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राष्ट्रीय भौतिक प्रयोगशाला
National Physical Laboratory
New Delhi

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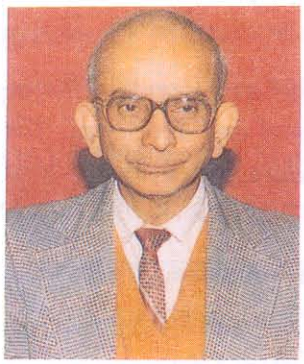
Director's Report



It is a matter of great privilege for me to present the Annual Report 1995-96 of National Physical laboratory, New Delhi. We feel pleasure in presenting through this report the main achievements and progress made by NPL in R & D and other activities.

In the light of the current emphasis in the CSIR laboratories, the technological development / achievements made during the year are summarized as follows-

High purity gallium arsenide crystals have been characterized for their purity and perfection using high resolution x-ray diffraction techniques. Novel Solid polymeric electrolytes based on poly vinyl butyral have been developed using different lithium salts and appropriate solvents. These are suitable for using in electrochromic device for "Smart window" applications. Piezoelectric accelerometers have been developed with 10 mv/g sensitivity. In the field of ultrasonic standard, a new method of measurement of ultrasonic attenuation in solids in form of rods has been developed.

Sol-gel techniques have been successfuly employed to develop silicon carbide incorporated carbon-carbide composites. Success have been achieved in fabricating superconducting tapes up to 5 m length having critical current density (Jc) value of about 2000 A/cm. Phosphor screens for scintillation counter for BARC, Bombay have been made. High efficiency Silicon Solar Cells have also been developed. NPL has successfully developed thin walled MMC tubes with targeted physical and mechanical properties using SiCp of different particle sizes. Glucose Biosensors developed at NPL for monitoring sugar levels in blood are now being manufactured by Pulsatum Health Care Pvt Ltd, Bangalore. A highly sensitive detector spectral response calibration facility using a monochromator based spectral comparator (350 nm to 1100 nm) has been established. NPL has continuously strived to interact with industry in the development of high technology. After the successful collaborative programme with BHEL on the development of the Superconducting High Gradient Magnetic Separator, NPL provided consultancy to BHEL on the development of 200 KVA Superconducting Generator.

Research & development work has been the main traditional work of the laboratory and have been continued in the field of materials development, Radio & atmospheric sciences. The work on characterization of different kinds of materials was continued. Characterization of material is important in evaluating their usefulness in scientific & technological applications. Various techniques including chemical methods, EPR spectroscopy, FTIR spectroscopy, x-ray diffraction techniques & electron - microscopy etc. were used for evaluating composition, purity, structure and perfection in inorganic and organo - metalic compounds. Nearly perfect crystals of oxides such as lithium Niobate and crystals of Bismuth Germinate were grown successfully. Work on preparation

PHYSICO MECHANICAL STANDARDS

LENGTH & DIMENSIONS

1. Length Standards

The primary Length Standard is being maintained in the form of an iodine stabilized He-Ne laser at 633 nm. A software has been developed and installed for beat frequency data acquisition and processing. One iodine stabilized He-Ne laser after its calibration at VNIIM, Russia and PTB, Germany has been received from PTB and installed at NPL.

Secondary standard lasers and laser interferometers for precision measurements from various industries were calibrated and certificates were issued. Commercially viable Zeeman stabilized secondary standard He-Ne laser has been developed and fabricated. Stability estimation of this laser is in progress.

Precision optical components like laser mirror blanks optical flats, prisms etc. were fabricated. Optical components from different industries were tested and reports were issued.

A consultancy project on reconditioning of He-Ne lasers and installation of Ar ion lasers in the laser based systems at Vikram Sarabhai Space Centre (VSSC), Trivandrum has been successfully completed. A project proposal on development of Laser Doppler Velocity Meter for non-contact length measurements of moving samples has been prepared and submitted to DOE for grants.

Bilateral collaboration programme with D.I. Mendeleyev Institute for Metrology at St. Petersuburg, Russia has been initiated.

2. Dimensional Metrology

i. At site calibration of precision measuring instruments was carried out for several companies and about 815 calibration certificates were issued.

ii. The following facilities have been upgraded/added.

A. Installed surface roughness measurement facility

B. Initiated action on establishment of form and roundness testing facility

C. And augmentation of angle measurement facility

— Measurement of TV tubes and its deflection coil was successfully carried out for M/s Samtel Color Ltd.

iii. The measurement uncertainty of NPL standard slip gauges has been improved from 0.04 µm to 0.015 µm for gauges upto 10 mm and 0.1 µm to 0.05 µm for gauges upto 100 mm length through their calibration at PTB Germany.

MASS

The following activities have been done during the period

A. Maintenance of National standards of mass, volume, density & viscosity.

B. Calibration of weights balances, hydrometers, volumetric measures and viscometers.

C. Generation of transfer solid based density standards (SBDS).

D. Generation of laboratory standard weights in denomination of 1 kg and its multiples and submultiples.

E. Development of viscosity scale.

Automatic Computer based solid density standard system

FORCE

6 MN Hydraulic Multiplication system has been erected and electrical work for its operation is in progress.

Some controls have been incorporated in the standard hardness m/c developed to regulate the speed of penetration of the indentor. Further tests are in progress.

Torque generation facility has been extended from 1500 N.m to 2000 N.m.

PRESSURE & VACUUM

1. Pressure Standards

i. In house calibration of three different secondary standards upto 12 MPa by cross floating with different working fluids namely nitrogen, argon, helium and hydrogen.

ii. Ultra high pressure generation upto 40 GPa using diamond anvil cell (DST project)

iii. The dielectric properties of ceramic relaxor of materials were studied under high hydrostatic pressure to investigate the feasibility for the development of capacitance transducer for the measurement of hydrostatic pressure (INDO-US project).

iv. Design and development of commercial hydrostatic piston gauge pressure standards upto 60 MPa with improved measurement uncertainty upto ±0.03%.

