing in specific schedules was carried out, and in one case, the crystals transformed to a tetragonal phase with a super-lattice.

1.5 ELECTRON MICROSCOPY SECTION

In various technologies — particularly ceramics and superconducting materials technology etc., — it has been found that the relevant physical properties of the final product are critically determined by its microstructure which, in turn, can be controlled by the various processing parameters. In view of this connecting link between the starting materials and the final product, great emphasis is laid on the study of the microstructure and on the understanding of the dependence of the physical properties on micro-structure and processing parameters. This Section undertakes the electron microscopic and diffraction studies of materials to determine their structure. The Section has carried out the particle size, shape, size distribution, microstructure etc, determination of a vast variety of materials like ferrites, gamma ferric oxide, greases, carbon fibres, superconducting materials like Nb-Ta, Nb-Ti, Nb_3Sn etc.

Superconductors : A large number of Nb-Ti, Nb-Ta and Nb_3Sn superconducting samples were examined under electron microscope to study the structure of the superconducting materials for understanding the relationship between the density of defects like dislocations etc., and the processing parameters such as annealing, cold working, quenching etc. The relevant superconducting properties of these samples, viz., the critical temperature, critical current etc. were found dependent on the structure of the samples.

Ferrites : A large number of ferrite samples prepared under different conditions by the Division of Materials were also examined with a view to determine the shape and particle size of the ferrite powders. The study clearly revealed the presence of different phases in the ferrites at different stages and conditions of preparation and ultimately helped in determining suitable conditions for the preparation of ferrite powders. Also the determination of size and shape of the γ-Fe_2O_3 particles used for making magnetic tapes was undertaken.

Greases : The examination of the structure of a variety of greases (fresh, used and reclaimed) was undertaken on behalf of the Research, Designs and Standards Organisation, Lucknow. The study revealed that fresh grease has a rope like structure while used grease samples did not show this feature. The structure of the reclaimed grease also showed rope like structure, indicating that it can be used for lubrication.

Surface Microtography of Fibres : The Section entered a new field by undertaking the study of surface microtography of all types of fibres. The work on the replication of carbon fibres and study of the surface defects was started.

1.6 X-RAY DIFFRACTION TOPOGRAPHY SECTION

Besides optical and electron microscopic facilities for studying the microstructure, the Specialized Techniques Group has developed methods for X-ray topography of crystals, using both kinematic diffraction as well as dynamic diffraction.

X-ray diffraction topography is an important tool for fundamental research as well as for routine testing of crystal perfection in some industries. X-ray diffraction topography can be used to detect and characterize (i) grain boundaries, (ii) low angle boundaries, and (iii) dislocations. For the grain boundaries and low angle boundaries, it is even possible to determine their angle. The dislocations can be resolved in good single crystals, and their nature, i.e., whether they are edge or screw dislocations, and their Burgers vector, can also be determined. Besdies, the method is non-destructive.

Lang Camera : The Section has developed a complete Lang camera for X-ray diffraction topography. It consists of (i) a collimating slit system which provides an X-ray beam with horizontal divergence of about 40 seconds of arc, (ii) a turn table which provides reproducible rotation to the crystal and the detector (The smallest possible rotation that can be produced by the turntable is below one second of arc), (iii) a vertical circle goniometer to provide rotations to the specimen crystal around a horizontal axis in addition to the rotation provided by the turntable around a vertical axis, (iv) a scintillation counter as X-ray detector, and (v) a traversing mechanism to provide very uniform to-and-fro motion to the crystal and the photographic film. This traversing mechanism is controlled by a simple circuit which makes its operation automatic.

Microfocus X-ray Generator : In addition to the Lang camera, a microfocus X-ray generator has been successfully designed and fabricated in this Section. This is a demountable X-ray generator which, in many ways, is an improved version of the similar equipment being imported. It consists of (i) a special electron gun, (ii) an anode assembly, (iii) an anode housing, (iv) vacuum system which gives vacuum better than 10^{-5} torr, (v) a cooling system which cools the target by an oil pre-cooled with water, and (vi) electric controls to operate the various pumps. Several safety devices are also incorporated.

Several hundred topographs of crystals like silicon, sapphire, zinc sulphide, lithium flouride, potassium chloride etc. were examined. A typical projection topograph of a CVD grown sapphire single crystal is shown in *Fig 5*. *Fig 6* shows a topograph of the same crystal taken by using dynamical diffraction of X-rays. The contrast reversal in this photograph as compared to *Fig 5* is clearly seen.

Growth, Perfection and Characterization of Single Crystals and Whisker Crystals : Growth of crystals is an important activity of this Section. Important examples are sapphire and yttrium aluminium garnet (YAG)—both of which are laser materials. Whiskers are another class of crystals which are important from academic as well as application point of view. Growth of bulk as well as whisker crystals by different growth techniques was undertaken.

Whisker crystals of NaCl and KCl were grown from solution. Laue photographs of whiskers were recorded on micro focus X-ray generator. Their growth directions were found to be [001].

Several cadmium sulphide crystals were grown from the vapour phase under H_2S atmosphere. Crystals were pulled at speeds of 10 mm per 24 hours with the growth temperature of about 1100°C. It takes 15-20 days to grow a crystal of about 30 mm length. Back reflection Laue patterns showed that these crystals have grown along [0001] direction.

Exploratory work on preparation and growth of yttrium aluminium garnet (YAG) single crystals was started. To begin with, a pellet of a stoichiometric mixture of yttrium oxide (Y_2O_3) and aluminium oxide (Al_2O_3) was fired at a temperature of 1700°C and it was found that higher temperature is required to produce the desired compound.

A new set-up was erected using silicon carbide heating rods by which temperatures of about 2000°C could be created. With this arrangement polycrystalline YAG could be prepared.

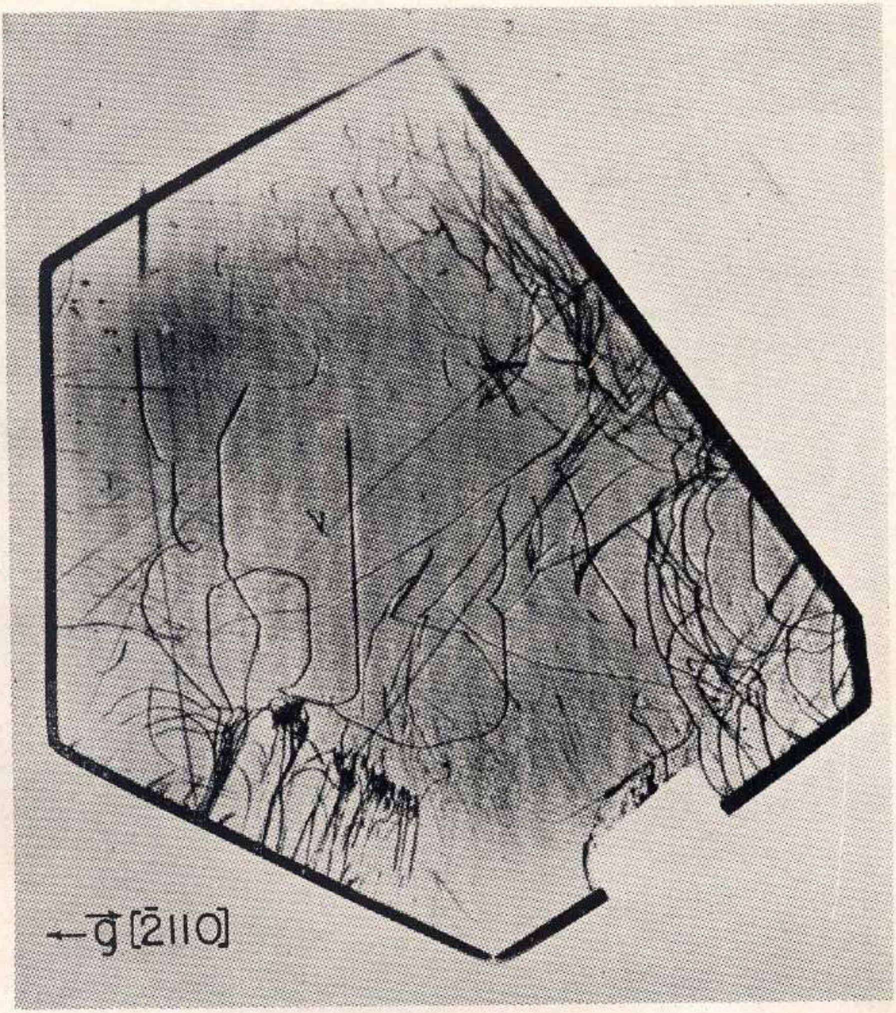


Fig 5 A projection topograph of a <0001> α-Al_2O_3 wafer recorded with [$\bar{2}$110] as diffraction vector. Mo K_{α_1} radiation is used

For identification of the end product of the reaction, X-ray powder method was used. The lattice constants and intensities were matched with the standard ASTM card.

Measurements of electrical conductivity and Seebeck coefficient of gadolinium gallium garnet (GGG) single crystal as a function of temperature were made between 200°C and 500°C. These crystals have resistance of about $10^{16}\ \Omega$ at room temperature which decreases with increase in temperature, which renders it difficult to make these measurements. A

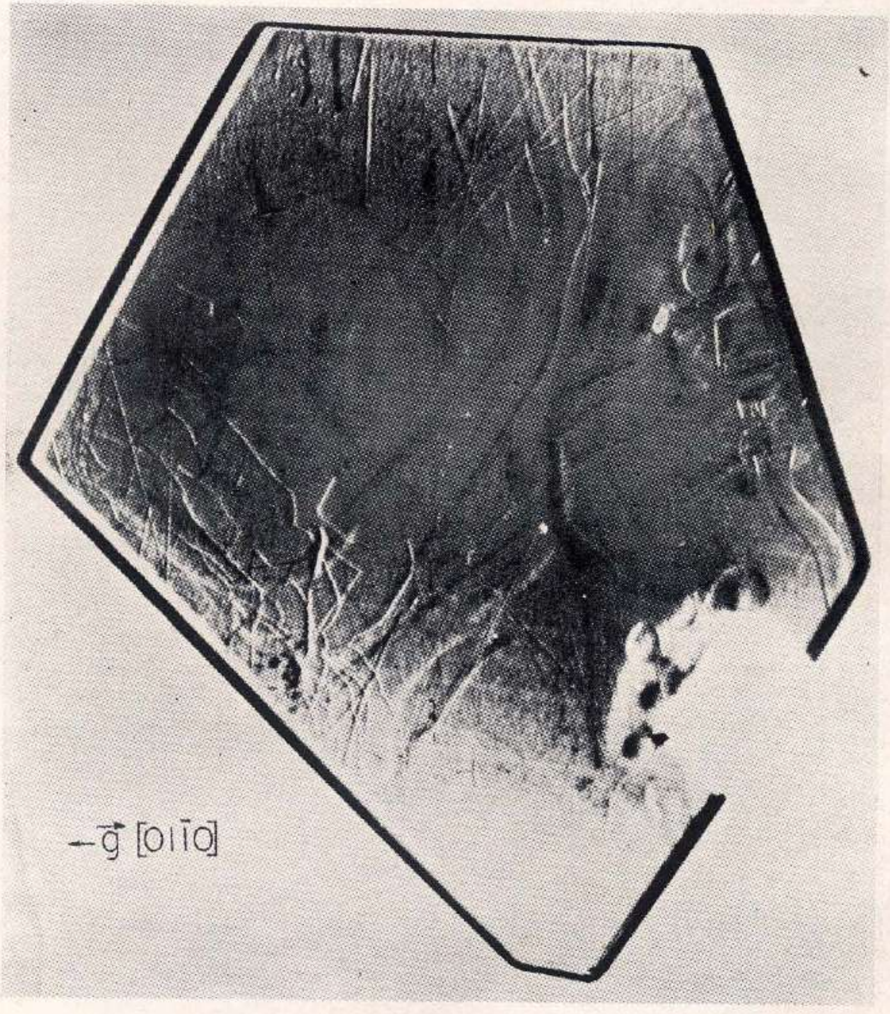


Fig 6 A projection topograph of the same wafer as in Fig 5, recorded using dynamical diffraction. In this case Cu K_{α_1} radiation is used

special sample holder was designed to make the Seebeck coefficient measurements.

One of the important parameters of insulating materials is dielectric constant. A set-up consisting of a new sample holder with which very accurate measurements of dielectric constant can be made, was developed. One can make out a difference of 10^{-5} pF at 1 pF value of capacitance. These measurements were made on sodium chloride and sapphire crystals. The values of dielectric constant have been determined as 5.895 for NaCl along [100] and 12.14 along [0001] for α-Al_2O_3.

This set up can be used for polycrystalline materials and to a lesser degree of accuracy for liquids also.

1.7 ELECTRON PARAMAGNETIC RESONANCE SECTION

A large variety of samples from Indian Agricultural Research Institute, All India Institute of Medical Sciences, industries, and various groups in the Laboratory were investigated, using E.P.R. spectrometer. In some of the samples interesting results were observed.

Carbon Fibres : EPR studies on PAN and carbon fibres were carried out. PAN fibres do not show any ESR absorption prior to heating in oxygen. The fibres, when heated in oxygen at 200°C, show an ESR spectrum. This heating causes an oxidation of the PAN fibres. The intensity and half-width of the ESP line were studied as a function of the time of oxidation. The half-width of the ESR line nearly remains independent of the time of oxidation. However, the intensity of the ESR line increases initially with the time of oxidation, reaches a saturation value, and then decreases.

It is interesting to note that when PAN fibres are heated in nitrogen atmosphere, no ESR signal is observed.

These experiments showed that paramagnetic radicals are generated only when the fibres are heated in oxygen. The free radicals are generated during oxidation of the hydroxyl groups to resonance-stabilized semiquinon structure which leads to aromatization. This finding helped in determining the optimum oxidation time of the PAN fibres.

ESR Studies in Crystalline Solids : ESR absorption measurements were made in alkali halides and other crystals. Some measurements were made on Cu^{2+} salts having distorted tetrahedral symmetry, approximating to D_{2d} symmetry. Such measurements are of great value in understanding the various properties of certain ferrites.

ESR Studies in Plastics and Polymers : Work on ESR studies on plastics and polymers was undertaken. Preliminary observations with toner used in electrophotography showed that there is no ESR signal for particles greater than 200Å. However, for smaller particles, ESR signal can be seen. This is perhaps due to degradation of plastics and resins where oxygen may be trapped or chains may be broken. This correlates very well with the observation that toner particles with a size less than 200Å retain an electrical charge better.

Help to Other Institutions : Solid and liquid samples were received from various institutions. Number of students from Delhi University, Allahabad University, All India Institute of Medical Sciences, Indian Agricultural Research Institute etc. were helped in recording and analysing ESR spectra.

I.8. MÖSSBAUER STUDIES

Considerable theoretical and experimental effort has gone into providing a model which would describe adequately the outer electrons of an atom in a crystalline solid.

There are essentially two descriptions of the outer electrons, viz., the crystal field theory, and the band theory. In the former, the outer electrons are assumed to be localized to discrete atomic positions, forming somewhat a Fermi solid. In the latter, each electron is shared collectively by all the atoms in a periodic array, forming, in contrast, a Fermi gas.

In the case of outer *s* and *p* electrons, there is no difficulty and they essentially conform to the band model. Conversely, *f* electrons are so tightly bound to the atom that they conform to the crystal field approach. The outer *d* electrons present an intermediate situation. In certain cases, they are described adequately by the crystal field theory whereas in other cases, the band model seems to provide a satisfactory description.

The question that arises is, whether the itinerant electron behaviour described by band theory and the localized electron behaviour described by the crystal field theory represent two distinct thermo-dynamic phases, and if they do, whether a first order transition from localized electron behaviour of outer *d* electrons to the collective electron behaviour is at all possible ? The same question appears in a different form when one considers the spin state of the 3*d* ion in a given compound. In the covalent crystal field approach, the parameter which determines whether the outer electrons are localized or collective is the magnitude of overlap integral $\Delta^{\pi,\sigma}_{cac}$. In this approach, one can envisage a possibility of σ electrons being collective while π electrons are still localized.

Rare Earth Cobaltates : Various rare earth cobaltates were studied using Mössbauer Effect, X-ray diffraction, electrical transport properties, magnetic susceptibility etc. It has been shown that localized electron behaviour and the collective electron behaviour are two distinct thermodynamic states, and a first order phase transition from one to the other is possible. Thus in $LaCoO_3$, outer $3d$ electrons are localized below 1210 K and become itinerant above this transition temperature. Indeed, these cobaltates exhibit metallic behaviour above respective transition temperatures.

Mössabauer investigations of $La_{1-x}Sr_xCoO_3$ system showed that for $x>0.25$, a ferromagnetic phase is initiated in the otherwise paramagnetic matrix. The proportion of the ferromagnetic phase increases with increase in the Sr content and with decrease in temperature. Detailed investigations on isomer shift, hyperfine field, Curie temperature and electrical conductivity, have conclusively shown that this system uniquely exhibits itinerant electron ferromagnetism. Indeed for $x=0.5$ the sample is ferromagnetic and shows metallic conductivity.

Detailed investigations have shown that of all the rare earth cobaltates, $HoCoO_3$ is an excellent catalyst for conversion of $CO \rightarrow CO_2$. $HoCoO_3$ is better than $LaCoO_3$ reported recently by the Bell Telephone Laboratories.

1.9 SULFAMPHTHALEIN INDICATORS

The objective is the introduction of a new series of indicators for chemical analysis, and the related dyes for animal fibres and medicinal purposes. The work aims at the synthesis of sulfamphthalein indicators, purifying them to the chromatographic grade, and examining their physico-chemical characteristics, viz., melting point, formation constants, IR, Visible and UV absorption spectra, and pH of colour transformation which would comprise of the characterization of colour change in terms of S.C.D. for sensitivity of colour change, pH m.c.c. correct to 0.01 pH units, and half band-width of pH for rapidity of colour change.

Work was initiated on the synthesis of sulfamphthalein indicators from the market-available starting materials. The various parameters of synthesis were investigated. In the initial stages, the separation of the product gave usable indicators, but the product was of technical grade. It was further purified to get chromatographically pure product (yield 70-80%).

Two useful gadgets, viz., (i) multipurpose solvent extractor and (ii) improved ammonia distillation apparatus were developed during the synthesis of these indicators. The former received the NRDC Invention Award for 1974 and is described below in some detail.

1.10 MULTIPURPOSE SOLVENT EXTRACTOR

The multipurpose solvent extractor combines the advantages of Soxhlet's apparatus (repeated extraction and concentrated extract) and the separating funnel (shaking, equilibration, and partition). It performs the functions of many an individual extraction apparatus. It can be used for multifarious extractions, e.g., solid-liquid, liquid (heavier or lighter) - liquid extraction at any temperature ranging from near room temperature to boiling point of the solvent at defined pressure/vacuum under any atmosphere. No mechanical or electrical stirrer is needed for mixing in the liquid-liquid extractions. The solvent vapours perform this function.

The extractor is useful for analytical determinations ; preparation and purification of fine chemicals; industrial, agricultural and biochemical extractions; for clinical diagnostic aid ; in environmental pollution ; in research and academic pursuits; and in standardization.

This apparatus has been fabricated in many sizes ranging from 20 ml to 2l capacity. In the design of this apparatus, the new features of using the solvent vapours for stirring and imparting their latent heat for obtaining higher defined temperatures of extraction have been introduced, while the beneficial features of the Soxhlet's apparatus, viz., repeated extraction of material with recycled fresh solvent, have been retained.

A novel feature which provides manifold advantages, is the introduction of a three-way proportionating stopcock in the vapour-lead tube. Through this stopcock one could proportionate the vapour to the condenser and into the extracting liquid. Thereby one could fix the temperature of extraction. By partially closing the stopcock and diverting the vapours to the condenser, one allows the mixed liquids to stand undisturbed and partitioned. By closing the stopcock during siphoning of the denser extract, the siphoning operation can be broken at any desired instance. Thus, one can retain the solution in the extractor for repeated extraction.

In case of a lighter liquid-liquid extraction, an additional glass arm is fitted through a standard glass joint provided at the end of the siphon inside the extractor, and extraction is carried out with little attention.

This apparatus can be assembled on a laboratory bench and secured by an iron clamp and stand. No special frame is required for operating it. It retains the simplicity of operation and can be used for batch extraction of a solute repeatedly with recycled fresh solvent.

1.11 ELECTRONICS SECTION

Digital Clock : A significant achievement of this Section during the period covered by the report was, the successful development of an Electronic Digital Clock as a project sponsored by M/s. K.L.B. Electronics, New Delhi.

This clock is useful for installation at public places for long distance viewing by the people. The numeral size is 15 cm $\times$ 19 cm. The clock operates on 220 V AC mains, but trips over to an emergency supply in case of mains supply failure, without the loss of accuracy in time. It is expected to cost about Rs. 2,000/-. It can find applications in places like railway platforms, air terminals, cinemas, business houses etc.

Auto Telephone Dialling System : A system was developed for use at a telephone subscriber's end, and was successfully tried on three digit internal telephone system. It provides a very convenient means of selecting the desired busy telephone numbers without the subscriber having to dial the number in a usual manner. In short, this would be a programmed computerized subscriber telephone system.

2. CRYOGENICS GROUP

Introduction

Cryogenics has no more remained a mere preserve of a research scientist but is finding ever increasing applications in various industries such as steel, fertilizers, chemicals, metal working, aerospace etc. In addition to the various industrial applications, cryogenics has another important aspect and, that is, — many materials behave in a peculiar way at very low temperatures. Thus some of the metals and alloys lose their resistance at low temperatures. These superconducting materials are also finding increasing applications for making high field magnets, motors and generators. In some advanced countries, superconducting materials are being used for power generation, transmission and high speed transportation. Similarly, cryogenic technology is being used in increasing measure to preserve food, fish, blood etc.

2.1. CRYO-TECHNICAL SERVICES

This Section maintains and operates various liquefiers such as air, nitrogen and helium liquefiers. These cryogens were supplied to the various Divisions in the Laboratory, and also to outside research institutions and industrial undertakings. Valuable assistance by way of technical advice to various scientists from within the Laboratory as also from outside was also given, regarding design of cryostats, techniques of low temperature measurement etc. A liquid nitrogen vessel from Agricultural University, Pant Nagar, was also repaired.

2.2. CRYOPROPERTIES OF MATERIALS

In the Section on cryoproperties of insulating materials, metals and alloys, emphasis was laid on the study of the behaviour of metals and alloys at very low temperatures. Systematic studies on thermo-electric power, electrical residual resistivity, and the magnetic susceptibility measurements were made on palladium and palladium-tungsten alloys. In conjunction with the high temperature electrical and thermal conductivities of these alloys (measured at IIT, Delhi), inferences were drawn regarding the density of electron states and the band gap in these metals and alloys.

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2.3. CRYOGENIC PLANTS AND FACILITIES

Dewars: In this Section, the design of 5 and 15 litre liquid air dewars was perfected. The know-how for making these dewars was passed on to NRDC for commercial exploitation, and M/s. Refrigeration and Cryogenics of Delhi took up the process.

Solid Carbon dioxide Generator: During the period under report, the Section also designed and fabricated solid carbon dioxide generator. This generator, on connecting it to a commercially available CO_2 cylinder, continuously produces solid carbon dioxide with about 60% efficiency. The generator is capable of producing 2-3 kg. of solid carbon dioxide per hour. In addition, when the generator is not being used to produce solid CO_2, it can be used to store chemicals, photographic plates etc. at a temperature down to —5°C. These solid carbon dioxide generators have a great demand and serve a useful purpose in colleges, research laboratories etc. The process for fabricating these generators was passed on to NRDC.

Air Liquefier: A notable achievement of the Section was the successful fabrication of an air liquefier. The air liquefier developed by the Laboratory is based on Claude cycle.

The machine consists of a reciprocating expansion engine, heat exchangers and Joule-Thomson expansion valve. High pressure air at 400 psi is passed through a purifying system where water vapour and CO_2 are removed from the air stream. The purified high pressure air is passed through the high pressure channel of the first heat exchanger. Part of the air emerging from this heat exchanger is fed to the expansion engine whereas the remaining air is passed through the second and the third heat exchangers after which it is subjected to Joule-Thomson expansion. The high pressure air which is passed to the expansion engine undergoes an adiabatic expansion to a pressure slightly above the atmospheric pressure. The cooled air, consequent on adiabatic expansion, is fed into the low pressure channel of the second heat exchanger where it pre-cools the incoming high pressure air. The cooled high pressure air at 400 psi undergoes Joule-Thomson expansion. Part of this air is liquefied whereas the rest goes out as cold flash gas. This cold flash gas is fed into the low pressure channel of the third heat exchanger thereby conserving the refrigeration generated.

