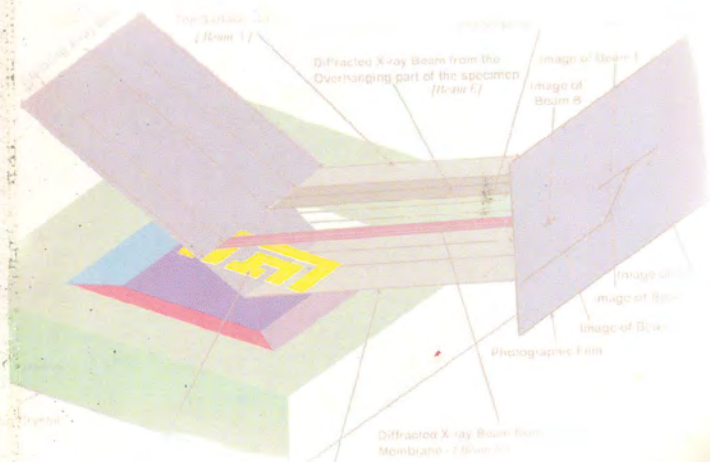
वार्षिक प्रतिवेदन
Annual Report
1998-1999



राष्ट्रीय भौतिक प्रयोगशाला, नई दिल्ली

National Physical Laboratory, New Delhi

CONTENTS

प्राक्कथन

राष्ट्रीय भौतिक प्रयोगशाला की वर्ष 1998-99 की वार्षिक रिपोर्ट को प्रस्तुत करते हुए मुझे अत्यन्त हर्ष हो रहा है।

वार्षिक रिपोर्ट को प्रकाशित करने में हुए विलम्ब के लिए गहरा खेद है। इस अवधि के दौरान डा. ए. के. रायचौधुरी एन.पी.एल. के निदेशक थे। वे मई, 2000 में इंडियन इंस्टीट्यूट ऑफ साइंस, बेंगलूर वापस चले गए।

रिपोर्ट में प्रयोगशाला के सभी अनुसंधान एवं विकास के क्षेत्रों जैसेः- भौतिक-यांत्रिक मानक, विद्युत एवं इलैक्ट्रॉनिक मानक, इंजीनियरी पदार्थ, इलैक्ट्रॉनिक पदार्थ, बहुलक और मृदु पदार्थ, पदार्थ अभिलक्षणन, रेडियो एवं वायुमण्डलीय विज्ञान, अतिचालकता तथा क्रायोजेनिक्स (निम्न ताप) में की गयी प्रगति की समीक्षा की गयी है । आन्तरिक परियोजनाओं के अतिरिक्त, प्रयोगशाला ने प्रायोजित परियोजनाओं पर भी कार्य किया, अंशांकन एवं परीक्षण सेवाएं प्रदान कीं और विविध संस्थाओं को परामर्श प्रदान किया।

मापों के राष्ट्रीय मानकों को बनाए रखना तथा शीर्ष स्तर पर अंशांकन सेवाएं प्रदान करना एन.पी.एल. का उत्तरदायित्व है। हमारी प्रयोगशाला देश में किए गए सभी प्रकार के मापों की राष्ट्रीय और अन्तर्राष्ट्रीय मानकों के साथ ट्रेसेबिलिटी को सुनिश्चित करती है। मानकों के अनुरक्षण के लिए लगातार अनुसंधान एवं विकास कार्यों की आवश्यकता यह सुनिश्चित करने के लिए होती है कि हमारे मानक न्यूनतम संभावित अनिश्चितता से संरक्षित किए जाएं और अपने क्षेत्र में स्टेट ऑफ आर्ट स्तर के आस-पास रहें। हमारे मानकों की अन्तर्राष्ट्रीय मानकों के साथ तुलनात्मकता को सुनिश्चित करने के लिए अन्तर्राष्ट्रीय अन्तर्तुलनाओं का भी दायित्व लिया जाता है। इस अवधि के दौरान एशिया पैसिफिक माप पद्धति(APMP) कार्यक्रम के अन्तर्गत ध्वानिक, लम्बाई मापन और दाब मापन के क्षेत्र में तीन अन्तर्राष्ट्रीय अन्तर्तुलनाओं को सम्पन्न किया गया। द्विपक्षीय व्यवस्थाओं के अन्तर्गत दो अन्तर्तुलनाएं कार्यान्वित की गयीं जिनमें से एक में पी.टी.बी., जर्मनी भी शामिल थी। पानी के रासायनिक विश्लेषण के क्षेत्र में नेशनल ऑथारिटी ऑफ टेस्टिंग एजेन्सीज (NATA), आस्ट्रेलिया द्वारा संचालित एक मुख्य प्रवीणता परीक्षण कार्यक्रम में एन.पी.एल. ने भी भाग लिया। प्रयोगशाला के सभी क्षेत्रों में महत्वपूर्ण अनुसंधान कार्य किए गए हैं। ये मुख्यतः इस प्रकार हैंः प्लेटिनम-इरीडियम अलॉय की सतह का अध्ययन; गैलियम आर्सेनाइड क्रिस्टल पर उच्चदाब रामन अन्वेषण; रेडियो आवृत्ति स्क्विड प्रभाव; वृहद् मैग्नेटो-प्रतिरोध अध्ययन; कॉम्पोज़िट्स में कार्बन फाइबर-मैट्रिक्स अन्योन्य क्रिया; क्वांटम इलैक्ट्रानिक्स; एडवांस्ड कॉयल्ड मैम्बरेन सेंसर्स का संरचनात्मक अभिलक्षणन; बिस्मथ जर्मेनेट के लगभग पर्फेक्ट एकल क्रिस्टलों का विकास और मैग्नीशियम डोप्ड कॉपर बेरियम कैल्शियम क्यूप्रेट्स (Cu -1234)। अनुसंधान एवं विकास गतिविधियों के मुख्य विषय थेः ऍयरो स्पेस अनुप्रयोगों हेतु वर्गाकार ट्यूब्स का विकास; एडवांस्ड लाइट हैलीकाप्टर (ए.एल.एच) हेतु अण्डाकार आकार की लम्बी ट्यूब्स; उच्च घनत्व समदैशिक ग्रेफाइट; थिन फिल्म कैडमियम टैल्यूराइड सोलर सैल्स; यूरिया, लैक्टेट व कोलेस्ट्रॉल हेतु बायो-सेंसर्स; चालक (कंडक्टिंग) पॉलीमर्स, नॉवल नॉन-लीनियर

इलैक्ट्रो-ऑप्टिक मैटीरियल्स व डिवाइसेज एवं पार्टिकल साइज विश्लेषण हेतु प्रौद्योगिकी। एम एस टी राडार व ओज़ोन साउंडिंग द्वारा ट्रोपोपॉज़ (Tropopause) संरचना पर भी अन्वेषण किया गया। लाइन-ऑफ-साइट माइक्रोवेव लिंक के निष्पादन पर अनुसंधान किया गया तथा ट्रांस-आयनोस्फरिक प्रवर्धन (Propagation) पर आयनोस्फरिक अनियमितताओं के प्रभाव का अध्ययन किया गया। इस क्षेत्र में अन्य प्रमुख गतिविधियां भारतीय समुद्र परीक्षण (INDOEX) के अंतिम चरण और ग्रीन हाउस गैसेज़ के अध्ययन से सम्बन्धित थीं।

वर्ष के दौरान नौ नई सुविधाओं (facilities) की स्थापना की गयी। इनमें द्रव चालित बल गुणन प्रणाली जो 3 MN तक जा सके; एक FTIR स्पैक्ट्रोफोटोमीटर; इलैक्ट्रिकल स्टील स्ट्राइप्स के चुम्बकीय गुण धर्मों के मापन हेतु सुविधा; टेलीक्लॉक सेवा; डायमण्ड समान कार्बन फिल्म्स के निर्माण हेतु माइक्रोवेव PECVD-सुविधा एवं ऊर्जा परिक्षेपी स्पैक्ट्रोमीटर सहित एक स्कैनिंग इलैक्ट्रॉन माइक्रोस्कोप शामिल हैं।

वर्ष के दौरान वैज्ञानिक पत्रिकाओं में 130 शोध-पत्र प्रकाशित हुए और राष्ट्रीय एवं अन्तर्राष्ट्रीय गोष्ठियों में 186 प्रस्तुतीकरण (Presentation) किए गए। एन.पी.एल. में कार्य करते हुए 17 युवा वैज्ञानिकों ने पी.एच.डी. की उपाधि प्राप्त की और 7 पेटेण्ट्स फाइल किए गए। वर्ष के दौरान लगभग 255 लाख के वित्तीय निवेश वाली प्रायोजित परियोजनाओं और करीब 76 लाख रूपए की परामर्श परियोजनाओं का उत्तरदायित्व लिया गया। अंशांकन एवं परीक्षण सेवाओं तथा जॉब-वर्क से लगभग दो करोड़ रूपए के राजस्व का उपार्जन किया गया। तीन इन-हाउस प्रशिक्षण सहित 6 प्रशिक्षण कार्यक्रम किए गए। एन.पी.एल. के वैज्ञानिकों द्वारा सात सम्मेलनों (कांफ्रेंस) का आयोजन किया गया, जिनमें दो अन्तर्राष्ट्रीय थे। उनमें से एक ICSU प्रायोजित मुख्य कांफ्रेंस व जनरल असैम्बली थी।

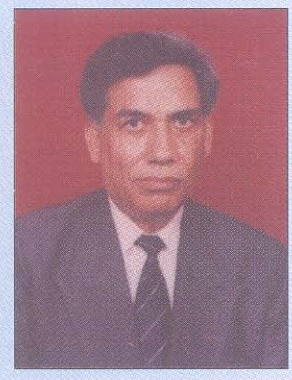
एन.पी.एल. के वैज्ञानिकों को राष्ट्रीय तथा अन्तर्राष्ट्रीय स्तर पर मान्यता प्राप्त हुई, उनमें से कई वैज्ञानिकों को रामन फैलोशिप और ब्वायस्कास्ट (Boyscast) फैलोशिप अवार्ड प्रदान किया गया। हमारे वैज्ञानिकों में से एक को एक प्रतिष्ठित विदेशी अकादमी द्वारा आनरेरी डाक्टरेट से सम्मानित किया गया।

मैं अपने उन सभी सहयोगियों को धन्यवाद देता हूं, जिन्होंने प्रयोगशाला की अनुसंधान एवं विकास की उपलब्धियों में अपना योगदान दिया। हममें उच्च क्षमताएं हैं और हमें अनुसंधान एवं विकास के सभी पहलुओं में प्रतिस्पर्धात्मक उंचाइयों पर पहुंचने के लिए कठिन प्रयास करना है। एन.पी.एल. वार्षिक रिपोर्ट टीम को उनके योगदान के लिए धन्यवाद। डा. वी. एन. ओझा, डा. (श्रीमती) रीना शर्मा, डा. एम. के. गोयल और डा. टी. डी. सैनगुत्तुवन द्वारा किए गए विशेष प्रयास प्रशंसनीय है।

कृष्ण लाल

(कृष्ण लाल)
निदेशक

FOREWORD



It gives me great pleasure to present the NPL Annual Report for the year 1998-99.

There has been a delay in bringing out the Annual Report, which is deeply regretted. Dr. A.K. Raychaudhuri was the Director of the NPL during this period. He has been repatriated to Indian Institute of Science, Bangalore in May 2000.

The report reviews the progress made in all the R&D areas of the laboratory namely: physico-mechanical standards; electrical and electronic standards; engineering materials; electronic materials; polymeric & soft materials; materials characterization; radio & atmospheric sciences; superconductivity; and cryogenics. Besides internal projects, the laboratory had undertaken sponsored projects, provided calibration and testing services and given consultancy to a variety of clients.

NPL has the responsibility of maintaining the national standards of measurements and to provide calibration services at the apex level to ensure traceability of all measurements made in the country to the national and the international standards. The maintenance of the standards requires continuous R&D work to ensure that our standards are maintained with the lowest possible associated measurement uncertainty and are close to the state-of-the-art level in the field. Also, international intercomparisons are undertaken to ensure comparability of our standards with the international standards. During this period three international intercomparisons in the field of acoustics, length measurement and pressure measurements were carried out under Asia Pacific Metrology Programme. Two intercomparisons were carried out under bilateral arrangements including one with the PTB, Germany. NPL also took part in a major proficiency testing programme coordinated by National Authority Testing Agencies (NATA), Australia in the field of chemical analysis of water.

Significant research contributions have been made in all the areas of activities. These were related to: surface studies on platinum-iridium alloy; high pressure Raman investigation of gallium arsenide crystals; radio frequency SQUID effect; giant magneto-resistance studies; carbon fibre-matrix interactions in composites; quantum electronics; structural characterization of advanced coiled membrane sensors; growth of nearly perfect single crystals of bismuth germinate; and magnesium doped copper barium calcium cuprates (Cu-1234). R&D activities were focussed on projects related to: development of square tubes for aerospace applications; oval shaped long tubes for Advanced Light Helicopter (ALH); high density isotropic graphite; thin film cadmium telluride solar cells; biosensors for urea, lactose and cholesterol; conducting polymers; novel non-linear electro-optic materials and devices; and technology for particle size analysis. Also. tropopause structure was studied by MST radar and ozone sounding. Performance

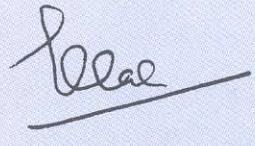
of a line-of-sight microwave link has been investigated and effect of ionospheric irregularities on transionospheric propagation has been studied. Other major activities in this field were concerned with the final stage of the Indian Ocean Experiment (INDOEX) and study of green house gases.

Nine new facilities have been added during the year. These include: a hydraulic force multiplication system which can generate upto 3 MN; a FTIR spectrophotometer; a facility for measurements of magnetic properties of electrical steel strips; teleclock service; microwave PECVD-facility for growing diamond like carbon films; and a scanning electron microscope with energy dispersive spectrometer.

During the year, 130 papers were published in scientific journals and 186 presentations were made at the national and international meetings. 17 young scientists received Ph.Ds while working at NPL and 7 patents were filed. Sponsored project with financial inputs of nearly 255 lakhs and consultancy projects worth about Rs. 76 lakhs were undertaken during the year. Calibration and testing services together with job work generated a revenue of Rs.2 crores approximately. Six training programmes were organized including three in-house trainings. Seven conferences were organized by NPL scientists, two of which were international. One of these was a major ICSU sponsored Conference and General Assembly.

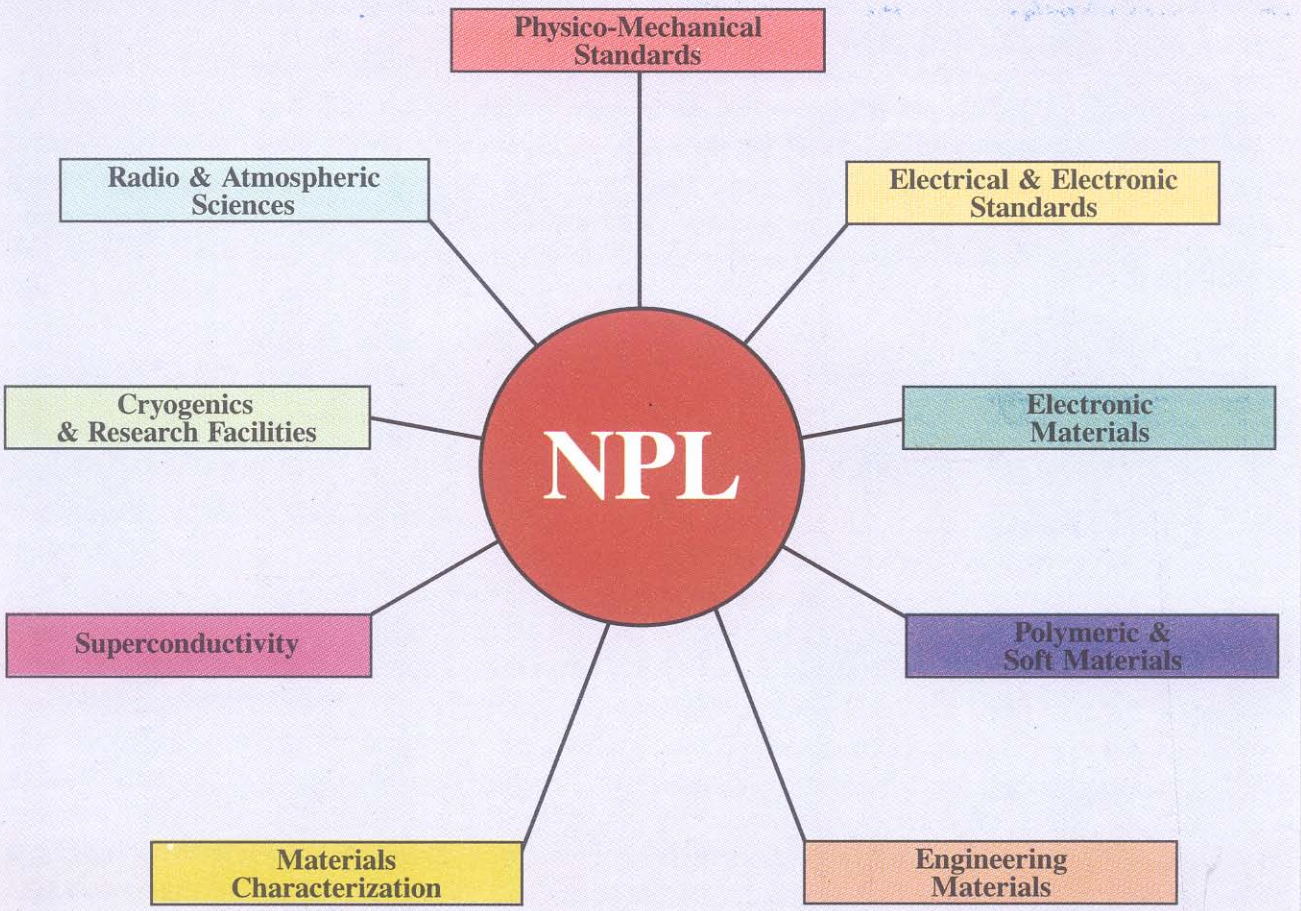
NPL scientists were recognized nationally and internationally and several of them were awarded Fellowships like the Raman Fellowship and the Boyscast Fellowship. An Honorary Doctorate was conferred by a prestigious Foreign Academy on one of our scientists.

I would like to thank all the colleagues who have contributed to the R&D achievements. We have high potential and have to strive hard to reach challenging heights in all aspects of R&D. Thanks are due to our NPL Annual Report team for their contribution. Special efforts of Drs V.N. Ojha, Mrs. Rina Sharma, M.K. Goel and T.D. Senguttuvan are highly appreciated.



(Krishan Lal)
Director

R&D Divisions of NPL



भौतिक-यांत्रिक मानक
PHYSICO-MECHANICAL STANDARDS

भौतिक यांत्रिक मानक प्रभाग का मुख्य कार्य ध्वनिक, पराश्रव्यिकी, लम्बाई तथा विमीय मापिकी, दाब तथा निर्वात, बल तथा कठोरता तापमान, अनआयनकारी विकिरण [पराबैंगनी (अल्ट्रावॉयलेट), प्रकाशीय (ऑप्टिकल) तथा अवरक्त (इन्फ्रारेड)], द्रव्यमान, घनत्व तथा श्यानता तथा तरल बहाव के मानकों और पृष्ठीय भौतिकी का अध्ययन एवं विश्लेषण करना है। प्राथमिक मानकों के द्वारा विभिन्न मूल(बेसिक) और व्युत्पन्न इकाइओं की परिभाषा को वास्तविक स्वरूप प्रदान किया जाता है। इन प्राथमिक मानकों का प्रयोग द्वितीयक तथा कार्यकारी मानकों का अंशाकन करने के लिए किया जाता है। ये अंशाकित मानक विभिन्न स्तर पर कार्यरत गुणवत्ता नियंत्रण प्रयोगशालाओं तथा विभिन्न औद्योगिक इकाईओं से प्राप्त होने वाले उपकरणों का अंशांकन करने में प्रयुक्त होते हैं। यदि आवश्यक हो तो अंशांकन का यह कार्य अपभोक्ताओं के कार्यस्थल पर भी किया जाता है। एन पी एल में स्थापित किए गए मानकों की यथार्थता को सुनिश्चित करने तथा उनका आधुनिकीकरण करने के लिए निरन्तर अनुसंधान एवं विकास कार्य किए जाते हैं। यह प्रभाग समय-समय पर द्विपक्षीय, क्षेत्रीय और अन्तर्राष्ट्रीय स्तर पर होने वाले मानकों के अन्तर्तुलन कार्यक्रमों में भाग लेता है। इस प्रकार अशांकन तथा अन्तर्तुलन द्वारा भारतीय उद्योगों के मापन को अन्तर्राष्ट्रीय संगति प्रदान कर यह प्रभाग इन उद्योगों की विश्व बाज़ार में प्रतिस्पर्द्धा को बढ़ाने में सहायक है। एन ए बी एल प्रत्यापन और आई एस ओ 9000 प्रमाणन प्राप्त करने के इच्छुक संस्थानों / प्रयोगशालाओं को यह प्रभाग तकनीकी सलाह एवं प्रशिक्षण सेवाएं भी उपलब्ध कराता है। परस्पर विचार विनिमय और प्रशिक्षण के माध्यम से यह प्रभाग ज्ञान का प्रसार न केवल भारत वरन् अन्य विकासीय देशों में भी करता है। उपभोक्ता उद्योगों की संख्या में निरन्तर वृद्धि इस प्रभाग के प्रयासों की सफलता का प्रमाण है।

The activities of the Physico-Mechanical Standards Division include acoustics; ultrasonics; length and dimensional metrology; pressure and vacuum, force and hardness; temperature; non-ionising radiation (ultra-violet, optical, infrared); mass, density and viscosity; surface physics and fluid flow. Various basic and derived parameters are realized through the established primary standards. These standards are used to calibrate secondary/working standards which are in turn used to calibrate the instruments received from the quality control laboratories operating at Echelon II and III level. The calibration work is also done at site. Continuous R&D efforts are made to update and reaffirm the measurement accuracies of the standards established at NPL. This Division very often participates in bilateral, regional and international key comparison exercises held periodically. These give an edge to the Indian industries to compete in the global market by providing them the national traceability and international compatibility. It also provides services for obtaining NABL accreditation and ISO 9000 certification, in building technical base and in dissemination of knowledge through interaction and training programme to people from India and other developing countries. The success of its efforts can be evaluated from the continuous increase in number of user industries.

Acoustics Standards

Sodar studies of the atmospheric boundary layer with special reference to air pollution meteorological data have been carried out for petrochemical industries in Gujarat region. A systematic noise and vibration survey was undertaken in and around certain historic monuments along the path of the proposed metro route in Delhi. A real time vibration data-collection due to the running of underground transit trains in Calcutta Metro was undertaken. Four consultancy projects were undertaken in areas of building acoustics, environmental pollution, structural integrity of historic monuments.

NPL participated in Round Robin key comparison programme viz. APMP intercomparison of sound calibrators, initiated by NML, Australia involving (i) B&K Type 4228 Piston-phone and (ii) B&K Type 4231 Acoustic Calibrator. These reference sound sources were calibrated using 4 standard microphones (two laboratory standards and two working standards) for their generated sound level outputs, total harmonic distortion and frequency under controlled environmental conditions.

Archaeological Survey of India (ASI) raised serious concerns about the proximity of the Delhi Metro Rail route near historic monuments. NPL undertook a systematic investigation to determine the existing noise and vibration in order to estimate the expected vibration due to proximity of metro route and to compare the measured/estimated data with the criteria available in respect of structural integrity of these monuments.

A limited vibration survey was undertaken at certain representative locations in and around the metro route in Calcutta to determine the maximum vibration levels at the source (near the track) and at the receiver (floor/wall of nearby buildings) locations towards assessing the damage potential of these induced structural vibrations.

Ultrasonics Standards

An analysis of various types of ultrasonic liquid level sensors, developed or envisaged, has been carried out. Various types of rods made of different materials and having different diameters and lengths have been studied experimentally under excitation of various frequencies.

The piezoelectric ceramic material based on modified lead titanate, designated as NPLPT-97 and equivalent to EDO-EC-97 have been developed for accelerometer, NDT, hydrophones and acoustic emission sensor elements. The dielectric and electromechanical properties have been studied on lead zirconate titanate ceramic containing different concentration of neodymium ions. The work on sponsored project for fabrication and characterization of prototype hydrophone using PZT-Polymer Composite Materials has been successfully completed. The measurements of receiving and transmitting sensitivity along with directivity pattern etc. were carried on 68 piezoelectric elements projector/receiver array.

Length Standards

Length Standard section participated in an international intercomparison of Length Scale under APMP. A precision length scale from NRLM, Japan was used as a travelling standard. It was compared with the Platinum-Iridium Metre Bar of NPL (Copy No. 4 of BIPM). The uncertainty in measurement is $\pm 0.5\mu m$. Also precision optical components like Zerodur sphere were fabricated.

Dimensional Metrology

In the series of awareness programmes conducted by NPL, a seminar on uncertainty in dimensional calibration was organised at Faridabad. Consequent upon this, work was done for one firm for preparation of project report and for setting up of a calibration laboratory at Faridabad. Request for such awareness programmes were received from several firms.

A project to install, commission and calibrate the horizontal gauge block instrument of SIP- Switzerland was completed successfully along with the development of human resource for Institute of Autoparts Technology, Ludhiana.

Vacuum and Pressure Standards

Participated in international intercomparison of medium vacuum range under CCM. The transfer standard artifact was provided by NIST, USA, which is the pilot laboratory. The artifact that was damaged during transit from New Zealand to New Delhi was also rectified.

Computer software was developed using QBASIC for evaluation of measurement uncertainty of pressure measuring instruments, especially for digital direct reading Pressure Gauges, U-Tube Manometers, Barometers, Sphygmomanometers and Pressure/ Vacuum Dial Gauges.

In the Asia Pacific Metrology Program (APMP) [Australia] intercomparison with NRLM (Japan) in the pneumatic pressure standard in the range (a) 10 - 140 kPa and (b) 0.4 to 4.0 MPa, was carried out. NPL as a pilot laboratory first metrologically characterized the travelling standard and intercompared it with reference to the secondary standards NPL-4 and NPL-8.

HBM Reference pressure transducer model P31AP has been intercompared with reference to secondary standards NPL-100 and NPL-280 at five different pressure points 10, 20, 30, 40, 50 MPa, respectively, under the Asia Pacific Laboratory Accreditation Corporation [APLAC] inter laboratory Comparison APM006. The pilot laboratory CSIRO (Australia) has circulated the results of the intercomparison which shows that NPL (India) is very near to the mean reference value at all pressure points.

Raman studies were carried out on InGaAs and InP for multilayer Quantum Well structures.

The mass gain problem in Pt-Ir (10%) alloy material used for standard kilogram mass, an international problem for mass standard, has been addressed using dynamic

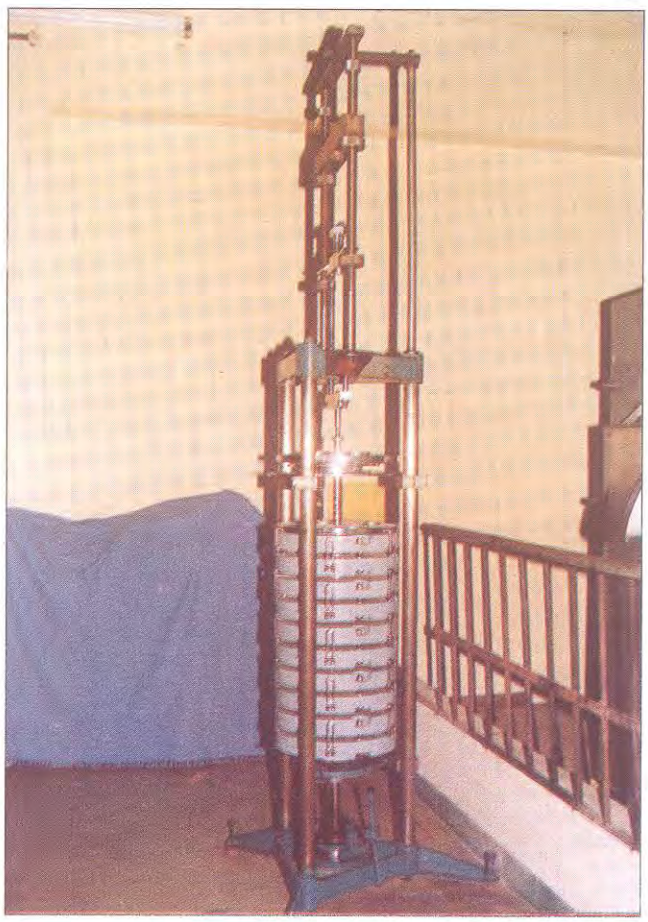


Fig. 1.1: 5 kN dead weight machine

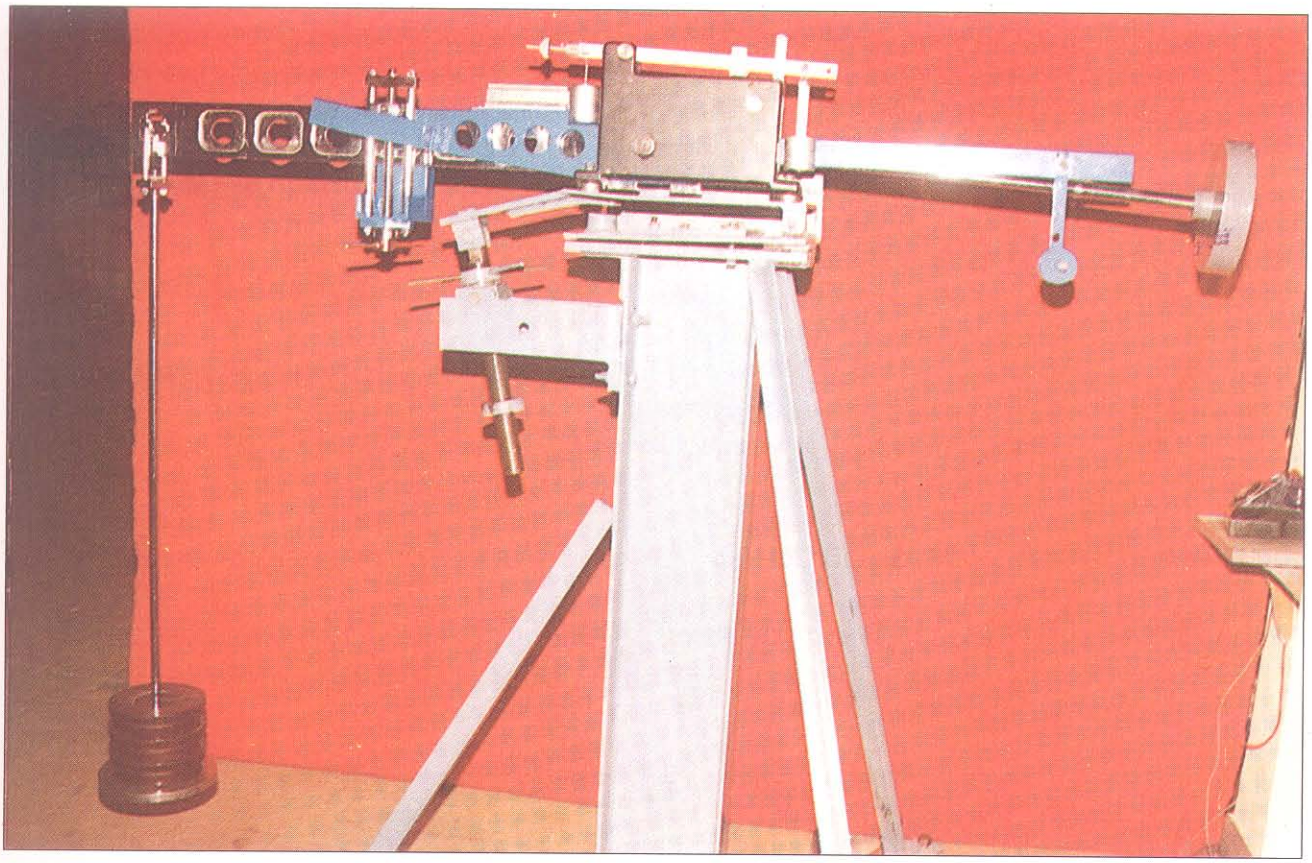


Fig. 1.2: Torque calibration facility

SIMS technique at NPL and later using a time-of-flight static SIMS at the Pennsylvania state university, USA, as a collaborative work. A comparative study of the surface contamination of Pt-Ir alloy, treated by different cleaning procedures has been carried out using SIMS technique. TOE-SIMS has been used further to characterize, particularly hydrocarbon surface contaminants, on the Pt- Ir alloy sample described above.

Force and Hardness Standards

A hydraulic multiplication system, which can generate forces up to 3MN, installed last year was calibrated for its best performance. The data obtained are inter-compared with an artifact already calibrated by PTB, Germany. The best measurement capability (BMC) of this machine is found to be better than ± 0.05%. The work of developing a new dead weight machine indigenously has been taken up as shown in Fig.1.1 to fill the gap in the force range of 5kN and provide calibration facility in both compression and tension mode. It has been assembled and tested for its performance.

Facility of torque standard has been upgraded to increase the generation of torque range from 2000 Nm to 4000 Nm (Fig. 1.2).

A 3-day workshop cum training programme was organised on force metrology where practical training was given on calibration of force proving instruments and verification of testing machines. A monograph consisting of various calibration procedures of force proving instruments and torque meters was also distributed.

Temperature Standards

Silver temperature standard (961.78°C) has been established at NPL as per the International Temperature Scale of 1990 (ITS-90) and has the reproducibility of ±10m°C using High Temperature PRT over the entire

range from 0 to 961.78°C. The fixed points of Tin, Zinc and Aluminium have been realized using SPRT and standard thermocouples type-S&R to enable re-establishment of the temperature fixed points for thermocouple standards in the range from 0° to 1000°C.

Fabrication works completed include one SPRT (0 to 660°C) SG-597, one triple point water cell (0.01°C+0.2m°C) along with a heat pipe immersion cooler, two type-S thermocouple standards for use as reference standards and blackbody cavity of specpure graphite for use as standard spectral radiation pyrometer.

Ultraviolet Radiation Standards

Transmission through PVC sheets, quartz and glass plates etc. was measured in UV spectral region for industries involved in the development of water purifiers.

Calibration facility was created for the calibration of broad band solar UV intensity meters/ radiometers, used in industries for NDT inspections. UV-A fluorescent lamps were calibrated for many industries involved in the development of the weatherometer for testing climatic effects.

Argon ion laser system was made operational.

Optical Radiation Standards

The primary standard of optical radiation has been upgraded in the form of a thin film thermopile detector based radiometer. The responsivity of this radiometer is 10 V/W and the time constant is 1s.

A new facility for measuring luminance, chromaticity coordinates, color temperature of cockpit lighting of aircraft has been setup.

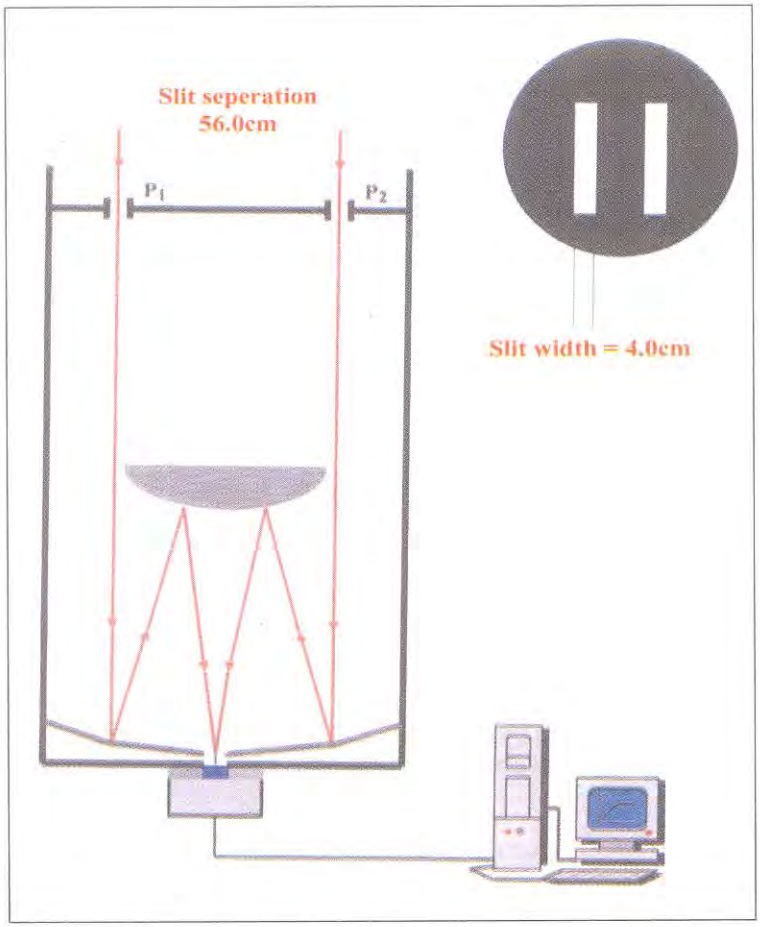


Fig. 1.3: 1.04 m Telescope at UPSO, Nainital used for Young's double slit experiment

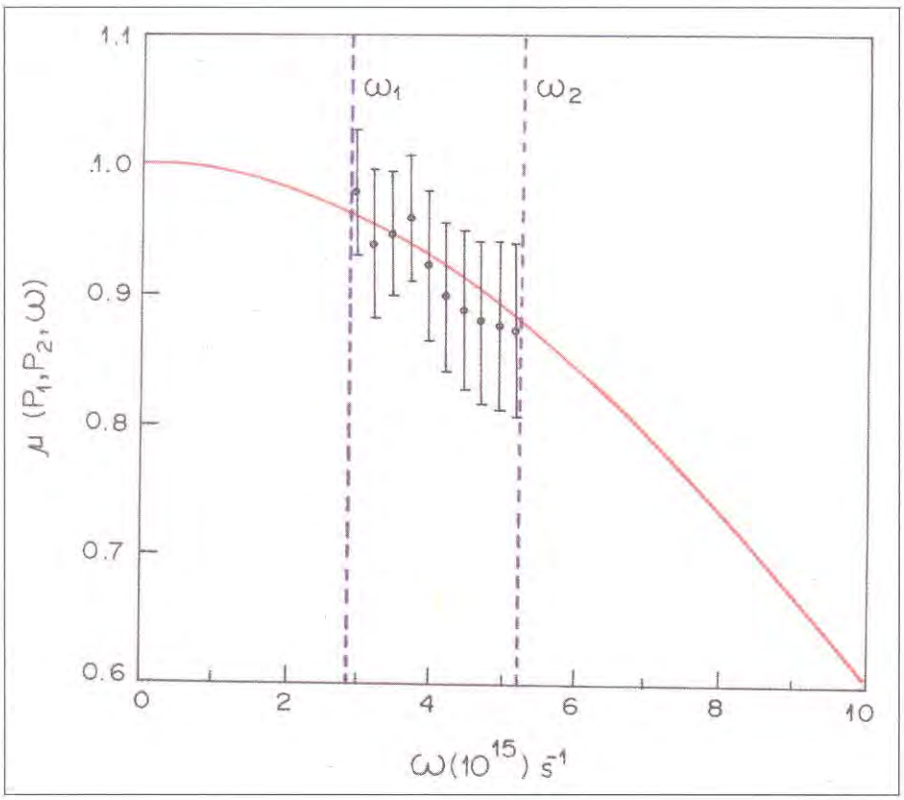


Fig. 1.4: Variation of spectral degree of coherence with frequency from the star α-Scorpio

The spectral measurements, made at the back focal plane of a lens always show blue shifted spectra. However, in geometrical plane of the lens no spectral shift is observed. These results suggest that for establishing the scales of spectral radiance and spectral irradiance, measurements must be made at the geometrical plane of a lens to reduce measurement uncertainty.

Laboratory experiments have been conducted to show the applications of coherence-induced spectral changes for determining the intensity distribution across a source and also the angular separation of a pair of sources.

The experiment for measuring the angular diameters of the stars was performed at the Uttar Pradesh State Observatory, Nainital (Fig. 1.3). The spectral degree of coherence of the light fields produced by the stars was also measured by probing the spectral changes that occur on interference of the light from the two sources formed at P_1 and P_2 in the form of Young's double slit.

The theoretically calculated value of the spectral degree of coherence in the spectral range from 360 nm to 660 nm for the star α - Scorpio is shown in Fig. 1.4 by solid line and is in agreement with experimental results.

Infrared Radiation Standards

In the Infrared Radiation Standards, a new central research facility for infrared calibration/testing comprising of Fourier Transform Infrared (FTIR) Spectrophotometer with various accessories has been established. The samples in the form of solids, liquids and gases can be studied with this new facility in the spectral region of 2.5 mm to 25 mm. In the Infrared applications, an indigenous, single beam, dispersive type, and computer based near infrared spectrophotometer was procured. It was used for systematic recording of sugar contents in sugar cane juices and sugar cane solids. Some modifications in its software were incorporated and it was found that the results were as good as obtained on imported FTIR Spectrophotometer.

Mass Standards

The Mass calibration laboratory was assessed by PTB/DKD, Germany in April 1998. As an appreciation of the Quality Assessment of the mass laboratory, PTB provided a 1kg Electronic Mass Comparator of Sartorious make. The mass comparator is being used in precision mass calibration work.

Consultancy service was provided to a firm for fabrication and calibration of high accuracy class weights.

The viscosity scale has been achieved upto 50 000 mm^2/s.

Fluid Flow Standards

The facility for calibration of flow meters was officially declared open on 16th June 1998 coinciding with a Workshop organized to demonstrate working of this facility and to explain the type of service that can be offered to the users.

Online Density Meter, one of the most important instruments of the water flow measurement system, was successfully calibrated using indigenous technique which can also be used to calibrate this type of transducers, used by others in India.

Research Activities in the Division

The high pressure Raman studies were done on n-GaAs sample with an emphasis to investigate the variation of the phonon frequency with pressure when n-dopant concentration is in the lower limit (» 10 ppm). The concentration of the n-dopant (silicon) is determined by secondary ion mass spectrometer (SIMS). The high pressure Raman data corroborated with SIMS analyses.

High-pressure X-ray diffraction studies on Tellurium at room temperature up to 40 GPa have been carried out in a diamond anvil cell. Self consistent electronic band structure calculations for ambient as well as high pressure phases have been carried out using the tight binding linear muffin tin orbital (TB-LMTO) method within the atomic-sphere approximation (ASA). In addition, the density of states (DOS), Fermi energy (E_f) for various high pressures have also been calculated. Auger Electron Spectroscopy study was done on the adsorption of molecular oxygen on Mn precovered Si(111) surface.

SODAR studies were done at IPCL, Dahej showing the occurrence of anomalous elevated layers which are thin (25 m thick) and which have descending characteristics. These patterns have been seen to occur for about 4-6 hours daily.

The new method for the measurement of ultrasonic attenuation in liquid was developed which is based on the comparison of ultrasonic pressure measurement by a hydrophone. Since the hydrophone, calibrated by primary standard of laser interferometry, gives highly accurate pressure values, the attenuation thus measured is also highly accurate.

A directional hydrophone, using a piezoelectric ring transducer at the focus of a parabolic reflector, has been designed and fabricated. Receiving sensitivity and directional response of this hydrophone has been measured at various spot frequencies ranging from 25 kHz to 160 kHz.

A new simple and quick method was developed to determine the coherence properties of the wave fields from the spectral changes produced on interference in Young's double slit experiment. The data obtained experimentally was used to determine the angular diameter of stars.

Studies were conducted for development of a rapid, sensitive and inexpensive infrared spectroscopy based technique for detection of breast cancer.

विद्युत तथा इलेक्ट्रॉनिक मानक
ELECTRICAL & ELECTRONIC STANDARDS

विद्युत तथा इलेक्ट्रॉनिक मानक प्रभाग विभिन्न विद्युत तथा इलेक्ट्रॉनिक प्राचलों, जैसे डी सी वोल्टता (डीसी वोल्टेज), धारा तथा प्रतिरोध, ए सी वोल्टता, धारा तथा प्रतिबाधा (ए सी प्रतिरोध, धारिता तथा प्रेरकत्व), ए सी शक्ति तथा ऊर्जा, ए सी उच्च धारा तथा उच्च वोल्टता (ए सी हाई करंट एण्ड हाई वोल्टेज), एल एफ तथा एच एफ वोल्टता, धारा, शक्ति (पावर), प्रतिबाधा स्थानीकृत प्राचल (लम्पड पैरामीटर्स) तथा क्षीणन (अटैनुएशन), सूक्ष्मतरंग शक्ति, क्षीणन, शौर, प्रतिबाधा, समय तथा आवृत्ति और चुम्बकीय मानक, के प्राथमिक तथा राष्ट्रीय मानकों के विकास तथा अनुरक्षण में कार्यरत है। मापन सम्बन्धी मानकों की यथार्थता (एक्यूरेसीज़) में सुधार लाने के लिए अनुसंधान और विकास द्वारा निरन्तर प्रयास किए जा रहे हैं । इसके अतिरिक्त भौतिकी एवं आयुर्विज्ञान से संबंधित यंत्रीकरण के क्षेत्र में भी कार्य किया जा रहा है। यह प्रभाग विभिन्न द्विपक्षीय (बाईलेटरल), क्षेत्रीय (रीजनल) तथा अन्तर्राष्ट्रीय मानकों के अन्तर्तुलनात्मक आयोजनों में भाग लेता है, ताकि मानकों को अंतरराष्ट्रीय स्तर पर अनुमार्गणीय(ट्रेसेबिल) बनाया जा सके। यह प्रभाग अंशांकन से सम्बन्धित प्रयोगशालाओं तथा उद्योगों को अंशांकन सम्बन्धी सेवाएं और परामर्श सेवाएं भी प्रदान करता है ।

The Electrical and Electronic Standards Division is engaged in the development and maintenance of Primary / National Standards of various electrical and electronic parameters such as; DC Voltage, Current and Resistance; AC Voltage, Current and Impedance (AC Resistance, Capacitance and Inductance); AC Power and Energy; AC High Current and High Voltage; LF & HF Voltage, Current, Power, Impedance (Lumped parameters); HF Attenuation; Microwave Power, Attenuation, Impedance & Noise; Time & Frequency and Magnetic Standards. Continuous R&D efforts are made to improve the measurement accuracy of the Standards. Apart from this, work is also being carried out in the field of physical and medical instrumentation. The Division participates in various bilateral, regional and international intercomparisons of its standards to establish international traceability. It also provides calibration and consultancy services to various calibration laboratories and industries.

Josephson Voltage Standard and Superconductina Devices

The Josephson series array voltage standard has been maintained at 1 volt level. In parallel, the basic research by the group was continued to help update the present standard when the field is ripe for such task in future.

RF-SQUID effect in YNi_2B_2C superconductor:

We have observed the rf-SQUID effect in YNi_2B_2C at 4.2K, which confirmed, for the first time, that natural grain boundary weaklinks in this superconductor behave as Josephson junctions and the observed SQUID effect is due to these weaklinks. We have also carried out a systematic study of the variation of the amplitude of RF-SQUID oscillations and spectral density of flux noise of the SQUID as a function of temperature. The RF-SQUID effect was observed upto 13.2K. The flux noise spectrum of the SQUID at 4.2K showed white noise down to 0.3Hz and 1/f noise below this frequency. In the white noise region the flux noise density was $2x10^{-3}\ \phi_0/\sqrt{Hz}$ where ϕ_0 is the flux quantum. Rapid increase in flux noise has been observed above 10K. The increase has been attributed to flux hopping.

Enhancement in T_c of Bi(Pb)SrCaCuO films due to irradiation of energetic argon ions:

In collaboration with Delhi University we have observed, for the first time, an enhancement in T_c of superconducting Bi(Pb)SrCaCuO (BPSCCO) thick films when they are irradiated with highly energetic high fluence argon ions which are generated in dense plasma focus (DPF) device. The films were prepared by screen printing technique and had mixed phase 2212 ($T_c \approx 85K$) and 2223 ($T_c = 110K$). They were exposed to the ions of DPF axially above the anode at various distances. T_c of the films irradiated at a particular distance have been found to increase with maximum of 15K. XRD peaks also confirmed the presence of only high-T_c (2223) phase of BPSSCO, for the films for which increase in T_c was 15K.

Enhanced magnetoresistance in Y-doped LaCaMnO films:

Magnetoresistance of $La_{0.60}Y_{0.07}Ca_{0.33}MnO_3$ and $La_{0.67}Ca_{0.33}MnO_3$ thick films (prepared under similar conditions) have been studied in the magnetic field up to 3kOe. Doping of Y in La-Ca-Mn-O thick films resulted in the reduction of its lattice constant, decrease in semiconductor-to-metal transition temperature (T_p) and increase in magnetoresistance effect. Temperature dependence of magneto-resistance ratio (MRR) of the film shows that the MRR is primarily due to grain boundaries. For low fields (upto 600 Oe) MRR in both the films were same. However, at higher fields MRR of Y-doped films was large. The enhanced MRR in Y-doped film is attributed to the presence of higher density of magnetic disorders at the grain boundaries as compared to the undoped film.

Giant magnetoresistance in Co/Cu/Co magnetic-normal-magnetic multilayers:

Thin film multilayers are deposited on Si wafers using Molecular Beam Epitaxy system. The Co and Cu layers are vacuum evaporated using e-beam and Knudsen Cell, respectively. The normal metallic Cu spacer layer is varied between 100 and 1000 Å. Various growth parameters are optimised to get high quality epitaxial films. The degree of epitaxy is monitored through in situ RHEED facility. The inter layer exchange coupling between magnetic layers manifests in oscillatory properties of the multilayer arrangement, which depends sensitively on the thickness of copper spacer layer. The irradiation of multilayers with high energy (28 MeV) proton beams with different fluences (10^{12}–10^{14} ions/cm^2) leads to creation of lattice defects. These in turn modulate the interlayer magnetic exchange interaction, magneto crystalline anisotropy and the magnetoresistance of the multilayer arrangement.