2. Vacuum Standards

i. Characterization of Quartz Gauges for negative and positive pressure measurements using two different primary pressure standards i.e. Ultrasonic Interferometer Manometer and Air Piston Gauge for helium, nitrogen, and argon gases.

ii. Development of software for calibration against QBG, CDG, Air Piston Gauge for industrial pressure gauges and pressure transmitters in the range 1 Pa to 500 kPa.

iii. Vacuum Leak Standards : A method has been developed in which a calibrated leak is used to calibrate a spinning rotor gauge or a capacitance diaphragm gauge. The attractive feature of this technique is that it can be used to calibrate those gauges which may have some discontinuity and for the precise existence and location of which the pressure would need to be recorded contuniously.

3. Surface Physics

i. Study of cleaning/washing effects on Pt-Ir alloy used as standard mass material using SIMS.

ii. Surface analysis of vacuum engineering material of sputter ion pump, namely stainless steel and titanium using TDS, AES and SIMS.

iii. Studies of super structural phase formation of Ag/Si (111) system and its thermally induced transformation using LEED, AES and SIMS.

iv. The formation of Mn/Si (111) interface at room and high temperature using LEED, ELS and AES.

TEMPERATURE

A. Temperature :- The following temperature standards were maintained/kept operational.

i.	Triple point of water	(0.01 + 0.2 m C)
ii.	M.P. of Galium	(29.7646 + 0.2 m C)
iii.	F.P. of Tin	(231.928 + 0.2 m C)
iv.	F.P. of Zinc	(419.527 + 0.2 m C)
v.	F.P. of Aluminium	(660.323 + 10 m C)
vi.	Triple point of mercury	(234.3156 + 1 mk)

B. Calibration Work :- Large amount of calibration work was carried out for the following items:

i.	Glass Thermometers	(-80 C to 300 C)
ii.	Thermocouples	(0C to 1100 C) Comparison method + Au/Pd. Points
iii.	Pyrometers & Tungstenstrip Lamp	(1064 to 1800 C)
iv	RTD's, Digital indicator with PT-100 Probe	(30 to 600 C)
v.	Liquid Baths Medal-Block Comparators	(-80 to 300 C)
vi.	Standard-Platinum Resistance Thermometers.	(30 to 600 C)

a. A lecture on "Temperature standards and calibration facilities at N.P.L., N. Delhi" was Delivered by Shri Ram Krishan at Cimet Conference, held during 5-7 Feb, 1996.

b. Accreditation of following labs:-

i. ETDC, Bangalore
ii. BHEL, Sultanpur (U.P.)

OPTICAL RADIATION

1. Established Detector Spectral Response Calibration Facility using a Monochromator based Spectral Comparator (350 nm to 1100 nm).
2. Took part in International Intercomparision of Spectral Responsivity of Silicon-Photodiodes obtained from KRISS, Korea under APMP. (Feb. 1996).
3. Traceability of the existing Colour Temperature Scale was checked with the Recalibrated Reference Standards from BIPM (Oct. 1995).
4. 40.5% Increase in Revenue Earning through Calibration Earning increased from Rs. 8.48 lakhs (1994-95) to Rs. 11.92 lakhs (1995-96).
5. Application of Coherence-induced spectral changes in Optical Measurement (DST and YSA sponsored projects).

INFRARED RADIATION

Increase diverse application of infrared instrumentation for energy conservation and control, general sensing and communication, military applications and for industries such as cement, steel, glass, textile, food, fertiliser and petrochemical require standards of these parameters in general and standards for spectral transmittance, spectral reflectance and emittance in particular.

These standards are not readily available from any of the standards laboratories of the world. Currently available standards provided by NIST, USA operate in the uv, visible and near infrared up to 2.5 μm only. Hence, the development work on the standards of spectral specular reflectance, and spectral transmittance for 2.5 to 25 μm region was taken up.

i. Various well characterized, both surfaces polished windows of ZnSe, As_2 S_3 and CaF_2 were procurred and studied for their use as standard of transmittance (high

transmittance values).

ii. Effects of aging, environment, surface conditions and thickness uniformity on transmittance standards were studied. Uncertainty in their transmittance values were evaluated.

iii. Transmittance of various well polished materials were studied in convergent incident radiation of 2.5 to 25 μm. These values were compared with regular transmittance values. Some interesting results have been obtained which were communicated for publication.

iv. Polarisation state of spectrophotometer was deduced and its effect on transmittance/reflectance of standards have been evaluated.

Five infrared scanners/thermovision systems were calibrated.

i. Essential and imported feed back regarding the quality, thickness and homogeneity of the DLC film developed by Amorphous silicon group of the laboratory was provided by studying reflectance/transmittance of these films in 2.5 to 25 μm spectral region.

ii. In-house testing was done for various developmental and sponsored projects of the laboratory.

