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NATIONAL PHYSICAL LABORATORY

NEW DELHI

CONTENTS

PHYSICO MECHANICAL STANDARDS

LENGTH & DIMENSIONS

1. LENGTH

Facilities were developed to calibrate commercially available 633 nm frequency stabilised He-Ne lasers against the iodine stabilised He-Ne laser. Improvements were made in the laser interferometric system for calibration of line gauges using photo-electric microsope. The uncertainty in the calibration of line scale of ± 1.0 um per metre was achieved. In the sponsored project of photolithographic mask aligner, it was possible to achieve an alignment accuracy of the order ± 50 nm using methods based on Moire interferometric technique and computer.

The precision optical components like, laser mirror blanks, optical flats etc. were made and tested. The calibration of precision length measuring machines, using laser interferometer was carried out.

2. DIMENSIONAL METROLOGY

The facility for angle measurement using laser interferometer was established. A three coordinate measurement centre model UPMC 850 ZEISS, of range 850 x 1200 x 600mm in x-y-z directions was installed. The calibration of long end bars, using laser interferometer and 4m bench was tried and results compared.

Intercomparison of gauge block was undertaken with PTB Germany and the results agreed within 15 nm. The calibration of heavy items was done at site.

MASS

The maintenance and recalibration of standards of mass was continued. Facility for testing of weighing machine for model approval was developed and the test procedure was drawn taking into consideration various international specifications. Viscometers of different ranges and calibrated at NPL, were calibrated at PTB and the results were compared. The measurement of density of silicon along with the study of water absorption using I.R. Technique was continued.

One secondary standard weight box of the Nepal Bureau of Standards and Metrology, was calibrated. The calibration of hydrometers of different types, viscometers, weights, measures etc., were done for state departments and industry.

FORCE

The 1 MN hydraulic multiplication system manufactured under FIE-NPL collaborative programme was installed at NPL. The accuracy of the application of force is better than ± 0.02 percent in the range of 100 kN to 1000 kN. This machine would now be used for calibration of all types of force measuring devices including precision load cells. The calibration for the industry was done as usual.

TEMPERATURE

Electronic circuitry was developed for automation in calibration of thermocouples using PC/AT. Studies on noble metal thermocouples at the fixed points were continued. The spherical furnace and automatic ice point cells received from PTB were installed and used .The development of software and hardware for automatic control of furnace temperature was done. The performance tests on the thermal conductivity apparatus were carried out and results compared.

Two standard platinum resistance thermometers and two triple points of water cells were fabricated. A new assembly for the realisation and establishment of Cd point was completed. The platinum resistance thermometers work was granted accreditation with reproducibility of ± 1 mK, in the range 630.74°c to -219°c

OPTICAL RADIATION

The photometry and radiometry laboratories were

being upgraded by installing new, automatic goniophotometer and spectroradiometer with the assistance of PTB, Germany. Basic research on spectral changes induced due to source correlation during propagation of radiation was continued. Calibration and testing were provided to the luminaire industry, educational and R & D institutions.

Under the sponsored project for the indigenous manufacture of retro-reflective sheeting/tapes, the method for characterizing beads was standardized. Detailed investigations with cost analysis of retro-reflecting properties of tapes embedded with indigenous, imported and blended types were made.

INFRARED RADIATION

The irradiance scale in the spectral region of 0.8 to 15 μm was set up and the irradiance of a few sources were measured. The detector and preamplifier parts of the infrared line scanner of a firm were calibrated for various target temperatures.

The transmittance and reflectances of a few samples of one surface polished and both surfaces polished silicon and germanium single crystals were measured in 2.5 to 25 μm spectral region and their values were computed and compared.

ACOUSTICS

Experimental studies, under reverberant conditions were conducted to evaluate roofing sheets for their relative sound insulation properties for use in the auditoria etc. The FRP sheets were found to have higher sound insulation (10dB) compared to GI sheets.

While that for asbestos sheets the sound insulation was only 5 dB higher. Noise power levels of room heaters, food mixers and washing machines, were determined for formulating specifications.

Sodar structures of the atmospheric boundary layer collected during the monsoon period of 1990 at Jodhpur were analysed for their characteristic features.

A monostatic sodar was installed at Nimbahera, Chittorgarh for studies of mixing height. A proposal was submitted to the Deptt. of Environment for undertaking environmental impact assessment studies in respect of noise pollution under Indian conditions.

The accuracy of primary standards of sound pressure and vibration amplitude was maintained through periodic checking/calibration. Secondary standards from regional laboratories including tachometers, vibration measuring systems, sound level meters and calibrators were periodically calibrated.

UNDERWATER ACOUSTICS

Three reference transducers and four high pressure hydrophones were fabricated and their transmitting response and receiving sensitivity measured. The variation of the relative sensitivity of a Bruel's Kjaer hydrophone upto hydrostatic pressures of 1000 psi was studied. The design of various components of the complete pinger device was completed. The acoustical performance characteristics of the 45kHz pinger tag was evaluated for frequency response and directional response and tested at the Badkhal lake, Faridabad. Calibration of transducers for transmitting and receiving sensitivity response was carried for KDIMPE, Dehradun. Exploratory studies in thermoacoustics and acoustic characterization of turbulence were carried out.

The investigations on displacement amplitude measurement of ultrasonic transducers using phase lock laser interferometer were made. Measurement of ultrasonic displacement over the transducer surface radiating in water was done using 1MHz transducer. Ultrasonic flaw detection system (C Scan) was used for characterization of various types of defects in steel bar. Extensive measurements were made on the ultrasonic velocity and attenuation of different piezoelectric ceramic poled and unpoled samples at 7.5 MHz. Acoustic field parameters of various transducers for ATL ultramark of medical diagnostic equipment were measured at AIIMS and UCMS, New Delhi.

CS PROGRAMME & FLOW MEASUREMENT

The Calibration Service Programme, under the NCTCF scheme of DST, was coordinated. Several accreditation documents and guide books were developed and updated to ensure complete alignment with European Community standards on laboratory accreditation. The number of accreditated industrial calibration laboratories (public & private sector) account for 21 out of 52 under this scheme. Consultancy assistance was provided to more than 30 laboratories in different areas of measurement. Technical collaborations were held with IIT's, defence labs., DOE, DST, CSIR labs., BARC, public & private sector industries and universities for various expert panels, working groups and membership of accredited fraternity.

The civil works were continued. The details of the major equipment, to set up the primary standards facilities based on two-master-meters measurement assurance techniques were finalised.

ELECTRICAL STANDARDS

TIME AND FREQUENCY

Improvements were made in the STFS transmission setup at Sikandrabad Earth Station with the installation of PC-XT and two new format generators. Several user institutions including All India Radio, Tata Electric and MCF, Hassan were helped in the usage of STFS transmissions. Some experiments were carried out to compare the clock between NPL and Sikandrabad Earth Station and an accuracy of one microsecond could be achieved.

The expertise developed for reconditioning the physics package of HP aged Rb standards was being used by outside organisations. The theoretical studies on squeezed states were carried out. Several electronic sub-assemblies of the Maser project were completed.

DC STANDARD

The maintenance of the e.m.f. values of group of saturated standard cells was continued. The dc standards of resistance were also maintained. The calibration of dc measuring instruments including standard cells, electronic voltage standards, digital multimeters and calibrators was carried out.

HF IMPEDANCE AC AND LF

The project of automatic precision capacitance bridge, in collaboration with Jadavpur University was successfully completed. The automatic capacitance bridge can be used for measurement of capacitances in the range 10 pF-1000pF with an accuracy of 1 ppm. Capacitances upto 1μF can be measured in the frequency range 50 Hz to 1kHz. A transfer standard of ac resistance of kiloohm was reassigned value against the standards of capacitance with an uncertainty of 3-parts in 10^7 using quadrature and ac resistance bridges. Using William's bridge facilities, high frequency impedance measurements were established in the frequency range 1 MHz to 100 MHz with a basic accuracy of 0.02% at 1 MHz for capacitance. A set of high frequency quasi-inductance standards having nominal values of 10 μH, 100 μH and 1 mH were designed and fabricated.

Single phase reference standard of ac power and energy was inter-compared with the PTB standard with an uncertainty of 0.02%. Facilities were established to determine the effect of variation of voltage(±20% of reference), frequency (± 5% of power freq) and temperature (± 10°C of ambient) on the accuracy of ac power and energy measurements. The range of phase measurement was extended upto 30 kHz. Techniques were established for the calibration of ac high current shunts upto 500 A capacity and for testing fireman's axe.

HF & MW VOLTAGE, CURRENT, POWER, FREQUENCY & NOISE

The primary standards of voltage, current, power, frequency and noise were maintained and updated. Towards establishing primary coaxial power standard in the frequency range of 10 MHz to 18 GHz, a new project on the development of "coaxial HF & microwave microcalorimeter" was initiated in the year with the collaboration of PTB. The fabrication of various parts of the microcalorimeter as per the drawings was completed and the assembly was in progress. Assistance was provided for assessment of laboratories under NCTCF programme. The calibration of a number of precision instruments from the user organisations was done.

MW ATTENUATION & IMPEDANCE

A prototype laboratory model of 30 MHz WBCO attenuator was designed and fabricated. The cylinderical precision waveguide, launching and receiving coils were designed for the attenuator. The preliminary testing and evaluation of attenuator gave an uncertainty of 0.05 dB/10dB for a range of 60 dB. The improvements were made in the design of K-band standard mismatches. Calibration of attenuators and matched terminations was carried out for different government departments and undertakings.

MATERIALS

SILICON AND DEVICES

A process for reusing crucible of demountable graphite moulds of different shapes was optimised. This enabled to grow as many as 16 silicon ingots. Attempts were made to scale up the process. The facilities were created for screen printing of 50mm dia round and 40 mm x 40 mm square CZ single crystal silicon solar cells, of 11% efficiency (AM 1.5) without the antireflection coating. A process of achieving very low reflectivity (2%) silicon (100) surface by texturization with an anisotropic wet-chemical etching followed by 1100 A° thick thermal SiO_2 layer was developed for maximum light absorption in silicon solar cells

Several trial films of metal, oxides like Cu, Ni, MgO, Y_2O_3, ZrO_2, YIG and Ba-ferrite, were deposited on saphire/silicon, using quartz glass apparatus. Cheaper derivatives such as acetyle acetonates and alkoxides were also tried. Useful data including volatility of derivatives, nature of carrier gases and flow rates needed and vapour flow dynamics were obtained . The fabrication of a suitable apparatus was taken up.

Ion-beam ($^{14}N^+_2$) mixing experiments of Ti thin films deposited on silicon wafers by e-beam evaporation followed by annealling in argon atmosphere were carried out to synthesize titanium silicides. Positive temperature coefficient of resistance studies of P doped barium titanate ceramics were carried out.

INTERFACE MICROSTRUCTURE DEVICES

Dielectric films of yttrium oxide, other rare earth and refractory oxides and composites and stacked dielectrics were studied. A large number of MIS structures were studied where over 75% showed optimized break down strength. New measurements of surface and depth analysis in thin film polycrystalline multi-interface solar cells, based on CdTe and $CuInSe_2$, were carried out to study different doping mechanisms. Some hetero-junctions with CdS window layer deposited by the electrochemical process were prepared, characterized and their photovoltaic properties studied. A new metod for preparation of $CuInse_2$ thin films by electroselenization process was developed and detailed analysis of the composition, structure and optical properties was carried out.

An atmospheric and low pressure chemical vapour deposition system for fabrication of Y-Fe garnet thin films, using metalorganic complexes was set up. Growth kinetics and parametric studies were undertaken for constituent iron oxide thin films. A technique for obtaining growth of highly coercive gamma iron oxide thin films was developed.

LUMINESCENT MATERIALS

Samples of Eu activated yttrium oxysulfide were made under varying preparative conditions using indigenously available as well as imported rare earth oxides. Photoluminescent emission spectra and light output under cathode rays were obtained and compared with the standard samples from user industry. The spectra of various Tb activated gadolinium oxysulfide phosphor samples were also obtained to study the effect of variation of Tb on line intensities. Thermoluminescence (TL) studies of Gd_2O_2S: Tb was initiated to know the nature of trapping states. The TL spectrum recorded in the temperature range of 93 to 500 K with a heating rate of 0.52 Ks^{-1} showed five glow peaks (Fig.). An analysis of the trapping parameters and order of kinetics for all the prominent glow peaks was done. Both intrinsic point defects and trace impurities are likely to be responsible for trapping states.

A fluorescent screen of full size, coated with an optimized layer thickness of 160µm Gd_2O_2S: Tb phosphor on a thick tungsten sheet, was prepared for 9 MeV NDT application in SHAR's varian imaging system. Specified illumination of 10^{-3} Ft Lambert at

X-ray radiation level of 1 Rad/m was achieved. The required screen sensitivity of 1% was obtained which corresponds to a detection of 8 mm thick defect in a total propellant thickness of 800mm. The resolution test was done using two blocks of perspex with a gap of 0.5 mm which was clearly detec ted.

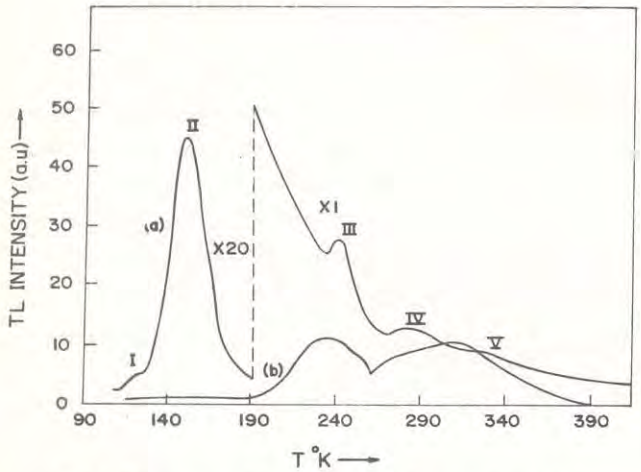


Fig. Glow curves of the Gd_2O_2S:Tb phosphor, (a) original (b) after H_2S firing.