The expansion engine is versatile in the sense that the timings of the inlet and outlet valves can be adjusted from outside. The expansion engine consists of a hard chrome-plated bronze cylinder in which nylon-sleaved mild steel piston with carbon loaded teflon rings reciprocates. The expansion engine produces a temperature drop of about 45°C.

The heat exchangers consist of two tapered coaxial cylindrical shells in-between which finned copper tube is wound helically. The total length of the heat exchanger is 5 ft. and the average diameter of the exchanger is roughly 7 inches. A technique.has been developed to fin copper tubing so as to produce greater surface area, and thereby better heat exchanger.

The machine starts liquefying within two and a half hours after it is switched on. It produces 6 litres of liquid air per hour *(Fig 7)*. Several universities

Fig 7 Laboratory type air-liquefier based on Claude cycle, developed at the Laboratory

and research laboratories have enquired about the possibility of supplying these liquefiers to them. The liquefier uses completely indigenous components and materials.

2.4 CRYOPROBES

Cryoprobes suitable for cataract removal and retinal re-attachment were developed *(Fig 8)*. The cryoprobe produces temperature upto — 80°C at the tip, within a couple of seconds. It has detachable tips of varying sizes and shapes. After the operation is over, the tip is heated by a heater mounted in the tip, for defreeze and quick removal of the cryotip from the operated part.

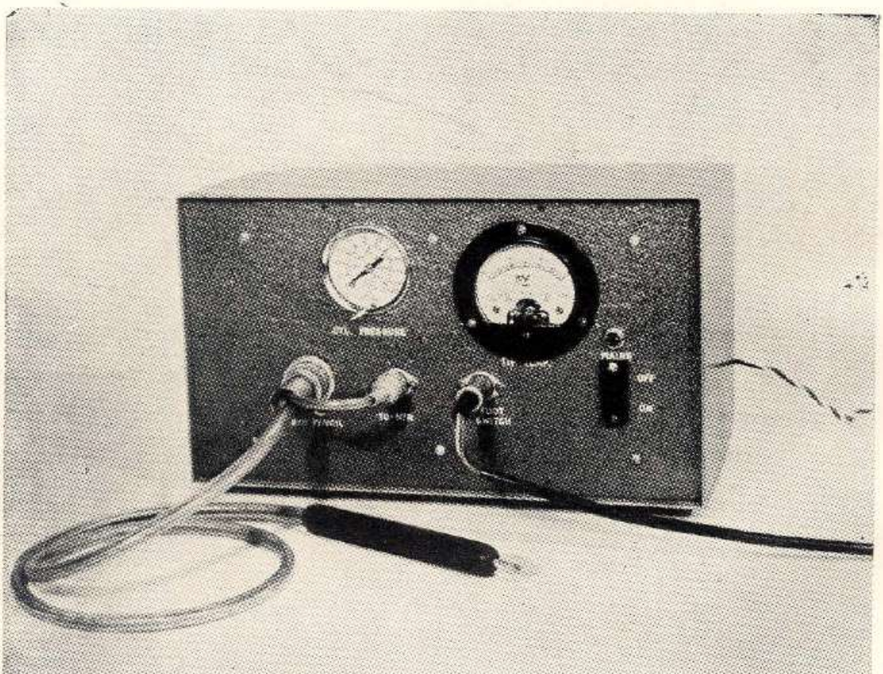

Fig 8 Cryoprobe suitable for cataract removal and retinal reattachment, developed at the Laboratory

2.5 SUPERCONDUCTING MATERIALS & SYSTEMS

The programme in this field centred round the development of superconducting materials, their characterization, the study of the relationship between superconducting properties and the microstructure resulting out of the heat treatment, making multi-stranded copper clad wires and then making superconducting magnet for laboratory purposes.

Small ingots of 5-10g of Nb-Ti were prepared in argon arc furnace designed and fabricated in the Laboratory. These samples were homogenised and annealed. These Nb-Ti ingots were drawn in the wire form, and in multi-stranded wire form. *Fig 9* shows the cross-section of the multi-stranded Nb - Ti wires in copper matrix. Techniques were developed for making multi-stranded wires in copper ingots. In addition to making small amounts of Nb-Ti, efforts were also made to make Nb_3Sn by diffusing tin in tapes of niobium. Some preliminary experiments were also made to draw multi-stranded Nb wires in bronze matrix and then diffusing tin from bronze into niobium wires. These experiments were successful.

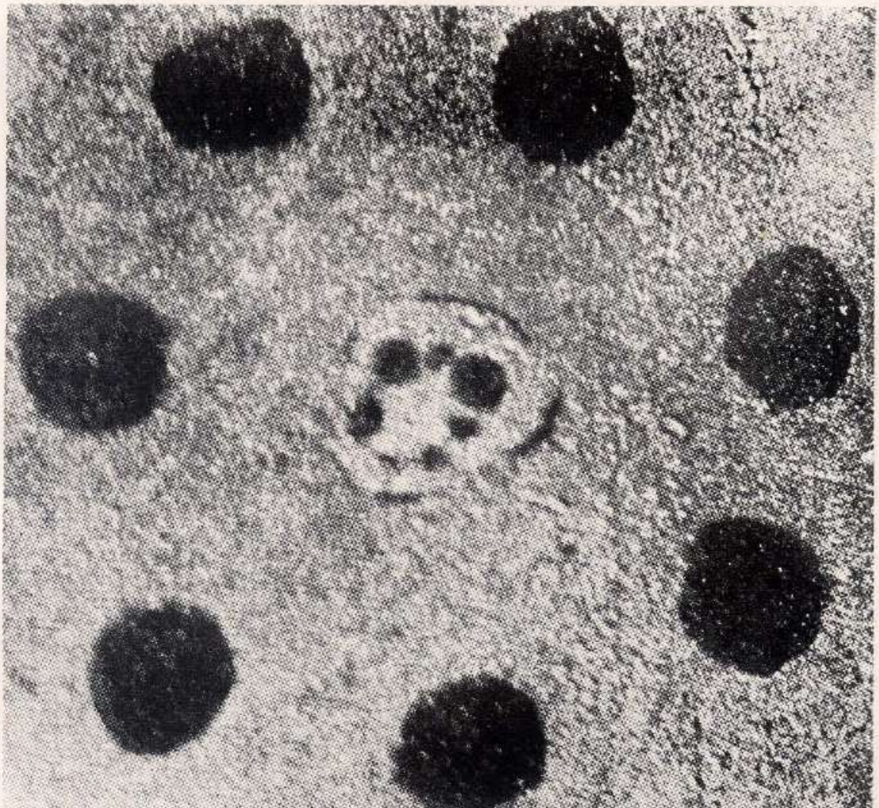

Fig 9 Nb - Ti superconductor : 14 filaments in copper matrix

Studies of microstructure of superconductors, using transmission electron microscopy, were also initiated. The materials studied included pure Nb, Nb-Ta and Nb-Ti alloys. The method of splat quenching was developed for making highly stoichiometric β tungsten compounds of high critical temperature.

Following a recent publication, an alloy of $Cu_{93}Nb_5Sn_2$ was prepared. It was then drawn into wires. It is possible to make superconducting materials following the method of melting together 93% by weight of Cu, 5% of Nb and 2% of Sn. The ingots thus prepared and drawn into the wire form require suitable heat treatment for initiating superconductivity in these materials. Work on the identification of the exact parameters of the heat treatment was initiated.

An arrangement for T_c measurement was designed which involved measurement of change of mutual inductance at the point of transition.

A convenient method for making thin foils was developed and some photographs of defect structure in Nb-Ta were obtained.

2.6 THEORETICAL INVESTIGATIONS AT LOW TEMPERATURES

A second-order non-linear differential equation for the spin-flip scattering amplitude was derived. For this derivation, the well-known Ward identities relating vertex and self energy corrections were used. The solutions of this non-linear equation and therefrom the resistivity of Kondo systems were obtained in terms of digamma functions for the different temperature regions. Abrikosov's formula for the region above the Kondo temperature was recovered. Nagaoka's spin compensated state was also obtained as a particular case.

The influence of magnetic impurities on the transition temperature of superconducting alloys was investigated by means of higher order parquet theory. This procedure is a self consistent renormalization of the *s-d* interaction vertex and the quasi-fermion self energy. The effective electron - electron interaction was evaluated beyond the logarithmic approximation in terms of the renormalized spin-flip amplitude which is responsible for the pair breaking effect of the magnetic impurities. A new formula for the maximal pair breaking which is dependent on the impurity spin and the superconducting coupling constant was derived.

2.7. JOSEPHSON TUNNELING

Systematic studies on both DC and AC Josephson effect were undertaken with a view to make some devices based on Josephson effect, and to standardize volt. If the insulating layer separating two superconductors is sufficiently thin (~ 10 Å) then in contrast to the thick insulator case, the decrease in free energy associated with phase coherence between pairs in two superconductors can be larger than the fluctuation energy. As a result, correlation between Cooper pairs on opposite sides of the barrier is appreciable, and the entire junction behaves as a single block of superconductor. This behaviour was predicted by Josephson in 1962 and has been called weak superconductivity. The I-V curve of such a junction displays a zero voltage for currents upto a certain value. When this critical current is exceeded, a voltage appears across the junction and it switches along the load line to the normal electron tunnelling I-V curve. The zero voltage super-current signifies the DC Josephson effect. Perhaps the more interesting phenomenon is the interference pattern observed when two Josephson junctions are in parallel with superconducting links. For this case the maximum super current which can be carried by the pair of junctions has two characteristic periods in the applied flux. One period is that associated with the flux threading a single junction. The second period is due to the quantum mechanical interference between currents flowing through the two separate junctions.

Measurement techniques were developed for the study of the critical (maximum zero voltage) currents I in coupled Josephson junctions. Self field effects in these junctions are identified from their oscillatory variation with temperature and also from their modulation by sub-gauss fields. Asymmetry of the junction loops was estimated. The I-V curves show that (above I_0) the areas enclosing the junctions and the London penetration regions of the super-conductors (older and niobium in our case), behave as type II superconductors, being in a resistive-superconductive state. Estimates are made for the Josephson penetration depth and H_{c_1}.

2.8 CRYOCHEMICAL METHOD OF SMALL POWDER PREPARATION

In an industrialized society, ceramic technology has come to occupy a very important place. By using the same unit process, but using different materials, one can make a large variety of products useful in many industries. Some of the sophisticated ceramic products such as high voltage ceramic capacitors, substrates for integrated circuits etc. cannot be made using conventional ceramic technology, consisting of grinding, ball milling, forming, sintering etc. It has been brought out that in these sophisticated ceramic compositions, it is necessary to start with materials composed of sub-micron, well characterized particles, with perfect homogeneity even in respect of trace dopants. Some new techniques have been developed in recent years to achieve this. Realising the importance of the small powder technology in ceramic making, the laboratory undertook a project on preparation of small powders using cryochemical method. In the cryochemical method, the solution of the salts in required proportion is

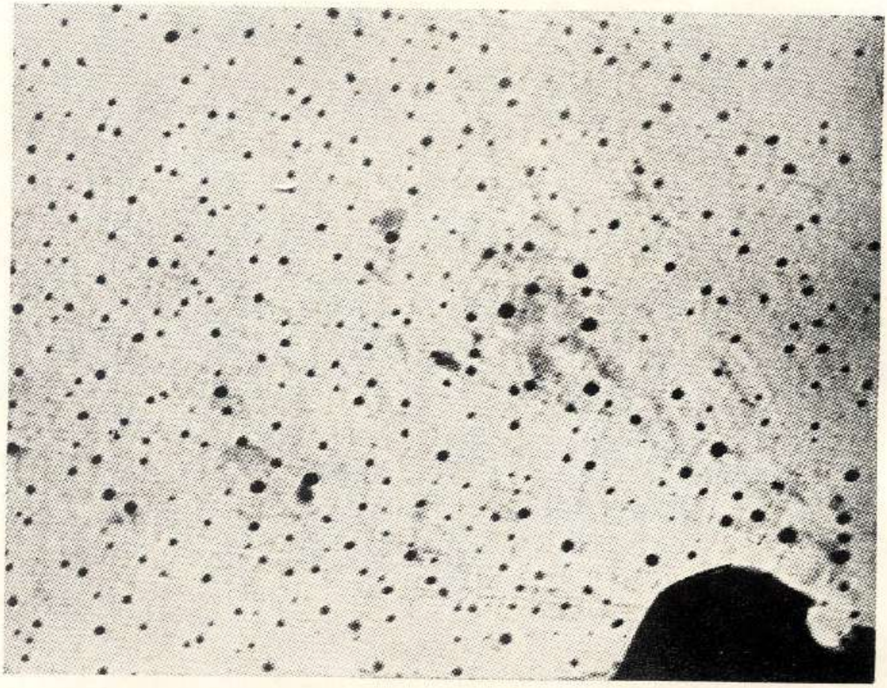

Fig 10 Microphotograph of Al_2O_3 particles prepared at the Laboratory, using cryochemical technique

sprayed through a nozzle in a bath chilled with liquid N_2. The chilled bath is then kept in the vacuum chamber, and water is allowed to sublimate, leaving behind particles of the salt, absolutely spherical and thoroughly homogenized. *Fig 10* shows the microphotograph of the Al_2O_3 particles prepared in the laboratory following the cryochemical technique.

Receipts from the testing work done by the Division of Specialized Techniques

The various specialized techniques were extensively utilized by the other activities of the Laboratory. With the spare capacity available, this service was also made available to outside parties on payment of nominal charges. The receipts for this work done for outside parties during the financial years 1973-74 and 1974-75 are given below :

Activity		*Number of Test Reports*		*Test fees in Rs.*	
		1973-74	*1974-75*	*1973-74*	*1974-75*
X-rays		10	8	5,190	1,680
Electron Microscopy		1	1	880	708
Low Temperature		1	—	—	40
Chemical Analysis		170	132	24,250	18,160
	Total	182	141	30,320	20,588

NOTE :— A number of jobs for spectro-chemical analysis were also undertaken for outside parties but the figures for these are not separately available.

A number of jobs done for outside parties are not reflected in the above table as the service was done gratis, and no test reports were issued.

A programme has been drawn out to make optimum use of the various specialized techniques, by running the equipment on two-shift basis, if necessary.

DIVISION OF MATERIALS

The Division of Materials pursued R & D activities in the following areas :

1. Semiconductor materials and devices ;
2. Magnetic materials ;
3. Piezoelectric & dielectric materials and devices
4. Low-loss ceramic insulators ; and
5. Carbon products.

This R & D activity was complementary to the activities of the two Pilot Plants, viz., (i) Development & Production of Electronic Components, and (ii) Carbon Technology.

1. SEMICONDUCTOR MATERIALS & DEVICES

Research and development in the area of semiconductors incorporated activity in silicon technology and luminescent materials and devices.

1.1 SILICON TECHNOLOGY

Polycrystalline Silicon : Generation of HCl gas by the reaction of hydrochloric acid and sulphuric acid was tried and a method was successfully developed for large scale production of HCl gas used in the preparation of trichlorosilane.

Cracking of trichlorosilane silicon on silicon filaments/rods was successfully tried.

Silicon rods of diameter 30 mm $\pm$ 1 mm were made. This is a dimensional requirement of the industry.

The resistivity of the material was upgraded. N-type silicon with a resistivity upto 200 ohm cm and a boron level corresponding to 250 ohm cm was produced.

Single Crystal Silicon : In the area of single crystals of silicon, the following achievements were made :

Growth of uniform diameter single crystal upto diameter of 50 mm by the Czhochralski method was perfected.

A process was developed for making thin silicon rods of 3.0 mm diameter and 55 cm length. These rods were made to be used as filaments in the preparation of polycrystalline silicon.

In order to improve the process, an argon gas purifier was commissioned.

Doping experiments were carried out to control the resistivity of single crystals of silicon grown in the Laboratory. Doped silicon of resistivity 1-50 ohm cm N-type was grown in the Laboratory.

220 slices of silicon single crystals worth Rs. 3,300/- made at NPL were supplied to semiconductor industry for consumer acceptability tests.

Two patents were also filed, viz., (i) a process for the preparation of 2 inches diameter single crystal silicon using commercially available (standard) argon gas, and (ii) A method for the preparation of long (55 cm) and thin (3 mm dia) silicon rods.

Silicon Devices : The work on the development of the know-how for the sponsored project for developing 50-75 A silicon diodes and peak inverse of 1,200 V was completed. The commissioning of the factory production at M/s Usha Rectifiers, the sponsor of the project, was completed. A formal know-how document was prepared and passed on to the firm for the transfer of the technology developed.

The technology for silver-tungsten tablet which was a by-product in the development of silicon diodes was also passed on to entrepreneurs through NRDC.

1.2 LUMINESCENT MATERIALS AND DEVICES

Work in the area of luminescent materials was continued further on the development of various phosphors. This included :

Studies on particle size for the suitability of phosphors in coating of T.V. picture tubes and cathode-ray tubes ;

Studies on cadmium sulphide regarding its photo-conductive properties with various coactivators ;

Preparation as well as EPR studies of CaS with a view to develop cheap materials as potential phosphors. To augment EPR studies, work on the setting up of cathodoluminescent unit with a negative EHT of 20 kV was also taken up ; and

Development of zinc silicate phosphors for a special CRT.

A proposal for setting up a pilot-plant for producing 600 kg per year of phosphors in the initial stages was submitted to NRDC. The proposal was accepted and NRDC agreed to finance the entire pilot plant involving expenditure of about Rs. 5 lakhs. Work was initiated in the setting of this pilot plant.

Feasibility studies on the development of a group of thin film luminescent devices, viz., solid-state X-ray image intensifier, alphanumeric display panels and video display panels, using the electroluminescent phosphors and photoconductors already developed, were also initiated, and work was taken up on development of improved materials for such applications.

2. MAGNETIC MATERIALS

R & D activities in the area of soft, hard and special ferrites were carried out.

2.1 SOFT FERRITES

Efforts were concentrated on the development of high permeability ferrites, medium and high frequency ferrites, T.V. deflection yoke cores, and hexagonal ferrites.

High Permeability Ferrites : Necessary facilities to produce high permeability ferrites with initial permeability $>20{,}000$ were set up. In the initial trials a high density Mn-Zn ferrite with $\mu_i \sim 6500$ and Curie temperature $\Theta > 125^\circ C$ was obtained. Experiments to study grain growth characteristics with respect to different additives like TiO_2, V_2O_5 etc. were planned for further work.

Medium and High Frequency Ferrites : A Ni-Zn-Cu ferrite suitable for medium wave applications, with μ_i of 300 ± 20 was developed and I.F. drum cores were produced using this material. Development of Ni-Zn based ferrites which are used in high frequency (1-10 MHz) with properties equivalent to Philips 4C6 or Siemens Kl was started. Initial experiments showed that using commercial grade raw material, it was possible to process a ferrite of $\mu_i = 80$ to 100, with D.F., T.F., and Θ_c within specifications.

Efforts were directed at improving the loss factor by using higher purity raw materials.

T.V. Deflection Yoke Cores : Efforts were concentrated on the development of T.V. deflection yokes using indigenously available cheap iron oxide. In the first stage, T.V. deflection yoke core used in Philips AT1030 deflection assembly was completely developed and pilot-produced for consumer acceptability trials. As a result of the feed-back from the consumers, work on the development of T.V. deflection yoke cores used in Philips AT 1040 was undertaken, and the cores were developed. About 2000 of these T.V. deflection yoke cores were produced and 600 of these were sent for consumer acceptability. The consumers approved the magnetic and electrical performance of these yoke cores. Technical personnel from M/s. Ferroelectric Private Ltd., Hyderabad underwent training for making T.V. deflection yoke cores. The process was also demonstrated to technical representatives of M/s. Semiconductors Ltd., Poona and M/s. Ceramic Magnets and Electronics, Madras.

Hexagonal Ferrites : Hexagonal ferrites to be used between 100-500 MHz were developed, resulting in replacement of costly and imported Ni with indigenously available and cheap element like Barium.

An indigenously available substitute for PVA as binder in extrusion of ferrite components was developed and this know-how was transferred to the licencee of the know-how for soft ferrites developed earlier. Engineers from M/s. Mulchandani Radio and Appliances, Calcutta, and M/s. Hari Ratan Gupta, New Delhi were trained in the processing of antenna rods and cores.

A patent entitled 'Improvement in or relating to the manufacture of medium wave cup and drum cores' was filed.

2.2 HARD FERRITES AND SPECIAL FERRITES

Hard Ferrites : Rubber based flexible magnets using hard ferrite powder with a $(BH)_{max}$ of 0.45 MGOe, B_r of 1300 gauss and H_c of 1110 Oe were developed and supplied to consumers for field trials.

Magnetic Tape Technology : A magnetic tape coating unit for production of magnetic tapes was designed, fabricated and commissioned. The trial runs showed that the magnetic tapes produced meet the ISI electro-acoustic specifications. The unit is capable of making 2 million metres of tape per year. Lacquer for coating the tapes was also developed. A patent entitled 'Improvement in or relating to continuous coating of magnetic tapes' was also filed.

Magnetic Transducers : Magnetostrictive ferrites having coupling coefficient $k=0.20\pm0.02$ were developed in torroidal form. Experimental ultrasonic transducers almost equivalent in their ultrasonic radiation capability to that of a PZT were fabricated.

Memory cores : Memory cores of 80 and 50 mil diameter were developed. These cores were supplied to consumers for testing.

Silver Paint : A new conducting silver paint of 'fire on' type was developed. This has a big use in ceramic capacitors, selective metallisation of ceramic surfaces and carbon track resistors.

3. PIEZOELECTRIC & DIELECTRIC MATERIALS AND DEVICES

In the activity on piezoelectric and dielectric materials and its devices, efforts were concentrated on development of suitable material for the use of different type of piezoelectric transducer elements and high voltage ceramic capacitors. The various shapes and sizes of the piezoelectric transducer elements and high voltage ceramic capacitors were produced on pilot plant scale and were sold for consumer acceptability.

Development of a number of ultrasonic instruments and devices was also undertaken using the developed materials.

3.1 PIEZOELECTRIC MATERIALS

The piezoelectric ceramic material, viz., NPLZT-5 (modified lead zirconate titanate) was developed and standardized. It can be used for making low power electromechanical transducers, acoustic sensing elements, flaw detection probes, hydrophones and bimorph elements.

NPLBTA piezoelectric ceramic composition, using barium titanate was also standardized for low power application where temperatures encountered are well below the curie temperature.

Tubular form of piezoelectric material was fabricated for which there is major demand by Navy.

Technical improvements in the process of fabrication of ceramic bimorphs and the R & D activity resulted in improved mechanical strength and output of pickups.

The typical properties of NPLZT-5 and NPLBTA indicating piezoelectric and dielectric parameters are depicted in Table I.

TABLE I

Typical properties of NPLZT-5 and NPLBTA Piezoelectric Materials

Property	*Symbol*	*Unit*	*NPLZT-5*	*NPLBTA*
Piezoelectric Charge Constant	d_{33}	10^{-10} coulomb/newton or metre/Volt	3.1	1.9
Piezoelectric Voltage Constant	g_{33}	10^{-2} Volt-metre/newton or metre^2/coulomb	2.1	1.78
Planar Coupling Factor	K_p	—	0.55	0.35
Longitudinal Coupling Factor	K_{33}	—	0.60	0.40
Relative permittivity (Free)	$\epsilon_{33}^T/\epsilon_0$	—	1750	1200
Dielectric Loss Factor	$\tan\delta$	$\times 10^{-2}$	1.5	1.5
Frequency Constant (Thickness mode)	N_3t	metre-Hz	1900	2900
Density	ρ	10^3 kg/m^3	7.5	5.3
Curie Temperature	Θ	°C	320	120

3.2 HIGH VOLTAGE CERAMIC CAPACITORS

Ceramic disc capacitors, in 2 kV and 4 kV DC working range were standardized for pilot production in the following two standard ceramic compositions :

Temperature Compensating (TCD) Type : The composition of TiO_2 and MgO has been used for capacitors suitable for use in resonant circuits or any other applications where low losses and high stability are essential.

General Purpose (MKD) Type : The composition based on $BaTiO_3$, $CaZrO_3$ and $PbZrO_3$ has been used for capacitors suitable for by-pass and coupling applications or frequency discriminating circuits where low losses and high stability of capacitance are not of major importance.

The technical specifications of the capacitors manufactured with the above two compositions are given in Table II.