ULTRAVIOLET RADIATION

There is global interest to have quantitative information about air UV (200 - 400 nm) radiation emitted from natural or artificial radiation sources producing several harmful effects on human and living beings and marine life. Such information in several ways is needed in industry, hospitals, agriculture, pharmacetical areas, etc. in contrast to these requirements the services offered by existing metrological laboratories for UV radiation measurement and standardisation are limited and moreover are required to be upgraded to meet the situation. In the laboratory with limited inputs and infrastructural facilities, some facilities for the calibration and measurement of

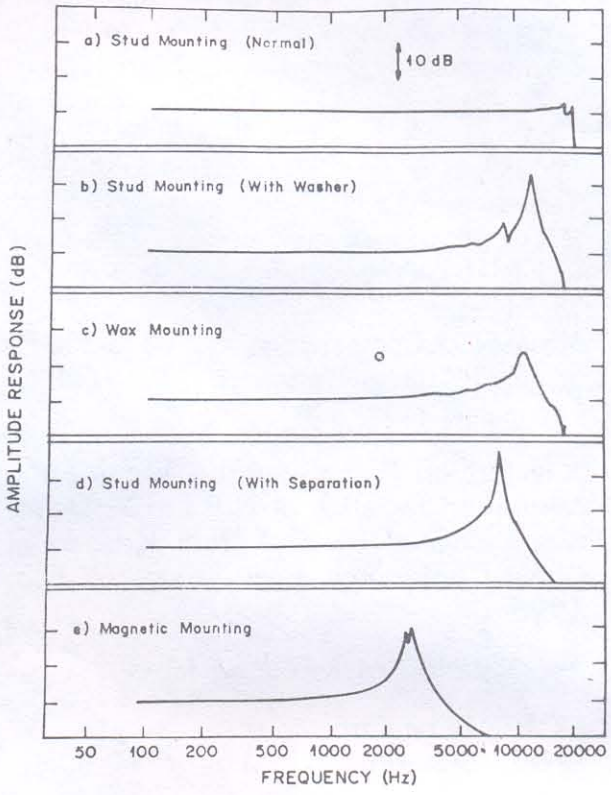
a. UV Radiation sources
b. UV detectors response and linearity
c. Characterisation of UV filters for transmittance, spectral bandwidth
d. Calibration of portable UV meter etc.

have been created and also extended to industries and user institutions. We have created facilities for quantitative measurement of air UV (200-400 nm) radiation with uncertainty of ± 10% at 260 nm.

ACOUSTICS

1. Improving the accuracy of accelerometer recalibration

i. Among the various factors responsible for improving the acuracy of recalibration of accelerometers, the method of mount-



A comparison of different mountings

ing, choice of preamplifier (with very high input resistance) and capacitance of the connecting cable are very important, from a practical point of view, in deciding the overall accuracy and the useful frequency range of the measuring system. The normal stud mounting, with silicon grease in between, is found to be superior to other mounting techniques.

ii. Traffic noise levels in busy roads are 75 dB (A) under Light traffic condition 80-85 db (A) under Medium to Heavy traffic condition 90 db (A) or more under congested slow traffic condition

With number of vehicles/Km of road increasing from 31 in 1975 to 103 in 1995, the average vehiclular speed has come down to around 20 Km/Hr from 40-50 Km/Hr, leading to increased air/noise pollution potential.

iii. Industrial Noise Surveys in two factory premises was done

Average noise levels in plant areas : 85 + 4 dB(A)

Noise level in generator room : 97 dB(A)

Increase in noise level to due spl. operation like fork lifting, stamping etc.

iv. Development of phased array antenna consisting of 76 elements for possible use in Doppler mini sodar, with efficiency about 25 db at 2.5 KHz and 30 dB at 4.5 KHz.

Can also be used as an efficient acoustic source for RASS temperature profilers.

v. Inversion Climatological Studies at IPCL, Nagothane and SAIL, Durgapur continued.

vi. Development of Doppler & Doppler Mini Sodar in progress.

vii. Antartica Boundary Layer Studies at Du Mont-da Vrville (French Base) undertaken by Dr. Gera B.S. under ICTP fellowship at Italy.

2. *Standardization, Calibration Testing work was done.*

i. Accuracy of primary standards of sound pressure (+ 0.2 dB) and vibration amplitude (+ 0.5%) was maintained through periodic calibration exercise.

ii. Calibration of secondary/working standards from regional laboratories/industrial units was undertaken.

iii. Evaluation & testing of electro-acoustic equipments and acoustic products developed indigeneously were undertaken.

iv. No. of calibration/Test Certificates issued : 115

v. Calibration range of non-contact techometer was enhanced to 40,000 rpm through multiple detecion technique.

vi. Noise & vibration measurement and analysis undertaken

ULTRASONICS

Further units of 38 KHz underwater pinger device complete with electronics and battery were supplied to NSTL, Visakhapatnam.

Various hydrophones fabricated using 1-3 composite ceramic elements supllied by NMRL, Bombay, have been tested in underwater acoustic test tank to evaluate their receiving sensitivity and directional characteristics. Receiving sensitivity of a typical 1-3 composite hydrophones with Neoprene encapsulation were measured in the frequency range 12 KHz to 100 KHz.

A complete pinger tag of miniature size 93 mm length, 18 mm dia, 12 gm weight in water suitable for tagging 400 mm larger fish has been developed.

The peak acoustic output of the tag at 75 KHz is dB re : μ Pa at 1 m.

A transponding acoustic system has been fabricated using a 75 KHz tuned acoustic receiver as trigger in combination with a acoustic pulse transmitter. The response

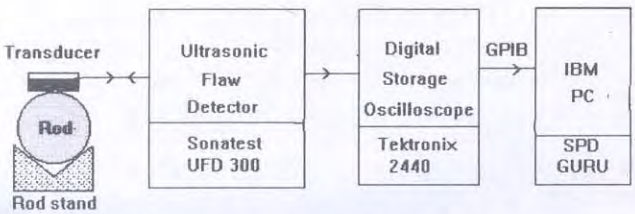
sensitivity of the transponding system is obtained to be about 154 dB re : 1μ Pa.

Investigation of Parameteric Acoustic Arrays in presence of interacting media has been initiated:-

A single element primary transducer resonant 1 MHz has been fabricated for generation of parametric signal in the frequency range 10 KHz to 100 KHz. The max acoustic output of the projector is 210 dB re: 1uPa at 1m.