DISPLAY DEVICES

1.1 *Liquid crystals*

The dielectric properties of a high-tilt-angle chiral-nematic-smectic C* phase ferroelectric liquid crystal were studied in the frequency range of 30 Hz to 1MHz. Measurements of electric permittivity at different temperatures and biasing fields were taken in thin homogeneously aligned samples with the electric measuring fields being parallel to the layer planes. The electro-optic behaviour of polymer dispersed liquid crystal (PDLC) films was studied as a function of frequency and amplitude of the applied voltage and size of the liquid crystal droplets. Visual and optical response studies showed that there were two types of PDLC films. It was observed tht both types of films, exhibited a two-step decay involving fast and slow components. Observations under the polarizing miroscope showed that the LC droplets in the two types of PDLC films undergo different transformations as the applied voltage was changed. Transparent and crackfree thin films of $BaBi_4Ti_4O_{15}$ were fabricated by solgel process and the surface structure, optical and dielectric studies were carried out.

The temperature dependence of the dc conductivity of electro-chemically polymerized polypyrrole films, having diffrent percentage of BF_4 ions, was investigated in the temperature range 77-300 K. It was found that reasonable values of Mott's parameters, were obtained for films having low doping level. Ac conductivity, dielectric constant and loss of vinylchloride: vinyl acetate copolymers were measured in the temperature range 77-410 K and in the frequency range 50 Hz - 100 kHz. The dielectric constant in this temperature region showed a very weak frequency and temperature dependence.

1.2 *Development of biosensors*

The technical development of some biosensors and biomaterials was continued. It was found that graphite was an excellent matrix both for the immobilization of glucose oxidase and the transport of electrical charge that essentially resulted due to the on-set of a desired biochemical reaction. The activity of the immobilized enzyme (glucose oxidase) in such a matrix was experimentally determined using spectrophotometric techniques. The use of a suitable mediator such as ferrocene carboxylic acid or dimethlyl ferrocene resulted into enhanced amperometric response. The strip type glucose electrodes developed indigenously were completed to the electronic circuit fabrication. The immobilization of urease was carried out in polyvinyl alcohol membrane. The urease eletrode showed a linear behaviour in the normal urea concentration range. Such an electrode follows the Mechallis-Menton behaviour of enzyme reaction mechanism. At higher urea concentrations, it showed saturation behaviour. The urease membrane could be used for 50-100 cycles.

1.3 *Conducting polymers*

A number of conducting polymers such as polyanilines, poly-2-ethylaniline and poly-N-methylanilines were chemically synthesized. The spectroscopic examination of both solution cast and vacuum-deposited films of polyaniline revealed the presence of backbone in the structure. Various conducting copolymers such as polyanilne-co-orthoanisidine and poly-phenyl pyrrole-pyrrole were synthesized using chemical and electrochemical techniques respectively. It was shown that the undoped polyaniline-co-ortho-anisidine was soluble in a number of organic solvents. FTIR and UV-visible studies conducted on this processable conducting polymer suggested the existence of a random copolymeric structure.

The dielectric relaxation studies were carried out on aluminium-polyaniline - polyaniline capacitors. It was found that the mobility of charge carriers in polyaniline increased with increase in temperature. Muon spin relaxation measurements were performed on a number of samples of conducting polymers. Extensive investigations were carried out on metal/ conducting polymer Schottky devices. It was discovered that the Schottky device based on metal/ polyaniline (vacuum deposited) yielded an excellent recification ratio.

1.4 *Xeroradiographic photoreceptors*

The study of electron and hole trapping levels at a microscopic level using thermally stimulated discharge current (TSD) technique was made. Fundamental investigations in polymeric materials such as study of charge trapping levels were made with a view to find their suitability as interfacial barrier layers in xeroradiography photoreceptors. XR photoreceptors were fabricated using the chemically modified selenium.

CARBON PRODUCTS

The characterization studies of PAN precursor and fibres including differential scanning calorimetry, FTIR, X-ray diffraction and surface morphology, were got done. Experimental results showed that the tensile strength of carbon fibres prepared from chemically modified samples increased to 4 GPa as compared to 2 GPa obtained from unmodified samples. The elongation to break for such carbon fibres was pushed up to 1.6% as compared to only 1.0%. The intercalation of carbon fibres, heat treated at varying degrees, was carried out with liquid bromine. The development of carbon fibresreinforced glass ceramic composites was continued. Silicon oxycarbide was prepared and its stability upto 1500°C was investigated. The precursor materials and the materials synthesized were investigated by various physico-chemical techniques.

The work on the sponsored project, to develop coal tar pitches of specific characteristics, was initiated. The development of mesophase (liquid-crystalline) spherules at a heat-treatment temperature of 420°C for different periods of heating was studied in terms of its size and anisotropic content in coal tar pitches. The mesophase spherules were moulded into rectangular plates and carbonized to different temeratures upto 2700°C to obtain high density carbons. Efforts were made to develop carbon-separator (bipolar) plate for phosphoric acid fuel cell for BHEL. Rheological studies on pitches were done in order to find out the narrow temperature range of constant viscosity.

THIN FILM SYSTEMS

Diamond like carbon (DLC) coatings were investigated further. Hardness values in excess of 1100 kg mm^{-2} on Ge substrates and 2800 kg mm^{-2} (Sifor same load) were realised. The coatings were found to remain unaffected by chemical attacks and other environmental variables. Various hard coatings on large area substrates were made and delivered to user agencies. Detailed characterization study of amorphous hydrogenated silicon-germanium films was carried out for integration of such material in a tandem solar cell structure. The

control of deposition rates and other process variables like reactant gas pressure and substrate temperature were studied. Lowest value of band gap realised for such films was about 1.43 eV with acceptable opto-electronic properties of the films so produced. Double tandem solar cell structures were also attempted. Under the new development project sponsored by DNES for designing and assembling a sophisticated multizone plasma CVD facility with BHEL and related industries, a large slit valve was fabricated at the workshop.

HIGH PRESSURE TECHNOLOGY

The work on the synthesis of cubic boron nitride (cBN) crystals under high pressure-temperature conditions was continued. Under static pressure-temperature conditions, the Wurtzitic phase of BN was detected. Some preliminary work of using iron, nickel and their alloys as catalyst solvents was done. The pressure calibration of 200 tonne press below 25 kbar was carried out.

CHARACTERIZATION

PURITY, COMPOSITION AND STRUCTURE

1.1 *Chemical Methods*

The work was done to develop accurate methods for the determination of traces of impurities in aluminium, copper, and germanium. A new water repellent chemical was developed for cellulose based materials. High purity acids, HCL and HNO_3 prepared by sub-boiling distillation, were analysed for ultra trace determination of metallic impurities. A number of milk samples were analysed for the evaluation of toxic pollutants like As, Cd, Pb and Cr for the preparation of milk standards.

A national '1991 Methane Campaign' for measurement of methane efflux rates from different major rice growing regions of the country was initiated. This was sponsored by the Deptt. of Environment & Forests and fourteen laboratories, institutes and universities participated. The absolute calibration compatibility at international level was established by exchanging samples with CSIRO, Australia and NIAES, Japan.

1.2 *Indian Reference Materials*

The preparation of Indian Reference Materials was continued. The data obtained from other laboratories was compiled and analysed. Nearly 80 bottles of IRM's were provided to different user organizations. Total organic carbon and inorganic carbon for a number of samples was determined. A two stage sub-boil distillation apparatus was designed and farbricated. A sequential optical emission spectrometer was installed and evaluated.

1.3 *Surface Area & Porosity*

Indigenous viscose rayon yarn was pre-treated and about twenty samples of activated carbon fibres were prepared. BET-surface area, yield of char and linear shrinkage were determined. Samples of catalysts were also characterized.

1.4 FTIR *Spectroscopy*

The FTIR spectrophotometer and emission spectrometer were maintained and used for the characterization of materials. A number of samples from different projects and thin film coated silicon received from CEERI, Pilani, were characterized by IR absorption method using FTIR facilities. Samples of electronic materials received from, IIT, Bombay were characterized by FTIR transmission measurement.

1.5 EPR *Spectroscopy*

Microprocessor based EPR data acquisition system was set up with X-band EPR spectrometer. Research investigations were continued on different materials. A number of samples from NPL and outside organizations were characterized at ambient and low temperatures.

1.6 *X-ray Fluorescence and Diffraction*

Identification of elements was carried out on samples received from government deptts. and industry. Semiquantitative analysis of trace elements using Compton scatter method was attempted. In this method the matrix correction is simple and quick and requires only one standard sample. Trace elements determined by this method, in BDH silicon powder and other samples, agreed in general with the values determined by analytical method.

X-ray diffraction studies were carried out for samples of materials including superconductors, carbon fibres, poly- silicon films and lime-soil mixes etc. It was found that (2212) single phase could be transformed to nearly (2223) single phase by reacting at 860°c with CaO with addition of Pb for stabilization. However, a sample prepared under identical conditions but using the (2223) nominal composition showed only a very small amount of (2223) phase. In collaboration with CEERI, Pilani, crystallite size and X-ray texture studies were carried out on different LPCVD polysilicon films deposited at temperatures

of 570° and 620°C and annealed under nitrogen or oxygen atmosphere.

1.7 *Electron Microscopy*

Different sets of couples of gold/tin were prepared by changing the sequence of deposition of the metal films. Films with offset configuration were prepared by depositing Au and Sn sequentially onto copper grids. The structure and formation of various phases of the as-deposited as well as annealed samples were investigated by transmission electron microsope and diffraction techniques. For the formation of intermetallic alloy in this configuration the films had to be annealed. The study also revealed that the grain size in Au/Sn couples was smaller compared to that in Sn/Au couples.

Pure and lead doped superconducting materials were prepared by using solid state reaction technique. Effect of sintering time, cooling mode and composition on the superconducting properties of these materials were studied. The morphology of the phases formed were investigated by using scanning electron microscope. The microstructure of these materials was investigated by using transmission electron microscopy and electron diffraction techniques. Tc was found to increase with sintering time upto certain period, after which it showed a decreasing trend. The increase has been explained due to the increase in the volume fraction of high Tc (2223) phase in the material. The samples rich in Cu and Ca showed relatively higher values of Tc. TEM studies also showed the presence of isolated dislocations in some local regions.

A number of catalysts were investigated for particle size, shape and size distribution. In collaboration with IIT, New Delhi, the microstructural analysis of a black copper solar selective coating prepared by chemical conversion process was studied by using transmission electron microscopy technique.

CRYSTAL GROWTH AND CHARACTERIZATION

A high resolution X-ray diffraction system, developed at NPL, enabled first time direct observation of anomalous transmission of X-rays Borrmann effect in thin natural diamond crystals. A new technique for isolating the forward diffracted beam from the residual direct beam was developed. This method in combination with the sharply defined highly collimated and monochromated exploring beam enabled direct observation of a well defined peak in the diffraction curve of the forward diffracted beam even when μt was only 0.3 and not ≥ 10 as expected theoretically.

High resolution X-ray diffraction, topography and curvature measurements were utilised for quantitative determination of stress induced by thin deposits of oxides, nitrides and silicides, in nearly perfect single crystals of silicon and also monitoring the degradation. The oxide film thicknesses were in the range of 250-1100A° and the nitride thicknesses in the range 700-1200A°. Large changes in radii of curvatures of the substrates were observed due to deposits. These investigations confirmed our earlier results on metallic deposits (ohmic contacts) on GaAs crystals that for measurement of stress it was necessary to take into account the initial bending of the blank wafers. The molybdenum films produced compressive stress of 2.17×10^9 dyne cm^{-2}. The oxide and nitride films produced stress of 5.6×10^9 dyne cm^{-2}. Interesting variations in contrast in topographs due to presence of stress in the case of molybdenum films were observed.

Lattice mismatch between gallium indium arsenide epitaxial films grown on indium phosphide substrates were determined by using high resolution X-ray diffractometry. Well defined peaks due to the substrate and the films could be observed in the diffraction curve of the specimen. The half widths of the diffraction curves (10-30 arc sec) indicated the good quality of the film and the substrate. It was observed that the films having compositions corresponding to near lattice match had a higher degree of perfection than those with finite mismatch. Also, films with the composition corresponding to compression mismatch were found to be of higher degree of crystalline perfection in comparison to those in tension. Composition of the films were obtained by using Vegard's law.

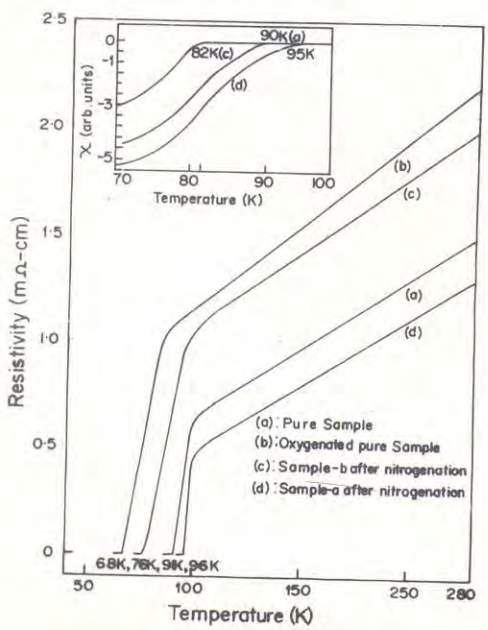
Single crystals of lithium niobate were grown successfully. Stoichiometry variations were studied and growth condition optimised. The diameter of the crystals was about 20 mm and length about 40mm. These crystals were characterized by using a five-crystal X-ray diffractometer in a three-crystal and a one-crystal configuration. Typical diffraction curves recorded with (11.0) diffracting planes were very sharp with half widths in the range 10-30 arc secs. Traverse topographs were recorded in Laue geometry. Single crystals of K_2ZnCl_4 and K_2XCl_4 (X=Cu, Fe) were grown and their dielectric properties investigated.

CONDENSED MATTER PHYSICS

HIGH TEMPERATURE SUPERCONDUCTORS

1.1 Basic studies

The crucial importance of interlayer coupling in the high Tc phenomenon of cuprate superconductors was brought forth by systematic studies of Bi-2122 carried out using the scanning tunnelling miscroscopy and spectroscopy techniques. A series of samples were prepared in the oxygen rich and oxygen deficient environments. Measurements showed that oxygen had a significant deleterious effect on superconductivity with Tc (R=o) values ranging from 70 K for the oxygenated sample to 91K for the air quenched sample (Fig.). By STM studies it was possible to directly observe the increase in the excess oxygen intercalated in the twin Bi-O layers of the Bi-2122 unit cell, while in the high temperature quenched sample, the oxygen intercalation was minimum.