TABLE II

Technical Specifications of high voltage ceramic capacitors

Characteristics	*TCD type*	*MKD type*
Capacity tolerance	±5%, ±10%, ±20%	±5%, ±10%, ±20%
tan δ (at 30°C)	.002	.02
Test Frequency	1 MHz	1 kHz
Temp. Coefficient	750±120 ppm/°C	—
Max. Capacitance change	—	±20%
Leakage Resistance	10,000 Megohm	10,000 Megohm
Flash test voltage	2× D.C. Working Voltage	2× D.C. Working Voltage
Operating Temperature	O°C to 85°C	O°C to 85°C
Values available	(a) 82 pF (b) 120 pF	(a) 120 pF (b) 150 pF
	(c) 150 pF (d) 220 pF	(c) 220 pF (d) 270 pF
		(e) 330 pF (f) 390 pF
		(g) 470 pF

Research and development work on high K material was initiated. Preliminary investigations carried out for various compositions based on $BaTiO_3$, $CaZrO_3$ & $PbTiO_3$ showed encouraging results.

3.3 ULTRASONIC INSTRUMENTATION & PIEZOELECTRIC DEVICES

3.3.1 Piezoelectric Liquid Level Controller

Prototype model of a Piezoelectric Liquid Level Controller for control of conductive and non-conductive liquids was made *(Fig 11)*.

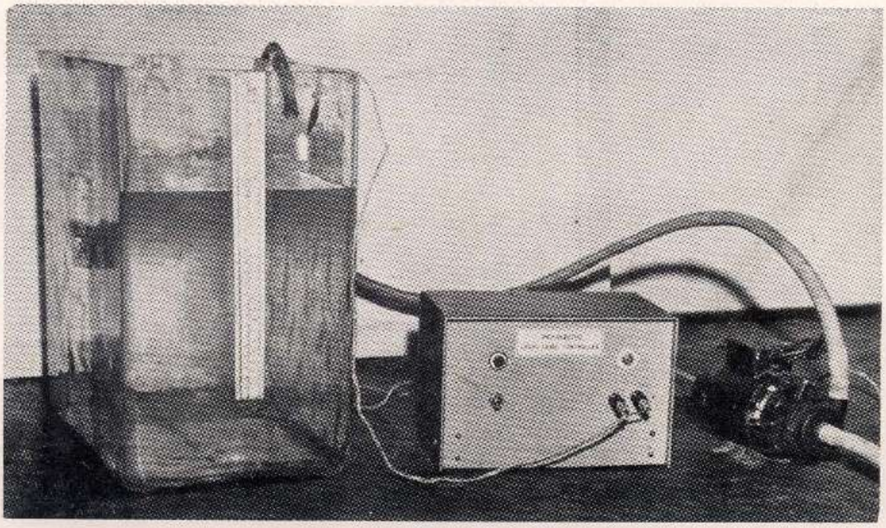

Fig 11 Piezoelectric liquid-level controller developed at the Laboratory, for control of conductive and non-conductive liquids

The device consists of a piezoelectric transducer vibrating in air in flexural mode and when any liquid comes in contact with the vibrating face of the system, the vibrations are damped, feeding an input signal to a circuit, which, in turn, operates a relay. The relay may be used to operate a motor, a pump to fill or evacuate a tank, or to indicate a particular level in the tank.

3.3.2 High Power Transducers

A prototype model of high ultrasonic cleaner (frequency-890 kHz, power—3 W ; 24 mm dia.) was made and supplied to Director, Physical Research Laboratory, Ahmedabad, for cleaning of moon rock samples.

Study of the ultrasonic sandwich transducers for 20 kHz & 35 kHz for cleaning applications, under different prestresses, was made.

Prototype model of 80 W generator for ultrasonic cleaner was fabricated on the basis of the above study.

3.3.3 Ultrasonic and Piezoelectric devices

Piezoelectric Displacement Transducer : Piezoelectric displacement transducer for very fine movement was made and studied under loaded

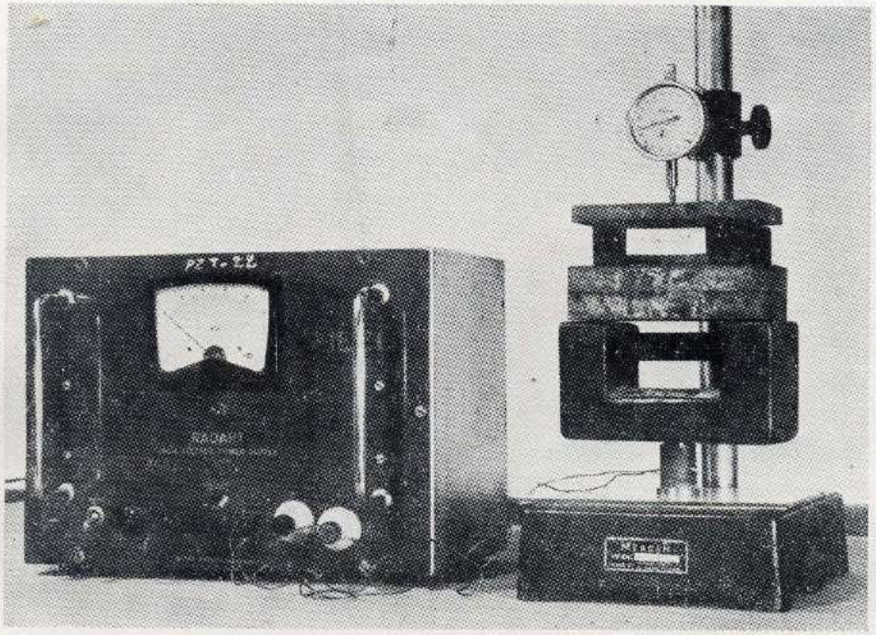

Fig 12 Piezoelectric displacement transducer for very fine movement, developed at the Laboratory

conditions *(Fig 12)*. It is an excellent means of giving a very small movement of a few microns or of a fraction of a micron, with precision, by applying DC voltage to it.

The transducer consists of a number of silver plated and polarized lead zirconate titanate discs, cemented together to form a stack of these discs. The electrical contacts with the silver plated ends of these discs are taken on alternate joints on one side and on the remaining alternate joints on the other side. The stack is enclosed in a case, and the terminals from the two sides are used for giving the DC voltage input. When the voltage is applied to the transducer, its top end moves freely up and down as the voltage is increased or decreased.

This translator is extremely useful in CW laser amplitude or frequency stabilization as well as for the normal applications such as Febry-Perot interferometry and for positioning in integrated circuit assembly.

Piezoelectric Mini Tuning Fork : The Piezoelectric mini tuning fork *(Fig 13)* is a miniature tuning fork which is driven with the help of piezoelectric elements, and works as an accurate frequency standard. This device is specially designed to be used in transmitting and receiving systems equally well, with improved electrical and mechanical performance.

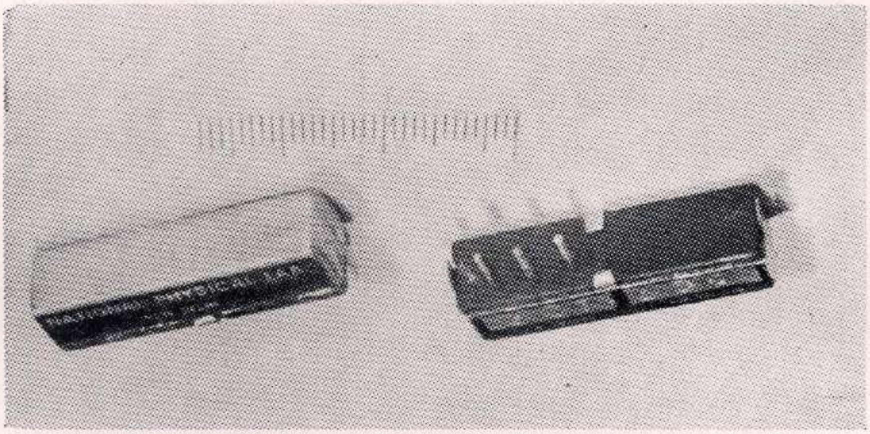

Fig 13 Piezoelectric mini tuning fork for bell boy systems, selective calling, remote control etc., developed at the Laboratory

It is a high Q resonator, and has a wide range of uses including bell boy systems, selective calling, remote control, and tone control of electronic musical instruments, to name only a few, where compactness, ruggedness, and economy are required.

Piezoelectric Spark Gas Igniter: The use of piezoelectric ceramic in high voltage generation is being applied now in various applications such as gas heaters, table and pocket cigarette lighters, ignition of flash bulbs, ignition of fuses for explosives etc., as it is considered to be more practical and economical.

The piezoelectric device developed for ignition is simple in design. The high voltage generated by the impact of a mass on a piezoelectric ceramic cylinder produces a powerful spark, which can be used in any of the applications mentioned above.

3.3.4 Ultrasonic Non-destructive Testing Probes

As a continuation to the development work on the non-destructive testing probes the following probes were developed :

Ultrasonic Material Testing Probe : Ultrasonic techniques have a definite advantage over the other methods as they are direct and can be used *in situ* for detection of any cavities and internal flaws of inhomogeneities in the structure of materials having coarse grains or porous structure, viz., concrete, timber, ceramics, grinding wheels, glass reinforced plastics etc.

The probes used for ultrasonic inspection work are the important part of ultrasonic test equipment *(Fig 14)*. These are the low frequency

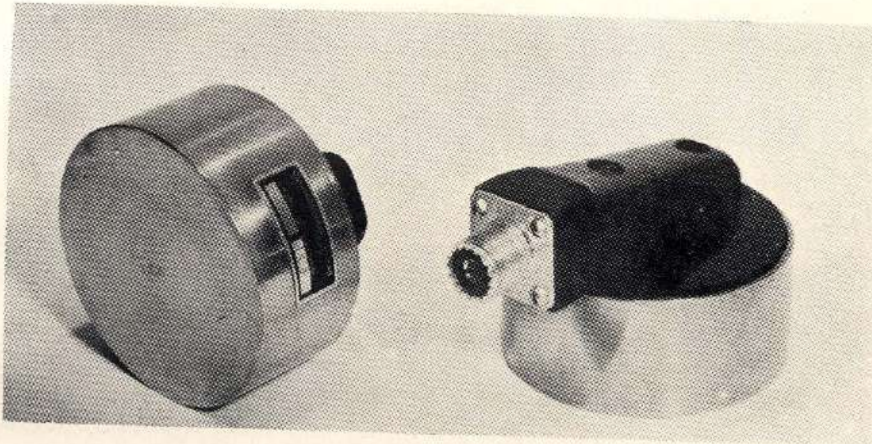

Fig 14 Ultrasonic material testing probe for testing concrete, timber, ceramics, plastics, etc., developed at the Laboratory

(150 kHz to 500 kHz) probe heads, and are capable of handling far more power as compared to the ordinary flaw detector probe heads.

The probe heads are available in three different diameters of (40 mm, 60 mm and 70 mm), in three different frequencies of 150 kHz, 300 kHz and 500 kHz approximately.

Normal Twin Probes and Miniature Normal Probes : Prototype models of normal twin probes and miniature normal probes for ultrasonic flaw detection were developed.

3.3.5 Underwater Acoustic Testing Facility

Construction of a tank for the measurement and testing of underwater acoustic transducers was started.

3.4 SERVICE TO THE INDUSTRY

A number of devices and instruments were supplied to various organisations during the year. They include :

(a) Apparatus for study of Bragg's Law of diffraction using ultrasonic waves ;

(b) Ultrasonic air transducers ;

(c) Ultrasonic non-destructive testing probes ;

(d) Ultrasonic timber testing probes ;

(e) Ultrasonic high frequency cleaner ;

(f) Mini tuning forks ;

(g) Ceramic capacitors ; and

(h) Piezoelectric materials.

A number of sophisticated imported ultrasonic non-destructive probes were reconditioned for various governmental organisations — like Civil Aviation, Railways, Heavy Electricals, Steels etc., and private organisations, resulting in foreign exchange saving of over Rs. 20,000/- for the probes only.

One rotor shaft of 120 HP motor belonging to Delhi Milk Scheme, Delhi, was ultrasonically tested for flaws.

3.5 KNOW-HOW RELEASED

Know-how on manufacture of ultrasonic interferometer was released to M/s. Electro-Mech Industries, New Delhi and its representative was given practical training for exploiting the know-how. A representative of M/s. Vijay Ceramic Industries, New Delhi, who are the Licencees of NPL's know-how for electro-ceramic materials, was also trained.

4. LOW-LOSS CERAMIC INSULATORS

Small quantities of (i) steatite ceramic items for use in electron tubes and vacuum devices, and (ii) alumina ceramics for certain applications like spacers in electron tubes for high operation temperature, were produced, and work on standardisation of their compositions for large-scale production was initiated.

5. CARBON PRODUCTS

Research and development activities in the area of carbon technology covered the following :

(i) Cinema arc and process carbons;

(ii) Midget electrodes;

(iii) Electrographitised grades of brushes;

(iv) Carbon fibres;

(v) Carbon mixes; and

(vi) Special carbon products.

5.1 CINEMA ARC AND PROCESS CARBONS

Research and development work was carried out to improve the quality of our cinema arc carbons in order to obtain better performance in electrical and light characteristics. As a result of these efforts it was possible to bring down the current consumption from 60-65 A to 45-50 A. It was also possible to remove flickers and get snow-white colour of the light emitted.

NPL licencees were assisted in setting up their industrial production. Products made by the licencees were tested for quality control.

With the Licencees going into production for cinema arc carbons and process carbons, further R & D activity in this area was closed. Work was initiated on the development of rotating carbons which are now being used for 75 mm projectors and which are being totally imported. A few experimental batches were tried and initial field trials were carried out.

At the instance of Indian Space Research Organisation, R & D activity was undertaken to develop arc carbon electrodes for solar simulators.

5.2 MIDGET ELECTRODES

Work on the development of know-how for midget electrodes was completed. It was possible to process midget electrodes of ISI specifications.

Four lakh pieces of midget electrodes were processed in the pilot plant to achieve reproducible results. About 3 lakh midget electrodes were supplied to the battery manufacturers for consumer acceptance trials.

The process know-how for midget electrodes was released to M/s. Britelite Carbons Limited, Halol. Training was given to their engineers in the processing.

The experimental production at the plant of our licencee was also started, and assistance was given by our scientists and engineers in controlling the quality of the product and solving the problems in commercial production.

NRDC got a project report prepared for midget electrodes from M/s. Kirloskar Consultants. This report justified the techno-economic feasibility of the project, based on our know-how.

5.3 ELECTROGRAPHITISED GRADES OF BRUSHES

The results of the field trial for E.G. grades of brushes developed earlier were not encouraging as such, and further improvements were made in the material composition and graphitisation techniques. It was concluded from our experimentation and field trials that higher temperature of graphitisation was needed.

5.4 CARBON FIBRES

A new developmental activity with a view to develop carbon fibres from various precursors was initiated. The fibres find an important place as a reinforcement material. Various precursors were tried. These included PAN and viscose rayon fibres. The facilities for carbonisation of these fibres were set up and it was possible to carbonise fibres from both PAN and viscose rayon upto 1000°C. The carbon fibres processed had the following mechanical properties :

PAN fibres

Tensile strength : 300×10^3 psi

Youngs modulus : 30×10^6 psi

Fibres processed from viscose rayon

Tensile strength : 50×10^3 psi

Youngs modulus : 2.3×10^6 psi

In addition to PAN and Viscose rayon, various other native precursor materials are being studied.

Detailed characterisation work revealed useful information for the development of fibres. UNDP approved the project as a part of a country programme. The following investments are envisaged :

UNDP investment : \$ 47,200

DST investment : Rs. 9,40,800/-

5.5 CARBON MIXES

A project on carbon mixes was initiated. This has a huge potential in the development of various types of carbon products, and it is proposed to carry out rheological studies on various carbon mixes under this project.

5.6 SPECIAL CARBON PRODUCTS

A few carbon seals for chemical plants were supplied to CMERI, Durgapur, and the results were encouraging.

Development work on graphite stopper heads for steel industry was initiated.

Graphite thrust blocks used in turbo generators in railways were developed for a firm. More than 2,000 pieces were supplied to the consumers for consumer acceptance trials.

Carbon contacts used by electrical and automobile industries were developed and batch-produced, and 10,000 pieces were passed on to users for commercial acceptance trials.

Carbon thrust bearings suitable for automobiles were developed and field-tested.

Samples of carbon piles for voltage regulators were supplied to the Defence authorities for field trials. These were approved.

DIVISION OF RADIO SCIENCE

The principal objectives of this Division are :

(i) To study, analyse and disseminate information on propagation of radio waves at all frequencies;

(ii) To conduct research on the nature of the media through which radio waves are transmitted;

(iii) To monitor solar-terrestrial environment;

(iv) To provide space environment disturbance monitoring and predictions. (Solar-geophysical services, radio warning services);

(v) To explore new radio techniques for the use of communication, meteorology, geodesy, environment monitoring and time standards;

(vi) To utilise the newly emerging techniques of space research in the study of the near space environment, and to explore new areas of applications; and

(vii) To study and identify the extent of man-made and natural environmental hazards.

1 GROUND-BASED FACILITIES FOR ENVIRONMENT MONITORING

Scope and objectives

(i) Development of facilities and competence in environment monitoring by radio methods, comparable to those in advanced countries; and

(ii) To provide environment data to users, and research on techniques.

Techniques used : The monitoring of upper atmospheric environment through radio techniques continues on a routine basis. The equipments operating currently are :

(i) Ionosonde;

(ii) Cosmic ray noise measurements with riometers at 28.5 & 30 MHz ;

(iii) Field strength measurements at 164 kHz (Radio Tashkent), 634 kHz (Lahore) and 22.3 kHz (NWC, Australia); and

(iv) A dopplometer at 10.0 MHz (receiving ATA at NPL, and JJY at Calcutta).

The measurements provide basic raw material for prediction of radio propagation conditions via the ionosphere, as well as monitoring of disturbances to propagation conditions caused by events like solar flares and magnetic storms.

Progress

The facilities have provided useful and valuable data over the years. In addition to routine ionospheric sounding and solar flare monitoring, the facilities have been successfully used for detection of atmospheric nuclear tests.

The effect of magnetic storms on cosmic noise absorption was investigated. It was observed that the severe magnetic storms do produce noticeable effect on riometer absorption during high sunspot years depending on the on-set time of the sudden commencement of the magnetic storm.

Research work centering around the following was also undertaken :

1. Data reduction methods involving electronic computer techniques, giving electron density variations with height in the ionosphere as well as computations of absorption of radio waves;

2. Long wave propagation studies including absorption studies at grazing incidence and seasonal influence of solar flares;

3. Limitation of using ionosonde and riometer absorption measurements to get temperatures in the F-region of the ionosphere;

4. Prediction of atmospheric radio noise field strengths on the basis of theoretical and experimental investigations on a comprehensive basis to cover the entire Indian sub-continent; and

5. Possibility of a low cost communication link between mainland India and Andaman & Nicobar islands via Sporadic-E ionization.

It has been observed that solar flare effects on 164 kHz are quite different in summer and winter and that the changeover occurs around October/ November. This is an important result and provides a method for monitoring mesospheric dynamics through the recording of ionospheric flare effects.

New activities include (a) an experimental project for measurement of atmospheric radio noise in the VHF band and (b) feasibility study for using ionospheric reflections to design an over the horizon radar (OHR). The latter should be of vital importance to Defence Services.

2 ROCKET AND SATELLITE EXPERIMENTS

Scope and Objectives

To study the lower and topside ionosphere using rockets and satellite radio beacon experiments. The various objectives are :

(i) To measure the electron, ion and neutral number densities in the lower ionosphere;

(ii) To measure the total electron content of the ionosphere and to study scintillations and large scale irregularities; and

(iii) To use this ionospheric study for various space applications such as, refraction errors in satellite ranging and position fixing, the effects of irregularities on communications, etc.

Progress

ATS - 6 Satellite radio receiving systems at 40 and 140 MHz are being designed at NPL. The work of the SBF antenna required for ATS-6 Satellite radio receiving system at 140 MHz was started at NPL workshop. One satellite radio receiving system at 140 MHz has also been designed and fabricated at Max Planck Institute, West Germany, under a collaboration programme between NPL, and that Institute. The satellite was launched in May 1974, but will be placed over 35°E longitude in July 1975.

The satellite INTASAT was launched in November, 1974. The Faraday fadings at 40 and 41 MHz have been continuously recorded since then.

The NPL-Japan collaboration rocket was flown on 4th July, 1973 from Thumba. The propagation experiment and the Gerdien condenser, included in the payload, were provided by NPL. All the experiments worked satisfactorily till the rocket reached an altitude of about 40 to 50 km. However, the telemetry signals could not be received afterwards due to the malfunctioning of the rocket. This flight will be repeated in March 1976. Payload fabrication and testing for the NPL-Japan collaboration flight (repeat) is being continued.

A study has been made to improve the accuracy of the electron density measurements using a radio wave propagation experiment in the altitude range 50-75 km.

Theoretical models of electron density distribution in the lower ionosphere for equatorial region are derived by solving the continuity equations for electrons and positive and negative ions. A computer program has been written and used for solving these equations.

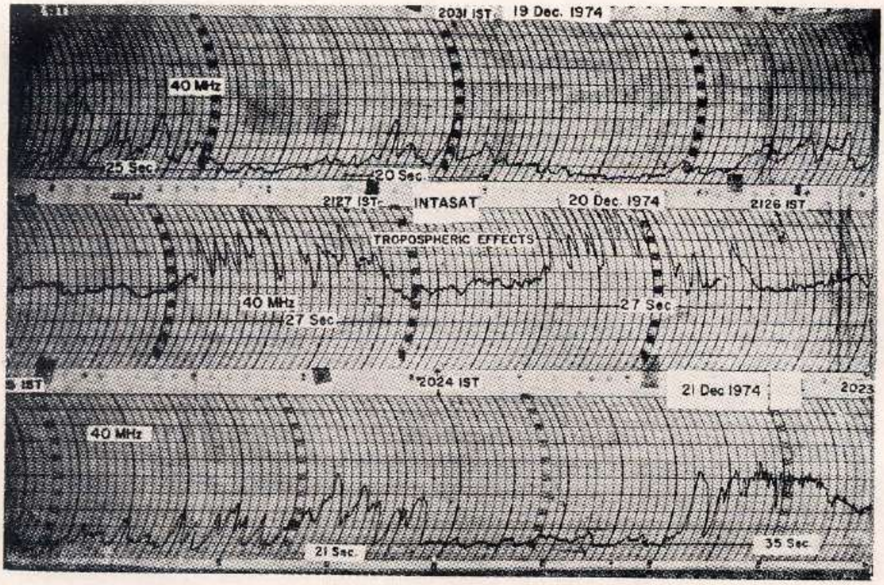

Fig 15 Signal enhancement/fluctuations due to tropospheric effect on satellite beacon signals

A major achievement was the first identification of a tropospheric effect with satellite beacon transmission. The effects were noticed in December, 1974 during a large atmospheric disturbance *(Fig 15)*.

3. RADIO AND SPACE SERVICES

Scope and Objective

(i) To study, analyse and disseminate information on propagation of radio waves at various frequencies especially at HF and VHF;

(ii) To explore and update the techniques of propagation with special emphasis on the Indian region;

(iii) To give alert warnings about solar and geophysical events that may have taken place recently or are likely to take place in the near future and are expected to influence the radio atmosphere;

(iv) To organise international exchange of ionospheric, solar and geophysical data and to arrange for national dissemination; and

(v) To cater to the special requests of radio communication organizations as well as geophysical research organizations in the country.

Progress

The current range of programme of the Radio and Space Services Group may be broadly classified as follows :

1. Ionospheric predictions;
2. Ionospheric and solar geophysical data;
3. Associate Regional Warning Centre;
4. Special advisory services;
5. Special radio propagation studies; and
6. Spacewarn services.

Most of the above items fall under the category of routine services, though the techniques adopted for the various services undergo continual updating.

A preliminary short-term forecasting service was initiated by using the flare patrol information obtained from Kodaikanal and Radio Science Division (NPL), and combining this with the solar and magnetic data received by telex from the Soviet Union. As in the past, a large number of requests for radio propagation services were catered to, the beneficiaries being the Indian Space Research Organisation, Overseas Communication Service and several arms of the Defence Services.

Major Facilities Installed : Until now the CSIR telex facility was being used for international data exchange. During this period, however, a new telex facility (No. RSDND 3726) was installed, and it is hoped that when the new facility is pressed into full service the national and international data exchange programme can be improved to serve the radio traffic organisations and research institutions in this country.

Collaboration with International Agencies : A successful programme of data exchange by the CSIR Telex and the IMD systems was initiated with IZMIRAN Moscow and with IPSO, Australia. The data thus exchanged include summary of f_0F_2 values, magnetic conditions and solar conditions.