Development of High Electric Drive Piezoelectric Transducer Ceramics Materials have been initiated. Optimisation of the Ceramic Processing Parameters for Fabrication of NPLLZT-PMN-1 have been carried and rejection rate minimised. The fabrication processing of tubular Transducer Elements for Pinger and other such Devices have been standardised.

A new method of measurement of ultrasonic attenuation in solids in form of rod developed. The method is free from sources of errors such as diffraction, reflection and transmission losses. Data has been generated for ultrasonic velocity in 485 pure liquids. (~500)



Schematic Diagram of the Setup

A method of calibrating the ultrasonic thickness gauges developed & Calibration Job has been undertaken. A method of measurement of ultrasonic attenuation at different frequencies in parallel plates has been developed facilitating the on-line diffraction correction. A method has been developed for the accurate measurement of ultrasonic longitudinal and transverse velocity in solids using single ultrasonic transducer.

Focussed Transducer Devices for Application in NDT and Medicine have been developed. These transducers can be tailor made suiting to the users requirement of desired focal length and Focal Zone.

FLUID FLOW MEASUREMENT

Setting up the water flow measurement facility as National primary standard having maximum flow rate 600 m^3/h has been undertaken.

Completion of infrastructurte facilities (Preparation of control & instrumentation room, pump & air compressor room, measurement hall, sump tank, electrification etc.). Procurement and erection of load hoist system calibration of 500 kg dead weights (20 Nos.). Leak proofing of OH tank and reconstruction of foundation for 10-ton weigh tank.

Erection of two test rigs, 200 DN and 50 DN, (Pipe work, weightanks, pumps, computer systems etc). Preliminary flow test using direct pumping (without using over head tank). Load cell calibration of 1-ton tank using dead weights has been done.

NATIONAL CALIBRATION SERVICE PROGRAMME

In order to attain the objective of reliable, adequately precise, accurate and uniform measurements; the test and measuring equipments used are made ultimately traceable to the accepted International Standards of Measurements, through *"National Standards"* maintained at NPL, New Delhi. In order to ensure 'traceability', the laboratories performing testing and calibration jobs are accredited by National Accreditation Board of testing and Calibration Laboratories (NABL), which is a Government

of India Programme. The calibration activities of NABL are operated by specially constituted cell, National Calibration Service Programme, located at NPL, New Delhi. The accreditation of laboratories is done in compliance to ISO-Guide 25 (1990). The programme became operative w.e.f. April 1993. Till date 93 applicants have sought NABL accreditation, out of which 32 have been accredited. The accrediation has been given in area of Mechanical (12), Fluid Flow (2), Electro-Technical (13) and Thermal & Optical (5) Measurements.

In order to facilitate the accreditation work, 24 documents have been prepared and published. Recently a NABL News Letter has been brought out from DST, New Delhi.

Similarly, the 1st issue of the NPL "Calibration News" was published in May'96 from NPL, New Delhi.

NCSP participated in International Programme of Laboratory Intercomparison organised by Asia Pacific Laboratory Accreditation Co-operation (APLAC), Australia. The intercomparison in area of mass, length, resistance and water samples have been completed. Except the water samples, two of the NABL accredited laboratories took part in each intercomparison.

ELECTRICAL STANDARDS

TIME AND FREQUENCY

During 1995-96, considerable breakthrough was made in STFS, both in terms of improving the time transfer accuracy and in drastically reducing the cost of the receiving set-up. Using compensation technique, the time transfer accuracy was reduced from ± 10 μs to ± 1μs. The receiving set-up was redesigned in collaboration with ER & DC, Trivandrum to bring down its cost from a prohibiting Rs. 2.5 lacs to mere Rs. 50,000. One such model has been sold to M/s. Secure Meters, Udaipur and is performing satisfactorily. STFS decoder with tailor made specifications has also been installed at SLDC, Kalwa.

A study of the reliability and availability of GPS signals over India has been successfully concluded. The effect of degradation of time transfer through GPS satellites has been reduced using an algorithm developed for the purpose.

The calibration of frequency standards has been automated in respect of data taking as well as for the computation of the results.

JOSEPHSON VOLTAGE STANDARD

(i) Calibration of zener diode standard against Josephson Voltage at 1 volt level.

Reassignment of value of secondary standard of DC volt. (Uncertainty ≈ 2 PPM)

(ii) Investigations have been carried on short and long term stability of zener diode standard (in collaboration with DC standard group). Variation in value of standard was observed over a period of 60 days and relative humidity varying from 55% to 90%)

Z1 Δ V = -0.41 ppm for 10% increase in RH

Z2 Δ V = +0.73 ppm for 10% increase in RH

Value of zener standards substantially changes with humidity. It is advisable to maintain them in humidity controlled rooms or they should be re-calibrated against Josephson Standard more often (One in a month)

(iii) Work has been initiated on fabrication and characterisation of high precision hall sensors of various materials.

I. High-Tc Thin Films

Indo-French project was completed successfully. Developed high quality YBCO thin films with Tc ~ 89-91K and Jc = $2x10^6$ A/cm^2 at 77K (DC magnetron sputtering technique). Observed spiral growth structures in these films with STM (CEERI, Pilani).

II. High-Tc RF-Squids

Fabricated several BSCCO RF-Squids. Developed suitable encapsulation technique to stop degradation in characteristics of squids with time and thermal cycles/moisture. Collaborated with CEERI, Pilani on development of RF-squid electronics.

Supplied one BSCCO RF-Squid probe to CEERI, Pilani for day to day testing of the electronics being developed there. Designed and fabricated cryostat & shielding arrangement for the RF-Squid. Testing and evaluation in progress.