The STS studies of these samples revealed that oxygen intercalation transformed the Bi-O layers from quasi metallic to insulating. When the Bi-O layers turned more resistive, the superconducting phase coherence between Cu-O layers across the demiunitcells in the C-direction, was expected to be adversely affected and thereby caused a significant decrease in Tc(R=O). The heat treatment needed was optimised by low temperature nitrogenation. The STM of the sample so produced showed clean Bi-O layers free from interstitial oxygen and the STS spectra was of metallic type, devoid of energy gap and having an enhanced LDOS at Ef. The Tc (R=O) of the sample was found to be 96K and the transition width was 3K.

Expertise was developed to synthesize Y-124 cuprate samples under ambient oxygen pressure using suitable catalysts. Zn and Ga substitutions at the Cu-sites were studied in detail and the results indicated that Zn atoms were substituted in twin Cu-O planes while Ga atoms in twin Cu-O chains. The effect of quasihydrostatic pressure on these samples transformed them first in orthorhombic Y-123 and subsequently in tetragonal Y-123. The effect of subsequent oxygenation was to reverse the process. Interestingly, however, this way the volume fraction of Y-124 was found to progressively increase. Extensive collaboration was carried out with IIT (Kanpur) in the area of low field microwave absorption in pure and substituted Y-123; with University of Rajasthan on XANES of Fe doped Bi-2122 and with Anna University on growth and characterization of bulk high Tc superconductors; with IIT (Bombay) on XPS and XANES studies of Ti, Zr and Ce substituted Y-123 samples and with Shivaji University on optical studies of Y (RE)- 123 system.

Detailed Hall effect measurements were performed on Zn substituted Y-123 system in collaboration with the CNRS laboratory at Meudon. The measurements depicted little change in the carrier concentration while the mobility of the charge carriers was found to be more significantly reduced with Zn doping. A manifestation of this was the localization revealed by the resistance-temperature curves on Zn

doped samples. The magnetization studies were carried out on both the laser ablated epitaxial thin films and the CVD processed thin films of Y-123, irradiated with helium ions, in collaboration with LEPES-CNRS laboratory at Grenoble. Synthesis and characterization of bulk single crystals of noncopper system, were also attempted.

1.2 Processing studies

On experimental basis, Bi(Pb)SrCaCuO and YBaCuO powders were processed separately by precipitation method using nitrates as starting material. The powder homogeneity was found to be better and the processing time shorter, as compared to the standard ceramic route. The high Tc 2212 material was observed to transform to 2223 phase when reacted with CaO and CuO at 860°C in the presence of Pb. The powder synthesized by this method was found to have high phase purity. Ac susceptibility measurements on high Tc superconductors were carried out at varying magnetic fields.

Screen printed 20 micron films of 2212 material on polycrystalline zirconia were studied. Tc of 20 A cm^{-2} at 77K, was observed. Silver clad tapes of superconductor materials were fabricated using low purity commercial grade starting oxides/carbonates. Maximum Jc values obtained were 6.3 x 10^3 A cm^{-2} at 77K. The high Jc values obtained are believed to be due to an excellent grain alignment and the presence of impurity precipitates and lattice defects.

To study the effect on the resistivity and microstructure, heavy ion high energy irradiation studies of $YBa_2Cu_3O_7$ bulk samples were made at the Nuclear Science Centre, New Delhi. The effects of radiation such as X-ray and ions on Bi-based superconducters were studied. At high dose of oxygen, the resistance increased almost linearly with the dose or fluence. The studies suggested that the defects were probably associated with the oxygen stoichiometry of these materials.

1.3 Superconducting magnet applications

An 11 T superconducting magnet was fabricated and operated successfully for the first time in the laboratory. The hybrid magnet consists of a Nb-Ti magnet providing a background field of about 7.5 T and a Nb_3-Sn magnet providing an additional field of 3.5 T. The working bore of the magnet was 44 mm. A large number of mineral ores such as ball clay, wolframite, iron ore and synthetic rutile were processed using the high gradient magnetic separator fabricated earlier in collaboration with BHEL. Experiments conducted have proved the efficacy of the system for separating weakly magnetic impurities of micron size and obtaining high grade material.

1.4 High temperature SQUIDs

Thick films of Bi Sr Ca CuO superconductor were prepared on MgO substrates by the screen printing technique with the starting composition of 1112. The films were subjected to a two step heat treatment with the first step temperature kept between 874 and 898°C for a fixed duration of 45 min. while the second step temperature was maintained at 864°C for a duration varying from 0 to 104 hrs. Growth of the high Tc (2223) phase in the films was found to be very sensitive to the first step temperature and the duration of the second step. These films were used to fabricate rf SQUIDs utilising naturally present grain boundary Josephson weaklinks in a microbridge. Extremely small magnetic signals generated from a quartz analog watch and magnetic rock samples were detected using the BSCCO rf SQUID.

Superconducting thin films of Y Ba Cu O were prepared by rf magnetron sputtering technique using a single composite target of stoichiometry (123). The resputtering effects due to presence of negative ions were almost eliminated by increasing the sputtering gas pressure. The films were characterized. The films grown on (100) $SrTiO_3$ were highly a-axis oriented while films grown on MgO (100) and VSZ (100), were highly c-axis oriented. Microbridges were patterned on these films and microwave induced shapiro steps due to ac Josephson effect in the grain boundary weaklinks were clearly observed in their I-V characteristics.

CRYOGENIC SYSTEMS

The optimisation of various design parameters of

Stirling engine for maximum power and efficiency, was made and the mechanical design work started. The special refrigerator for immunisation programme was tested rigorously. The liquid nitrogen plant was maintained during the year and about 20,000 litres of liquid nitrogen was produced and distributed in the laboratory.

THEORETICAL STUDIES

A Jahn-Teller bipolaron hamiltonian induced by oxygen hole doping in Ba_{2-x} Sr_x CuO_4 was investigated in BCS scheme. The calculated doping dependance of the transition temperature Tc was in agreement with the experimental results. A modified BCS theory for the coherently excited pair of holes in anti-bonding bands under coulomb interaction was proposed. The results were compared with the experiments on normal to superconducting tunnelling conductance and low temperature specific heat in cuprates. An excitonic mechanism suggested for superconductivity in alkali fullerides showed that the halogen doped alkali fullerides may have higher Tc than alkali fullerides.

Electronic structure studies on disordered $Cu_{75}Pt_{25}$ alloy using KKRCPA method enabled the interpretation of the angle resolve photoemission data. Such studies on ordered pervskite $SrFeO_3$ and $SrCoO_3$ using LMTO method showed that the conduction bands consist of hybridized 3d orbitals of Fe or Co and 2p orbitals of oxygen and explained the experiments on magnetic moment on the systems. Bond orders, valence indices, net atomic charges and bond lengths were evaluated at the MINDO/3 and MNDO levels for uracil and 2-thiouracil. The calculated bond lengths were in good agreement with ab-initio results.

RADIO SCIENCE

INTERNATIONAL GEOSPHERE BIOSPHERE PROGRAMME

1.1 *UV-B and aerosol measurements*

The trend analysis of UV-B measurements at 297nm and 310 nm wavelength revealed that during the year, UV radiation decreased drastically in comparison to the previous year. The contour maps of solar UV-B radiation received in Indian sub-continent at 290, 300, 310 and 320 nm wavelengths taking appropriate ozone mean values were prepared for local noontime and monthly basis. Contour maps of UV-B doses were also prepared for biological effects.

Aerosol measurements were made using nine filter multi-wavelength radiometer nearly on all clear days. The event of Phillipino volcanic eruption was studied to determine whether there was any abnormal increase in aerosol content over Delhi just after this event.

1.2 *Solar infrared measurements*

A ground based solar infrared spectroradiometer was installed to measure atmospheric greenhouse gases and aerosols. A 6 IN. heliostat was designed and fabricated in collaboration with Indian Institute of Astrophysics, Bangalore to continuously monitor the solar spectra in the infrared band. Analysis was made of spectroscopic measurements of upper tropospheric and stratospheric water vapour by sequentially measuring solar radiations in two different wavelengths 6500 nm and 6499nm, one in the absorption line of water vapour and the other off this line where there was negligible absorption of water vapour. The effect of cloud was seen on 6th Jan., 92 at 1600 hours when the water vapour content suddenly decreased.

The measurement of solar infrared radiation using the sunphotometer was continued. The total ozone content computed compared well with the data of IMD, New Delhi. A one dimensional photochemical model for ozone was developed for the altitude region 0 to 50 km taking into account various chemical reactions and their reaction rates for 39 different species belonging to HO_x NO_x and ClO_x groups. This programme was successfully tested and will be used for the studies involving perturbations in the form of increase in CFC's loading and their effect on atmospheric ozone.

INDIAN ANTARCTIC RESEARCH PROGRAMME

The NPL team members operated their instruments and collected air samples and data from various surface based instruments installed by IMD and radiosonde flighs during the 11th Antarctic Expedition. The sonic three-axis anemometer was designed and developed specially for antarctica and the system worked successfully and the digital data so obtained was being analysed. Microbarograph data on infrasonic pressure variations was collected for one full year for the first time and was being analysed.

The measurements of UV-B radiation for 280 nm to 400 nm by spectroradiometer was continued during antarctic spring of 1991 along with the measurements of optical depth by sun photometer. Preliminary analysis indicated rise in aerosol content during the months of October, November and December in comparison to March and August. Sporadic-E and spread-F studies were conducted between low and high solar activity periods at Syowa (Japanese station) near Indian base in antarctica on quiet and disturbed days. Positive and negative correlations with magnetic activity were found for sporadic-E and spread F respectively on yearly basis. Work was continued during the year for the development of a mm-wave radiospectrometer for ozone observations. The front end of the system was tested in the laboratory using hot and cold calibrated loads. The efforts were continued to make an acousto-optic spectrometer. A new facility to produce liquid nitrogen was installed and operated in the division.

RADIO COMMUNICATIONS

1.1 *HF field strength studies*

Variations in HF field strength were studied using

measured field strength data of several HF transmissions in India. Apart from solar activity, season and local time dependent variations, the variations in HF field strength with equivalent vertical frequency of the circuits were also studied. A simple HF field strength prediction procedure was evolved.

1.2 *Longterm solar and ionospheric predictions*

Routine sunspot number and ionospheric predictions for the East Zone were made six months in advance regularly. An atlas of ionospheric communication parameters over the Indian subcontinent was completed and printed. The atlas contains contour maps of foF_2 and $MUF(4000)F_2$ over the Indian subcontinent (≅75°E) in the latitude vs. local time frame. Contour maps were plotted for five different levels of sunspot numbers (0, 50, 100, 150 and 200) for every month from January through December. The co-efficients of the 2nd degree curves for all the stations at each hour were included in tabular forms for each month.

1.3 *Troposcatter studies*

Studies were conducted to investigate the performance and reliability of two tropo-scatter links in the northern India. Apart from the signal levels monitored from the links, the data included the radiosonde observations of the IMD corresponding to the same period of signal observations and also some slow rising meteorological balloon observations conducted for few days in the worst month. The results showed that April and May were the worst months and refractivity gradients in the common volume were responsible for the weak signal levels. A comparison of diffrent path loss prediction techniques showed that Yeh's prediction method came close to the observed values.

1.4 *Anomalous long distance TV signals*

Studies of monitored anomalous long distance TV signals on quiet and disturbed days during the period between 1978 and 1991 for channel 2 and channel 3 showed a negative correlation with the magnetic activity. Similar negative correlations were found between the occurrence of high frequency sporadic-E in the high latitude temperate zone, foF2 in the low latitude temperature zone and magnetic activity.

1.5 *Airborne microwave refractometer*

Fine structure information on radio refractivity for various seasons and locations in the Indian sub-continent were collected (using an airborne microwave refractometer) under a variety of meteorological conditions and analysed. These were associated with sub/super refractive and ducting features. Large fluctuations in the vertical refractivity gradients ranging from 17 to 1400 N units/km. were observed. Estimates of turbulence energy dissipation rates were obtained in the planetary boundary layer in terms of the variance of radio refractive index fluctuations, the Brunt-vaisala frequency, the mean vertical gradient of generalised potential refractive index and the turbulence structure parameter.

1.6 *GHz scintillations*

Analysis of propagation data generated for 4 GHz transionospheric satellite communication for more than half a solar cycle showed that the scintillations observed at 22°N magnetic seems to be caused by the equatorial plasma bubbles generated near the magnetic equator and propagating down to the observation latitude through the magnetic fluxlines. It was observed that the systems with small aperture antenna are likely to experience frequent system outages within a period of ±1 year of peak solar activity.

1.7 *Microwave/millimeter wave radiometery*

Results and measurements of attenuation by microwave radiometers and the corresponding rainfall rates by 10 seconds fast response rainguage were analysed for the frequencies at 11, 18 and 22.2 GHz. The data recorded included number of intense rain storms, medium rain and drizzle. The effect of meteorological condition of attenuation was evaluated in terms of the difference of maximum and minimum attenuation against rainfall rate. It was noticed that the percentage relative difference decreased with rainfall rate. The effective path length calculations showed that the effective distance decreased with increase of surface rainfall rate. The gradient over New Delhi was less steep than presented by CCIR for rainfall rates less that 20 mm/hr.

RADIO AND ATMOSPHERIC PHYSICS

1.1 *Venus nightside ionosphere and solar EUV flux*

The controlling factor for the nightward flow is the altitude of the terminator ionopause which is determined by the combined effect of solar wind pressure and solar EUV flux. By using langmuir probe measurements on Pioneer Venus, it was observed that the main nightside ionosphere above 200 km varied directly with solar EUV flux, if orbits containing, holes and large scale fluctuations were deleted and that electron density below 200 km did not respond to changes in EUV flux. This supports the transterminator flow mechanism for the maintenance of the Venus nightside ionosphere.