4. AERONOMY

The current programme of activities includes :

1. NPL-TIFR scintillation work with Ooty radio-telescope and ATS satellite;
2. Energy budget of magnetic storms ;
3. Topside ionosphere and plasmasphere ;
4. Neutral atmosphere/troposphere coupling ;
5. Sudden ionospheric disturbances, including F-region effects;

6. Ionospheric models ;
7. Ionospheric chemistry ;
8. Polar wind ;
9. Laboratory aeronomy ; and
10. Incoherent scatter radar.

4.1 TOPSIDE IONOSPHERE AND PLASMASPHERE

Scope and Objective

To investigate the morphology and dynamics of the topside ionosphere and plasmasphere.

Progress

A model of topside ionospheric composition and temperature for medium solar activity was developed using the Explorer-31 and OGO-4 RPA data.

Theoretical models of F-region are being developed for Delhi, taking into account all chemical and dynamical processes.

Theoretical programme for calculating photo-electron fluxes under different conditions is being developed.

Studies are initiated on the problem of proton precipitation in the equatorial ionosphere.

4.2 HIGH LATITUDE TOPSIDE IONOSPHERE

Scope and Objective

To study the behaviour of high latitude topside ionosphere during quiet and disturbed periods.

Progress

The Alouette-II topside sounder data at the trough and higher latitudes were used to study the plasma flux outside the plasmasphere. The spectacular decrease of scale heights with increasing altitudes on several occasions has yielded quantitative flux estimates by studying the departure from the diffusive equilibrium profiles. The scale height profiles at the trough latitude and at latitudes close to the trough on either side are most coincident upto a certain altitude above which they show rather random divergent trends. This feature is observed to be more salient during night time and this trend indicates a considerable escape of fluxes of plasma away from the earth.

The electron density profiles obtained by the topside sounder data of Alouette-II satellite were analysed to study the polar wind fluxes around middle and high latitudes. The dependences of H^+ fluxes on plasma temperature and temperature gradient have been studied. It has been observed that H^+ attains supersonic velocity around trough latitudes and the flux values tend to decrease with increasing plasma temperature. It is also seen that the height where H^+ attains supersonic velocity increased with decrease in temperature gradients.

It is proposed to study the polar wind phenomena using the data obtained by topside sounder at high latitudes with special reference to quiet and disturbed periods.

4.3 NPL-TIFR SCINTILLATION WORK

A joint work on radio scintillation was initiated with the Ooty radiotelescope. Scintillations on 326 MHz showed bursts of scintillations which are far in excess of any currently existing model. For India, the particular point of concern is the potential degradation in satellite TV signals due to such heavy scintillations.

4.4 SUDDEN IONOSPHERIC DISTURBANCES

Flare effects in the ionosphere continue to be recorded and information fed into the international URSIGRAM Warning Systems. Our work on the physics and chemistry of the ionospheric flare effects is now a standard international work.

5. ENVIRONMENTAL HAZARDS

The current programme of activities includes :

(i) Sodar facility in monostatic mode ; and

(ii) Ozone environment - Threats from SSTs and Freon

5.1 ACOUSTIC SOUNDING OF THE LOWER ATMOSPHERE

Scope

Monitoring of the atmosphere upto a height of 1 km for use in hazardous situations in communication, aviation and air pollution.

Objective

To lay out the technique along with complete instrumentation, and calibrate it for monitoring parameters like temperature inhomogeneities, inversions, wind velocity and turbulence intensity in the lower atmosphere.

Progress

A colocated sodar system using the reflector horn antenna as receiver and square array antenna as the transmitter was operated in the NPL campus

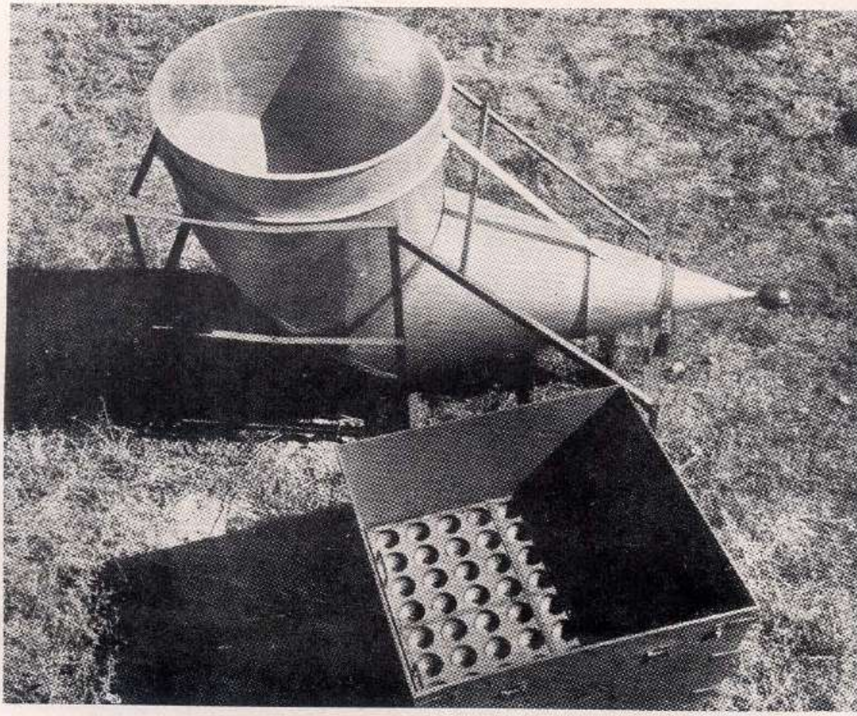

Fig 16 The square array and reflector horn antennas used for collocated Sodar experiments, developed at the Laboratory

for both day and night *(Fig 16)*. Records were obtained on the facsimile recorder (borrowed from IMD) on a two second sweep (repetition rate) covering a range of 340 metres of the lower atmosphere. These records were quite interesting as a simple glance of them could inform about the nature of the turbulence in the clear air of the lower atmosphere. The records of the bistatic system were analysed. A monostatic sodar system was designed and fabricated including the development of the necessary electronic circuitry. The system was operated for mapping the thermal structure of the lower atmosphere upto a height range of 340 metres *(Fig 17)*.

Major facilities installed: The facility for the monostatic sodar was created. This includes the design of the transmit-receiver switch and the low noise pre-amplifier.

The operation of the monostatic system was demonstrated to Director General and Deputy Director General, India Meteorological Department.

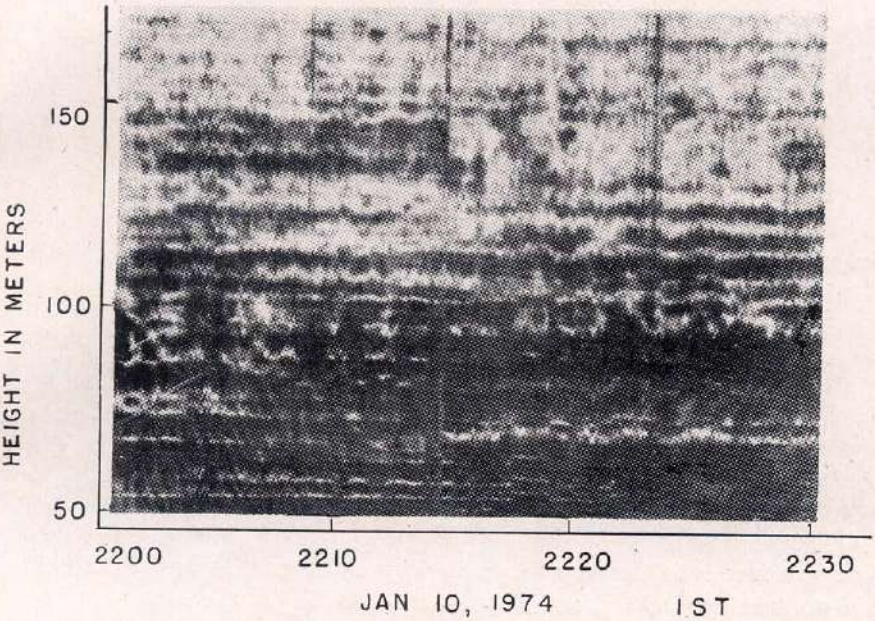

Fig 17 Typical stratified laminated structure formed during a night of radiative cooling, recorded with the Sodar system developed at the Laboratory

It is proposed to :

(i) Study and design an appropriate acoustic shield around the antenna to suppress the further side lobes ;

(ii) Design and develop gating circuits to use the antenna as a monostatic sounder ; and

(iii) Perform field experiments to improve the facility.

MICROWAVES AND DISPLAY TUBES TECHNOLOGY

Scope and Objectives

Under this project, activities on the following three areas are covered :

(i) Design, development and batch-production of microwave components circuits, and instruments ;

(ii) Fabrication techniques for cathode-ray tubes and TV picture tubes ; and

(iii) Development of composite displays (3-D photography and radiography).

The objective is to develop the technology and then to transfer the know-how to industry for commercial production.

Progress

1. Design, Development and Batch-production of Microwave Components, Circuits and Instruments

Batch-production of S, Ku and K-band microwave components, in wave-guide configuration was carried out for meeting the requirements of BEL, Ghaziabad, ISRO, Ahmedabad, Sarabhai Space Centre, Thumba, some universities and other research organisations. Till 31st March 1974, the total sales of batch-produced components was of the order of Rs. 4 lakhs.

Some modifications were carried out in the design of S, Ku and K-band components, viz., slotted sections, cavity frequency meters, adaptors, crystal detectors etc., and technical know-how was released to M/s. K.L.B. Electronics, Delhi and M/s. Scientific Instruments Co. Ltd., Allahabad.

Reflex Klystron 2K28 was batch-produced for field trials by IAF. The test reports received showed that their performance was satisfactory. Harmonic generators for X to Ku bands were developed for use with 2K28.

Work was started on coaxial line components, viz., fixed attenuators, matched terminations, tuners, slotted sections, directional couplers etc. Coaxial line terminations with VSWR of the order of 1.2 in the frequency band 2.0 to 10.0 GHz were developed. Work was started to increase the band-width from 1.0 to 10.0 GHz with better matching characteristics. Coaxial line attenuators of 6,10 and 20 db, using central conductor of ceramic, coated with aquadag were developed, with a maximum VSWR of 1.4 in the frequency range 2.0 to 10.0 GHz. Work was initiated on nichrome coated ceramic to decrease the spread in attenuation with frequency and to obtain better VSWR.

The design of micro-strip components, viz., directional couplers for octave band-width was completed, and 20db and 10db couplers were fabricated for S-band (2 to 4 GHz) on a substrate of dielectric constant 16. Basic techniques of microstrip components fabrication, viz., thin film coating, photo-etching etc., were developed.

N-type coaxial line connectors available in the country were not found to be very satisfactory. Hence, work was initiated on complete design and fabrication of coaxial line connectors and test jigs for microstrip components.

Gunn oscillator in X-band was fabricated in the frequency range 10.0 to 12.0 GHz. Work on improvement of the design of the cavity and the power supply for the Gunn diodes was started.

The licencees of the NPL know-how for microwave components and instruments had already gone into production. Their annual production capacity rose to about Rs. 4 to 5 lakhs per year.

Microwave instruments like universal klystron power supply and modulation unit for klystron, were commercially manufactured by M/s. KLB Electronics, Delhi, and were tested at NPL.

2. Fabrication Techniques for Cathode-ray Tubes and TV Picture Tubes

Batch production of CRT type 5UP1, using indigenous electron guns, was continued, and comparison was made using phosphor screens of various sizes with imported and indigenous phosphors.

With the techniques already developed, work on reconditioning of CRTs and TV picture tubes was continued for outside parties on payment basis. Two Radar Indicator tubes of type 810 CV/59 were also processed for IAF.

Two more parties were given licence for fabrication/reconditioning of CRTs and TV picture tubes, and the technicians deputed by them were given the necessary training.

Tri-carbonates prepared by the Analytical Chemistry Section of NPL were successfully tried on the cathodes of electron gun assemblies.

A tilt table with vacuum chuck was perfected for coating television screens. A bread-board model of the test console for TV tubes was also made.

Work was initiated on the fabrication of high frequency cathode-ray tubes upto 100MHz. One tube was reconditioned for M/s. Electronics Corporation of India Ltd., Hyderabad. Resistive ink for writing the helix in the high frequency cathode-ray tubes was developed.

3. Composite Displays

3-D Photography : Four methods were developed for making composite photographs which are eventually used for 3-D panoramic photographic displays. Plate dies for making lenticular grids were fabricated and embossing techniques were developed for PVC by hot pressing.

The process of 3-D Photography was referred to NRDC for commercial exploitation. Some experiments on off-set printing of 3-D photographs were successfully carried out at M/s. Thomson Press, Faridabad, using a 250 dot screen. An apparatus for precise placement and movement of contact printing screens in offset printing was developed.

3-D X-Ray Radiography : A novel method for taking 3-D X-ray radiographs was developed. It is based on the technique of using a radiographic line grid comprising X-ray opaque and X-ray transparent vertical narrow strips. This radiographic grid is placed between the object and the radiographic film and several strip-radiographs of the object are taken on the same film, using the conventional X-ray machines and films. This composite radiograph is placed behind a photographic line grid (replica of radiographic grid) and when viewed with illumination from behind, it gives a 3-D panoramic view of the object. With this technique, it is possible to locate the foreign object or defect in the organs of a human body in true perspective.

Complete techniques of making radiographic line grids for taking the composite X-ray radiograph, and of making the photographic grid for viewing the 3-D X-ray radiograph, were developed. The method is suitable for all sizes of grids and with X-ray source upto 100 kV.

The technique was used for taking several composite X-rays, and the results were shown to radiologists at the All India Institute of Medical Sciences, New Delhi.

ELECTROPHOTOGRAPHIC MACHINES

Scope and Objectives

Electrophotographic machines are essential for the document copying facilities and for the fast and accurate dissemination of information. No such facilities were so far available in the country. Manually operated machines, based on the principle of electrophotography and using selenium plate, have already been developed at NPL with completely indigenous resources, and the process know-how is being successfully exploited by the licencees. The work for the development of the following is in progress :

(i) Automatic electrophotographic machines, using selenium plate photoreceptors ;

(ii) Automatic electrophotographic machines, using selenium drums, capable of copying documents at much faster speed ;

(iii) Electrofax paper (sensitized ZnO coated paper) ;

(iv) Liquid developers for electrophotographic machines ; and

(v) Automatic machines — electrofax type — using sensitized ZnO coated paper.

Progress

ZnO Coated Paper : The process know-how for the sensitized ZnO coated paper was developed and released to the industry through NRDC. Demonstration of the coatings of sensitized ZnO emulsions etc. on paper, on the laboratory scale, were given to M/s. Tokushu Menon, Madras. As the process know-how of the sensitized paper had been developed on the laboratory scale only, various parameters to coat the paper with commercial plant were planned.

Electrofax Machine : The various components and parts to be used in the prototype were studied and a few parts were fabricated.

Further Development of Photoconductive Plates and Drums : Work on development of the interface barrier layer between the aluminium base plate and the selenium deposited on it, and also of the over-coatings on the selenium surface were undertaken and completed. The testing for proper assessment of the plates with these coatings was started. A few selenium drums were also coated.

Developer : In order to reduce the deposition of the toner on selenium plates, further modifications in the toner composition were taken up. Work was again taken up towards the coating of the glass beads with suitable materials, in order to modify and replace organic seeds as carriers.

Corona Studies : Studies on the threshold voltages for corona discharge between a wire and a parallel conducting plate were made for DC and AC/DC systems. A part of this work was reported in an international conference.

Development of Masters with Electrophotographic Machines : Some difficulties were encountered by the licencees and the users of the electrophotographic machines, for making good masters for photo off-set printing. These problems were looked into and were solved to their satisfaction.

THIN FILM DEVICES

Scope and Objective

(i) Development of thin film optical devices and also limited production of the same to cater to the needs of various organisations, specially in industries and defence establishments : and

(ii) Investigations of the optical characteristics of thin film multilayer systems which are useful in the development of desired optical devices.

Optical coatings normally consist of thin films of metals and dielectrics deposited in a certain sequence, and the purpose of the coatings is to alter to a desired extent the optical characteristics, such as reflection, transmission and absorption, of the coated surface. The essential principle involved in the operation of these coatings is destructive or constructive interference between monochromatic beams derived and selected out from a single white beam, which, after incidence, undergoes multiple internal reflections within the system of the thin films constituting the optical coating.

Progress

Initially vacuum coating plants (300 mm dia) comprising three resistant evaporation sources, ionic bombardment, planetary substrate holders, optical film thickness monitor etc., were fabricated. With these plants, devices like antireflection coatings, interference filters, neutral density filters, beam splitters etc., were successfully developed.

Colour absorption filters are required for the suppression of side bands which appear in the transmission characteristics of thin film interference filters. Normally colour glass filters are used for this purpose, but the same are not available indigenously. As such, work was undertaken on the development of colour absorption filters using polymer films containing suitable chemical dyes. The films are grown by solution growth technique.

Sputtering method of depositing thin films is gaining importance for the last few years. In view of this, a sputtering plant was designed and fabricated. Films of platinum, copper, tantalum etc. were successfully prepared.

A versatile high vacuum coating plant Type A· 500V was imported from M/s. Leybold-Hereaus, West Germany, and the same was installed in October 1974. The special features of this plant are : optical and quartz crystal film thickness monitors, electron beam evaporation source, rotating substrate holder, planetary substrate holder, radiant heater etc.

Trial runs were given to the plant, and success was achieved in respect of the following :

(a) Single and double layer antireflection coatings ;

(b) Neutral density filters ;

(c) Cold mirrors ;

(d) Beam splitters ; and

(e) Heat reflecting mirrors.

A consultancy agreement with M/s. Vacuum Metallizing Industries, Delhi, on yearly basis, was signed.

LIQUID CRYSTAL DEVICES

The work pertains to two types of devices (i) thermal, and (ii) electro-optical. These devices use different types of liquid crystal materials. The former uses cholesterics, whereas the latter uses either nematics, or mixtures of nematics and cholesteric liquid crystals.

Liquid Crystal Thermal Devices : Thermal devices depend upon the temperature sensing characteristics of cholesteric liquid crystals. In these liquid crystals (in the liquid crystalline phase) molecules arrange themselves in a helical pattern so that, when ordinary light falls on them, they scatter

5. Non destructive testing of materials and components ;
6. Thermography in medical diagnostics ;
7. Microwave intensity pattern display in colour. Possibility of getting a plot of near field antenna patterns, and mode patterns in complex wave-guides. Microwave holography may also be possible;
8. Display of mode patterns in infra-red lasers ; and
9. Safety devices for electric motors, transformers etc.

In view of the large applications of liquid crystal thermal devices, several commercial firms evinced interest in exploiting the know-how.

Electro-optical Display Devices : There are two types of liquid crystal electro-optical devices. These are (a) dynamic scattering type, and (b) twisted nematic type. These are single plane displays for wide angle viewing and consume extremely low power ($\sim\mu W$). These devices are used as display devices in systems such as electronic calculators (especially portable), digital instruments, electronic digital clocks and watches, and public information displays etc.

The following techniques were used for the complete fabrication of electro-optical 7-segments $3\frac{1}{2}$, 4 and 10 digits numeric display panels :

(a) Transparent, electrically conducting coating on glass plates ;

(b) Photo-etching techniques ;

(c) Vacuum deposition of thin films like nichrome, chromium, aluminium etc. ;

(d) Metallized solderable contacts on glass plates ;

(e) 'Homogeneous' and 'homeotropic' alignments of nematic material ; and

(f) Filling of the material and sealing of the cell hermatically.

Various experimental set ups were designed and fabricated to measure : (i) contrast ratio, (ii) cut off frequency, (iii) current-voltage characteristics, (iv) rise and decay times, (v) nematic temperature range etc., and (vi) texture and domains in cholesteric-nematic mixtures.

The characteristic features of these reflective type of electro-optical devices developed, operating in dynamic scattering mode are : (a) low power consumption, (b) good readability under severe ambient light conditions, (c) compatible with 7446, 7447 or equivalent TTL decoders/drivers as well as COS/MOS integrated circuits, (d) low cost, (e) 1-10 digits available in one panel, (f) different sizes and shapes possible.

Operational life tests were carried out. More than three thousand hours of continuous a.c. (50 Hz) operation did not show any marked degradation in the device. Tests for humidity and dry heat were also carried out.

Continuing involvement in both basic research and developmental work on cholesterics and nematics led to the development of a nematic mixture (a nematic material suitably doped with cholesteric) which has lower threshold voltage, lower power consumption, and gives a better contrast than that of earlier devices.

Twisted nematic (field effect) liquid crystal display cells using a nematic material of positive dielectric anisotropy were also made and used for transmissive mode. Work on the development of these cells for reflective mode, and improving the contrast and angle of viewing etc., was also initiated. Twisted nematic liquid crystal displays have lower threshold voltages and consume even less power than dynamic scattering displays.

A number of parties showed interest in taking up the know-how.

Patents

The following patents were filed with CSIR Patent Office :

(i) A process for microencapsulating cholesteric materials for use as a liquid crystal thermal device ;

(ii) A liquid crystal electro-optic device ; and

(iii) A new type of liquid crystal material for use in electro-optical display devices.

PILOT & DEMONSTRATION PLANT IN HYDROSTATIC EXTRUSION & MATERIAL SYNTHESIS (UNDP PROJECT)

Scope and Objective

SCIENTIFIC AND TECHNICAL

(a) Short Term :

(i) Development of composite materials like copper-clad aluminium and alloy aluminium clad aluminium ;

(ii) Extrusion of hard-to-extrude materials like alloy aluminium and alloy steels ; and

(iii) Extrusion of complex shapes like gear profiles and twist drills.

(b) Long Term :

(i) To undertake development of indigenous production equipment in hydrostatic extrusion ; and

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(b) Long Term :

(i) To undertake development of indigenous production equipment in hydrostatic extrusion ; and

(ii) To investigate the possibility of putting up similar units in hydroforming and hydropressing.

SOCIO-ECONOMIC

(i) To reduce dependence on imported materials like copper by development of composite materials ;

(ii) To make more efficient use of indigenous materials like hard aluminium alloys; and

(iii) To cut manufacturing costs in the production of complex shapes such as gear profiles and twist drills.

Progress

UNDP funds amounting to $ 2 million were released and the necessary contracts for equipment etc. were given to the manufacturers. A detailed list of the other equipment, experts and training facilities required was worked out. Activities to get the building etc. ready before the equipment arrives, were undertaken.

A detailed survey was conducted on the requirements of extruded products in the country. The requirements of the four units of the Bharat Heavy Electricals Limited (BHEL) alone amount to about 3000 tons of materials. This requirement includes tubings and sections of duralumin, copper and copper alloys, and stainless and alloy steels. Included in the requirements are such complicated shapes as copper busbars, duralumin profiles and turbine blades. It is proposed to devote the first year of this development programme to develop and batch produce some of the products required by the BHEL. The unit will also extrude, on a trial basis, composite materials such as copper-clad aluminium wire, rods and busbars which, it is hoped, will lead to substantial savings in the imports of copper. The refrigeration and air-conditioning industry have also asked us to develop composite materials such as alloy aluminium clad aluminium which will give resistance to corrosion — one of the major problems in using pure aluminium in air-conditioning and refrigeration equipment.

The hydrostatic extrusion process technology will also be used to develop materials such as aluminium sandwiched between two layers of copper.

The technology is ideally suited to extrude tubings of such materials as titanium and zirconium. Substantial quantities of zirconium tubes are used in the atomic power plants and this, therefore, is one strategic material for this country. Titanium tubing has a huge market all over the world. The present methods used in the manufacture of titanium and zirconium tubings are expensive and hydrostatic extrusion technology can make a cheap and better product. This product alone can give us substantial markets abroad. Titanium-clad copper nickel tubing is another very interesting and useful item that is proposed to be developed on the pilot plant. This is a new material which is being experimented upon in advanced countries for use in the fabrication of heat exchangers.

The establishment of this pilot plant is the culmination of NPL's effort in building up indigenous capability in high pressure technology in the Laboratory. It will be worthwhile to mention here that NPL has already built pressure vessels to stand a maximum pressure of 8000 atmosphere, to extrude aluminium and copper.

GLASS TECHNOLOGY DEVELOPMENT AND PRODUCTION UNIT

This Unit undertakes fabrication of sophisticated scientific glass and silica equipment for use in the Laboratory as well as for outside organisations.

The Unit produced glass equipment worth about Rs. 7.5 lakhs during the period under review. The types of equipment fabricated during this period are as under :

All-glass fractionating columns.

Molecular weight apparatus.

Mercury pipettes for testing of bytrometers.

Water distillation apparatus.

Multi-heater high-output water distillation apparatus.

Low temperature cryostat.

Spherical joints.

Dewar flasks.

CO_2 purity testers.

Nitrogen distillation apparatus.

Vacuum systems.