Experimentally confirmed for the first time that natural grain boundaries behave as Josephson weaklings in electron-doped NdCeCuO superconductor. First observation

of RF-squid effect due to natural grain boundary weaklinks in $YNi_2 B_2 C$ superconductors. A sensitive magnetic field sensor based on harmonic generation effects in high-Tc superconductors has been developed.

Observation of Squid behaviour in Hg (Tl) Ba-Ca-O thin film upto 117.5K, the highest temperature at which squid has ever been operated. Earlier, in 1994 IBM group reported DC-squid characteristic upto 111.8K in Hg-1223 film. Development has been done of a novel non-contact technique for measurement of Tc of superconducting samples of irregular shape and very small size.

MICROWAVE SUPERCONDUCTIVITY

Microwave surface resistance measurements have been carried out YBCO thin films using parallel plate dielectric resonator designed and fabricated at NPL. The variation of surface resistance with temperature, microwave frequency, dc and rf magnetic fields have been measured.

A modified and plate replacement technique has been developed for measurement of microwave surface resistance of HTS samples of small dimensions.

A systematic study of magnetic penetration depth $\lambda(O)$ for bulk and thin film samples of YBCO has been carried out as a function of density and frequency. $\lambda(O)$ decreases with increase in density and is minimum for c-axis oriented thin films. $\lambda(O)$ is independent of frequency in the range 10-26.4 GHz.

YBCO thin film microstrip resonator has been designed & fabricated. Various characteristics of the resonator, such as quality factor, insertion loss and frequency shift as a function of temperature and input incident power have been measured.

AUGER STUDIES

Electron spectral studies have been carried out on YBCO thin films The strength of electron correlation and changes in Cu valence for in plane carriers has been found crucial to sustain superconductivity. Doping of Pr Ions changes the copper valency which causes suppression of superconductivity.

LF & HF IMPEDEANCE STANDARDS

(i) The work on fabrication of 1000 MHz high precision admittance bridge in collaboration with Slovak Institute of Metrology has started. One of the four arms of the bridge has been constructed at NPL workshop. The rest of the bridge will be constructed after electrical evaluation of this arm has been completed.

(ii) The design and development of a set of high frequency inductance standards has been completed. This set consists of three inductors having nominal values of 1, 10 and 100 µH. This set will be used for calibration and performance evaluation of 4-TP LCR meters etc.

(iii) A 10 pF reference standard capacitor of parallel plate configuration has been designed, fabricated and assembled. Its stability has been studied for a period of more than one year and as such it is found to be stable within 20 ppm per year. It is now ready for hermetically sealing.

(iv) A new facility has been set up for measurement of tan δ of capacitors upto 100 V at 1 kHz.

(v) A new facility for absolute calibration of Transformer Ratio Standards has been set up. This set up can measure transformer ratio with an uncertainty of ± 0.03 ppm.

(vi) The automated IVD (Inductive Voltage Divider) calibration set up has been modified to improve the measurement accuracy from 0.1 ppm to 0.05 ppm.

AC & LF STANDARDS

I. Power & Energy Measurements

1. Facility for phase current measurement

under 17.5% of 3RD harmonics distortion in current paths.

2. Improvement of measurement uncetainty for
   3ϕ system : from + 0.05% to 0.03%
   1ϕ system : from + 0.03% to 0.02%

3. Bilateral comparison of watt converter (± 0.02%) PTB Germany/NPL India. Tally of results : within 80 ppm

(II) AC high current & high voltage standards

1. Facility for the calibration of PTTS JIG was established.
   Accuracy : ± 0.1%

2. Extension of the range for calibration of weld testers/scopes from 10 kA to 15 kA at 50 Hz.
   Accuracy : ± 1%

3. Bilateral comparison of reference standard current transformer with PTB Germany.
   Tally of Results : Within ± 0.03%.

4. Facility established for the calibration of CT burdens at 50 Hz.
   Accuracy : ± 1%

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

This group is working for the establishment, maintenance and updating of primary and transfer standards of AC and LF voltage and current. HF and MW power and noise in the frequency range of 10 Hz to 26 GHz. This activity provides apex level calibration facilities for the above parameters to user organisations all over India.

(i) International intercomparison of multi junction thermal converters (primary std. of LF voltage) has been carried out under BIPM umbrella with 11 laboratories under euromet loop and 11 laboratories in world wide loop. 3 volt MJTC was intercompared at 1 kHz, 20 kHz, 100 kHz and 1 MHz. The intercomparison was carried out on a fully automated setup which was designed at NPL. The relative AC_DC transfer error of NPL MJTC with respect to PTB MJTC is within ± 5 PPM upto 100 kHz and ± 20 PPM at 1 MHz which indicates an excellent agreement in NPL and PTB LF voltage standards.

(ii) Automation introduced in the calibration of thermal voltage converters.

(iii) One voltage calibration tee has been fabricated based on PTB design for voltage calibration work in the 10 MHz to 1000 MHz frequency range.

(iv) Evaluation of coaxial microcalorimeter further continued and results are being summarized.

Parameter	Accuracy of Standard	Mesurement Uncertainty
LF Voltage (10 Hz-100 KHz)	2X E-06 to 1.5X E-05	±0.005% - ± 0.01%
LF Current (10 Hz-100 kHz)	do	± 0.01% - ± 0.05%
HF Voltage (1MHz - 1GHz)	1X E-04 to 5XE-03	± 0.05% - ± 5%
HF & MW Power (1 MHz - 18 GHz)	2 X 1E - 03 (effective efficiency)	± 0.5% - ± 1.5%
HF & MW Noise	1 K (ENT)	± 0.32 dB (ENR)

HF & MICROWAVE ATTENUATION AND IMPEDANCE STANDARDS

Calibration facilities were upgraded for coaxial fixed & variable attenuators in the frequency range 1-18 GHz in coaxial & waveguide systems using AF Substitution Technique & IF Substitution Technique.