For altitudes above 500 km, atomic hydrogen is the major neutral constituent at Venus and therefore theoretical models suggested H^+ to be the dominant ion above 500km. The ion mass spectrometer measurements on Pioneer Venus showed $O^+$to be the dominant ion upto the altitudes above 500 km. The upper boundary of the Venus ionosphere could move up to very high altitudes during some rare events. An analysis of Pioneer Venus measurements during such events again showed O^+ to be dominant ion at altitudes even as high as 2800 km. This provided ionospheric evidence of hot oxygen in the upper atmosphere of Venus.

1.2 MST *radar studies*

Indian MST radar, installed at Godanki near Tirupati started functioning for scientific purpose. Analysis of the observations to study the short period waves in the tropo-stratosphere regime, refractivity turbulence structure constant, detection of tropopause height and comparison with simultaneous IMD measurements and the hydrostatic stability of the atmosphere, were in progress. Some modifications were also suggested in the software being used there.

1.3 *Long period waves in the middle atmosphere*

Latitudinal and height characteristics of 30-70 day period waves were examined using zonal and meridional wind data from radiosonde and rocketsonde flights from Thumba, SHAR and Balasore. The spectral analysis of the data yielded some interesting features. These waves were not only confined to tropospheric heights but were also found in stratospheric heights. The amptitude of these waves was found to be much larger at stratospheric heights than at tropospheric heights. The present results showed that these waves were not confined to equatorial region but were also seen upto 22°N latitude.

The same waves were also studied at Volgagrad and Heiss Island for zonal winds with the help of weekly flights wind data of rocketsonde and radiosonde. The amplitude of these waves was much larger at stratospheric heights than that of the tropospheric heights. Waves were found throughout the year in troposphere but were observed dominating only during October to March at stratospheric heights.

1.4 *Satellite beacon studies*

A data acquisition system was developed to record scintillation at a selectable sampling rate capable of 1-50 samples/sec. recording. During March-April, 1991, both Fleetsat (73°E) at 244 MHz & INMARSAT (63°E) at L-band were recorded using the PC based acquisition system. These data were processed through a standard software employing FFT techniques for obtaining the power spectrum and auto correlation etc. It was seen that there were very clear fresnel oscillations in the power spectrum. Also, there were instances when the slopes showed a break-scale corresponding to 300 m or less, markedly at L-band revealing the outer turbulent scale beyond which the roll off was steeper with an index of -3.2.

1.5 F-*layer dynamo polarization fields & VHF scintillation*

The effect of sporadic E-layer on the F-layer height rise was studied and it was observed that the presence of Es did not affect the F-layer height rise. It was pointed out that the extent of modification to

be made in the E-region conductivity in the post sunset period to observe its dynamical effect on the F-region at Thumba will not be altered even if there was Es layer at the conjugate point.

A study of low latitue VHF scintillation revealed that the usual pre-midnight scintillation activity can be supressed during the progress of main phase due to presence of disturbance dynamo electric fields. The occurrence of post-midnight scintillation activity during recovery phase could be due to electric fields of magnetospheric origin. A piggy back balloon experiment was conducted on Nov. 26, 91 from Hyderabad, using an improved gerdien condenser payload. Good data was obtained between 5-18 km. The Monte-Carlo calculations of energy deposition by precipitating ke V range protons and neutral hydrogen atoms in the equatorial atmosphere - dependence on the neutral atmosphere model was completed.

1.6 SROSS-*C aeronomy satellite*

The high altitude rocket experiment consisting of energetic protons and electron spectrometer-payloads for the measuremet of the precipitating keV range proton and electron energy spectra were constructed. First rocket launching is expected to take place in July, 92.

1.7 *Microbarograph studies*

The microbarograph records taken at Trivandrum were analysed. Some characteristic signatures of a coastal station in the morning hours were noted. An interesting result was that on a particular day infrasonic waves were detected at Delhi, Hyderabad and Trivandrum with a suitable time lag. This may be attributed to the magnetic storm or an active western disturbance. The propagation of infrasonic waves upto a very low latitude of Trivandrum (8.5°N) has far reaching significance for atmospheric studies.

TECHNICAL INFRASTRUCTURE

LIBRARY

The library continued to render documentation and reprographic service to the scientists of the laboratory. About 262 books in physics and related sciences were added, raising the book collection to 89,372. In Hindi collection it added 74 books. The journal subscription was reduced this year, it continued to receive 19 journals as gratis. The patent specifications from the Indian Patent Office were received. The services rendered by the library included document lending, inter-library lending, bibliography service, literature search, the selective dissemination of information and photocopying service. The research scholars and visitors from scientific and technical institutions used the facilities.

COMPUTER FACILITY

VAX-11/780 Computer system was in regular operation during the year. The computer was utilized by the scientists for their computational work, by the library and other staff for creating/maintaining information systems and the administrative staff for monthly pay roll and allied activities.

Zenith SC, was also used to provide training on the usage of softwares like Word Star and D base. A computer appreciation training programme for the administrative and technical staff of the laboratory was conducted. The outside jobs regarding software design and its execution on our VAX system were undertaken. Since Dec. 91, a new activity of E-MAIL services to its users was started. One can contact the persons working on computers in other organizations and exchange messages.

MECHANICAL PROCESSING ACTIVITY

The developmental studies of hot deformation behaviour of metal matrix composites and aluminium-lithium alloys using hot extrusion and warm forging were continued. The characterization of the extruded products was done. The routine heat treatment and tool room jobs for other divisions were carried out.

GLASS WORKSHOP

Assistance was provided by the unit in the design and fabrication of glass and silica apparatus to various projects of the laboratory and outside organisations. Various items fabricated and reconditioned included compact double distillation apparatus and heaters, helium and nitrogen Dewars, standard glass joints, separating funnels, manometers, stop cocks, glass tubes and columns, various types of condensers and mercury diffusion pumps.

The laboratories, institutes and organisations assiste included NEERI, Nagpur, RRL, Bhubaneswar, RRL, Jammu; IARI, New Delhi; JNU, New Delhi; Allahabad Univerity, IISc, Bangalore; Jamia Millia Islamia New Delhi; IOC, Faridabad and LNJP Hospital, Delhi. The jobs worth Rs. 3.697 lakhs approximately were completed during the year.

INSTRUMENTATION

A laboratory model of a standard crystal frequency generator was fabricated and tested. Additional improvement was made in a pulsedelayed generator to shift 1 pps obtained from standard 10 MHz in steps of 100 msec, 10 msec, 100 μ seç and 1 μ sec. The fabrication of micro-processor based temperature controlled crystal oscillator was completed. Improvements were made in the electronic ultrasonic powermeter.

The work on calibration of lithotripsy instrumentation and focal transducers was carried out. An ultrasonic adulteration detection system was developed for liquid food and biological materials. The materials studied inlcuded diesel and honey. Basic piezoresistive silicon micro-sensor chips were designed and fabricated during deputation at Delft University of Technology, Netherland. The maintenance of equipment/devices and their recalibration was done. Assistance was provided in the procurement and verification of electronic, electrical and glass stores.

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APPENDICES

SPONSORED/SUPPORTED PROJECTS

TITLE	AGENCY	AMOUNT RECEIVED Rs. (Lakhs)
NEW		
Design & fabrication of plasma CVD system, for deposition of a-Si films on large area.	DNES	15.500
Development of process for fabrication of 15% efficiency single crystal and multicrystal solar cells	DNES	10.000
Development of graphite reinforced carbon bipolar plates for fuel cells.	DNES	5.250
Preparation and characterization of halogen intercalated carbons.	DST (Indo-French)	6.860
Development of high strain to failure and high modulus carbon fibres.	ARDB	11.620
Investigation of surface stabilised ferro-electric liquid crystal devices.	DST	2.000
Design and fabrication of plasma CVD system for deposition of diamond like carbon films on Ge.	IRDE	19.500
Indigenous development of distrometer for study of tropospheric propagation parameters over selected sites in India	DOE	7.750
Development of ionospheric models for high reliability HF systems.	DRDO	1.400
Development of software packages on rain effects in the microwave & mm wave bands in selected regions over India	DRDO	4.500
Monitoring of monsoon circulation	DST (Indo-USSR)	0.850
National methane campaign for actual methane measurements during the year 1991.	Env. & Forests.	1.000
Preparation of solar UV-B contour maps	Env. & Forests	1.500
Development of warm forging & hot extrusion processes for metal matrix composites.	ARDB	3.500
CONTINUING		
Augmentation of primary electronic standards.	DOE	18.398

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CONTINUING		
Augmentation of primary electronic standards.	DOE	18.398

Photolithographic mask aligner using modified moire technique	DOE	-
Calibration service programme under National Coordination of Testing & Calibration Facilities	DST	17.000
Study of the tropical boundary layer meteorology at Jodhpur using monostatic acoustic sounder and instrumented tower	DST	-
Metrological studies on standards on measurements	DST (Indo-US)	-
Interaction of small gas molecules with semiconductor metal interfaces as studied by surface analytical techniques.	DST (Indo-US)	-
Establishment of transfer leak standards in vacuum metrology.	DST (Indo-US)	-
R & D in laser frequency standards	DST (Indo-USSR)	-
Development of technology of indigenous manufacture of retro-reflective sheeting/tape.	Sur.Transp.	-
Development of laser resistant carbon fibre composites	ARDB	-
Study of electrical conductivity of mantle forming rock minerals under high temperature environment	DST	-
Technical feasibility and concept proving in the area of biomolecular electronic devices.	DST	5.810
Synthesis, characterization & application of some conducting polymers.	DST (Indo-EEC)	6.868
Volatile metal organic compounds	DST (Indo-USSR)	-
Development of high X-ray sensitive photo receptors for dose reduction in xero -radiography.	DOE	2.860
DOE-NPL Centre for characterization of materials for electronics	DOE	-
Growth of nearly perfect crystals of oxides like lithiumniobate.	DST (Indo-USSR)	0.850
Data base on electronic materials.	DST Indo-USSR)	-
National superconductivity fellows (National superconductivity programme)	DST	1.332
Superconducting magnetic separator	DST	-
Preparation, characterization and precision measurements of semiconducting materials.	DST (Indo-USSR)	-
Study on high temperature superconductivity	DST (Indo-USR)	-
Development of Stirling engines for power production	DNES	-

Synthesis of high Tc superconductive materials through eutectic melt.	DST	0.200
Laser heterodyne system for the study of ozone and other minor constituent in Antarctica.	DOD	13.000
A ground based millimeter wave technique for ozone observations at Antarctica	DOD	-
To monitor solar infrared radiation for studying minor constituents in atmosphere.	DST	0.800
Development & decay of scintillation producing irregularities and gravity wave propagation in low latitudes.	DST	-
Very long baseline interferometry.	NGRI	-

COMPLETED

Development & characterization of acoustic transducers & materials for application in ocean engineering.	DOD	-
Improving the quality and reliability of standard Time &	DOE	-
Frequency signals (STFS) to Echelon-II laboratories.		
Hot extrusion & cold forging.	British Council	-
Multicrystalline silicon ingot technology	CEL	-
Development of sodium-sulphur batteries for electric vehicle	DNES	9.000
Hydrogenated amorphous silicon film (Phase-II) (Completed last year)	DNES	1.000
Bench scale experimental studies on impregnating pitch	DST	-
Development and supply of pressure vessels and stroage tanks.	DRDL	-
Low dimensional coulomb system	DST	-
Studies of polycrystalline bulk, thin films and crystals of high temperature superconductor	DST (Indo-EEC)	-
Ionospheric modelling for radio communication including effects of the artificial modification of ionosphere.	DST (Indo-USSR)	-
Acoustic sounding system at Antarctica	DOD	-

R & D COLLABORATION

The laboratory maintained scientific collaboration and liaison with other scientific institutions, universities, government departments, CSIR laboratries and international institutes regarding various activities. The names of the organisations and the areas of collaboration are listed below.

INDIA

Anna University, Madras (Superconductivity, Theoretical Studies)

All India Radio (Time & Frequency Standard)

Banaras Hindu University, Varanasi (Theoretical Studies)

Bharat Heavy Electricals Ltd, Hyderabad (Superconductivity, Carbon)

Bureau of Indian Standards (Standards)

Central Arid Zone Research Institute, Jodhpur (Acoustic Standard)

Central Electronics Engineering Research Institute, Pilani (Superconductivity, Characterization)

Central Electronics Ltd. Sahibabad (Silicon)

CSIR Centre for Biochemicals, Delhi (Biosensors)

Defence Research & Development Lab, Hyderabad (Carbon)

Delhi University (Characterization, Instrumentation)

Department of Environment (Standards)

Department of Science & Technology (Calibration)

Earth Station, Sikandrabad (Time & Frequency Standard)

F.I.E.Research Institute, Ganga Nagar (Force Standard)

Indian Association for Cultivation of Science, Calcutta (Biosensors)

Indian Institute of Astrophysics, Bangalore (Radio Science)

Jadavpur University, Calcutta (Impedance Standard)

National Remote Sensing Agency, Hyderabad (Radio Science)

Poona University, Pune (Superconductivity)

Rajasthan University, Jaipur (Superconductivity)

Shivaji University (Superconductivity)

OVERSEAS

FRANCE

Centre de Recherche Paul Pascal Bordeaux (Carbon)

CNRS Laboratories, Meudon, and Grenoble (Superconductivity)

GERMANY

Physikalisch Technische Bundesanstalt, Braunschweig, (Standards)

Technical University of Darmstadt (Characterization)

NEPAL

Nepal Bureau of Standards and Metrology (Mass Standard)

UK

Commonwealth Science Council, London (Standards)

Oxford University (Conducting Polymers)

USA

National Institute for Standards and Technology, Washington (Standards, Characterization)

USSR

Institute of Inorganic Chemistry, Novosibirsk (Crystal Growth)

P.N. Lebedev Institute, Moscow (Length Standard)

VINIIFTRI, Moscow (Acoustic Standard)

VINNIOFI, Moscow (Optical Radiation Standard)

CALIBRATION/TESTING CHARGES

(Realised during 1991-92)