From the observed patterns of variation in the saturation magnetization M_s and the corresponding field H_s with the layer thickness we have calculated the magnetic domain wall energy, while from the area between the perpendicular and parallel magnetic hysteresis curve

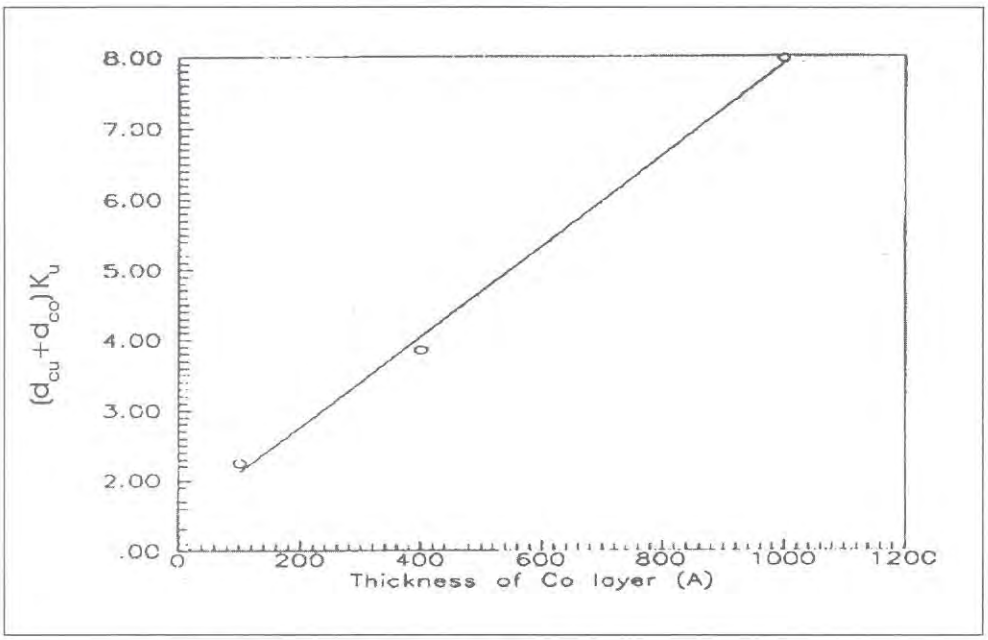


Fig. 2.1: Variation of $(d_{Cu} + d_{Co}) K_u$ with thickness of Co layer

and M-axis we have calculated the magnetic anisotropy energy K_u. By plotting $K_u (d_{Co} + d_{Cu})$ Vs. d_{Co}, where 'd' is thickness of a layer, (Fig. 2.1) we calculated the bulk and interface anisotropy K_v and K_s. The variation in these parameters with the radiation fluence is noted which helped in quantitatively estimating the extent of defects in the bulk and the interface regions. Interestingly, even though the saturation magnetization M_s is dropped due to irradiation, the corresponding field and the coercive field have improved which are significant from the point of view of application of these multilayers as magnetic sensors. These observations highlighted that it is possible to suitably modify the extent of radiation defects for improving the magneto-resistivity.

Microwave surface resistance measurement of high-T_c superconductors:

Measurements of microwave surface resistance of Y-Ba-Cu-O thin films and bulk samples, in the temperature range 20K to room temperature, have been carried out by partial/complete end plate substitution technique in an indigenously developed cylindrical cavity resonator operating at 20GHz. Theoretical modeling of the electromagnetic field distribution was carried out to determine geometrical factors required for extracting accurately the surface resistance value of small size samples. Partial end plate substitution technique developed by us, provided for the first time a unique method to laterally resolve surface resistance measurement of HTS samples by exposing the different area of the sample to the microwave field inside the cavity through annular masks of different openings.

Microwave surface resistance of YBCO bulk samples prepared by addition of different Wt% of HgO has been measured. It was found that the YBCO sample prepared by 0.5% addition of HgO has minimum surface resistance of 5.8 mΩ at 20 GHz and 40K.

DC Standards

DC Standards activity maintains the National Standards of DC Voltage, Current and Resistance and disseminates these standards by providing calibration services. Calibration of standard cells, electronic voltage standards, constant voltage sources, calibrators, high voltage sources and probes, standard resistors, Wheatstone and Kelvin bridges, milliohm meters, teraohmmeters, digital multimeters, transconductance amplifiers, voltage & current meters etc. was carried out.

Bank of standard cells representing the 'National Standard" of volt was calibrated against a Zener Standard which was earlier calibrated against the Josephson Voltage Standard. Thus NPL's 'National Standard' of volt was provided traceability to the Primary Standard.

AC Power & Energy Standards

The AC Power & energy standard activity is maintaining National standard of AC power at power frequencies and is providing traceability to other laboratories and power sector industries and utilities. Test and calibration services were provided for different class of power & energy meters. The following facilities have been added during this year:

- Test of influence of 3rd harmonic in current (upto 40%), in phase and out of phase with respect to main waveform, on the performance of energy meters.
- Test of influence of 5th harmonic (10% in voltage and 40% in current) in phase with respect to main waveform.
- Effect of voltage dips and short interruptions on the performance of energy meters.
- Tamper and fraud detection tests for single phase and three-phase energy meters. These include load earth condition, neutral missing, reverse current, phase and neutral exchange and unbalance conditions & reverse phase sequence (for three phase meters).

AC High Current & High Voltage Standards

This activity maintains National standards for AC high current ratios and AC high voltage ratios at power frequencies and provides calibration services for the instruments like current transformers, CTTS, clamp meters, AC current shunts, weld testers, CTTS jigs, CT burdens, potential transformers, PTTS, H.V. probes, electro-static volt meters, HV breakdown test sets, and PT burdens etc.

LF & HF Impedance Standards

The group is working to establish, maintain and update primary and transfer standards of Capacitance, Inductance, AC Resistance and Q at low and high frequencies. As such this activity provides apex level calibrations for the above parameters to various user

Fig. 2.2: Calculable cross capacitor established at NPL as the 'Primary Standard' used for realisation of 'National Standards' of capacitance, resistance and inductance

organisation all over India. Calculable Cross Capacitor, one of the relevant Primary Standards established at NPL, is shown in Fig. 2.2. Experimental set-up for absolute calibration of Inductive Voltage Dividers is shown in Fig. 2.3.

Intercomparison of NPL Standard, Inductance (10mH) was carried out with PTB (Germany). The results of inter-comparison showed an agreement within 3 ppm.

An automatic bridge for comparison of inductance based on difference voltage measurements has been set up. The value of inductance obtained by this bridge shows an agreement of better than 0.01% with the value obtained using Maxwell-Wein Bridge at 1kHz.

LF, HF and MW Standards of Voltage, Current and Power

This activity is maintaining primary/national standards of AC & LF voltage and current (10Hz to 100 kHz), HF voltage (1 MHz to 1000 MHz), HF & MW power and noise (10 MHz to 18 GHz) and provides apex level calibration facilities for the above parameters to various laboratories and industries.

HF & Microwave Attenuation & Impedance Standards

The calibration of attenuation and impedance standards and associated equipment for various organisations was carried out. A bilateral comparison on attenuation measurements between National Physical Laboratory (NPLI), New Delhi and Standards and Calibration Laboratory (SCL), Hong Kong was carried out under the Asia-Pacific Metrology Programme. Commercial 50 Ω coaxial attenuators (in APC-7 connectors) of nominal attenuation values 3dB, 10dB and 20dB were calibrated at 30 MHz, 5 GHz & 10GHz against the 30MHz standard waveguide below cut-off attenuators of both the

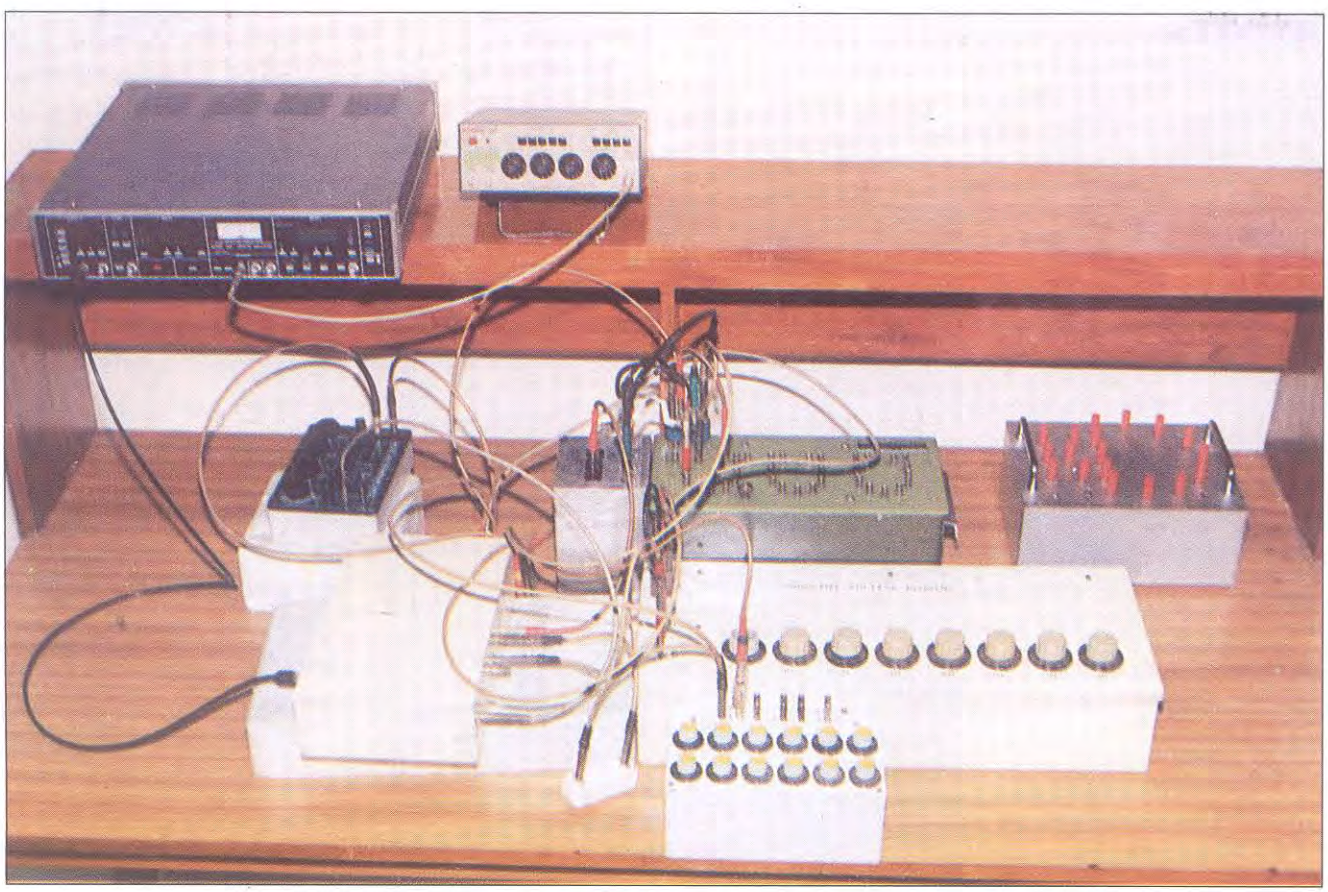


Fig. 2.3: Experimental set-up for absolute calibration of inductive voltage dividers

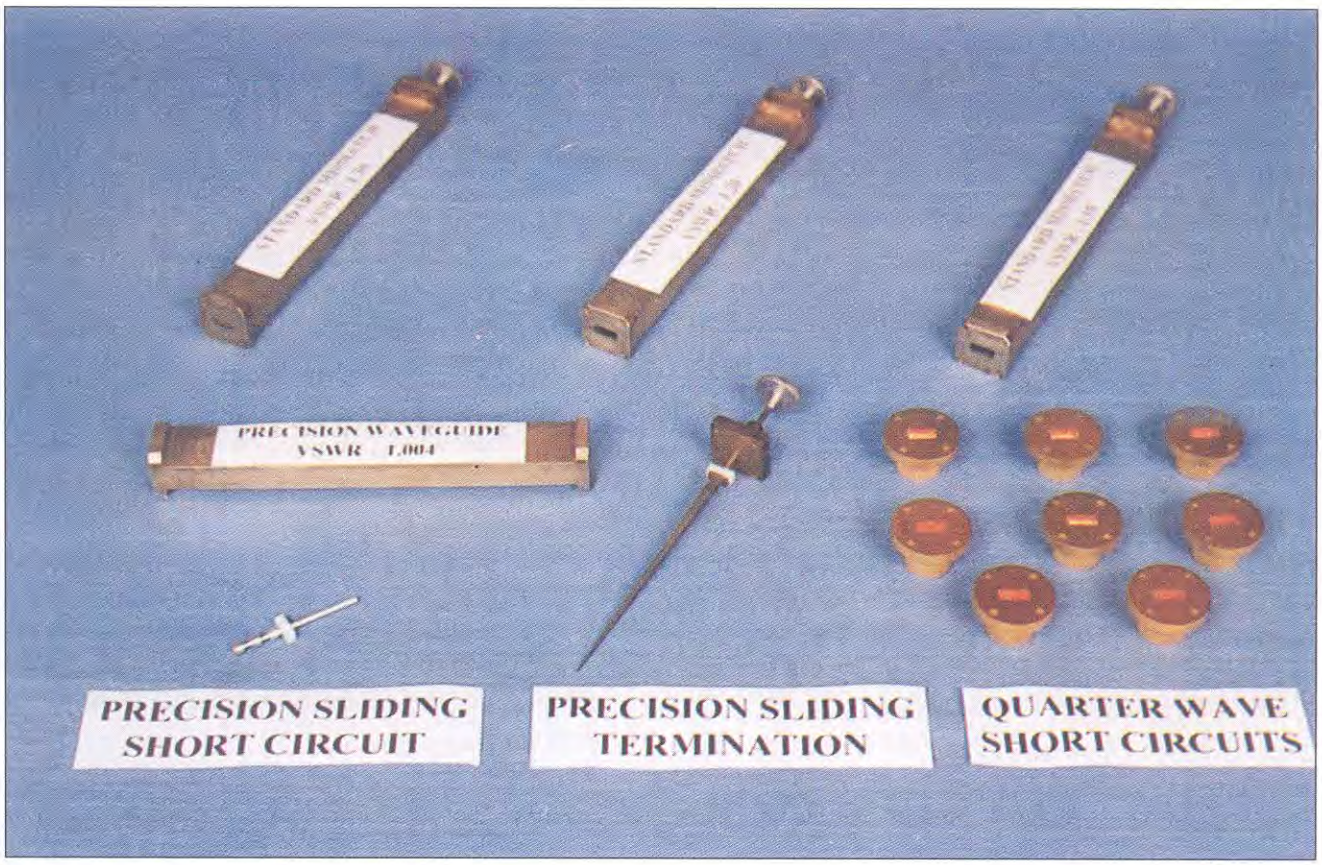


Fig. 2.4: Indigenously developed K-band (18.0 - 26.5 GHz) microwave impedance standards

Table 2.1. Measured attenuation and expanded uncertainty (quoted at 95% confidence level)

Nominal Attenuation (dB)	Measured Attenuation (dB)	
	NPLI	SCL
(Frequency : 30 MHz)		
3	2.873 ± 0.007	2.863 ± 0.011
10	9.837 ± 0.010	9.845 ± 0.009
20	19.764 ± 0.015	19.769 ± 0.011
(Frequency : 5 GHz)		
3	2.920 ± 0.017	2.918 ± 0.015
10	9.925 ± 0.022	9.918 ± 0.010
20	19.900 ± 0.032	19.906 ± 0.016
(Frequency : 10 GHz)		
3	2.875 ± 0.020	2.895 ± 0.021
10	9.895 ± 0.027	9.907 ± 0.016
20	20.200 ± 0.037	20.201 ± 0.023

laboratories. A direct 30MHz series-substitution technique and a 30MHz intermediate-frequency substitution technique were employed at NPL, India to calibrate attenuators at 30MHz and Microwave frequencies using a VM-3 attenuator and signal calibrator, respectively. The same techniques were used at SCL, Hong Kong in association with a vector signal analyser (HP-89441A). The mean values of the measured attenuation of both the laboratories were found to lie within the quoted limits of uncertainties. The results of the two laboratories are given in Table 2.1.

Magnetic Standards

Facility for industrial metrology has been established to measure magnetic properties of electrical steel strips (both grain oriented and non-oriented) used in transformer cores, motor rotors etc. The method for measurement utilizes standard 25 cm Epstein frame fabricated as per IEC standards. The parameters measured are total core loss, peak values of magnetic induction and polarization, specific apparent power, peak values of magnetizing field etc. The overall uncertainty in the measurement is ± 0.2% to ± 2%, depending upon the range of measurement.

Time and Frequency Standards

Time and Frequency Section of NPL has been successfully maintaining the Indian Standard Time (IST) and the UTC (NPLI) time scale from an ensemble of commercial models of Cesium atomic clocks (HP5071A). This UTC (NPLI) is continuously intercompared with other time keeping laboratories through monitoring of GPS signal and sending this data to BIPM periodically.

Besides, maintaining IST, this 'Time' is made available to users all over India through various techniques. One of them is the technique to transmit time signal via satellite INSAT with an accuracy of ±1μsec. For users requiring time accuracy up to a second, a unique system called 'Teleclock Service' has been started where the data containing current time (hour, minute & seconds) and date (day, month & year) from NPL is made available

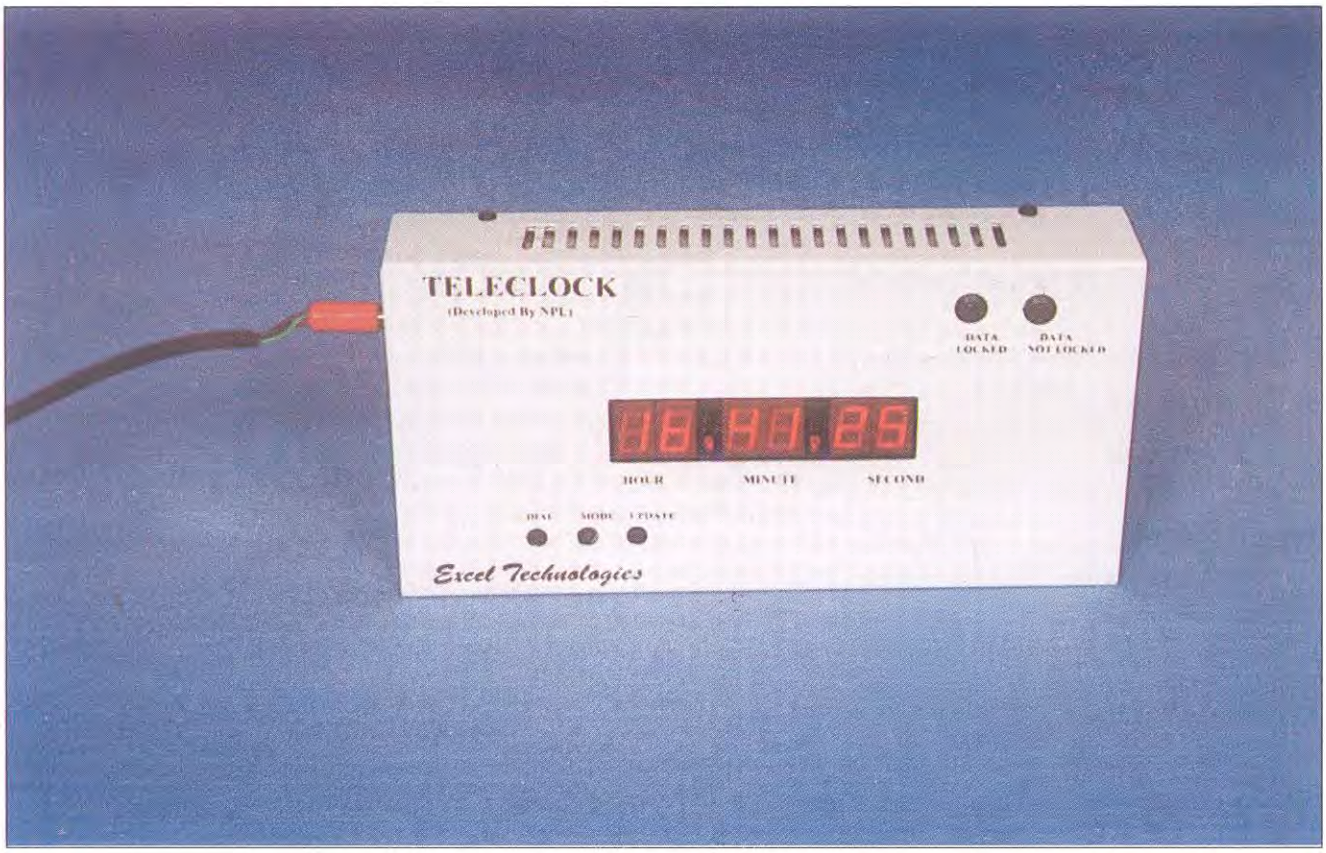


Fig. 2.5: Teleclock developed at NPL

to users through a telephone line. This Teleclock system contains its own clock (Fig. 2.5) which can be updated through its modem connected to local telephone line and the in built auto-dial system which by dialing a specific telephone number gets connected to the Teleclock system maintained at NPL. This way the local clock gets synchronized to NPL time (IST) within an accuracy of 1 second. This system will be very useful for many public time display systems like railway platforms, airports, railway reservation counters, STD/ISD booths etc.

On development side, another achievement is the design and development of an oven controlled crystal oscillator and the transfer of technological know-how to an Indian Company.

A project entitled 'To improve frequency standard by suppressing quantum noise through squeezed states' has been initiated under INDO-US Project. Frequency stability of Cs standard depends on line width. Theoretical studies have shown that squeezed light can change the rate of the spontaneous decay rate of the excited Cs atoms than with ordinary laser light. The reduced decay rate corresponds to narrowing of the line width thus improving S/N and should therefore result in better frequency stability of optically pumped Cs atomic frequency standard. Efforts are going on to work out the experimental set up for generation of the squeezed states.

Work is also going on another Indo-US project regarding study of the methods of measurements of phase modulation (PM) and amplitude modulation (AM) noise. The measurement noise floors of -170 dBc/Hz have been reached. Another major achievement is the development of a novel Cs hyperfine frequency (9.192GHz) synthesizer that is designed to be sufficiently rugged for use in space as well as ground applications.

One HP Rubidium Atomic Frequency Standard (belonging to Department of Light House and Light Ships) was reconditioned and calibrated.

Instrumentation

A low cost biometery unit has been developed indigenously and tested on patients, to diagnose the abnormality of the human eye. Tumor therapy study with focussed ultrasound has been made in the deep-seated brain tumors. Feasibility of pumping of bubbles to enhance the efficiency of the stone disintegration process has been studied, by stimulating the main shock wave with acoustic wave. It has been established that additional cavitational bubbles are generated due to external stimulation, to increase, in turn, the size and/or number of bubbles to disintegrate the stones faster.

In collaboration with AIIMS, New Delhi, a prototype model of biometry unit has been developed and tested on patients, and a high power focused ultrasonic transducer, 1 MHz, was developed for the treatment of tumors, particularly deep-seated brain tumors. A special battery operated bone fracture evaluator has been designed and the fabrication is in progress. To produce high power ultrasonic pulses by the PZT crystal one has to excite the crystal by high power electrical pulses, with a variable frequency generator covering the range 800 kHz to 2.5 MHz. The research in lithotripsy was continued. The high-energy focused shock waves are generated by the lithotripter and are applied to the stone for its fragmentation into small increments, sand like particles, which are then flushed out with urine. The actual mechanisms of stress/shock waves with the renal calculi or gall bladder stones, during disintegration, non-invasively and non-destructively, are still not understood clearly. The high-pressure shock waves create cavitation, which is generally accepted as one of the mechanisms behind the disintegration of these stones. However, the research was carried out, both experimentally and theoretically, to establish the fact, particularly on in vivo systems. The main emphasis has been on (i) the optimisation of the lithotripter, in this case, Lithostar from Siemens, Germany, for its various performance parameters, and (ii) study of the energy distribution of the reflected shock waves for the complex/layered stones by using visualisation techniques like Schlieren technique or high speed camera.

Feasibility study has been made to enhance the disruption of kidney stones by external stimulation in ESWL (Extracorporeal Shockwave Lithotripter). Deep-seated tumours are found to be sensitive to temperature with focussed ultrasound and hence can be treated easily.

इंजीनियरी पदार्थ
ENGINEERING MATERIALS

इंजीनियरी पदार्थ प्रभाग की विविध गतिविधियों में अनेक उच्च सामर्थ्य/अल्प घनत्व वाली धातुओं और मिश्र धातुओं के विभिन्न अवयवों से लेकर विविध प्रकार के उन्नत कार्बन उत्पादों तथा अति कठोर पदार्थों का विकास सम्मिलित है।

इस विभाग का विशेष ध्यान सामान्य इंजीरियरिंग तथा उच्च तकनीक (अन्तरिक्ष/रक्षा) वाले उद्योगों में काम आने वाले विविध पदार्थों और सम्बन्धित अवयवों के विकास की ओर है। विभाग ने अनेक प्रौद्योगिकियों तथा उच्च गुणवत्ता वाले उत्पादों का सफलतापूर्वक विकास किया है ।

The activities of the Division of Engineering Materials are wide ranging from the development of different metallic components of various high strength/ low density metals and alloys to the development of a variety of advanced carbon products and super hard materials.

The main emphasis of this Division has been to develop different materials and their associated components which are required by general engineering and high tech (Space / Defence) industries. The Division has successfully developed a number of technologies and quality products.

Metals and Alloys

The Metals and Alloys Group has set up a modern metal forming facility to develop components for engineering industries. In addition to other facilities, the group has 500 ton vertical hydraulic multipurpose press, which is being used to develop through two routes viz. (i) hot extrusion of ferrous, non-ferrous metals/alloys & composite materials, and (ii) cold/warm forge near net shaped components. Several organizations have already used this facility for developing components, such as, tubes, shapes and sections in different ferrous, non-ferrous, and other hi-tech materials, as well as, to study the hot deformation behaviour characteristics of newer materials. The main emphasis has been to develop materials which are light in weight, have high strength and high modulus, such as, metal matrix composites (MMCs), aluminium - lithium (Al-Li), magnesium (Mg) and other high strength alloys. The group has been providing active use of its facilities for the development of technologies which have direct relevance to the Indian industries. A number of national and international projects have also been undertaken.

Development of precision forging technology to manufacture near net shaped parts:

Mechanical Engineering Laboratory (MEL), AIST, MITI, Japan signed a memorandum of understanding with National Physical Laboratory, New Delhi to undertake collaborative research and exchange of scientists for a duration of 5 years (1996 - 2001). During the third year of this joint collaborative project, work was continued to develop some prototype components using cold forging. Some typical prototype components were cold/warm forged to understand the design of tooling, sequence of operations and estimation of forging pressures.

Under the project, scientists of NPL attended 6th Japan - China joint symposium on Precision Forging held in Nagoya during October 1998, and also in the joint symposium on "Precision Forming" held at Mechanical Engineering Laboratory, Tsukuba, Japan, on September 30, 1998.

Development of square tubes of Mg-alloy (ZK 30) for space applications:

The group has successfully developed square tubes of Mg-alloy (ZK 30), using hot extrusion technology. This developmental work was taken up jointly with VSSC, Trivandrum. On the development of Mg-alloy (ZK 30) square tubes for Payload Adapter Structure of PSLV/GSLV, a Memorandum of Understanding was signed with VSSC, Trivandrum, in March, 1997. The Mg-alloy square tubes are to be used as a payload adapter in PSLV. It can result in weight savings of about 30% over the presently used Al-alloy version. The significance of these Mg-alloy extruded tubes is further compounded when one considers their application in dual payload adapter needed for payload recovery experiments and launching of multiple satellites. It is a sponsored/in-house project.

The extrusion of Mg-alloys is a challenging task in view of poor workability and high reactivity. Further, from deformation point of view, the tubes with square shapes are one of the most difficult to shape using hot extrusion. A technology development project for the development of square tubes of Mg-alloy was taken up with stringent target mechanical properties & dimensional tolerances, as specified by VSSC, Trivandrum.

These square tubes were successfully developed using the hot extrusion technology. Using the specially designed tooling and optimized extrusion process parameters, Mg-alloy square tubes were produced with good surface finish (Fig. 3.1) and meeting the target mechanical properties and dimensional tolerances, as specified by VSSC, Trivandrum and are shown in Table 1(a) & (b). About 70 square tubes of Mg-Alloy were developed and supplied to VSSC, Trivandrum.

Development of oval shaped tubes for advanced light helicopter:

The Al-alloy (2024) oval shaped tubes, being developed under this project, are to be used as the skid landing gear in the Advanced Light Helicopter (ALH). This project involves the technology development of converting circular tube to oval tube having a size of 150 X 100 mm (oval shape) in length of about 4.5 metres. This developmental work has been taken up under the

Table 3.1: Relative comparison between the target and achieved mechanical properties and Dimensions of Magnesium square tubes developed at NPL

(Table 3.1a: Mechanical Properties)

PROPERTY	TARGET	ACHIEVED
U.T.S. (MPa)	280	280-300
0.2% YS (MPa)	205	240-260
ELONGATION (%)	10	12-15

(Table 3.1b: Dimensional Tolerance)

DIMENSIONS	TARGET	ACHIEVED	REMARKS
Outer square – 30 mm	± 0.2	± 0.2	Meets Specification
Wall thickness – 3 mm	± 0.1	± 0.2	Meets ASTM Standard B107
Length - 500 mm	± 8.0	± 2.0	Meets Specification
Radius (Outer)	4R	4R	
Radius (Inner)	3R	3R	

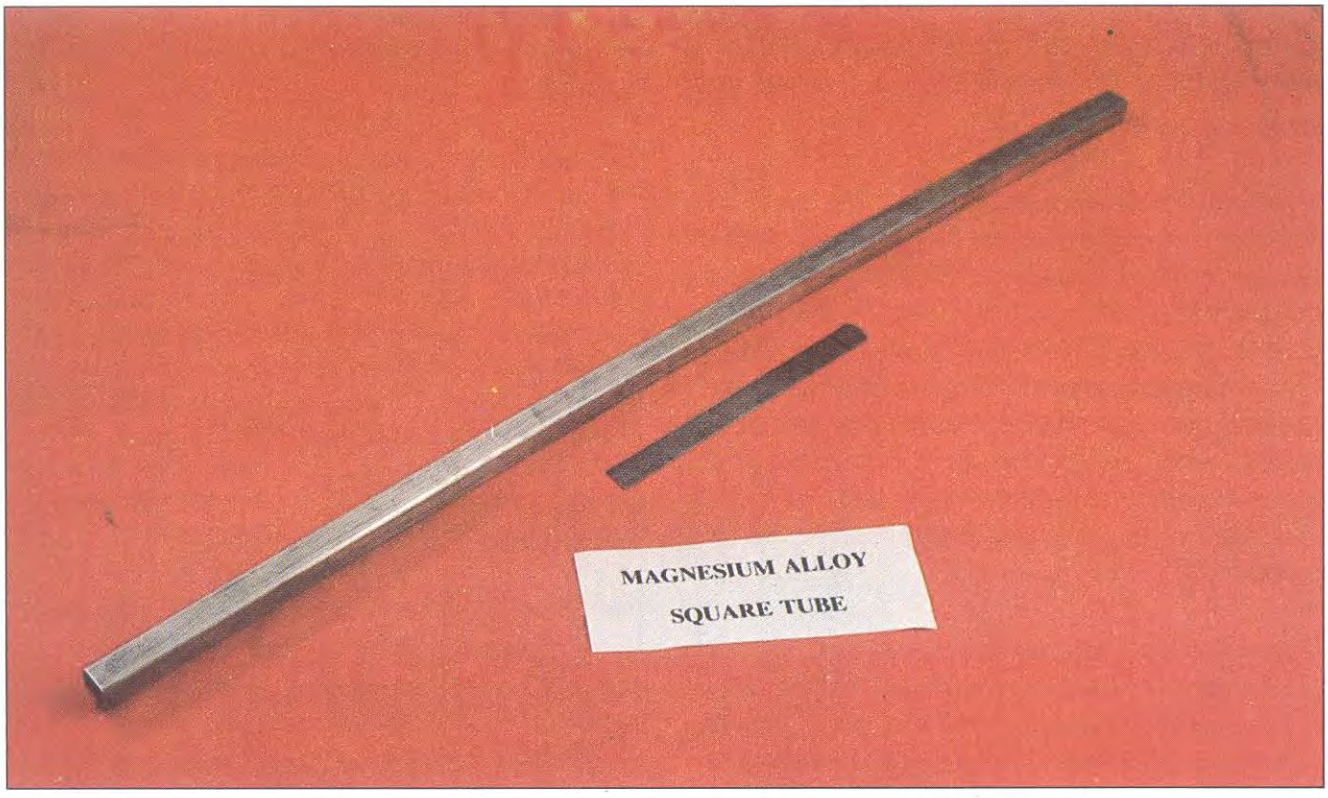


Fig. 3.1: Pictorial view of square tubes of Mg-alloy, ZK 30, developed at NPL for space applications

Fig. 3.2: Pictorial view of the prototype actual sized oval shape tubes

indigenisation and weight reduction programme for ALH. Under this project, work was continued to develop actual sized oval shaped tubes, as per dimensional tolerances laid down by HAL, Bangalore. Special tooling employing rotary type roller die were designed and fabricated to carry out the actual sized development. Various design and process parameters were optimized in order to develop the actual sized Al-alloy oval shaped tube. The prototype actual sized oval shape tubes made at NPL are shown in Fig. 3.2. The final work of producing these tubes would commence only after the Centre has certified this developmental process for Military Airworthiness Certification Centre, Bangalore.

Consultancy project on the techno-economic feasibility for the development of automobile components using cold/warm forging technology:

The National Physical Laboratory, New Delhi, was entrusted with the responsibility of preparing a Techno Economic Feasibility Report for setting up a cold/warm forging plant in Gurgaon. M/s Hero Group of Industries, New Delhi had given a consultancy project on the preparation of Techno-Economic Feasibility Report for the Development of Automobile components using cold/warm forging technology. An exhaustive report was prepared by the NPL, New Delhi, and was submitted which comprises the following sections: Management Summary, Study Brief, Technology, Process, Basis of Equipment Selections & Capacities, Process Costing, Financials, Raw Material & Equipment Catalogues etc.

The project report was prepared for manufacture of 10 components for their transmission system with a production capacity of 2,50,000 pieces per year. The two categories of components selected i.e. gear blanks and splined shafts, envisage considerable material savings and improved properties of products. The proposed new technology clearly shows that the material saving is more than 30% between the existing conventional and the proposed cold/warm forging process. The report concluded that the project was a

viable proposition and on the basis of this report, a plant is being set up in Gurgaon, Haryana.

Spray deposition and property evaluation of aluminium alloys:

Most of the sub-assemblies of the spray atomization and deposition unit has been individually commissioned. A special type of hydraulically operated substrate movement assembly (for depositing atomized droplets of the melt) was designed and fabricated. It consisted of water cooled, circular copper substrate having rotational as well as vertical movement with a provision for alignment with respect to falling droplets of melt. A temperature controller was interfaced with the main induction furnace for achieving precise control of the melt temperature. Purging system for nitrogen or argon was designed, fabricated and commissioned using different pneumatic valves and control fittings for regulating the gas flow. A gas atomizer for melt droplets was also integrated and tested with the main system. An exhaust system to be integrated with the main unit was designed as per specifications. Using this unit, a few spray-atomized deposits of monolithic aluminium alloy have been synthesized on rotating substrate, for optimizing various process parameters.

Technical development of titanium fasteners using warm forging for aerospace applications:

Under this project the detailed design of the warm forging tooling and the sequence of operations required to develop these titanium fasteners, has been completed.

Synthesis of metal matrix composites:

Work on Al-SiCp 10% v/o, Al - graphite and Al - Flyash was continued, to synthesize MMCs using Stir Casting Technique. Various process parameters were optimized to get a good quality preform samples. Detailed investigations with respect to Al-SiCp v/o 15% were carried out to study the effect of different extrusion process parameters, such as, die design, ram speed, billet temperature and extrusion ratio on the mechanical properties and microstructural features of these extruded MMC rods. Detailed metallurgical characterization of as cast and extruded samples were also carried out by evaluating the density, volume fraction of reinforcement and studying the microstructure using optical microscopy. Cast structure of the composites formed was found to be completely broken and a fine and equiaxed grained microstructure was evolved after the extrusion. Some inherent defects of cast MMCs such as porosity, gas entrapment and agglomeration of SiCp had also been observed. The densities of the extruded samples were near the theoretical densities and the detailed volume fraction analysis of reinforcement indicated no backward migration of ceramic reinforcement particulate during extrusion. The microstructure results indicated reasonably good distribution of reinforcement in the matrix & the mechanical characterization results indicated that the tensile properties of the MMC extruded samples met the target properties.

The tensile testing of various samples from M/s. Shriram Pistons were also carried out. Work was also initiated to set-up a powder metallurgy laboratory for the development of billets.

Advanced Carbon Products

The advanced carbon products group has been carrying out active and extensive R&D work in the field of Carbon. The main objective of this group is to develop newer carbon products that are either import substitutes or hold strategic importance and are at times not available to India at any cost. This group at NPL has over the years developed strong infrastructure and sound theoretical base in the field of carbon. As a result, it has been able to develop a number of carbon products and the knowhow generated was transferred to various industries and institutions. The group has established strong links with several renowned laboratories of the world. As a consequence of this, the group is in a position to undertake new projects of national importance, which in the current year are, namely (i) Development of pitch based carbon mono-filament for CVD–based SiC fibres, sponsored by ARDB, New Delhi, (ii) development of high thermal conductivity special graphite for first wall component of SST-1 Tokamak,

sponsored by Institute for Plasma Research (IPR), Gandhinagar and (iii) feasibility studies on various petroleum refinery streams as precursors for high performance carbon fibers, sponsored by IOC R&D Centre, Faridabad. Besides these projects, the group is continuing R&D work on carbon fibre composite rings (Ilizarov fixator) for orthopedical applications, asbestos free brake pads for automobiles, fibre matrix interaction studies on C-C composites and whiskers through sol-gel technique.

High density-isotropic graphite:

The ongoing project on the development of high density-isotropic graphite from green coke, sponsored by M/s Graphite India Ltd., Calcutta / Bangalore (a major carbon company in India), was completed and the technology was transferred to this company in September 1998. The graphite developed under this project possessed a bulk density of 1.9–2.0 g cm^{-3}, bending strength of 60–90 MPa, Young's modulus of 9–13 GPa, Shore hardness of 60–80 and an electrical resistivity of 1.0–2.0 m Ω cm. A patent for the process on the development of high density - monolithic graphite from green coke was also applied for. Besides this, extensive work to enhance the bending strength of this type of graphite to higher values of 100 – 130 was also carried out.

Development of pitch-based carbon monofilament:

Under the ARDB sponsored project, the work to be done involved (1) development of suitable pitch precursor, (2) spinning of the pitch precursor into a monofilament and, finally, (3) processing (oxidation followed by carbonisation to 1000°C and higher) of the pitch monofilament into a carbon monofilament. Efforts were made to develop a suitable pitch precursor with a softening point of 175–250°C, quinoline insoluble (QI) content of 0 %, toluene insoluble content of 50–55 % and a coking value of 75–80 %, by heat-treatment of a self-prepared QI-free coal tar pitch or a commercial petroleum pitch or a blend of the two. Besides this, a Pitch Distillation Assembly was also designed.

Development of high thermal conductivity graphite:

Under the IPR sponsored project on high thermal conductivity graphite, green coke was made by suitable heat-treatment of self-prepared QI-free coal tar pitch for producing this graphite. This coke was modified by oxidation and solvent extraction techniques and then used to produce special graphite (HTT = 2600°C). The samples were characterised with respect to bulk density, bending strength, Young's modulus, Shore hardness and electrical resistivity etc.

Development of carbon-carbon composites through sol-gel technique:

Carbon-carbon composites were prepared incorporating SiC into the matrix by sol-gel technique, characterised and impregnated using silica sol to improve the oxidation resistance. It was noticed that by incorporating 5–10 % SiC, the initiation temperature of oxidation was enhanced whereby the mechanical properties of the composites got improved.

Synthesis of silicon carbide whiskers (SiC_w) by sol-gel process from rayon fibres:

SiC_w were synthesised from rayon fibres and sol-gel derived silica. The proximity achieved between silica and carbon (produced from rayon) by employing sol-gel technique helped in getting SiC_w. The growth of whiskers from carbonised rayon surface as seen from SEM studies showed clearly that close contact between silica and carbon achieved through sol-gel process led to the growth of SiC_w. Further, SiC_w prepared from rayon fibres impregnated with sol-gel derived silica are straight whiskers and hence more stable when compared to the curved and bent SiC_w. Effect of SiO_2: C and boric acid in this sample was studied. It was observed that boric acid which melts around 700°C also helps in bringing the constituents close to each other and SiO_2:C < 1:3 yielded SiC_w with residual silica.

Post spinning modification of PAN fibres:

It has been shown earlier that the mechanical properties of the carbon fibres are dependent on the precursor characteristics. In the latest series of experimentation, the so-called post spinning treatment of Polyacrylonitrile (PAN) fibres was carried out using succinic acid. Succinic acid itself did not react with the PAN fibres, but converted into succinic anhydride during heating in thermal stabilization, which could act as plasticizer, and resulted in more than three time larger elongation in the treated fibres as compared to untreated fibres by stretching. The resulting carbon fibres had a small diameter of 6μm as compared to 7μm. These resulting carbon fibres were found to possess superior mechanical properties after heat treatment to 1500°C [T.S. 4.0 GPa as compared to 2.8 GPa for unmodified fibre] and 2500°C [Y.M. 550 GPa as compared to 400 GPa for unmodified fibres], respectively.

Development of special acrylic fibres:

Under the project sponsored by DST, oxidation and carbonization studies were carried out on the several PAN fibres supplied by IIT, Delhi. A comprehensive analysis report was prepared and submitted to DST.

Carbon fibre composite based Ilizarov fixator for orthopedic applications:

Carbon fibre composite rings of diameters 120 mm as well as 160 mm, were developed using carbon fibre tape developed from indigenous carbon fibres. These rings were first characterized for their mechanical properties on INSTRON universal testing machine before sending for field trials on polio patients at M/s. Agrawal Orthopaedic Hospital, Gorakhpur. About 40 numbers of such rings were supplied for clinical trials. The feed back received was highly encouraging.

Asbestos free brake pad materials for automobiles:

Samples of size 25 mm x 25 mm x 3 mm were fabricated using different reinforcements like chopped glass fibres, carbon fibres, kevlar fibre pulp and phenolic resin as binder. These composites were characterized for their thermal properties like CTE and specific heat, on TA–4000 model thermal analyser.

Studies on the fibre matrix interactions during processing of c/c composites:

Under the joint Indo-French project, unidirectional (UD) composites of size 130mm x 5mm x 4mm were developed using T-800 carbon fibres (as received) as well as the T-800 carbon fibres received from CEMES, France, after pyrolytic carbon coating. These composites were subjected to various heat treatment temperatures upto 2600°C. The composites were characterized for their mechanical properties and their fracture behaviour was studied on SEM. The matrix microstructure was studied on polarized light microscope. The composites made out of pyrocoated carbon fibres show a five fold increase in the flexural strength [550 MPa as compared to 110 MPa] and two fold improvement in the flexural modulus [150 GPa as compared to 70 Gpa].

High Pressure Physics & Technology

The high-pressure research group has been engaged in the area of materials behaviour under high pressure and high temperature especially on the study of transformation of low ordered form of boron nitride into the hard phases of boron nitride and diamond synthesis using some non-conventional catalyst-solvents.

Amorphization of boron nitride:

The main objective of this project was to try the amorphization of boron nitride using different chemical systems, such as, boric acid and urea & boric acid and amorphous carbon. In both these systems, the mixture was heated to 700 – 1300 °C for about 2 hours in nitrogen atmosphere followed by quenching the reaction product.

It was concluded that only highly crystalline form of boron nitride (hexagonal boron nitride) could be synthesized, instead of amporphous boron nitride, which was

revealed by the XRD patterns of the reaction product. This DST project was completed on 31st March 1999.

Diamond synthesis under high pressure & temperature in the presence of copper as a non-conventional catalyst-solvent

In another DST funded project the growth and morphology of the diamond crystals were studied as a function of pressure and temperature using copper as the non-conventional catalyst. It is known that essential condition for the formation of diamond using conventional catalyst-solvents (Fe, Ni, Co etc.) is that they must be in molten state and the diamond formation begins immediately after their melting temperature in the presence of graphite in its thermodynamically stable region.

Under the present studies (C– Cu system), it has been observed that when temperature is increased by about 300°C above its melting temperature of copper, diamonds begin to form. The reaction rate was found to be lower than when conventional catalyst is used.

इलेक्ट्रॉनिक पदार्थ
ELECTRONIC MATERIALS

एनपीएल का इलेक्ट्रॉनिक पदार्थ विभाग इलेक्ट्रॉनिक पदार्थों के अभिलक्षण, उनसे सम्बन्धित प्रौद्योगिकी विकास और उन्हें तैयार करने में कार्यरत है। इसमें सिलिकॉन और सिलिकॉन साधन, तनु परत प्रौद्योगिकी ग्रुप, विशेष सिरेमिक ग्रुप, संदीप्तिशील पदार्थ और डिवाइसेज ग्रुप व सूक्ष्म संरचना साधन ग्रुप हैं।

ये गतिविधियां कई अर्धचालकों और विद्युतरोधी (इन्सुलेटर्स), तात्विक और मिश्र दोनों के स्थूल और तनु परत रूपों के विविध अनुप्रयोगों से संबंधित हैं। पदार्थों और डिवाइसेज़ के उत्पादन के लिए प्रौद्योगिकी के विकास से सम्बन्धित मुख्य गतिविधियों में से कुछ इस प्रकार हैं:- सिलिकॉन, प्रकाश विद्युत सैल्स, फास्फर्स और प्रदर्श साधन, उच्च तापीय अतिचालक घटकों, संरध्र सिरेमिक फिल्टर्स और तनु परत प्रकाशीय और विशेष परतें आदि।

The Electronic Materials Division is engaged in preparation and characterization of electronic materials, devices and related technology developments. It has activities in areas of Silicon and Silicon Devices, Luminescent Materials & Devices, Thin Film Technology, Special Ceramics and Microstructure Devices

These activities are focussed on a large number of semiconductors and insulators, both in elemental and composites as well as bulk and thin film forms, for diverse applications. Some of the important activities relate to the development of technology for production of materials and devices, such as silicon, photovoltaic cells, phosphors and display devices, high temperature superconducting components, porous ceramic filters beta alumina and thin film optical and special coatings.

The processing units are also developed. For example this year a thin film coating unit for Plasma Enhanced Chemical Vapour Deposition (PECVD) was developed.

The silicon devices group has investigated substrate bonding for fabricating thin, efficient and large area silicon photovoltaic (PV) cells with a supporting silicon substrate and has designed a mechanical load tester for PV cells.

The luminescent materials and devices group has developed an advanced model of particle size analyzer for industrial powders. An independent user has tested long decay phosphor coated tapes developed by the group.

The thin film technology group conducted studies on anti-glare coating for opthalmic lenses, amorphous silicon coating on glass substrates for use in Optically Addressed Spatial Light Modulator (OALSM) and Diamond Like Carbon (DLC) films.

The Special Ceramic Group has continued its work on current carrying high temperature superconducting material (BPSCCO) by fabricating long lengths of silver clad mono filamentary tapes and high current tube conductors. This group has also developed a new high alumina cordierite composition for porous filters and beta alumina tubes.

The microstructure Materials and Devices group has continued its investigation in the fabrication of CdTe and CIS solar cells and initiated studies in ferroelectric thin film non volatile memory devices, layered perovskite ferroelectric material based on $SrBiTaO_5$ (SBT), Si and CdTe nanocrystal quantum dots passivated in high energy gap oxides.

Silicon and Silicon Devices

The substrate bonding approach is developed for the first time by this group. This approach was examined for its potential for fabricating more efficient thin n^+-p-p^+ silicon cells of large area with a supporting silicon substrate at the bottom to avoid breakage of the thin wafer during processing and avoiding a need of making any drastic change in the cell fabrication process. Some solar cells were made with this approach using Cz -Si wafers of 1-ohm cm resistivity and 300 ìm thickness which were thinned and then bonded to each other using Al alloying prior to fabrication of the n-p-p^+ structure. The junction was formed by thermal diffusion from a $POCl_3$ source and front and back contacts were made by screen printing of silver. The sizes of the cells were 100-mm pseudo square. I-V characteristics of the cells were measured under tungsten halogen lamp corresponding to 100-mW/cm^2 intensity of AM1.5 solar spectrum. The measurement of spectral response in the wave length range 400-1100 nm was done using narrow band filters and a reference silicon solar cell obtained from PRC Krochmann, Germany.

I-V characteristic of one of the cells, viz., cell # 5BC-1 of 78.cm^2 area is shown in the curve 1 in Fig. 4.1. The rest of the curves (2-7) in Fig. 4.1 have been generated by computer simulation. Superior values of the parameters have been used. It has been demonstrated that with appropriate choice of parameters efficiency in excess of 17% can be achieved in this structure. The cause of low short circuit current density (J_{sc}) values can be traced to the absence of texturization and antireflection coating on these cells. The evidence of it is seen in Fig. 4.2, which shows the plots of external quantum efficiency (EQE), and internal quantum efficiency (IQE) of cell # 5BC-1, which had the highest J_{sc} values. The values of EQE are very small in comparison with IQE values and this difference is attributed to high reflection losses at the front surface of the cell. Giving texturization and AR coating to the front surface would minimize this loss. Then, the EQE would approach the IQE curve and J_{sc} would be enhanced to a value ~30mA/cm^2. Further improvements can be achieved by reducing series resistance and increasing shunt resistance. Additionally aluminum can be made to cause gettering of deep level impurities.