Vacuum measuring equipment & mercury diffusion pumps.

Graded seals.

Quartz equipment.

Graded glass-to-metal seals.

Gas respirometers.

Estimation pipettes.

High-vacuum stop cocks.

Multipurpose solvent extractor.

Ion pumps.

Barometric condensors for DDT condensors.

Q.V.F. Type stop cocks.

Discharge tubes.

Hand cones.

In addition, 12 mercury-arc-rectifier bulbs were reconditioned which brought a return of Rs. 41,500/-.

A large number of liquid nitrogen flasks were made and supplied to universities for low temperature studies. The Unit also started production of spherical joints.

DEVELOPMENT-CUM-PRODUCTION OF ELECTRONIC COMPONENTS

The Plant undertook pilot production of the following items developed by the Division of Materials of the Laboratory :

High frequency oscillator cores.

TV deflection yoke cores.

Cup and drum cores.

E and C cores.

Magnetic tapes.

Professional ferrites.

High voltage ceramic capacitors.

Piezoelectric materials and devices.

Conducting silver cement.

Low-loss ceramic insulators etc.

Fig 18 Sintering of TV deflection yoke cores

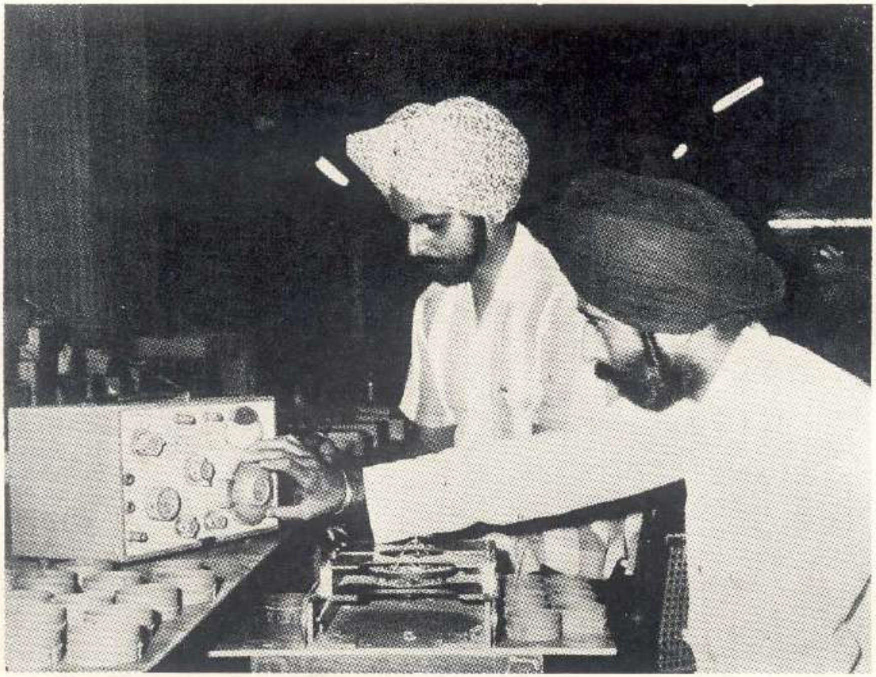

Fig 19 Testing of TV deflection yoke cores

The sales during the years 1973-74 and 1974-75 were as under :

Item	1973-74 (in Rs.)	1974-75 (in Rs.)
Soft ferrites	1,86,554.51	1,00,544.39
Hard ferrites	8,852.24	5,341.95
Piezoelectric and dielectric materials and devices	67,000.00	43,600.00
Silver cement	12,374.00	13,730.00

NOTE :- This excludes the sales made by the Electronic Components Production Unit of the Laboratory which grew into the Central Electronics Ltd. — a Government of India Undertaking — during the period under report.

CARBON TECHNOLOGY

The Experimental Pilot Plant for Carbon Technology undertook small-scale production of the items detailed belo v for supply to the user industry for trials, and for getting feed-back information for further R & D work on them, and recorded the sales mentioned against each :

Item	1973-74 (in Rs.)	1974-75 (in Rs.)
Cinema carbons & process carbons	1,23,400	79,300
Midget electrodes	2,214	5,807
Carbon thrust rings	—	1,316
Total	1,25,614	86,423

Fig 20 Extrusion of midget electrodes, using the extrusion press fabricated at the Laboratory

DEVELOPMENT OF METROLOGICAL GRATINGS

Scope and Objective

Moiré is one of the latest techniques for determining surface strains in structures and machine parts. The basic requirement for this technique is the large size gratings in various line densities ranging from 100 lines per inch to 2500 lines per inch. The technique is specially suited for investigations in the elasto-plastic range. The activity aims at developing these gratings indigenously and to develop techniques for transferring them to metallic as well as non-metallic specimens.

Progress

A linear ruling machine and a circular ruling machine designed and fabricated at the Laboratory were commissioned and operated to produce master gratings in different line densities. Techniques were developed to produce high fidelity photographic copies of the masters thus made, since a day-to-day use of the masters should be avoided on account of their high cost. Such copies have been supplied to various laboratories and research institutions engaged in work on moiré technique.

Techniques were also developed to transfer these gratings to metallic as well as non-metallic specimens using KPR and stripping film techniques.

Some problems of practical interest in elastoplastic strain distribution were studied using moiré technique. These related specifically to strains due to interference fits and inhomogeneities in flat metallic plates with or without a uniaxial tension.

The installation of a 19″ vacuum coating unit was undertaken to produce metrological gratings on glass, coated with thin chromium films. The designs of the crossing jig to make orthogonal and triangular gratings were completed. Some applications of moiré technique to topological problems were also investigated with special reference to a study of the topography of human cornea.

Negotiations were initiated with the N.E.L., Glasgow, for the supply of precision copying machines to produce metrological gratings.

DESIGN AND DEVELOPMENT OF OPTICAL SYSTEMS

Scope and Objective

To help small-scale units to assimilate the results of scientific research on optical systems through consultation.

The workshops of the firms are themselves used as pilot plants to develop optical components and devices for which, as far as possible, the optical designs based on the existing tools and glass types are supplied. Feed-back from the industry is used to improve the standard of the products.

This activity has three functions, viz., (i) research, (ii) design, and (iii) consultancy service to the industry, for development and production.

Progress

Research : A theory of lenses in which systems progressively emerge as derivatives of single lens system with reduced demerit (or improved merit) for a given application has been developed and established. A property-wise classification of lens systems which resembles Mendeleeff's classification for elements has been evolved. During the period under report, research on triplets and doublets in which industry was specially interested, was carried out.

Design : Designs for practical systems are worked out on the basis of the research work. A tentative design based on available materials and tools is first given to the interested parties, who make prototypes for subsequent improvement. During the period under report, attention was paid on optics for stereoscopic microscopes, automatic slide projector and fresnel lenses.

Consultancy : A society working for the development of U.P. hills was helped to plan an optical industry in hills on cooperative basis with a built-in R & D Cell. Consultancy work relating to fresnel lenses, over-head projectors, slide projector objectives, miniprojector, episcope objectives, special eye-pieces, optics for diamond viewing apparatus and microscope optics was also undertaken, as given on the next page :

Problem	Party
Slide projector objective	(a) Prince Optical Works, Delhi. (b) Ravesyn 73, 9 UA Jawahar Nagar, Delhi-7.
Over-head projector	(a) Cinesales Corpn., Delhi. (b) Getner Instrument Industry, Ambala Cantt. (c) KB Industries, Lucknow. (d) Printex Corporation, Delhi. (e) Beam Engineers, Ambala.
Eyepieces (special)	Prince Optical Works, Delhi.
Optics for diamond viewing apparatus	Shri Mumbadevi Jewellers, Bombay.
Microscope objective 6.4 X	Sangavi Instrument Co., Delhi.
Fresnel lens	Jenkins Electronics, Jullundur City.
Mini-projector	Printex Corporation, Delhi.
Episcope objective	Beam Engineers. Ambala.

INSTRUMENTATION SERVICES

Scope and Objectives

(i) Maintenance and calibration of scientific laboratory type instruments and apparatus which are electrical, electronic and electro-optical. Besides rendering this service to the laboratory, work from other institutional users in respect of imported instruments only, is also undertaken.

(ii) Advice on instrumentation problems and also on the availability of Indian made instruments and components of certain specifications.

(iii) On-the-spot consultancy service for (a) assessment of damage to equipment, (b) technical advice on maintenance of equipment, and (c) inspection reports for initiating write-off, calibration or repairs.

(iv) Inspection service (for NPL scientists only) for new equipment on arrival or for instruments being returned to the Central Stores.

Progress

Instrument Servicing : About 60 instruments were serviced for NPL scientists. Another about 50 instruments were serviced for outside parties.

Instruments servicing assistance to outside parties covered the CHS ; Willingdon Hospital ; Medical College, Agra ; Holy Family Hospital ; Womens Polytechnic ; Central Rice Research Institute, Cuttack ; IVRI, Izatnagar ; Haryana Agricultural University, Hissar ; Chemistry Deptt., Gorakhpur University ; CPWD ; Kurukshetra University ; IIT Delhi ; Dairy Research Institute, Karnal ; Safdarjung Hospital ; INSDOC ; Agricultural University, Udaipur ; Blood Bank ; Central Revenues Laboratory ; Presbyterian Church Office, New Delhi, etc.

The instruments serviced were : audiometer, doctors' head-light, suction apparatus, current comparator, resistance bridge, potentiometer, multimeter, slide rotator, colorimeter, photo colorimeter, flame photometer, spectro-photometer, vibrograph, differential thermal analysis apparatus, DGA apparatus, watch accuracy tester, ECG machine, X-Y recorder, temperature recorder, temperature programmer, electrolyser, electro-analyser, electro-convulsive therapy unit, extra high voltage supply, dekameter, photocell, galvanometer-amplifier, divisuma calculator, power amplifier, research microscope, metallurgical microscope, live-eye microscope, ophthalmoscope, dark adaptometer, monopan balance, VTVM, Muller resistance bridge, pH meter, eye perimetry-apparatus, standard electrical meters, megohmmeter, microfilm processer, helium purity monitor, Spectronic-20, Cooke microscope for nuclear emulsions, oscilloscopes, clip-on ammeter/voltmeter, thermostatic oven, electro-surgical apparatus, film deposit rate controller, magneto-tachometer, time switch, electric thermometer, polyflex galvanometer, photocopying machine, automatic voltage regulator, bomb calorimeter, microvolter, tesla coil, petrol consumption meter etc.

Consultancy and Advisory Services : More than 200 requests, including about 70 from outside parties, were attended to. The outside agencies which were rendered these services included the following :

National Institute of Communicable Diseases, Delhi ; Central Rice Research Institute, Cuttack ; Bongaigaon Refinery ; Instrumentation Ltd., Kota ; Indian Institute of Public Administration, Delhi ; Central Control Laboratory, New Delhi ; Haryana Agricultural University, Hissar ; Indian Veterinary Research Institute, Izatnagar ; Army H.Q. ; Delhi Electric Supply Undertaking ; Tea Research Laboratory, Jorhat ; Air Force, Palam ; Central Ground Water Board, Faridabad ; Irwin Hospital, Delhi ; NCERT, Delhi ; World University Service Health Centre ; RRL, Jammu ; Govt. Test Centre, Jullundur ; National Dairy Research Institute, Karnal ; Survey of India, Dehradun ; Hindustan Zinc, Udaipur ; Willingdon Hospital, Delhi ; Indian Oil ; Allied Electronics, Madras ; AIIMS, New Delhi ; Ministry of Agriculture ; Orissa University of Agriculture : Ordnance

Factory, Kanpur ; CHS ; Delhi Milk Scheme ; Empire Industries ; CMRS, Dhanbad ; Agriculture Station, Udaipur ; College of Agriculture, Udaipur, ECIL, Hyderabad ; Safdarjung Hospital, Delhi ; INSDOC, New Delhi ; Medical College, Agra ; Patel Chest Institute ; National Oceanic Institute ; Kissan Food Products ; Nuclear Research Laboratory ; PTC, Okhla ; M.C. Industries, Okhla ; Food Corporation of India ; U.P. State Electricity Board ; Horticulture Research Station, Saharanpur ; I.A.F., Tughlakabad ; Air India ; Regional Engineering College, Allahabad ; Hindustan Wire Products, Faridabad ; Invention Promotion Board ; Hindustan National Glass Works, Ballabhgarh ; Snowden Hospital ; Wanless Hospital ; Bhowali Sanatorium ; Central Training Institute for Instructors, Kanpur ; ATIRA, Ahmedabad ; East India Transformers, Faridabad ; Bharat Heavy Electricals, Hyderabad.

STRAIN - GAUGE TRANSDUCERS

The work on strain-gauge transducers was continued.

Different kinds of load cells for measurement of big and small weights were designed and fabricated.

Different types of bio-medical transducers using both resistance wire and semiconductor strain-gauges were fabricated and tested. In particular, the transducers were fitted with transparent plastic domes, so that while filling the transducers with saline and connecting them to the blood supply of live animals, the air bubbles formed in the dome may be detected and removed. Also, by a special design, the active volume of the transducer was made small so as to keep the mechanical resonance frequency high. Both, femoral intra-arterial and intra-venous pressures could be recorded, but more reliably the intra-arterial.

Development of electronic amplifiers, having the required high sensitivity, linearity, bandwidth and freedom from drift, has been done in stages. Carrier frequency amplifier using integrated circuits and phase detector, and instrumentation amplifier, using integrated circuits and modern circuit techniques, have been made.

For increasing the sensitivity of transducers, corrugations on thin elastic diaphragms, used in combination with strain-gauges as pressure sensors in transducers, were made by means of dies specially fabricated for the purpose.

A transducer for sensing torque was developed.

A new development has been to make quartz crystal transducers workable at DC and low frequencies. Uptil the present, quartz crystals due to charge leakage taking place at static conditions, have only been used for dynamic tests, such as of internal combustion engines. With the proper treatment of the quartz crystal and proper design of the input stage of the electronic amplifier, the charge leakage can be made negligible for being able to work the quartz at DC. A host of applications open out due to this fact, since the voltage developed by the quartz due to its piezoelectric effect is quite high and the input stage does not require a Wheatstone bridge, which due to random drift in the values of the resistances of its arms and in the bridge supply voltage, contributes to give drift and instability in the output.

SYMPOSIUM ON MICROWAVE TECHNOLOGY

A Symposium on Microwave Technology was organized from 4th to 7th February 1974, jointly by the National Physical Laboratory, New Delhi and the Department of Physics and Astro-Physics, University of Delhi. An Exhibition of Microwave products was also arranged at the laboratory on this occasion.

The Symposium and Exhibition were formally inaugurated by Prof. M.G.K. Menon, Chairman, Deptt. of Electronics, and Secretary to the Government of India. Prof. Menon in his inaugural address stressed the need for concerted R & D effort in the Microwave area, about which there is no ambiguity towards the objective of achieving self-reliance as early as possible.

It was heartening to learn from Prof. Menon that the Department of Electronics will support major R & D projects in the field of Microwaves with time bound objectives. He also stressed the need for trained man-power in this particular area, and here, both the research organisations

Fig 21 Prof M G K Menon inaugurating the Symposium on Microwave Technology

and the teaching institutions can play important roles. He suggested more interaction between the research laboratories/organizations, universities and engineering colleges etc.

The Symposium was attended by about one hundred delegates and invitees from various R & D organizations, IITs and universities, including three delegates from UK, Japan and West Germany. The technical deliberations were spread over six sessions covering different aspects of microwaves. The following technical sessions were held :

Microwave Tubes and Solid State Devices.
Microwave Components and Circuits.
Microwave Techniques — I.
Microwave Standardization, Calibration and Measurements.
Microwave Techniques — II.
Microwave Systems and Applications.

In each technical session the presentation of the technical papers was preceded by invited talks by distinguished scientists from India and abroad. The following is the list of the invited talks :

Dr. Amarjit Singh	Microwave tubes and semiconductor devices—Some emerging trends.
Dr. H.L. Hartnagel	(1) Recent developments in Gunn oscillators. (2) Gallium arsenide integrated circuit technology.
Prof. H. Yanai	Theoretical analysis on thermally induced noise in Gunn diode oscillator.
Prof. P. Venkateswarlu	Millimeter wave spectroscopy.
Dr. K. Chandra	A review of microwave standards.
Prof. Guntur Nimtz	Transient carrier decay of impact-ionised carriers of semiconductors.
Dr. B.S. Mathur	Microwave frequency standards.
Dr. C.M. Srivastava	Microwave ferrites and garnets.
Dr. G.P. Srivastava	Contactless microwave measurements of semiconductor parameters.
Prof. P.T. Narsimhan	Design of X-Band EPR and NMR double resonance spectrometers.
Dr. O.P.N. Calla	Design and testing of antenna systems.
Prof. P.V. Indiresan	State of the art in microwave acoustic signal processing.

About forty technical papers were presented in the Symposium.

On the 7th February, a panel discussion on self-reliance in microwave area was held in the Department of Physics and Astro-Physics, University of Delhi. Prof. B.D. Nag Chaudhury, Scientific Adviser to the Minister of Defence, chaired this discussion.

The following organizations participated:

Bharat Electronics Ltd., Ghaziabad.

Central Electronics Engineering Research Institute, Pilani.

Defence Electronics Research Laboratory, Hyderabad.

Department of Electronics.

Department of Physics and Astro-Physics, University of Delhi, Delhi.

Electronics Commission.

Indian Space Research Organization (Space Application Centre), Ahmedabad.

Indian Telephone Industries, Bangalore.

Institute of Armament Technology, Poona.

M/s. KLB Electronics, New Delhi.

National Physical Laboratory, New Delhi.

M/s. Scientific Instruments Co. Ltd., Allahabad.

Solid State Physics Laboratory, Delhi.

Tata Institute of Fundamental Research, Bombay.

Wireless Adviser to the Government of India.

Fig 22 Prof M G K Menon visiting the exhibition of microwave products

The following research institutions and industries displayed their microwave products in the exhibition which presented a glimpse of their research and development activities :

Central Electronics Engineering Research Institute, Pilani.

Defence Electronics Research Laboratory, Hyderabad.

Delton Cables Private Ltd., Delhi.

Department of Physics and Astro-Physics, University of Delhi, Delhi.

M/s. KLB Electronics, New Delhi.

National Physical Laboratory, New Delhi.

M/s. Scientific Instruments Co. Ltd., Allahabad.

Solid State Physics Laboratory, Delhi.

Tata Institute of Fundamental Research, Bombay.

SEMINAR ON STATUS OF FERRITE TECHNOLOGY IN INDIA

A seminar on Status of Ferrite Technology in India was hosted by the National Physical Laboratory, New Delhi on Nov 23, 1974, under the aegis of the Magnetic Society of India. Participants from industry, research and development organisations and various government agencies, took part in the discussion which was divided into five sessions, viz., (i) status of high permeability and special ferrites, (ii) status of high frequency and hard ferrites, (iii) status of microwave ferrites, (iv) problems of ferrite industry, and (v) future trends in ferrite industry.

Initiating the discussion, Dr. Tamhankar, President of the Magnetic Society of India, outlined the development of ferrite technology in India. In the first session the speakers were Dr. G. C. Jain of NPL and Mr. U. Venkateswarlu of the Central Electronics Ltd. (CEL), with Mr. T. V. Ramamurty in the chair. Dr. Jain discussed the various grades of Mn-Zn ferrites with high permeability developed at NPL for use in TV deflection yoke cores, inverter cores, E-cores, EHT cores and pot cores. He indicated that NPL is planning to develop ferrites with initial permeability as high as 10,000. He also discussed various developments taking place at NPL in the area of memory cores, magnetostrictive ferrites and magnetic tapes. Mr. U. Venkateswarlu presented the programme of CEL which has been set up by the Government of India. According to him the difficulty faced by his organisation in productionising the high permeability ferrites developed at NPL was non-availability of standardized high purity raw materials and sophisticated production equipment like automatic presses and tunnel kilns with controlled atmosphere, from within the country. He observed that it is easier to directly transfer a laboratory know-how to an industry which has strong engineering group, rather than going through a pilot plant stage. He also suggested that royalty system of know-how transfer should be replaced by a transfer of know-how through a lumpsum payment.

In the second session on 'Status of High Frequency and Hard Ferrites', the speakers were Mr. M.H.V. Murthy of Solid State Physics Laboratory (SPL), Dr. B. K. Das & Mr. R. S. Khanduja of NPL, and Dr. Morris of M/s Morrite Electronics, with Brig. S. Malhotra in the chair. Mr. Murthy informed the delegates that SPL has developed a nickel-zinc ferrite for use in h.f. inductors & pulse and power transformers, with a $\mu_i = 125 \pm 10\%$, and Q at 5 MHz greater than 80. A 100 W transformer using torroids has been made by them and tested by the Bharat Electronics Ltd., Bangalore. A 5 kW wide-band transformer with insertion loss less than 2% at 5 kW is being fabricated by them. Dr. Das outlined the part developments in the area of entertainment-grade ferrites for medium-wave and short-wave region, at NPL. He indicated that NPL has taken up work on professional grade nickel-zinc ferrite for use upto 10 MHz with good time-temperature stability. He also indicated that NPL has developed a hexagonal ferrite of ferroxplana type, for use upto 400 MHz. Mr. Khanduja discussed the development of isotropic and rubber bonded barium ferrite magnets and indicated that NPL is thinking of taking up development of oriented ferrite magnets — both sintered and rubber bonded ferrites — using cellestite ore. Dr. Morris of Morrite Electronics expressed his views that the country has the know-how and raw materials for making nickel-zinc ferrites for radio and TV industry and for making hard ferrites both of isotropic and oriented type. He said that besides supplying loudspeaker magnets made of oriented hard ferrite to Philips India Ltd., his firm is also exporting them in fairly large numbers. As for the TV ferrites, he observed that due to various reasons TV production has gone down, as a result of which, the demand for TV ferrites has also stagnated.

The third session on 'Status of Microwave Ferrites' was chaired by Brig. S. Mishra. Dr. K. Lal of NPL, Dr. B.V.S. Subbarao of Defence Metallurgical Research Laboratory (DMRL), Mr. Pran Kishan of SPL and Dr. J.K. Sinha of DLRL took part in it. Dr. Lal said that NPL is taking up work on growth of YIG and YAG single crystals using flux method. He has prepared polycrystalline garnets at NPL. Dr. Subbarao of DMRL suggested that the know-how for microwave ferrites developed at SPL and RRL Hyderabad, should be productionised by CEL. He suggested that work on YIG should be taken up earnestly. YIGs have a narrow line width, low loss, and they have various applications as light modulators, acoustic delay lines, acoustic gyrators, ferromagnetic amplifiers, resonance filters and harmonic generators. Mr. Pran Kishan outlined the programme of SPL in the area of microwave ferrites. According to him, SPL has developed several grades of spinel type microwave ferrites, and these have been supplied to ITI for use in microwave ferrite devices like circulators and phase shifters. MIC substrates have also been developed at SPL, and a three port circulator for X-band has been fabricated there, using these substrates. SPL has also developed polycrystalline YIGs and has grown some YIG crystals using PbO/PbF_2 flux. Mr. Kishan indicated that SPL is taking up work on lithium ferrite for microwave applications. Dr. Sinha informed the delegates that DLRL has developed several types of microwave ferrite devices.

In the fourth session on 'Problems of Ferrite Industry', representatives from ferrite industry, ferrite users, and governmental agencies in liaison with ferrite industry, took part. The speakers were Mr. Balasundram of M/s. Eastern Electronics, Mr. R.N. Mittal of M/s. Ferroelectrics, Mr. Baldev Singh of CSIR, Mr. Subramanyan of NRDC, and Mr. G. Soni of Electronics Commission. The chairman was Prof. E.C. Subbarao of IIT, Kanpur. Initiating the discussion, Mr. Balasundram said, that, as a user of ferrites, he always finds that ferrites available in the country are inferior in quality to those available from abroad, specially in their mechanical specifications. Mr. R. N. Mittal informed the delegates that it is often difficult to exactly substitute an imported ferrite component in so far as its dimensions are concerned, when the requirement is little. He said that ferrite industry being capital intensive, it requires heavy expenditure which is not justified on account of the small demand for ferrites in the country. He also said that the policy of the government has resulted in creation of idle capacity. Among the technical difficulties he listed non-availabilty of standardized raw materials. He suggested a central research centre for R & D work on ferrites. Mr. Soni gave the views of the Electronics Commission. According to him the country lacks a proven know-how for raw materials for advanced types of ferrites, and the industry is yet to adopt a product development programme for high-quality professional grade ferrites.