ACTIVITY	AMOUNT (Rs.)	REPORTS (No)
PHYSICO MECHANIAL STANDARDS		
Force & Hardness	10,32,475	590
Dimensional Metrology	4,54,225	425
Optical Radiation	4,37,400	82
Temperature	3,98,550	300
Mass, Density, Volume & Viscosity	2,83,475	440
Pressure & Vacuum	1,90,250	44
Acoustic	87,550	34
Length	16,250	6
Ultrasonic	------	2
ELECTRICAL STANDARDS		
HF, MW Voltage, Power, Freq. & Noise	2,69,125	73
AC & LF	2,17,000	52
DC	2,09,425	123
LF & HF Impedance	72,750	79
Time & Frequency	15,250	7
HF & MW Attenuation & Impedance	15,000	8
MATERIALS CHARACTERIZATION	1,38,050	81
TOTAL	38,36,775	2,346

PROCESSES RELEASED

PROCESS	LICENCEE	TERMS
Flexible graphite tapes & sheets	M/s J.D. Jones & Co (P) Ltd, Calcutta. M/s Inmarco Industrial Maintenance (P) Ltd., Bombay.	Premium- Rs. 2 Lakh Royalty- 2%
Electronic capacitive ballast	M/s Odelphia Marketing (P) Ltd., Mayapuri Indl. Area, New Delhi.	Premium- Rs. 25,000 Royalty-Nil
Black stamp cancellation ink	M/s Mysore Lac & Paint Works Ltd, Mysore.	Premium - Rs. 15,000 Royalty - 3%
Carbon thrust bearings	M/s Perfect Carbons, Fatehnagar, Hyderabad.	Premium - Rs. 7,500 Royalty - 5%
Indelible ink	M/s Mysore Lac & Paint Works Ltd. Mysore.	Premium - Rs. 5,000 Royalty - 4%

CONSULTANCY

TITLE	PARTY	AMOUNT
ACOUSTIC STANDARDS		
1. Installation of sodar system at CPCB.	Incharge (Air Lab), Central Pollution Control Board, Delhi	1.25 Lakh
2. Sodar studies of boundary layer at Mangrol, Rajasthan.	Director (Tech), Envirotech East (P) Ltd. Calcutta.	75,000
3. Accoustic treatment of auditorium building at New Delhi.	Ex Engineer, PWD Division, New Delhi	30,000
4. Acoustic treatment of traffic police building, Chandigarh.	Ex Engineer, CP Division, Chandigarh	25,000
5. Acoustical design of gymnasium hall, Lucknow.	Additional Project Manager, Sapru Marg, Lucknow.	25,000
MATERIALS		
1. Low QI Impregnating coal tar pitch.	M/s Graphite India Ltd, Netaji Subhas Marg, Calcutta.	1.75 Lakh
CONDENSED MATTER PHYSICS		
1. 5 MVA superconducting generator	Dy. Gen Manager, BHEL Corporate Research and Development, Hyderabad	4.75 Lakh

PREMIA & ROYALTIES

(1.1.90 to 31.3.91)

PROCESS	LICENCEE	TOTAL AMOUNT (Rs)	LAB SHARE (Rs)
Indelible ink	M/s Mysore Paints & Varnish Ltd, Mysore.	5,50,000	2,20,000
Monochorme TV picture tube phosphor	M/s Hindustan Hi-Tech Indus. Ltd, New Delhi.	5,00,000	2,00,000
Silver impregnated graphite contact	M/s Jyoti Refinery, Bombay	1,00,118	40,047
	M/s Chokshi Multimetals (P) Ltd, Udaipur.	55,000	22,000
Film optical coating	M/s Haryana State Electronic Development Corpn. Ltd., Chandigarh.	© 95,000	38,000
Hard ferrites	M/s Ferrite & Electronic Components (P) Ltd, Lucknow.	59,107	23,643
	M/s The Scientific Instrument Co. Ltd. Ghaziabad.	50	20
Flexible graphite tapes and sheets	M/s Stoplik Services (India) (P) Ltd, Bombay	55,000	22,000
Magnetic tape.	M/s Michibuki Magnetics (India) (P) Ltd, Delhi.	30,000	12,000
Piezoelectric materials	M/s Concord Electroceramic Indus., Delhi.	20,000	8,000
Recovery of silver from waste hypo solution.	Mrs. B. Rajeshwari Devi, Trivandrum,	10,000	4,000
Microwave components	M/s Vidyut Yantra Udyog, Modi Nagar	5,071	2,028
	M/s The Scientific Instrument Co-Ltd, Ghaziabad	9,026	3,611
Reconditioning of TV picture tube	M/s Videotronics, New Delhi	2,970	1,188

RESEARCH COUNCIL

Prof. B.V. Sreekantan, INSA Professor, Tata Inst. of Fundamental Research, Bombay-400 005.	Chairman
Prof. D. Chakravorty Indian Association for the Cultivation of Science, Calcutta-700 032	Member
Prof. N. Kumar, Deptt. of Physics, Indian Inst. of Science, Bangalore-560 012.	Member
Prof. P.K. Das Emeritus Scientist, A-59, Kailash Colony, New Delhi-110 048.	Member
Sri KR. Paramesvar, 8138, Pocket 11, Sector B, VasantKunj, New Delhi-110 030.	Member
Lt Gen. A.S. Bhullar (Retd), Dir. General, Bureau of Indian Standards, New Delhi-110 002.	Member
Dr. R.K. Krishnan Director, Gas Turbin Research Establishment, Post Bag 9302, Bangalore-560 053.	Member
Sri N. Vittal, Secretary, Department of Electronics, New Delhi-110 003.	Member
Dr. W.S. Khokle, Director, Central Electronics Engineering Research Inst., Pilani-333 031	Member
Prof. E.S.R. Gopal Director, National Physical Laboratory, New Delhi-110 012.	Member
Prof. C.K. Majumdar, IACS, Calcutta, DG's Nominee	Member
Sri G.K. Arora, Scientist, NPL.	Non-Member Secty.

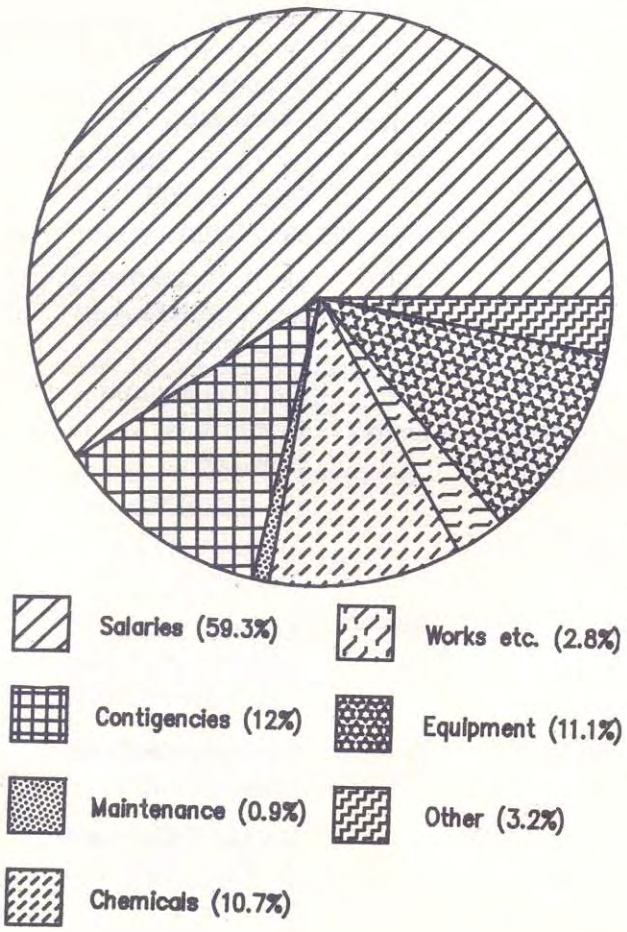
MANAGEMENT COUNCIL

Prof. E.S.R. Gopal, Director, National Physical Laboratory, New Delhi-110 012.	Chairman
Sri S.R. Taneja Scientist, Central Scientific Instruments Organisation, Chandigarh- 160 020.	Member
Dr. J.K. N. Sharma Scientist, NPL, New Delhi.	Member
Dr. R. Bhattacharya, Scientist, NPL, New Delhi.	Member
Dr. Ravi Mehrotra, Scientist, NPL, New Delhi.	Member
Dr. S.K. Sarkar, Scientist, NPL, New Delhi.	Member
Sri. B.C. Joshi, SFAO, NPL. New Delhi	Member
Dir. Gen, CSIR or his nominee,	Member
Sri M.M. Sharma, Sr. COA, NPL, New Delhi.	Member Secty.

ACTUAL EXPENDITURE

(1991 -92)

Budget Head	Rs (Lakhs)
Salaries	628.925
Contigencies	126.753
Maintenance	9.697
Chemicals	113.170
Works etc.	29.474
Equipment	118.260
Other	33.998
Total	1060.277
Sponsored Projects	166.590



HUMAN RESOURCES

SCIENTISTS OFFICERS

(in order of Gp.IV to Gp III as on 1.4.92)

DIRECTOR
ESR GOPAL, Ph. D

PHYSICO MECHANICAL STANDARDS

LENGTH & DIMENSIONS

V D Dandawate, Ph. D, Sc EII
RP Singhal, B.E. Sc EII
V T Chitnis, Ph. D, Sc EI
H S Dahiya, Ph. D, Sc C
VG Kulkarni, Ph. D, ScC
Om Prakash, Ph.D, Sc C
LS Tanwar, Ph.D, Sc C
M Karfa, M.Sc,Sc B
V Roonwal (Smt.), M.Sc, TOC
NK Aggarwal, B.Sc, TO B
AK Kanjilal, B.Sc, TO B
Ram Narain, ITI, TO B
BK Roy, B.Sc, TO B
S L Thind, Dip. Engg., TO B
VD Sharma, M.A., TO A

MASS

BG Mathur, B.A., Sc El
D C Sharma, M.Sc, Sc El
ML Das, M.Sc, Sc C
S N Nangia, AMIE, ScC
Tripurari Lal, M.Sc, Sc C
N K Kohli, B.A., TO C
S Verma (Smt.), B.Sc, TOA

FORCE

MK Dasgupta, B.Sc Engg, Sc F
RS Sharma, M.Sc, Sc El
Anil Kumar, B.Sc. Engg, Sc C
M K Chaudhury, AMIE, Sc C
JK Dhawan, B.E., Sc C

PRESSURE & VACUUM

JKN Sharma, Ph. D, Sc G
AK Bandyopadhyay, Ph.D, Sc El
BR Chakraborty, Ph.D, Sc El
A C Gupta, M.Sc, Sc El
KK Jain, Ph.D, Sc El
DR Sharma, Ph.D, Sc El
Pardeep Mohan, Ph.D, Sc C
S M Sivaprasad, Ph. D, Sc B
SP Sharma, ITI. TO A

TEMPERATURE

KN Bhantnagar, AMIE, ScEl
VP Wasan AMIE, ScEl
RK Luthra, M.A, Sc C
TK Saksena,Ph.D,Sc C
NK Srivastava, M.Sc Sc C
Y P Singh, M.Sc, Sc C
Mansha Ram, M.Sc, ScB
SK Nijhawan, Dip. Engg, TO B

OPTICAL RADIATION

KC Joshi, Ph. D. ScF
Mahesh Chandra, PhD, ScEl
JS Vaishya, Ph. D, Sc El
TK Chakraborty, AMIE, ScC
Kailash Chand, M.Sc, ScC
HC Kandpal, Ph.D ScC
S Manrai (Smt.) M.A, ScC
Jai Bhagwan, B.Sc, TO A

INFRARED RADIATION

SP Varma, Ph.D, Sc Ell
Joginder Singh, M.Sc, Sc El
RS Ram, Ph.D, Sc EI
D Gupta, Ph.D, Sc C

ACOUSTICS

S P Singal, Ph. D, Sc F
B S Gera, Ph.D, Sc EI
V Mohanan Ph.D, Sc El
D R Pahwa, M. Sc, Sc El
Omkar Sharma, M.Sc, Sc El
HL B Bhaskar B.Sc, Engg, Sc C
R M Khanna, DMIT, Sc C
OP Sharma, ITI, TO A

UNDERWATER ACOUSTICS

T K Saksena, Ph. D, Sc Ell
Ashok Kumar, Ph. D, Sc El
SC Gupta, Gd. IETE, Sc El
S K Jain Ph. D, Sc El
Janardan Singh, Ph. D, Sc El
J N Som, Ph. D, Sc El
R P Tandon, Ph.D, Sc El
Harish Bahadur, Ph. D, Sc C
Mukesh Chandra, M.Sc, Sc C
Ved Singh, M.Sc, Sc C
N Narayanaswamy, B.Sc, TO B
Subhash Chandra, B.Sc, TOB
Jagdish Lal, I.Sc, TO A

CS PROGRAMME &
FLOW MEASUREMENT

Sharwan Kumar, Ph.D, Sc Ell
Raj Singh, AMIE, ScC
Sudarshan Kumar, M.Sc, Sc C
O P Bhola, B.Sc, TO C
Virendra Babu, Gd, IIE TO C

TESTING & CALIBRATION

H K Thadani, Gd. BIRE, Sc El
C P Singh, Matric TO C
S D Bahl, ITI, TO B

ELECTRICAL STANDARDS

TIME & FREQUENCY

B S Mathur, Ph.D, Sc G
P Banerjee, Ph.D,Sc El
G M Saxena, Ph.D, Sc El
A Sengupta, Ph. D, Sc EI
M L Shakdhar, B.Sc, Sc El
A Chatterjee (Smt), M. Tech, Sc C
A K Hanjura, Ph.D, Sc C
M Saxena (Smt.), Gd. IETE, Sc C
G K Goel B.Sc, TO C
Gurdial Singh, Matric, TO B
A K Suri, Dip. Engg, TO A

D C STANDARDS

V K Batra, M.Sc, Sc Ell
S K Mahajan, Ph. D, Sc El
P K Mittal, B.Sc, TO B
B Sircar, B.Sc TOB