For coaxial & waveguide standard mismatches coupled sliding load technique tuned relectometer technique (Xn-, X-& Ku-

band microwave frequencies) using indigenously designed & developed impedance standards e.g., Quarter wave short circuits, Precision waveguides, match terminations etc.

MAGNETIC STANDARDS

Facilities have been established for the calibration of fluxmeters using volt-second generator with an over all uncertainty better than ± 0.5%.

Search coils of different turn-areas used for the measurement of flux have been designed and fabricated. Results have shown good agreement between calculated and experimental values of turn-areas.

A multilayered one meter long standard solenoid has been designed and fabricated in NPL workshop. Preliminary measurements are in progress.

Measurements conducted for studying variations in geomagnetism during solar eclipse (24th Oct., 1995) at NPL, New Delhi. Pronounced effect on the variation of vertical component of magnetic field observed. Both the vertical component and the total magnetic field intensity remained depressed by about 250 nT.

Extension of flux density measurement range from 10000 gauss to 15000 gauss. Work has been initiated for the fabrication of hall probes of different materials in collaboration with JVS & squid group.

Helped the following groups of NPL in conducting magnetic measurements

i) JVS & Squid Group
ii) Thin Film Group
iii) Cryogenics Division

AC measurement setup for soft magnetic materials is ready for testing and calibration. NMR measuring set-up ready for evaluation. Electromagnets and power supply to be tested at Bruker co., Germany before being sent to NPL, India.

MATERIALS DEVELOPMENT

SILICON AND SILICON DEVICES

More than 35 batches of 100 mm x 100 mm size silicon solar cells were processed. The cells were fabricated using both CZ single crystal or multicrystalline silicon wafers and had screen printed silver contacts on front and back. A novel method of bringing about a substantial improvement in the I-V characteristics of the cells showing high series resistance was developed. In this method the cells are treated with NaOH and $AgNO_3$ solutions. This reduces the series resistance and increases the curve factor of the cells without any noticeable adverse effect on the contacts. The PECVD system, Vacutec model 1530S, was made functional by making it PC controlled and a number of cells were given Si_3N_4 AR coating using this system. The cells were found to have the open circuit voltage (V_{OC}) ~ 585-595mV, the short circuit current density J_{SC} ~ 27-30mA/cm², curve factor ~0.68-0.73 and efficiency ~11-13% (AM 1.5, active area).

The contribution of the depletion layer to the series resistance of the cells was estimated and a new theoretical model was developed. The model is applicable equally to fully and partially illuminated cells.

The work on 2-D diffusion modelling for VLSI process simulator was continued. The simulation of bird beak which develops during oxidation of silicon near the edge of a silicon nitride mask was carried out. The bird beak was digitised on non linear grids to calculate the interfacial fluxes of the diffusant impurities. The 2-D oxidation routine was developed and integrated with the diffusion programme.

Efforts were made to establish an active collaboration with the Solar Energy Centre, Gwal Pahari, Gurugaon (Haryana) in the field of Solar Energy Utilisation.

The porous silicon specimen which showed photoluminescence under UV excitation were studied with the help of atomic force microscopy (AFM). The nanocrystalline regions of 1-3 nm size were clearly seen. The existence of a negative differential resistance (NDR) region was found in the I-V characteristics of photoluminescent specimen. These investigations showed that there existed a possibility of quantum confinement of carriers in the nanocrystalline regions which may have been responsible for photoluminescence in these samples. Application of electric field showed a decrease in the intensity of photoluminescence. Attempt was made to explain this behaviour based on quantum confinement and resonant tunneling phenomenon.

1. High Temperature Superconducting Wires/Tapes

During 1995-96, techniques to fabricate long length silver clad monofilamentary BPSCCO tapes by the PIT method has been further refined to produce tapes and spiral coils (see photograph). Thickness was reduced first in form of wire and then the resultant wire was rolled in tape form in several reduction steps with an intermittent anneal after each step. Finally the tape was alternately rolled/pressed to reduce thickness and sintered at 800-850°C for 100-300 hrs. 5 meter long tapes single filmentary and 10 cm long multi-filamentary (6-9 filaments) tapes have been fabricated and end-to-end superconductivity at 77K has been demonstrated. The tapes showed critical current density (J_c) of ≈ 3000

A/cm² at 77K and OT. Small superconducting coils made out of these tapes show a J_c of 1000 A/cm² at 77K in self field.

2. Porous Ceramic Materials

New designs of prototypes of sponge ceramic (cordierite) particulate filters for the exhaust of a two wheeler were evolved for effective filtration using the sponge ceramics made at NPL. These were tried on two wheelers.

3. Magnetic Materials

A project to increase the silicon content of silicon steel sheet to 6 wt% Si by CVD process and optimise its magnetic properties was taken up under the sponsorship of the Tata Iron & Steel Co. (TISCO). A CVD reactor to deposit silicon from $SiCl_4$ on low silicon steel was built with diffusion anneal facility upto 1300°C. Starting from steel with 1.5 wt% Si, feasibility on increasing the silicon content to 6.5 wt% Si was established. The operational data on silicon deposition rate and its variation with substrate temperature, time, gas flow rate and $SiCl_4$ content of the gas was generated. Parameters for homogenization anneal was also optimised. The high silicon steel showed the following properties - Si - 6.0-7.5 wt%, B_s - 1.5-1.8 T, H_c - 2-4 AT/m and electrical resistivity - 90-100 μΩ-cm.