One dimensional physical models of Electrovoltaic (EV) and Electrophotovoltaic (EPV) cells were developed and applied to describe the observed I-V characteristics of an n-p-n silicon bipolar transistor 2N3055 in EV mode and of an EPV cell in EV, PV and EPV modes of operation. EV and PV effects were indeed found to work cooperatively and the output power was enhanced

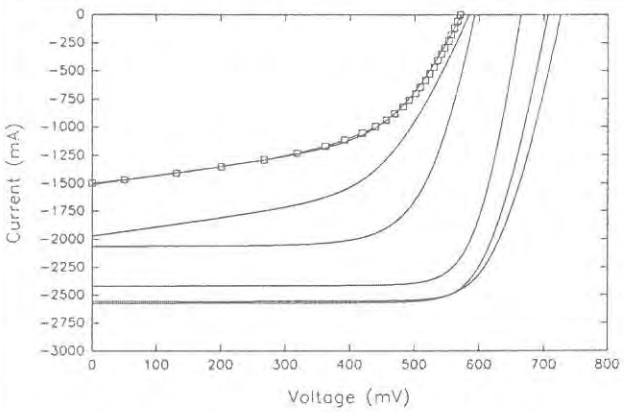


Fig. 4.1: I-V Characteristics of the Cell # 5 BC-1 of 78 cm² area. Experimental values are plotted as -0-0- and theoretical values are plotted as continuous lines. The latter represent various possibilities of improvement

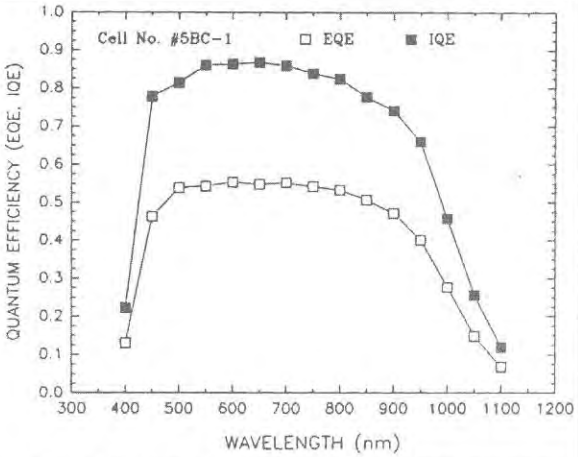


Fig. 4.2: Plots of external and internal quantum efficiencies (EQE and IQE) of the Cell # 5BC-1 corresponding to the highest values of J_{sc}

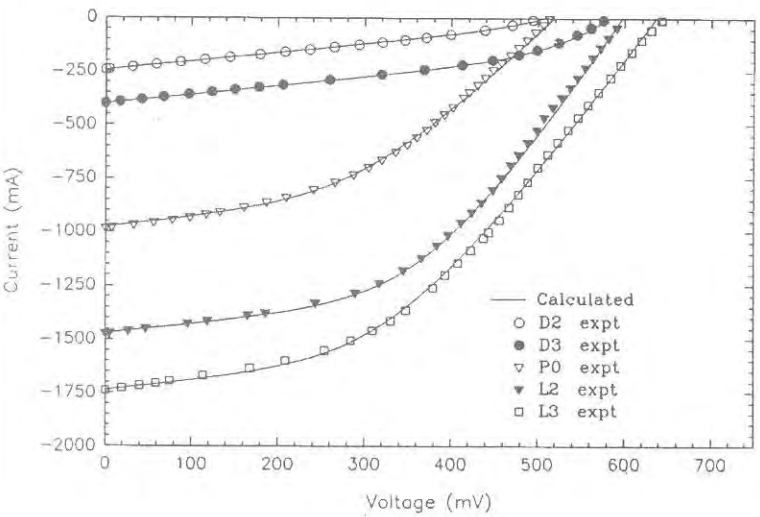


Fig. 4.3: Measured I-V characteristics of the four terminal EPV cell under EV (curves D_2, D_3), PV (curve P_0) and EPV (curves L_2, L_3) modes

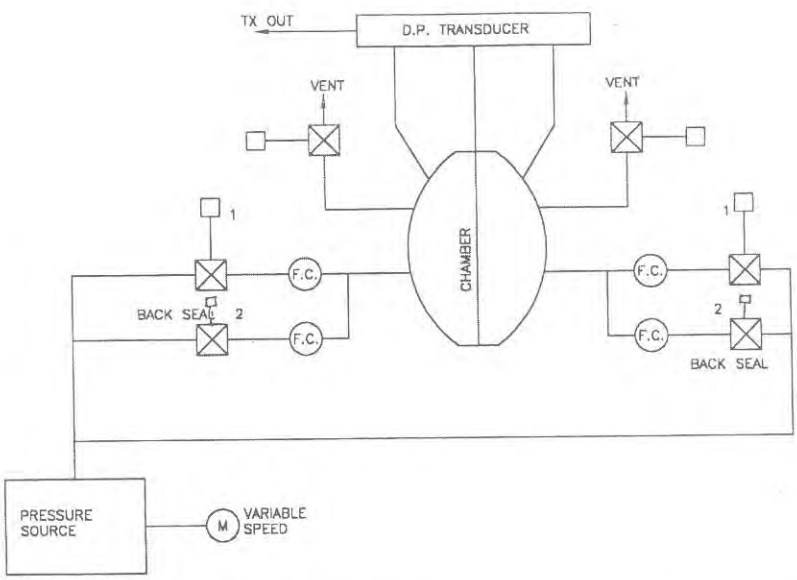


Fig. 4.4 Schematic diagram of the mechanical load tester

substantially in EPV mode over its PV mode value. Fig. 4.3 shows the measured I-V characteristics of a four terminal EPV cell under EV (curves D2, D3), PV (curve P0) and EPV (L2, L3) modes. The cell was made on 100mm dia Cz -Si wafers using screen-printed contacts. The cell thickness d was 360μm and the value of diffusion length L in the base region was ~100μm resulting in d/L >3. The efficiency of this cell increased from a value of 3% in EV mode to 4.4 % in the EPV mode. The physical model revealed that for getting high values of efficiency in EV mode (>60%), and EPV mode (>20%) the EPV cell should be designed to have d/L<<1.

Solar cells are not used directly in practice. Modules are made of solar cells and are installed for field applications where they have to withstand severe atmospheric conditions of wind, snow and ice depending on their location. A wind velocity of 130 km/hr corresponds to a differential pressure of 800 Pa across the module. As per the IEC standards 1215 and 1262, simulated loads of 800-2400 Pa should suffice for winds including gusty winds. However, for snow and ice loads, the differential pressure would require being 5400 Pa to simulate the test conditions. Design parameters of a PV mechanical load system have been worked out. The designed chamber consists of two halves, each of 1 m^3 volume that can be pressurized and depressurized to an excess pressure of ± 1440 Pa for dynamic wind load testing for 10,000 cycles at the rate of 5 cycles per minute. Static loads of 800-5400 Pa would be applied for 30 min on each side of the module. Schematic diagram of the mechanical Load Tester is shown in Fig. 4.4.

Work on photodiode for use with scintillating crystals was initiated. An n-p-p^+ solar cell scribed out of a bigger solar cell was used with a BGO crystal in the photovoltaic mode to detect and quantify X-rays. Under x-ray intensity corresponding to a tube current of 30μA and accelerating voltage of 50 KV of the x-ray generator, the BGO crystal/silicon photovoltaic detector gave short circuit current density of 2.2 μA and open circuit voltage of 200 μV.

Luminescent Materials & Devices

An advanced model of a particle size analyzer was developed. It is known as multichannel or multisample particle size Analyzer that can analyze industrial powder in the range of 0.5 – 100 micron. It can analyze up to six samples simultaneously in six different settling liquids. The instrument works on the principle of Stoke's law of settling and turbidimetry. Since manual data handling is not possible, data acquisition and analysis is done by a multichannel ADC software developed in the group. Know-how for this unit is ready for transfer and there is a good response from industry and entrepreneurs.

R & D in phosphors:

The project on "Development of long decay phosphors and tapes" was concluded on 23rd June 1998 with submission of project closing report along with necessary phosphors and tapes as per agreement. The long decay phosphor coated tapes were tested by an independent user from Defence sector, viz., the Indian Navy, Lonavala. Tapes having printed letters of size of 50 mm x 32 mm were subjected to a single tube light (40-Watt) for one minute. When placed at a distance of 24 ft in total darkness it was visible for about 4 minutes. Subsequently when placed at a distance of 15 ft the same was legible for about 7 minutes with good intensity. With the above observation it was decided that these tapes may be used conveniently for displaying locations and for risk and control markings. With the above as basis several projects have been discussed with DLJ on phosphors. Among these are:

- Development of gadolinium oxysulfide based screens for imaging with high energy X-rays, gamma/neutron radiation.
- Electroluminescent display panels as a replacement for their existing tritium gas filled beta lights.
- Adaptation of NPL developed long decay tapes for various DRDO applications.

The final completion report of DST funded project entitled, "Development of thin film electroluminescent display devices" was submitted to DST.

Thin Film Optical Coating Technology

A DST funded grant-in-aid project entitled 'Deposition and properties of mixed composition infrared optical thin films' that began in 1995 was successfully concluded in July 1998. Under the project several mixed composition thin film systems were studied in this project: zinc sulfide-thorium fluoride, zinc selenide-cryolite, magnesium fluoride-thorium fluoride and zinc telluride-magnesium fluoride. The mixed composition films were deposited from mixtures of the constituents in varying proportions by weight, and characterized for the optical properties (refractive index, extinction coefficient, near IR transmittance) and mechanical properties (intrinsic stress, surface morphology, crystalline/amorphous structure). In many cases, the mixed composition films showed superior characteristics to the single material films – tailorable refractive index, low internal stress, smooth surface morphology, etc. and thus they were shown to be suitable candidates for inclusion in multilayer dielectric stacks useful for the near IR region (2-10 microns). For the determination of the optical constants of the films an alternative to the envelope method was developed and findings were published.

A project entitled 'Silica-on-silicon integrated optical devices for wavelength division multiplexing applications-Part I', for joint execution by NPL and CEERI, Pilani, was funded by Dept. of Electronics as a grant-in-aid project [25-01-99 to 24-01-2001, DOE contribution Rs. 42.50 lakhs]. In this project, NPL will deposit low loss (less than 0.2 dB/cm) waveguides of silica on silicon substrates, using the Flame Hydrolysis Deposition technique. The integrated optical devices – power splitters, arrayed waveguide grating demultiplexer, etc. will be designed and fabricated in these waveguides at CEERI. A Flame Hydrolysis Deposition Facility was designed after extensive study of the literature and detailed consultations with CGCRI, Calcutta and other institutions.

The design and fabrication of a prototype anti-glare coating for ophthalmic lenses, which provide protection from UV radiation and from the glare of headlights during night driving, was successfully accomplished. Evaluation and improvement of coating is in progress.

A high reflectance all dielectric multilayer coating on an amorphous silicon coated glass substrate was developed for use in the fabrication of OASLM (optically addressed spatial light modulator) under a DRDO/DST project.

Amorphous Semiconducting Thin Films, Devices and Systems

Analysis of field emission from DLC films has been carried out. These DLC films were prepared by variety of techniques such as RF PECVD, VHF PECVD, Pulsed PECVD and a technique that utilizes a saddle field fast atom beam source. Field emission behavior in these materials has been understood in the light of residual stress, hardness, optical band gap (E_g) and characteristic energy of band tails (Urbach energy E_o). The existence of a correlation of threshold field ($E_{turn-ON}$) required for emission on residual stress, E_g and E_o was found, perhaps for the first time. Specifically the values of $E_{turn-ON}$ are found to decrease with the decrease of residual stress, E_g and E_o values. Residual stress in DLC films is, thus, found to play an important role in the field emission behavior and significant field emission was observed at low threshold fields for those DLC films that recorded low stress values. The low stress DLC films have been deposited on S.S. blades and they have been evaluated for cutting edge applications.

A sophisticated Microwave PECVD facility has been set up for growing DLC films. In this system hydrocarbon plasma is generated using a source working at 2.45 GHz and the substrates are placed down stream and a high enough bias at RF frequency 13.56 MHz is applied (Remote Plasma PECVD). Different hydrocarbon gases were released upstream and mass flow controlled, whereas chamber pressure was controlled through a pressure transducer and throttle valve controller in order to map the parameter space. DLC films prepared under different conditions have been characterized in terms of conductivity, optical band gap, stress, hardness, IR transmission, and photoluminescence efficiency. DLC films so formed have been applied on silicon solar cells as antireflecting (AR) coatings. Our initial results indicate about 30% increase in short circuit current. An improved design of Filtered Vacuum Arc Discharge (FVAD)

technique was arrived at after intense consultations with other groups overseas who are working on similar process for the development of DLC coatings with semiconducting properties. DST, Govt. of India has since approved a project proposal on this subject for financial support.

Special Ceramics

High temperature super conductors have proven their utility as current carrying conductors and thus NPL has been developing technology for fabrication of silver clad superconducting wire using high temperature superconductors. The work on current carrying high temperature superconducting BPSCCO conductor was done in three main directions.

- Fabrication of long length silver clad BPSCCO mono filamentary tapes.
- Fabrication of multi filamentary silver clad BPSCCO tapes,
- Fabrication of high current tube conductors.

Silver clad mono- filamentary and multi- filamentary tapes were made by the PIT (Powder in tube) method. The process parameters were optimized for long length tapes. Several coils made of 10 to 15 meter long mono filamentary tapes have been fabricated. These coils have showed end to end superconductivity up to 25 meters length with critical current density (J_c) of approximately 6000 A/cm^2 at 77K and 10^4 A/cm^2 at 4.2 K. Multi- filamentary tapes with 17 filaments of 2 meters length were also processed. These tapes were sintered at 830-845°C for 250 hours with intermittent rolling. An I_c of 2.7 A for multi-filamentary tapes at 77 K and an I_c of 10 A at 4.2 K in self-field was recorded.

High current leads featuring rods or tubes look certain to be the first applications of ceramic super conductors in electrical power engineering as they offer major advantages over conventional metal leads. A reduction of heat load at 4 k by more than a factor of 10 with a current of 500-1000 A for various applications like the leads for super conducting magnets, generators etc can be obtained. NPL has prepared 10,20 and 43 cm long tube conductors of Bi 2223 capable of carrying more than 120–200 A at 77 K in the super conducting state. Preliminary studies at liquid Helium Temperatures showed that the losses due to contacts and tube conductors were minimum as expected. These can be used as current leads for conventional super conducting magnets and it is particularly suitable for operation with cryo-coolers.

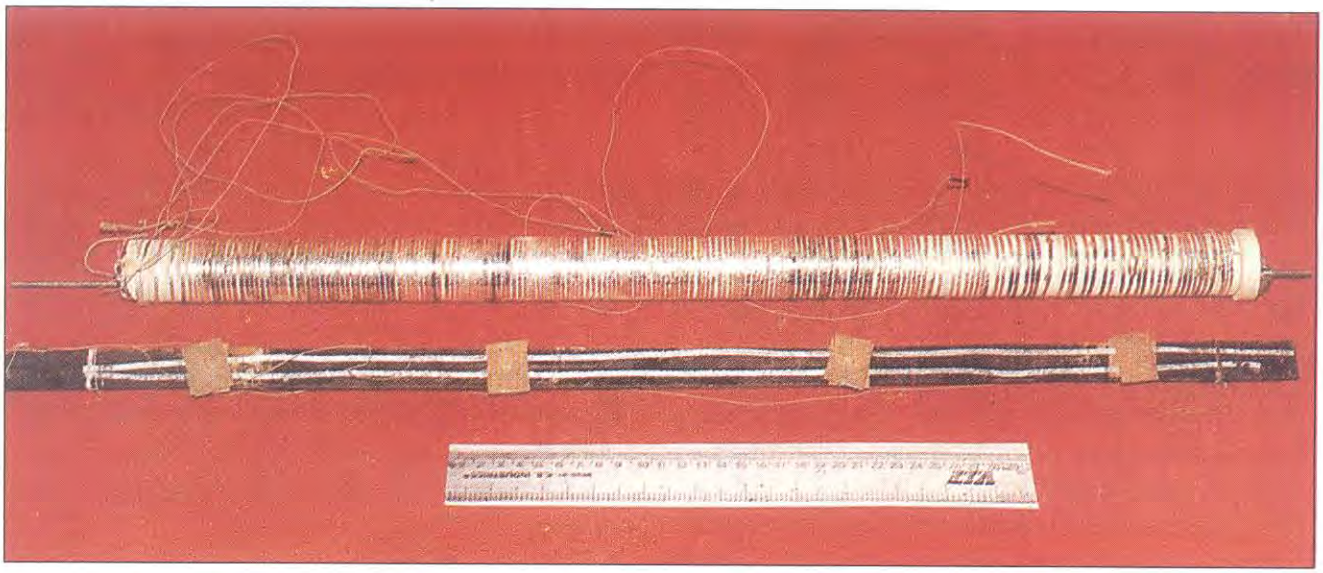


Fig. 4.5: Long length silver clad BPSCCO tapes fabricated at NPL, which showed end-to-end superconductivity. The one near the scale is I m long muti-filamentary tape and the other one 25 m long mono-filamentary tape

Apart from the above applied work basic studies of Bi2212 and Bi 2223 relating to NRMA (Non-Resonant Microwave Absorption) were also carried out.

A project on development of porous ceramic particulate filters for IC engine exhaust was successfully completed. Under this project a new high alumina consisting of 47mol% SiO_2, 23mol% MgO and 30 mol% Al_2O_3 cordierite composition was developed. They are used for processing candle type filter for two wheelers. These filters were designed to have following dimensions; OD of 62.5mm; ID of 35 mm and effective length of 130 mm. A percentage reduction of around 90% was achieved after introduction of the filter. Another project, Development of Beta Alumina tubes for sodium metal production, which was in collaboration with Indira Gandhi Centre for Atomic Research (IGCAR) with funding from the Board of Nuclear Studies was extended till March 2000. Under this project, we have supplied 35 no. of 50 mm x 100mm x 2mm wall thickness one end closed Beta alumina tubes with an alpha alumina header joined by a special glass seal. 15 nos of 50 mm x 150mm x 2mm wall thickness one end closed Beta alumina tubes with an alpha alumina header joined by a special glass seal will be supplied before March 2000. A new project entitled 'Novel graded Porosity Gas Separation Membrane - Synthesis and characterization' was prepared and submitted to DST.

Microstructure Materials and Devices

Thin film polycrystalline solar cell development activity at NPL has two focal activities. Development of thin film CdTe solar cells based on inexpensive processing technology routes and exploitation of novel technologies to synthesize solar grade $CuInSe_2$ (CIS) absorber and heterojunction materials. Electrodeposition and chemical spray technologies have been developed for CdTe solar cells. All important and critical steps involved in the fabrication of solar cells were developed and conversion efficiencies of over 10% were achieved. These steps have been put on a fixed scientific footing. Cell area enhancement research has been carried forward and integrated sub-modules of 5 cm x 5 cm have been developed. Further work on identifying parameters to realize 10% sub module efficiency at higher yield is underway. Innovative new approaches for the preparation of CdTe solar cell absorber layers of improved properties have been developed. Pulsed electroplating and electrodeposition from organo-metallic precursors are some critical processing approaches for future application in CdTe cells fabricated at higher deposition rates. In the development of thin film photovoltaic materials for CIS based solar cells, further work on the development of new ZnSe based heterojunction materials has been carried out. The basic technology is based on selenium vapour selenization of metallic precursors. While ZnSe is yet untested material for CIS solar cells, success of our work in ionized nitrogen doping and In alloying have brought forward its application for heterojunctions. This has opened up new possibility of integrated processing approach to CIS solar cell fabrication, which offers simplification of technology. Extensive research has been carried out to understand the effect of Se reactor pressure, precursor temperature, Te/Se ratio, In content, nitrogen plasma condition and post growth treatment towards achieving viable solar cell technology.

In the area of oxide electronics, major R & D activities at NPL are related to thin films of magnetic materials, ferroelectric materials, gate dielectrics and sensor oxides. In the past, chemical vapour deposition technologies using metallo-organic precursors has been applied for the formation of Yttrium Iron Garnet (YIG) for magneto optical recording media development. New technology for enhancing the perpendicular anisotropy in the film based on CoO infiltration has been introduced by us. This patented process was a result of introduction of a new type of magneto crystalline anisotropy in the media. A new technology component of this research was to achieve low temperature (< 580°C) processing and stabilization of magnetic garnet phase. In the past 900°C anneal step was inevitable. This development has lead to new possibility of application of MO media over inexpensive substrates/disks. This process, whose patent is pending, is based on novel multi-layer growth concepts.

Ferroelectric thin film materials are being investigated for application in non-volatile memory (NvRAM) devices.

Key requirements for this are high storage charge density, low coersive electric field and stability under multiple cycles. In this respect lead zirconate titanate (PZT) film prepared by electron beam deposition have been investigated in the past. Studies critical to device use such as leakage currents and relaxor behaviour and their inter relationship with defects and secondary phases in the film have been carried out. Role of pyrochlor phase and secondary TiO_2 phase is established by these studies is of importance in view of electrode PZT reactions in actual devices. New work has been initiated in layered perovskite ferroelectric based on $SrBiTaO_5$ (SBT). This work carried out in collaboration with the Materials science and engineering department of Virginia Tech, USA exploits pulsed laser (PLD) ablation technique to form SBT films. A new variant was introduced which exploits electric field ionized O_2 growth of SBT film to enhance ferroelectric properties and reduce processing temperature. This is an important development for application of SBT based NvRAM technologies with Si planar technology used in microelectronics/VLSI.

Nanocrystalline semiconductor materials have potential applications in quantum electronics. Work was initiated for fabrication of Si and CdTe nanocrystal quantum dots passivated in high energy gap oxides, SiO_2, TiO_2 materials by novel approaches. Quantum confinement effects of coupled excitons and single particle (electron or hole) dependent on nanocystal size have been demonstrated. Current focus of this research is in evolving an understanding of current transport to gain insight in charge transfer in nanocrystal quantum structures. Future work is planned on application as gate dielectrics and realizing new electronic transport based on charging of nano semiconductors.

NPL has initiated an activity on epitaxial growth of nitride group of semiconductor materials. These emerging materials have recently gained importance for future optoelectronic devices. NPL work in these area aims at using MBE technology for GaN growth and study of the epitaxial phenomenon and defects by various techniques.

बहुलक व मृदु पदार्थ
POLYMERIC AND SOFT MATERIALS

इस प्रभाग में कार्यान्वित होने वाली गतिविधियों में प्रायः बहुलक/कार्बनिक पदार्थों को सम्मिलित किया जाता है । इन पदार्थों की संक्रिया 100°C या उससे भी कम तापमान पर की जाती है । इन पदार्थों में मुख्य हैं :- द्रव क्रिस्टल्स्, स्व संरेखित एकाणु परत, चालक बहुलक, पारंपरिक व बहुलक परावैद्युत, विद्युतक्रोमिक पदार्थ, ठोस विद्युत अपघट्य, यथोचित रसायनिक संशोधन किए गए अक्रिस्टलीय अर्धचालक, कार्बनिक ग्लासेज़ तथा अन्य अनुकूल अकार्बनिक, रंजकों द्वारा सुग्राहित नैनो-क्रिस्टलीय अर्धचालक पदार्थ एवं कई धातुएं जो विभिन्न साधनों की संरचना के लिए आवश्यक हैं । इस प्रकार विकसित किए गए पदार्थों का प्रयोग विविध अनुप्रयोगों में प्रयुक्त होने वाली युक्तियों की संरचना में किया जाता है । कुछ निरूपक अनुप्रयोगों में लौह विद्युत मैमोरी स्विच, स्थानीय प्रकाश माडुलक, पर्यावरण मानीटरिंग और खाद्य गुणवत्ता मूल्यांकन आदि के लिए बहुलक संवेदक, जैव संवेदकों (कोलेस्ट्रॉल, यूरिया, ग्लूकोज़ आदि के निर्धारण हेतु), पानी से वायरस निरोध हेतु बहुलक झिल्ली चालक, अन्य अरैखिक प्रकाशीय डिवाइसेज़ और बहुलक पर आधारित प्रकाशीय पथ निर्धारित तरंग, स्मार्ट विन्डोज़ (विद्युत क्रोमिक), चालक बहुलक पर आधारित ई एम आई परिरक्षण डिवाइसेज़, अति उच्च संवेदनशीलता के प्रकाशग्राही आदि सम्मिलित है।

Activities being carried out in this division often involve the use of polymeric/organic materials, which do not require high temperatures for their processing (processing temperatures <100°C). These materials include liquid crystals, self aligned monolayers, conducting polymers, conventional and polymeric dielectrics, electrochromic materials, solid electrolytes, amorphous semiconductors which have suitably been chemically modified, organic glasses, nano-crystalline semiconductors which have been sensitised by dyes, together with host of other compatible inorganic materials /metals required to fabricate various devices. The materials so developed were incorporated in various device structures that find diverse applications. Some representative applications include ferroelectric memory switches, spatial light modulators (electrically and optically addressed, for interesting photonic applications), polymeric sensors for environmental monitoring and food quality assessment etc., biosensors (for lactate cholesterol, urea, glucose etc.), conducting polymeric membranes for virus retention from water, optical wave guides based on polymers and other non-linear optical devices, smart windows (electrochromic), conducting polymer based EMI shielding devices, photoreceptors of very high sensitivity etc.

Liquid Crystal Physics and Applications

Surface order and structure studies on polymer-solid interfaces:

This work is being carried out under an Indo-US collaborative project. The objective of this project is to study and control the surface structure at the atomic levels so that the desired alignment of the liquid crystals in the bulk can be achieved and in turn their electro-optic properties could be controlled.

Work on Self-Assembled Monolayer of alkoxy silanes by chemisorption was initiated, for the first time in this laboratory, to control the properties of the substrate interface at the molecular levels. For the present study two silanes namely; octadecyl-triethoxy silane (OTS) and amino-propyl-triethoxy silane (APTES) were chosen. It has been found that there are several important parameters, which affect the quality of the grown monolayer of these organo-silanes. Some of them are pretreatment of the substrates, contracting the substrates in silane solution in anhydrous conditions, post treatment of the substrates etc. A rigorous substrate cleaning procedure has been established to yield substrate surfaces showing high hydrophilicity. The high hydrophilicity was ascertained by ensuring the low contact angle of water with the surfaces. An experimental facility has been created to measure the contact angle of the surfaces. The deposition of monolayer on the cleaned glass substrates was achieved by dipping them in silane solutions under strongly anhydrous conditions. The fully-grown monolayer was obtained by optimizing the time of dipping of the substrate in the silane solution. The other crucial factors are: concentration of the silane in the solution, temperature of the solution and amount of moisture present in the solution. Fig. 5.1 shows the variation in the contact angle of water on the APTES monolayer, the time of immersion of the substrate in the silane solution. It can be seen that the contact angle plateaus off with increasing immersion time of the substrate in the silane solution. It was observed that the APTES deposited substrates produce no preferred alignment of liquid crystal in the sandwich configuration. However, the OTS coated substrates produced excellent homeotropic alignment of nematic liquid crystals.The homeotropic alignment was checked under a polarizing

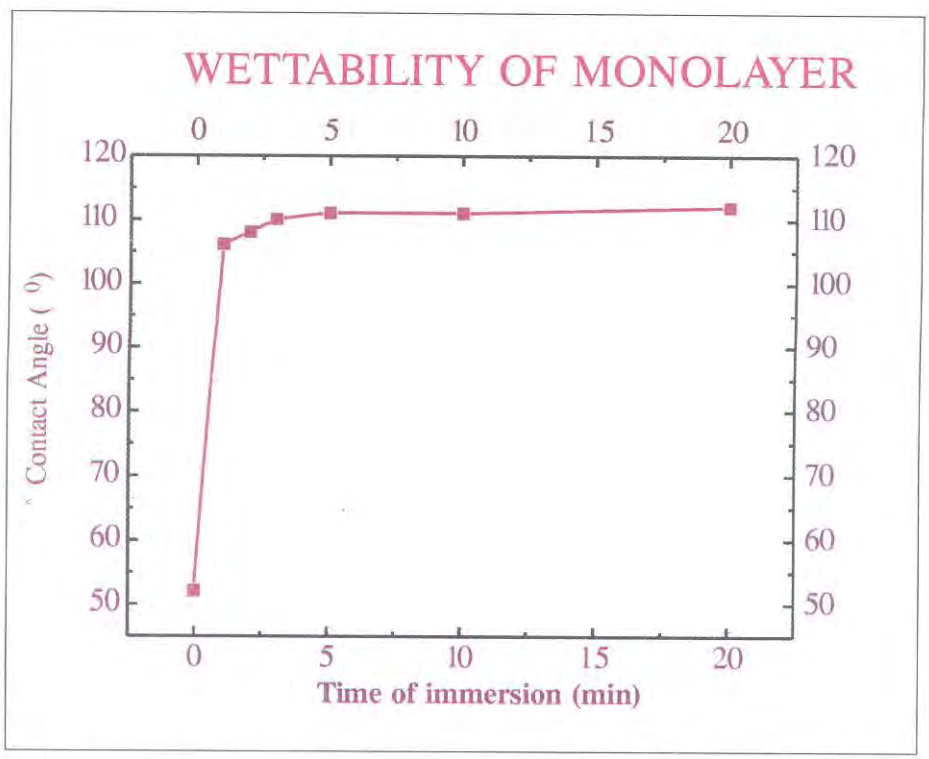


Fig. 5.1: Variation in the contact angle of APTES coated glass substrate as a function of time of immersion in 1% APTE solution

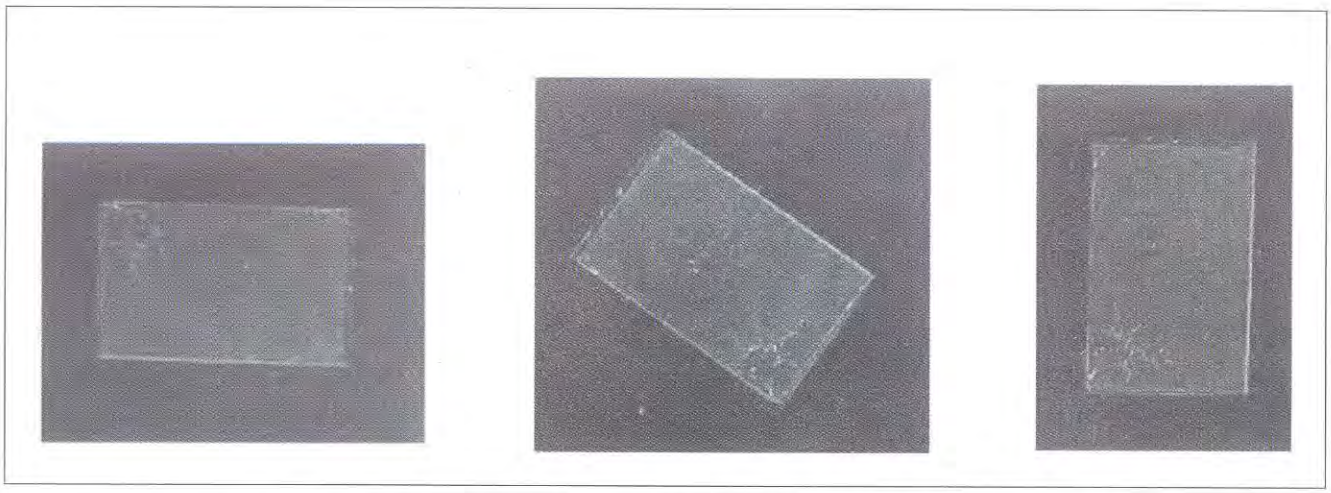


Fig. 5.2: Photographs of a 'Homeotropically Aligned Liquid Crystal Cell' under various orientations between crossed polarized with orientation axis aligned: a) parallel to one of the polarizers, (b) at 45° and c) at 90°

microscope. A homeotropically aligned liquid crystal cell appears complete dark between crossed polarizers and shows no variation in its transmission intensity on rotating it on the microscope stage. Fig. 5.2 shows the photographs of one such cell under various orientations between two crossed polarizers.

Achieving better surface stabilized states in SSFLC devices:

The discovery of surface stabilization of ferroelectric liquid crystal (SSFLC memory effect) has shown a tremendous application potential. The fast and bistable switching SSFLC displays are ideal for highly multiplexible video rate addressed flat panel displays. It is well known that the switching time of an SSFLC device is inversely proportional to the spontaneous polarization and directly proportional to the rotational viscosity of ferroelectric liquid crystal (FLC) material used. Recently many studies have shown that the use of high spontaneous polarization materials improves the switching speed, but destroys the bistability (memory effect). The surface bistability is lost mostly due to the accumulation of free charges at the interface between the FLC medium and the insulating alignment layers. This accumulation of charges has been found to depend on the nature of the alignment layers. Therefore, to achieve better switching speeds without compromising the bistability in SSFLC devices, various approaches were tried. This involved the use of extremely thin alignment layers or conducting alignment layers etc. Still there is no clear understanding as to how the charge accumulation at the FLC alignment layer interface affects the switching dynamics of SSFLC devices. Previous studies with ion doped FLC samples have shown the possibility of getting a non-conventional bistability in the FLC devices. Recently at NPL it has been demonstrated that by utilizing the accumulated charges at the interface one can achieve better stabilized states in SSFLC devices. It has been observed that the accumulation of free charges at the interface between the FLC medium and the alignment layer gives rise to a phenomenon of reverse switching in SSFLC devices. These reverse switched states are found to be highly stable (i.e. have memory) for months due to charge stabilization. Such memory SSFLC devices have a lot of potential in storing the holographic images and also in Spatial Light Modulators for photonic applications.

Biomolecular Electronics

Lactate biosensor:

Amperometric response measurements of screen printed lactate oxidase immobilized graphite electrodes were periodically conducted as a function of lactate concentration It has been found that these lactate oxidase graphite electrodes show linear behaviour from 1 mM to 8 mM.

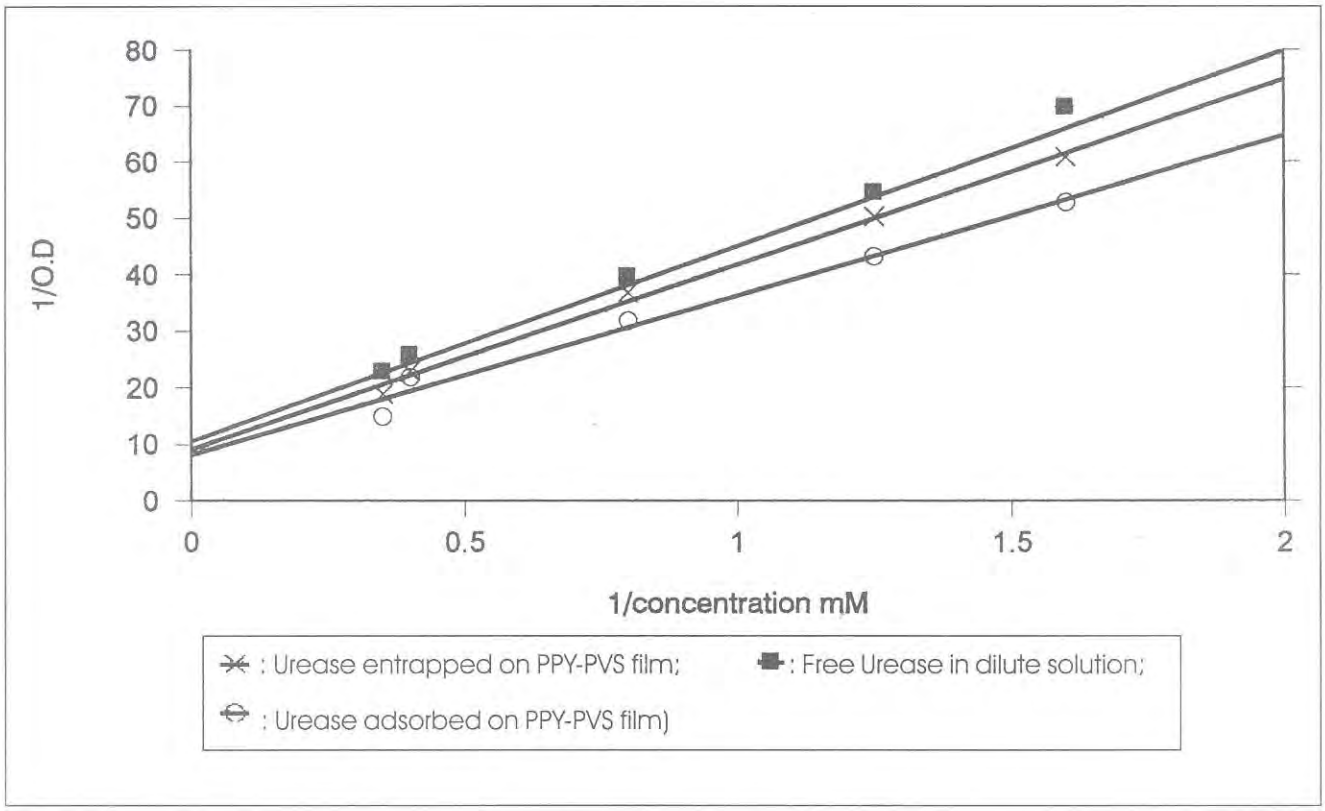


Fig. 5.3: Lineweavar Burk plots of urease activity

Lactate dehydrogenase was immobilized onto the polypyrrole polyvinyl sulphonate films by cross-linking through glutaraldehyde. The optical studies show the linearity from 1-12 mM of lactate

Cholesterol biosensor:

Cholesterol oxidase, cholesterol esterase and peroxidase were co-immobilized onto modified cellulose matrix (supported onto a plastic mould) by physical adsorption at room temperature. Hydrogen peroxide is produced as a result of cholesterol dissolved in phosphate buffer oxidizes 4-amino phenazone (4-aminoantipyrine) in the presence of 2,4 dicholorophenol to 4-(p-benzoquinone) mono iminophenazone (dye). It has been found that the coloured product (dye) arises on the modified cellulose matrix as a result of capillary action and chromatographic effect. Attempts are presently being made to calibrate this cholesterol sensing system.

Urea biosensor:

Urease has been immobilized onto electro-chemically prepared polypyrrole-polyvinyl sulphonate films by physical adsorption and electro-chemical entrapment techniques, respectively. The activity of urease in this matrix has been estimated using Nessler's reagent. Fig. 5.3 shows lineweaver Burk plots obtained for free, adsorbed and entrapped urease. It is thus evident that immobilized enzymes still obey Michaelis Menten kinetics.

Langmuir Blodgett films of polyvinylcarbazole:

Pressure area isotherms of mono/multilayers formed onto air-water interface by dissolving polyvinylcarbazole in tetrahydrofuran have been obtained. Efforts are being made to immobilize enzyme (glucose oxidase) in the Langmuir Blodgett films of polyvinylcarbazole transferred onto the indium-tin-oxide glass plates.

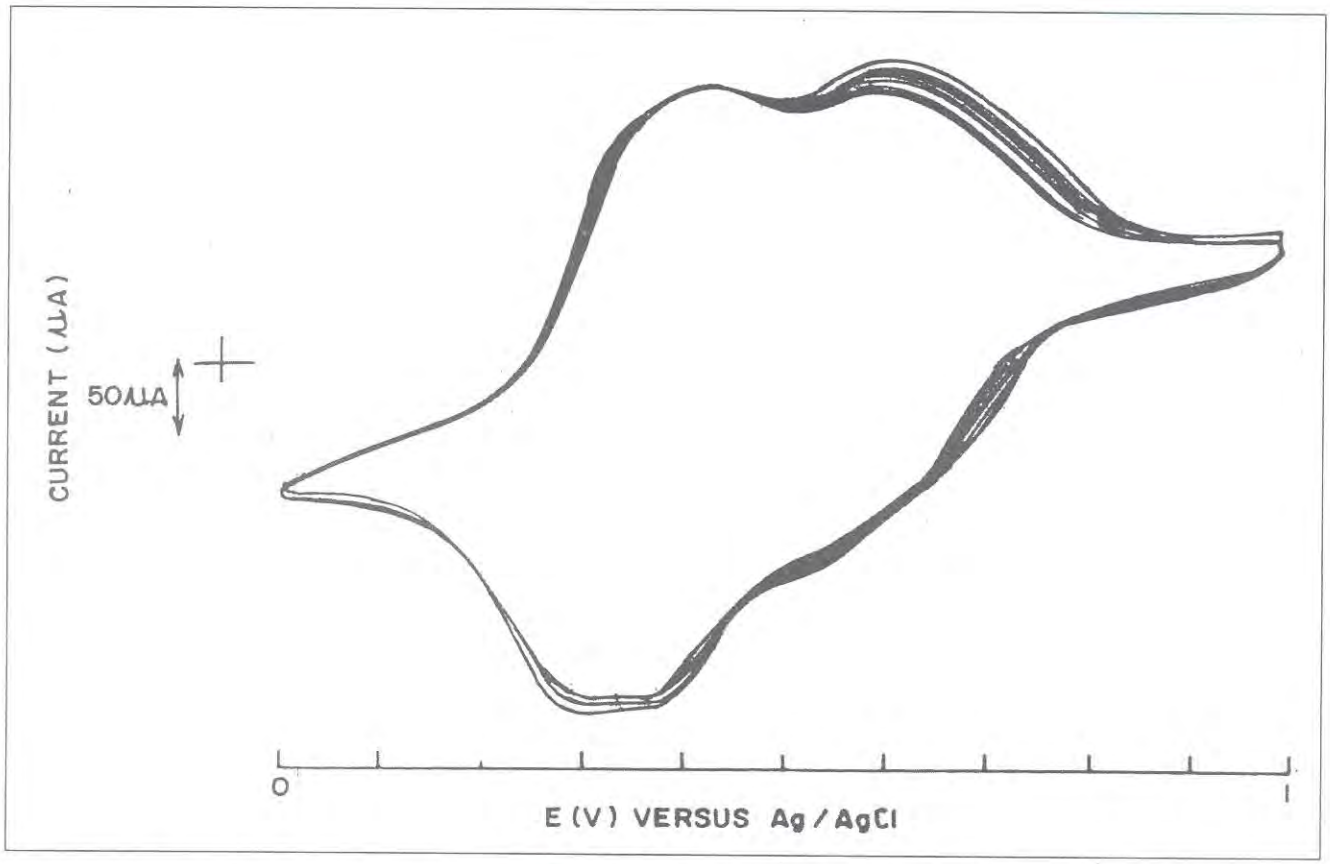


Fig. 5.4: Cyclic voltamogram of poly(2-fluoroaniline) in 4M perchloric acid at a scan rate of 50 mV/s

Fluorosubstituted polyaniline:

Poly (2-fluoroaniline) has been prepared by both chemical and electrochemical polymerization in acidic medium. Fig. 5.4 shows the cyclic voltamogram of poly(2-fluoroaniline) obtained in 4M perchloric acid at a scan rate of 50mV/S. The UV-visible and FTIR spectra suggest the presence of the bipolaronic species in poly (2-fluoroaniline) backbone responsible for its weak conductivity. SEM studies reveal globular morphology of chemically synthesized poly (2- fluoroaniline).

Technology transfer:

The know-how for the technology of manufacture of glucose biosensor was transferred to Transgenics, Ahmedabad. Mr Shirish Awasthi and Mr Ashith Shah of Transgeniks, Ahmedabad were given hands-on training for the manufacture of glucose biosensor on 13-14 October 1998.

Conducting Polymers-I

The polypyrrole family of polymers, prepared by electrochemical polymerization and chemical oxidation method, is receiving increasing attention for its various types of applications. At NPL conducting polymeric membranes have been developed for monitoring water borne viruses by using polypyrrole (PPY) and its copolymer; poly (N-methyl pyrrole-pyrrole) [P (NMPY-PY)]. The elimination of viruses from drinking water has become necessary because of the concern about the viral diseases. There are about 1,60,000 villages in India that do not have proper drinking water facilities. Extensive practical knowledge of the monitoring and treatment of bacterial contamination of water is available, but there is only limited experience with regard to viral contamination. Membranes developed at NPL have been tested for Polio I virus retention at the All India Institute of Medical Sciences, New Delhi. Encouraged by the success of these investigations, a patent

entitled "A process for the preparation of conducting polymeric membrane and a conducting polymeric membrane prepared thereby useful as a filter for capturing viruses from potable liquids" has been filed (Indian Patent Application No. 1302/DEL/98, dated May 15, 1998.)

The study of transport of charge carriers in polymeric materials is an enduring theme and several models have been proposed. The absence of well-defined valence and conduction band edges in the forbidden gap makes it possible to describe the conduction mechanism in these materials by the models developed for amorphous semiconductors. Earlier studies at NPL confirmed the validity of Mott's three dimensional variable range hopping (VRH) model in PPY family of polymers. The validity of Mott's VRH model in the samples of HCl-doped polyaniline (PAN) was also examined to correlate the dc conductivity data with their ac conductivity results. The dc and ac (100 Hz-1 MHz) conductivities of HCl-doped PAN were measured in the temperature range 77-300°K. At 77°K, the ac conductivity $\sigma(\omega)$ can be described by the relation $\sigma(\omega) = A\omega^s$, where the parameter s lies close to unity and decreases with the increase in the temperature and doping level. The ratio of measured ac to dc conductivity shows dispersion at 77°K which decreases with increase in the doping level. This decrease is found to be sharp at around pH~3.0. In the temperature range 77-150°K, the observed dc conductivity data can be described by Mott's three dimensional variable range hopping (VRH) model. Scanning electron microscopy studies reveal a sharp change in structural morphology of HCl-doped polyaniline at pH~3.0. A strikingly remarkable structural morphology has been observed in the form of a channel formation at this pH value. This change is accompanied by a rapid increase in dc conductivity, dielectric constant along with sharp changes in structural morphology, which indicates the existence of a doping induced structural conductivity correlation in this system (See Singh et al., J. Mater. Sci., 33, 2067-2072 (1998)).

Conducting Polymers II

Among conducting polymers polyaniline has received much attention because of its environmental stability and unique conduction mechanism. The processing and solubilization of conducting polymers are still the major unsolved problems from scientific and industrial point of view. To solve the unprocessible nature of these conducting polymers emphasis has been made to develop conducting polymer composites which should possess the mechanical properties of the conventional polymers and the conductivity exhibited by the conducting polymers. The interest in such materials derive from the low cost, light weight, mechanical durability and ease of processability of the thermoplastic polymer component in concert with reasonable good bulk conductivity exhibited by conducting polymer.

At NPL some specific conducting polymer composites have been developed by blending polyaniline doped with specific dopants with thermoplastics like polystyrene, PMMA, ABS which shows shielding effectiveness in the range of 20-60 dB at 101 GHz. We have also observed that these composites can be used for the dissipation of static charge and a static decay time of 0.01 sec has been observed on dissipating the charge from 5000 volts to 500 volts.

Thermo gravimetric analysis and isothermal studies of the conducting polyaniline doped with organic dopants was carried out in order to see the thermal stability of the polyaniline. Whereas the undoped form of the polyaniline – emeraldine base was stable upto 434°C, polyaniline doped with p-toluene sulphonate was found stable upto 234°C. The thermal stability of polyaniline doped with HQSA, HQSA:PTSA and DBSA was found stable upto 270-280°C and this was the reason for selecting this polymer for blending with thermoplastics. Isothermal studies of polyaniline doped with organic dopant showed that on keeping the polymer at 200°C for 30 minutes, there is a 4.7 % weight loss and 7.8 % weight loss on keeping the polymer at 250°C for 30 minutes.

Development of Polymeric Devices

Polymeric sensors for environmental monitoring:

Fast response polymer based sensing devices have been fabricated from semiconducting polymers which exhibit excellent sensitivity towards toxic gases and microbiological species normally encountered in daily life including pathological and non pathological microbiological species in environment, medical sciences and food processing. The polymeric sensors have shown excellent sensitivity towards micro - organisms like Escherichia Coli, Pseudomanas Salmonella, Staphylococcus Aureus and Rhizobiaceae, Fungus and Yeast. The sensors have also been fabricated for detection of traces of CO in mines, ammonia, Hydrochloric acid and Hydrogen Cyanide. The sensitivity depends upon the concentration of the microorganisms present in the environment. The specificity and selectivity of the sensors has been achieved by suitably doping the polymer during preparation of the sensor. The behavioral acceptance test like, sensitivity, specificity, response, decay and recovery time, reliability and reproducibility of the sensors are found to be reasonable. These sensors have the advantages of being highly sensitive, have fast enough response, allow room temperature operation, technology involved is simple and may become cost effective when the process is fully stabilized. These sensors can be used for on line monitoring and can be positioned remotely at hazardous locations, to provide an audio - video alarm. These sensors find applications in detection of toxic gases and vapors in environment, for monitoring hazardous gases in atmosphere, semiconductor and other industry, mines, food processing industry and monitoring of microbiological activity in medical sciences and related areas. The sensitivity characteristics of these polymeric sensors for staphylococcus aureas microorganisms for different types of dopants used in the fabrication of these sensors are shown in Fig. 5.5. Sensor arrays, with various types of dopants, were also prepared (Fig. 5.6).