In the final session on 'Future Trends in Ferrite Industry', the participants were Dr. A.R. Verma of NPL, Dr. C.V.S. Ratnam of NRDC, Mr. R. G. Deodhar of DGTD, Dr. Morris of M/s. Morrite Electronics, Dr. E.C. Subbarao of IIT, Kanpur and Mr. R.N. Mittal of M/s. Ferroelectrics. Initiating the discussion, Dr. Verma said that NPL will continue its efforts to make ferrites of higher permeability, single crystal ferrites, square loop ferrites, and magnetostrictive ferrites. He offered the pilot plant facility at NPL to other R and D organisations for establishing viability of their know-how. Dr. Ratnam pointed out that most electronic industries in India are based on imported raw material and capital equipment, but utilise Indian labour. So it is time to put more attention to the raw materials and production engineering. This would help in convincing the entrepreneurs of the viability of know-hows. According to him know-how for a particular product is available from many organisations in many cases, and best features of each know-how should be combined and given as a package to the industry. Mr. Deodhar outlined the licensing policy of DGTD and said that there is already over capacity for entertainment grate ferrites, and import of know-how will be permitted only in cases where export content is high. He asked for improvement in quality of ferrites being produced now. Dr. Morris agreed with Mr. Deodhar that the demand for soft ferrites is stagnating. He forecasted that tonnage-wise the demand for ferrites is going to shrink because of miniaturisation. He suggested that in future the industry should try to export wound sub-assemblies using indigenous ferrites, rather than ferrite cores alone, since it is in the winding that the labour content is high. Dr. Subbarao, discussing the future of ferrite materials, said that chromium oxide for magnetic tape and rare-earth cobalt (specially Misch-metal-Cobalt) magnets are some of the developments that will be important in future. For establishing a know-how for professional grade ferrites he advocated more work on unconventional methods like co-precipitation, freeze drying and spray drying. He pointed out that the academic institutions have shown a little interest in the area. He asked the industry to solve many problems discussed during the Seminar by in-house research. Mr. Mittal suggested that development be undertaken after taking note of the trend in the demand, both in foreign countries and in India.

WORKSHOP

The workshop executed about 4000 work orders. A few major jobs done are listed below :

Horn reflector antenna.

Flight simulator.

Electron gun assembly for X-ray machine.

Hydraulic multiplication system for force measurement.

Michelson interferometer parts.

Driving mechanism for universal spectrometer.

Krypton lamp cryostat — parts and assembly.

Sample holder for dielectric measurements.

Ice shaving machine.

Die for pressing transducers.

Gerdien condenser for measuring positive ion density in lower ionosphere.

Crystal holder for Lang camera.

Adjustable mirror mounts for He-Ne gas laser.

Weight changing device for mass standard balance.

Luminance meter.

A number of design jobs were carried out by the Drawing & Design Section. The following are some of the important ones :

Reflector horn antenna.

Device for driving to and fro valve of sputtering unit.

Crystal puller.

Optical bench.

X-ray goniometer head.

Hydraulic multiplication system.

Adjustable table for micro-hardness tester.

Bed for travelling microscope.

Multipurpose solvent extractor.

LIBRARY

The library continued to provide library, documentation, and reprographic services to the scientists of the Laboratory – Documentation services through its Selective Dissemination of Information (SDI), replacing in August 1974, the earlier fortnightly bulletin entitled 'Current Titles'; Library services through its additions in the Library of books, journals and other literature of relevant interest; and Reprographic services through Majox-121 photocopier.

Library data on books, journals, photocopies & translations etc., during April 1973 – December 1974 are given below:

	Number
Publications holdings as on 31 Dec 1974	77360
Publications accessioned	2198
Standard Specifications added	2280
Journals subscribed	315*
Photocopies and translations accessioned	141
Publications issued (including inter-library loan)	20,000 (approx)
References provided in SDI (manual service)	1221
Bibliographies prepared on demand	5
Xerox copies supplied	12,000 (approx)

*Subscription to 12 journals was stopped.

The Library is recognised as a patent inspection centre and it continued to receive Indian patents.

Fig 23 A view of the reading room

HONOURS AND AWARDS

Dr. A.P. Mitra was awarded the scale equivalent to that of the Director of the Laboratory. This award has been instituted to prevent diversion of outstanding research talent to non-research assignments, and applies only to outstanding scientists and technologists who have acquitted themselves most spectacularly by creating new vistas of scientific research or technological break-through.

Bronze shield was awarded to NPL for Development of Microwave Components, by the Board of Awards for Import Substitution. The team comprising Dr. Kailash Chandra, Dr. Ram Parshad, Mr. V.K. Aggarwal and Mr. H.M. Bhatnagar was also honoured with a cash award of Rs. 4000/- in 1973.

NRDC Invention Award of Rs. 500/- was jointly received by Mr. V.M. Bhuchar, Mr. A.K. Agarwal, Mr. Franz Kiss, Mr. J.P. Vasisht, Mr. Dharam Prakash and Mr. O.N.L. Srivastava for design of Multi-purpose Solvent Extractor.

Dr. A.K. Saha was made a member of the working group set up by the URSI for standardization of procedures for reduction of ionograms to electron density-true height (N-h) profiles.

Mr. Ram Prasad was given honorary membership of the Bulgarian Union of Scientists.

Dr. S.R. Das was awarded a citation by the National Bureau of Standards, Washington.

Dr. A.V. Narlikar was nominated Advisory Editor of (i) Journal of Material Science, Chapman and Hall (London), and (ii) Instruments India.

FICCI AWARD 1973

In recognition of the Laboratory's initiative in Research in Science and Technology, the National Physical Laboratory was given Federation of Indian Chambers of Commerce and Industry (FICCI) Award for the year 1973.

CITATION

"The National Physical Laboratory, New Delhi, has developed a variety of materials, components and equipments of wide applications based on indigenous resources. The range of R&D embraces passive electronic components and materials, electrostatic photocopying machine and glass instrumentation, technology for cathode ray and television picture tubes, carbon, microwave, high power silicon rectifier, etc. Already its activities have yielded foreign exchange savings to the tune of about Rs. 7 crores and given rise to employment opportunities, both direct and indirect. The Laboratory's achievements are of strategic importance and merit recognition."

Fig 24 Dr A R Verma, Director of the Laboratory, receiving the FICCI Award 1973 from Shrimati Indira Gandhi, Prime Minister of India, at Vigyan Bhawan, New Delhi, on 15 April 1974

Ph.Ds AWARDED

Scientist	University	Topic of the Thesis & Guide(s)
1973		
Mr. Mahesh Chander	IIT, Delhi	Behaviour of mechanisms of colour vision under transient adaptation. (Guides — Dr. P. K. Katti & Dr. S.R. Das)
Mr. D.K. Chakrabarty	Delhi	Study of D-region of the ionosphere during quiet times and solar eclipses. (Guide — Dr. A.P. Mitra)
Mr. P.N. Puntambekar	Delhi	Studies on the interference fringes of superposition and their application to precision optical measurements. (Guides — Dr. D. Sen & Dr. A.N. Mitra)
1974		
Miss Sudesh Kumari	Panjab	Thermal structure of the ionosphere. (Guides — Dr. K. K. Mahajan & Dr. A.P. Mitra)
Mr. M.M. Bindal	Delhi	On some strain distribution problems by Moiré technique. (Guides — Dr. B.K. Agarwala & Dr. A.R. Verma)
Mr. R.G. Sharma	Delhi	Electrical and thermal conductivities of dilute megnetic alloys at low temperatures. (Guide — Dr. M.S.R. Chari)
Mr. M.B. Avadhanulu	Andhra	Exploration of the equatorial D-region by sounding rocket techniques. (Guide — Dr. Y.V. Somayajulu)
Mr. A.S. Yadav	Meerut	Investigations on the correlation of dielectric behaviour of powder and bulk. (Guide — Dr. Ram Parshad)
Mr. Ved Ram Singh	IIT, Delhi	Silicon strain gauge transducers for industrial, medical, engineering and scientific applications. (Guides — Dr. Ram Parshad & Dr. Harsh Vardhan)

LECTURES

Name of the Speaker	Subject	Date
Dr. B.K. Agarwala	High pressure techniques	7.4.73
Mr. N.P. Garg	New dimensions in graphic communications	18.4.73
Prof. T. Urbanski	Charge transfer phenomena	16.5.73
Dr. S.V. Damle	Infra-red astronomy	28.6.73
Dr. V. Subrahmanyan, Boston College, Messachusetts, USA	Radio-chemical study of the code-deposition of selenium with silver from electro-chemical baths	20.8.73
Mr. C.P. Grover	Optical information, storage and retrieval by use of interference phenomenon	22.8.73
Dr. A.D. Danilov, USSR	On the ion composition and the ionospheric structure	14.9.73
	On the processes involving charged particles	15.9.73
	On the scheme of ion transformation at altitudes 100-200 km	17.9.73
	The behaviour of the E-region	28.9.73
	Ion chemistry of D-region	28.9.73
	Connection between the charged particle behaviour and natural atmosphere	1.10.73
Dr. E.F.I. Roberts, City of London Polytechnic	Some reflections on surface studies by metallurgists	18.9.73
Dr. Seiken Shimakawa Chou, Univ. of Tokyo	High power ultrasonics and lasers	28.9.73
Dr. A.P. Mitra	Posssible environmental consequences of high flying supersonic aircrafts and the outstanding solar flare events of August 1972	29.9.73
Prof. S.K. Guha, IIT, Delhi	Recent advances in the medical engineering activities in India	4.12.73
Prof. V. Gerold, Max Planck Institute, West Germany	Application of small angle X-ray and neutron scattering	24.12.73
Dr. V. Subrahmanyam	Trace element determinations by neutron activation analysis	15.1.74

Name of the Speaker	Subject	Date
Dr. Vojta, Central Inst. of Solid State Physics and Material Sciences, GDR	Statistical theory of transport processes in solids	16.1.74
Prof. L.N. Mulay, Pennsylvania State University	Super paramagnetic materials	19.2.74
Prof. R. Stephen White, University of California, USA	The proton radiation belt	25.2.74
Dr. Krishan Lal	Difference of radio-isotope traces of silver indium zinc in magnesium	2.3.74
Prof. Eng. E. Ninov, Bulgaria	Protective coating of graphite electrodes — Properties and applications	4.3.74
Prof. Bethge, Heidelberg University, Germany	The production of energy in the modern world	5.3.74
Dr. Eng. Kiril Serafimov, Scientific Secretary, Bulgarian Academy of Sciences, Sofia, Bulgaria	Equatorial anomaly in the distribution of the ionic components established by satellite information	6.3.74
Prof. W.E. Wallace, University of Pittsburg	Application of rare earth cobalt alloy systems	13.3.74
Dr. A.K. Sinha, Bell Laboratories, New Jersey	Thin tungsten film for silicon integrated circuits	14.3.74
Prof. K.J. Rosenbruch, Optics Division, PTB, West Germany	Activities in optics at PTB	19.3.74
	Work at PTB in assessment of lenses, optical instruments and measuring techniques	20.3.74
Prof. Reginald Gonslez, Technical Director, Science Research Council of Jamaica, Kingston	Nature of industrial science, process of industrial science and education of industrial science	28.3.74
Dr. N.K. Girla, Roorkee University	Dislocations in ice	3.4.74
Dr. B. Lengel, Imperial College of Science and Technology, London	Hydrostatic extrusion	11.4.74
Dr. George Lubin, Guueman Aeroscope Corporation, USA	Fibre composites	4.5.74
Prof. A.K. Ramdas, Purdue University, USA	Raman and Brillouin scattering in crystals	10.7.74
	Piezospectroscopy of Raman spectra of crystals	11.7.74

Name of the Speaker	Subject	Date
Dr. D.G. Gupta, IBM, New York, USA	Diffusion processes in FCC metals and alloys	16.7.74
Prof G.B. Mitra, IIT, Kharagpur	Lattice defects and lattice vibrations	24.7.74
Dr. M.S.R. Chari	The band structure of palladium tungsten alloys	30.7.74
Dr. Dan Dumitras, Institute of Atomic Physics, Romania	Physics and lasers in Romania	4.9.74
Mr. Daniel Latafi	My recent impressions of China	13.9.74
Mr. Jai Yogi Raj	Scientific aspects of palmistry	27.9.74
Dr. F.J. Fuchs, Western Electric Co., Princeton	High pressure technology	31.10.74
Mr. R.J. Place, Consultant to Revere, Copper and Brass Inc., USA	High pressure technology	31.10.74
Dr. M.S. Iyengar	India in 2000 A.D.	15.11.74
Dr. Kurt. R. Stehling, Science and Technology Adviser, Nat. Oceanic and Atmospheric Admn., US Dept. of Commerce	Alternative sources of energy—An in-depth perspective of the progress made by American scientists towards solution of the present energy crisis	20.11.74
Dr. S.K. Bahl, University of Maryland	Electronic properties of elemental amorphous semiconductors	22.11.74
Dr. I.J. Saunders, Lecturer in Physical Electronics, Lancaster University, UK	Some recent results of photoluminescence from Si doped GaAs	27.11.74
	Double injection switching diodes	10.12.74
	Semiconductor digital emitting diodes	13.12.74
Prof. A.K. Jonscher, University of London	Dielectric properties of solids — A critical review	2.12.74
Dr. R. Srinivasan, IBM Watson Research Centre, New York, USA	Photochemical technique in semiconductor fabrication	4.12.74
Mr. William Zettler, Microwave Associates Inc., USA	Microwave solid state devices	19.12.74

KRISHNAN MEMORIAL LECTURE – 1973

Prof. M.G.K. Menon, Chairman, Department of Electronics, & Secretary to the Government of India, delivered the Krishnan Memorial Lecture — 1973, on 23rd April 1974. The topic of his lecture was *'Physics Deep Underground'*. He also gave away the NPL Merit Awards — 1973.

NPL MERIT AWARDS — 1973

Development of Gas Lasers

A team of scientists and technicians was given the NPL merit award of Rs. 2000/- for successfully developing the techniques for the manufacture of He-Ne, Argon ion and CO_2 gas lasers, and for using these for a variety of applications, viz, metrology, holography, interferometry and testing of optical components and instruments.

These lasers were fabricated using totally indigenous materials and techniques developed in the laboratory for laser mirror coating, gas filling etc. The team supplied lasers and laser components, and also reconditioned a

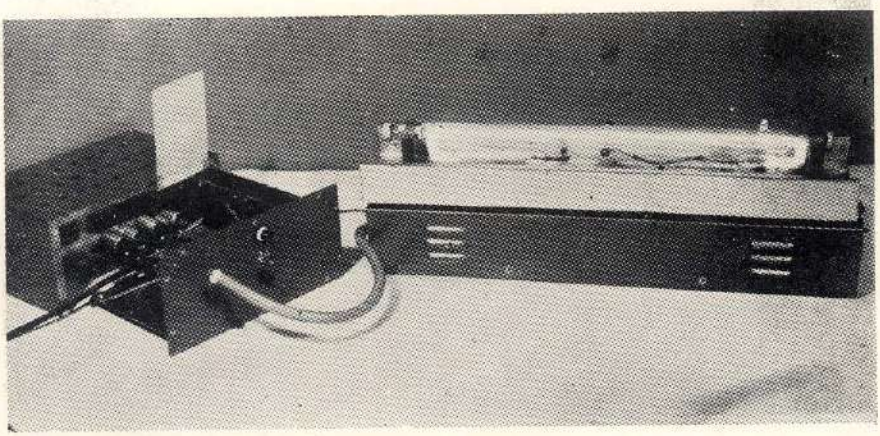

Fig 25 Prototype of the He - Ne laser of 1 mW power. The know-how has been released to the industry for commercial exploitation

large number of imported lasers for various institutions. The know-how has been passed on to industry for commercial exploitation.

Members of the team were : Dr. D. Sen, Dr. S. R. Das, Mr. V. D. Dandawate, Dr. P. N. Puntambekar, Dr. C. P. Grover, Mr. V. G. Kulkarni, Mr. B. K. Roy, Mr. Ram Narayan, Mr. Jayanti Prasad and Mr. Dharam Rawat.

Development of Semiconductor Strain Gauge Transducers

Dr. Ram Parshad and Dr. Ved Ram Singh together were given the NPL merit award of Rs. 2000/- for developing a variety of semi-conductor strain gauge transducers and for using them for measurement of pressure, flow, level, load and displacement. These transducers are useful in industry and in diverse fields of medicine, physiology, etc.

These strain gauge transducers were made from indigenous raw materials, using novel techniques developed in the Laboratory. This is a significant step in initiating a large scale use of transducers in the country.

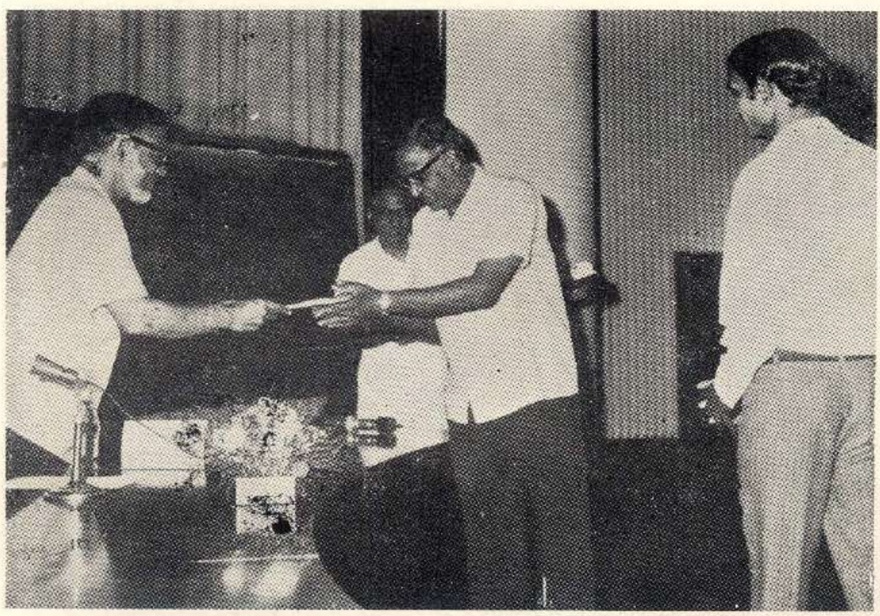

Fig 26 Dr Ram Parshad receiving NPL Merit Award — 1973 from Prof M G K Menon. On the right is Dr Ved Ram Singh the co-winner of the Award

KRISHNAN MEMORIAL LECTURE – 1974

Prof. F. C. Auluck, Professor of Physics, University of Delhi, delivered the Krishnan Memorial Lecture—1974 on 6th November 1974 on '*Superfluidity and Superconductivity*'.

Prof. Auluck recounted his contact with Sir K. S. Krishnan — the Founder Director of the Laboratory — in the following words :

'I had the privilege of coming in contact with Prof. K. S. Krishnan early in my career. This was in connection with some mathematical problems in which he was interested. He was very much devoted to his scientific work. I remember we had a Summer School in Mussoorie. In fact this was the first one organised by the Ministry of Education where Prof. S. N. Bose presided. We had long discussions among all the participants,

Fig 27 Dr F C Auluck, Professor of Physics, University of Delhi, delivering the Krishnan Memorial Lecture — 1974

and Prof. Krishnan stayed throughout the duration of the Summer School. The last Summer School on Theoretical Physics which Prof. K. S. Krishnan attended was held in Dalhousie in 1961. He was not well but even then he spoke for one hour. He returned to Delhi the next day. Probably he could not bear the strain of the journey and died the next day. I pay my homage in the memory of the noble scientist of international fame.'

Developing the subject of his talk, Prof. Auluck talked about the excitation spectrum in He^4 and the Bose condensate, observing that the problem of condensate is not even now fully understood inspite of a number of attempts. He then talked at length about the phenomenon of superconductivity, stating that Bose-Einstein condensation represents the basis of the superfluid and superconducting phenomenon. He expressed the thought of some theorists who felt that metallic hydrogen could be a room-temperature superconductor, and this may open entirely new vistas in technology. He then turned to one-dimensional organic super-conductors, the properties of which no theory was able to explain at present. Then he talked about electron-hole droplets in germanium and silicon, stating that eventually the droplet phenomenon may be of technological importance. He concluded with a well illustrated talk on the superfluidity of liquid He^3.

PARTICIPATION IN EXHIBITIONS

Exhibition	Place	Organised by
1. Electronics in India	Bombay	Publishers of 'Electronics Today'
2. Exhibition of Scientific & Commercial Electro-medical and Bio-medical Engineering Equipment	Bangalore	Aero Medical Society
3. National Science Exhibition	New Delhi	NCERT, New Delhi
4. Electronics Exhibition '73	New Delhi	Department of Electronics
5. Science Exhibition	Delhi	Kirori Mal College, Delhi
6. Exhibition at the time of the 62nd Indian Science Congress	Delhi	Indian Science Congress Association
7. Science Exhibition at the time of Third Meeting of the Association for Science Cooperation in Asia	Delhi	Council of Scientific & Industrial Research

COLLABORATION

Dr. J. Szilard from Loughborough University of Technology, England, visited the Piezo-electric Materials Section for a period of six weeks on exchange programme.

An ultrasonic probe head for cataract operation was made and tested in co-ordination with IIT, Delhi and AIIMS, New Delhi.

A symposium was organised jointly with the Department of Physics and Astrophysics, University of Delhi, on 'Microwave Technology'.

Collaboration was done with the scientists of National Aeronautics & Space Administration, on Ionospheric studies with satellite measurements.

Under a collaboration programme between Radio Science Division of the Laboratory and Max Planck Institute, Lindau Hertz, West Germany, one 140 MHz polarimeter was designed and fabricated.

A close collaboration has been continuing with the Kurukshetra University. 20 and 40 MHz satellite radio receiving systems were installed at the University of Kurukshetra in 1966-67. Regular consultation, data exchange and joint data-analysis is continuing since then.

A rocket was flown on July 4, 1973 in collaboration with the University of Tokyo, Japan. NPL provided the propagation experiment and the Gerdien Condenser.

One person from the University of Sri Lanka underwent training in the field of Glass Instrumentation under TCS Colombo Plan.

In the field of Infrared Instruments and Techniques, collaboration was done with the Institute de Physique, Universite de Nancy, France.

Collaboration was done with the National Bureau of Standards in the study of spectro-radiometry.

Two trainees from M/s. Gedore Tools worked on methods for analysis of ferrous and non-ferrous metals.

Scientists from Cyprus, Tanzania, Nepal, Iran, Nigeria, Malawi, Afghanistan and Philippines, and also from the Directorate of Weights and Measures from different States of the country obtained training in the field of metrology.

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1. Aggarwal (S) & Reddy (BM) : Effects of magnetic and solar activity on HF communication via F2 region. *Indian J Radio Space Phys.* Vol 3 ; 1974 ; 401-6.
2. Alam (IM), Nair (NR), Sharma (CD) & Ramamurti (TV) : Design and construction of a gas-tight furnace for sintering professional grade ferrites. *Res & Ind.* Vol 19 ; 1974 ; 139-43.
3. Bahadur (Harish) & Parshad (R) : Atomic frequency standards — A review. *J Sci Ind Res.* Vol 33 ; 1974 ; 561-69.
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8. Bhatia (G) : Rheological properties of carbon mixes at low shear rates using a capillary rheometer. *Carbon.* Vol 11 ; 1973 ; 437-40.
9. Bhatnagar (KN) & Jain (PC) ; A new test bench developed for testing of taxi meters. *J Inst Engrs India.* Vol 54 IDGE ; 1974 ; 51-53.
10. Bhide (VG) & Bahl (MK) : X-ray K absorption edge of niobium in some of its niobates. *J Phys Chem Solids.* Vol 34 ; 1973 ; 667-71.
11. Bhide (VG) & Kaicker (SK) : X-ray K absorption studies of some ruthenium compounds. *J Phys Chem Solids.* Vol 35 ; 1974 ; 695-98.
12. Bhide (VG) & Kaicker (SK) : X-ray K absorption studies of molybdenum sulphides, selenides and tellurides. *J Phys Chem Solids.* Vol 35 ; 1974 ; 901-4.
13. Bhide (VG) & Patki (BA) : X-ray spectroscopic study of zirconium and molybdenum diselenides. *Pramana.* Vol 2 ; 1974 ; 290-97.

14. Bhide (VG) & Rajoria (DS) : Itinerant electron ferro-magnetism in $La_{1-x} Sr_x CoO_3$ — A Mössbauer study. *J De Physique*. Vol 35 ; 1974 ; C6-629 — C6-632.

15. Bhide (VG), Rajoria (DS) & Reddy (YS) : Spin state equilibria in holmium cobaltate. *Phys Rev B*. Vol 8 ; 1973 ; 5028-34.

16. Bhuchar (VM) & Agarwal (AK) : Rapid methods of chemical analysis for quality control and maintenance-II. *ISI Bull*. Vol 26 ; 1974 ; 10-12, 22.