Work on fabrication of YIG (yttrium iron garnet) films formed by MOCVD process has been further extended. An overcoat of CoO on YIG thin film resulted in coercivity of > 280 kA/m, the highest value reported in literature for YIG thin films. Another interesting result obtained was low temperature in-situ MOCVD deposition of magnetic garnet phase in multilayer YIG and Co and Ce doped YIG thin films obviating a high temperature (at ≈ 900°C) anneal normally required to obtain the magnetic garnet phase. This opens up the possibility of use of low cost substrates like glass for YIG films for magnetic and magneto-optic recording.

A DST funded project to fabricate an Automatic Self Locking NMR Gaussmeter was started during the year. Several sub-systems like controller, auto range selector, digital amplitude detector and NMR resonance-to-frequency converter were fabricated.

Interface and Microstructure Devices

Significant progress has been achieved on the post deposition processing which involves annealing, $CdCl_2$ treatment, surface conditioning and formation of pseudo-ohmic contacts. As part of the industrial consultancy for EcoSolar Systems, Pune, process technology for the preparation of contacts has

Photograph showing some of the superconducting coils of different lengths, (up to 5 m) of silver clad HTSC BPSCCO tapes.

been provided. The cells fabricated at the industry have been investigated in conjunction with the NPL developed contacts and suitability of the contact technology has been established.

Development of space quality solar cells, using a high temperature thermal deposition system for CIS cells has been taken up in view of the interest shown by the department of space in space quality CIS cells. This complements the new Se vapour selenization process developed and patented to fabricate photo absorber CIS layers for solar cells. Fabrication of hetero junction using new high band gap ZnSe by Se vapour selenization is undertaken in search for a single step solar cell fabrication technology. Significant lowering of the electrical resistivity of Se vapour selenized Zn (In) Se films has been achieved by compensation of Zn vacancies formed during the deposition and selenization of the Zn precursor in a novel low pressure Zn treatment.

The design, fabrication and testing of an ion beam micro etching system for the fabrication of samples for structure analysis in electron microscopy has been undertaken for DST. The ion source has been designed and developed and employed to generate ion beams of energies upto 6 kev use in micro etching. A complete system with multiple ion beam guns and sample manipulator assembly has been designed and integrated for supply to user organizations.

Work on magnetic YIG films by MOCVD process and their characterization for applications in magneto optic storage media is in progress. In our quest for obtaining high out of plane coercivity and high magnetization in Faraday rotation, a new material, Co diffused YIG film has been developed and patented. Novel multi layer YIG/Co-YIG film has been prepared showing optimized magnetic properties without high temperature annealing as a significant step towards development of disks.

LUMINESCENT MATERIALS

Process development was done for zinc sulphide pellets of vacuum evaporation grade with a view to future sponsorship from industry. Work on powder electroluminescent panels and improved phosphors was continued.

Phosphor screens for scintillation counters for BARC were made and feasibility trials for photostimulable phosphor screens were also conducted. A project proposal submitted to DAE. The main coating unit in the DST project was received in March 96. Initial samples on development of long decay phosphors and coated tapes sponsored by DLJ have been made.

Work on installation and commissioning of ZnS and CdS preparation facility has started. This facility is for producing ZnS for in house R&D on long decay phosphor. Particle size analysis of samples from outside as well as from laboratory is continuing.

Display Devices

The following activities are being done in this group.

Liquid Crystals	. Patterns and alignment
	. dielectric studies
	. electro-optics
Photonics	. Spatial light modulators
	. optical information processing
	. optical switches
Biosensors	. Amperometric
	. Enzyme Biochemistry
	. Applications/Instrumentations
Biomolecular	. Ultra-thin films
Electronics	. Configurations
Conducting	. Physics
Polymers	. Electro-Chemistry
	. Applications
Gas Sensors	. Semiconducting Oxides
	. Polymeric
Xerography	. Imaging and Reproduction
	. Non-Destructive Testing

Electrochromics	. Solid Polymer Electrolyte . Applications
Sol-Gel Processed Materials	. Oxides . Ferroelectric . Thin film, Monoliths . Composites
Spectroscopic techniques and applications	. Instrumentation . Methodology

BIOMOLECULAR ELECTRONICS AND CONDUCTING POLYMERS

(A) Following activities have been done

(i) Electrochemical synthesis and characterisation of polycarbazoles.

(ii) Electrochemical entrapment of polyaniline in sol-gel films.

(iii) Fabrication of electrochromic displays based on polyaniline.

(iv) Immobilisation of glucose oxidase in polypyrrole and polyaniline.

(v) Prepration of langmuir-blodgett films of polyaniline.

(vi) Fabrication of glucose biosensor based on polyaniline langmuir-blodgett films.

(vii) Release of glucose biosensor developed at NPL by Pulsatum Healthcare Pvt. Ltd. Banglore for clinical trials on January 18, 1996.

Glucose Biosensors

The Glucose biosensors developed at NPL for monitoring sugar levels in blood is now being manufactured by Pulsatum Health Care Pvt. Ltd., Bangalore. The company has released a commercial model for extensive clinical trials and user reactions.

Development of solid state electrochromic devices (ECD's) for display applications.

Novel solid polymeric electrolytes based on poly vinyl butyral have been developed using different lithium salts and appropriate solvents. High ionic conductivity has been achieved as to be suitable for using them in electrochromic devices for "Smart window" applications (see figure).