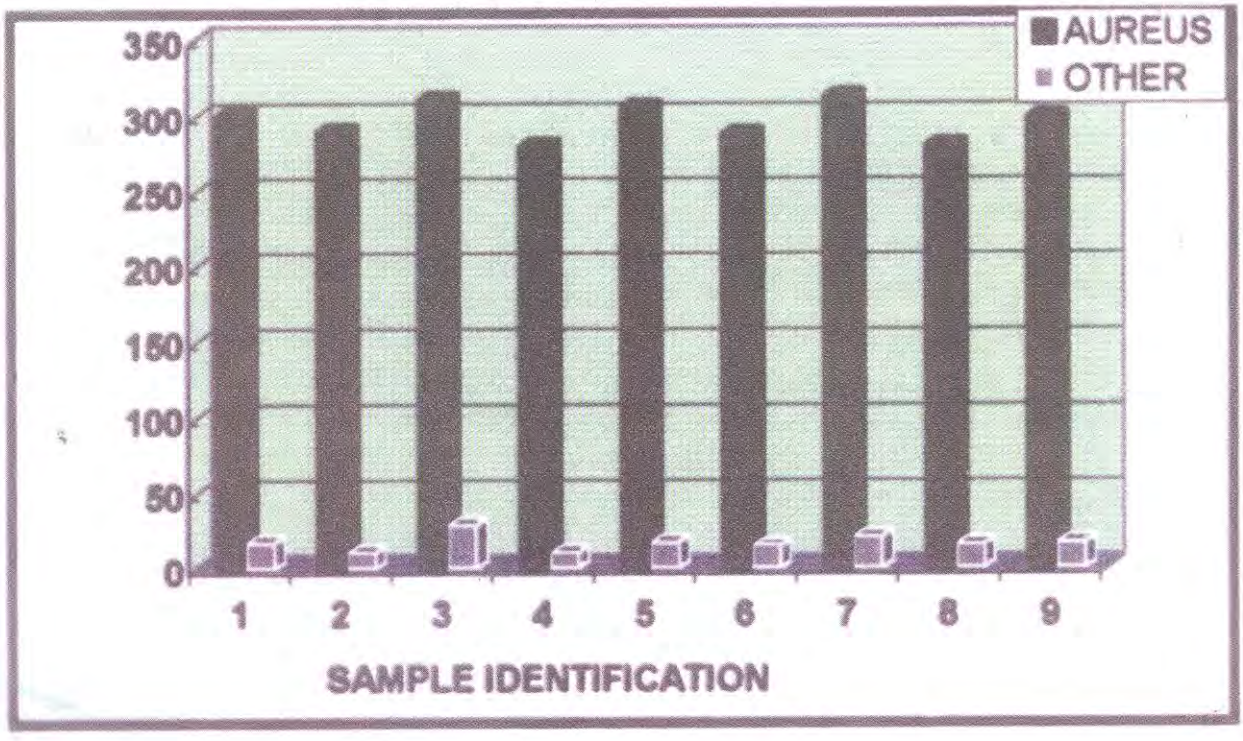


Fig. 5.5: Sensitivity of polymeric thin film sensors for Staphylococcus Aureas

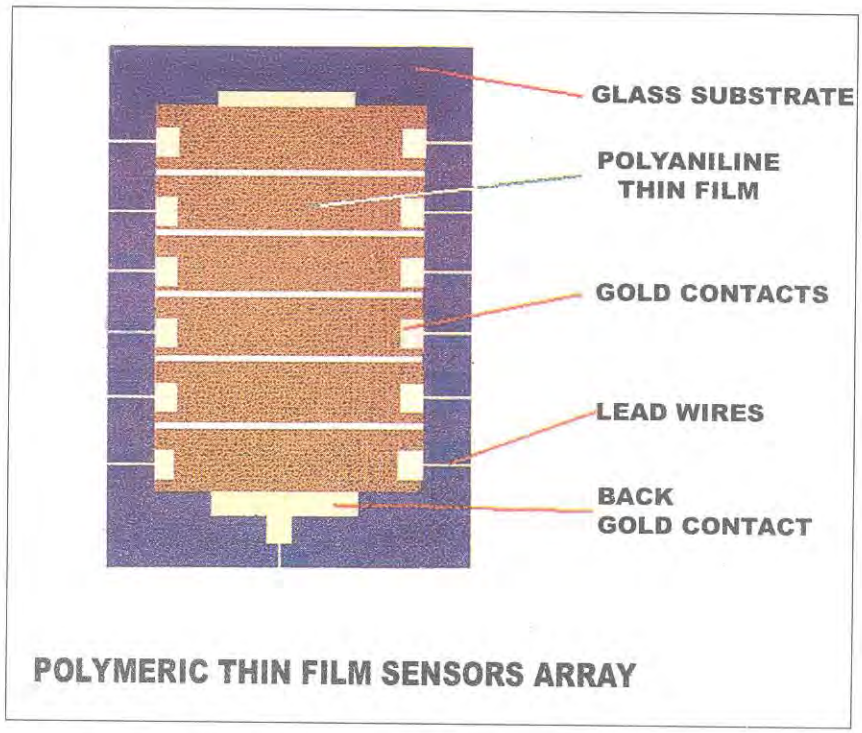


Fig. 5.6: Sensor arrays doped with various types of dopants prepared at NPL

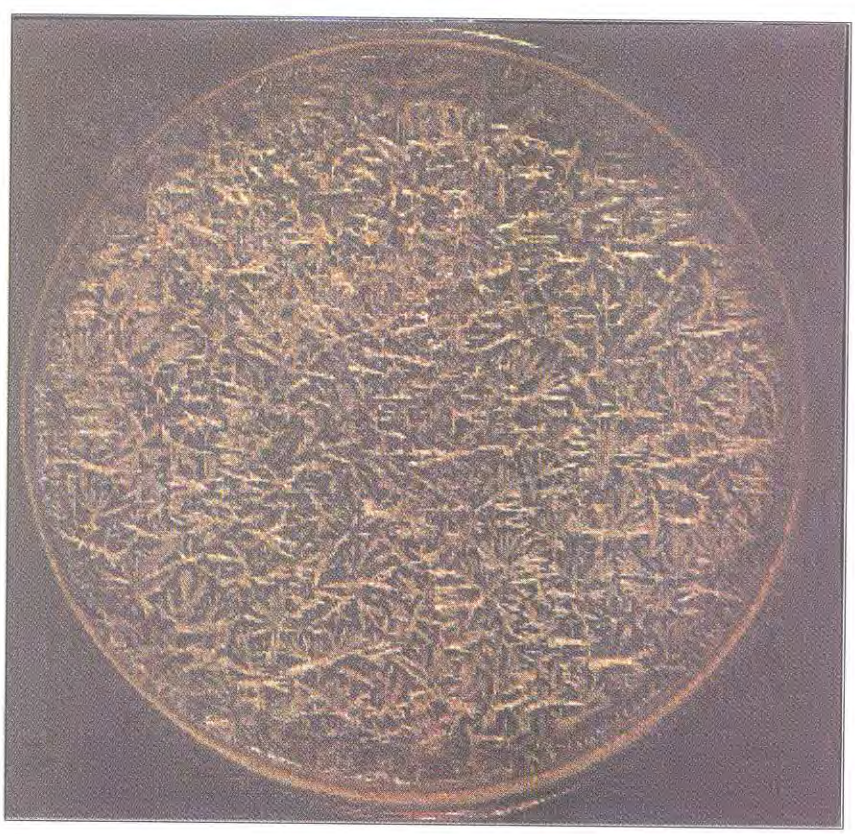


Fig. 5.7: Aminobenzophenone solution grown thin films prepared at NPL

Non linear electro-optic devices:

Collaborative R&D work has been taken up on the development of polymeric electro -optic devices under UISTRF, in collaboration with the University of Strathclyde UK. Under the programme, aminobenzophenonelin films were grown by solution growth and various other techniques and their non-linear electro-optic behaviour was studied (Fig. 5.7 and 5.8).

Polymeric thin film optical waveguides:

Optical Waveguides involving thin films of various polymers, like polyacrylate and polycarbonate etc., were prepared and their optical signal delivery performance characteristics were studied

Electrochromic Devices

Transmissive electrochromic devices (ECDs) promise actively controlled continuously tunable transmission for window applications with significant energy saving. The WO_3 electrode is ubiquitous in ECDs and is a common choice as the electrochromic (EC) electrode. Earlier work under DST sponsored project on development Of WO_3 based EC films by sol-gel technique was advanced further with the aims,

- to improve the stability of the precursor materials and their solutions preferably in alcohol to deposit films,
- To achieve large area uniform WO_3 films with EC efficiency and charge capacity adequate enough for their possible application in windows.

To achieve the above two objectives, a number of strategies were planned and executed. A modified ion-exchange route yielded a precursor with unusually enhanced stability. A special feature of this process is the use of indigenously available low cost materials. The precursors derived from the peroxo route were

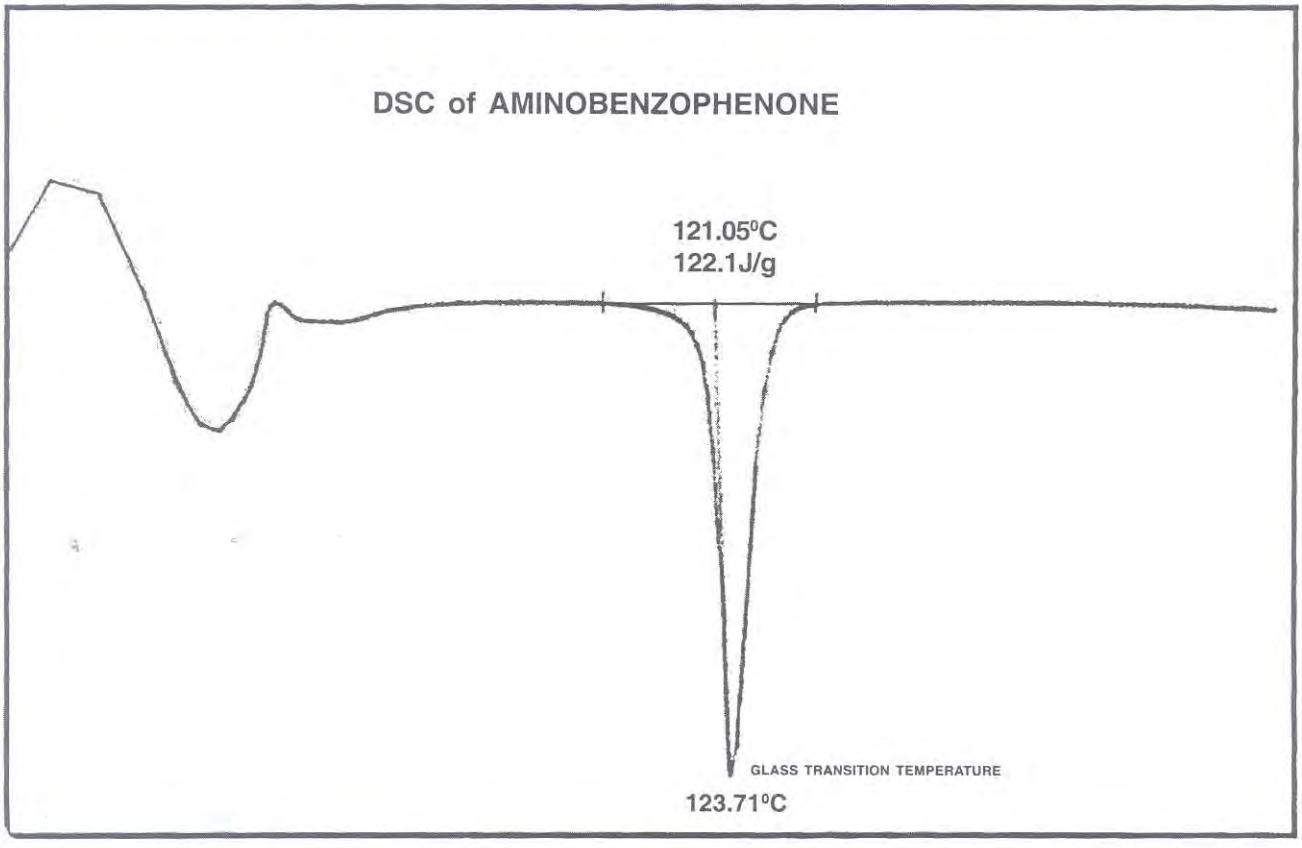


Fig. 5.8: Differential scanning calorimetry of aminobenzophenone thin films grown at NPL

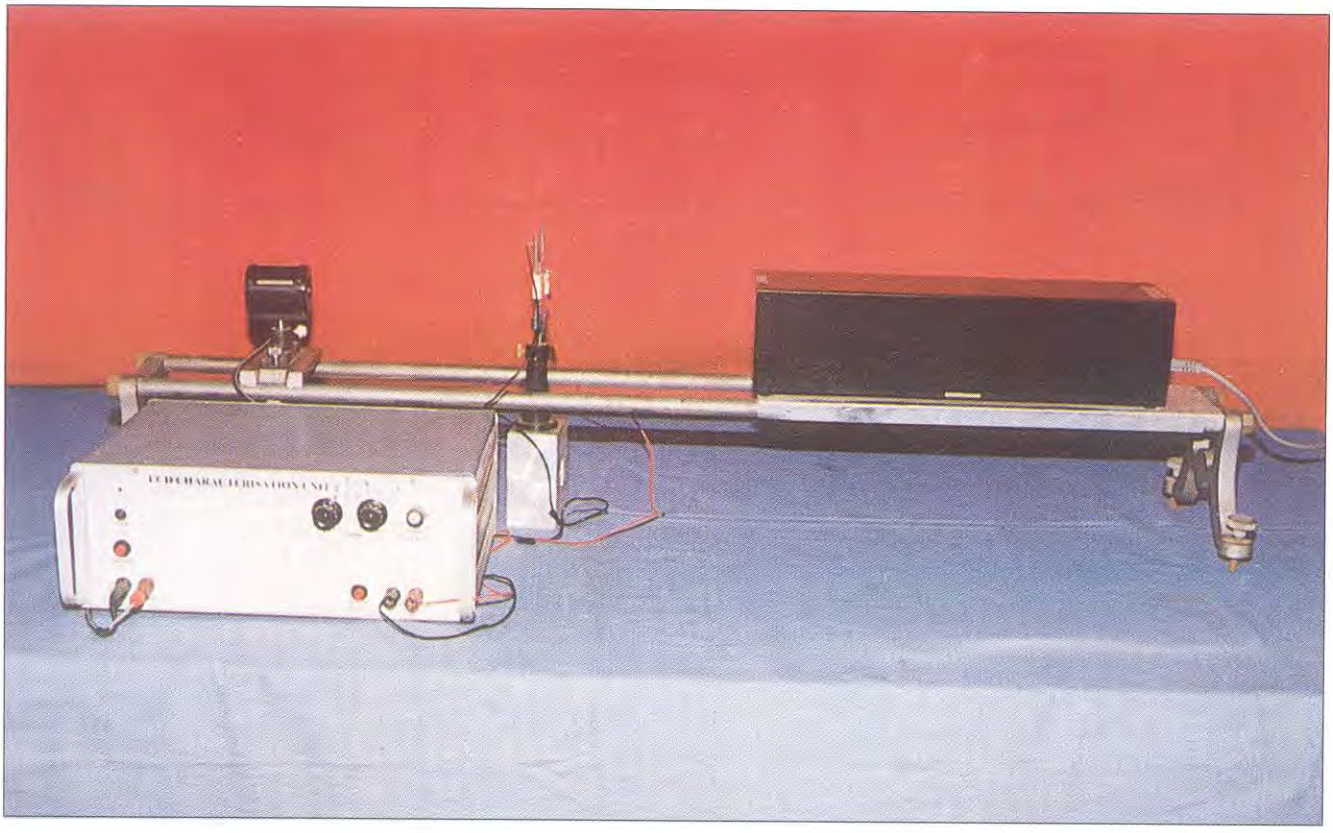


Fig. 5.9: ECD characterization unit at NPL

modified with different organic additives. Oxalic acid, in optimum amount as a chemical additive was found to show the fastest bleaching action.

A computer-controlled set up, consisting of a He-Ne laser source and a photodetector, together with a custom made microprocessor controlled versatile ECD characterization unit (Fig. 5.9) were used to assess the EC performance of the electrodes, electrolytes as also the ECDs fabricated using them. Parameters like colouration/bleaching times, the amount of charge inserted/extracted; operational lifetime and profiles of optical transmission and current, with respect to time can be determined with this set-up. Fig. 5.10 shows a typical such profile for our WO_3 film with Ta as the counter electrode and a gel polymeric electrolyte under the action of a square wave potential of ~1 volt.

A detailed characterization study of films, grown by the other techniques simultaneously, was undertaken to firmly establish the advantages that accrue following the ion-exchange route.

Under the combined in-house project for development of "All Gel ECDs" and a Visiting Associateship Scheme of CSIR, preliminary work on the other two components, namely, the counter electrode and the polymeric gel electrolyte for transmissive ECDs, was initiated. Highly transparent gel electrolytes based on PMMA prepared in a few single & binary mixtures of plasticizing solvents like Propylene Carbonate (PC), Ethylene Carbonate (EC) and γ-Butyrolactone were made. These systems exhibited maximum room temperature conductivity of about 10^{-2} Scm^{-1} best suited for ECD application.

Following the peroxo route (used extensively for fabricating WO_3 electrodes) precursor material for depositing SnO_2: MO films were prepared and the films deposited by the spinning technique were variously characterised and assessed for their

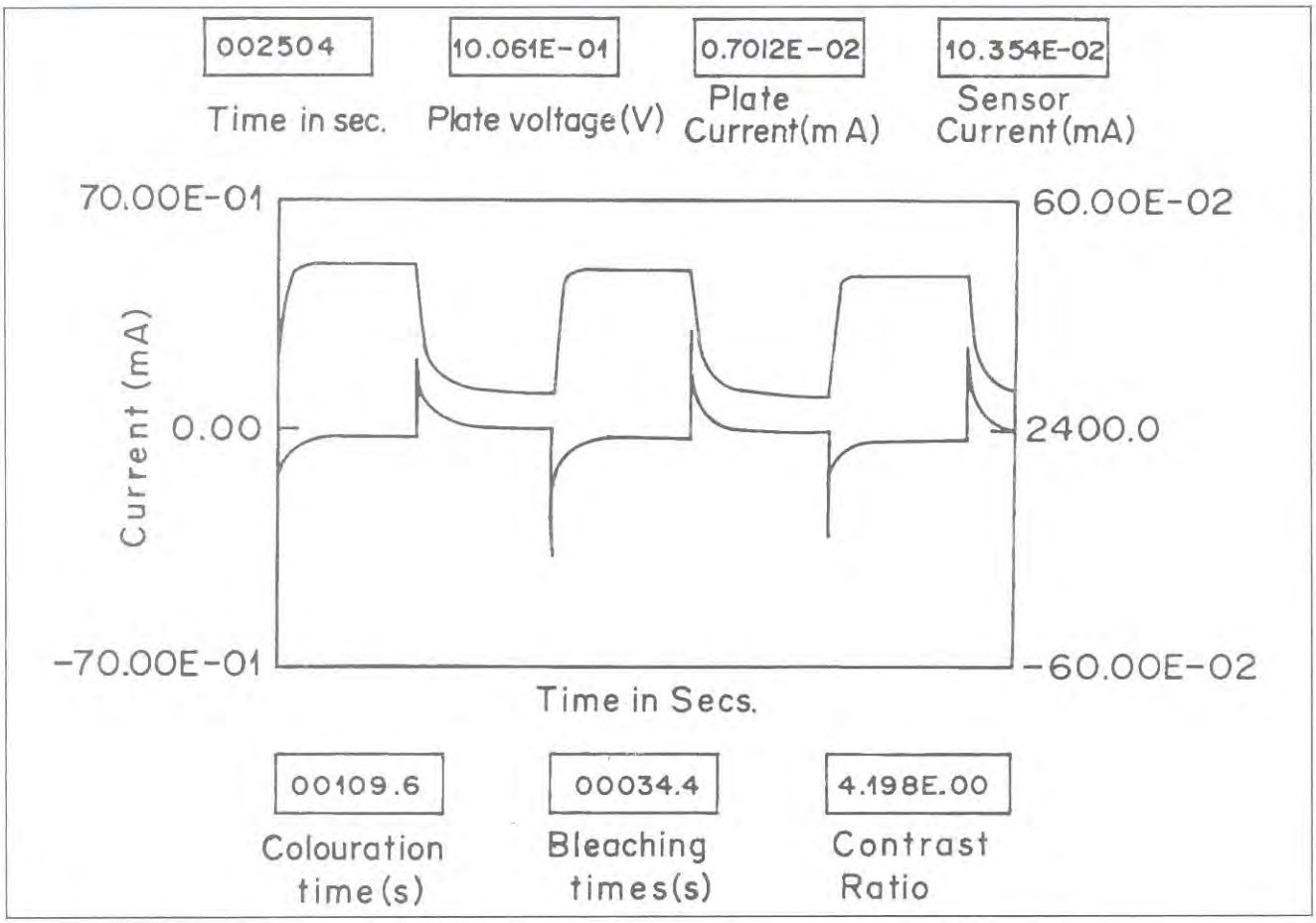


Fig. 5.10: Profiles of transmission and current with time for WO_3 - EC thin film

use as neutral passive counter electrodes for transmissive ECDs.

Xeroradiography

R&D for enhancing X-ray sensitivity of xeroradiography:

With a view to develop photoreceptors with enhanced X-ray sensitivity for xeroradiography applications, a variety of polymer/selenium combinations were investigated and detailed study of dopant incorporation carried out. This comprehensive study gave a depth of understanding of the basic processes that control X-ray sensitivity of such materials and allowed to tailor the material to yield highest x-ray sensitivity reported so far (21 eV per pair of electron-hole generation energy in chemically modified Selenium, as compared to 30eV per pair lowest value previously reported. (J.Phys.D: Appl.Phys. 31,1049,1998.)

Development of a portable X-ray xerography unit:

The development work relating to a portable X-ray xerography unit, meeting the various requirements for bio-material applications such as in medical, veterinary and forensic fields for bio-material applications such as in medical, veterinary and forensic fields was perused. This unit has been designed to work at places where dark room facilities for film processing are not available. The components developed for achieving this objective include, image development triboelectric chamber, image development electrodes, venturi generaor for image development, image fixing trays etc. The entire system has been designed based on a new concept of increasing the toner cloud capacity and uniform flow, etc. This allows one to achieve large area uniformity and better contrast and resolution of the images that are obtained on a paper.

पदार्थ अभिलक्षणन

MATERIAL CHARACTERIZATION

इस प्रयोगशाला में क्रिस्टल के दोषों की संरचना और शुद्धता का निर्धारण करने, प्रतिचरण विश्लेषण करने और उनकी विशेषताएं बताने से सम्बन्धित व्यापक सुविधाएं मौजूद हैं। यह प्रयोगशाला ये सुविधाएं देश के अन्दर और देश के बाहर के प्रयोक्ताओं को प्रदान करती है। अनुसंधान और विकास कार्य वायुविलयों (एरोसोल्स), अम्ल वर्षा (acid rain) और ग्रीनहाउस गैसों, चालक बहुलक और कांच, संयुक्त अर्धचालक उच्च T_c अतिचालक, फेरो तरल बहुलक संघटन परतों, InSb तथा AlSb परतों, कुण्डलित झिल्ली संवेदकों और बी जी ओ क्रिस्टल्स पर किया जा रहा है।

एक पाउडर एक्स-रे विवर्तनमापी और एक एक्स-रे विवर्तन स्थलाकृति (टोपोग्राफी) सिस्टम विकसित किया गया है। उच्च गुणवत्ता वाले बी जी ओ क्रिस्टलों (BGO Crystals) का निर्माण किया गया है। दो नए भारतीय निर्देशक द्रव्य (प्रमाणित सन्दर्भ-द्रव्य) तैयार किए गए। अन्तर्राष्ट्रीय अंतर्तुलनात्मक आयोजनों में भागीदारी और प्रवीणता परीक्षण का कार्य आगे किया गया। जर्मन, रूस और संयुक्त राज्य अमेरिका के संस्थानों द्वारा प्रायोजित अनुसंधान और परियोजनाओं पर कार्य भी आगे किया गया।

एक सम्पादित पुस्तक और सत्रह शोध पत्रों का प्रकाशन किया गया। एक पेटेन्ट प्रस्तुत किया गया तथा चौदह आमन्त्रित व्याख्यान दिए गए। एक अन्तर्राष्ट्रीय सम्मेलन का आयोजन किया गया। डा. कृष्ण लाल को रूसी विज्ञान अकादमी द्वारा डी एस सी (एच सी) उपाधि प्रदान की गयी।

The laboratory is equipped with elaborate facilities for determination of composition and purity, phase analysis, and characterization of crystal defects. These are being provided to internal as well as outside users. R&D work has been carried on: aerosols, acid rain and greenhouse gases; conducting polymers and glasses; compound semiconductors; high Tc superconductors; ferro fluid–polymer composite films; InSb and AlSb films; coiled membrane sensors; and BGO crystals.

A powder X-ray diffractometer and an X-ray diffraction topography system have been developed. High quality BGO crystals have been grown. Two new Bharatiya Nirdeshak Dravyas (Certified Reference Materials) were prepared. Participation in international inter-comparisons and proficiency testing was continued. Sponsored research and projects with German, Russian, and US institutes was pursued.

An edited volume and 17 research papers were published, 1 patent was filed and 14 invited talks were delivered. An international conference was organized. Dr. Krishan Lal was conferred D. Sc. (h.c.) by Russian Academy of Sciences.

Advanced materials are building blocks of technologies, which are at the forefront in advancing human civilization. One important measure of the development of a society or a nation is the variety and the quantity of materials being produced and used by it. Materials for advanced applications as well as for fundamental research need to be thoroughly characterized. Characterization of materials covers determination of their elemental composition, estimation of trace impurities, identification of crystallographic phase/s and information about crystal defects in solid materials. Materials can be in any of the states of the matter, namely gaseous phase, liquid phase, or solid phase. In the case of solids one may be concerned with their surfaces or with the bulk of the material. The question of dimensions has become quite important as materials with nano dimensions are of considerable topical interest. While characterizing thin films one has also to be concerned with their interfaces with substrates. NPL has a wide range of facilities for characterization of materials regarding all aspects. The major facilities include chemical and spectrochemical instrumental methods, EPR spectroscopy, and X-ray fluorescence spectrometry and energy dispersive X-ray fluorescence spectrometry for determination of major and minor constituents of a material. X-ray diffraction as well as electron microscopy/diffraction are employed for the structural characterization of bulk and thin film materials. For evaluation of perfection of single crystals and characterization of defects in the same, high resolution X-ray diffraction techniques are employed. Multi-crystal X-ray diffractometers have been developed indigenously with state-of-the-art level resolution. These include a five crystal X-ray diffractometer. These facilities are being used by different groups of the laboratory working on various types of materials. Outside organizations are provided the testing services on payment basis. Progress made during the year is described in the following.

Crystal Growth and Characterization

Structural characterization of GaAs coiled membrane for force sensor applications, produced by micromachining:

A versatile five crystal X-ray diffractometer developed at NPL particularly for high resolution X-ray diffraction studies of bulk crystals, thin epitaxial films and devices has been employed in the present studies.

High-resolution X-ray diffraction studies of micromachined GaAs coiled membranes for force sensor applications were continued. In this period, the study was focused on the morphology of the cavity formed by selective etching of the highly damaged region of N^+-implanted n-GaAs crystal. A highly monochromated and collimated Mo Ka_1 beam was used as the exploring beam. Diffraction experiments were performed with (400) diffracting planes in symmetrical Bragg geometry in (+,-,+) configuration of the diffractometer (Fig. 6.1). Observed contrast and morphology in these topographs were analyzed in terms of diffracted X-ray intensity from the bottom and the sides of the cavity, as well as the diffracted X-ray intensity from small volume of the membranes. The observed images of sensor segments in topographs confirmed that there were large tilts between different segments and at a time images of only one or at the most two segments with small tilt angles could be observed. Topographs recorded with (400) diffracting planes in symmetrical Bragg geometry directly revealed morphology of the cavity produced by etching. It was found that walls created by etching were not vertical but tapered, with angle of taper being in the range: $50^0 - 60^0$. This has been attributed to anisotropic etching of (111) and (100) diffracting planes. There was significant under-etching and tin strip of the wafer found to be

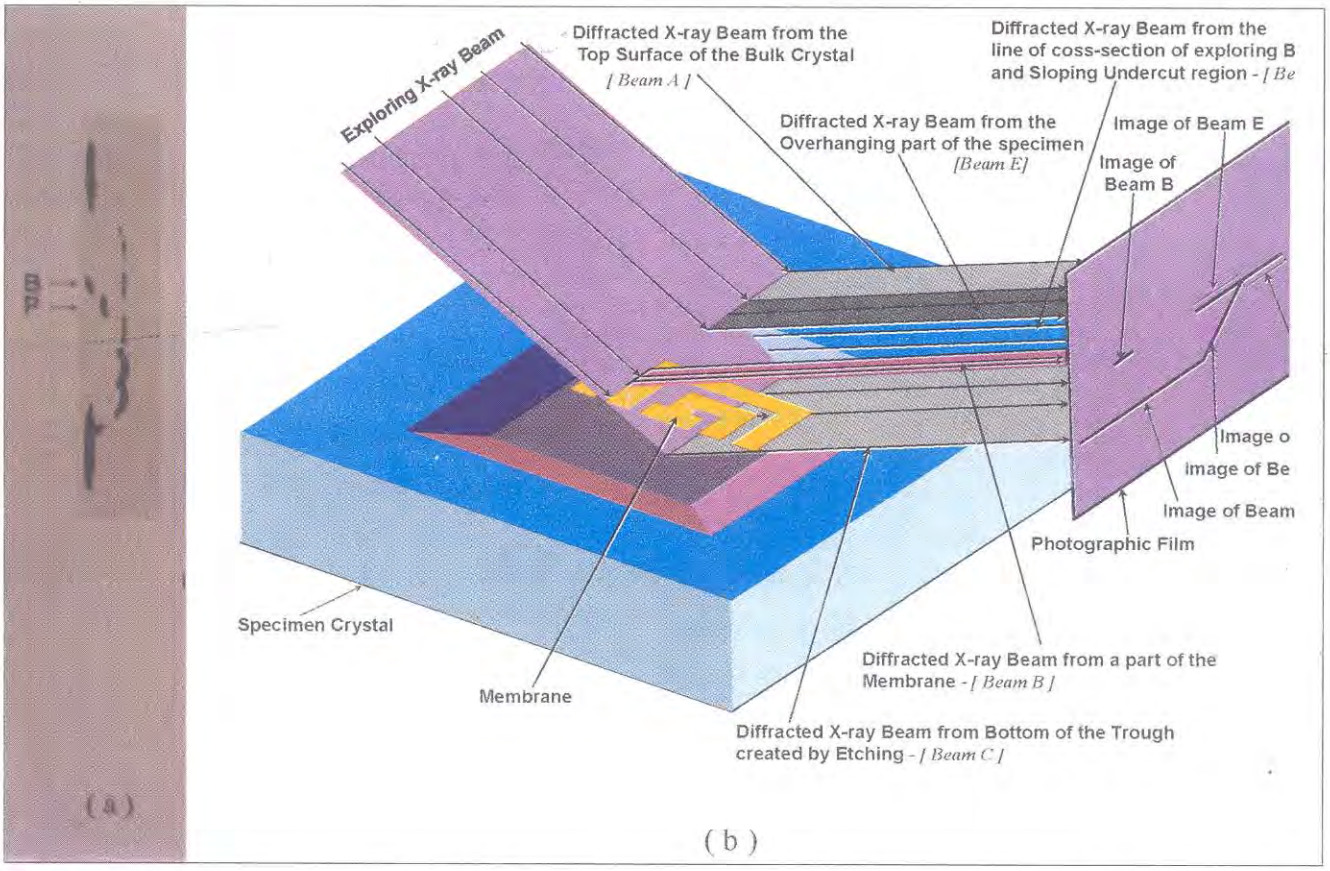


Fig.6.1: (a) A high resolution X-ray diffraction section of a free standing GaAs coiled membrane for force sensor application produced by micromachining and recorded with (4 0 0) diffracting lattice planes and MoKα_1 radiation in (+, -, +) configuration of a five crystal X-ray diffractometer and (b) a pictorial representation of the origin of the observed diffraction image in section topograph

freely hanging over the cavity along its boundary. The bottom of the cavity was found to be uneven and topographs revealed its morphology. It was possible to determine average depth of the cavity as 90 ± 4 mm. Such details about the cavity could be directly observed due to penetrating nature of X-rays. Other techniques like scanning electron microscopy could not provide this information. Further, processing steps were found to introduce bending of substrates. The radii of curvature were determined experimentally. In a typical case it was found to be only 3.4m. This study shows that X-ray diffraction techniques can be successfully employed for determining structural perfection of membranes. Further, one can obtain a good idea about long-term stability and reliability of free hanging membranes for force sensor applications by using these non-destructive methods.

Growth of large size single crystals of Bismuth Germanate (BGO) by automatic weight control process:

Single crystals of large size bismuth germanate (BGO) were grown by Automatic Weight Control process in a Russian crystal growth system. The diameters of these crystals were ~50 mm and these were ~ 75 mm long. Low thermal gradient Czochralski technique was employed (Fig. 6.2). These crystals were cut, lapped and polished to prepare suitable specimen for charaterization of X-ray diffractometry, topography diffuse scattering (DXS) measurements etc. The central regions of the crystals were found to be dislocation free. Very low angle boundaries were observed on the peripherals. Please see Fig. 6.3.

Fig. 6.2: A nearly perfect single crystal of bismuth germanate grown at NPL using the low thermal gradient Czochralski method

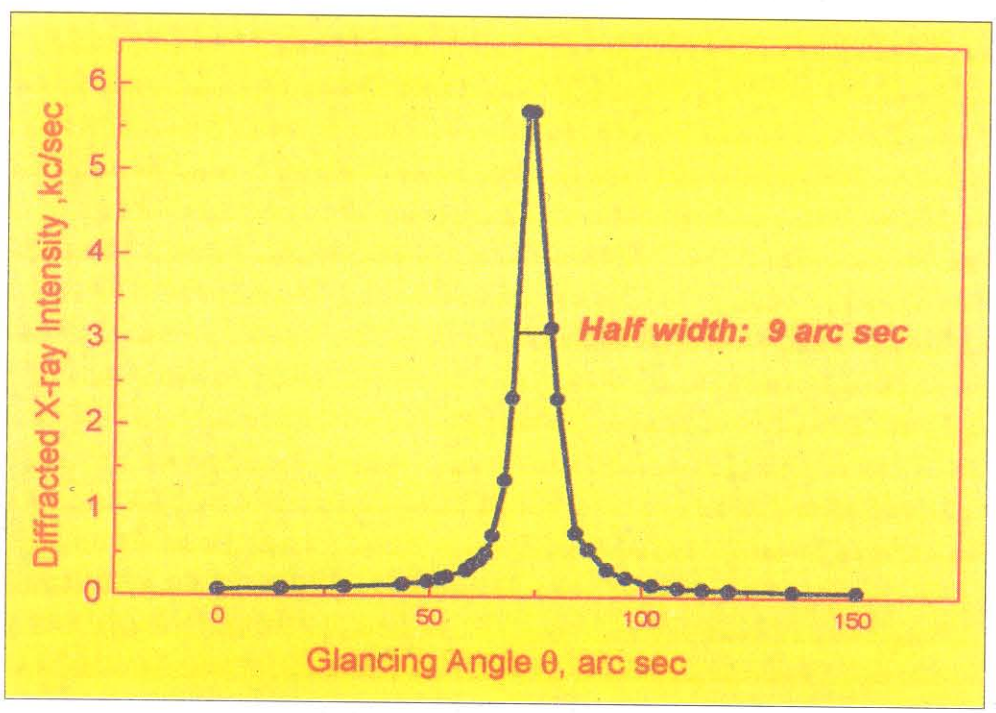


Fig. 6.3: A high resolution X-ray diffraction curve of (100) bismuth germanate crystal X-ray diffractometer for (400) diffracting planes in (+, -) geometry with Mo $K\alpha_1$ radiation. The small half width of the diffraction curve is a good measure of the perfection of the crystal.

Diffuse X-ray scattering study of point defect clusters in colourless and coloured (yellow tinge) BGO single crystals:

High resolution diffuse X-ray scattering (DXS) measurements have been made to characterize point defects and their clusters in bismuth germanate (BGO) crystals grown by low thermal gradient (LTG) Czochralski method. BGO crystals have been grown along different growth directions and with raw materials of varying degree of perfection. Variations in growth conditions have been introduced for any given growth direction. The crystals are generally colourles (type A). However, some crystals exhibit yellow tinge (type B). High-resolution X-ray diffractometry and DXS measurements have been employed to reveal structural differences between type A and type B crystals. A multicrystal X-ray diffractometer employing a well collimated and highly monochromated MoKα$_1$ beam set in (+,-,-,+) configaration has been used. It was found that all these crystals are free from grain boundaries and dislocations. The diffraction curves of all the samples are quite narrow having half widths (~ 10 arc sec) close to the theoretically expected values (2.23 arc sec for 444 RLP, 3.40 arc sec for 224 RLP and 3.50 arc sec for 400 RLP). DXS measurements could be made very close to the reciprocal lattice point (RLP) and at small incremental increases in the magnitude of the scattering vector. The distribution of DXS intensity showed that the point defects were predominantly agglomerated into clusters. Experimental data of DXS intensity has been analyzed by using a phenomenological model for small concentration of dislocation loops wherein the point defects are loosely clustered with weak interactions among them. From this analysis, the cluster radius R_{cl}, cluster volume A_{cl}, the number of point defects within a cluster N_{cl} and the relative concentration of the point defect clusters among the samples have been determined. Typical values of defect parameters were: $R_{cl} = 0.76$ mm, $A_{cl} = 8.75 \times 10^{-17}$ cm^3 and $N_{cl} = 3.03 \times 10^4$. From these results, it has been found that the cluster sizes do not show significant variation from sample to sample. However, there are remarkable changes in the concentration of clusters. An investigation of the specimens belonging to the same boule had shown that concentration of defect clusters is approximately double in the coloured region in comparison to that found for colourless region. The cluster sizes were approximately the same. The tinge may be due to Mie scattering.

Development of sophisticated equipments:

Development of Powder X-ray Diffractometer (sponsored project by DST) had been continued. Automation of powder X-ray diffractometer which involves simultaneous movement of θ /2 θ of the goniometer, X-ray intensity data acquisition, data analysis, display of X-ray diffraction pattern and Table of results was done with the help of M/s Vinytics Peripherals Pvt. Ltd., Delhi. After several trials the hardware and software were developed and incorporated with the system. The data acquisition was done with the help of a EIA interface card. The complete system is now under testing with different powder samples. A radiation shield enclosure was designed and fabricated using 12mm thick glass on all sides and 6mm-glass plate on the top. A special aluminium channel was used for making the frame. The fabrication of parts of three more diffractometers is under progress.

Indian Reference Materials

Work on preparation, certification and dissemination of Bharatiya Nirdeshak Dravyas (BNDs) i.e. Certified Reference Materials was continued. By the use of certified reference materials precise and accurate measurement data traceable to national measurement system can be generated. The measurement data generated with the use of certified reference material is acceptable at national and international level. Its usage enhances the quality of industrial products also. During the year following two BNDs had been certified:

Certified Reference Materials of multi-element solution in high purity water (BND 1101):

Multi-element standard solutions are required for calibration analytical equipment i.e. atomic absorption

spectrometer, ICP-emission spectrometers, ICP-mass spectrometers, UV-visible spectrometers and validation of analytical methods. Sixteen national laboratories including Indian Oil Corporation R&D Centre and National Thermal Power Corporation R&D Centre are participating in this programme. Ten litre stock solution of multi-element standard containing zinc, iron and copper solution was prepared and distributed to the participating laboratories for round-robin test. The values of concentration of zinc, iron and copper in water had been certified after statistical analysis of the measurement data carried out at sixteen participating laboratories every fortnight in six months time. Following values had been assigned to this Certified reference material:

Zinc	concentration	100.17 ± 0.58 mg/l (ppm)
Iron	concentration	100.56 ± 0.54 mg/l (ppm)
Copper	concentration	100.01 ± 0.52 mg/l (ppm)

Certified Reference Materials - Silicon powder for X-ray diffraction (BND 1501):

Silicon powder for X-ray diffraction will be used as a calibration standard for X-ray powder diffraction equipment. Six national laboratories had been participating in the programme of preparation and dissemination of certified reference materials of silicon powder for X-ray diffraction. Poly-silicon powder in the particle range of 5-15mm with high level of crystallinity had been prepared and distributed to the participating laboratories for measurement of d-spacing at first five reflections at 23°C. The certified values of first five reflections are given below:

Hkl	d (A°)	σ_d
111	3.1340	0.0073
220	1.9194	0.0029
311	1.6371	0.0022
400	1.3576	0.0014
331	1.2459	0.0011

These two new Certified Reference Materials were released by Prof. V. S. Ramamurthy, Secretary, Department of Science and Technology, on September 15th 1998. The users of Multi-element certified reference materials are State Pollution Control Boards, State Public Health Laboratories, R&D laboratories of private and public sectors and industries. Certified reference material of silicon powder for X-ray diffraction will be used at academic institutes, industries and R&D laboratories of private and public sectors.

This project directly helps in quality assurance of analytical data and products with wider acceptability at national and international level.

Solutions of three new BNDs i.e. zinc, iron and copper in nominal concentration of 1 mg/l and also solutions of earlier batches i.e. lead, cadmium, chromium and arsenic had been prepared. These had been distributed to the participating laboratories for round-robin tests.

International Inter-comparison:

NPL has participated in international water proficiency testing programme organized by National Association of Testing Authorities (NATA), Australia. Four water samples were tested for fluoride, chloride and bromide contents. 166 laboratories from 14 countries had participated in this programme. All the measurements were found to be within the acceptable limits.

X-ray Analysis

X-ray diffraction and fluorescence studies were carried out on about 170 samples of materials including high Tc superconductors with different dopants, carbon composites & powders, boron nitride, InSb, AlSb, peroxo-tungstic acid powder & films, WO_3, CdS/CdTe films, lead magnesium niobate, SiC, bismuth germenate, $KNbO_3$, gall bladder and kidney stones, synthetic diamonds etc. Assistance was provided to M/s Polyplex Corporation Ltd., New Delhi; M/s Modi Xerox, Rampur; M/s Dabur Research Foundation, Sahibabad; M/s Das Paper Enterprises, Calcutta regarding the X-ray analysis of their materials.

The quaternary semiconducting compound CuInSeTe is a technologically important material in view of its potential for optoelectronic device applications. The research work was further continued on this compound which crystallizes in the chalcopyrite structure having space group I42D with Z=4. Complete X-ray powder diffraction data has been established with a = 5.987(1) A°, c = 11.979(4) A°, D_x = 5.96 g/cc and figure of merit F_{30} = 17(0.028, 63). Atomic positions of Cu, In, Se and Te atoms in the unit cell consistent with the space group are proposed. GaTe was synthesized by quenching and annealing techniques. The fine powder was annealed in a sealed and evacuated quartz ampule at 300°C for about 1200 hrs. No XRD peak was recorded beyond $\sin\theta/\lambda$ = 0.531. It crystallizes in the hexagonal cell. It is very interesting to note that if annealing is done for over 2000 hrs at this temperature the entire powder pattern changed into new Te like structure with well resolved lines.

Powder X-ray diffraction studies were carried out on doped high Tc materials $ErBa_2Cu_{3-x}M_xO_{7-y}$ where M = Fe, Co, Ni and Ga with 0£x£0.06. The X-ray analysis indicates that there is a reduction in the orthorhombic distortion in the lattice with progressive doping of Fe, Co and Ga with respect to pure Er123 sample while there is no change in the orthorhombic distortion with Ni doping. Similarly, XRD studies were carried out on $Y_{1-x}Ca_xBa_2Cu_3O_{7-y}$ and $Sm_{1-x}Ca_xBa_2Cu_3O_{7-y}$ with 0£x£0.5. It was revealed that Y(Ca) crystallizes in the orthorhombic structure for all values of x whereas Sm(Ca) showed an orthorhombic structure for x< 0.1 and transforms to tetragonal structure for x> 0.1.

The effect of Mn-Zn-Gd ferrofluid-polymer composite film on high Tc superconducting material Bi(2223) was studied. Two sets of ferrofluid polymer composite films were prepared, films deposited on high Tc pellet under the influence of and without magnetic field and homogeneous mixture of ultrafine high Tc particles and ferrofluid polymer used to grow on glass substrate under the influence of and without magnetic field. The applied magnetic field was of the order of 500 gauss and normal to the substrate. These films were characterised by XRD, SEM and VSM techniques. The study reveals that by polymerization technique the stabilized crystallographic phase of high Tc material is retained. The uniform size agglomerate distributions are formed due to supermagnetic behaviour of the particles under the influence of magnetic field. These type of films may have some applications in superconducting devices such as switches, sensors etc.

The uncertainty of measurement in quantitative XRF analysis by the scattered radiation method was evaluated following internationally accepted guidelines. There are only a few case studies available in literature. The standard uncertainty is calculated for each of the quantities on which the concentration of the analyte is considered to depend upon. Estimation of the minor concentration of iron in a silicon powder specimen was considered as an illustration for calculation. The concentration of iron in the silicon powder was estimated as 0.34 ± 0.05%. Similar calculations were also undertaken for an estimation of manganese in steel by spectrophotometric method.

Apart from above, the gall bladder and kidney stones had also been characterized by XRD/XRF techniques. It was observed that predominantly cholesterol is present in gall bladder while calcium oxalate monohydrate is present in renal calculi stones. The major elements found in these stones are Ca, P, Mn, Cu, Si and Al.

In the area of Indian Reference Material program, a silicon powder standard reference material (BND 1501) was prepared for use as a d-spacing standard for X-ray powder diffraction experiments.

Analytical Chemistry

A number of different types of samples received from different organizations (industries, institutes) and also from other Divisions of NPL were analyzed for their constituents by chemical methods which include both classical and instrumental. This year a number of poly

aluminiumchloride samples received in batches from Delhi Jal Board were analyzed for their aluminium content. These are important chemicals for water purification.

The samples of Indelible ink received regularly from Election Commission were analyzed for election purposes. Samples received from Crime Branch, Govt. of India in the form of cylinders, caps, rivets etc. (materials mainly steel) collected by Delhi Police during bomb blasts in different areas of Delhi were analysed for their important constituents, like Si, S, P and Mn, to help them in connection with their investigations.

Uncertainty of measurements in chemical analysis of elements by spectrophotometry has been worked out as per ISO guidelines. A case study for Mn analysis in steel has been carried out as an example of uncertainty measurement estimate.

In the area of Indian Reference Materials programme, 2nd batch of Cr, Zn and As of 1-2ppm concentration prepared by IRM section was evaluated from time to time by flame AAS for their certification as reference materials for use in analytical instruments.

Nitrates of 1ppm concentration were evaluated by Ion chromatography and UV visible spectrophotometry.

Intra-laboratory project – Development of tungstenoxide based electrochromic films by sol-gel technique:

Precursor material-Polytungstic acid and peroxopolytungstic acids for WO_3 prepared by solgel technique were characterized for compositional analysis by different techniques. The precursor material peroxo polytungstic acids were further improved for better stability by reacting them with low carbon organic acids and isolation of the acid product by vacuum drying under controlled conditions of heating.

Further reactions of the acid product with alcohols of low carbon content helped in preparation of the corresponding esters, which had good stability at low temperature and also good solubility in alcohol. They thus showed good electrochromism when deposited as films on conducting glass plates.

Study of atmospheric aerosols, acid rain and green house gas have been carried out regularly in this laboratory. Compositional analysis of aerosols samples collected in Delhi indicated environmental status of Delhi. Samples collected during INDOEX cruise have been analyzed with a special reflection on soot carbon analysis.

Methane (CH_4) emission studies from rice paddies:

Data generated by NPL for methane emission during Indian methane campaign 1991 and further measurements done, has contributed significantly in Indian national inventory for IPCC. The inventory methodology has been improved taking into the account of facts that methane emission is greatly influenced by factors viz. water management, cultivar type, fertilizers used etc. also apart from soil temperature. Indian methodology using seasonally integrated flux (E_{sif}) has been recognized by IPCC and has been incorporated by IPCC in its 1996 update. The methane budget, for India including the categorization of paddy ecosystems for estimating emissions from the country utilising the E_{sif} approach, has been estimated as 4.07 Tg/y. Presently NPL is coordinating Asian Development Bank (ADB) funded Methane-Asia Campaign 1998 [MAC-98] involving India, China, Thailand, Philippines, Vietnam and Indonesia. It will improve the methane emission estimates from paddy fields of Asia, which accounts for more than 90% of world's rice production.

Electron Microscopy

Synthesis and characterization of semi-conducting thin films:

Semiconducting thin films were deposited on different types of substrates at different temperatures. The substrates in general used for the synthesis of InSb were KCl and NaCl crystals and Corning glass. A good quality

films were achieved using thermal evaporation technique, employed in the present investigation. Efforts are being made to understand the optimum process conditions for the epitaxial growth of these films.

New SEM and EDS facility:

A new state of art fully PC controlled Scanning Electron Microscope (SEM) model LEO 440 has been installed in January 1999 (Fig. 6.4). SEM is fitted with turbo molecular pump for producing clean vacuum and is equipped with secondary electron image detector, retractable back scattered electron detector, cathodoluminescence detector and specimen current monitor to investigate the microstructure of materials under different mode of operation. It has a resolution of 3.5 nm, accelerating voltage variable from 300 V to 40 kV and magnification varying from 5X to 300,000X.

SEM has an attachment of energy dispersive spectrometer (EDS) make and model Oxford Link ISIS-300 using Si(Li) detector. It can be used to detect elements from atomic no. 5 to 92 and has a resolution of 133 eV. The EDS system can provide information about the composition of the unknown materials and offers information about the distribution of elements (X-ray mapping). The facility is fully functional and operative.

SEM and EDS, a combined facility is efficiently in use, since the day of its installation. Samples for microstructural features and compositional details have been examined. Different types of materials, like semiconductors, metals & alloys, composites of various kind, oxides and insulators are being analyzed, in thin film, powders and bulk form. A representative micrograph of Carbon – Carbon composites examined under secondary electron detection mode has been displayed in (Fig.6.5). Carbon filaments aligned in the matrix are clearly distinguished.