17. Bhuchar (VM) & Kukreja (VP) : Rapid spectrophotometric determination of chromium and manganese in steels. *Metallurgia & Metal Forming*. Vol 40 ; 1973 ; 91-92.

18. Bhuchar (VM) & Sarkar (AK) : Rapid determination of copper, silver and gold in the mixture. *Indian J Tech*. Vol 12 ; 1974 ; 366.

19. Chakrabarty (DK) & Chakrabarty (Purobi) : Some studies on D-region electron density profiles. *Indian J Radio Space Phys*. Vol 2 ; 1973 ; 211-18.

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69. Varma (SP) : Effects of photo decomposition on the optical properties of lead azide. American Physical Society Meeting, Philadelphia, Mar 1974.

70. Varma (SP) : Homogeneity of vapour deposited lead azide films. American Physical Society Meeting, Washington, DC, April 1974.

71. Verma (AR), Lal (K) & Kumar (V) : Study of growth and lattice imperfections in ZnS whiskers. Indo-German Conference on Defects in Non-metallic Crystals, IIT, Madras, Feb 1974.

72. Verma (AR), Lal (K), Kumar (V) & Aggarwal (Keshav) : Dislocation structure in CVD grown Al_2O_3 crystals by X-ray diffraction topography. Indo-German Conference on Defects in Non-metallic Crystals, IIT, Madras, Feb 1974.

73. Verma (AR), Lal (K) & Bhanu Pratap Singh : Elastic constants of silicon crystals using a high resolution X-ray diffuse reflection technique. National Conference on Crystallography, Bangalore, Dec 1974.

74. Yadava (RS) & Parshad (R) : Investigations on dielectric behaviour of aliphatic alcohols in non polar solvents. Symposium on Microwave Technology, NPL, New Delhi, Feb 4-7, 1974.

75. Yadava (RS) & Parshad (R) : Accurate measurement of impedance by determination of VSWR by tuned reflectometer method and phase by slotted section. Symposium on Microwave Technology, NPL, New Delhi, Feb 4-7, 1974.

PATENTS

Sr. No. Name of the Process & Patent Office Number	*Members*
(A) **Patents Filed**	
1. A 25 dm^3 precision pipette. (*126/Cal/73*).	M. Nath
2. A process for manufacture of silver graphite compositions. (*147/Cal/73*).	D. Sen
3. Dielectric sample holder for very thin membrane type of materials. (*186/Cal/73*).	K.B. Lakshmi
4. Improvements in or relating to the recovery of silver from silver waste. (*265/Cal/73*).	M.R. Verma, J. Rai & K.M. Munjal
5. A letter bomb detector. (*721/Cal/73*).	T.N. Ghosh, P.N. Taneja, G.K. Sharma & R.K. Pande
6. A gas lighter. (*1064/Cal/73*).	O.P. Bhola
7. A process for manufacture of silver-cadmium oxide compositions. (*1447/Cal/73*).	D. Sen
8. A process for manufacture of copper, copper alloys, graphite composite materials. (*1480/Cal/73*).	Daneshwar Sen
9. A process for the manufacture of ceramic bimorphs. (*1571/Cal/73*).	V.N. Bindal, C.V. Ganapathy, T.R.K. Menon & N. Narayanswamy
10. Angle probes for ultrasonic flaw detectors. (*1713/Cal/73*).	V.N. Bindal & V. Gogia

Sr. No.	*Name of the Process & Patent Office Number*	*Members*
11.	Improvements in or relating to the manufacture of ceramic capacitors. (*1775/Cal/73*).	V.N. Bindal, C.V. Ganapathy, T.R.K. Menon & N. Narayanswamy
12.	A strain gauge medical drip transducer. (*2344/Cal/73*).	V.R. Singh & R. Parshad
13.	A linear drive transducer for precision movement. (*2462/Cal/73*).	V.N. Bindal
14.	A device for defining the width of an X-ray beam. (*2540/Cal/73*).	K. Lal, D.R. Pahwa, V. Kumar & K. Agarwal
15.	A process for preparing an etching composition suitable for etching on glass to give permanent and opaque letters. (*2768/Cal/73*).	M. Nath
16.	A linearized resistance bridge to read temperature directly. (*2822/Cal/73*).	K.D. Baveja, R.K. Luthra & P.P. Bahl
17.	Improvements in or relating to the continuous coating of magnetic recording tapes. (*2825/Cal/73*).	S.S. Hanspal & R. Kumar
18.	An extractor. (*696/Cal/74*).	V.M. Bhuchar, A.K. Agarwal, D.P. Sharma, Franz Kiss, J.P. Vasisht & O.N.L. Srivastav
19.	Method of reduction of silver salts to silver in very dispersed phase over carbon, based on inert material or without it. (*864/Cal/74*).	V.M. Bhuchar & A.K. Sarkar
20.	A miniature tuning fork. (*876/Cal/74*).	V.N. Bindal & T.R.K. Menon
21.	Improvements in or relating to the manufacture of medium wave cup and drum cores. (*877/Cal/74*).	G.C. Jain, C.V. Ganapathy, G.S. Govindaswamy, B.K. Das, H.S. Kalsi, T.R. Pushpangadan, S. Chandra, S.C. Gupta, S.S. Hanspal, T. Podikunju & R.S. Khanduja

Sr. No. Name of the Process & Patent Office Number	*Members*
22. A process for preparation of white emitting phosphors for T.V. Screens. (*944/Cal/74*).	P.K. Ghosh, H.P. Narang & R.K. Kapoor
23. Combustion boat for combustion of steel. (*1192/Cal/74*).	V.M. Bhuchar, A.K. Agarwal, J.P. Vasisht & O.N.L. Srivastav
24. Normal beam probes for ultrasonic non-destructive testing. (*1193/Cal/74*).	V.N. Bindal & V. Gogia
25. A process for manufacture of silver graphite compositions. (*1330/Cal/74*).	Daneshwar Sen
26. A collimating system for X-ray topography cameras and similar equipments. (*2372/Cal/74*).	K. Lal, D.R. Pahwa, V. Kumar & K. Agarwal
27. Supersensitive opto-electronic solid state switch.	S.P. Suri & Madhu Khullar
28. A strain gauge level transducer.	V.R. Singh & Ram Parshad
29. A modified distillation flask.	F. Kiss
30. A strain gauge blood pressure transducer.	V.R. Singh & Ram Parshad
31. Three-dimensional panoramic X-ray radiography with conventional radiographic equipment.	K. Chandra & K.D. Kundra

(B) Patents Accepted

1. A process of making the developer for the electro-photographic machine. (*131258*). & 2. A process of making multiple prints. (*131734*).	P.C. Mehendru, D.C. Parashar, G.D. Sootha, Narendra Kumar, Devendra Singh & S. Subrahmanyam
3. Improvements in photocopying machine. (*131907*).	P.C. Mehendru, D.C. Parashar, G.D. Sootha, Narendra Kumar & Devendra Singh

Sr. No. Name of the Process & Patent Office Number	*Members*
4. Temperature controller. (*133629*).	V.P. Wasan, S.P. Suri & Madhu Khullar
5. A strain gauge immersion transducer. (133630).	Ram Parshad & Ved Ram Singh
6. A process for making silver powder. (*134017*).	Daneshwar Sen
7. A strain gauge obstruction flow transducer. (*135066*).	Ram Parshad & Ved Ram Singh

PROCESSES WHICH HAVE GONE INTO PRODUCTION

Sr. No.	*Process*	*Party*	*Nature of Licence*
1.	Universal klystron power supply	KLB Electronics, New Delhi.	Non-exclusive
2.	Hard ferrites	Ferrites & Electronic Components Pvt. Ltd., Bangalore.	Non-exclusive
3.	Linear mechanical drive for Mössbauer spectrometer	Toshniwal Instruments Engg. Co., New Delhi.	Non-exclusive
4.	Midget electrodes	Britelite Carbons Ltd., Halol Gujrat.	Non-exclusive
5.	Modulation unit for klystron power supply	KLB Electronics, New Delhi.	Non-exclusive
6.	Penning, Pirani & Penning-Pirani gauges	Vacuum Instruments Co., New Delhi.	Sponsored
7.	Ultrasonic interferometer for velocity measurement in liquids	Maheshwari Associates, New Delhi.	Technical aid
8.	Ultrasonic transducers for automation, sensing & remote control applications	Vibronics Pvt. Ltd., Bombay.	Non-exclusive
9.	VSWR meter	KLB Electronics, New Delhi.	Sponsored

PROCESSES RELEASED FOR COMMERCIAL DEVELOPMENT TO INDUSTRY

Sr.No.	*Process*	*Party*	*Nature of Licence*
1.	Cadmium sulphide photocells	Desh Deep Agarwal, Meerut.	Non-exclusive
		Chemicals (India), Calcutta.	Non-exclusive
2.	All distillation apparatus	Scientronic Instruments, New Delhi.	Non-exclusive
3.	Helium-neon gas laser	Thermometer & Thermometric Appliances, New Delhi.	Non-exclusive
4.	Modulation unit for klystron power supply	KLB Electronics, New Delhi.	Non-exclusive
5.	Piezoelectric materials & bimorph elements	Bombay Foods Pvt. Ltd., Bombay.	Non-exclusive
		T.V. Satakopan, Madras.	Non-exclusive
		Shilpi International, Nasik.	Non-exclusive
		Concord Electroceramic Industries, Delhi.	Non-exclusive
6.	Soft ferrites	Director of Industries & Commerce, Madras.	Non-exclusive
		V.S. Vaidya, Poona.	Non-exclusive
		Mulchandani Radio & Appliances, Calcutta.	Non-exclusive
7.	Universal klystron power supply	KLB Electronics, New Delhi.	Non-exclusive
8.	Carbon track for volume control	Springs & Stampings Inc. Ltd., Faridabad.	Sponsored
9.	Fabrication & reconditioning of cathode ray tubes & T.V. picture tubes	Electro-technical Enterprises, New Delhi.	Non-exclusive
		Atlas Engineering Works (P) Ltd., Calcutta.	Non-exclusive

Sr.No.	Process	Party	Nature of Licence
10.	Thin film thickness monitor	Vacuum Instruments Co., New Delhi.	Non-exclusive
11.	Metallic liquid air/ nitrogen dewars	Refrigeration & Cryogenics, New Delhi.	Non-exclusive
12.	Microwave components (S, K & KU bands)	KLB Electronics, New Delhi.	Non-exclusive
13.	Penning, Pirani & Penning-Pirani gauges	Vacuum Instruments Co., New Delhi.	Sponsored
14.	Sensitized zinc oxide paper for electro-photocopying machines	Tokushu Menon Mfg. Co. Ltd., Madras.	Non-exclusive
15.	Silicon diodes	Usha Rectifiers, Faridabad.	Sponsored
16.	Silver tungsten tablets	Compact Contacts Pvt. Ltd., Delhi.	Non-exclusive
17.	Ultrasonic transducers for automation, sensing & remote control applications	Oxford Motors, Bombay.	Non-exclusive
18.	Vacuum leak detector	Vacuum Instruments Co., New Delhi.	Non-exclusive
19.	Manufacture of wave-guide components for microwave applications (X-band)	Vidyut Yantra Udyog, Modi Nagar.	Non-exclusive
20.	Ceramic rods for carbon resistors	Director of Industries & Commerce, Madras.	Non-exclusive
		B.N. Bhaskar & Sons, New Delhi.	Non-exclusive
21.	Hard ferrites	Kumar Ferrites, Lucknow.	Non-exclusive
22.	Midget electrodes	Britelite Carbons Ltd., Halol, Gujrat.	Non-exclusive

VISITORS

Mr. P.S. Sampatkumar, Research, Designs & Standards Organisation, Lucknow.

Mr. P.R. Krishnamurty, Bharat Heavy Electricals Ltd., Bangalore.

Mr. T. Nath, Polytech Institute, New York, USA.

Mr. R.N. Bhargav, Philips Lab, USA.

Dr. M. De, Prof. and Head, Department of Applied Physics, Calcutta University.

Delegates attending IFAC International Symposium.

Dr. M.K. Matta, UAR Atomic Energy Authority.

Dr. I.J. Saunders, Lecturer in Physical Electronics, Lancaster University, UK.

Dr. J. Taubanheim, Zentralinstitut für Solar-Terrestrische Physik, Akademie der Wissenschaften der DDR, Germany.

Dr. K. Attenborough, Lecturer in Mechanical Engineering, The Open University, UK.

Hon'ble James Richardson, Minister of National Defence, Canada.

Professor Marshal F. Merriam, Associate Professor of Engineering, Department of Materials Science, College of Engineering, University of California, Berkley, California, USA.

Dr. T.R. Thomas, Senior Lecturer, Tesside Polytechnic, Middlesborough, UK.

Dr. E.F.I. Roberts. Senior Lecturer in Physical Metallurgy, City of London Polytechnic.

Mr. Bhola Prasad Lohani, Unesco Fellow from Nepal.

Mr. Martin Staveley, First Secretary, British High Commission, UK.

Mr. M.S. Orosz, Director, Videoton, Budapest, Hungary.

Prof. H. Kolsky, Professor of Applied Physics, Brown University, USA.

Mr. J.B.P. Maramis, Executive Secretary, ECAFE.

Dr. (Mrs.) C.V. Delle, Paleobotanical Laboratory, USSR

Mr. Abdul Ahad Amiri, Afghanistan.

Dr. W.K. Chagula, Tanzanian Minister for Economic Affairs and Development.

Prof. B. Chalmers, Harvard University, USA.

Dr. G.J. Davies, University of Cambridge, UK.

Dr. Vojta, Department Director, Central Institute of Solid State Physics and Materials Research, GDR.

Dr. John G. Guarrera, President of IEEE, New York, USA.

Mr. P. Jaychandran, General Sales Manager, Taylor Instruments Co (India) Ltd., Faridabad.

Mr. A.G. Loudon, Scientist, Building Research Establishment, UK.

Delegation from Bulgaria.

Lt Col J. Aeria, Commander, Singapore Armed Forces.

Delegates attending the Third Meeting of the Association for Science Cooperation in Asia.

Colombo Plan Trainees from Burma assigned to work at CLRI, Madras.

Mr. Walter Schwarv, Special Correspondent, 'Guardian', UK.

Dr. Vasile Draganescu, Head of the Department of Plasma and Radiation, Institute of Atomic Physics, Romania.

Dr. Virgil Vesilliu, Senior Scientist, Institute of Atomic Physics, Romania.

Dr. Dan Dumitras, Senior Scientist, Institute of Atomic Physics, Romania.

Dr. Amilcar O. Herrera, Fundacion Barliche, Latin America.

Dr. Raj Rangi, Low Speed Aerodynamics Laboratory, National Research Council, Ottawa, Canada.

Dr. Richard W. Roberts, Director, National Bureau of Standards, Washington, USA.

Dr. Mohd. Shamsul Haq, Dr. Irfan Ali, and Mr. Meshabuddin Ahmed— Delegation from Bangladesh.

Dr. G. Lesimple, Paris University, France.

His Excellency Dr. Hisham al Shawi, Minister of Higher Education and Scientific Research, Iraq, accompanied by a team of officials.

Prof. Dorothy Hodgkin, Eminent Scientist, Crystallographer and Nobel Laureate, Oxford, UK.

Dr. Peter Kapitza, Academician of the Soviet Academy of Sciences, Director of the Institute of Physical Problems, Moscow.

Japanese Trade Delegation.

REPRESENTATION ON ISI COMMITTEES

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BDC 12 : 8	Forced ventilation	Mr. Naunihal Singh (P) Mr. Shiv Nath (A)
BDC 19	Sieves, sieving and other sizing methods	Dr. M. Pancholy (C) Dr. P.T. John (P)
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BDC 60	Instrumentation	Dr. B.K. Agarwala (P)
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CDC 10 : 7	Signal glasses	Dr. S.R. Das
CDC 10 : 13	Protective glass	Dr. S.R. Das (P) Dr. D. Sen (A)
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CDC 33	Laboratory glassware and related apparatus	Mr. Mohinder Nath (P)

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CDC 33 : 1	Volumetric glassware	Mr. Mohinder Nath (P)
CDC 33 : 2	Thermometers	Mr. T.D. Bansal (Con) Mr. V.P. Wasan (A)
CDC 33 : 3	Hygrometers	Mr. Mohinder Nath (Con)
CDC 37	Thermal insulation materials	Mr. T.D. Bansal (C)
CDC 37/P1	Panel for terminology & methods of test for thermal insulation materials	Mr. T.D. Bansal (Con)
CDC 37/P6	Panel for thermal insulation at cryogenic temperatures	Dr. M.S.R. Chari (P) Dr. J.S. Dhillon (A)
CPDC 12	Medical glass instruments	Dr. K.C. Joshi (P) Dr. S.V. Gupta (A)
CWCE	Standing Working Committee on Mechanical Engineering	Dr. B.K. Agarwala (P)
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EDC 1 : 1	Atmospheric conditions for testing	Dr. B.K. Agarwala (P)
EDC 36	Optical and mathematical instruments	Mr. P.C. Jain (P) Mr. Ram Prasad (A)
EDC 36 : 1	Drawing instruments	Mr. P.C. Jain (P)
EDC 36 : 2	Optical instruments	Dr. S.R. Das (P) Mr. Ram Prasad (A)
EDC 36 : 3	Surveying instruments	Mr. P.C. Jain (P)
EDC 36 : 5	Materials and components for instruments	Mr. Ram Prasad (P)
EDC 41	Commercial weights & measures	Dr. A.R. Verma (C)
EDC 41 : 1	Commercial weights, lengths and capacity measures	Mr. P.C. Jain (P)
EDC 41 : 3	Taximeters	Mr. P.C. Jain (P)
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EDC 43 : 2	Precision measuring equipment	Mr. P.C. Jain (P)
EDC 43 : 3	Gauges	Mr. Mohinder Nath (P)
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EDC 57/P2	Panel for standardization of vacuum equipment	Dr. J.K.N. Sharma (C)
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EDC 66 : 1	Air-conditioning and refrigeration appliances and commercial refrigerators	Mr. Naunihal Singh (P) Mr. R.S. Khandekar (A)
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ETDC 1 : 2	General nomenclature and symbols	Mr. V.K. Batra (P)
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ETDC 10/P8	Panel for export	Dr. G.C. Jain (Con)
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ETDC 15 : 3	Carbon brushes	Dr. G.C. Jain (P) Mr. K.K. Datta (A)
ETDC 18	Insulating materials	Dr. R.N. Dhar
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ETDC 23/P2	Panel for IEC work	Mr. K.S. Sarma (P)
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ETDC 24 : 1 : 4	Television receivers	Dr. Ram Parshad (P) Mr. S. Chandra (A)

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ETDC 27	Acoustics	Dr. M. Pancholy (C)
ETDC 27/P3	Panel for accoustical terminology	Dr. M. Pancholy (Con)
ETDC 27/P4	Panel for hearing aids & audiometers	Dr. M. Pancholy (Con)
ETDC 27/P5	Panel for tapes & tape recorders	Dr. M. Pancholy (Con)
ETDC 27/P6	Panel for sound systems	Dr. M. Pancholy (P)
ETDC 28	Safety electronics and telecommunications	Dr. M. Pancholy (P)
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ETDC 35	Relays	Dr. Y.V. Somayajulu (P) Mr. K.S. Sastry (A)
ETDC 36	Capacitors & resistors	Dr. V.N. Bindal (P) Mr. T.R.K. Menon (A)
ETDC 38	Transformers and coils for electronic equipment	Mr. P. Suryanarayan (P)
ETDC 40	Semiconductor devices and integrated circuits	Dr. G.C. Jain (P) Dr. Y.R. Anantha Prasad (A)
ETDC 40/P5	Panel for terminology	Dr. G.C. Jain (P) Dr. Y.R. Anantha Prasad (A)
ETDC 40/P7	Panel for methods of measurements on transistors	Dr. G.C. Jain (Con) Dr. Y.R. Anantha Prasad
ETDC 42	Cables, wires & waveguides for telecommunication equipment	Dr. K. Chandra (P)
ETDC 43	Electrical appliances	Mr. R.K. Tandan (C) Dr. R.N. Dhar (A)
ETDC 45	Illuminating engineering	Mr. K.S. Sarma (P)
ETDC 45/P2	Panel for code of practice for industrial lighting	Mr. K.S. Sarma (P)
ETDC 45/P3	Panel for aviation lighting fittings	Mr. K.S. Sarma (P)

No. & Name of the Committee		*Members*
ETDC 45/P4	Panel for lighting fittings for hospitals	Mr. K.S. Sarma (P)
ETDC 45/P6	Panel for evaluation of glare	Mr. K.S. Sarma (Con)
ETDC 47	Cinematographic equipment	Dr. A.F. Chhapgar (P) Mr. Ram Prasad (A)
ETDC 47/P1	Panel for still projector	Mr. Ram Prasad (P)
ETDC 47/P2	Panel for cinema arc carbons	Dr. G.C. Jain (P) Dr. S.S. Chari (A)
ETDC 48	Electrical instruments	Mr. V.K. Batra (A)
ETDC 51	Piezo-electric crystals for frequency control and selection	Dr. V.N. Bindal (P)
ETDC 54	Reliability of electronic components and equipment	Dr. Y.V. Somayajulu (P) Mr. P. Suryanarayan (A)
SMDC 3	Methods of chemical analysis	Mr. V.M. Bhuchar (P)
SMDC 3	Methods of physical tests	Mr. M.K. Das Gupta (P)
SMDC 25	Non-destructive testing	Mr. M.K. Das Gupta (P) Dr. V.N. Bindal (A)
SMDC 25/P3	Panel for reference blocks for ultrasonic testing	Dr. V.N. Bindal
SMDC 52	Magnetic components & ferrites	Dr. G.C. Jain (P) Mr. R.S. Khanduja (A)
SMDC 52/P3	Magnetic components & ferrites	Mr. C.V. Ganapathy
SWCET	Standing Working Committee	Dr. G.C. Jain (P)
TDC	Mechanical Engineering Division Council	Dr. B.K. Agarwala

C : Chairman
Con : Convener
P : Principal
A : Alternate

VISITS ABROAD

Sr. No.	*Name, Country visited and Duration*	*Purpose of visit*
1.	Dr. A.R. VERMA	
	USSR (22-28 Aug 1973)	To attend the First Meeting of the Indo-Soviet Working Group for Bilateral Co-operation in the field of Standardisation and Metrology.
2.	Dr. A.P. MITRA	
	West Germany (23 May-6 June 1973)	To attend 16th Plenary Meeting of COSPAR.
	Norway (12-16 June 1973)	To attend the Conference on Incoherent Scatter, at Tromso.
	USA (18-22 June 1973)	(i) To attend the Chapman Memorial Symposium on Magnetospheric Motions, at Boulder. (ii) To visit Pennsylvania University.
	Japan (9-21 Sept 1973)	To attend the International Symposium on the Dynamics, Chemistry and Thermal Processes in the Thermosphere, at Kyoto.
	USA, Brazil, UK and Sweden (June-Aug 1974)	(i) To visit Pennsylvania State University, USA, to complete an International Programme on D-region. (ii) To attend International Symposium on Solar Terrestrial Physics, at Brazil. (iii) To attend the 17th Plenary Meeting of COSPAR. (iv) To visit Environmental Space Science Administrative Laboratory, Boulder, USA. (v) To visit Radio and Space Research Station, UK. (vi) To visit Research Institute of National Defence, Sweden.
3.	Dr. G.C. JAIN	
	USA (21 April-5 May 1973)	(i) To attend International Magnetic Conference, 'Intermag', at Washington, DC. (ii) To visit the Magnetic Materials Research & Development Wing of IBM. (iii) To visit the Research activities of L.E.D. at Philips Laboratories in Briaclof Manor, New York.