HF IMPEDANCE & AC LF

SL Dahake, Ph.D, ScF
Omkar Nath, Ph.D, Sc El
S R Gupta, Ph. D, Sc C
Gurmej Ram, B.Sc Engg, Sc C
Kewal Krishan, Gd. IETE, Sc C
M K Mittal, M. Tech, Sc C
M R Nagar, Gd. IETE, Sc C
A K Saxena, B.E, Sc C
Naib Singh, AMIE, Sc B
T R Arora, ITI, TOB
A R Kaushik (Smt.), Dip Engg, TOB

HF & MW VOLTAGE, POWER,
FREQUENCY & ATTENUATION

V K Agrawal Ph.D, Sc Ell
P C Kothari, Ph. D, Sc Ell
R S Yadav, Ph.D, Sc Ell
Ram Swarup, M. Tech, Sc El
V K Rustagi B. Tech, Sc El
Ritander Aggarwal, AMIE, ScC
H M Bhatnagar, M.Sc, Sc C
A K Govil M.Sc, Sc C
P S Negi, M. Tech, Sc C
Ranjit Singh, M. Tech, Sc B
R L Mendiratta, AIC, TO A

MATERIALS

SILICON DEVICES &
SUPERCONDUCTOR

B K Das, Ph. D, Sc F
Balbir Singh, AMIE, Sc EI
B V Reddi, Ph.D, Sc El
S N Singh, Ph.D, Sc El
R B Tripathi, Ph.D, Sc El
N K Arora, Ph.D, Sc C
B R Awasthy, M.Sc, Sc C
B C Chakravarty, Ph.D, Sc C
Kiran Jain, (Smt.) M. Tech, Sc C
R K Kotnala, Ph.D, Sc C
S B Manmohanan, M. Sc Sc C
Mohan Lal, Ph.D, Sc C

P K Singh, Ph.D, Sc C
Ram Kishore, Ph.D, Sc C
Satbir Singh, Ph.D, Sc C
Ravi Kumar, Gd. IETE, ScA
N S Bangari, B.Sc, T O C
S S Hanspal, Gd. IETE, TO C
H S Kalsi, B.Sc, TO C
S M Khullar AIC, TOC
RC Goel, B.Sc, TO B
H P Gupta, B.Sc, TO B
B S Khurana, AIC, TO B
Prem Prakash, AIC, TO B
S K Sharda, B.Sc, TO B
M K Banerjee, ITI, TO A
T Podikunju, ITI, TO A
TR Pushpangadan, Matric, TO A

INTERFACES & MICROSTRUCTURE

ST Lakshmi Kumar, Ph. D, Sc El
A C Rastogi, Ph. D, Sc El
K S Balakrishnan. (Smt), Ph. D, TO B

LUMINESCENT MATERIALS

P K Ghosh, Ph. D, Sc Ell
H P Narang, M.Sc. Engg, Sc El
V Shankar, Ph.D, Sc El
Harish Chander, Ph.D, Sc C

DISPLAY DEVICES

Subhas Chandra, Ph.D, Sc Ell
S S Bawa, Ph.D, Sc El
S N Ekbote, Ph.D, Sc El
S C Jain, Ph. D, Sc El
M N Kamalasanan, Ph.D, Sc El
S A Agnihotri (Smt), Ph.D. Sc C
A M Biradar, Ph.D, Sc C
K K Saini, Ph.D, Sc C
C P Sharma, Ph.D, Sc C
Suresh Chand, Ph.D, Sc C
N S Verma, M.Sc, Sc C
R K Sharma, Ph.D, Sc B
R C Bhateja, ITI, TO B

CONDUCTING POLYMER

S C K Misra, Ph.D, Sc El
B D Malhotra, Ph.D, Sc C
V S Panwar, Ph.D, Sc C
Ramadhar Singh, Ph.D, Sc C

CARBON PRODUCTS

O P Bahl, Ph.D, Sc Ell
R L Seth, Ph.D, Sc Ell
R K Aggarwal, Ph.D, Sc El
Gopal Bhatia, Ph.D, Sc El
R B Mathur, Ph.D, Sc El
Chhote Lal, Ph.D, Sc C
T L Dhami, Ph.D, Sc C
R K Kulshrestha, B.Sc. Engg, Sc C
P Siva Ram, M. Tech, Sc C
Vasantha Raman (Smt), Ph.D, Sc C
C L Verma, B. Sc, TO C

THIN FILM SYSTEMS

R Bhattacharya,Ph.D, Sc Ell
A Basu, Ph. D, Sc El
Devindra Singh M.Sc, Sc El
B S Verma, Ph.D, Sc C
C Anandan, Ph.D, Sc C
P N Dixit, Ph.D, Sc C
M Kar (Smt), Ph.D, Sc C
O S Panwar, Ph.D, Sc C

HIGH PRESSURE TECHNOLOGY

A K Aggarwal, B.E, Sc Ell
M M Bindal, Ph. D, Sc Ell
B P Singh, Ph. D, Sc C
Rajeev Chopra, B.E, Sc C
S K Singhal, Ph. D, Sc C
R K Nayar, Dip Engg, TO C
Dharam Chand, ITI, TO B

CHARACTERIZATION

CHEMICAL METHODS

P K Gupta, Ph. D, Sc Ell
D C Parashar, Ph.D, Sc Ell
V K Amar, M.Sc, Sc El
J N Bohra, Ph. D, Sc El
R Ramachandran (Smt), Ph. D, Sc El
A K Sarkar, Ph. D. Sc El

J C Trehan, Ph. D, ScEI
A K Aggrawal, Ph.D, Sc C
P.K. Gupta, M.Sc, Sc C
Mewa Singh, M.Sc, Sc C

IR & EPR SPECTROSCOPY

M M Pradhan, Ph D Sc E II
S K Gupta, Ph. D, Sc El
R K Garg, M.Sc, Sc C
S Parthasarathi, B.Sc, TO C ✓

X-RAY MEASUREMENTS

K D Kundra, Ph. D, Sc EII
R H Bhawalkar, Ph. D, Sc El
D K Suri, Ph. D, Sc EI
U Dhawan, (Smt), M.Sc, Sc C ✓
Rashmi, (Km), Ph.D, Sc C

ELECTRON MICROSCOPY

S K Sharma, Ph. D, Sc EII
Narendra Kumar, M.Sc, Sc El
SUM Rao, M.Sc, Sc El

CRYSTAL GROWTH &
CHARACTERIZATION

Krishan Lal, Ph. D, Sc Dir Gd
R V Ananthamurthy, Ph.D, Sc El
Vijay Kumar, Ph. D, Sc EI
G Bhagavannarayana, M.Sc, Sc C
S N N Goswami (Smt), Ph.D, Sc C ✓
S K Haldar, Ph. D, Sc C
S D Sharma, Ph.D, Sc C

CONDENSED MATTER PHYSICS

HIGH TEMPERATURE
SUPERCONDUCTORS

A V Narlikar, Ph. D, Sc G ✓
A K Gupta, Ph.D, Sc EII
S K Sarkar, Ph.D, Sc EII
R G Sharma, Ph.D, Sc EII
M S Hegde, Ph.D, Sc El
N D Kataria, Ph.D, Sc El
P K Ashwini Kumar, Ph.D, Sc El
Ravi Mehrotra, Ph.D, Sc El
N S Natrajan, Ph.D, Sc El
Y S Reddy, M.Sc, Sc El ✓
V S Tomar, Ph.D, Sc El
P K Dutta B.E, Sc C
V K Gumber, M.Sc, Sc C
Neeraj Khare, Ph.D, Sc C
B V Kumaraswami. M. Tech, Sc C
Manmohan Krishan, M.Sc, Sc C
V N Ojha, Ph. D, Sc C
M L Sharma, M. Sc, Sc C
U C Upreti, M.Sc, Sc C
S K Aggrawal, Ph.D, Sc B
P L Upadhyay (Km.), Ph.D, ScB
S B Samantha, B.Sc, TO B
V S Yadav, Dip Engg, TO A

CRYOGENIC SYSTEMS

A P Jain, Ph.D, Sc F
S C Gera, B.E. Sc El
N K Babbar, AIC, Sc C
Ganga Parshad, B.E, Sc C
Hari Kishan. Ph.D, Sc C
Kasturi Lal, M.Sc, Sc C
R B Saxena, M.Sc, Sc C
S S Verma, B.E. Sc C
R S Khandekar, Dip. Engg. TO C ✓
G S Bhambra, ITI, TO A

THEORY

Ramji Rai, Ph.D, Sc El
Ratan Lal, Ph.D, Sc C

RADIO SCIENCE

B M Reddy D. Sc, Sc G ✓
K K Mahajan, Ph.D, Sc F
M N M Rao, Ph.D, Sc F
S C Garg, MSc, ScEII
S B S S Sarma, Ph.D, Sc EII
B N Srivastava, Ph.D, Sc EII
T R Tyagi, Ph.D, Sc EII
S Aggarwal (Smt.), M.Sc, Sc El
R S Arora, Ph.D, Sc El
P K Banerjee, Ph.D, Sc El
H N Dutta, Ph.D, Sc El
A B Ghosh, Ph.D, Sc El
S L Jain, Ph.D, Sc El

P N Vijaya Kumar, M.Sc, Sc El
Lakha Singh, Ph.D Sc El
D R Lakshmi (Smt), Ph.D, Sc El
P K Pasricha, Ph.D, Sc El
M K Raina, Ph.D, Sc El
Y V Ramanamurthy, Ph.D, Sc El
R C Saksena, Ph.D, Sc El
S K Sarkar, Ph.D, Sc El
M C Sharma, Ph.D, Sc El
R Venkatachari, Ph.D, Sc El
K S Zalpuri, Ph.D, Sc El
B C Arya, M.Sc, Sc C
Madhu Bahl (Smt.), Gd. IETE, Sc C
P Chopra (Smt.), Gd IETE, Sc C
R S Dabas, Ph.D, Sc C
M K Goel, Ph.D, Sc C
J K Gupta, M.Sc, Sc C
N Kundu (Smt.) Ph.D, Sc C
Mahendra Mohan, Ph.D, Sc C
H K Maini. Gd. IETE, Sc C
P L Malhotra, M.Sc, Sc C
D R Nakra, B.E, Sc C
V K Pandey, Ph.D, Sc C
M V S N Prasad, Ph.D, Sc C
S S Rajput, M.E, Sc C
V P Sachdeva, M.Sc Sc C
N K Sethi, M. Phil, Sc C
S K Singhal, M.Sc, Sc C
P Subrahmanyam, M.Sc Tech, Sc C
C B Tandel, M.Sc, Sc C
D K Tewari, M.Sc, Sc C
John Thomas, M.Sc, Sc C
Meena Jain (Smt.), M.Sc, Sc B
Risal Singh, Ph.D, Sc B
R S Tanwar, M.Sc, Sc A
S K Shastri (Smt), B.Sc, TO B
A R S Vashisht, Matric, TO B
Abdul Hamid, B.Sc, TO A
Didar Singh, ITI, TO A
K L Gulati, ITI, TO A
Raksha Marwah (Smt.), B.Sc, TO A
D B Sharma, ITI, TO A
Vishram Singh, ITI, TOA

TECHNICAL INFRASTRUCTURE

PLANNING, LIAISON, INFORMATION PUBLICATION

G K Arora, M.Sc, Sc Ell

R S Khanduja, M.Sc. Engg, Sc Ell
G Govindaswamy, MBA, Sc El
S K Kapur, B.Ch. E, Sc El
F C Khullar, M.A,, Sc C
Shikha Mandal (Smt), M.Sc, Sc C
S K Sharma, M.Sc, Sc C
Indra Tewari (Smt.), Sc B
P K Kohli, M.A, TO C
S S Bhakri, M.A, TO B
T R Tomer, M.A, TO B
S C Verma, I.Sc, TO A

LIBRARY

S M Dhawan, M. Lib. Sc, Sc Ell
S K Phull, M. Lib. Sc, Sc El
Sawanti Lal, B.A, TO A
Hasan Haider, B.Lib. Sc, TO A

COMPUTER

V C Jain, M.A, Sc El
Sanjay Raizada, M.C.A. Sc B

WORKSHOP & MECH. PROC. ACTIVITY

J R Anand, Ph. D, Sc Ell
Anil K Gupta, Ph.D, Sc Ell
H N P Poddar, B.E, Sc El
R C Anandani, B. E, Sc C
I A Malik, Dip. Engg, TO C
M K Chibber, Dip. Engg, TO B
Ganpat Singh, ITI, TO B
Harish Chand, ITI, TO B
Kewal Krishan, ITI, TO B
R Khanna, Dip. Engg, TO B
M G Sehgal, ITI, TO B
H B Singh, ITI, TO A
Jaswant Singh, Dip. Engg, TO A
T R Marwah, ITI, TO A
Ram Swarup ITI, TO A
J P Sharma, ITI, TO A
Rajiv Sikand, Dip. Engg, TO A

GLASS WORKSHOP

V P Varma, Matric, Sc El
Chandan Singh, Middle, TO C

M C Jusht, Matric, TO C
Mohan Lal, Matric, TO C
Shashi Bhushan, F Sc, TO C
J P Vashisht, Matric, TO C
G S Hans, Matric, TO B
Kani Ram, Matric, TO B
Karnail Singh, Matric, TO B

INSTRUMENTATION

V R Singh, Ph.D, Sc El
Aftab Ahmad, B.A, TO C
I Banaudha, B.Sc, TO C
D S Sachdeva, Gd. IETE, TO B
Y P S Negi, ITI, TO A

SERVICES

C S P Kumar, M.E, Sc Ell
S Dwivedi, M.Sc, Sc C
J C Sharma, AMIE, Sc B
R C Dhawan, B.Sc, TO C
O P Tagra, I T I, TO C
P K Garg, Dip. Engg, TO B
K V Krishnamurthy, Dip. Engg, TO B
S L Sharma, ITI, TO B
R S Singh, B.Sc, TO B
J S Dhama, M.A, TO A
S S Kapur, Dip. Engg, TO A
P L Sharma, ITI, TO A

ON DEPUTATION

Ajay Dhar
A R Jain'
J Kar
L M Manocha

ADMINISTRATION
ACCOUNTS

M M Sharma, B.A, Sr. CO A
B S Gaira, B.A, AO
B C Joshi, B.A, SFAO
J M Sardana, Inter, SPO
O P Kakkar, B.A, FAO
A K Ghosh, Dip. Engg, TO A
Anil Kumar, B.Sc, SO
N K Bajaj, B.A, SO (F & A)
O P Meni H Sec, SO
Jitender Parasar, M.A, SO
Sardara Singh, Matric, SO
R K Sharma, M.A, SO
Sarla Sonsi, (Smt.), Matric, SO
Sarla Srivastava (Smt.), M.A, SO
S K Vohra, AICWA, SO (F&A)
S Sharma (Smt.) Ph.D, H. Offr.
Prem Singh, B.Com, Dy SPO
Brijesh Sharma, PG Dip, Dy. SPO
R K Bhasin, B.A, SPA
B B Chopra, Matric, SPA
Jagdish Kumar, M.A, SPA
S A Josheph (Smt.), H Sec, SPA
Pran Nath, Inter, SPA
D V Sharma, Matric, SPA
Vijay Kumar, P.G. Dip, Sec Offr.