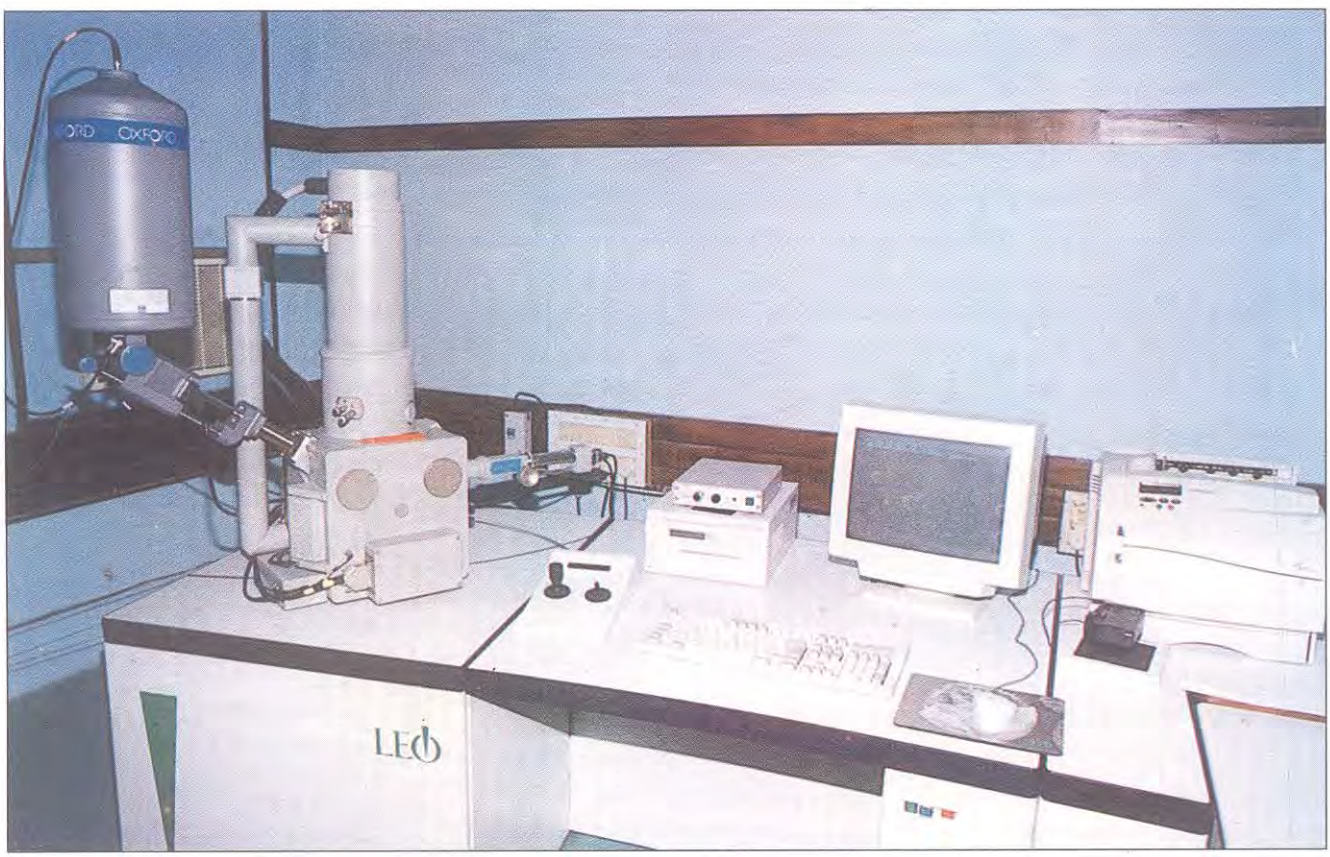


Fig.6.4 New SEM model LEO440

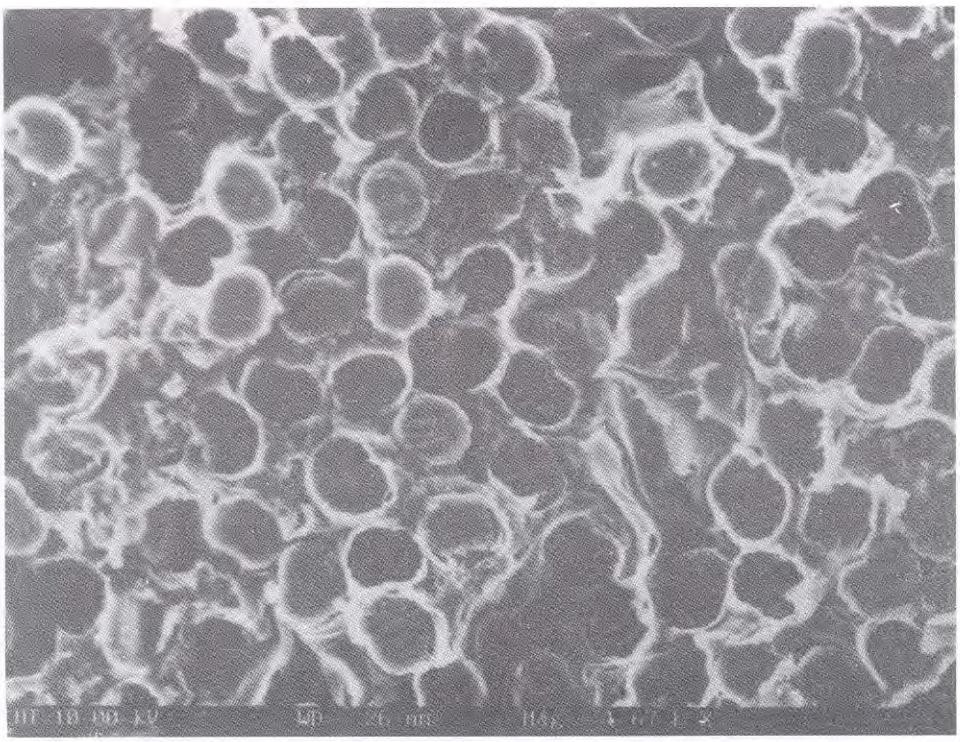


Fig. 6. 5: A micrograph of a carbon-carbon component recorded under SEM in secondary electron image mode

EPR Spectroscopy Section

Electron Paramagnetic Resonance (EPR) spectroscopy is the method of choice for characterizing different kinds of materials containing paramagnetic centers/defects/ impurities. Characterization of different types of materials using EPR technique was done for NPL research groups as well as for outside organizations. EPR study of microstructure of ternary oxide glasses doped with transition metal ions was continued. It was observed that in glasses having composition xCoO.(0.4-x)SrO.0.6B_2O_3 doped with 1.0 mole % V_2O_5, the increase in CoO:SrO ratio keeping B_2O_3 constant resulted in decrease in tetragonal distortion of the $V^{4+}O_6$ complex and covalency of vanadium-oxygen bonds was also decreased. In the conducting polymer polyaniline, doped with HCl and H_2SO_4 acids, EPR signal obtained was assigned to polarons formed due to doping. Also, the spin concentration was found to increase with increasing doping level. Further work on this polymer is in progress.

रेडियो एवं वायुमण्डलीय विज्ञान
RADIO & ATMOSPHERIC SCIENCES

रेडियो एवं वायुमण्डलीय प्रभाग (आर ए एस डी) भूमण्डलीय परिवर्तन सम्बन्धी अध्ययन करने के लिए ग्रीनहाउस गैसों, एरोसोलों, यू वी-बी विकिरणों और ओज़ोन का मापन करता है। वर्ष के दौरान इस प्रभाग ने हमारे पर्यावरण में हो रहे जैव मात्रा (बायोमास) के प्रभाव का अध्ययन करने के लिए प्रयोग के रूप में अभियान शुरू किए और एम एस टी रडार और ओजोनसोन्डे प्रयोगात्मक आंकड़ों का प्रयोग करते हुए उष्णकटिबंधीय स्थानों में होने वाली ओजोन संवहन सम्बन्धी समस्याओं का अध्ययन किया तथा बदलती हुई वायुमण्डलीय परिस्थितियों के कारण दिल्ली क्षेत्र के वायुमण्डल में होने वाले प्रदूषण का अध्ययन करने के लिए भी प्रयोग के रूप में अभियान शुरू किए । इस प्रभाग ने इंडोएक्स (INDOEX) और अंटार्कटिक कार्यक्रमों में भी सक्रिय रूप से भाग लिया।

इस प्रभाग ने रेडियो संचार में सहायता प्रदान करने के लिए उपग्रह और भू-आधारित तकनीकों का प्रयोग करते हुए भारतवर्ष के रेडियो परिवेश के सम्बन्ध में कुछ अध्ययन करना आरम्भ किया है। इस क्षेत्र में इस वर्ष की मुख्य उपलब्धियां हैं - उपग्रह सिग्नलों का प्रयोग करते हुए आयनोस्फरिक प्रस्फुरण (Ionospheric scintillation) का अध्ययन, वी एच एफ ट्रांसमीटरों का अभिलक्षण, दक्षिण भारत में एल ओ एस (LOS) माइक्रोवेव लिंक्स की कार्यप्रणाली के संचालन का पता लगाना, 37 GHz रेडियो मीटरों का डिजाइन और विकास तथा लिओनिज़ उल्का वर्षण के दौरान स्रॉस (SROSS C2) उपग्रह के आंकड़ों से धातु आयनों का पाया जाना।

RASD monitors greenhouse gases, aerosols, UV-B radiation and ozone for global change studies. During the year the Division conducted experimental campaigns to study the effect of biomass burning on our environment, studied ozone transportation problems in tropics using MST radar and ozonesonde experimental data and conducted experimental campaigns to study atmospheric pollution in Delhi region under varying atmospheric conditions. It also actively participated in INDOEX and Antarctic programmes.

RASD has taken up several studies on the radio environment over the Indian region using satellite as well as ground based experimental data to aid in radio communications. Ionospheric scintillation studies using satellite signals, characterisation of VHF transmitters, performance evaluation of some LOS microwave links in Southern India, design and development of 37 GHz radiometers and detection of heavy metallic ions from SROSS C2 satellite data during the Leonid meteor showers are some major highlights of this year.

Atmospheric Environment and Global Change

Ozone transport from stratosphere to troposphere:

Ozone, an important minor species in the atmosphere with maximum levels in the stratosphere, protects us from the hazards of UV radiation. Basic mechanisms that control ozone concentration in troposphere and stratosphere though are different, it is now widely appreciated that the dynamics of the troposphere and stratosphere are inseparable. Tropopause, the intermediate barrier between stratosphere and troposphere, plays a crucial role in different interactive processes between these two layers. Downward intrusions of ozone-rich stratospheric air through the perturbation of tropopause is thought to take place only outside the tropics. Our studies using MST radar data which gives information on the structure of the tropopause, alongwith simultaneous ozonesonde data from IMD flights have provided first experimental evidence of ozone transport from startosphere to troposphere in tropics also. However, this happens under some specific conditions of tropopause.

A comparison of simultaneous observations of tropopause structure by MST radar and ozone profile by ozonesonde show that as long as tropopause is sharp and well defined, no transport of ozone takes place (Jan.7 Fig. 7.1). But when the tropopause is broad and structured, known as "tropopause weakening", the downward transport of ozone from stratosphere to troposphere can take place (Jan.8 Fig. 7.1). The inset in the Figure 7.1 which represents the expanded view of the curves shows that on January 8, ozone mixing ratio in the troposphere has increased to the same amount by which ozone has decreased in the startosphere, although integrated total ozone remains same for the observed period.

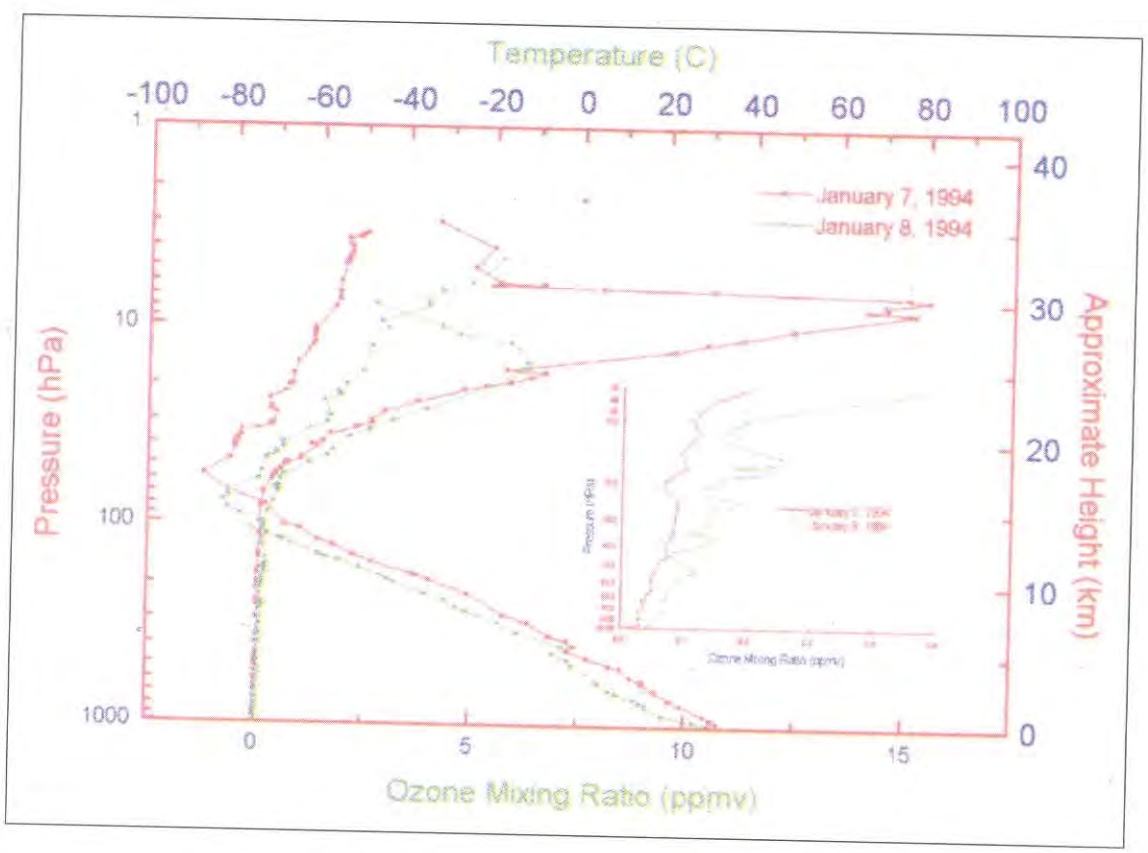


Fig. 7.1: Tropopause structure and ozone profile

UV-B and aerosol measurements:

Total ultra violet radiation densities in the UV – B range were measured by two instruments i.e. UV–B biometer (280 – 340 nm) and Erythema probe (290 –310 nm) during biomass burning campaign conducted under the INDOEX program in the hilly forests of East Godavari District of Andhra Pradesh during 18th – 22nd Feb. 1999. These instruments were operated on 17th Feb., the control day, and also during the forest fire days, namely, 18, 20 and 22nd Feb., 1999. The results (Fig. 7.2) indicate that UV–B intensities are affected by the onset of the forest burning and normal values are restored with some delay after the fire has stopped. The intensity dips seen in UV-B associated with the onset of the forest fire on different forest fire days show that the smoke and smoke generated aerosols released during the forest fire could reduce the intensity of UV radiation by 20 to 60 % of the ambient intensity.

Sporadic pollution increases over Delhi:

Aerosol optical depths derived from solar radiation measurements at 400, 450, 500, 590, 700, 750, 800, 935 and 1025 nm made at NPL, Delhi normally show a smooth decrease from sun rise to mid-day. However, on certain days during winter season when surface winds are low, the aerosol optical depth shows a gradual increase during 0900 to 1100 hrs. Strong inversions in the atmospheric boundary layer are also observed during such events. Under these conditions rapid dissipation of pollutants is prohibited and this results in accumulation of pollutants within the planetary boundary layer. Thus, the solar radiation reaching the ground does not show normal increase. The variation in aerosol depth under slow wind and no wind conditions at various wavelengths is shown in Fig. 7.3.

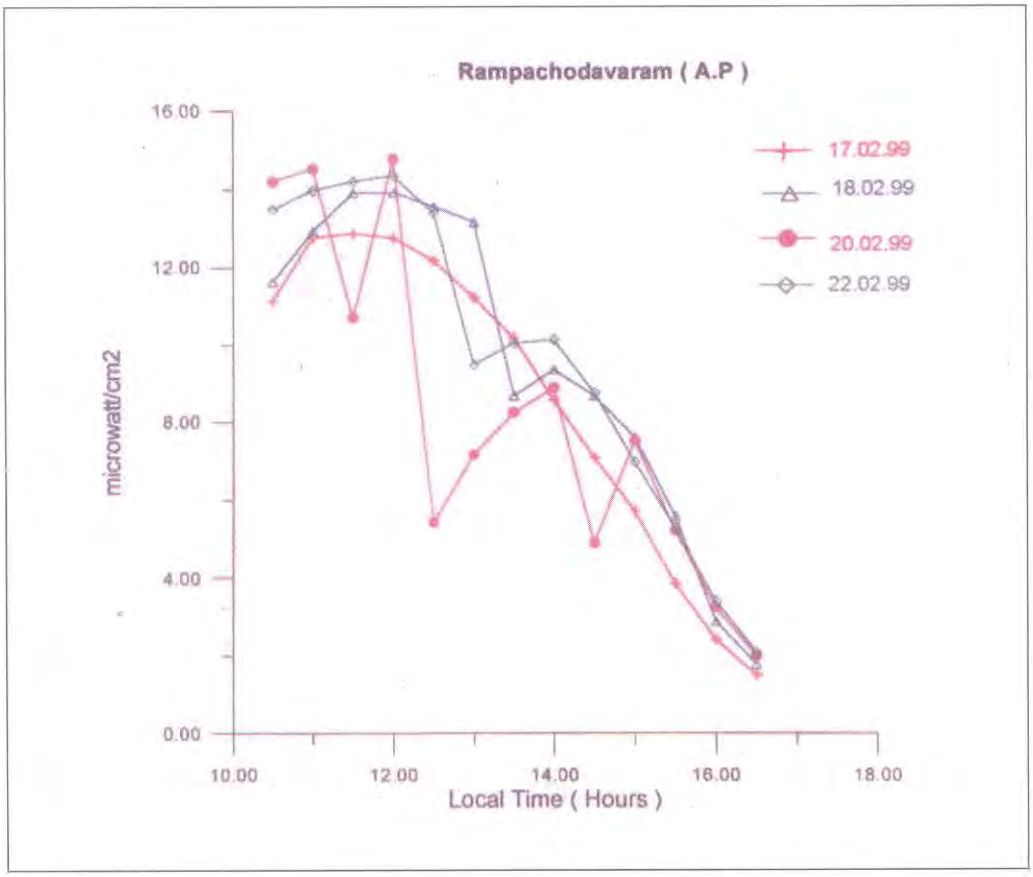


Fig. 7.2: Diurnal variation of UV-B intensity

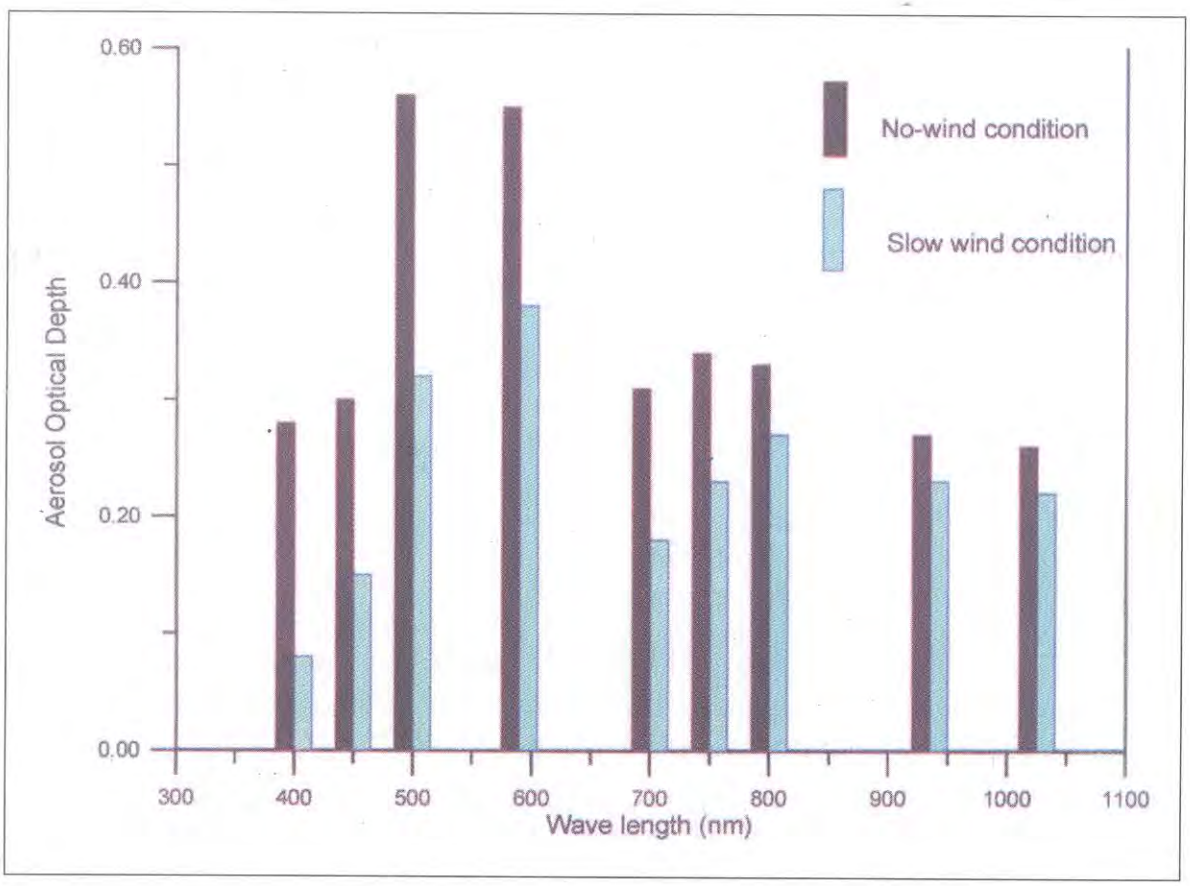


Fig 7.3: Variation of aerosol optical depth near no-wind and slow-wind conditions observed during 0900 hrs-1100 hrs.

Green house gases monitoring:

The Solar Infrared Spectroradiometer, installed at N.P.L., takes measurement of different atmospheric trace gases. The seasonal variation of atmospheric CO_2, CH_4 and water vapour was evaluated in terms of integrated total column density. The surface concentration of CO_2 and methane was deduced from the integrated total column by taking a model distribution of CO_2 and CH_4 as initial guess. The monthly means of integrated total column density of CO_2 showed higher values during the post-monsoon period and post-winter months and lower values during winter months. A comparison was made between Delhi, Mauna Loa, U.S.A. and Westerland, Germany surface CO_2 concentrations. The concentrations of CO_2 at Delhi and Mauna Loa largely agree within a range of 5 ppm. However, the concentration of CO_2 at Westerland, Germany was found to be lower by 20 ppm. The monthly means of integrated column density of CH_4 showed a minimum during winter months. The surface concentration of CH_4 at Delhi and Mauna Loa agree within a range of 0.5 ppm in their monthly means except for September and March. The integrated water vapour shows higher values in the month of July and August.

Surface ozone monitoring:

Field measurement of tropospheric surface ozone using an ozone analyzer was continued on round the clock basis at NPL, Delhi. During summer months values as high as 140ppb have been observed. It is also found that there are two maxima (April and October) and two minima (December and August) in surface ozone annual variations.

INDOEX final phase:

The main aim of the Indian Ocean Experiment (INDOEX) which is an international programme, is to study the

effect of pollutants due to anthropogenic sources in the Indian continent on climate. With this objective, the First Field Phase of this programme (FFP-98) was carried out. In this campaign, the measurements were carried out from a chain of ground stations in India, Maldives and Mauritius. In addition, ship borne observations on board Sagar Kanya were also carried out.

The final phase called the Intensive Field Phase (IFP-99) was successfully carried out between Jan. - Mar. 1999. In this campaign, besides the Indian ship Sagar Kanya, (fig. 7.4) another ship Ron Brown from USA also participated. The additional platform for this final phase included C-130, Citation, Mystere, Geophysica aircrafts with different experiments on board that flew at differing altitudes. Existing satellites over the region of interest were also utilized. All the ground stations set up during FFP-98 were also operational during this time. About 17 French constant level balloons were launched from Goa. In addition, French groups have also set up two stations at Goa and Dharwad for atmospheric observations. The scientific co-ordination for all ship borne measurements was done by NPL. About 12 organizations including NPL participated in this programme. NPL had contributed experiments for measurement of trace gases and aerosols and also for acid rain studies.

Radio Environment

Detection of metallic ions by RPA during the Leonid meteor shower, November 1998:

The ion and electron RPA payloads aboard SROSS-C2 were operated in campaign mode during the Leonid meteor shower event which occurred during 15-19 November 1998. Data were collected for more than 40 orbits visible over Mauritius, Bangalore and Lucknow ground stations during this period. The observations from the ion RPA data show the presence of heavier ions in

Fig. 7.4: The 'Oceanic Research Vessel Sagar Kanya' of NIO/CSIR used for mounting shipborne measurements for the INDOEX cruises

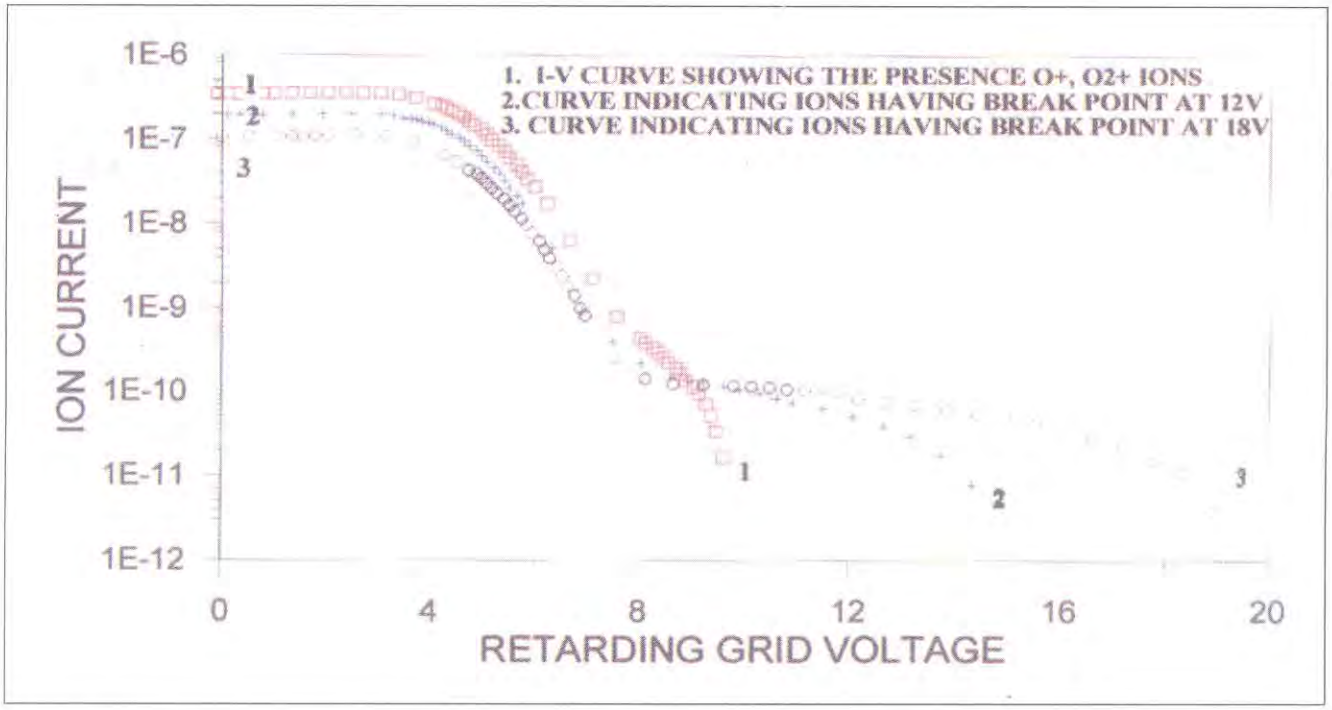


Fig. 7.5: I-V Curves obtained from the retarded potential analyzer satellite experiment on board SROSS

the altitude region of around 420km which is attributed to the meteor shower activity.

The RPA measures different ion species that are present in the ionosphere. The ions that are normally found in the altitude region covered by the measurements are H^+, He^+, O^+ and O_2^+. However, The data collected during the meteor shower days have indicated the presence of heavier ions of mass numbers that lie between 40 and 60 amu also. This can be seen in the in the I-V curves shown in Fig.7.5, which are representative examples of the cases observed. In the curve (2), one can see a break point around 12 V corresponding to an ion mass of about 40 amu, this is in addition to the break point at 4 V, which represents the dominating O^+ ions normally found at those regions. Curve (3) is an example for the presence of still heavier ions of mass around 55 amu. Curve (1) is an example of a normal situation in which we can see that the heaviest ion measured is the O_2^+ (break point ~8 V). The mass numbers of the heavy ions that have been detected correspond to metallic elements like Calcium, Cobalt, Manganese and Iron, which are usually found in ionisation caused by meteor debris. The maximum number density of these heavy elements is of the order of 100 ions cm^{-3} in the background ion density of $5x10^5$ cm^{-3}.

Ionospheric Modelling

Prediction of the size of Cycle 23 using multivariate relationships:

A new technique based on multivariate analysis is developed for the prediction of the size of maximum amplitude of present sunspot-cycle 23. The importance of the technique lies in its ability to predict the size of forthcoming cycle even before the start of the cycle that was not possible with traditional statistical techniques. The number of geomagnetic disturbances at selected times in the declining phase of cycle 22 are used as precursors to predict the size of cycle 23. Table 7.1 shows the hindcasts of the technique applied to the earlier cycles starting from the 18th cycle using separately three multivariate equations used in this technique. The observed values are found to be within 5%. The technique has predicted the size of present cycle 23 to be 152.

Cycle	Obs. Peak	Hindcast Eq. 1	Hindcast. Eq.2	Hindcast. Eq.3
18	151.8	147.1	146.8	147.2
19	201.3	198.2	198.0	198.4
20	110.6	110.3	110.2	110.4
21	164.5	167.8	167.4	164.2
22	158.5	162.2	163.4	154.6
23		153.2*	148.1*	153.8*

* : Expected Peak Values

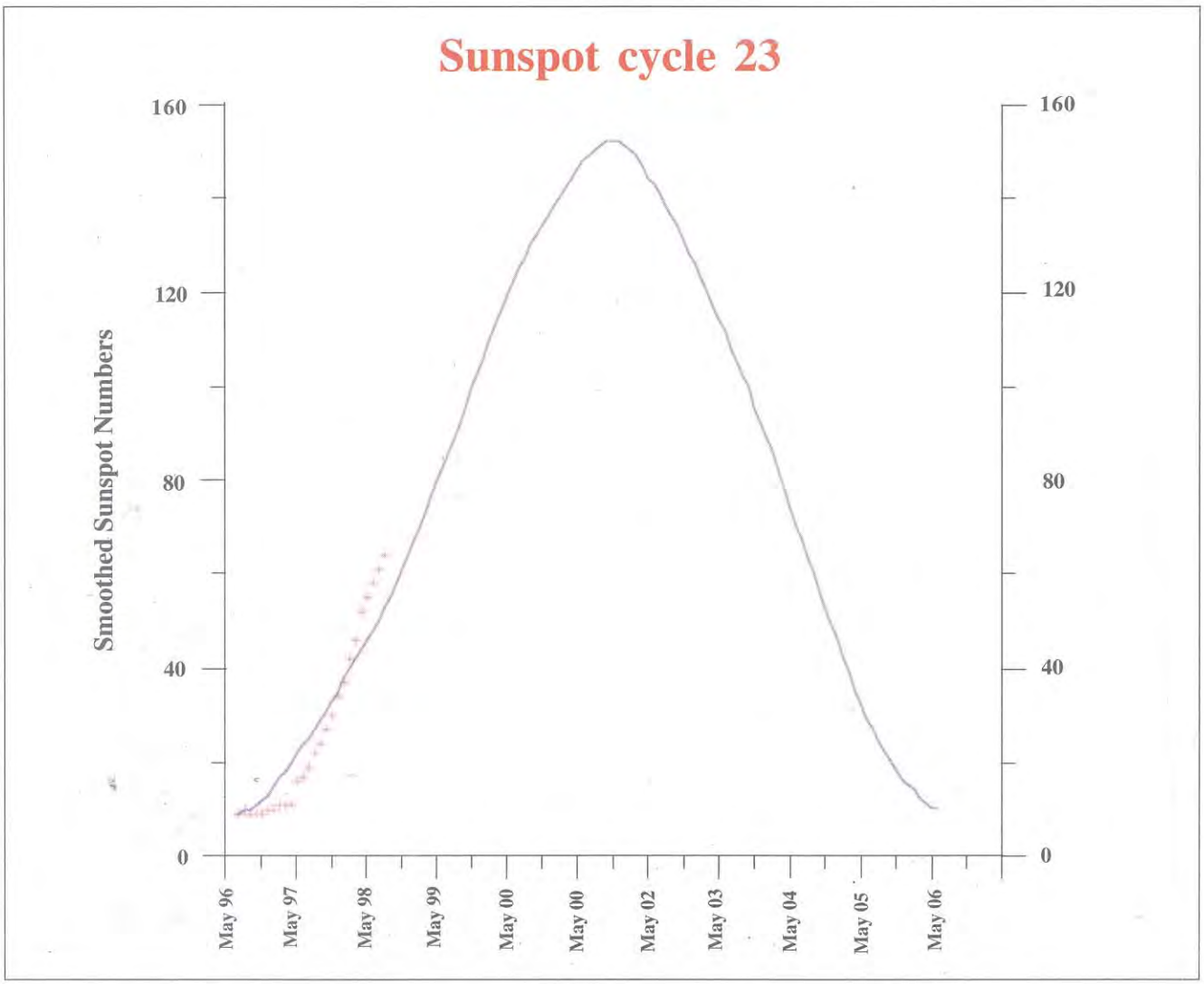


Fig. 7.6: Predicted variation for the solar cycle 23. This prediction was made before the start of the cycle; smooth curve shows the prediction and plotted + points show the observed values

Improvements In IRI:

About 1500 electron density (Ne) profiles observed with the Arecibo incoherent scatter (I.S.) radar were used to obtain the thickness parameters of the bottomside F layer (Bo and B1 parameters) by fitting the observed profiles to the IRI profile function. The relative errors between the best-fit profiles and the observed I.S. profiles were also examined. This error was found to be very large during the day, especially at times when F1 layer was present which happened for about 30% of the total population. The Bo, B1 values obtained for the remainder 70% of the cases showed large variability and were different from the IRI model values. The Bo, B1 were modeled and suitable changes were suggested to be included in IRI model.

The central nightside Venus ionosphere:

The aeronomy experiments on the Pioneer Venus Orbiter (PVO) established three characteristic features of the nightside ionosphere of Venus, (1) the disappearing ionospheres, (2) the large spatial/temporal variability of ion densities and (3) the plasma holes. As the nightside ionosphere is essentially maintained by the trans-terminator flow of O^+ ions from the dayside, this flow must be the major parameter controlling these features. Disappearing ionospheres were indeed found to occur during episodes of high solar wind dynamic pressure (Psw), when the height of the terminator ionopause was greatly reduced and thus the transterminator flow severely diminished. The studies on the other two features, viz the temporal/spatial ion density variability and the plasma holes, were carried out by analyzing O^+ density profiles measured by the ion mass spectrometer experiment on the PVO. It was found that most of the variability in the central nightside ionosphere was related to Psw, which was seen to control the O^+ peak density and the height of the nightside ionopause. The plasma holes were found to occur above the nightside ionopause when Psw was generally moderate. It was demonstrated that these were not

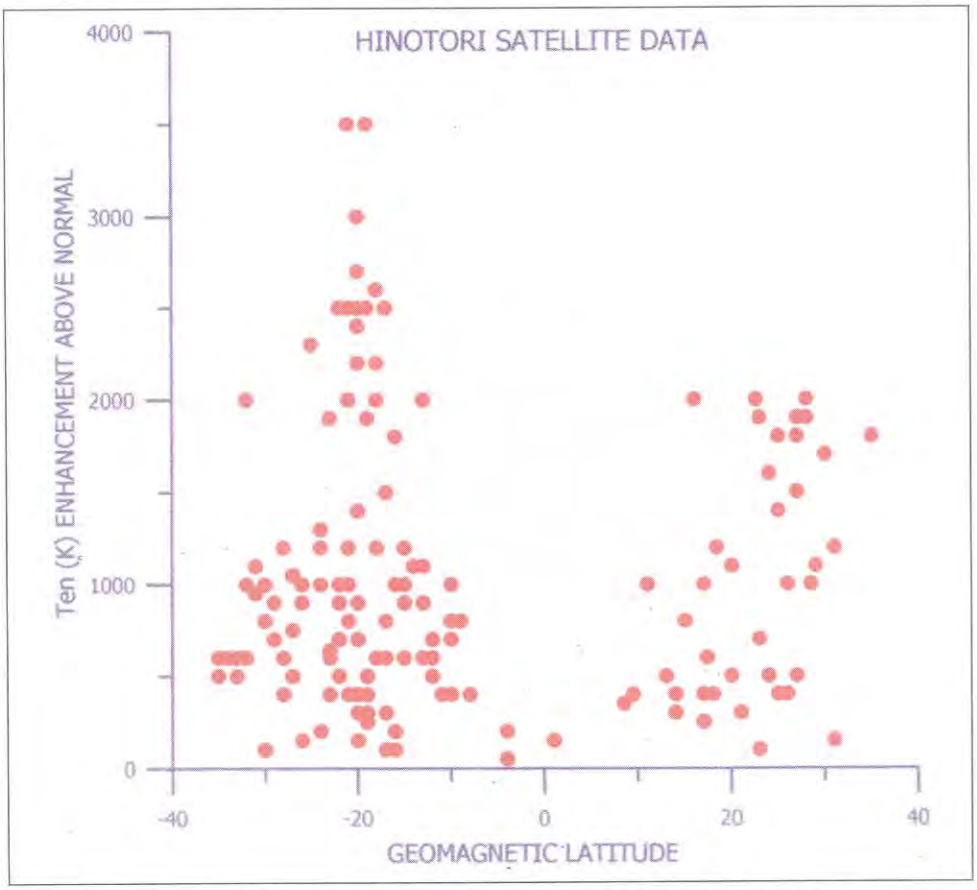


Fig. 7.7: Latitude distribution of ionospheric temperature enhancement (Ten) for a high solar activity year

real holes in the main ionosphere but were ionospheric structures seen above the nightside ionopause. The plasma in these structures was generally found to be disturbed and it is proposed that the source of these structures is the plasma clouds/detached plasma transported from above the dayside ionopause. The strong radial (sunward/antisunward) magnetic fields, which have been reported to exist in the holes, were quite similar to the ones, which were generally seen in the nightside ionopause.

Anomalous Ionospheric electron temperatures:

Study conducted using electron temperature data from HINTORI satellite has revealed certain anomalous variations in the ionospheric electron temperatures at 600 km altitude, by way of exceptionally large increases as compared to back ground value in ± 30° latitude range. These ionospheric electron temperature enhancements (T_{en}) have been observed in a wide range of longitudes including the Indian zone with distinct seasonal and local time bias. On a large number of occasions they have been found to occur on either side of the geomagnetic equator coinciding with the well-known equatorial ionization anomaly. Fig.7.7 shows latitudinal distribution of T_{en} for high solar activity years. The results are explained in terms of zonal winds, winter anomaly in electron density and electrodynamic drifts.

Ionospheric Scintillations

Signals from FLEESAT satellite were monitored to study the effects of ionospheric irregularities on trans–

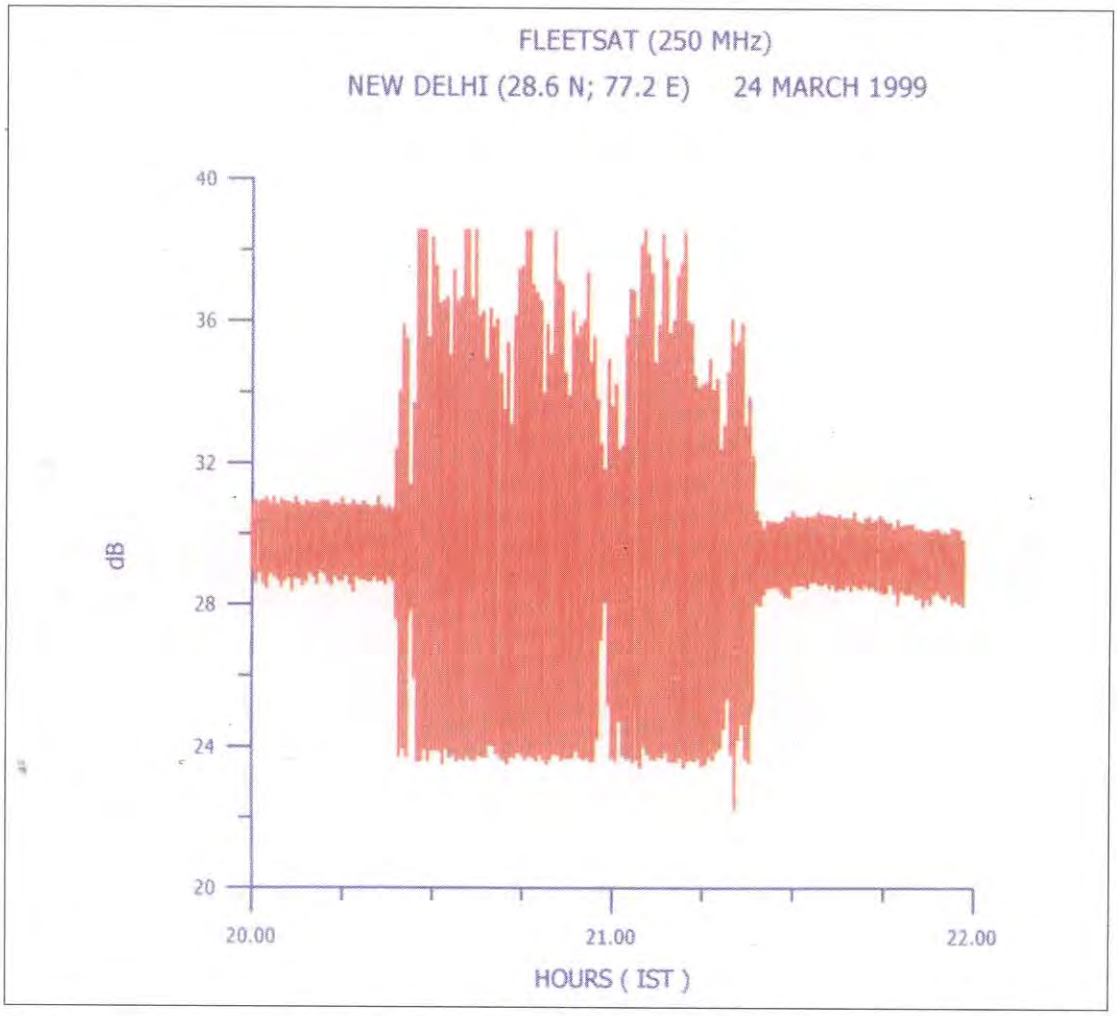


Fig 7.8: Scintillation activity observed at New Delhi using FLEETSAT signals at 250 MHz on March 24, 1999

ionospheric propogation. Figure 7.8 shows the scintillation activity observed at New Delhi using FLEETSAT signals at 250 MHz on March 24, 1999. The data was analysed to study the role of neutral winds and electric fields on generation and sustenance of equatorial ionospheric irregularities. The result have shown the importance of electric fields as evidenced from ionospheric height variations at the geomagnetic equator in producing the scintillations at a location like Delhi. This study was also taken up as part of nationally co-ordinated programme on equatorial ionospheric irregularities.

Radio Communication

LOS link performance assessment:

The performance of a microwave communication link at 7.2 GHz situated between Guntakal and Vadrahalli has been investigated. It has been found that the link performance starts deteriorating when the signal level reduces to -75 dBm and below. The most problematic period is from November to May and during 2300-0800 hrs IST. Other than these periods, the link has been found to work satisfactorily. The causes of deterioration are mainly due to mainly stratified atmospheric conditions. Various remedial measures like antenna tilting, antenna pattern diversity, angle diversity, path inclination have been investigated to improve the performance of the link in troubled months.

Studies on HF fading:

While planning the services in the HF band especially for the Digital systems, appropriate fading allowance will have to be provided. Keeping in view the present day requirements for digital communications, a study has been undertaken on the fading characteristics of signals of certain trans-equatorial HF links that suffer from heavy fading. The study based on our observational campaign initiated during 1997-98 at around Tirupati indicated that fade allowance of 11-12 dB need to be provided for links operating in 10-18°N latitudes for 90 % reliability and they were higher by at least 3-4 dB when compared to ITU-R recommended values. Different types of modulations that are normally used in digital communications have also been considered in the study.

Characterization of FM transmitters:

A study was undertaken for characterizing a proposed FM transmitter in north India. The design calculations consisted of prediction of signal levels based on radiometeorological parameters, variation of signal levels with day, night and season, fixing the transmitting antenna height and size, predicting the range of transmitter in various directions etc. Latest ITU-R recommendations were utilized and prediction methods based on propagation mechanisms derived from experiences of analyzing various data sets were employed. The results derived from various experiments conducted in the VHF band over different parts of Indian subcontinent were also utilized in this study.

RWC (New Delhi) and forecasting services:

Short term forecasting and data exchange services continued at Regional Warning Centre hosted by RASD. The radio communication organizations were particularly interested in solar events and updates on MUFs in view of the increasing solar activity levels during this year. Indo –Tibetan Border Police and Communication Wing, Naval base, Vishakhapatnam are among those who used extensively our solar and geophysical forecasts. Information on solar particle events and short-term forecasts on solar and magnetic activities have been provided to ISTRAC, Bangalore and Master Control Facility, Hassan.

System Design

37 GHz radiometer:

37 GHz frequency lies in the atmospheric window region between the absorption line of water vapor at 22.235 GHz and the oxygen absorption lines around 60 GHz. Propagation studies at this frequency, therefore, become important because of the possible use of this band for Radar and remote sensing applications. A low noise 37 GHz Radiometer has been designed for

atmospheric attenuation measurements under different weather conditions. This radiometer is designed at NPL for installation at J.K. Institute, Allahabad. Schematic block diagram of the system is shown in fig. 7.9. It uses a horn antenna for receiving radiations from the sky. Received signal in 37 GHz band is then modulated by square wave at 45 Hz by a mechanical modulator and then down converted by means of a balanced mixer to get an IF frequency of 60 MHz using a 20 mw gun oscillator. The balance mixer output is first amplified by a three stage 60 MHz IF amplifier with 20 MHz bandwidth that is then fed to a diode detector. The detected output is further amplified in a low noise amplifier and is synchronously detected at the modulation frequency of 45 Hz by using phase sensitive detector. The D.C. output is logged on a PC based data acquisition system for automatic recording of signals.

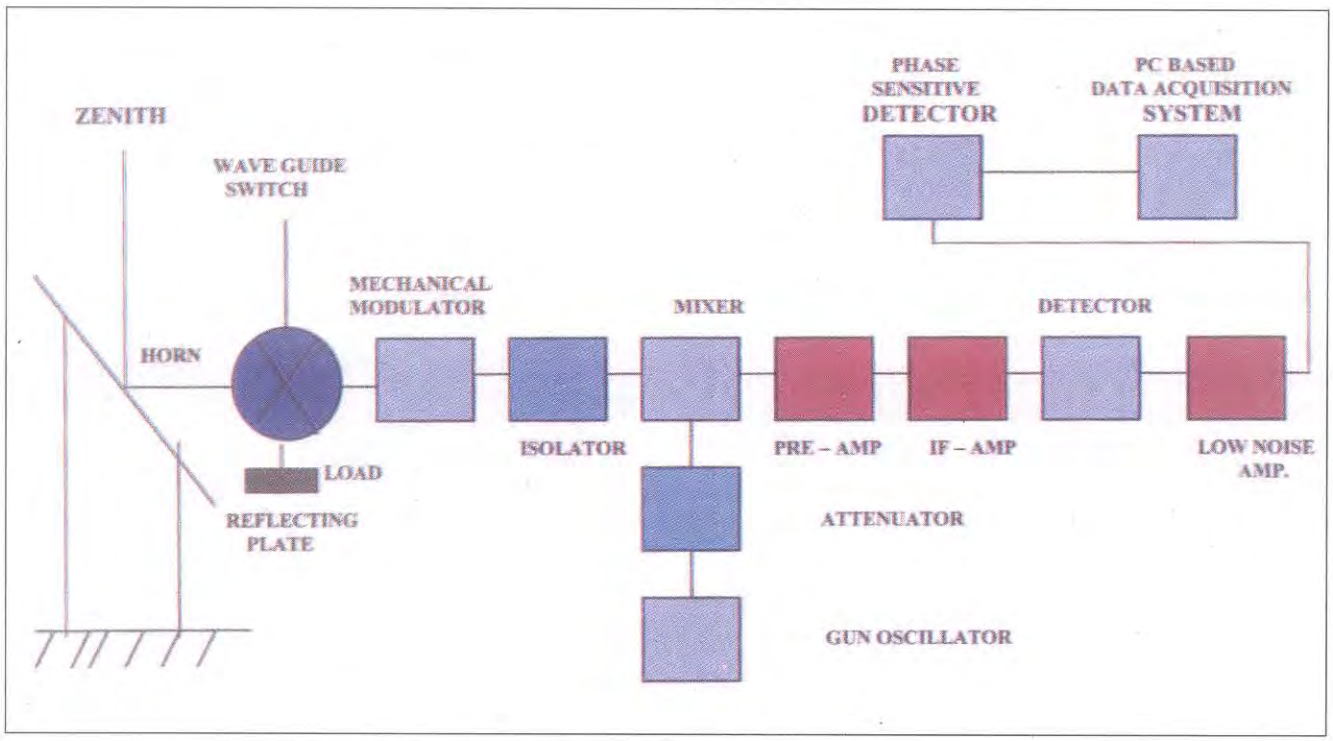


Fig. 7.9: Block diagram of a 37 GHz radiometer developed at NPL

अतिचालकता
SUPERCONDUCTIVITY

राष्ट्रीय भौतिक प्रयोगशाला निम्न ताप अनुसंधान की शुरूआत करने वाली भारत की सबसे पुरानी संस्था है। उच्च ताप अतिचालकता परिघटना का अन्वेषण व अति चालका चुम्बक प्रौद्योगिकी का विकास योगदान के दो प्रमुख क्षेत्र हैं। असामान्य अतिचालकता व सामान्य अवस्था आचरण और उच्च Tc परिधटना कैसे घटित होती है इस पर अन्वेषण कार्य किया गया। इसकी बारीकियों का पता लगाने के लिए अनेक प्रतिस्थापन अध्ययनों का प्रयास किया गया। उच्च ताप अतिचालक क्यूप्रेट्स में धनायनी प्रतिस्थापन (Cationic substitutions) त्रुटियों और अवयवस्था की उत्पत्ति को अनिवार्य रूप से प्रेरित करती है। अधिमान्य स्थल पराश्रित विशिष्टताएं (प्रीफेंशियल साइट डिपेंटडेंट सिंगुलैरिटीज़) पारस्परिक प्रतिस्पर्धात्मक परिधटनों यथा स्थानीकरण (स्थान निर्धारण), विमीय परिवर्तन, अस्थिर चालकता व आर्डर पैरामीटर रूपान्तरण, इलैक्ट्रोनिक गुण धर्मो में स्थानीय परिवर्तनों को प्रेरित करती है। ऐसे प्रभाव अतिचालकता एवं सामान्य अवस्था गुणधर्मों के प्रति बृहत्तर भूमिका अदा करते हैं। एकल वैण्ड (पट्टी) या परत मजबूत बाध्यकारी (Binding) हैमिल्टनोनियन समावेशन अन्तः एवं अन्तर्परत आकर्षक अन्योन्य क्रिया (Interactions) पर इन परतदार क्यूप्रेटस् में अन्तः परत युग्मन की भूमिका का भी अन्वेषण किया गया है। विभिन्न विश्वविद्यालयों और प्रमुख अनुसंधान एवं विकास संस्थानों से पर्याप्त सहयोग इस प्रभाग की गतिविधियों की विशेषता रही है।

NPL is the oldest institution in India to have started low temperature research. Two major areas of contribution are basic investigations of the high temperature superconductivity phenomena and development of superconducting magnet technology. Unusual superconducting and normal state behaviour and the underlying mechanism of high Tc phenomenon are investigated. Host of substitutional studies have been attempted to unveil such details. Cationic substitutions in high temperature superconducting cuprates lead essentially to the generation of defects and disorders. Preferential site dependant singularities lead to various mutually competing phenomena like localization, dimensionality changes, fluctuation conductivity and order parameter variations, local changes in the electronic properties. Such effects have greater role to play towards SC and normal state properties. The role of interlayer coupling in these layered cuprates has also been investigated on a one band two layer tight binding Hamiltonian incorporating the intra- and interlayer attractive interactions. A substantial collaboration with different universities and premier R&D institutes has been the hallmark of the activities of this Division.