Sr. No.	*Name, Country visited and Duration*	*Purpose of visit*
4.	Dr. Y.V. SOMAYAJULU Czechoslovakia & Hungary (8-16 Nov 1973)	To participate in the International Symposia held in Czechoslovakia and Hungary.
5.	Dr. B.M. REDDY Italy (8-11 Oct 1974)	For attending International Symposium on 'Radio Propagation in Natural Media'.
6.	Dr. M.N.M. RAO Bulgaria (One month from 15 Dec 1974)	For work on Ionospheric and Space Physics and Physics of Radio Communication, under Indo-Bulgarian Exchange Programme.
7.	Dr. S.R. DAS USA (8 Oct 1973-April 1974)	For getting experience on the working of Photometric, Colorimetric and Radiometric Standards at N.B.S. Washington, under Indo-US Exchange Programme.
8.	Dr. K.K. MAHAJAN West Germany (23 May-6 June 1973)	To attend 16th Plenary Meeting of COSPAR.
	France (7-11 June 1973)	Scientific discussion at the National Centre on Telecom.
	Norway (12-16 June 1973)	For participation in the Conference on Incoherent Scatter, at Tromso.
9.	Dr. C.V. SUBRAHMANYAM GDR (April 1974-May 1975)	For training in the field of Solar-Terrestrial Relationship and new experimental techniques, under Indo-GDR Technical Cooperation Programme.
10.	Mr. MOHINDER NATH Japan (1 Feb-1 April 1974)	To attend Training Course in Metrology and Measurements Standards, under Colombo Plan.
11.	Mr. M.K. DAS GUPTA GDR (March-May 1974)	For advanced training in the fields of metrological tests and metrological research and development, under Indo-GDR Technical Cooperation Programme.
12.	Dr. D. SEN GDR (March-May 1974)	For advanced training in the fields of metrological tests and metrological research and development, under Indo-GDR Technical Cooperation Programme.
13.	Dr. Y.R. ANANTHA PRASAD France (Nov 1974-Jan 1975)	For training in the field of Semi-conductor Physics, under the Indo-French Cultural Exchange Programme.
14.	Mr. P.N. PUNTAMBEKAR UK (10 March 1974-3 July 1975)	For studies under Commonwealth Scholarship.

EXECUTIVE COMMITTEE

(As on 31st December, 1974)

Chairman

Dr. A.R. Verma
Director,
National Physical Laboratory,
New Delhi.

Members

Mr. C.R. Subramanian,
Managing Director,
M/s Bharat Electronics Ltd.,
P.O. Jalahalli,
Bangalore-560013.

Prof. K.L. Chopra,
Dean,
Faculty of Science,
Indian Institute of Technology,
Hauz Khas,
New Delhi.

Dr. Kailash Chandra,
Scientist,
National Physical Laboratory,
New Delhi.

Accounts Officer,
National Physical Laboratory,
New Delhi.

Mr. V.B. Mainkar,
Director (W & M),
Directorate of Weights & Measures,
Ministry of Commerce,
Shastri Bhawan,
New Delhi.

Dr. A.P. Mitra,
Scientist,
National Physical Laboratory,
New Delhi.

Dr. M.S.R. Chari,
Scientist,
National Physical Laboratory,
New Delhi.

Administrative Officer,
National Physical Laboratory,
New Delhi. (*Member Secretary*)

Permanent Invitees

Director-General SIR
(or his nominee)

Chairman, Coordination
Council for Physical and
Earth Sciences Group

Committee to Identify Areas of Thrust for NPL during the Fifth Five-Year Plan Period

1. Dr. A.R. Verma,
   Director,
   National Physical Laboratory,
   New Delhi-110012.

2. Dr. R. Ramanna,
   Director,
   Bhabha Atomic Research Centre,
   Trombay,
   Bombay-400085.

3. Prof. J.N. Bhar,
   Director,
   Institute of Radio Physics,
   92 Acharya Prafulla Chandra Road,
   Calcutta-9.

4. Prof. A. Bose,
   Professor of Physics,
   Department of Magnetism,
   Indian Association for the Cultivation of Science,
   Jadavpur,
   Calcutta-32.

5. Dr. E.C. Subbarao,
   Professor of Metallurgy,
   Indian Institute of Technology,
   IIT Post Office,
   Kanpur-208016.

6. Dr. C.N.R. Rao,
   Professor of Chemistry,
   Indian Institute of Technology,
   IIT Post Office,
   Kanpur-208016.

7. Prof. K.L. Chopra,
   Dean,
   Faculty of Science,
   Indian Institute of Technology,
   Hauz Khas,
   New Delhi.

8. Mr. C.R. Subramanian,
   Managing Director,
   Bharat Electronics Ltd.,
   Jalahalli,
   Bangalore-560013.

9. Mr. V.B. Mainkar,
   Director (W & M),
   Directorate of Weights and Measures,
   Ministry of Commerce,
   Shastri Bhawan,
   New Delhi.

10. Dr. A.S. Rao,
    Managing Director,
    Electronics Corporation of India Ltd.,
    Industrial Development Area,
    Cherlapalli,
    Hyderabad-40.

11. Mr. M.M. Suri,
Managing Director,
M/s. M.M. Suri and Associates
Private Ltd.,
B 14, Greater Kailash-I,
New Delhi-110048.

12. Mr. A. Rahman,
Chief (Planning),
Council of Scientific &
Industrial Research,
Rafi Marg,
New Delhi-110001.

13. Dr. A.P. Mitra,
Scientist,
National Physical Laboratory,
New Delhi-110012.

14. Dr. V.G. Bhide,
Scientist,
National Physical Laboratory,
New Delhi-110012.

15. Dr. G.C. Jain,
Scientist,
National Physical Laboratory,
New Delhi-110012.

16. Dr. M. Pancholy,
Scientist,
National Physical Laboratory,
New Delhi-110012.

17. Dr. Kailash Chandra,
Scientist,
National Physical Laboratory,
New Delhi-110012.

18. Dr. M.S.R. Chari,
Scientist,
National Physical Laboratory,
New Delhi-110012.

Proceedings of the Meeting of the Committee constituted by the Executive Committee of NPL, for Identifying Areas of Thrust for the Laboratory during the Fifth Five-Year Plan Period, held on 9th November 1974.

The following attended the meeting :

Dr. A.R. Verma
Dr. R. Ramanna
Prof. J.N. Bhar
Prof. A. Bose
Dr. E.C. Subbarao
Prof. K.L. Chopra
Mr. V.B. Mainkar
Dr. A.P. Mitra
Dr. V.G. Bhide
Dr. G.C. Jain

Dr. M. Pancholy	
Dr. Kailash Chandra	
Dr. M.S.R. Chari	
Dr. V.V. Shah	By invitation
Dr. B.K. Agarwala	By invitation
Dr. P.C. Mehendru	By invitation
Mr. N. Sen	Representing Mr. A. Rahman

Dr. C.N.R. Rao, Mr. M.M. Suri, Dr. A.S. Rao and Mr. C.R. Subramanian expressed their inability to attend the meeting. Dr. Y. Nayudamma, DGSIR, who had also been requested to give the benefit of his participation and advice in the meeting, could not attend.

All the members had been invited by the Director to visit the Laboratory and spend two whole days (i.e. 7th and 8th November), for intimate familiarisation with the activities of the Laboratory. In response to this invitation, Prof. Bhar, Prof. Bose, Dr. Subbarao and Prof. Chopra visited the different divisions and projects.

While a document giving brief information about the technical and financial aspects of the various project proposals for the Fifth Five-Year Plan had been sent to the members of the committee earlier, the following documents were placed before them at the time of the meeting :

1. Organisational set-up and programme charts (A simplified presentation of activities), Nov 1974.
2. NPL Overview 1974.
3. A note on 'SWOT analysis and key result areas'. This also contained a list of the redefined objectives of the Laboratory.
4. A note on the hydrostatic extrusion facility at the NPL.
5. 'Summary of objectives, achievements, present and future programmes' of the Radio Science Division.

Dr. A.R. Verma welcomed the members who had so willingly and unhasitatingly accepted to help the Laboratory to identify areas where a thrust could be made during the Fifth Plan period in the light of the National Science & Technology Plan, keeping in view the expertise that had been built by the Laboratory over a number of years and also the statutory obligation that the Laboratory had, of establishing and maintaining national standards of physical measurements. He informed the members about the recent re-structuring of the R & D set-up of the Laboratory, which was reflected in the document 'Organisational set-up and programme charts', which could form the basis of the discussion.

Division of Standards

Dr. Ramanna, while emphasising that NPL should be the base for primary standards, felt that the Laboratory should also recognize the existence of other standards, e.g. the radio-active standards at BARC. Further, he said that good amount of publicity should be given to the standards established and maintained by NPL to avoid any duplication by other agencies, as these were all very costly activities.

Mr. V.B. Mainkar invited the attention of the members to the Maitra Committee Report. He agreed with Dr. Ramanna that BARC being the immediate users of radioactivity standards, that institution should be the natural choice for the location of national standards for such measurements.

Mr. N. Sen felt that since NPL has a statutory obligation in regard to national standards, all of them should be maintained here only.

Summing up the discussion on this issue, it was decided that though the housing/location of radioactivity standards will be at BARC, yet liaison with the international agencies in regard to all the national standards will be through NPL. Further, the availability of the various national standards will be given wide publicity.

Commenting upon the programme of work, Mr. Mainkar observed that only standards of length, force, vibration and the various electronic/electrical standards including time and frequency standards were being proposed to be taken up as plan programmes, while funds for all the other standards activities were proposed to be provided from within the non-plan allocations. He feared, that by doing so, the large number of standards activities proposed to be funded from the non-plan allocations may be seriously affected because of the cuts that were often made on the budgets of the Laboratory.

Dr. Verma explained that since maintenance of standards is a continuing programme of work, substantial portion of the non-plan allocation to the Laboratory is assigned to it. Only a few of these activities have been identified as plan activities where initial heavy capital investment is required and therefore a thrust is proposed to be made during the Fifth Plan period. For this, special funds under the plan-head will be required. There is no intention of stopping work on the other standards activities.

Division of Specialized Techniques

Dr. Ramanna observed that work on materials in general and crystals in particular was lacking in the country. Based on the expertise already built up, NPL should concentrate on crystal growth. He felt that NPL is the right place to become a national centre for crystal growth so that crystals of all types could be made and supplied. Dr. Ramanna also emphasised the need for intensive study on the relationship between composition, structure, imperfection and the physical properties of materials.

Dr. Verma added that crystal growth work and characterization of materials go together. As such, it is necessary to strengthen the Laboratory's activities in the field of characterization of materials also. A good start had been made in this regard through the development of Lang Camera for X-ray topography.

Dr. Ramanna, Prof. Bose, Prof. Subbarao and Prof. Chopra were unanimous in emphasising the need for characterization of materials and understanding the relationship between composition, structure and imperfection with the physical properties of materials.

Cryogenics

Dr. Ramanna emphasized that the character of the projects should be such that it attracts the attention of scientists in various walks of life so that the Laboratory gets a high status in the national effort.

Prof. Bose said that he had visited the various activities of the Laboratory during the two days preceding the meeting and observed that while the Laboratory has been given a very good orientation, there appears to be a tendency to isolate the programmes of the Laboratory from those of the other laboratories in the country. He felt that it would be a good policy to take along other laboratories also so that full benefit could be derived from the available expertise in the country. Thus for instance, IIT, Kanpur, University of Delhi, and some of the Defence Science laboratories could be associated in the low-temperature programme. He paid a tribute to the Laboratory for the continuous running of the helium plant for the last about 20 years and for some of the work that has come out from this group. He was glad that the activity in this group is now being oriented to applied programmes.

Dr. Bhide informed that the document which had been circulated to the members gave only a very brief account of the activities, and perhaps some of the envisaged collaborations had not been reflected therein properly. In fact, the Laboratory had drawn out extensive proposals of collaboration. A collaborative programme between NPL, Delhi University, and the Indian Institute of Science, Bangalore has recently been started on Josephson tunneling phenomena. Similarly the programme on superconducting materials and magnets was proposed to be carried out by the Laboratory, jointly with the Bharat Heavy Electricals Ltd., BARC and NML, Jamshedpur. NML's role would be in respect of the metallurgical aspects concerned with the preparation of superconducting materials.

The work on cryo-probes which was of interest to the medical profession also held promise and should be continued. However, this deserved a low priority as compared to the other activities in the field of cryogenics.

Division of Materials

Mr. Mainkar wanted to know whether any definite programme had been drawn out for the materials proposed to be taken up under the standard reference materials programme of the Laboratory during the Fifth Plan period. He held that this was an important aspect needing careful attention.

Dr. G.C. Jain presented a brief summary of the present and projected programme of work. The semiconductor activity was presently confined to making of polycrystalline silicon, single crystal silicon, and silicon devices. Development of high power silicon rectifier had been completed as a project sponsored by the industry, and the know-how had been recently released to the party. The programme was to take up work on 400 Amp silicon controlled rectifiers, which is a project identified by the Coordination Council for the Physical and Earth Sciences Group of CSIR Laboratories, for NPL. Both NPL and BARC/ECIL were presently having more or less the same status of technology in the development of semiconductor grade silicon. It would require clean room facilities for making any further progress in this direction, and this would require almost about ten times the available inputs.

Prof. E.C. Subbarao observed that since ECIL were better placed as compared to NPL, this work should be done by them. Both the polycrystalline and single crystal work should not therefore receive priority at NPL. The project should be reviewed at the end of 1974-75.

In respect of carbon products, it was observed that NPL were the pioneers in the country in this area, and a very strong and competent group exists at the Laboratory. The available equipment, however, cannot lead much farther than what has been achieved. The plant has been giving good returns, but the pilot plant production should be done for consumer acceptability trials only, without getting into a competition with the licencees of the Laboratory know-how. It is necessary to continue filling up the credibility gap especially in the context of the import of technology, and to feed the results of R & D to the industry, for improving their products.

Dr. Jain emphasised the need for taking up work on graphite anodes as an area of thrust for the Laboratory. This, however, would require a complete modernization of the plant. The work on carbon fibres formed a part of a UNDP Country Programme for which Indian counterpart funds will be coming from the DST.

It was recommended that a loan of Rs. 20 to 25 lakhs should be given to the carbon plant, which should gradually develop into an agency similar to CEL. The programme of work should be so drawn out as to have a link with the user industry all through.

In regard to magnetic materials it was observed that it was necessary to concentrate on the physics of materials. This aspect needs strengthening. There was unanimity of opinion on the assignment of highest priority to the work on soft ferrites — (a) high frequency professional ferrites and (b) very high permeability ferrites. However, it was necessary to have a close look on the proposed work on hard ferrites. The laboratory could go to the extent of preparation of powders for use by other agencies, suiting their machines. The work on memory cores should be taken up as a project sponsored by the Central Electronics Ltd., who were interested in it. All activity on single crystal preparation (including single crystal ferrites, garnets and silicon single crystals) should be grouped together.

In respect of piezoelectric and dielectric materials and devices, it was necessary to make an overall assessment as to where to stop especially with the creation of the Central Electronics Ltd. It was decided that the work on ultransonic instrumentation and devices should be clubbed with the work on these materials.

Division of Radio Science

Prof. Bhar said that he had spent a good amount of his time on the 7th and 8th instant in visiting the various groups, and in particular, those falling within the Radio Science Division. Since this was his own field of interest he could say with authority that very good quality of research work has been done by this Division, which is recognised not only in India, but also at the international level. SODAR is one area in which NPL is one of the first few laboratories who have made signal achievement in a very short time. Besides being a prestigeous area for the Laboratory, the work on environmental hazards of which SODAR is just a part, is gaining international importance.

This Division, Dr. Bhar added, has been turning out very useful data, and, as such, the radio propagation services need to be strengthened. In this context he made a specific reference to the improvement of the time & frequency services. The CSIR's comments on the item relating to this item of the agenda for the Executive Committee meeting to be held later during the day, saying that this programme should have a very low priority, were brought to the notice of the members. It was unanimously agreed that this activity was of utmost importance and should receive the highest priority.

A reference was also made to the ionosonde. The NPL ionosonde is now almost 17 years old. The spares of the equipment are no more available, and a number of changes in its circuitry etc. have been effected to keep it going. There is every possibility of its breakdown any time now. Fabrication of ionosonde in India is recognised as an immediate problem not only for NPL but for other laboratories also, and the Indian National Committee for the URSI has recommended that a prototype construction be taken up by some organisation in India. It was suggested that a proposal could go to the Basic Sciences Committee of INSA for providing funds for design and fabrication of a prototype by the joint efforts of several Indian institutions, including NPL.

Dr. Chopra felt that it may perhaps be a good idea to limit the activity to certain areas. He felt that for space physics projects, money should come from agencies like ISRO. Similarly, funds for the environmental hazards activity should come from some other agencies.

Dr. Mitra clarified that NPL's participation in the space physics programme was done in consultation with ISRO, and facilities like rockets, use of rocket range and telemetry and tracing are in fact provided by ISRO free.

Microwaves & Display Tubes Technology

Dr. Kailash Chandra gave a brief account of the present and proposed activities of this project, and informed that the Electronics Commission had shown interest in the field of microwaves. The development of reflex klystron and harmonic generator for X-band has already been completed. Recently success has also been achieved in the development of Gunn oscillator for X-band.

Wave-guide components for C/XN and X-band had been developed and are being commercially manufactured by two firms in the small scale sector. Technical know-how for S, KU & K-band wave-guide components has also been released. The proposal is to extend the work to cover broad band wave-guide components, high-power wave-guide components and coaxial line components for both low and high power requirements. It is also proposed to take up the development of precision components, stripline and microstrip components and microwave integrated circuits (in collaboration with CEERI, Pilani who have got photo-lithographic cameras). He estimated that it would require a few lakhs of rupees for setting up some clean room facilities and buying a drafting machine etc. The Laboratory already had competence in thin-film and microwave design work.

It was agreed that with the limited resources available, the Laboratory should not take up work on MICs. The rest of the programme of work on microwave hardware could constitute an area of thrust.

In regard to the microwave instruments, Dr. Kailash Chandra informed that klystron power supplies — low voltage and universal types, and also the VSWR meter (sponsored project) had already been developed and were in production. The proposed work on frequency counter was linked up with the Laboratory's project on frequency standards. Other instruments proposed to be developed were spectrum analyser, insertion loss test-set, field intensity meter, noise sources and noise measuring equipment.

It was agreed that work on the proposed microwave instruments may be carried on, partly funded by the revolving fund of micro-wave components.

In regard to the display tubes, Dr. Kailash Chandra informed that techniques for fabrication/reconditioning of low frequency CR tubes and black & white TV tubes have been developed, and it is proposed to set-up a demonstration plant for these tubes at NPL, with funds coming from NRDC. This will become a self-sustaining unit.

Electronics Commission have been approached for financing a project on high frequency cathode ray tubes. The other display tubes covered in the programme are the double gun-tubes and the radar display tubes.

It was learnt that the country was not yet prepared for the Colour TV. As such it was decided to keep the work on colour picture tube in low key.

Electrostatic Photocopying Machines

Dr. P.C. Mehendru informed that during the last about 3 years the Laboratory had received more than Rs. 10 lakhs towards premium and royalty on the sale proceeds from the licencees of the NPL know-how.

Dr. Verma added that this was one of the areas where the Laboratory had developed expertise and the efforts should be continued. It was decided to lay emphasis on complete indigenisation of the process and to make the machine faster and automatic in operation.

Thin Film Devices

Dr. V.V. Shah briefly informed about the various types of optical devices which had already been developed, and which were proposed to be put into production on the plant recently procured at a value of more than Rs. 7 lakhs. Director informed that this was the single costliest equipment that the Laboratory had procured and, as such, it would be better to get returns from the investment made.

Dr. Shah made a particular mention of the development work relating to the preparation of thin film interference filters as a finished product. Know-how had already been developed for the preparation of three types of interference filters viz., M-D-M type, induced transmission type, and all-dielectric type. However these filters have inherent property of showing transmission bands at other wavelengths also along with the peak transmission wavelength. To suppress these side bands, colour glass filters are normally used but the same are not indigenously available In this direction, some work had already been carried out and now an attempt is being made to deposit polymer films after mixing them with certain dyes. A set-up similar to the one used by Prof. K.L. Chopra at IIT, Delhi for depositing pure polymer films has been set up.

It was decided that as far as the production activity was concerned, it should be concentrated on the out-turn of critical items. However, one could so plan the product mix so as to make this a self-sustaining proposition.

The R & D activity on thin film devices will however require funding from the Laboratory.

It was decided that the emphasis should be laid on the making of thin film optical devices not available in the country, and utilizing the spare capacity for other work of a sophisticated nature.

Liquid Crystal Displays

Dr. Bhide informed about the status of the work on liquid crystal displays. In as far as the liquid crystal thermal devices were concerned, they had caught the imagination of the industry and five parties had already come forward to take up the know-how. He briefly touched upon the application of these devices in the family planning programmes also. He also brought out the significant features of the Electro-optical devices using liquid crystals. The large screen displays had a great social implication.

Dr. Subbarao and others highly appreciated the work done in this area and said that it was because there was a happy blending of fundamental research and developmental work that such a rapid progress could be made. There was unanimity in laying priority on this emerging area.

Glass Technology Unit

It was decided that this unit should work for self-sufficiency.

Pilot and Demonstration Plant in Hydrostatic Extrusion and Material Synthesis

Dr. Verma informed that this was a unique project which was sponsored by the UNDP. The technology is very important and is physics-based. It was after a very careful consideration that NPL which had done work in the area of high pressures, took up this project for implementation.

Dr. B.K. Agarwala informed that the programme of work includes — (a) product development, (b) indigenous development of high pressure equipment, and (c) training of staff in this technology. The idea of making it a self-supporting proposition has been mooted from the very beginning.

Dr. Subbarao felt that this project should not, in the long run, become an appendage to NPL.

The Director again emphasised that the NPL took up the project because the country needs it. There is no other agency which has shown an interest in meeting this demand. The NRDC had earlier formed a committee under the chairmanship of Mr. K.B. Rao, the then Director General Technical Development, and this committee had assigned this task to NPL. Various agencies like the DGTD, CSIR, NML. and others connected with it had been consulted before arriving at this decision.

It was finally agreed to take up this project.

BUDGET

(*Rs. in lakhs*)

		1973-74	*1974-75*
Recurring			
(i)	For the Laboratory	77.112	102.732
(ii)	For Test & Evaluation Centre (TEC)	3.336	3.413
	Sub-Total	80.448	106.145
Capital		15.978	24.114
Pilot Plants			
(i)	Development-cum-Production of Electronic Components (DPEC)	13.451	19.108
(ii)	Glass Technology Development and Production Unit (PPG)	7.779	7.613
(iii)	Carbon Technology (PPE)	1.925	4.931
(iv)	Pilot & Demonstration Plant in Hydrostatic Extrusion & Material Synthesis	—	1.648
	Sub-total	23.155	33.300
	Total	119.581	163.559

STAFF*

	(As on 31.12.1974)
Scientific	182
Technical	524
Administrative	145
Total	851
Research Fellows	71

*Excluding Class IV

Receipts on Account of Fabrication, Supply and Repair of various products during 1973-74

Sr. No.	*Item*	*Rs.*
1.	Sale of Carbon Rods. (Process, Projector, Midget electrodes)	1,14,631-99
2.	Supply of Shock-absorption Testing Equipment.	20,000-00
3.	Supply of Photo-conductive Plates.	18,345-00
4.	Repair and Supply of He-Ne Laser.	12,250-00
5.	Instruments Servicing.	4,600-00
6.	Coating of Glass Plates.	2,620-00
7.	Repair of Traffic Control Devices.	1,848-00
8.	Supply of Photometric Integrator.	1,500-00
9.	Supply of Liquid Air.	1,732-22
10.	Supply of Moiré Gratings.	1,030-00
11.	Repair and Supply of Probes and Ultrasonic Instruments.	1,025-00
12.	Workshop jobs.	489-75
13.	Fabrication of Ice-point Equipment.	275-00
14.	Supply of Tungsten-Silver Discs and Photo-cell	92-00
15.	Fabrication of Microwave Components.	85-00
16.	Packing, Postage and Charges for visiting at site, and extra copies of test reports.	1,638-30
	Total :	1,82,162-26

Receipts on Account of Fabrication, Supply and Repair of various products during 1974-75

Sr. No.	*Item*	*Rs.*
1.	Supply & Fabrication of Photometric Integrater.	11,300-00
2.	Supply, Fabrication & Repairs of He-Ne Lasers.	7,150-00
3.	Supply & Fabrication of Photo-conductive Plates.	6,930-00
4.	Supply & Fabrication of Platinum Resistance Thermometer & Triple Point of Water Cell.	4,500-00
5.	Instruments Servicing	3,950-00
6.	Repairs, Supply & Fabrication of Ultrasonic Probes, Piezoelectric Mini Tuning Fork, Ultrasonic Bragg's Diffraction Apparatus.	3,075-00
7.	Supply & Fabrication of N-type Wafers, Photo-cell etc.	1,580-00
8.	Supply & Fabrication of Neutral Density Filters and Vacuum Coatings.	1,295-00
9.	Reconditioning of TV Picture Tubes.	725-00
10.	Fabrication & Supply of Moiré Gratings.	410-00
11.	Repair of Traffic Control Devices and Supply of Shock Absorption Test Equipment.	360-00
12.	Workshop jobs.	258-45
13.	Supply/Repair of Metal Detector.	217-30
14.	Furnace of Mössbauer Linear Drive Unit.	50-00
15.	Packing & Postage Charges.	173-40
16.	TA/DA Charges for the visits of the Scientists.	107-15
	Total :	42,081-30