SCIENTISTS, FELLOWS, RESEARCH ASSOCIATES & POOL OFFICERS

K S Bartwal, M.Sc Sc (DST)
RN Chaudury, Ph.D, Sc (DST)
S Govindarajan, M, Tech, Sc (DST) ✓
S K Gupta, Ph.D, Sc (UGC)
V Soni, Ph.D, Sc (UGC)
K P S Bajaj, M.Sc, Fellow
R Kothari, Ph.D, Fellow ✓
Prashant Kumar, M Sc, Fellow
R S Rao, Ph.D, Fellow
Taney Seth, M.Sc, Fellow
R Agrawal, Ph. D, RA
Anil Kumar, Ph.D, RA
S Annapoorni (Smt), Ph.D, RA ✓
G Beig, Ph. D, RA
D R Chaubey, Ph D, RA
S Chaudhury (Km), M.Tech. RA
Archana Garg (Km), Ph. D, RA
Chetna Kaw (Km), Ph. D, RA
Keshav Kumar, Ph. D, RA
Reshmi Mitra, Ph.D, RA ✓
J Mittal, M.Tech, RA
G K Padam, Ph.D, RA
Arun Pandya, Ph.D, RA
G S Reddy, Ph.D, RA
Kanchan Saxena (Km), Ph.D, RA
Rina Sharma (Km), Ph.D, RA

S K Sharma, M.Sc, RA
Jaivir Kaudinya, Ph.D, PO
Nirupa Sen (Smt), Ph.D, PO
P K Srivastava, Ph.D, PO
J S Thakur, Ph.D, PO

RETIRED

M L Nagpal TO B, April
Puran Singh, Tech. VII, April
C B L Gautam, TO B, May
P S Limbu, Helper B, May
P C John, TO C, June
V V Shah, Sc Ell, July
G L Malhotra, Sc El, July
Chhatar Singh, STA, July
K B Lal, Tech. VII, July
BCN Rao, Sc F, Aug.
KL Sharma, Tech VIII, Aug.
S V Gupta, Sc Ell, Sept.
P C Jain, Sc Ell, Sept.
Jitendra Rai, TO C, Sept.
S S Sen, TO C, Sept.
Gopal Krishan, Tech. VIII, Sept.
Shadi Lal, Tech VIII, Oct.
K C Nagpal, Sc Ell, Dec.
G S Uppal, Sc El, Dec.
Harihar Prasad, Tech. VIII, Dec.
Tukar Prasad, Tech. VII, Dec.
Sri Ram, Tech VII, Dec
Rumali (Smt). Helper B, Dec.
S Ramanathan, TO B, Jan.
Surinder Singh, TO B, Jan.
S R Bakshi, TO A, Jan.
Bahadur Singh, Tech. VIII, Jan.
Ram Swarup, Tech. VIII, Jan.
Swinder Singh, Tech. VIII,Jan.
Fazalur Rehman, Tech. VIII, Feb.
S P Mathur (Smt.), TO B, March
Harphool Singh, Tech. VIII, March
Chhaju Ram. Tech VII, March

OBITUARIES

M L Sarkar, Sc C
Tilak Bahadur, Tech. VII
Jai Kishan, Tech.II
Amba Dutt, W/S Asstt.
Kishan Lal, Helper B

STAFF STRENGTH

(as on 1.4.92)

Category	*Grade*	*Number*	
SCIENTIFIC			
Grade IV	IV (1) to Director (Scientist)		284
TECHNICAL			
Group III	III (3) to III (5) (Tech. Officer)	96	
Group V	V (4) (A Ex. Engr)	3	
Group III	III (1) to III (2) & V (1) to V (2) (Tech. Asstt)	84	
Group II	II (1) to II (4) (Technician)	399	
Group I	I (1) to I (3) (Helper)	124	706
ADMINISTRATIVE			
	Officer	24	
	Establishment	147	
	Group D	108	279
	Total		1269

ANALYSIS OF TECHNICAL OFFICERS (Gp III. (No)

(as on 1.4.92)

QUALIFICATION-WISE

Gd\Q	Matric/H Sec/Inter	ITI	BSc/D Engg/BA	Msc/AIC/MA/IETE	Total
III (3) (A)	2	15	12	4	33
III (4) (B)	4	11	18	5	38
III (5) (C)	6	1	13	5	25
TOTAL	12	27	43	14	96

* In the category of Technical Officer A, 12% are postgraduate in science or arts or engg-grad. equivalent, 36% are science graduate or diploma engineer and 52% are ITI and or Matric/H. Sec/Inter.
* Regarding Tech. Offr B, 47% are Sc grad/dip engr, 40% are ITI or Matric/H. Sec/Inter and only 13% higher qualified. One TOB is Ph.D.
* In the case of Tech Offr C, 20% are postgrad/ engg. grad equivalent, 52% are Sc grad/dip engr. and 28% are ITI or Matric/H. Sec/Inter.
* Considering entire Tech Offrs, 14% are postgrad in Sc. or arts or engg-grad equivalent, 45% are Sc-grad/dip engr. and 41% are ITI Matric/H. Sec/Inter

AGE-WISE

Gd\Age (Ys)	34-45	45-50	50-55	55-58	58-60	Total
III (3)	7	3	15	6	2	33
III (4)	4	11	13	5	5	38
III (5)	1	3	10	7	4	25
TOTAL	12	17	38	18	11	96

* In the category of Tech. Officer A, 70% are above the age of 50 years and 30% are in the range of 35-50 years.
* In the case of Tech. Offr. B, 60% are in the range of 50-60 years and 40% in the range 35-50 yars.
* Regarding Tech. Offr. C, 84% are above the age of 50 years.
* Considering entire Tech. Offrs. 11 No will be retiring in two years, 30% are above the age of 55 years, 40% are in the range of 50- 55 years and 30% are between 35-50 years.

Ph. D's AWARDED

Name	Title	University	Guides
Awadesh Prasad	Studies on characterization of solid state devices for scientific and biomedical applications.	Meerut	Dr A.S. Yadav, Meerut University Dr. V.R. Singh , NPL
K.S. Balakrishnan (Smt.)	Structure, growth kinetics and electronic properties of electro chemically deposited CdS and Cd Te thin films for solar cells	Delhi	Dr. G.K. Chadha, Delhi University Dr. A.C. Rastogi, NPL
S.R. Gupta	Studies of ohmicity of metal-semiconductor and metal-insulator contacts with special reference to applied pressure & voltage	Meerut	Dr. M.L. Pandya, Meerut University Dr. Ram Parshad, NPL
N.C. Mehra	To elaborate selective surfaces and to characterize them for there structure and thermal properties.	Meerut	Dr. S.B. Agrawal, Meerut University Dr. S.K. Sharma, NPL.
Mukesh Kumar	Josephson studies in high Tc oxide superconductor-bulk and rf sputtered thin films	Delhi	Prof. A. Mansingh, Delhi University Dr. A.K. Gupta, NPL
Pardeep Mchan	Study of various aspects of pressure measurements in vacuum systems.	IIT Delhi	Prof. K.L. Chopra, IIT, Kharagpur Dr. J. K. N. Sharma. NPL.
Ajay Tyagi	Some studies on the electrical and optical behaviour of hydrogenated amorphous silicon thin films.	Kurukshetra	Dr. P.J. George, Kurukshetra University Dr. R. Bhattacharya NPL

HONOURS AWARDS

Prof. E.S.R. Gopal delivered the Platinum Jubliee Lecture of the Indian Science Congress Association at Baroda in Jan. 92. Prof. Gopal also delivered the fifth Dr. B.N. Singh Memorial Lecture at Delhi University in March 92.

Dr. Krishan Lal led the Indian delegation to the second Soviet Symposium on Crystal Growth and Characterization to Moscow in Oct. 91.

Dr. B.M. Reddy was elected a Fellow of the Indian National Science Academy.

Dr. Neeraj Khare was awarded the CSIR Young Scientist Award in Physical Sciences for the year 1991, for his contribution in the development of dc and rf SQUIDs of high Tc materials.

S/Sri O.P. Bahl, R.B. Mathur and S.S. Hanspal were awarded by NRDC for the development of technology for flexible graphite sheets and tapes.

S/Sri O.P. Bahl, L.M. Manocha, G. Bhatia, T.L Dhami and R.K. Aggarwal, were awarded the CSIR Technology Prize of 1990 for their work on the development of high density carbon-carbon composites.

Dr. A.K. Bandyopadhyay received Vineet Gupta Memorial Trust Award for outstanding work in the field of science.

Sri Ranjit Singh was awarded URSI Young Scientist Award.

Dr. S.P. Singal was elected the Vice President of the Acoustical Society of India, for the years 92-94.

Dr. B.K. Das was awarded a medal by the Material Research Society of India for the year 1992.

KRISHNAN MEMORIAL LECTURE

Prof. Charles H. Townes, NL, of University of California, Berkeley, U.S.A. delivered the 22nd Krishnan Memorial Lecture on Feb. 10, 1992. The title of the lecture was "What's happening at the centre of our Galaxy".

Prof. Townes said that the nature of the high energy object at the centre of our Milky Way Galaxy has long been considered as an enigma. It is suspected to be a massive black hole but there has been no definite observational confirmation so far.

Prof. Townes described the most recent results obtained from high resolution infrared and millimeter wave telescopes. These observations show the presence of high velocity neutral as well as ionized gas clouds close to the galactic centre. Their velocities systematically increase towards the centre indicating the presence of a massive object which could only be a black hole.

Prof. Townes, however, cautioned that a definite confirmation of the black hole would require further observations with more sensitive solid-state infrared cameras. This, he said, should be possible within the next decade.

Dr. S.K. Joshi, DGSIR, presided over the function. Dr. E.S.R. Gopal, Director NPL, presented a memento to Prof. Townes on the occasion. The lecture was attended by a large number of scientists, teachers, research scholars and others from NPL and outside.

VISITS ABROAD

(1.4.91 to 31.3.92)

Scientist	Country	Purpose & Month
Dr. V K Agrawal	Germany	NPL-PTB (Phase-II), Technical Cooperation Programme , April.
Dr. R K Garg	Germany	Under Indo-GDR S & T Programme, April-July.
Dr. S S Bawa	USA	Raman Research Fellowship, April-Sept.
Sri Gurmej Ram & Sri V P Wasan	Germany	NPL-PTB (Phase-II) Technical Cooperation Programme, April-May.
Dr. Omkar Nath	UK	For calibration and evaluation under NPL-PTB (Phase II) Technical Cooperation Programme, April-June.
Dr. V T Chitnis,	Japan	For working on development of mask aligner, April-May.
Dr. S L Jain	France	For fabrication of acoustics-optic spectrometer at Meudon Observatory, April.
Dr. A V Narlikar	Sri Lanka	For attending symposium, April
	UK	Under INSA-Royal Society Exchange Progamme, Sept-Oct.
Smt. Veena Roonwal	Germany	NPL-PTB (Phase II) Technical Cooperation Programme, May.
Dr. Neeraj Khare	USSR	Visited Insts. at Novosibirsk and Kharkov under ILTP Programme, May-June.
Dr. A K Gupta	Germany	NPL-PTB (PhaseII) Technical Cooperaton Programme,May-June.
Sri S B Samanta	USA	For equipment training, June-July.
Dr. B D Malhotra	UK	For carrying out Indo-EEC Project, July-Aug.
Dr. R P Tandon	Canada	For attending international conference at Vancouver, July.
Dr. T K Saxena	S Korea	Under INSA- KOSEF Exchange Programme, July-Oct.
Dr. P Banerjee	Germany	INSA-DFG Exchange Programme, Aug-Oct.
Dr. V D Dandwate	Germany	For training under NPL-PTB (Phase-II) Programme, Aug-Oct.
Dr. J K N Sharma	USSR	For attending the working group meeting in the area of standards and

		metrology, Aug.
	Germany, UK & USA	Familiarised with the latest developments in the field of surface analytical facilities under UNDP project, Feb.
	Japan	For developing cooperation between NRIM and NPL, March.
Dr. Harish Chander	Germany	Under CSIR-DAAD Exchange programme, Sept-Oct.
Dr. J S Vaishya	Italy	For attending tropical meeting of Intl. Commission of Optics, Aug.
Sri S N Nangia	Germany	Under NPL-PTB (Phase-II) Technical Cooperation Programme, Aug-Oct.
Dr. V R Singh	Denmark & Netherland	For attending meeting of World Federation on Ultrasound and to work at Delft University, Sept-April, 92.
Sri K K Saini	UK	For equipment training, Sept.
Dr. Krishan Lal	USSR	Attended Soviet-Indian symposium on crystal growth, Oct.
	Japan	Participated in the ASCA seminar on Materials Data Base Technology at Tokyo, Feb.
Dr. D C Parashar	Switzerland	Participated in the meeting of Inter-Governmental panel on climate change, Oct.
	Japan	Presented a paper at Intl. Symposium on Global Changes, March.
Dr. Y V Ramnamurthy	Germany	Under Max Planck fellowship and AVH fellowship, Oct.
Dr. Sharwan Kumar	Germany, UK, Italy & Netherland	For studying the facilities of capital equipment under NPL-PTB (Phase-II) Programme, Oct-Nov.
Dr. P C Kothari	Korea	Attended 9th workshop of National Standards System at Seoul, Nov.
Dr. S K Sharma	France	Under CSIR-CNRS Exchange Programme, Jan-Feb.
Dr. S K Halder	U K	Under British Council Exchange Programme, Jan.
Dr.O P Bahl	France	For study on IFCPAR project, Feb.
Dr. Mohan lal	Poland	Under CSIR-Polish Academy of Sciences Exchange Programme, March.
Dr. V S Tomar	France	For training on Alcatel Neutral reactive ion etching system, March.
Dr. K S Zalpuri	Japan	Attended Intl. symposium on Middle Atmosphere, March.