Basic Investigations on High Temperature Superconductors

One aspect of the basic investigations programme on high T_c superconductors is that of studying the effect of magnetic impurities of d- and f- level. Studies on the Bi-2223 (BiPb-Sr-Ca-Cu-O) superconductor doped with some d-band impurities have suggested the formation of a virtual bound state (VBS) of the d-band dopant near the Fermi level of the superconductor. These studies have been extended to f-level doped systems of Bi-based high T_c superconductors. Two series of Bi-2223 (Pb-doped) and Bi-2212 (un-doped) superconductors doped with various impurities of 4f-level have been studied (characterisation of the samples being done by a.c. and d.c. resistivity measurements) and a distinct effect of f-level filling on the superconductivity of these materials has been observed. Evidence of VBS formation is indicated for some f-level dopants also while others show the traditional behaviour of metal-insulator transition (or normal metallic behaviour) outside the region of under- or over-doped hole states.

High temperature superconductivity:

Synthesis of $CuBa_2Ca_3Cu_4O_{12-Y}$ (Cu-1234) with Mg doping at the Ca site, hitherto unexplored, was taken up. Different samples with 5%, 10%, 20%, and 33% Mg (in nominal stoichiometry) have been prepared in gold capsules under 3.5 GPa pressure and at about 1000°C temperature using a cubic anvil press. These samples were characterized through X-ray diffractometry, resistivity, dc-susceptibility and Hall effect measurements. These samples were then aligned along their c-axis under 10 T field at room temperature. Magnetization (both in H || ab and H || c) was measured between 120 and 5K in different field values upto 5T. The superconducting anisotropy, estimated in the reversible magnetization regime, comes out to in ~1.4 and is lower than that of the pristine sample. Improvement in the anisotropy factor obtained has been discussed in the light of the observed changes in the lattice parameters and the hole concentration emanating from Mg doping in the Cu-vacancies in charge reservoir blocks of the 1234 structure.

Single crystals of $CuBa_2Ca_3Cu_4O_y$ (Cu-1234) with dimensions upto 200x100x20 μm^3 were synthesized under high pressure using a belt type anvil apparatus. The impurity of Au emanating from Au capsule was found in the crystals by SEM-EDS analysis. These crystals showed superconducting transition temperature (Tc) ranging from 105K to 68K and are lower than that of the Au-free polycrystals (Tc=118K). The Tc values are found to decrease linearly with Au content at a substantially high rate of 7.0 ± 0.4K /%, indicating the substitution of Au ions for Cu- sites. Superconducting anisotropy γ estimated from the resistivity data of Cu-1234 single crystals just above Tc (102K) was found to be higher (γ=5.8) than that for the Au-free polycrystals.

A superconducting gap resonating with a phonon, intakes a structure in the phonon spectral function even in the d-wave pairing. This is demonstrated by a theoretical calculation. The conditions employed in our calculations are $q \rightarrow 0$ and the clean limit where q is the momentum of the phonon. The difference in the line shape of the phonon between the s-wave model and d-wave model is noticeable. The resonance structure would be observed in the Raman spectrum when the phonon propagates in the ab-plane, i.e. the direction of the incident light and the scattered light are perpendicular to the c-axis. We propose a new method to investigate the symmetry of superconducting gap function in the cuprate superconductor through this resonance structure.

The role of the interlayer coupling in the superconducting state of high Tc layered cuprate system has been studied using one-band two-layer tight binding Hamiltonian with intra and inter-layer attractive interactions. The expressions of charge carrier (hole) density and momentum dependent energy gap function are derived on the basis of BCS type pairing in narrow band within Hubbard like decoupling approximations. The hole density and generalized gap parameter was found to depend on interlayer interactions. Numerical analysis shows that change in the holes between the cuprate planes depend upon the magnitude of the interlayer hopping element and superconducting transition temperature.

Three YBaCuO epitaxial thin films were irradiated with 250MeV Ag ions with ion doses of 0.5,1.0,10 x 10^{11} ions/cm^2 to create columnar type defects in them. Nanolevel studies of columnar amorphization and structural symmetry changes produced by irradiation were studied by scanning tunneling microscopy (STM). The columnar amorphized regions were found to have sizes between 2-3 nm and structural distortion up to 4-5 nm size around the ion tracks. The change in spacing between the nearest columnar defect as a function of ion fluence was studied. The observed columnar amorphization is discussed in the framework of electronic energy loss of swift heavy ions which excites the electronic system of the materials leading to the deterioration of structural symmetry due to energy transfer to lattice via electron-phonon interactions.

Metglass MG2705M foils of about 17 μm thickness were radiated at 90K by 130MeV ^{28}Si ions up to a fluence of 1.154x10^{16} ions/cm^2. The surface modifications induced by irradiation have been examined by scanning electron microscopy (SEM) and scanning tunneling microscopy (STM). It has been observed that smoothing of the sample surface is evident in both SEM and STM micrographs. The SEM pictures show a decrease in the heights of the hills and filling up the valleys on the micrometer scales. The STM pictures on the other hand, show smoothing of scratch like surface disorders at nanometer length scales. However, the electronic energy loss S of 5.75KeV/nm, does not lead to detectable track diameters, in agreement with the existing results. The observations have been attributed to a large electronic energy deposition due to high fluence, and a subsequent local shear relaxation of the near surface atoms. The theory of shear flow mechanism has been further extended to explain the results.

A consolidated study of structural and superconducting properties of Ca substituted $R_{1-x}Ca_xBa_2Cu_3O_{7-d}$ system with R = Er, Y, Sm, and Nd and for 0.50>x>0.0 was undertaken. Interestingly, with increasing x Er/Y samples show behaviour significantly different from Sm/Nd. In particular (1) orthorhombhic distortion of R: 123 lattice is found to be little affected for Er/Y samples with increasing x in comparison to Sm/Nd samples. (2) Although, Ca substitution leads to oxygen depletion for all the four sets of the samples, the average Cu valence is in general found to remain invariant with x. (3) ρ(T) is found to show upward curvature for Er/Y samples which is absent for the Sm/Nd samples. (4) Tc (ρ=0) as a function of x and d shows a much steeper decrease in Er/Y based samples than in Sm/Nd based samples. The results unequivocally point to a different structural order/disorder in Er/Y samples as compared to Sm/Nd based samples. Different site preferences of oxygen vacancies, predominantly created in CuO_2 planes (CuO chains) of Er and Y (Sm and Nd) based samples, might be responsible for the observed difference in the behaviour. This contention is supported by host of other considerations and experimental observations.

Studies on excess conductivity, resulting from superconducting fluctuations above Tc, have been carried out in pure and doped 123 HTSC systems. The preferential dopings have been attempted on planar and chainer Cu-sites in its structure. Strong interplay between impurity effects and carrier-carrier scattering has been indicated. The dependence of order parameter dimensionality on Cu-site disorder and its crossover behaviour on superconductivity suppression and on anisotropy are discussed. The order parameter fluctuations are seen to be invariant to low Fe content (at Cu-sites) and with increase in Fe, there is marked dimensionality variation and oxygen dependnce. Dimensionality reversal is seen to be promoted at higher Fe content. Thermogravimetric analysis (TGA) of Poly Nitryl Polymers show very encouraging results. On the basis of the findings PAN sheets have been prepared which are to be tested for their own TGA behaviour.

Theoretical Investigations

Study of phase transition in rubidium halides:

The phase transition phenomenon in rubidium halides is studied and the results are compared with the available experimental findings. It is found that the three body potential model, arising out of charge transfer effects during overlapping of electron shells of adjacent ions,

provides better result than the two body potential model. The Rb-compounds are found to obey Vinet equation of state.

Jahn-Teller theory of EPR behaviour of d1 ions in $LiNbO_3$:

The EPR study of Ti^{3+} $3d^1$ and Nb^{4+} $4d^1$ centres on trigonal sites in $LiNbO_3$ at temperature lower than liquid nitrogen show the presence of dynamic pseudo-Jahn-Teller interaction. The presence of this interaction is inferred from the reduction of orbital magnetic moment, which is very large at Nb sites and moderate at Li sites. There is no proportionate reduction in the spin-orbit coupling coefficients. Moreover the orbital reduction factor for T_i^{3+} is lower than that for Nb^{4+}. In order to explain these complexities a Jahn-Teller theory of d^1 ion in trigonally distorted octahedral symmetry is developed. The Jahn-Teller, spin-orbit and trigonal field interactions are all treated on equal footing. The hamiltonian is analyzed in an infinite coupling model and the results compared with the experimental behaviour.

क्रायोजेनिक्स
CRYOGENICS

इस प्रभाग का मुख्य उद्देश्य उच्चतापीय अतिचालकों पर आधारभूत अध्ययन करना तथा अतिचालक चुम्बकों का विकास करना है। इसके अतिरिक्त द्रवीय नाईट्रोजन तथा द्रवीय हीलियम के वितरण का कार्य भी इस प्रभाग का है। आर्द्रता के मानकों के अनुरक्षण तथा विकास से सम्बन्धित कार्य भी इसी प्रभाग द्वारा किया जाता है। उच्चतापीय अतिचालकों के सामान्य तथा असामान्य (एनामलस) व्यवहार को समझने के उद्देश्य से विभिन्न धनायनी स्थलों (Cationic Sites) पर प्रतिस्थापन का आधारभूत अध्ययन किया गया है। रजत-शीथ (Ag-sheath) उच्च T_c टेप्स तथा यान-टेलर (Jahn - Teller) पोलरॉन के रिलैक्सेशन से सम्बन्धित कार्य भी किया गया है। एक 7 T और एक इन्सर्ट टाईप 3 T बेबी चुम्बकों का डिज़ाईन, विकास एवं परीक्षण किया गया।

The broad aim of this division is to carry out basic studies on high temperature superconductors and continue work on the development of superconducting magnets. In addition we also have the responsibility of supplying liquid nitrogen and liquid helium to various groups in the laboratory. Humidity standard related activities are also carried out in this division. The basic studies relate to substitutions at various cationic sites, with a view to understand anomalous superconducting and normal state behaviour of these materials. Studies have also been carried on Ag-sheath high T_c tapes and on the evidence of relaxation of Jahn-Teller polaron. A 7 T and an insert type 3 T baby magnet were designed, built and tested.

Superconducting Magnet Technology

Superconducting Magnet Technology is an important ongoing activity. It basically involves design & fabrication of superconducting magnets customised to various applications. Superconducting magnet development work is undertaken both for laboratory and for outside institutions.

Development of computer programme for designining superconducting magnets:

A computer program in programming language 'C' was developed to calculate and optimize the design parameters like winding diameter. ratios (α), winding length to diameter ratio (β), the field factor $F(\alpha,\beta)$ and required field & field homogeneity. Conductor selection was done to make best use of the current carrying capacities of the conductors & the final design of the solenoid was frozen. The magnet shall have a clear bore of 52mm and will be housed in a 165mm diameter super-insulated LHe cryostat. During the year various parts of the formers and the end flanges were fabricated.

Design of a super-insulated LHe cryostat was completed. The Dewar has a neck diameter of 165 mm & height of about 1.2 meter and a total capacity of 27 litres of liquid helium. The cryostat has a 80 K radiation shield and super-insulation. It will be fitted with pressure relief valve to take care of He gas in the event of magnet quench. An order for cryostat fabrication based on NPL's design was placed with an outside fabricator. Various items such as SC wire, Hall Gaussmeter, LHe level meter and power supply are being procured.

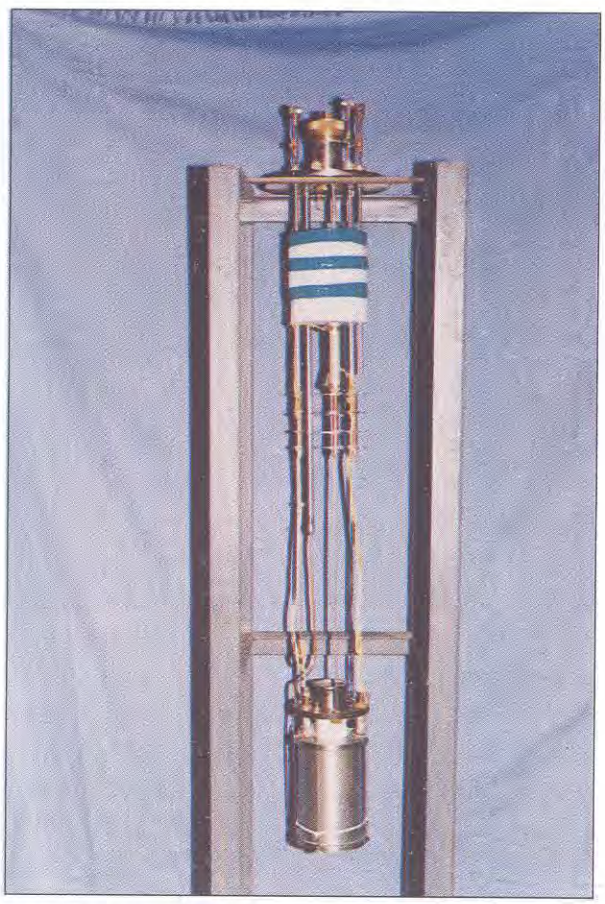


Fig. 9.1: A 50 mm Bore 7 T SC Magnet alongwith support system. The styrofoam spacers, baffles are provided to reduce the liquid He evaporation rate. The dump resistor provided protects the magnet during the quench. This magnet produced a field of more than 7 T at 100 A current.

S. No.	Parameter	Inner coil	Outer COIL
1.	Inner Winding Diameter	57.4 mm	94.3 mm
2.	Outer Winding Diameter	93.9 mm	127 mm
3.	Winding Length	185 mm	185 mm
4.	Conductor Used	Nb-Ti	Nb-Ti
5.	Cu : SC ratio	1.35 : 1	1.35 :1
6.	Conductor Dia.	0.75 mm	0.54 mm
7.	No. of Filaments	45	54
8.	No. of Layers	22	24
9.	Total No. of Turns	5371	7999
10.	Conductor Length	1.28 Km	2.78 Km
11.	Field at 87.2 Amp.	2.93 T	4.07 T
12.	Field at 100 Amp.	3.37 T	4.65 T
13.	Total Central Field	7 T at 87.2 Amp	
14.	Homogeneity over 10 mm SDV	0.072 %	
15.	Total Central Field	8.02 T at 100 Amp	
16.	Interlayer Material	Fibre Glass Cloth	
17.	Impregnating Material	Bees Wax	
18.	Quench Protection	Through Dump Resistor	
19.	Inductance	5.36 H	
20.	Stored energy	20.4 KJ	

Fabrication of one 7 T superconducting magnet with 50mm bore was completed:

The magnet designed and fabricated at NPL, shown in Fig. 9.1, has a working bore diameter of 50 mm and produces a field well above 7 Tesla at a current of 100 Amps. Design parameters are listed in Table 9.1

3 T Insert type superconducting magnet:

The group has developed a 3 T superconducting magnet with a working bore of 28 mm. The magnet has a support system with LHe level sensor, radiation baffles and current leads. The magnet with support system can be inserted and operated in a 100 litres, 3 inches neck dia, LHe storage dewar. There is no hassle of having a bucket type LHe Dewar or transfer of liquid helium. 3T field is sufficient for a large variety of physical measurements like Hall effect, magneto-conductivity etc. The magnet is taken out of the container after the measurements are over and can be hung on a wall. The magnet is wound in single section using 0.285-mm dia. (Cu/Nb-Ti) wire. The magnet produces a central field of 3 T at an operating current of 30.5 A with field homogeneity of 0.12% over 10 mm SDV. This newly built

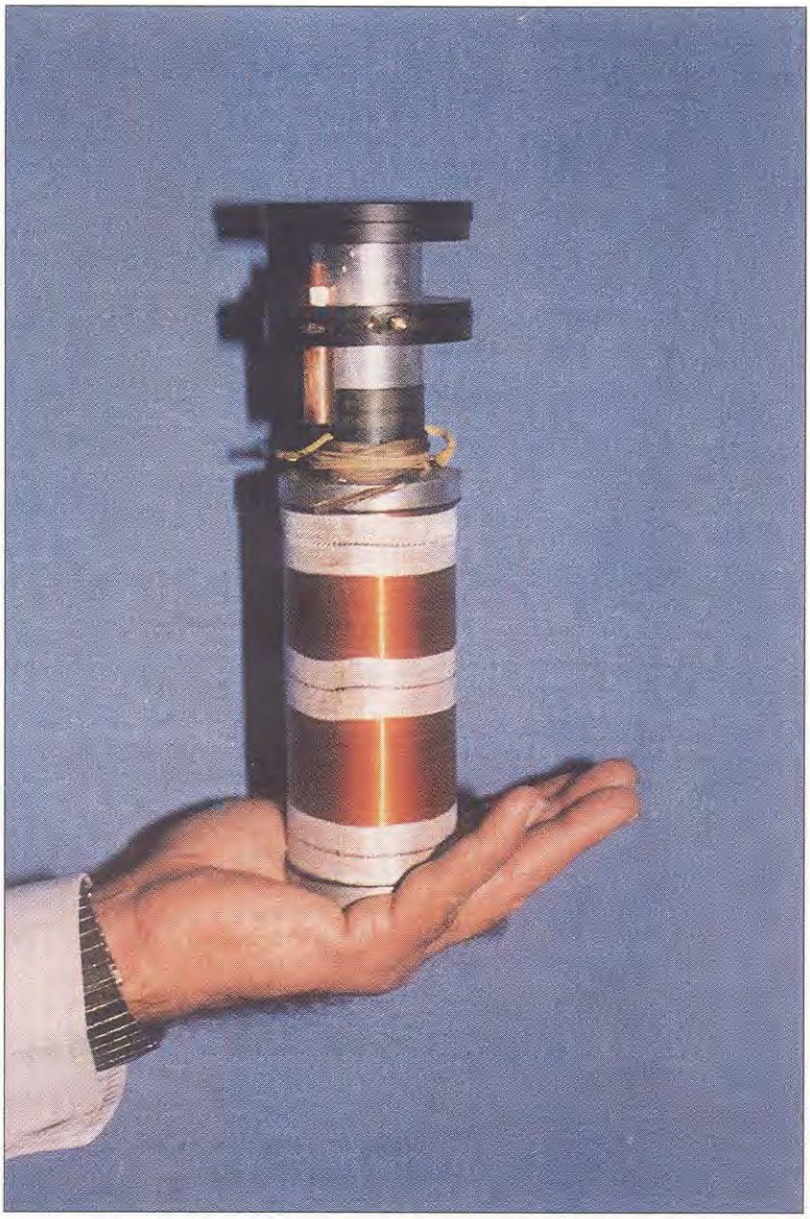


Fig. 9.2: A 3 Tesla superconducting insert type 'Baby Magnet'

3T insert superconducting magnet has overall dimensions of 55mm diameter and 130mm length for use as an insert (Fig. 9.2).

The 2.35 Tesla superconducting magnet for 100 MHz NMR was integrated with NMR spectrometer developed at Indian Institute of Science. Joint experiments were performed for testing and evaluation of SC magnet for its compatibility with the 100 MHz FTNMR spectrometer developed at the Indian Institute of Science, Bangalore.

Study of the magnetic relaxation under low field (10-50 Oe) in granular high - Tc superconductors - Impact of order-disorder:

Granular high-Tc systems like, $YBa_2Cu_3O_{7-x}$ and $Bi_{1.75}Pb_{0.35}Sr_2Ca_2Cu_3O_{10+x}$ systems have been prepared and low-field (10-50 Oe) magnetic relaxation study was carried out over a temperature regime of 20-80 K. The flux line dynamics and pinning could be studied over the field and temperature ranges. It is observed that while the

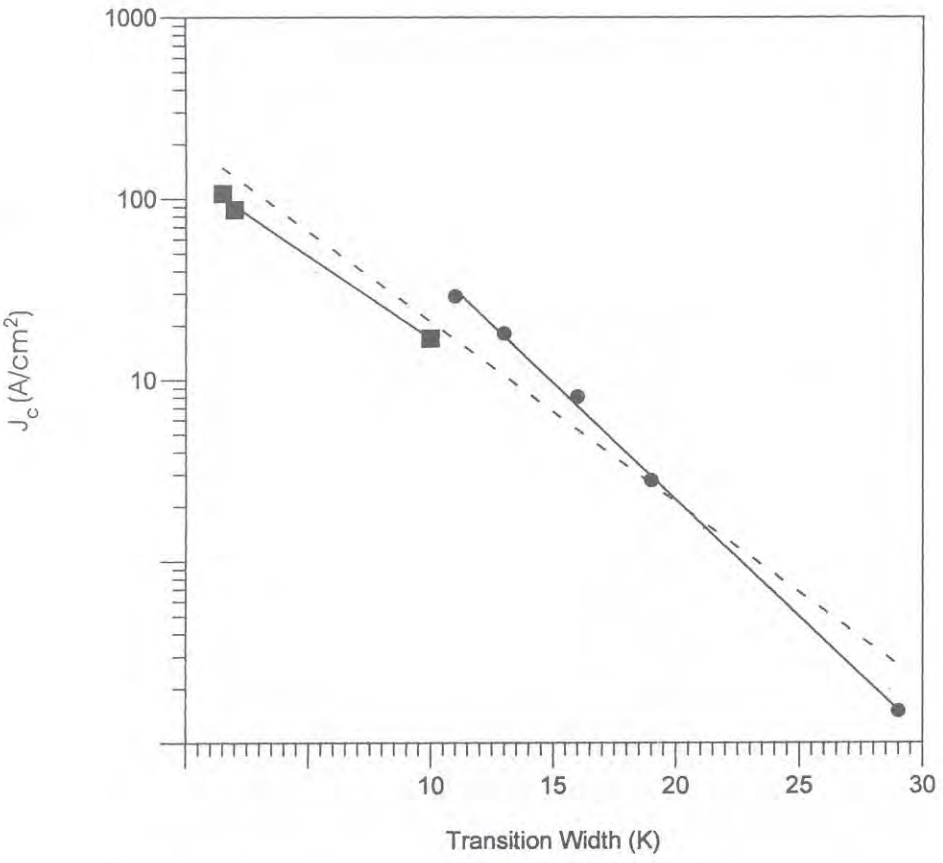


Fig. 9.3: The transport J_c versus transition width pattern for BPCCO (filled circles) and YBCO (filled squares) systems fitted with theoretical pattern (solid line)

parent granular samples depict lower relaxation and hence higher flux pinning energy U, silver added samples offer a substantial rise in the relaxation rate which, in turn, gives rise to smaller U. Such an observation has been explained through uniformity in the grain boundary properties across the matrix: silver addition gives rise to improved uniformity and hence lower flux pinning energy. It is also noted that in a granular sample the transport critical current density (J_c) depends on the net current carrying cross-section. Since uniform matrix offers larger current carrying cross-section, silver added samples depict higher J_c (Fig. 9.3). It seems, therefore, that in order to achieve higher J_c and lower decay rate, an optimum combination of order and disorder is required across the entire granular matrix. Silver addition appears to be an effective tool in tailoring the granularity of the samples.

Fabrication of the Ag-sheathe High-T_c superconducting tapes by powder in tube technique:

Silver sheathed $YBa_2Cu_3O_{7-x}$ tapes were prepared by powder-in-tube technique. Tapes of thickness 0.1 to 1.0 mm have been prepared by repeated rolling and intermediate annealing. The current voltage (I-V) characteristics as well as J_c have been measured at 77K under zero field. The nature of I-V curves has been fitted using the flux-flow and Josephson junction array models. The J_c values depict remarkable thickness dependence with higher J_c for thinner samples and vice versa. The thickness dependence too, could be explained by flux flow and Josephson junction array models.

Evidence of relaxation of Jahn-Teller polarons in La_{1-x} Sr_xMnO_3(0.1<x<0.5):

The study of resistivity over a wide temperature range – from 15 to 1273 K – in a series of $La_{1-x}Sr_xMnO_3$ (0.1<x<0.3) samples reveals transition and re-entrant metallic behavior at a very high temperature beyond T_c (Curie Point). The transition temperature T_{JT} that marks the small Jahn-Teller polaron (around Mn^{3+} ions) to large polaron transition turns out to be crucial for estimating the role of Jahn Teller effect in this class of materials. It has been observed that T_{JT} varies and drops sharply with the drop in the Jahn-Teller active Mn^{3+} ions.

Module hydride air-conditioner:

Significant progress has been made on the DST funded project entitled Development of module hydride air-conditioner of 250 to 500 watts cooling capacity. This is a joint collaborative project between BHU and NPL. Both the hydride materials were got characterized for their P-C-T curves, which became possible as a result of our interaction with University of Stuttgart, Germany. The project is formally completed on 30th September 1998. The first order testing of the device has been completed. The results were encouraging and confirm the feasibility of the heating/cooling device from technical point of view.

Liquid nitrogen supply:

One big storage cryo-container of about 6000 litres capacity has been installed near the existing liquid nitrogen facility.

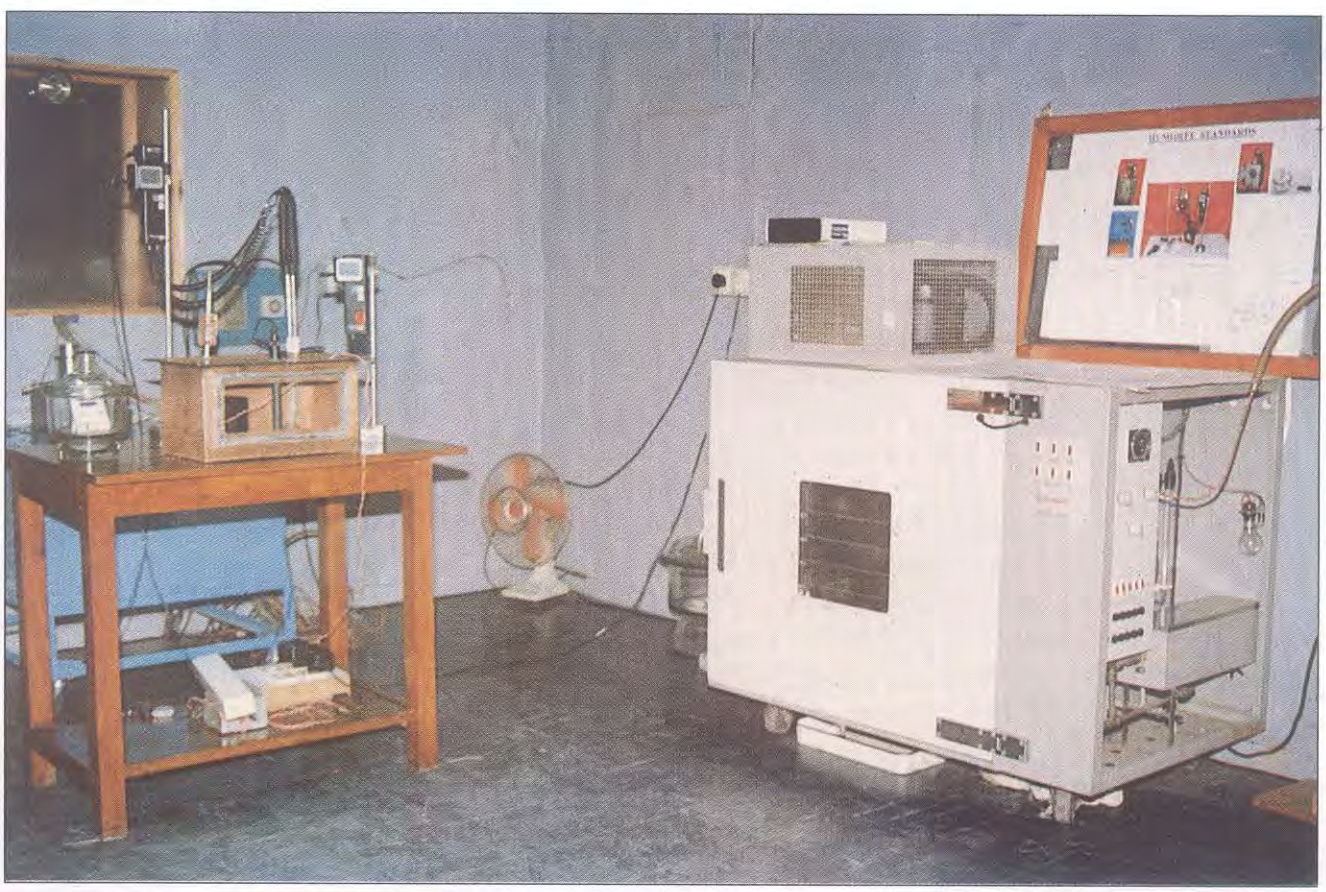


Fig. 9.4 The experimental set-up for the calibration of relative humidity sensors

Humidity Standard

Setting up of national humidity standard:

It is one of the recent activities of the laboratory with an objective to provide calibration service to various industries. In its first year of operation, the group offered calibration services to several industries. Besides, the following facilities have been set up:

- Setting up of secondary humidity standard using two matched and precise quartz thermometers (aspirated psychrometer) RH range 10 % to 95 % RH with an accuracy of ± 1 % RH (Fig. 9.4).
- Installation of humidity oven for calibrating different types of RH sensors at various temperatures. Generation of different RH using saturated salt solutions.
- Insitu calibration facility of RH sensors using capacitance type hygrometer.
- A proto- type unit for RH generation using two-flow method.
- Humidity generation using glycerine-water mixtures.
- Preliminary studies on the feasibility of portable RH generator using two-pressure technique

शोध सुविधाएँ व सहायक सेवाएँ
RESEARCH FACILITY AND SUPPORT SERVICES

यह प्रभाग निदेशक की अध्यक्षता में वर्ष 1997-98 में गठित किया गया था । इस के आधीन विभागों में सम्मिलित हैं: निम्नतापिकी व अन्य परिष्कृत सुविधाएँ, तकनीकी अवसंरचनाः- उदाहरणार्थ केन्द्रीय कम्प्यूटर सुविधा, मुख्य वर्कशॉप, ग्लास प्रौद्योगिकी, वर्कशॉप, विद्युत वितरण, पम्पिंग, वातानुकूलन, सिविल वर्क्स, कैम्पस रख-रखाव, दूरभाष, फैक्स, फोटोग्राफी, पुस्तकालय, अनुसंधान एवं विकास प्रबंधन व प्रशासन इकाइयों का प्रबन्धन व अन्य ऐसी सुविधाएं जिनका उपयोग सभी प्रभागों द्वारा होता है, इस प्रभाग के अधीन आते हैं । इसी का एक भाग तकनीकी सचिवालय कहलाता है। सभी आंतिरक एवं बाह्य परियोजनाओं का नियोजन व समन्वय मार्केटिंग व तकनीकी ज्ञान का हस्तान्तरण, विभिन्न अन्तर्राष्ट्रीय कार्यक्रमों में भ्रमण, पेटेंटों का निवेदन व पंजीकरण, मानवीय संसाधनों का संवर्धन, प्रयोगशाला के डेटा बेस का प्रबन्धन, राजभाषा विषयक प्रसारण व प्रयोगशाला के तकनीकी प्रकाशन ये सभी इसी प्रभाग में आते हैं । निम्नतापिकी के क्षेत्र की गतिविधि पिछले अध्याय में प्रस्तुत की गई है । इस प्रभाग की अन्य गतिविधियॉ संक्षेप में यहां दी गई है। इस वर्ष 275 कम्प्यूटरों को जोड़ने की क्षमता वाली एन.पी.एल. लैन (NPL-LAN) स्थापित कर दी गई हैं ।

This Division was constituted during 1997-98, with Director, NPL as its head. Cryogenic and some other sophisticated instruments facilities, technical infrastructure - such as, central computer facility, main workshop, glass technology workshop, electrical supply, pumping, air-conditioning, civil works, campus maintenance, phones, fax, auditorium, photography, library, R&D management and administration units, that provide support to and are shared by all the other divisions, whose R&D activities are given in the preceding chapters of this report, function under this division. The Technical Secretariat, one of the units of this Division is responsible for planning and coordination of all in-house and externally supported R&D projects, marketing and transfer of technological know-how developed indigenously, processing of deputation under various international collaborative programmes, filing of patent, human resource development programmes, maintaining laboratory information data bases, propagation of Rajbhasha and bringing out technical publications of the laboratory. Activities in the area of cryogenics were described in the previous chapter. The rest of the activities of this Division are briefly presented here. NPL-LAN with the capability to connect 275 PCs across the laboratory was put in place this year.

Central Computer Facility

The CCF provides services through an array of PC's, workstations and a library of software that serve as common user facilities. It also administers e-mail service to various users in the laboratory. The facilities added this year include the following:

- NPL - LAN consisting of three optical fibre segments between the main building and other campus buildings and UTP segments inside buildings was put in place during this year. A total of 275 information outlets were installed in various rooms inter-connected through switches and hubs located at various places on the campus. All staff members have been provided a personal e-mail account.

- A VSAT for connecting to the Internet and many server for users of NPL-LAN were configured and set-up. These included an e-mail server (on LINUX), DHCP (Dynamic Host Configuration Protocol) server (on LINUX) to distribute dynamic IP addresses, a name server (on an HP 9000/735 workstation) for translating internet host names to IP addresses.

Apart from the in-house management a joint project with M/s Amil Ltd., Delhi for the automation of a compression testing machine was successfully completed. The sponsoring industry has launched this fully automated system in the market. Another joint project with NCHM and IHTMCN for computerization and networking of the premises was also completed..

Library and Technical Information Services

NPL library is a leading repository of publications in physics and related sciences in the country. During the year it

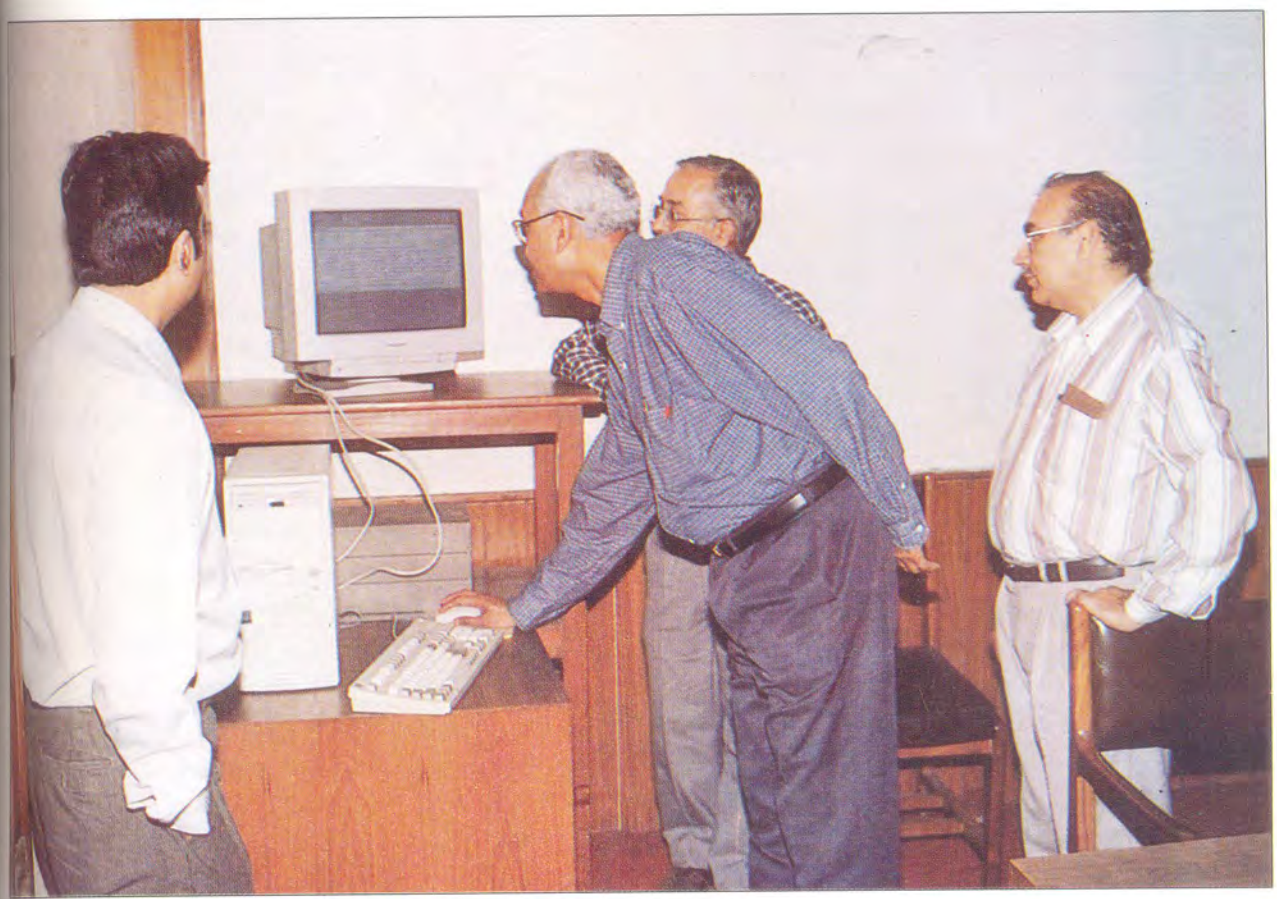


Fig. 10.1 : Inauguration of NPL - LAN connection First Phase by Dr. R A Mashelkar, FRS, DG-CSIR; others present (L to R) Prof. A K Raychaudhuri, Dr. Ravi Mehrotra and Dr. S M Dhawan

strengthened its collection by acquiring new books and journals on need basis. It spent Rs. 80.09 lakh for this purpose – Rs. 76.13 lakhs on journals and the rest Rs. 3.96 lakhs on books. During the year it subscribed to 144 journals and purchased 371 books of which 181 were in Hindi. Its collection by the end of the year stood at 43047 books and 65000 volumes of bound journals.

Named as KSK Library, in the honour of the first director of the laboratory, Late Sir K S Krishnan, the NPL Library is gradually transforming itself into an electronic library. During the year it has started dial-up service for Internet access as a central facility in the library and has also created a web page on the NPL intranet. The library web page provides Internet access to information on journals of current subscription, new issues received in the current week, current contents of electronic journals, impact factor of journals, etc. It also provides links to electronic journals, electronic libraries, publishing houses of electronic journals, etc. The page is updated weekly. The page also provides to its users Internet access for performing e-mail, www, ftp and telnet functions. It also subscribed to three leading CD-ROM databases in physical sciences - Current Contents: Physical, Chemical & Earth Sciences, Current Contents: Engineering, Technology and Applied Sciences (both with reference additions) and Material Science Citation Index. The library continued to perform its house keeping function on computer using a Library Information Package developed in house.

The library also continued to provide services like selective dissemination, literature search, access to bibliographical databases available in-house, inter-laboratory loan, document supply, photography, etc.

Technical Services

Responsibility of general maintenance of infrastructure like electricity, pumping, air conditioning, telephones, fax, photography service, auditorium, maintenance of campus and colony, civil works, etc. lies with this section.

Workshops

Central Workshop:

Different types of machining facilities have been established in NPL's central workshop to extend support to laboratory's R&D needs and to undertake external contract jobs. In addition to normal milling, lathe and welding machines etc. for normal fabrication jobs the NPL workshop also has a CNC milling facility backed up by a CAD-CAM facility comprising a high precision German 'Deckel FP4A' universal milling machine, CNC rotary table and a Gildemeister CT-200 CNC lathe machine capable of producing turned components. This workshop also has AutoCAD based drawing and tracing facilities. During the year the central workshop has completed 1255 in-house and 31 externally contacted machining jobs. ECF generated during the year was Rs 12.90 lakhs.

NPL also has a separate high pressure and metal extrusion shop, which caters to in-house as well as external users.

Glass Technology Unit:

This unit has the facilities and expertise for design, development, fabrication and repair of scientific glass and quartz glass apparatus and equipment. It undertakes scientific glass instrumentation work for in house as well as other institutions, industries and organisation. During the current year GTU completed 201 jobs for NPL and 39 jobs for outside users and earned Rs. 3.02 lakhs as ECF.

Technical Secretariat

Planning and Coordination:

This Group coordinates all the projectised activities of the laboratory, including in-house, collaborative, sponsored and grant-in-aid projects. It keeps track of current manpower deployment. On these it collects information, analyses it and places it to top management for decision making. During the year

the group handled 49 grants-in-aid, 29 collaborative and one sponsored projects. The group also handles coordination in matters related to the Research Council.

Intellectual Property Right:

Realizing the strategic importance of intellectual property in the ever-changing global economic scenario, an independent cell looks after this. Its main thrust is to manage in totality the IP portfolio of the laboratory. This includes not only helping scientists to file patents of deserving R&D outputs but also to scout around and look for and secure the possibility to protect any R&D output. During this year 6 patents have been filed in India and one patent application has been filed in foreign countries. One technology know-how was also transferred. Details are given in Appendix.

Marketing Group:

This Group is responsible for marketing technologies developed by NPL. It also facilitates and processes taken up by NPL scientists contract research projects from external agencies. This group arranged NPL participation in the India International Trade Fair (ITF-99) held at Pragati Maidan, New Delhi, during 14-27 November 1998 and exhibited NPL developed R&D products. One know-how transfer was arranged during the year. The details are given in the Appendix.

International Science & Technology Affairs Group (ISTAG):

This group is responsible for maintaining and processing applications of NPL staff for deputations abroad. The Group also arranges special lectures by visiting scientists. The deputations and lectures arranged this year are listed in the Appendix.

Human Resource Development Group (HRDG):

This Group arranges various training programmes for the benefit of NPL staff and also the trainings offered by NPL for the benefit of industries in various areas of calibration. The group also supports organization of various symposia, conferences etc. by NPL staff at NPL. It also attends to various PR activities and follows up various MoUs with educational institutions in respect of doctoral, post-graduate and summer training on reciprocal basis. It processes induction of JRFs, SRFs and Research Associates for NPL programmes. The Group also pursues other schemes of CSIR on EMR and HRD activities. List of training programmes and other events organized by the group is given in the Appendix.

Publication and Documentation:

This cell is responsible for compiling, editing, printing and distribution of Annual Reports and other documents informing about laboratory's activities. A monthly circular 'NPL-Info' for internal consumption is also being brought out in printed form. This unit also compiles monthly and annual inputs to go from NPL for CSIR level reports.

Rajbhasha Unit:

This unit is looked after by both the office of COA and also the Technical Secretariat and helps scientists in Hindi transcription of their papers, articles, reports, etc. This year also the Rajbhasha unit arranged various training programmes. Hindi fortnight was celebrated in the month of September to encourage use of Hindi in all official proceedings and also to encourage writing of R&D outputs in Hindi for the benefit of the society. As per Govt. of India directives the Unit arranges selection for cash awards of NPL employees who contribute most to the propagation of Hindi in office work. Cash awards are given to winners in various categories. Detailed report of the Unit is given in Hindi in the following pages.

वर्ष 1998-99 के दौरान राष्ट्रीय भौतिक प्रयोगशाला में हिन्दी की प्रगति

PROGRESS OF RAJBHASHA IN THE LABORATORY

राजभाषा नीति के अनुपालन और कार्यान्वयन हेतु इस प्रयोगशाला द्वारा निरन्तर प्रयास किए जा रहे हैं । अब प्रयोगशाला के लगभग सभी अधिकारी ध्कर्मचारी हिन्दी का कार्यसाधक ज्ञान रखते हैं और हिन्दी में कार्य करने को वरीयता देते हैं । वर्ष के दौरान प्रयोगशाला ने कार्यान्वयन की दिशा में उल्लेखनीय सफलता प्राप्त की है ।

प्रयोगशाला चूँकि नियम 1976 के नियम 10(4) के अन्तर्गत अधिसूचित है। अतः इसका दायित्व और भी बढ़ जाता है कि यहाँ के अधिकारी /कर्मचारी अपना अधिकांश कार्य हिन्दी में ही करें। राजभाषा यूनिट द्वारा समय-समय पर जारी किए गए परिपत्रों/नोटिसों तथा निदेशक महोदय तथा प्रशासन नियंत्रक/प्रशासनिक अधिकारी के दिशा निर्देशों एवं प्रेरणा के फलस्वरूप ही वर्ष के दौरान राजभाषा अधिनियम 1963 की धारा 3(3) के अन्तर्गत जारी किए जाने वाले सभी कागजात द्विभाषी ही जारी किए गए हैं।

वर्ष के दौरान प्रत्येक तिमाही में राजभाषा कार्यान्वयन समिति की बैठक बुलाई गई तथा बैठक में लिए गए निर्णयों पर सफलतापूर्वक अनुवर्त्ती कार्यवाही की गई। निदेशक महोदय की अध्यक्षता में हुई उक्त राजभाषा कार्यान्वयन समिति की बैठकों में राजभाषा नीति के कार्यान्वयन के लिए राजभाषा विभाग, गृह मंत्रालय, भारत सरकार द्वारा तैयार किए गए वार्षिक कार्यक्रम पर विस्तार से चर्चा हुई तथा निर्धारित लक्ष्यों को प्राप्त करने का पूरा-पूरा प्रयास किया गया ।

चित्र 10.2: हिन्दी पखवाड़े, दिनांक 1.9.1998 से 18.9.1998, के समापन समरोह के अवसर पर भाषण प्रस्तुत करते हुए प्रो. ए. के. रायचौधुरी, निदेशक, एन.पी.एल. (बाएं से तृतीय)।

APPENDIX : 1
PUBLICATIONS

Physico-Mechanical Standards

Papers in Journals:

Arun Vijaykumar D.; Estimation of measurement uncertainty in pressure measurement: A case study; MAPAN, 13, 1998, 85.

Bandyopadhyay A. K., and Gupta A. C.; Establishment of the National pressure standards -A case study for uncertainty statements; MAPAN, 14, 1999, 3.

Bandyopadhyay A. K., Dilawar Nita, Arun Vijaykumar D., Varandani, Deepak, and Singh Dharambir.; A low cost laser-Raman spectrometry , Bull. Mater. Sci., 21, 1998.

Chakraborty B. R., Lehman D. E., and Winograd N.; Time-of-Flight static secondary ion mass spectrometry analysis of surface contamination on Pt/Ir standard mass material, Rapid commun. Mass Spectrom., 12, 1998, 1261.

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Chawla Santa; uncertainty of measurement: A case study for frequency calibration of He-Ne lasers, MAPAN, 13, 1998, 117.

Dancheva Y., Sharma R., Sterr U. and Riehle F.; Development and investigation of frequency references for the 1.55 ìm optical communication band, SPIE Publ. 3571, 1998, 209.

Garg R. K., Kumar Pardeep, Ram R. S. and Zaidi Z. H.; Photoacoustic spectroscopic studies of mono-substituted naphthalene molecules, Spectrosc. Lett., 31, 1998, 1013.

Gera B. S., Ramakrishna K. V., Pahwa D. R., Singh Gurbir, Ojha V. K. & Saxena Neeraj; Design, development and fabrication of a sequential switching network for 3-axis Doppler Sodar, J. Instrum. Soc. India, 28, 1998, 206.

Jain S. K., Chandra Mukesh and Gupta Reeta.; On the design and receiving characteristics of a directional hydrophone using a paraboloid reflector, J. Acoust. Soc. India, 26, 1998, 70.

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APPENDIX : 2
PATENTS FILED

S.No.	Title	Country	Project
1.	A process for the preparation of conducting polymeric membrane and a conducting polymeric membrane prepared thereby useful as a filter for capturing viruses in potable liquids.	India	GIA
2.	A conducting polymeric membrane and a process for the preparation of the said membrane.	USA, Germany, Malayasia, Bangladesh, Romania, and Pakistan	GIA
3.	An Apparatus useful for measuring particle size of a powder sample	India	In house
4.	An improved process for the preparation of high coercivity yttrium iron garnet thin films useful for magnetic and magneto optic recording	India	In house
5.	A process for the preparation of Silica Glass	India	In house
6.	An improved process for the preparation of thin films useful for electronic optical tribological application	India	In house
7.	A device useful for the enhancement of resolution of an autocollimator and an autocollimator incorporating the device	India	In house

Knowhow Transfer	
Oven controlled crystal oscillator	Party: M/s Sertel Electronics (Pvt.) Ltd., Chennai.

APPENDIX : 3
COLLABORATING INSTITUTES

Collabarating Agency	Activity / Area
Physico-Mechanical Standards	
Archaeological Survey of India; ,	Applied acoustics
Bhabha Atomic Research Centre, Mumbai	Laser cooling of atoms
Bureau of Indian Standard	Applied acoustics
Central Pollution Control Board;	Applied acoustics
CNR-IFA, Italy; I.P.C.L., Dhalej	Applied acoustics
Delhi Metro Rail Corporation Ltd.	Applied acoustics
Department of Environment & Forests,	Applied acoustics
Department of Science & Technology; Delhi,	Applied acoustics
Indian Association for the Cultivation of Science, Calcutta,	Surface characterization of thin films
Indian Institute of Technology, Kharagpur,	Surface and interface characterization of semiconductor devices
Indian Institute of Technology, New Delhi.	Surface and interface characterization of thin films, ultrasonic studies
Indira Gandhi Centre for Atomic Research, Kalpakkam;	High Pressure R&D
Instituto di Metrologia "G. Colonnetti" (IMGC), Italy,	Vaccuum & leak standards
KADAM Env. Consultants,Barod	Applied acoustics
National Institute of standards & Technology (NIST), Gaithersburg, USA,	Development of diffuse reflectance/ transmittance & emittance standards and bilateral intercomparison of infrared standards
National Institute of Standards and Technology, USA.;	Diffuse reflectance/emittance standards, Intercomparison and R&D collaboration in vacuum, pressure & leak standards
National Research Laboratory of Metrology, Japan,	Pressure & vacuum standards
Nuclear Science Center, New Delhi, The Pennsylvania State University, USA	Surface analysis, collaborative project funded by DST

Collabarating Agency	Activity / Area
PTB, Germany	Pressure & vacuum standards
Rajeev Gandhi Cancer Institute and Research Centre, New Delhi,	Detection of cancerous tissues by near infrared techniques
Steel Authority of India, Ranchi.	Applied acoustics
Sugar Technology Mission, TIFAC, DST, New Delhi, and Sriram Industrial Enterprises Ltd., New Delhi,	On line determination of sugar contents in sugar cane juices & sugar cane solids by near infrared techniques
University of Ulm, Germany	Studies on hetroepitaxial growth
Uttar Pradesh State Observatory, Nainital,	Steller interferometry

Electrical and Electronic Standards

CEERI, Pilani	Development of rf-SQUID electronics
NPL-PTB technical cooperation programme	Shri P.C. Negi undergone training on "Vector network analyser measurement system at NPL, Teddington, U.K. with effect from 12th April to 9th May, 1998
Physics Department, Banaras Hindu University	rf-SQUID and harmonic generation studies in Hg-based high-T_c superconductors
Tata Institute of Fundamental Research, Mumbai	rf-SQUID and harmonic generation studies in borocarbide superconductors
University of Delhi, Delhi	Microwave Superconductivity

Engineering Materials

Defence Metallurgical Laboratory, Hyderabad	Al alloy metal matrix composites
Department of Materials Science, University of Leeds, Leeds, UK	High thermal conductivity carbon- carbon composites
Graphite India Ltd., Bangalore	High density graphite
Hindustan Aeronautical Limited, Bangalore	Al alloy oval shaped tube for ALH, Development of Ti fasteners
Indian Oil Corporation Research & Development Centre, Faridabad.	High performance carbon fibre from petroleum streams

Collabarating Agency	Activity / Area
Institute for Plasma Research, Gandhinagar, Gujrat.	High thermal conductivity graphite
ITMMEC, IIT, New-Delhi	Asbestos free break pads material for automobile
Mechanical Engineering Laboratory/AIST/MITI, JAPAN	Precision forming technology
Vikram Sarabhai Space Centre, Trivandrum	Square tube of Mg alloy

Electronic Materials

CEERI, Pilani (Rajasthan).	Development of Si on Si optical waveguide for WDM applications
DRDO Defence Lab., Jodhpur.	Phosphors
IIT Kanpur	a Si:H Alloys
IIT Kanpur.	Development of a Si:H pixel array for X-ray and Neutron imaging
IGCAR	Beta alumina tube. For sodium metal production
IIP Dharadun	particulate filter for 10 BHP Diesel Engines

Polymeric and Soft Materials

AIIMS, Deptt. of Microbiology, New Delhi	Conducting polymeric membranes
Center for Bio-Chemical Technology, New Delhi	Bio sensor and related material
Delhi University, Deptt. of Physics and Astrophysics, Delhi.	Conducting polymers.
GE Corporate Research and Development, New York	Conducting polymers composite for shielding of electromagnetic interface and as antistatic materials.
G.N.D University, Amritsar	PAN/PMMA based solid polymer electrolytes
IACS Calcutta	Bio sensor and related material
India-Germany (CSIR-KFA/DLR)	Characterization of high switchable ferroelectric liquid crystal materials for optical modulation

Collabarating Agency	Activity / Area
ISRO Vikram Sarabhai Space Center, Thiruvanandapuram	Metalization of Fabrics as a shield against electromagnetic Interface (EMI)
Institute of Physical Chemistry, Technical University Dermstadt Germany	Dielectric studies of surfaces stabilized ferroelectric liquid crystal cells
IRDE(DRDO) Dehradun	Development of optically addressed spatial light modulators
Maitreyi College (Delhi University), Chanakya puri, New Delhi	Conducting polymeric membranes, Polymeric Schottky junction devices, Conducting polymers.
NIST Gathersburg, USA	Immoblization of Proteins / Enzymes in Conducting polymer
Navel Research Laboratory, Washington DC, USA	Surface order and structure studies of polymer solid interfaces

Materials Characterization

India

Bhabha Atomic Research Centre, Trombay, Mumbai.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Central Building Research Institute, Roorkee.	Preparation and dessimination ofBhartiya Nirdeshak Dravyas
Central Food Technological Research Institute, Mysore.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Central Glass & Ceramic Research Institute, Calcutta	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Central Salt & Marine Chemicals Research Institute, Bhavnagar	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Gharda Chemicals Limited, Dombivili	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
IACS, Calcutta	Characterization by SEM/TEM
IIT Delhi	Characterization by SEM/TEM
Indian Agricultural Research Institute, New Delhi	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Indian Institute of Chemical Technology, Hyderabad.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas

Collabarating Agency	Activity / Area
Indian Institute of Petroleum, Dehradun.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Indian Oil Corporation, R & D Centre, Faridabad.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Industrial Toxicology Research Centre, Lucknow.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
National Aeronautical Laboratory, Bangalore	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
National Chemical Laboratory, Pune.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
National Environmental Engineering Research Institute, Nagpur	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
National Geophysical Research Institute, Hyderabad	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
National Institute of Oceanography, Goa	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
National Metallurgical Laboratory, Jamshedpur.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
National Thermal Power Corporation, R & D Centre, NOIDA.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Pantnagar University, Pantnagar	Characterization by SEM/TEM
Physics Department, M.D. University, Rohtak	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Regional Research Laboratory, Bhopal.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Regional Research Laboratory, Bhubaneswar.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Regional Research Laboratory, Jorhat.	Preparation and dessimination of Bhartiya Nirdeshak Dravyas
Regional Research Laboratory, Tiruvanthapuram	X-ray characterization
Solid State Physics Laboratory, New Delhi	X-ray characterization
University of Delhi, Delhi	X-ray characterization

Collabarating Agency	Activity / Area
Overseas	
Institute of Inorganic Chemistry, Siberian branch of the Russian Academy of Sciences, Novosibirsk, Russia	Crystal growth and high resolution X-ray diffraction
NATA, Australia	International inter-comparison programme on water testing. Proficiency Testing
National Institute of Standards and Technology, Gaithursburg, USA	High resolution X-ray diffraction
Naval Research Laboratory, Washington, DC, USA	High resolution X-ray diffraction
Technical University of Darmstadt, Darmstadt	High resolution X-ray diffraction

Radio and Atmospheric Sciences

Electronic and communication Sciences unit, Indian Statistical Institute, Calcutta	Estimation of rain charactristics using X-Band rader
International chain of RWCs under ISES.	Ionospheric and trpospheric prediction for aid in radio communication
Maulana Azad College of Engineering, Bhopal	Radio communication
S.V. University, Tirupati.	VHF/UHF propagation studies
Satellite Application Centre, Ahmedabad	Ionospheric corrections in sea surface radiometer data on board indian satellite

APPENDIX : 3

SPONSORED R&D PROJECTS

New Beginnings

Agency/ Client	Title	Funds Received 1998-1999 *(Rs. in Lakhs)*
HAL (PSU)	Development of oval shape tubes as Said Landing Gear,for Advanced Light Helicopter - Phase I	1.500
DST	A study of flare triggering and associated hard X-ray emissions and other flare-related phenomena for modelling of flares	1.600
DST	Asbestos free brake material for automoblle tailoring characterization & evaluation	8.945
HAL	Development of titanium fastners using warm forging	1.000
ISRO	A study of QUAS: horizontal and vertical transport of air from tropical upper troposphere and stratosphere	1.550
ARDB	Development of carbon monofilament suitable for CVD-based SiC fibres	29.200
DAE	Low temperature scanning tunneling microscopy and spectroscopy of rare earth	6.318
DAE	Development of frequency stabilised diode laser for laser cooling of alkali atoms	15.280
DST	Study of droplet dynamics and heat flow characteristics during spray atomization and deposition	1.700
IPR (Inst. for Plasma Research)	Development of high thermal conductivity special graphite for first wall components of SST-1 TOKAMAK	8.350
DOE	Silica-on-silicon based integrated optic components for wavelength division multiplexing (WDM) application (Partial)	34.250
DST	Development of a portable analytical X-ray imaging instrument for biomaterials	8.150
DST	Development of ultrasonic nebulising spray system for medical application	2.000
M/s Malhotra Shaving Products Ltd.	Sample preparation for evaluation of NPL's diamond like carbon technology	0.500
IOC	Feasibility study on various petrolium refinery streams as picture for high performance carbon fibre	1.710

Continuing Projects

Agency/ Client	Title	Funds Received 1998-1999 *(Rs. in Lakhs)*
DST	Calibration service programme under the NABL programme	0.000
DST	Investigations aimed at producing stress relieved diamond like carbon film of high IR transmission	0.000
Indo-US	Research and development on (a) atomic hydrogen masers and (b) precision frequency metrology	0.000
DST	Development of post earthquake rescue system by continuous wave doppler technique	0.000
DST	Development of an acoustic wind profiler (with multi beam acoustic array antenna) for remote atmospheric wind measurement	0.000
NIST	Programme of Technical Collaboration and Co-operation in Metrology with NIST, USA	0.000
DST	Simple technology development for a heat pipe room heater from ground heat	0.000
DST	Testing and evaluation of a superconducting magnet for making it a compatible unit for FT-NMR spectrometer	0.000
INDO/UK FUND	Development of polymeric optoelectronic devices	0.440
DST	Development of an automatic self locking NMR Gaussmeter	0.000
UGC	Interaction with universities/laboratories in the area of superconductivity	2.000
NGRI	Hydrogen Maser for VLBI studies	0.000
NSTL	Fabrication and supply of underwater pinger unit	0.000
Asian Institute of Technology, Thailand	A study of biomass as energy source and technical option for greenhouse gas emission reduction	4.500
DOE-DRDO	Studies on potentialities of Glonass for positioning and timing vis-a-vis application of GPS	5.000

Agency/ Client	Title	Funds Received 1998-1999 (Rs. in Lakhs)
ADB	Study of a Least Cost Green-House Gas Abatement Strategy for Asia (ALGAS Project)	6.992
INDO-US	High resolution X-ray diffraction imaging for advanced materials characterization	0.000
DST	Development of six HTSC RF SQUID based systems suitable for operation at liquid nitrogen temperature	0.000
DST	Online determination and systematic recording of sugar content in sugarcane juice and sugarcane solids	0.000
DST	Laboratory level technology development of some biosensors and related biomaterials	2.000
DST	Electron paramagnetic resonance optical absorption and electrical conductivity investigations in glasses	0.000
DST	To investigate a new category of catalyst used for the synthesis of diamond under high pressure and temperature	2.000
DST	Measurement of thermospheric wind and temperature with ground-based Fabry-Perot interferometer	3.200
ISRO/UCAR (USA)	Indian INDOEX Programme	4.300
DST	Deposition and properties of mixed composition infrared optical thin films	0.000
Indo-US	Standardization of techniques for immobilization of proteins and enzymes in conducting polymers	13.490
DST	Characterization of tropospheric and ionospheric media to aid in radio communication	4.000
DAE (BRNS)	Development of the Beta Aluminia tubes for sodium metal production	0.000
ARDB	Spray deposition & property evaluation of aluminium matrix composites	3.200
DST/RRL Thiruva-nanthapuram	X-ray diffraction study of solid state electrolysis in quartz crystals	0.000

Agency/ Client	Title	Funds Received 1998-1999 (Rs. in Lakhs)
MoEnF	Continuous measurement, updating, modelling and assessment of greenhouse gases	0.000
MoEnF	ozone over India - Change in the past & future	0.000
ARDB	Development of silicon carbide incorporated carbon-carbon composites	3.350
Indo-French	Influence of the surface energetics of micro-structure of matrix and fibre/matrix interaction in composites	1.296
Indo-ISRAEL	Studies of organic and inorganic thin film : Self assembled monolayer templates for metal oxide film processing	2.000
DST	Development of tungsten oxide based electrochromic films by sol-gel technique	1.500
DST	Intensifying screen : a new dimension in X-ray xerography	0.500
DST	Carbon composite ring based Ilizarov Fixator for orthopaedic application	3.950
DST	A study of optically addressed spatial light modulars based on nematic and ferroelectric liquid crystals	3.000
DST	Transport behavior of strongly corrected electron systems	2.500
ISRO	Metallization of fabrics as shield against electromagnetic interference	1.120
DRSO (DTSR)	Fabrication and characterization of real time image processing devices	6.000
Indo-US	Total spectral reflectance, total spectral transmittance and spectral emittance study of various materials in thin, thick films and bulk samples in the infrared region	5.745
DAE (BRNS)	A major upgradation of the standard time and frequency signal (STFS) broadcast via INSAT satellites	0.000
NIST (USA)	Improved Pressure Standards in the range 10-360 kPa	5.550
DST	Non-linear dynamics and vortex flows in AC-driven Josephson Junction Arrays	0.000
Int. START Sectt.	SASCOM activity such as meeting on Indo-Gangetic Plains research effort	0.000

Agency/ Client	Title	Funds Received 1998-1999 (Rs. in Lakhs)
DST	Investigation of materials under ultra high pressure metrological application (Phase - II)	4.000
DST	To compose monographs on noise pollution	0.000
Int. Start Sectt.	Operation of the South Asian Regional Research Centre for Study of Global Change (SAS-RRC) under SASCOM	15.290
Indo-US	Surface order and structure studies of polymer solids interfaces	0.000
NIST	To improve frequency stability of Atomic Time and Frequency Standards by suppressing quantum noise through squeezed states	0.000

Projects Completed

Agency/ Client	Title	Funds Received 1998-1999 (Rs. in Lakhs)
DST	Development of a powder X-ray diffractometer	0.000
NRDC	Manufacture of 50 prototypes of glucose biosensors and 50,000 glucose biosensor strips for full scale field trials	4.661
DBT	Development of conducting polymeric filters for virus monitoring in water	0.000
DST	Development of a module hydride air-conditioner	0.300
DST	Spectral shift due to source correlation and its implication in optical measurements	0.000
DST	Optical and electrical properties of Langmuir Blodgett films	0.000
VSSC/ISRO	Development and supply of ZK 30 Magnesium-alloy square tubes	0.000
Allahabad Univ.	Development of operational front end of the radiometer at 37GHz	0.000
DST	Development of a unit for the destruction of benign and malignant tumors in the region of ENT, based on high refrigeration capacity J.T. Cryo Probes	0.000

Agency/ Client	Title	Funds Received 1998-1999 (*Rs. in Lakhs*)
DST	Global Atmospheric Science Programme on Centre on Global Change	2.300
DST	Development of electroluminescent display devices	0.000
DNES/MNES	Development of process technology for electro-deposited CdTe solar cells/modules	4.000
DOD	Laser Heterodyne System for the study of ozone and other minor constituents in Antarctica	0.000
DST	Development of sensors & particulate filters for diesel engine exhaust	0.000
DST (Industry)	Development of Piston Gauge Transfer Pressure Standard upto 80 mPa	4.080
DST	Amorphization of boron nitride and study of its behaviour under pressure and temperature	0.000
Sardar Patel Univ.	Studies on development and structure of Si, C, N, O based multicomponent ceramics through organometallic route	0.000
ASI	A study of the effect of aircraft induced vibration on Mahadeo Temple, Khajuraho	0.000
DRDO	Development of a long decay phosphor and phosphor coated plastic tapes for the Army	0.000

APPENDIX : 5

RECEIPTS THROUGH CONSULTANCY

Client	Project	Amount (Rs. in Lakhs)
M/s Leader Engineering Works, Jallandhar	Consultancy for Test Rig for testing of cryogenic valves	1.280
Steel Authority of India, Ranchi	Supply of acoustic sodar for generation of data on mixing height at Durgapur steel plant	1.800
Steel Authority of India, Ranchi	Supply of acoustic sodar for generation of data on mixing height at Bhillai steel plant	2.875
Department of Lighthouse & Lightships, Ministry of Surface Transport	Consultancy with DGLL for commissioning DGPS system	0.250
M/s Vaibhav Engineering Association	Setting up a calibration centre	0.325
Central Pollution Control Board, Delhi	Characterisation of noise generated by bursting of crackers and proposing suitable noise standards at the manufacturing stage and guidelines for its use.	0.100
Airport Authority India	Consultancy with AAI for determination of precise co-ordinates of airport at Palam & Safdarjung	0.250
QMC, Govt. of Haryana, Faridabad	Project report for calibration laboratory	0.100
M/s Weigh India, Bihar	To fabricate and calibrate high precision weights	0.250
National Council for Hotel Management	Computerisation and networking in national council	0.240
M/s S. S. Engineering Works	Intitutional consultancy for development of high speed cams (five different types) and modeling in CNC Machining for the same.	1.500
M/s Hero Exports, Hero Nagar, Ludhiana	Consultancy project prima facie techno economic feasibility report	3.500
M/S Poonam Intrumentation Services	Improvement in the design of dead weight tester.	3.150

Client	Project	Amount (Rs. in Lakhs)
M/s Hindustan Copper Ltd., Rajasthan	Operational performance checking of dead weight tester	0.200
PWD, Ludhiana	Accoustic treatment in auditorium in Audit blind institute	0.360
M/s British Plastic & Stationary Works	Institutional consultancy for assistance and modelling in CNC Machining of core cavity and electrodes for meter housing	0.750
M/s Cosmo Ferrite Ltd., New Delhi	Trouble shooting for high permeabilty Ferrite	1.300
Department of Lighthouse & Lightships — Ministry of Surface Transport	Optimisation of physics package of HP- Rb frequency standard	1.500
M/s Horizon Industrial Products, Delhi	Develop & modeling of sheet metal component (reinforcement component for front door hinge	0.080
M/s Mepco Industries Ltd., Madurai	Assistance in certification of the process for the manufacture of synthetic diamond	0.070
M/s Bentex Enginnering, New Delhi	Consultancy/guidance in calibration of RSS meters.	0.080
M/s Associated Soapstone Distributing Co. Pvt. Ltd.	Particle size acquisition and analysis using software and its upgradation	0.120
M/s Opto Electronica Factory	Consultancy for evaluation of uncertainty in dimensional, electrical and optical measurements	0.800
	Consultancy/guidance in calibration of EMH 102/I Meters	0.120
M/s S. S. Engineering Works	Intitutional consultancy for development of high-speed cams and modelling in CNC Machining.	0.750
M/s Regional Testing (SR), Chennai	Design and fabrication of the dead weight piston gauge to generate/measure hyraulic pressure upto 800 bar to a level of +0.01%	7.250
M/s Bothra Manufacturing Co (P) Ltd., Delhi	Modelling & assistance in CNC machining of head lamp glass lens	1.050

Client	Project	Amount (Rs. in Lakhs)
M/s GE BE Private Limited, Banglore	Characterisation of Penning gauge	0.500
M/s HEG Ltd., Mandideep	Marketability of activated carbon cloth	0.100
M/s Bananzo Engineering & Chemicals Pvt. Ltd.	Particle size acquisition and analysis using software and its ugradation	0.150
M/s Unitech Machines Limited, Delhi	Institutional consultancy for assistance and modelling & CNC machining of rear combination lamp for use in Maruti-800	1.500
Ms Institute of Hotel Management	Computerisation of the Institute	0.213
SAMTEL (India) Ltd., New Delhi	Lectures on thin film optical coatings and phosphor coatings for Samtel personnel.	0.400
Delhi Metro Rail Corporation Ltd.	To asses the effect of vibrationon historic structures due to construction/operation of Metro Rail in Delhi.	0.750
M/s S. S. Engineering Works	Institutional consultancy for assistance in modelling for CNC machining of high speed cams.	0.600
M/s Unitech Machines Ltd.	Institutional consultancy for assistance and modelling in CNC machining for core cavities and electrodes for head lamp reflector for LML	0.550
M/s Unitech Machines Ltd.	Institutional consultancy for assistance and modelling CNC machining for core cavities and electrodes for tail lamp reflector.	1.350
M/s Institute of Applied Physics& Technology	Assistance in low noise microwave receiver with data acquisition system as a back end to the 37 Ghz Radiometer.	3.000
M/s S. S. Engineering Works	Institutional consultancy designing, development generation of Nc programme of high-speed cams.	0.400
M/s Regional testing centre, New Delhi	Development of computerised calibration system for dead weight gauge calibration	4.000

Client	Project	Amount (Rs. in Lakhs)
M/s Indira Gandhi Centre for Atomic Research	11Tesla Superconducting Magnet Development	5.500
M/s N.B.C.C.	Design of noise barrier for elevated rail corridor of DMRC	3.500
M/s N.B.C.C.	Design of noise barrier for elevated rail corridor of DMRC	0.600
M/s AVON Meters Private Ltd.	Consultancy/guidance in calibration of single/polyphase energy meters	0.100
M/s S S Engineering Works	Institutional consultancy designing, development and CNC machining of CRM-300 & CRM-200 components.	1.050
M/s Real Scientific Engg. Corpn.	Assistance to establish the laboratory for calibration of force proving devices for 1 MN as per IS: 4169-1988	0.500
M/s Real Scientific Engg. Corpn.	Assistance in project planning to establish laboratory for calibration of the force proving devices for 1 MN as per IS: 4169-1988	0.500
M/s Institute for Autopart Technology	To install, commission and provide training in use and application of horizontal gauge block machine.	0.860
M/s Japsin Test House	Development of the software for data analysis and calibration report generation for liquid-in-glass thermometers.	0.220
M/s Structural Engineering Research Centre	Expert opinion on acoustic treatment of auditorium under construction at SERC, Chennai	0.350
Graphite India Ltd.	Development of Green Coke based high density graphite	1.000
GE Corporate Research & Development, New York	Conducting polymer composited for shielding of EMI and also as antistatic materials	4.100

Client	Project	Amount (Rs. In Lakhs)
M/s NTPC/NCPP, Ghaziabad	Development of INSAT STFS Master Clock/Decoder specifically suited to interface the data acquisition system at DGPP	2.440
National Council for Cement & Building Material	Development and fabrication of temperature baths	3.300
M/s NTPC/NCPP, Ghaziabad	Design & development of a mechanical load tester for determining the ability of a PV module to withstand wind, snow and ice loads.	8.300
	TOTAL	*75.883*

APPENDIX : 6

RECEIPTS THROUGH CALIBRATIONS AND TESTING

Calibration

Physico-Mechanical Standards

Activity	Gr. Code	Reports	Charges (Rs.)
Length Standards	16	18	114850
Dimensional Metrology	7	756	2973650
Mass, Density, Volume & Viscosity	8	651	1724600
Force & Hardness Standards	5	642	3573300
Pressure & Vacuum Standards	9	166	2054000
Temperature Standards	6	622	2262200
Optical Radiation Standards	10	232	1532450
U V Radiation Measure Standards	19	19	49650
I R Radiation Standard	21	05	28250
Acoustic Standards	11	92	412400
Ultrasonics Standards	17	04	45100
Humidity Standards	34	15	37500
Fluid Flow Standards	40	1	13200
Total		3223	14821150

Electricals & Electronics Standards

AC&LF Standards (up to 1 kHz)	1	196	1503200
D C Standards	2	71	413000
HF & Microwave Attenuation and	3	11	153500
Impedance Standards LF & HF Impedance Standards	4	95	231600
HF & Microwave Standards of Power, Voltage, Frequency & Noise	15	68	846600
Magnetic Measurement Activity	18	20	98000
Time & Frequency Standards	14	26	97650
Total		487	3343550

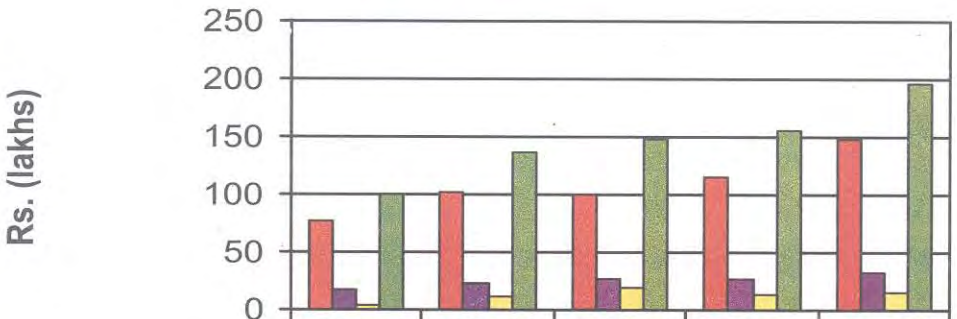
Testing

Activity	Gr. Code	Reports	Charges (Rs.)
Material Characterisation	12	0	0
Chemical Analysis	13	63	424500
RASD	20	1	15000
Indian Reference Material	22	7	81500
Xray Analysis	23	6	51000
Electron Microscope Analysis	24	5	28300
EPR Analysis	25	1	40000
Surface Area & Porosity Analysis	26	2	10200
Spectroscopic Analysis	27	0	0
Luminance Spectroscopy	28	2	4900
Materials Division	29	0	0
Carbon Technology	30	0	0
Metal & Alloys Group	31	8	15000
Solar Cell	32	11	44050
Electrical Engineering	33	3	6000
Total		109	720450

Job Work

Activity	Gr. Code	Reports	Charges (Rs.)
Piezoelectric Accelerometer	36	2	31700
Central Workshop	43	29	734750
Thin Film	44	3	19500
Total		34	785950
Grand Total		3853	19671100

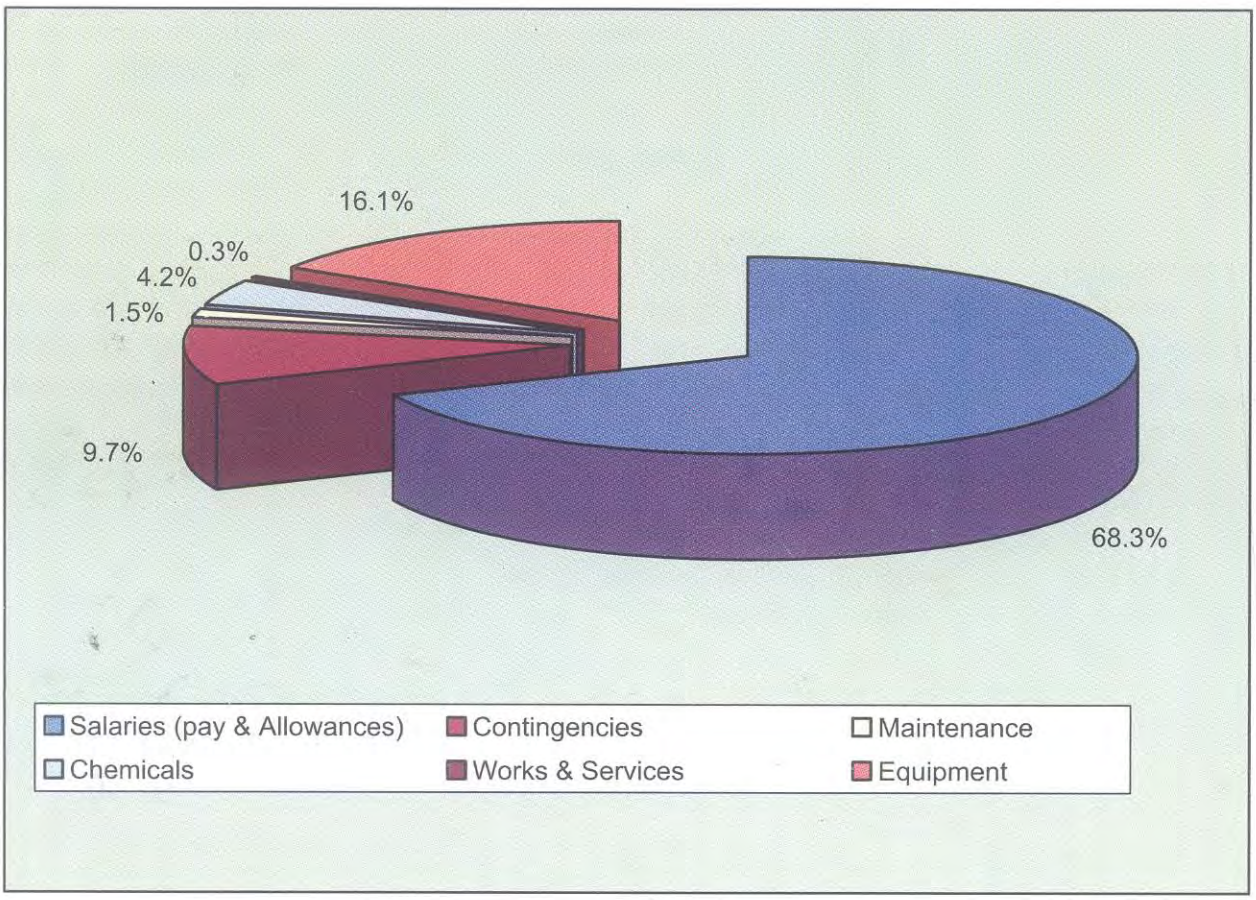
YEARWISE FINANCIAL GROWTH FROM TESTING AND CALIBRATION SERVICES



	1994-95	1995-96	1996-97	1997-98	1998-99
Phy.Mech. Std.	77.6	101.3	100.9	116.3	147.9
Elect.Std.	17.1	23.2	27.7	26.3	33.4
Other services	3.4	11.1	18.7	12.9	15.4
Total	99.3	135.8	147.8	155.5	196.6

APPENDIX : 7
ACTUAL EXPENDITURE

Budget Head	Rs (Lakhs)
Salaries (Pay & Allowances)	1848.524
Contingencies	262.418
Maintenance	39.935
Chemicals	113.309
Works & Services	6.990
Equipment	435.399
Total	2706.574
Sponsored Projects	364.223



APPENDIX : 8
HONOURS & AWARDS

Physico-Mechanical Standards

- Ashok Kumar was conferred Chief Editor, Acoustical Society of India.
- H.C. Kandpal was elected as Honorary Member of Optical Society of America
- Rina Sharma was awarded BOYSCAST Fellowship by DST.
- Santa Chawla was invited to give a talk in the Annual Meeting of Indian Academy of Sciences
- Tripurari Lal was nominated as a Member of the APMP Technical Committee of Mass and Related Quantities (APMP-TCM) since January 1999.
- Tripurari Lal was nominated as a member of the 'Standing Advisory Committee on preparation of Specifications of Weights and Measuring Instruments' of the Department of Legal Metrology, Ministry of Food and Consumer Affairs, Govt. of India.

Electrical & Electronic Standards

- V.R. Singh was elected as Vice-President of IFUMB (Ind Fed Ultr Med Biolog), Bombay (1998-2000).
- V.R. Singh was elected as Vice-President of Ultrasonic Society of India.(1998-2000).
- V.R. Singh was re-elected as a Member of Executive Council and the Chairman of IEEE (Delhi) Fellowship and Awards Committee.

Electronic Materials

- O.S. Panwar's updated biography has been included in the "Dictionary of International Biography, Twenty Seven Edition", 1999 published from International Biographical Centre, Cambridge, England.
- A.C.Rastogi has been awarded the 1998 Raman Fellowship of the CSIR and was Visiting Professor at the Department of Materials Science and Engineering, Virginia Polytechnic and State University, Blacksburg, USA

Materials Characterization

- Krishan Lal was elected President, Metrology Society of India for the period 1998-2000.
- Krishan Lal was elected Foreign Member, Russian Academy of Metrology, Moscow, w.e.f. 1998.
- Krishan Lal has been honoured with Honorary Degree of, D. Sc. by Russian Academy of Sciences (Siberian Branch) Institute of Inorganic Chemistry, Novosibirsk, Russia.
- Rashmi's name appeared in Biographical note in Indo-American Who's Who.
- R.P. Pant was the guest editor for a special issue of Indian Journal of Engg. and Materials Science, Vol 5, No 6, Dec 1988 on " Symposium on Recent Trend in Science and Technology of Magnetic Fluids" held on Oct 16 - 181997.

Radio and Atmospheric Sciences

- D.R. Lakshmi has been appointed member, Research Advisory Council, Indian Institute of Geomagnetism, Bombay.
- D.R. Lakshmi has been appointed member, PAC, Atmospheric Sciences, DST.
- H.N. Dutta was selected to be on the DOD Tableaux on Antarctica which took part in the Republic Day Parade-1999 in New Delhi (26th January, 1999) and subsequently honoured by Hon'ble President of India, Hon'ble Vice-President of India and Hon'ble Prime Minister of India.

- M. K. Tiwari was invited to be Co-Convenor along with M. Velayutham for the ' South Asian Level Workshop on Scientific Issues in Indo-Gangetic Plains Land-Use Land-Cover Change Research in the Context of Study of Global Change', held at NBSS&LUP, Nagpur in April 1998 and organized by South Asian START Regional Research Network for Study of Global Change.
- S. L. Jain has been appointed Member of Steering Committee on LIDAR project constituted by Department of Electronics, Govt. Of India
- T. K. Mandal of Centre on Global Change received the Young Scientist Award of START.

Library

- S. M. Dhawan has been appointed Member, Editorial Board, ILA Bulletin.

APPENDIX : 9
VISITS ABROAD

Sl. No.	NAME		COUNTRY	DURATION	PROGRAMME
1.	Sh. M.K.Mittal,	Sc.EII	Germany	05.04.98 to 24.04.98	Under NPL-PTB technical Cooperation
2	Dr. A Sen Gupta,	Sc.EII	USA	06.04.98 to 31.07.98	To study low noise metrology & frequency synthesis.
3	Sh. P.S.Negi,	Sc.EI	Germany	16.05.98 to 19.06.98	NPL-PTB Technical cooperation
4	Dr. R. Bhattacharya	Sc.F	USA	27.04.98 to 01.05 98	Attended the meeting of ICMCTF, 98 and visited M/s Dimonex.
5	Dr. S.K. Sarkar	Sc.EII	Canada	27.04.98 to 07.05.98	Attended the conf. on climate parameters in radio wave propagation& ITU. R Meeting
6	Dr. A.C. Rastogi,	Sc.F	USA	01.05.98 to 31.10.98	Raman Research Fellowship
7	Sh. R.S.Khanduja	Sc.F	Thailand	27.04.98 to 02.05.98	Under Business Development Programme
8	Dr. Mahesh Chander	Sc.EII	-do-	-do-	-do-
9	Dr. K. Lal ,	Dir. Grade	Russia	13.05.98 to 02.06.98	Under ILTP of Cooperation between India & Russia.
10	Dr. A.M. Biradar,	Sc.EII	Germany	15.05.98 to 15.08.98	Under CSIR-KFA Joint Project.
11	Dr. P.C. Kothari,	Sc F	Germany	18.05.98 to 12.06.98	NPL-PTB Technical Cooperation.
12	Dr. R.K.Kotnala	Sc.EI	Germany	18.05.98 to 12.06.98	NPL-PTB Technical Cooperation.
13	Dr. S.C.K. Mishra,	Sc EII	U.K	05.06.98 to 05.07.98	Under the on going UK -India S&T Research fund Entitled Development of Polymeric Electro-optic devices.

Sl. No.	NAME		COUNTRY	DURATION	PROGRAMME
14	Dr. V.N.Ojha	Sc.EII	Germany	13.06.98 to 30.06.98	NPL-PTB Technical Cooperation
15	Dr. B.S.Mathur	Sc.G	Germany	16.06.98 to 19.06.98	To attend the seminar on the Role of Metrology in Economic & Social Development.
16	Dr. A.V.Narlikar	Sc.G	Germany	30.06.98 to 02.10.98	Visited Max Plank Inst.Under CSIR-KFA Project.
17	Dr. O.P.Bahl,	Sc. F	France	01.07.98-42 days	Visited under IFCPAR Funds Project
18	Dr. Sanjay Yadav,	Sc.B	France	22.06.98 to 26.06.98	Under Equipment Training Programme
19	Dr. D.K.Suri,	Sc.EII	Romania Germany	29.06.98 to 08.07.98	1. Attended 8th Int.C Magnetic fluid 2. Visited Bruekar AXS Inst. For Discussion.
20	Dr. K.S.Zalpuri,	Sc.EII	Nether-Land	20.06.98 to 23.06.98	Attended the INDOEX Workshop & Int. Steering Committee of INDOEX.
21	Dr.S.K. Sharma,	Sc.F	Japan	17.07.98	Under KYUSHU Univ Fellowship.
22	Dr. S.K. Mahajan,	Sc. EII	Saudi-Arabia	03.09.98 1 Year	Took up the position of Coordinator at SASO under CSIR-SASO Programme.
23	Sh. R.M. Khanna,	Sc. EII	Austria	06.07.98 to 10.07.98	Attended the 9th Int. Symposium on Acoustic Remote Sens. Associated Techniques of Atmos. & Oceans.
24	Dr. B.S.Gera,	Sc.EII	Austria, Italy	06.07.98 to 07.08.98	ISARS. 98 Conf Austria under CSIR CNR S& T Agreement Italy -
25	Sh. Gurbir Singh,.	T.O.A	Do-	-Do-	-Do-

Sl. No.	NAME		COUNTRY	DURATION	PROGRAMME
26	Dr. Mahesh Chander ,	Sc.EII	Taiwain	10.08.98 to 21.08.98	Under ASIA-Pacific Laboratory Accredition Cooperation (APLAC) Training Course on Proficiency Testing for its Member Country.
27	Dr.S.K.Halder,	Sc. EII	UK	01.11.98 to 31.01.99	Under INSA- R.S.Exchange Prog.
28	Dr. A.B.Ghosh,	Sc.EII	USA	19.08.98 to 25.08.98	Participated in the Join Int. Symposium on Global atmospheric Chemistry.
29	Dr. K. Lal ,	Dir. Grade	Brazil	17.08.98 to 20.08.98	Attended International Conference on Engineering Education.
30	Dr. K.K. Mahajan	Sc. G	Japan	16.10.98 Six months	Visiting Professor at the Institute of Space & Astronautical Science, Japan.
31	Dr. R.V. Anantha Murthy,	Sc. EII	Germany	01.09.98 to 31.11.98	Under CSIR-DAAD Exchange Prog.
32	Dr. S.A. Agnihotry	Sc. EII	UK	07.09.98 to 09.09.98	Participated in the Intl. Mtg. on Electrochromics- 3
33	Dr. K.Lal	Dir Grade	Switzerland	05.09.98 to 16.09.98	Delivered a talk at the Intl. School on Crystal Growth Technology.
34	Dr. A.K.Sarkar,	Sc. EII	France, Germany	26.09.98 to 07.10.98	1. Visited the Vth Conf. Of Int. Society for Trace Elements Research in Humans. 2. Visited Mrs Helena Kachei Lab France to work on Soot Analysis on . INDOEX Samples.
35	Dr. S.K.Dhawan,	Sc. C	USA	09.09.98 to 23.12.98	Visited Polymer Materials Lab. of GE-CRD under GE-NPL Project.
36	Dr. Anil K. Gupta,	Sc F.	Japan	29.09.98 to 16.10.98	Under-AIST Co-operation through ITIT Scheme.
37	Dr. Ajay Dhar		-Do-	-Do-	Do-
38	Sh. I.A. Malik		-Do-	-Do-	

Sl. No.	NAME		COUNTRY	DURATION	PROGRAMME
39	Dr. H.N. Dutta	Sc.EII	Brunei	04.10.98 to 10.10.98	Attended a seminar on role of Acoustic Sounder Control in atmospheric pollution arising from forest fires and related natural factors
40	Dr. Sanjay Yadav,	Sc. B	Japan	05.10.98 to 01.08.99	Attended Training on Research on Measurements, Technology and Standards
41	Dr. Ashok Kumar	Sc.EII	China	11.10.98 to 14.10.98	Attended the 7th Int. work shop on Modern Acoustics
42	Dr. A.K.Raychaudhuri	Director	Sri Lanka	09.11.98 to 12.11.98	Attended the first meeting of Experts of the member countries of IOA-RAC Project on Coooperation in Standadrds and Accreditation
43	Sh. Prabhat Kumar	Sc. EI	Vietnam	12.10.98 to 16.10.98	Attended the Methane-ASIA Campaign 1998 (MAC 98)
44	Dr. T.L. Dhami	Sc.EII	France	17.11.98 41 days	Under IFCPAR Project
45	Dr. P.K. Singh	Sc.EII	Germany	04.02.99 3 Months.	Visited under INSA-DFG Exchange Programme
46	Sh. A.C. Gupta	Sc.F	France	19.01.99 to 21.01.99	Attended meeting on key comparision their evaluation & interpretation at BIPM & also visit to M/S D.H. Budenburg Paris
47	Dr. S.M.Shivaprasad	Sc. C	Germany	15.01.99 6 Months	Visited ULM University for doing research under Dr. R. J. Behm
48	Dr. K.S.Zalpuri	Sc. EII	Mauritius	20.01.99 to 19.02.99	Visited under INDOEX-Project to carry out Indian Ocean experiment intensive final phase observation.
49	Dr. B.K. Das	Sc. G	S. Korea	23.03.99 to 19.04.99	Under INSA-KOSEF Exchange Measurement Technology and Standards.

शोध सुविधाएँ व सहायक सेवाएँ
RESEARCH FACILITY AND SUPPORT SERVICES

यह प्रभाग निदेशक की अध्यक्षता में वर्ष 1997-98 में गठित किया गया था । इस के आधीन विभागों में सम्मिलित हैं: निम्नतापिकी व अन्य परिष्कृत सुविधाएँ, तकनीकी अवसंरचनाः- उदाहरणार्थ केन्द्रीय कम्प्यूटर सुविधा, मुख्य वर्कशॉप, ग्लास प्रौद्योगिकी, वर्कशॉप, विद्युत वितरण, पम्पिंग, वातानुकूलन, सिविल वर्क्स, कैम्पस रख-रखाव, दूरभाष, फैक्स, फोटोग्राफी, पुस्तकालय, अनुसंधान एवं विकास प्रबंधन व प्रशासन इकाइयों का प्रबन्धन व अन्य ऐसी सुविधाएं जिनका उपयोग सभी प्रभागों द्वारा होता है, इस प्रभाग के अधीन आते हैं । इसी का एक भाग तकनीकी सचिवालय कहलाता है। सभी आंतिरक एवं बाह्य परियोजनाओं का नियोजन व समन्वय मार्केटिंग व तकनीकी ज्ञान का हस्तान्तरण, विभिन्न अन्तर्राष्ट्रीय कार्यक्रमों में भ्रमण, पेटेंटों का निवेदन व पंजीकरण, मानवीय संसाधनों का संवर्धन, प्रयोगशाला के डेटा बेस का प्रबन्धन, राजभाषा विषयक प्रसारण व प्रयोगशाला के तकनीकी प्रकाशन ये सभी इसी प्रभाग में आते हैं । निम्नतापिकी के क्षेत्र की गतिविधि पिछले अध्याय में प्रस्तुत की गई है । इस प्रभाग की अन्य गतिविधियॉ संक्षेप में यहां दी गई है। इस वर्ष 275 कम्प्यूटरों को जोड़ने की क्षमता वाली एन.पी.एल. लैन (NPL-LAN) स्थापित कर दी गई हैं ।

This Division was constituted during 1997-98, with Director, NPL as its head. Cryogenic and some other sophisticated instruments facilities, technical infrastructure - such as, central computer facility, main workshop, glass technology workshop, electrical supply, pumping, air-conditioning, civil works, campus maintenance, phones, fax, auditorium, photography, library, R&D management and administration units, that provide support to and are shared by all the other divisions, whose R&D activities are given in the preceding chapters of this report, function under this division. The Technical Secretariat, one of the units of this Division is responsible for planning and coordination of all in-house and externally supported R&D projects, marketing and transfer of technological know-how developed indigenously, processing of deputation under various international collaborative programmes, filing of patent, human resource development programmes, maintaining laboratory information data bases, propagation of Rajbhasha and bringing out technical publications of the laboratory. Activities in the area of cryogenics were described in the previous chapter. The rest of the activities of this Division are briefly presented here. NPL-LAN with the capability to connect 275 PCs across the laboratory was put in place this year.

Central Computer Facility

The CCF provides services through an array of PC's, workstations and a library of software that serve as common user facilities. It also administers e-mail service to various users in the laboratory. The facilities added this year include the following:

- NPL - LAN consisting of three optical fibre segments between the main building and other campus buildings and UTP segments inside buildings was put in place during this year. A total of 275 information outlets were installed in various rooms inter-connected through switches and hubs located at various places on the campus. All staff members have been provided a personal e-mail account.

- A VSAT for connecting to the Internet and many server for users of NPL-LAN were configured and set-up. These included an e-mail server (on LINUX), DHCP (Dynamic Host Configuration Protocol) server (on LINUX) to distribute dynamic IP addresses, a name server (on an HP 9000/735 workstation) for translating internet host names to IP addresses.

Apart from the in-house management a joint project with M/s Amil Ltd., Delhi for the automation of a compression testing machine was successfully completed. The sponsoring industry has launched this fully automated system in the market. Another joint project with NCHM and IHTMCN for computerization and networking of the premises was also completed..

Library and Technical Information Services

NPL library is a leading repository of publications in physics and related sciences in the country. During the year it

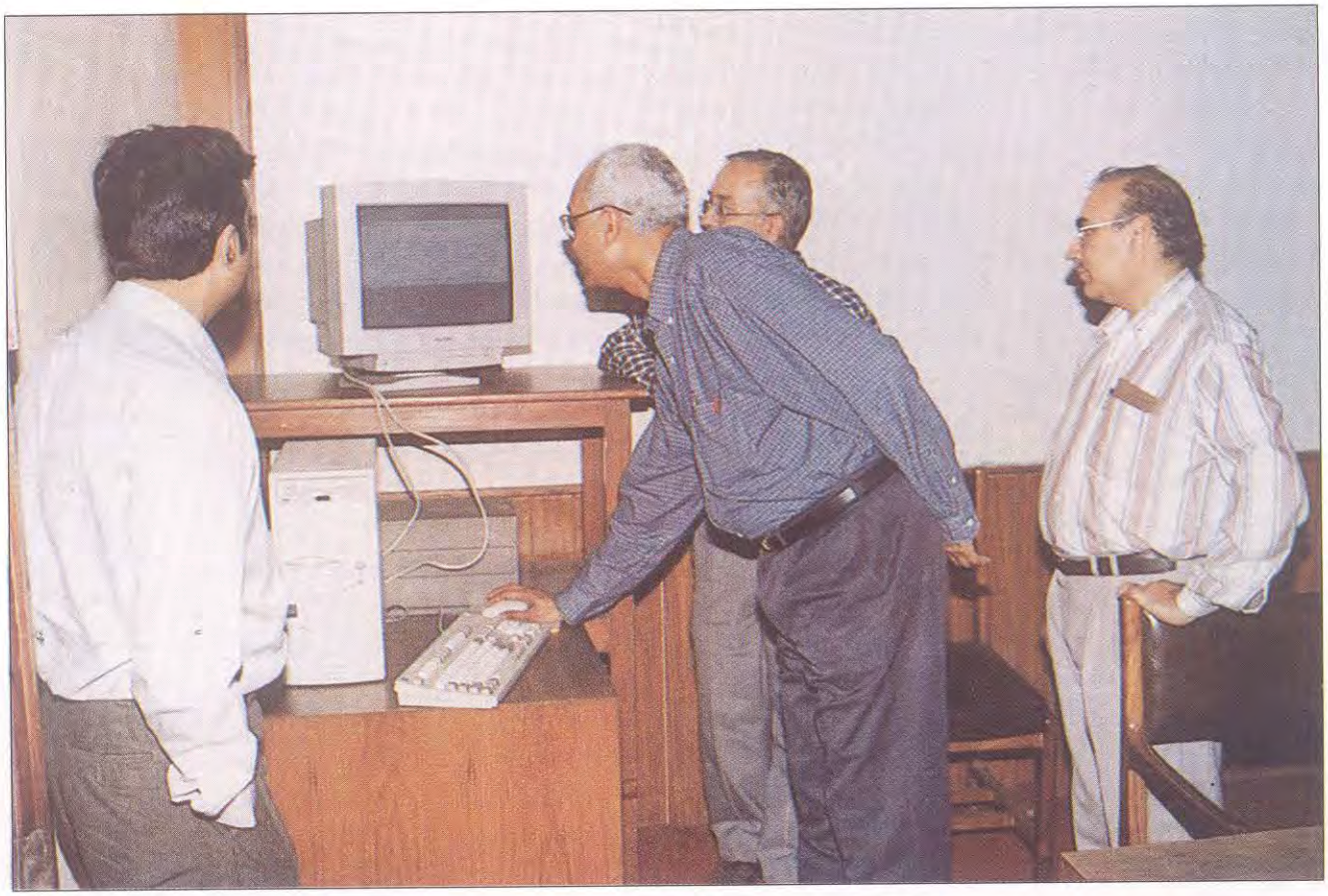


Fig. 10.1 : Inauguration of NPL - LAN connection First Phase by Dr. R A Mashelkar, FRS, DG-CSIR; others present (L to R) Prof. A K Raychaudhuri, Dr. Ravi Mehrotra and Dr. S M Dhawan

strengthened its collection by acquiring new books and journals on need basis. It spent Rs. 80.09 lakh for this purpose – Rs. 76.13 lakhs on journals and the rest Rs. 3.96 lakhs on books. During the year it subscribed to 144 journals and purchased 371 books of which 181 were in Hindi. Its collection by the end of the year stood at 43047 books and 65000 volumes of bound journals.

Named as KSK Library, in the honour of the first director of the laboratory, Late Sir K S Krishnan, the NPL Library is gradually transforming itself into an electronic library. During the year it has started dial-up service for Internet access as a central facility in the library and has also created a web page on the NPL intranet. The library web page provides Internet access to information on journals of current subscription, new issues received in the current week, current contents of electronic journals, impact factor of journals, etc. It also provides links to electronic journals, electronic libraries, publishing houses of electronic journals, etc. The page is updated weekly. The page also provides to its users Internet access for performing e-mail, www, ftp and telnet functions. It also subscribed to three leading CD-ROM databases in physical sciences - Current Contents: Physical, Chemical & Earth Sciences, Current Contents: Engineering, Technology and Applied Sciences (both with reference additions) and Material Science Citation Index. The library continued to perform its house keeping function on computer using a Library Information Package developed in house.

The library also continued to provide services like selective dissemination, literature search, access to bibliographical databases available in-house, inter-laboratory loan, document supply, photography, etc.

Technical Services

Responsibility of general maintenance of infrastructure like electricity, pumping, air conditioning, telephones, fax, photography service, auditorium, maintenance of campus and colony, civil works, etc. lies with this section.