SPECIAL LECTURES

SPEAKER	TOPIC & DATE
Prof V.N. Varyukhin & Dr A.B. Nazarenko, Inst of Metal Physics, Kiev, USSR.	Some objects of the acoustic investigation and influence of anisotropy on some properties of high Tc superconductors, April 24.
Prof E. Jaeger, PTB, Germany.	Design and manufacture of measuring instruments at PTB at present and for future, April 25.
Dr. M.A. Gubin & Dr. D.A. Tyurikov, P. N. Lebedev Inst, Moscow.	Laser frequency standards based on super narrow methane lines, April 26.
Prof. Johannes Samthein, Vienna, Austria.	Electron stimulated desorption from alkali halide surfaces, April 29.
Prof T. R. Anantharaman, Thaper Corporate Research & Development Centre, Patiala.	Quasi-crystals or complex crystals, May 20.
Prof V A Ivanov Kumakov, Inst. of Gen. and Inorg. Chem, Moscow.	Possibility of high Tc superconductivity in vanadates, May 2.
Dr. U. Balachandran, Argonne National Laboratory, Illinois, USA.	Recent developments in high Tc superconductors, July 24.
Prof. David H. Kerridge, Southampton University, UK.	Some chemical and physical studies on acetamide salt eutectics, Aug 29.
Dr. V. Laurinavicius, Inst of Biochemistry, Lithuanian Academy of Science, USSR	Biosensors creation and applications, Sept 30.
Dr. B.N. Dev, Inst. of Physics, Bhubaneswar.	Surface and interface studies by wave X-ray standards, Oct. 11.
Dr. T. J. Quinn, Director, BIPM, France.	BIPM-current R & D programme, Nov.1

Dr. C.M. Verma, A T & T Bell Lab., USA.	Model for high Tc superconductors, Nov. 19, 20 & 26.
Prof. Colin Summerhayes, Director Inst. of Oceanographic Sciences, UK	Ocean modelling, Nov. 19.
Dr. R Chidambaram, Director, BARC, Bombay	Enigma of quasi-crystals, Dec. 19.
Dr. Y. Uchida, Aichi Inst of Technology, Toyota, Japan	Microcomputer controlled alignment system using Moire sensor, Dec, 24.
Dr. Shiva M. Deshpande, USA	Science, technology-manufacturing concepts, Jan 1.
Dr. S C Jain, Interuniversity Microelectronic Centre, Belgium.	Physics of silicon of germanium strained layers and devices. Jan. 3.
Prof H H Weetall, NIST, USA	Biosensors, Jan 7.
Prof J C Farman, British Antarctic Survey, UK.	Discovery of ozone hole, Jan. 23.
Prof V Ramanathan, University of California, USA	Clouds, Indian monsoon and global warming : unresolved issues in IGBP modelling, Feb. 18.
Prof WC Sinke, Netherland Energy Foundation, Amsterdam.	Bulk and surface contributions to enhanced solar cells performance, induced by aluminium alloying, Feb 19.
Prof H Wondratschek, Emeritus Prof, Institut fur Kristallographie der Universitat, Karlsruhe, Germany.	The strange behaviour of some K-feldspar and its possible correlation with crystal perfection, Feb 21.
Prof B.E. Jones, Brunel University, UK.	Recent advances in fibre optic instrumentation, Mar. 4.
Prof. Olga Suvorova, Inst of Organometallic Chemistry, Gorky, Russia.	The application of organometallic compounds in the CVD process, Mar 13.
Dr. URK Rao, BARC, Bombay	Soild state chemistry of oxyfluoron anionic compounds, Mar. 17.

TRAINING

The second CIMET-NPL group training workshop in metrology was organized from Feb. 25 to March 13, 92. Thirteen participants from various commonwealth countries including Zimbabwe, Malaysia, Tanzania, Botswana, Ghana, Pakistan, and Bangla Desh attended. The areas of electrical standards were covered. A number of trainees stayed back for further training and research programme of their interest.

Training was imparted tor 3-6 weeks in the field of legal metrology to four trainees from Kenya and Malaysia. They were sponsored by the Deptt. of Weights and Measures, New Delhi.

Training was imparted to a scientist deputed by IRDE, Dehradun, on the deposition and characterization of diamond like carbon films.

Mr. S.I Mandal of Dhaka University was trained in methology, field sampling and analysis of green house gases for three weeks.

Training in the field of glass fabrication was provided to a trainee from Nepal, sponsored by UNDP, for two months.

Four trainees, including two officers from M/s BHEL, Jhansi, got training in the section of Temperature Standard for two weeks.

Two trainees from M/s AIMIL (P) Ltd., New Delhi were trained in the section of Vacuum and Pressure Standards for two weeks.

About 45 students from different engineering colleges and institutes carried out their project work in various divisions of the laboratory during vacations.

Ten M.Sc students from the Universities of Agra, Hyderabad, Jamia Millia, Manipur and Roorkee; IITs of Delhi and Madras, attended CSIR-science familiarisation programme for six weeks in June-July.

SYMPOSIA

The Indo-Soviet symposium on Experimental Mineralogy and Petrology, was held from Oct, 3 to 5.

A seminar on Effect of Pollution, both Tangible and Intangible, was organised by Indian Woman Scientists Association, Delhi Branch, on Dec. 21.

The international symposium on Photovoltaic Science and Engineering was held from Feb. 10 to 14.

The Indo-US workshop on Perspectives in New Materials was held from March 23 to 25.

About 215 staff members were deputed to attend various symposia and workshops held at Delhi and outside at Ahmedabad, Bangalore, Calcutta, Dhanbad, Gorakhpur, Jaipur, Jamnagar, Karaikudi and Varanasi.

DISTINGUISHED VISITORS

1. Hui Byong Han Dr. Vice President, National Science Academy, DPR, Korea with delegation, April 29.
2. Trotz U. O'D Dr., Secretary Commonwealth Science Council, London, July 10.
3. Rahman Habibur Mr., Additional Secretary, S & T, Bangla Desh, July 30.
4. Wood Robert Dr., Department of Energy, Washington, USA, August 12.
5. Chidambaram R Dr., Director Bhabha Atomic Research Centre, Bombay, Dec. 19.
6. Thrush B.A. Prof., Cambridge, UK, Dec. 31
7. Townes C.H. Prof., University of California, USA, Feb. 10.
8. Roy Rustom Prof., Materials Research Laboratory, Pennsylvania, USA, March 23.
9. Anantharaman T.R. Prof., Thaper Corporate Research & Development Centre, Patiala, May 20.

NPL-TWENTY YEARS BACK

(from the Annual Report 1971-73)

Scientists and Technical officers -155
Total Staff (31-3-73) -1017
Expenditure (71-72) -Rs. 121.172 Lakhs

SCIENTIFIC HIGHLIGHTS

Maintenance of and research on Standards was continued. Work on design of an interferometric comparator was continued. Fixed points on the temperature (K) scale were realised according to International Practical Temperature Scale. Work was carried out to improve the accuracy of standards for derived units of microwave power, acoustic pressure, force and vacuum. The design and fabrication of Lang camera was taken up.

In the field of Materials the activities were confined on carbon technology, semiconductor technology, ferrites and piezoelectric ceramics. The development of a project on silver impregnated graphite relay contacts was taken up. Single crystals of silicon were grown in the laboratory. The coloured phosphors of TV tubes were prepared on experimental scale. TV deflection yokes were developed and approved. The niobates of alkaline oxides with additives were also developed. PZT materials and projector and process carbons were produced in the pilot plant. The techniques for recondioning of CR and TV tubes were established.

In the area of Radio Physics, the ionospheric environment was monitored using a variety of radio techniques. The SODAR system was initiated to monitor the lower troposphere. The short term forecasting service (beamed by AIR, IMD & NPL) was started. Aeronomical studies of the ionosphere were pursued intensely.

Basic investigations, related to the applied research programmes, were undertaken. The influence of pair breaking mechanism on Josephson tunnelling was theoretically investigated. Mossbauer effect studies of ferroelectrics were undertaken.

Open days were organised in Aug. 1972 on the occasion of Silver Jubilee Celebrations of the Independence of India.

The processes released included:-

1. Photocopying machine.
2. Cinema arc carbons.
3. Metal graphite brush blocks.
4. Piezoelectric materials.
5. Ceramic capacitors.
6. Soft and hard ferrites.
7. Microwave components.

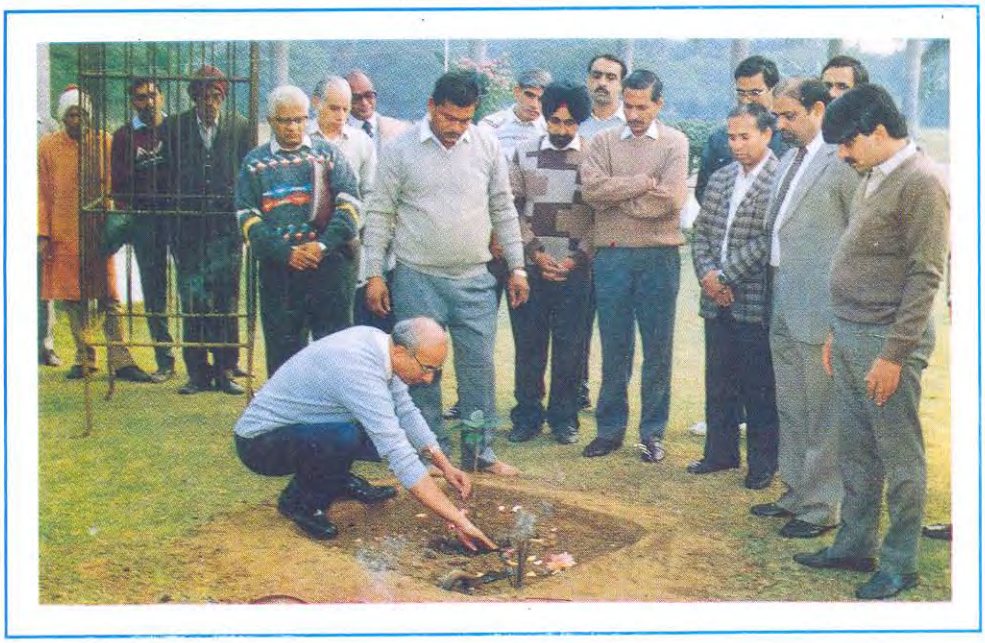
OPEN DAY

NPL observed Opcn Day on Jan. 8, 1992, when all the activities were kept open for the students from various schools and colleges of Delhi. The scientific activities in the areas of Standards, Materials, Characterization, Superconductivity and Radio Science were visited by more than two thousand students and teachers. A number of instruments and equipment with experimental set-up, of various activities including time and frequency, holography, thermometry, sodar, rocket and balloon experiment, liquid crystal, electron microscopes, X-rays, characterization of crystal, antarctic studies, high temperature superconductor and thin film coating etc. were shown to the visitors.

An exhibition was also arranged on this occasion where in the activities were displayed using charts, photographs and demonstrations. The information was also supplemented by screening a number of scientific and video films. The technical sections such as workshop, glass fabrication, intrumentation and computer were also shown to the visitors. Teams of volunteers of scientific and technical staff provided assistance and guidance to the visitors alongwith necessary facilities.

ABBREVIATIONS USED

AIIMS	:	All India Institute of Medical Sciences.
ARDB	:	Aeronautial Research Development Board.
ASCA	:	Asian Crystallographic Association.
BARC	:	Bhabha Atomic Research Centre.
BHEL	:	Bharat Heavy Electricals Ltd.
CCIR	:	International Radio Consultative Committee.
CEERI	:	Central Electronics Engineering Research Institute.
CEL	:	Central Electronics Ltd.
CFC	:	Chloro Fluoro Carbon.
CSIRO	:	Commonwealth Scientific and Industrial Research Organisation.
CSIR	:	Council of Scientific and Industrial Research.
DAAD	:	German Academic Exchange Service.
DMRL	:	Defence Metallurgical Research Laboratory.
DNES	:	Department of Non-Conventional Energy Sources.
DOD	:	Department of Ocean Development.
DOE	:	Department of Electronics.
DRDO	:	Defence Research and Development Organisation.
DST	:	Department of Science & Technology.
EPR	:	Electron Paramagnetic Resonance.
FTIR	:	Fourier Transform Infrared.
IARI	:	Indian Agricultural Research Institute.
IIT	:	Indian Institute of Technology.
IISc	:	Indian Institute of Science.
IMD	:	Indian Meteorological Department
INMARSAT	:	International Maritime Satellite.
INSA	:	Indian National Science Academy.
IRDE	:	Instrument Research Development Establishment.
JNU	:	Jawaharlal Nehru University.
KDMIPE	:	K D Malviya Institute of Petroleum Exploration.
MCF	:	Master Control Facilities
MST	:	Mesospheric Stratospheric & Tropospheric.
NCTCF	:	National Coordination of Testing and Calibration Facilities
NEERI	:	National Environmental Engineering Research Institute.
NGRI	:	National Geophysical Research Institute.
NIAES	:	National Institute of Agro-Environmental Studies.
NIST	:	National Institute for Standards & Technology.
NTPC	:	National Thermal Power Corporation.
PTB	:	Physikalisch Technische Bundesanstalt, Braunschweig.
SEM	:	Scanning Electron Microscope.
SHAR	:	Shriharikota Rocket Launching Station.
STFS	:	Standard Time & Frequency Signal.
UCMS	:	University College of Medical Sciences.



Prof. E.S.R. Gopal, Director, planting a sapling in the lawns during the Qaumi Ekta Week. (top)

The students visiting the exhibition on the Open Day. (bottom)