Workshops

Central Workshop:

Different types of machining facilities have been established in NPL's central workshop to extend support to laboratory's R&D needs and to undertake external contract jobs. In addition to normal milling, lathe and welding machines etc. for normal fabrication jobs the NPL workshop also has a CNC milling facility backed up by a CAD-CAM facility comprising a high precision German 'Deckel FP4A' universal milling machine, CNC rotary table and a Gildemeister CT-200 CNC lathe machine capable of producing turned components. This workshop also has AutoCAD based drawing and tracing facilities. During the year the central workshop has completed 1255 in-house and 31 externally contacted machining jobs. ECF generated during the year was Rs 12.90 lakhs.

NPL also has a separate high pressure and metal extrusion shop, which caters to in-house as well as external users.

Glass Technology Unit:

This unit has the facilities and expertise for design, development, fabrication and repair of scientific glass and quartz glass apparatus and equipment. It undertakes scientific glass instrumentation work for in house as well as other institutions, industries and organisation. During the current year GTU completed 201 jobs for NPL and 39 jobs for outside users and earned Rs. 3.02 lakhs as ECF.

Technical Secretariat

Planning and Coordination:

This Group coordinates all the projectised activities of the laboratory, including in-house, collaborative, sponsored and grant-in-aid projects. It keeps track of current manpower deployment. On these it collects information, analyses it and places it to top management for decision making. During the year

the group handled 49 grants-in-aid, 29 collaborative and one sponsored projects. The group also handles coordination in matters related to the Research Council.

Intellectual Property Right:

Realizing the strategic importance of intellectual property in the ever-changing global economic scenario, an independent cell looks after this. Its main thrust is to manage in totality the IP portfolio of the laboratory. This includes not only helping scientists to file patents of deserving R&D outputs but also to scout around and look for and secure the possibility to protect any R&D output. During this year 6 patents have been filed in India and one patent application has been filed in foreign countries. One technology know-how was also transferred. Details are given in Appendix.

Marketing Group:

This Group is responsible for marketing technologies developed by NPL. It also facilitates and processes taken up by NPL scientists contract research projects from external agencies. This group arranged NPL participation in the India International Trade Fair (IITF-99) held at Pragati Maidan, New Delhi, during 14-27 November 1998 and exhibited NPL developed R&D products. One know-how transfer was arranged during the year. The details are given in the Appendix.

International Science & Technology Affairs Group (ISTAG):

This group is responsible for maintaining and processing applications of NPL staff for deputations abroad. The Group also arranges special lectures by visiting scientists. The deputations and lectures arranged this year are listed in the Appendix.

Human Resource Development Group (HRDG):

This Group arranges various training programmes for the benefit of NPL staff and also the trainings offered by NPL for the benefit of industries in various areas of calibration. The group also supports organization of various symposia, conferences etc. by NPL staff at NPL. It also attends to various PR activities and follows up various MoUs with educational institutions in respect of doctoral, post-graduate and summer training on reciprocal basis. It processes induction of JRFs, SRFs and Research Associates for NPL programmes. The Group also pursues other schemes of CSIR on EMR and HRD activities. List of training programmes and other events organized by the group is given in the Appendix.

Publication and Documentation:

This cell is responsible for compiling, editing, printing and distribution of Annual Reports and other documents informing about laboratory's activities. A monthly circular 'NPL-Info' for internal consumption is also being brought out in printed form. This unit also compiles monthly and annual inputs to go from NPL for CSIR level reports.

Rajbhasha Unit:

This unit is looked after by both the office of COA and also the Technical Secretariat and helps scientists in Hindi transcription of their papers, articles, reports, etc. This year also the Rajbhasha unit arranged various training programmes. Hindi fortnight was celebrated in the month of September to encourage use of Hindi in all official proceedings and also to encourage writing of R&D outputs in Hindi for the benefit of the society. As per Govt. of India directives the Unit arranges selection for cash awards of NPL employees who contribute most to the propagation of Hindi in office work. Cash awards are given to winners in various categories. Detailed report of the Unit is given in Hindi in the following pages.

APPENDIX : 10

Ph. Ds AWARDED BASED ON RESEARCH WORK AT NPL

Title	Awardee	University/Institute	Guides
Study of surface impedance of high-T_c superconducting ceramics at microwave frequencies	Ram Swarup:	Chaudhary Charan Singh University, Meerut	Dr. Ashok Kumar Gupta, NPL, Dr. M.C. Bansal, MMH College, Ghaziabad
Investigations on high-T_c super conducting thin films	Vijay Kumar	Punjab University, Chandigarh	Dr. Ashok Kumar Gupta, NPL
Study of Focussing Mechanisms of Ultrasound for Biomedical and Scientific Applications	Rita Malik	University of Delhi, Delhi	Dr. V.R.Singh, NPL, Prof. V.R. Prakasham University of Delhi
Study of Kidney Stone Disintegration under Focussed Ultrasound	P. Kaur	Univ. of Delhi, Delhi	Dr. V.R.Singh, NPL Prof. V.R. Prakasham University of Delhi
Study of Diamond like Carbon (DLC) Films Grown by some Novel Techniques	Debajyoti Sarangi	Birla Insitute of Technology and Science, Pilani (Rajasthan),	Dr. R. Bhattacharyya, NPL
Diamond Like Carbon Films of low Compressive Stress	Sushil Kumar	Benaras Hindu University, Varanasi	Dr. P.N. Dixit, NPL, Prof. S.K. Srivastava, Benaras Hindu University, Varanasi.
Study of Hydrogenated Amorphous Silicon Films Grown by a Novel Pulsed Plasma Discharge	Chandrachur Mukherjee	Birla Institute of Technology and Science, Pilani	Dr. R. Bhattacharyya, NPL
Growth, Structure and Electronic Properties of Electron beam Deposited Ferroelectric $Pb(Zr,Ti)O_3$ Thin Films	S. R. Darvesh	University Of Delhi, Delhi	Dr. A. C. Rastogi, NPL, Prof. P. K. Bhatnagar, University of Delhi
Polymeric and Soft Materials Electro-optical and dielectric studies of ferroelectric liquid crystals	E. P. Haridass	University of Delhi, Delhi,	Dr.A.M.Biradar, NPL, Prof. G.K. Chadha, University of Delhi

Title	Awardee	University/Institute	Guides
Synthesis, Characterization and Transport Properties of Polyaniline Doped with Various Protonic Acids	Vandna Arora	University of Delhi, Delhi	Dr. Ramadhar Singh, NPl Prof. Abhai Mansingh, University of Delhi
Mechanism of Conduction and Dielectric Relaxation in High Polymers	Raj Deo Prasad Sinha	Chaudhary Charan Singh University, Meerut	Dr. Ramadhar Singh, NPL, Dr. N. P. Gupta, Meerut University
Satellite Radio Beacon investigations of the ionosphere	J K Gupta	Choudhary Charan Singh University meerut	Dr. T R Tyagi, NPL, Prof. M.L. Pandya MM Postgraduate college of Science, Modinagar
Studies of Ionospheric scintillations using satellite signals at Indian low latitude stations	P.N. Vijayakumar	University of Delhi, Delhi	Dr. T.R. Tyagi, NPL, Prof. M.P. Srivastava, Univ. of Delhi
Measurement of Water Vapour, Ozone Absorption and Turbidity using IR Sun Photometer,	B. C. Arya	Birla Institute of Technology and Science, Pilani	Dr. S.L. Jain, NPL
Rain Characteristics and Rain Attenuation in Microwave and millimeter wave frequency bands	N.C. Mondal	Kalyani University, (West Bengal)	Dr. S.K. Sarkar, NPL, Dr. A.B. Bhattacharya, Kalyani University
Electron Spectroscopic Studies of Y-Ba-Cu-O Thin Films & (Y, Pr)-(Ba,Sr)-Cu-O High Temperature Superconductors	VHS Moorthy	University of Rajasthan, Jaipur	Dr. V. S. Tomar, NPL Prof. K. B. Garg, University of Rajasthan
Substitutional Studies in High Temperature Superconductors	Manisha Verma	University of Delhi, Delhi	Dr. V. S. Tomar, NPL Prof. V. S. Trikha, University of Delhi, Delhi

APPENDIX : 11
TRAININGS ORGANISED

Training Courses Organised For Industries

- Training in Dimensional Metrology for Industries , 3-17 April '98, & 5-9 Oct. '98
- Pressure Standards and Procedures for Calibration of Industrial Gauges, Transducers and Dead Weight Testers, 7-11 September '98
- Measurement Standards and Calibration Techniques for LF & HF voltage and LF Current , 17-21 February '99

Overseas Trainees

- One staff member from Mangolia was trained on thermometer calibration.
- Seven agricultural scientists from Bangladesh, Nepal and Sri Lanka and few more from Indian institutions were trained in use of CO_2 enrichment technology developed at NPL for crop experimental research.

Trainings organised for NPL staff

- In-House Training Programme on Administrative Rules and Regulations for Administrative Staff, 4-7 August '98
- Training on Windows 95 & MS Office 97 for Administration, 14-25 September '98
- Trainings on MS Window 95, MS Office 95/97 and Lotus Smart Suite for Electrical & Electronic Standards Staff,30 Nov.-18 Dec. '98

Post Graduate Level Dissertation Work at NPL

- Design and fabrication of tunable radio frequency power amplifier for biomedical applications, S.K. Srivastava, Regional Engg College, Kurukshetra. Guided by V.R.Singh, R.B.Tripathi & M.L.Matta.
- PC-Based Solar Cell Tester for the Characterisation of Solar Cell, A.K. Singh, Regional Engg College, Kurukshetra.
  Guided by V.R.Singh, R.B. Tripathi & M.L. Matta.
- Design and fabrication of low cost digital load cell, S.K.Dagar, Regional Engg. College, Kurukshetra.
  Guided by V.R.Singh, R.B.Tripathi & S.K.Chakarvarti.
- EPR study of Order Parameter and Phase Transitions of Liquid Crystal, Sunil Kumar Arya, Physics Department, Meerut University.
  Guided by S.K. Gupta, NPL and Prof. V.K. Agarwal, of Meerut University.
- Study of atmospheric environment around rice crop growing under enhanced CO_2 conditions, Mahesh Datt, Department of Environmental Sciences and Engineering, Guru Jambheshwar University, Hisar.
  Guided by M. K. Tiwari and Prabhat K. Gupta of NPL and D. C. Uprety of IARI, New Delhi.
- History of land-use and land-cover transformations in the NCT Delhi and their biotic and abiotic physical and anthropogenic driving factors – parameters relevant to study of global change processes, Savita Mehta, Department of

Environmental Science and Engineering, Guru Jambheshwar University, Hisar.

Guided by M. K. Tiwari of NPL, Y. P. Abrol of IARI and Mridula Abrol of Kamla Nehru College, New Delhi.

Miscellaneous

- One person from M A C T, Bhopal was provided training related to participation in the 18th Indian Scientific Expedition to Antarctica.
- Training imparted to two M.Sc. (Physics) students of Dayalbagh Educational Institute, Agra in the area of Solar Photovoltaics (SPV).
- Training imparted to six B.E. (P.S. I - level) Students from BITS, Pilani in different divisons of the Laboratory during may - June, 1998
- A third year student of B. Tech. From IIT, Bombay and a summer trainee under the Jawahar Lal Nehru Centre for Advance Studies Fellowship (Bangalore), were trained in fundamentals of vacuum science, surface analysis and SIMS application in particular, for period of two months, May-June, 1998.
- Two B. Tech students from Inst. of Radio Physics and Electronics, Calcutta and one from Institute of Engg. And Technology, Bereilly were provided training in RASD.

APPENDIX : 12

CONFERENCES, SYMPOSIA AND WORKSHOPS ORGANISED

April, 3 '98

One day Symposium on 'Porous Carbons',

August, 17-21 '98

Workshop-cum-Training Programme on Good Laboratory practice in Force Measurements,

October, 22-25

22nd National Symposium on Instrumentation (NSI-22) with a focal theme 'Sensors and Transducers'. Organised jointly with the Instruments Society of India,

November, 8-12 '98

16th International CODATA Conference and 21st General Assembly of CODATA. Organized at the invitation of INSA and held at India Habitat Center, New Delhi.,

November, 16-18 '98

National Workshop on the Indian Participation in the Indian Ocean Experiment (INDOEX)

November, 19-20 '98

Magnetic Measurements & Calibration,

February, 24-26 '99

2nd International Conference on Metrology, Quality and Global Trade (MQGT - 99),

APPENDIX : 13
SPECIAL LECTURES

S. No.	Speaker's Name and Affiliation	Topic	Date
1.	M/S Symatec, New Delhi	Management Information System developed for standards activities	14.04.98
2.	Dr S. P. Perov	Ozone layer and climate problem	14.05.98
3.	Prof Lother Schafer Fraunhofer, Institutschiet und Oberflachentecnik, Germany	CVD diamond and related materials	15.06.98
4.	Prof C Z Rudowicz, President Asia Pacific EPR/ESR, Head, Dept of Physics & Materials Science, City Univ, Hongkong.	Theoretical and computing tools for spectroscopic studies of transition metal ions in crystals	02.09.98
5.	Prof S Horiuchi, National Institute for Research in Organic Materials, Tsukba, Japan	Studies on quantized magnetic flux lines (vortices) in superconductors using Cryo-Lorentz Electron Microscpe	09.09.98
6.	Dr A V Virouetr, Institute of Inorganic Chemistry, SBRAS, Novosibirsk, Russian.	Chologenide cyanide clusters of transition metals	13.11.98
7.	Prof. N. Kuwano.	Cross-sectional TEM observation of selectively grown GaN	16.11.98
8.	Dr Tsuruta, Head, Impact Assessment Lab, National Inst. of Agro Environment Sciences, Tsukuba, Japan.	Influence of 1997 Indonesian forest fires on atmospheric chemistry	19.11.98
9.	Prof Juan G Roederer, Geophysical Institute, University of Alaska, USA.	Communicating with the public politicians and the media: a social responsibility of all scientists	20.11.98
10.	Dr M A Padmanabha Rao, Ex-Deputy Director, Defence Lab., Jodhpur.	Discovery of light emission from X -ray and radio-isotope sources	23.11.98
11.	Dr Nick Randall, CSEM, Switzerland.	Advanced mechanical testing equipment, like microhardness tester, nano-hardness tester, AFM	11.12.98

S. No.	Speaker's Name and Affiliation	Topic	Date
12.	Dr A K Kar, Heriot Watt University, Edinburg, Scotland.	Ultrafast nonlinear spectroscopy semiconductors	15.12.98
13.	Prof Thomas Rossing, Northern Illinois University, USA	Modal analysis of vibrations using electron	15.12.98
14.	Prof M N Kunchur, Univ. of South Carolina, Colombia.	Transport behaviour in super- conductors at high dissipation carrier	16.12.98
15.	Dr Kalpana Katti, Deptt of Polymers, and Coatings North Dakota State University, Fargo, USA	Structure-property relationship in natural laminated composites	17.12.98
16.	Dr G Mastrantonio, IFA, Roma, Italy.	Sodar developments at IFA in italy	24.12.98
17.	By Dr S Argentini, IFA, Roma, Italy.	Sodar boundary layer studies in east Antaractica	24.12.98
18.	By Dr I Toimatchev & Dr V Boukhovets	Diamond, diamond like carbon and related materials	15. 02 99
19.	By Dr J E Bouree, ECOLE Polytechnique, France.	Thin film microcrystlline sillicon for photovoltaic application	09. 02.99
20.	By Dr E K Smith, Department of Electronics & Computer Engineering, Univ of Colorado, Boulder, USA.	VHF sporadic-E in Japan	10. 02.99
21.	By Dr Marc Monthioux, CEMES, CNRS, France.	The various ways to make carbon nanotubes and recent developments in fullerene-related STR.	18. 03.99

APPENDIX : 14
HUMAN RESOURCES

Staff Strength, as on March 31, 1999

S.No.	Category	Grade	Number
(A).	*Scientific & technical Staff*		
1	Scientific Staff	Group IV	260
2	Technical Staff	Group III	140
	Sub-Total		400
3	Engineering Cadre Staff	Group V	Nil
4	Supporting Technical Staff	Group II	319
5.	Supporting Technical Staff	Group I	108
	Total S&T Staff		827
(B).	*Administrative & Non-Technical Staff*		
6	Administrative (Gazetted)	Group A	8
7	Administrative (Gazetted)	Group B	17
8.	Administrative (Non-Gazetted)	Group B	73
8	Administrative (Non-Gazetted)	Group C	71
9	Non-Technical Staff	Group D	111
	Total Administrative & Non-Tech. Staff.		280
	GRAND TOTAL (A) + (B)		1107

Scientists and Officers as on 31. 03. 1999

Director
Prof. A. K. Raychaudhuri

Standards
Chief Metrologist
Dr. B. S. Mathur

Physico-Mechanical Standadrds Division

Head
Dr. S. P. Verma

LENGTH

Scientist E-II
V G Kulkarni

Scientist E-I
Santa Chawla

Scientist B
Rina Sharma

TO E-I
B K Roy
A K Kanjilal

DIMENSIONAL METROLOGY

Scientist F
R P Singhal

Scientist E-I
K P Chaudhary
M Karfa

TO E-I
V Roonwal
N K Aggarwal

TO C
S L Thind

MASS

Scientist E-II
S N Nangia
Tripurari Lal
M L Das

Scientist C
S Sinha

Scientist B
T K Parameshwaran

FLUID FLOW

Scientist E-II
J N Som
Raj Singh

TO E-I
Virendra Babu

TO A
I S Tak

FORCE

Scientist F
K K Jain

Scientist E-II
S K Jain
J K Dhawan
M K Chaudhuri

Scientist E-I
M Ganga Prasad
Anil Kumar

Scientist B
S S K Titus
Rajesh Kumar

TO B
V D Arora

TO A
H K Jain

PRESSURE & VACUUM

Scientist F
A C Gupta

Scientist E-II
A K Bandyopadhyay
D R Sharma
B R Chakraborty
Pardeep Mohan
S M Shivaprasad

Scientist B
D Arun Vijay Kumar
Sanjay Yadav
Nita Dilawar

TEMPERATURE

Scientist E-II
Joginder Singh
Ram Kishan

Scientist E-I
N K Srivastava
Y P Singh

TO C
S K Nijhawan
J K Gupta

TO A
Gurcharanjit Singh

OPTICAL RADIATION

Scientist F
J S Vaishya

Scientist E-II
H C Kandpal

TO C
Jai Bhagwan

ULTRAVIOLET RADIATION

Scientist E-II
R S Ram
Om Prakash
R K Garg

INFRARED RADIATION

Scientist F
S P Verma

Scientist E-I
D Gupta
Ranjana Mehrotra

ACOUSTICS

Scientist F
V Mohanan

Scientist E-II
BS Gera
Omkar Sharma

Scientist E-I
R M Khanna

Scientist C
Mahavir Singh

TO B
V K Ojha

TO A
Gurbir Singh

ULTRASONICS

Scientist E-II
Janardan Singh
Ashok Kumar
Ved Singh
Mukesh Chandra

TO C
Subhash Chandra

TO B
Reeta Gupta
N C Soni

TO A
G S Lamba
V K Hans
Yudhisther Kumar

Electrical & Electronic Standards Division

Head
Dr. A. K. Gupta

TIME & FREQUENCY

Scientist G
B S Mathur

Scientist F
P Banerjee
A Sen Gupta

Scientist E-II
G M Saxena
A K Hanjura

Scientist E-I
M Saxena
A Chatterjee

Scientist B
C Sri Kumar

TO B
Gurdial Singh
A K Suri

DC STANDARDS

Scientist E-II
S K Mahajan

Scientist C
Ajeet Singh

TO C
P K Mittal

JOSEPHSON VOLTAGE STANDARD & SUPERCONDUCTING DEVICES

Scientist G
A K Gupta

Scientist E-II
N D Kataria
V N Ojha

Scientist E-I
Vijay Kumar
Neeraj Khare

Scientist C
M M Krishna

TO A
A K Goel

HF IMPEDANCE & AC, LF STANDARDS

Scientist E-II
O N Khanna
S R Gupta
M K Mittal

Scientist E-I
A K Saxena

Kewal Krishan
Naib Singh

Scientist C
J C Biswas

TO C
A R Kaushik

TO A
Mohammad Saleem

HF & MW VOLTAGE, POWER, POWER FREQUENCY & ATTENUATION

Scientist F
R S Yadava
Ram Swarup

Scientist E-II
V K Rustagi
A K Govil
Ritander Aggarwal

Scientist E-I
P S Negi
Ranjit Singh *
(* Abroad on EOL)

TO C
R L Mendiratta

MAGNETIC STANDARDS

Scientist F
P C Kothari

Scientist E-I
R K Kotnala

INSTRUMENTATION

Scientist F
V R Singh

Scientist E-II
R B Tripathi

TO B
Y P S Negi

NABL PROGRAMME

Scientist E-II
Mahesh Chander

Scientist E-I
J L Pandey

TESTING & CALIBRATION

Scientist E-II
H S Dahiya
M L Sharma

TO B
S P Sharma
P C Sharan

TO A
G K Kapoor
J N Prasad

Engineering Materials Division

Head
Dr. O. P. Bahl

METALS & ALLOYS GROUP

Scientist F
Anil K Gupta

Scientist E-II
R C Anandani

Scientist E-I
Ajay Dhar

Scientist B
A K Srivastava

TO E-I
I A Mallik

TO B
H B Singh
Jaswant Singh

TO A
Rakesh Khanna

ADVANCED CARBON PRODUCTS

Scientist G
O P Bahl

Scientist F
Gopal Bhatia

Scientist E-II
R B Mathur
R K Aggarwal
Vasantha Raman
T L Dhami

Scientist E-I
C Lal

Scientist C
S R Dhakate

TO B
P R Sen Gupta

HIGH PRESSURE GROUP

Scientist E-II
B P Singh
S K Singhal

Scientist E-I
Rajeev Chopra

TO B
K D Sharda

Electronic Materials Division

Head
Dr. B. K. Das

Scientist G
B K Das
P K Ghosh

Scientist F
R Bhattacharya
S N Singh
A C Rastogi

Scientist E-II
S N Ekbote
S T Lakshmi Kumar
Virendra Shanker
Harish Chander
Mohan Lal
B C Chakravarty
P K Singh
B S Verma
A Basu
P N Dixit
M Kar
O S Panwar
S S Rajput

Scientist E-I
Kiran Jain
N K Arora

Scientist C
K M K Srivatsa
C M S Rauthan

Scientist B
G K Padam
V K Shankarnarayanan
T D Senguttuvan
Santosh Singh

TO E-I
Prem Parkash
H S Kalsi
R C Goel

TO C
S K Sharda
B S Khurana
M K Banerjee
Ravi Kumar
K S Balakrishnan

TO B
T K Chakraborty
T K Bhattacharya
T R Pushpangadan
Mukul Sharma

Polymeric & Soft Materials Division

Head
Dr.Subhas Chandra

Scientist G
Subhas Chandra

Scientist F
S C Jain
S S Bawa

Scientist E-II
MN Kamalasanan
S C K Misra
Suresh Chand
A M Biradar
S A Agnihotri (Smt.)
Ramadhar Singh
B D Malhotra
C P Sharma

Scientist E-I
V S Panwar
S Dwivedi
R K Sharma
S K Dhawan

Scientist C
K K Saini

Scientist B
K L Yadav

TO B
G D Sharma

TO A
Chander Kant

Materials Characterization Division

Head
Dr. Krishan Lal

CRYSTAL GROWTH AND CHARACTERIZATION

Sc. Dir. Grade
Krishan Lal

Scientist E-II
R V Anthamurthy
S K Halder
G Bhagavannarayana

Scientist E-I
S N N Goswami

Scientist B
K K Maurya

TO A
S K Rastogi

INDIAN REFERENCE MATERIALS

Scientist E-II
A K Agarwal

TO A
R K Saxena
Abha Bhatnagar

X-RAY ANALYSIS

Scientist E-II
D K Suri
U Dhawan

Scientist E-I
Rashmi
R P Pant

TO A
D P Singh

ANALYTICAL CHEMISTRY

Scientist E-II
A K Sarkar
R Ramachandran

Scientist E-I
Prabhat Kumar Gupta

Scientist B
Nahar Singh

TO B
R C Sharma
M K Das Gupta
Niranjan Singh

ELECTRON MICROSCOPY

Scientist G
S K Sharma

Scientist E-I
Ram Kishore
Kasturi Lal

Scientist C
Sukhvir Singh

TO B
K N Sood

EPR SPECTROSCOPY

Scientist E-II
S K Gupta

TO A
Manju Arora

Radio And Atmospheric Sciences Division

Head
K K Mahajan

Scientist G
KSK Mahajan
S C Garg

Scientist F
D R Lakshmi
M K Tiwari
S L Jain
P K Banerjee
A B Ghosh
H N Dutta

Scientist E-II
R C Saksena
M K Raina
S K Sarkar
Lakha Singh
R K Pasricha
K S Zalpuri
M C Sharma
P N Vijaya Kumar
M K Goel
Mahendra Mohan
Madhu Bahl
S D Sharma
R S Dabas
D R Nakra
P Subrahmanyam
M V S N Prasad
B C Arya
R S Arora
J K Gupta
V K Pandey
N K Sethi
S K Singhal
H K Maini

Scientist E-I
V K Vohra
P Chopra
Thomas John
Jayanta Kar
Risal Singh
Meena Jain

Scientist C
C B Tandel
R S Tanwar

TO C
S K Shastri
Didar Singh

TO B
Raksha Marwah
D B Singh
V S Yadav
Iqubal Ahmed
S K Bhatia
D B Sharma
R Kohli

TO A
D S Chaunal
Shambu Nath
A K Goghar

Cryogenics Facilities

Head
RG Sharma

Scientist G
RG Sharma

Scientist E-II
Hari Kishan
R B Saxena
S S Verma
N K Babbar

Scientist E-I
B V Reddi
P L Upadhyay

Scientist B
M A Ansari
Dipten Bhattacharya

TO A
Bhikham Singh
M C Singh

Super-conductivity Division

Head
A V Narlikar

Sc. Dir. Grade
A V Narlikar

Scientist E-II
B V Kumaraswamy
P K Dutta
Ramji Rai

Scientist E-I
S K Agarwal

Scientist C
U C Upreti
Rattan Lal

Scientist B
Anurag Gupta

TO C
S B Samanta

TO B
V S Yadav

Research Facility & Support

P&C, MARKETING AND ISTAG

Scientist F
R S Khanduja

Scientist E-II
P K Ashwini Kumar
F C Khullar

Scientist E-I
T K Chakraborty
S K Sharma
Shikha Mandal
Indra Tewari
D P Bhatt

TO C
K Chibber

TO A
A K Suri

LIBRARY

Scientist F
SM Dhawan
SK Phull

Scientist E-I
DK Tewari

Scientist B
NK Wadhwa

TO B
Hasan Haider
Jagdish Prasad

TO A
S Bhatnagar

CCF

Scientist F
MS Tyagi

Scientist E-II
Ravi Mehrotra

Scientist B
Sher Singh

TO A
Kanwaljit Singh
Ashok Kumar
Vijay Sharma

WORKSHOP

Scientist G
J R Anand

Scientist F
S C Gera

Scientist E-II
H N P Poddar

TO C
Ravi Khanna
Kewal Krishan
Ram Swarup

PUBLICATION & REPORTS

Scientist E-II
V S Tomar

Scientist C
N S Verma

TO A
V K Sharma

GLASS WORKSHOP

TO E-I
Mohan Lal

TO C
Karnail Singh

TECHNICAL SERVICES

Scientist F
C S P Kumar

Scientist E-I
J C Sharma
H L B Bhaskar
Exe. Engr.
S K Jha

TO E-I
Shashi Bhushan
R S Singh

Scientist C
S K Kulshrestha

TO C
S L Sharma
K L Ahuja

TO B
B K Chopra
Asstt.Exe.Engr.
Harbans Singh
B S Negi
Damodar Prasad

TO A
Krishan Kant
Deepak Bansal
Hitesh Jan
P S Tripathi

Administration, Accounts, Stores & Purchase

COA
H R Gupta

Senior F & AO (SG)
S C Santosh

AO
O P Maini

Deputy SPO
S N Gupta
P D Aggarwal

SO (F&A)
C Ramesh
Satish Kumar
H Chongloi

SO
D Rajashekhar
D K Salone
O P Meni

C Tobden
Bijenddra Kumar
Beena Kulu

TO C
A K Ghosh

TO B
K G M Pillay

Hindi Officer
Shakuntala Sharma

PS
R K Bhasin
Paramjit Kaur
Mange Ram
S A Joseph
Shish Ram

Security Officer
Vijay Kumar
Lakhpat Singh

Staff on Deputation

V T Chitnis
A R Jain
R P Tandon
K Varadan

Scientist Fellows, Research Associates & Pool Officers

A P Mitra,
Homi Bhabha Fellow

D C Parashar,
Emer. Sc.

T R Anantha Raman,
Sr. Sc.

R Murli Krishna
Young Sc.

Vikram Soni
UGC Res. Sc.

RAs & Pool Officers

Ashish Aggarwal
Archana Gulati
Ananika Gulati
Alka Gupta
Arvind Paandey
A S Grover
B Veenadhari
Deepak Varandani
Dilip Singh Mehta
G S Okram, RA Sawa
Hari Om Upadhyay
Jagjiwan Mittal
Jaya Naithane
Kanchan Saxena
MR Srivastava
Mitali Shah
Manju Gerad
Neeraj Saxena
Pradeep Varshney
Rajesh
Rajesh Kumar
Ranu Godi
R K Choudhary
R Jaya Kumar
Sandeep Singh
Sanjay Srivastava
Swati Haldar
Sushil Kumar
Suchitra Ghosh
T K Manual
Vibha Rani
V C Bagar
V K Parashar

List of the retired persons for the year 1998-1999.

R K Sharma,A.O.
B Sircar,TOC
Prem Lamba, Dy. SPO
G S Bhambra, TOB
Babu Ram Sharma,W/S Asstt. VII
Ram Das, Tech.VIII
Sardar Singh, Tech.VIII
R L Verma, Tech.VIII
Vishwanath, Tech.VIII
M S Just, TOEI
J N Bohra, Sc.EII
Ganga Sharan Sharma, Security Guard
R B Rana, SMA
R S Bist, Tech.VIII
J S Dhama, Sc.C
J P Vashist, TOC
P L Malhotra, Sc.EII
B K Bharti, Tech.VIII
D C Sharma, Sc.F
B R Awastiay, Sc.EII
T N Sharma, Asstt.
Hukam Singh,W/S Asstt. VII
Chhote Lal, Tech.VIII
Jagdish Lal, TOB
S M Khullar, TOEII
Suraj Bhan, Tech.VIII
Abdul Hamid, TOB
V K Agrawal, Sc.G
S S Bhakri, TOC
Santosh Manrai, Sc.EI
Nathu Lal, Mali Gd.I
D S Sachdeva, TOC
E W Baron, SM

Obituaries

V K Kohli, Sc. EII
Daya Nand, Tech.VIII
Raj Pal, Safaiwala
Ram Lal, Tech.VII
Maheshwar Datt, Tech.VIII
M L Thukral, Tech.VIII
Shiv Prasad, Tech.VII

APPENDIX : 15

RESEARCH AND MANAGEMENT COUNCILS

Research Council

Name	Position
Dr. R. Chidambaram Chairman AEC & Secretary Department of Atomic Energy Anushakti Bhawan Chhatrapati Shivaji Marg Mumbai-400039	Chairperson
Prof. V.S.Ramamurthy Secretary Department of Science & Technology Technology Bhavan New Mehrauli Road New Delhi-110016	Member
Dr. R.R. Kelkar Director General Indian Metrological Department Mausam Bhavan Lodi Road, New Delhi-110003.	Member
Mr. P.S. Das Director General Bureau of Indian Standards Manak Bhavan 9, Bahadur Shah Zafar Marg New Delhi-110002	Member
Prof. Dipankar Chakravarty Director Indian Association for Cultivation of Science 2A & B, Raja S.C. Mullick Road Jadavpur Calcutta-700032.	Member
Dr. N. Srinivasan Deputy Director General Confederation of Indian Industry Gate No. 31, North Block Jawahar Lal Nehru Stadium Lodi Road New Delhi-110003	Member

Name	Position
Mr. M.K. Mittal Director (E& RD) BHEL BHEL Headquarter Sirifort, New Delhi-110049	Member
Prof. R.N. Biswas Director Central Electrical & Electronics Ressearch Institute (CEERI) Pilani-333031 (Rajasthan)	Member Sister Laboratory
Dr. S.P. Vassireddi CMD Vimta Laboratories Limited 142, IDA Phase II Cherlapally Hyderabad-500051(AP)	Member DG'S Nominee
Dr. A.K. Raychaudhuri Director, NPL	Member
Mr. T.K. Chakravarty Scientist E-I P & C Group, NPL	Non-Member Secretary
Dr. H.R. Bhojwani Head Research Planning & Business Development (RPBD) Council of Scientific & Industrial Research (CSIR) Anusandhan Bhawan Rafi Marg, New Delhi-110001.	

Management Council

Dr. A. K. Raychaudhuri Director National Physical Laboratory New Delhi-110012	Chairman
Dr. A.K. Srivastava Scientist National Physical Laboratory New Delhi-110012	Member
Dr. Gopal Bhatia Scientist National Physical Laboratory New Delhi-110012	Member

Name	Position
Dr. R.P. Singhal Scientist National Physical Laboratory New Delhi-110012	Member
Dr. B.S.Mathur Scientist National Physical Laboratory New Delhi-110012	Member
Dr. S. Mallick Head HRDG CSIR Complex New Delhi-110012	Member
Dr. Mansha Ram Scientist National Physical Laboratory New Delhi-110012	Member
Sr. FAO National Physical Laboratory New Delhi-110012	Member
COA National Physical Laboratory New Delhi-110012	Member Secretary

Central Computer Facility

The CCF provides services through an array of PC's, workstations and a library of software that serve as common user facilities. It also administers e-mail service to various users in the laboratory. The facilities added this year include the following:

- NPL - LAN consisting of three optical fibre segments between the main building and other campus buildings and UTP segments inside buildings was put in place during this year. A total of 275 information outlets were installed in various rooms inter-connected through switches and hubs located at various places on the campus. All staff members have been provided a personal e-mail account.

- A VSAT for connecting to the Internet and many server for users of NPL-LAN were configured and set-up. These included an e-mail server (on LINUX), DHCP (Dynamic Host Configuration Protocol) server (on LINUX) to distribute dynamic IP addresses, a name server (on an HP 9000/735 workstation) for translating internet host names to IP addresses.

Apart from the in-house management a joint project with M/s Amil Ltd., Delhi for the automation of a compression testing machine was successfully completed. The sponsoring industry has launched this fully automated system in the market. Another joint project with NCHM and IHTMCN for computerization and networking of the premises was also completed..

Library and Technical Information Services

NPL library is a leading repository of publications in physics and related sciences in the country. During the year it

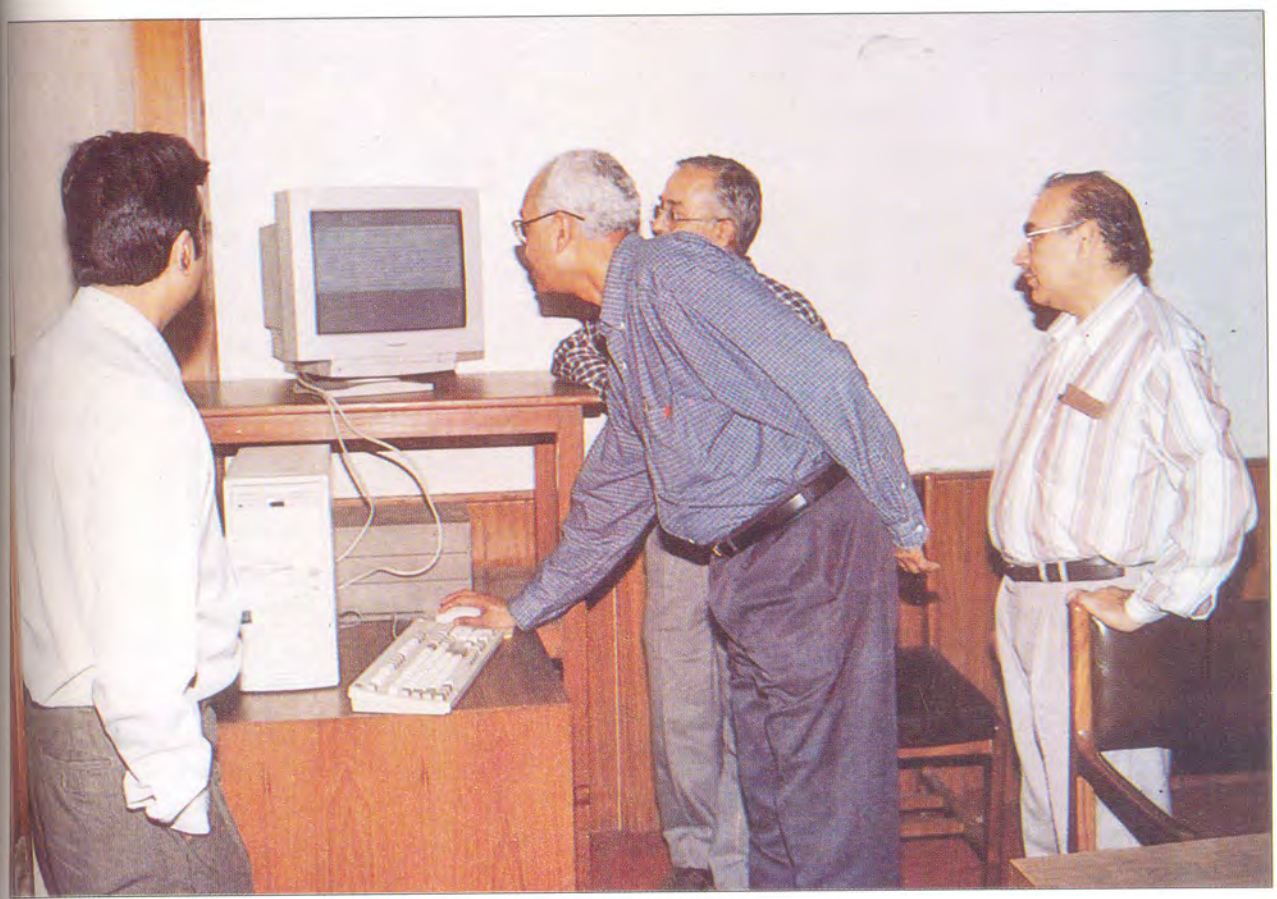


Fig. 10.1 : Inauguration of NPL - LAN connection First Phase by Dr. R A Mashelkar, FRS, DG-CSIR; others present (L to R) Prof. A K Raychaudhuri, Dr. Ravi Mehrotra and Dr. S M Dhawan

वर्ष के दौरान दो कार्यशालाएँ आयोजित की गई जिसमें प्रयोगशाला के लगभग 70 अधिकारियों, कर्मचारियों ने उत्साहपूर्वक भाग लिया। दिनांक 27.4.98 को हिन्दी सॉफ्टवेयर पर एक दिवसीय कार्यशाला का आयोजन किया गया जिसमें श्री वी.पी.गोयल, निदेशक तकनीकी, राजभाषा विभाग, गृह मंत्रालय, प्रो. सूरजभान, श्री पूरन पाल तथा श्री सुधांशु द्विवेदी, वैज्ञानिक, एन.पी.एल. ने प्रतिभागियों को हिन्दी के विभिन्न साफ्टवेयरों के सम्बन्ध में विस्तृत जानकारी उपलब्ध कराई (चित्र-10.2)।

दिनांक 1.3.99 को आयोजित की गई एक दिवसीय हिन्दी कार्यशाला में राजभाशा विभाग के निदेशक श्री राजकुमार सैनी ने राजभाषा नीति व इस सम्बन्ध में सरकारी कर्मचारियों का दायित्व, श्री कृण कुमार ग्रोवर, पूर्व सचिव, भारत सरकार ने संसदीय राजभाषा समिति की संस्तुतियों पर राष्ट्रपति जी के आदेशों की जानकारी तथा हिन्दी में टिप्पण/आलेखन एवं अभ्यास, श्री सुधांशु द्विवेदी, वैज्ञानिक, एन.पी. एल. ने वैज्ञानिक प्रयोगशालाओं में हिन्दी का प्रयोग और संभावनाएँ तथा श्री पूरन पाल, हिन्दी अधिकारी, सी.एस.आई.आर. ने वार्षिक कार्यक्रम सम्बन्धी विस्तृत जानकारी व तिमाही प्रगति रिपोर्ट को भरने पर व्याख्यान दिए ।

प्रयोगशाला में हिन्दी का माहौल बनाए रखने तथा अधिकारियों/कर्मचारियों को प्रेरित और प्रोत्साहित करने के लिए सितम्बर, 1998 में 'हिन्दी पखवाड़ा' का आयोजन किया गया तथा निदेशक महोदय की ओर से अपील की गई कि सभी स्टाफ सदस्य अपना अधिक-से-अधिक कार्य हिन्दी में ही करें । इस अवसर पर विभिन्न प्रतियोगिताओं का आयोजन किया गया ।नोटिंग-ड्राफ्टिंग, कविता, टाइपिंग, निबन्ध तथा डिक्टेशन प्रतियोगिताओं में लगभग 105 अधिकारियों/कर्मचारियों ने भाग ले कर हिन्दी के प्रति अपनी गहरी आस्था एवं रुचि दिखाई ।

उपरोक्त कार्य के अतिरिक्त प्रयोगशाला में हिन्दी में किए गए कार्य की तिमाही प्रगति रिपोर्ट सी.एस.आई.आर. मुख्यालय भेजी गई जो प्रयोगशाला के विभिन्न अनुभागों से प्राप्त प्रगति रिपोर्ट के आधार पर तैयार की जाती है । प्रशासन व अन्य वैज्ञानिक/तकनीकी अनुभागों से प्राप्त अंग्रेजी सामग्री का हिन्दी अनुवाद किया गया । विभिन्न अधिकारियों द्वारा प्रयोग में लाई जाने वाली रबड़ की मुहरों को द्विभाषी तैयार किया गया तथा निदेशक महोदय के कार्यालय से प्राप्त कुछ अंग्रेजी पत्रों का 'क','ख' क्षेत्रों में जवाब हिन्दी में दिया गया जैसा कि संसदीय राजभाषा समिति को आश्वासन दिया गया था । राजभाषा नीति के सुचारू रूप से कार्यान्वयन के लिए वर्ष 1999-2000 के दौरान प्रयोगशाला ने उल्लेखनीय सफलता हासिल की है ।

the group handled 49 grants-in-aid, 29 collaborative and one sponsored projects. The group also handles coordination in matters related to the Research Council.

Intellectual Property Right:

Realizing the strategic importance of intellectual property in the ever-changing global economic scenario, an independent cell looks after this. Its main thrust is to manage in totality the IP portfolio of the laboratory. This includes not only helping scientists to file patents of deserving R&D outputs but also to scout around and look for and secure the possibility to protect any R&D output. During this year 6 patents have been filed in India and one patent application has been filed in foreign countries. One technology know-how was also transferred. Details are given in Appendix.

Marketing Group:

This Group is responsible for marketing technologies developed by NPL. It also facilitates and processes taken up by NPL scientists contract research projects from external agencies. This group arranged NPL participation in the India International Trade Fair (ITF-99) held at Pragati Maidan, New Delhi, during 14-27 November 1998 and exhibited NPL developed R&D products. One know-how transfer was arranged during the year. The details are given in the Appendix.

International Science & Technology Affairs Group (ISTAG):

This group is responsible for maintaining and processing applications of NPL staff for deputations abroad. The Group also arranges special lectures by visiting scientists. The deputations and lectures arranged this year are listed in the Appendix.

Human Resource Development Group (HRDG):

This Group arranges various training programmes for the benefit of NPL staff and also the trainings offered by NPL for the benefit of industries in various areas of calibration. The group also supports organization of various symposia, conferences etc. by NPL staff at NPL. It also attends to various PR activities and follows up various MoUs with educational institutions in respect of doctoral, post-graduate and summer training on reciprocal basis. It processes induction of JRFs, SRFs and Research Associates for NPL programmes. The Group also pursues other schemes of CSIR on EMR and HRD activities. List of training programmes and other events organized by the group is given in the Appendix.

Publication and Documentation:

This cell is responsible for compiling, editing, printing and distribution of Annual Reports and other documents informing about laboratory's activities. A monthly circular 'NPL-Info' for internal consumption is also being brought out in printed form. This unit also compiles monthly and annual inputs to go from NPL for CSIR level reports.

Rajbhasha Unit:

This unit is looked after by both the office of COA and also the Technical Secretariat and helps scientists in Hindi transcription of their papers, articles, reports, etc. This year also the Rajbhasha unit arranged various training programmes. Hindi fortnight was celebrated in the month of September to encourage use of Hindi in all official proceedings and also to encourage writing of R&D outputs in Hindi for the benefit of the society. As per Govt. of India directives the Unit arranges selection for cash awards of NPL employees who contribute most to the propagation of Hindi in office work. Cash awards are given to winners in various categories. Detailed report of the Unit is given in Hindi in the following pages.

वर्ष 1998-99 के दौरान राष्ट्रीय भौतिक प्रयोगशाला में हिन्दी की प्रगति

PROGRESS OF RAJBHASHA IN THE LABORATORY

राजभाषा नीति के अनुपालन और कार्यान्वयन हेतु इस प्रयोगशाला द्वारा निरन्तर प्रयास किए जा रहे हैं । अब प्रयोगशाला के लगभग सभी अधिकारी ध्कर्मचारी हिन्दी का कार्यसाधक ज्ञान रखते हैं और हिन्दी में कार्य करने को वरीयता देते हैं । वर्ष के दौरान प्रयोगशाला ने कार्यान्वयन की दिशा में उल्लेखनीय सफलता प्राप्त की है ।

प्रयोगशाला चूँकि नियम 1976 के नियम 10(4) के अन्तर्गत अधिसूचित है। अतः इसका दायित्व और भी बढ़ जाता है कि यहाँ के अधिकारी /कर्मचारी अपना अधिकांश कार्य हिन्दी में ही करें। राजभाषा यूनिट द्वारा समय-समय पर जारी किए गए परिपत्रों/नोटिसों तथा निदेशक महोदय तथा प्रशासन नियंत्रक/प्रशासनिक अधिकारी के दिशा निर्देशों एवं प्रेरणा के फलस्वरूप ही वर्ष के दौरान राजभाषा अधिनियम 1963 की धारा 3(3) के अन्तर्गत जारी किए जाने वाले सभी कागजात द्विभाषी ही जारी किए गए हैं।

वर्ष के दौरान प्रत्येक तिमाही में राजभाषा कार्यान्वयन समिति की बैठक बुलाई गई तथा बैठक में लिए गए निर्णयों पर सफलतापूर्वक अनुवर्त्ती कार्यवाही की गई। निदेशक महोदय की अध्यक्षता में हुई उक्त राजभाषा कार्यान्वयन समिति की बैठकों में राजभाषा नीति के कार्यान्वयन के लिए राजभाषा विभाग, गृह मंत्रालय, भारत सरकार द्वारा तैयार किए गए वार्षिक कार्यक्रम पर विस्तार से चर्चा हुई तथा निर्धारित लक्ष्यों को प्राप्त करने का पूरा-पूरा प्रयास किया गया ।

चित्र 10.2: हिन्दी पखवाड़े, दिनांक 1.9.1998 से 18.9.1998, के समापन समरोह के अवसर पर भाषण प्रस्तुत करते हुए प्रो. ए. के. रायचौधुरी, निदेशक, एन.पी.एल. (बाएं से तृतीय)।

शोध सुविधाएँ व सहायक सेवाएँ
RESEARCH FACILITY AND SUPPORT SERVICES

यह प्रभाग निदेशक की अध्यक्षता में वर्ष 1997-98 में गठित किया गया था । इस के आधीन विभागों में सम्मिलित हैं: निम्नतापिकी व अन्य परिष्कृत सुविधाएँ, तकनीकी अवसंरचनाः- उदाहरणार्थ केन्द्रीय कम्प्यूटर सुविधा, मुख्य वर्कशॉप, ग्लास प्रौद्योगिकी, वर्कशॉप, विद्युत वितरण, पम्पिंग, वातानुकूलन, सिविल वर्क्स, कैम्पस रख-रखाव, दूरभाष, फैक्स, फोटोग्राफी, पुस्तकालय, अनुसंधान एवं विकास प्रबंधन व प्रशासन इकाइयों का प्रबन्धन व अन्य ऐसी सुविधाएं जिनका उपयोग सभी प्रभागों द्वारा होता है, इस प्रभाग के अधीन आते हैं । इसी का एक भाग तकनीकी सचिवालय कहलाता है। सभी आंतिरक एवं बाह्य परियोजनाओं का नियोजन व समन्वय मार्केटिंग व तकनीकी ज्ञान का हस्तान्तरण, विभिन्न अन्तर्राष्ट्रीय कार्यक्रमों में भ्रमण, पेटेंटों का निवेदन व पंजीकरण, मानवीय संसाधनों का संवर्धन, प्रयोगशाला के डेटा बेस का प्रबन्धन, राजभाषा विषयक प्रसारण व प्रयोगशाला के तकनीकी प्रकाशन ये सभी इसी प्रभाग में आते हैं । निम्नतापिकी के क्षेत्र की गतिविधि पिछले अध्याय में प्रस्तुत की गई है । इस प्रभाग की अन्य गतिविधियॉ संक्षेप में यहां दी गई है। इस वर्ष 275 कम्प्यूटरों को जोड़ने की क्षमता वाली एन.पी.एल. लैन (NPL-LAN) स्थापित कर दी गई हैं ।

This Division was constituted during 1997-98, with Director, NPL as its head. Cryogenic and some other sophisticated instruments facilities, technical infrastructure - such as, central computer facility, main workshop, glass technology workshop, electrical supply, pumping, air-conditioning, civil works, campus maintenance, phones, fax, auditorium, photography, library, R&D management and administration units, that provide support to and are shared by all the other divisions, whose R&D activities are given in the preceding chapters of this report, function under this division. The Technical Secretariat, one of the units of this Division is responsible for planning and coordination of all in-house and externally supported R&D projects, marketing and transfer of technological know-how developed indigenously, processing of deputation under various international collaborative programmes, filing of patent, human resource development programmes, maintaining laboratory information data bases, propagation of Rajbhasha and bringing out technical publications of the laboratory. Activities in the area of cryogenics were described in the previous chapter. The rest of the activities of this Division are briefly presented here. NPL-LAN with the capability to connect 275 PCs across the laboratory was put in place this year.