1. *Dielectric investigations in ferroelectric liquid crystals.*

Extensive dielectric investigations in ferroelectric liquid crystals have been carried out in the frequency range 10 HZ-13 MHz. The

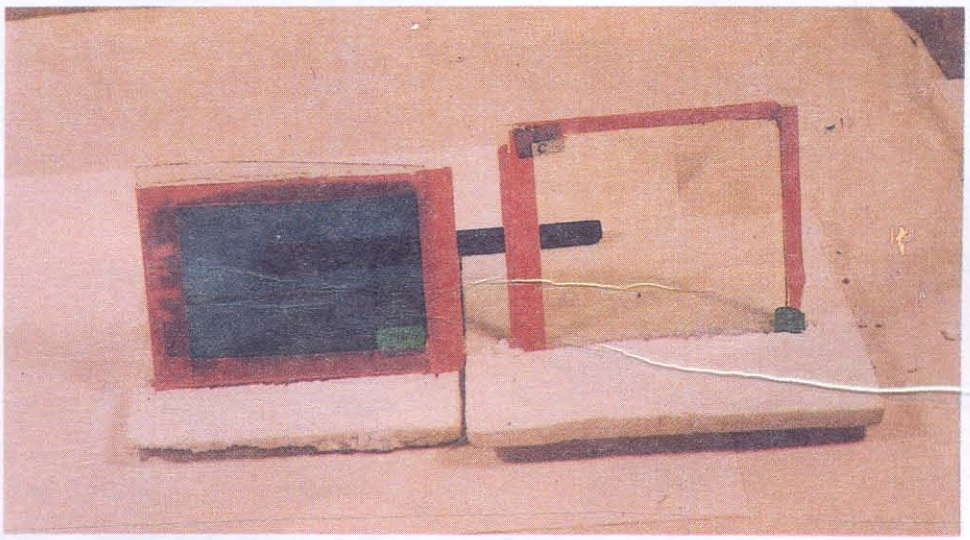
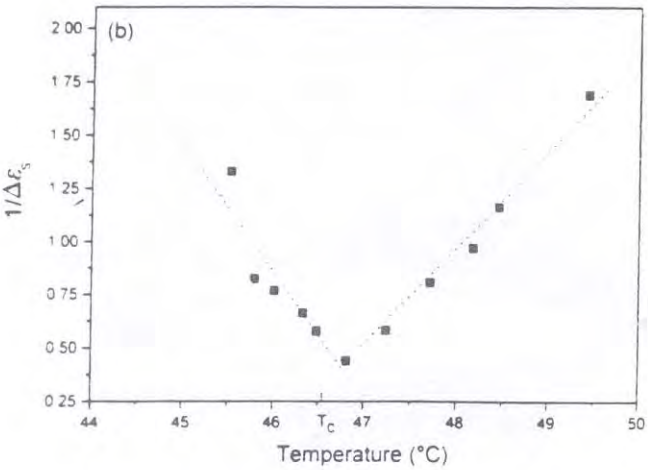
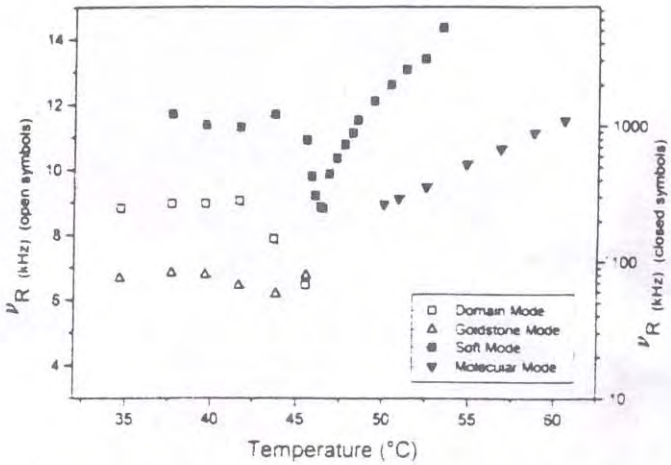


Figure illustrates an ALL SOLID STATE ECD with PVB based SPE in its coloured and bleached states



Temperature dependence of dielectric strength (Curie-Weiss plot) for the soft mode near the transition temperature



Temperature dependence of the relaxation frequencies of the different dielectric modes in Smc* and N* phases.

dielectric spectroscopy near transition temperature T_C detects Curic-Wiess behaviour as the reciprocal of dielectric strength is minimum at Tc (i.e. paraelectric phase to ferroelectric phase). This beviour (most common in solid ferroelectrics) has been observed for the first time in ferroelectric liquid crystals material, showing first order phase transition. These studies by electro-optical and dielectric relaxation method have led us to predict three collective dielectric processes namely Goldstone mode, soft mode and domain mode connected to the director reorientation in planarly aligned cells. In homeotropic alignment the molecular relaxation around the short axis of the molecule has been observed in chiral nematic phase. A new dielectric process, called surface molecular mode has also been proposed and reported in homeotropic alignment in the frequency range of 10 KHz in smectic C phase. These experimental results of surface molecular process agree with theoretical predictions.

2. Solgel synthesis and characterization of ceramic thin films. Achievements made are:-
   1. Studied dielectric properties of $SrTiO_3$ thin films.
   2. Developed thin films of SnO_2 doped with noble metals for gas sensors.
   3. Immobilization of organic molecules in silica matrix.
3. Electrical and optical properties of langmuir blodgett films Achievements made are:-
   1. Fabrication of LB films of
      Arachidic acid
      Polyaniline poly (O-Toluidine)
   2. Characterisation of the films by
      UV-visible,
      FTIR Optical Microscopy Study at elevated temperatures
4. On-line determination and systematic recording of sugar content in sugarcane juices and sugarcane solids
   1. Quantitative determination of sugar content in sugarcane liquids and sugarcane solids using IR/ATR techniques, done on synthetic mixtures

2. Software development for multi-variate calibration

5. Development of conducting polymeric filters for virus monitoring in water

Achievements made in this area are:-

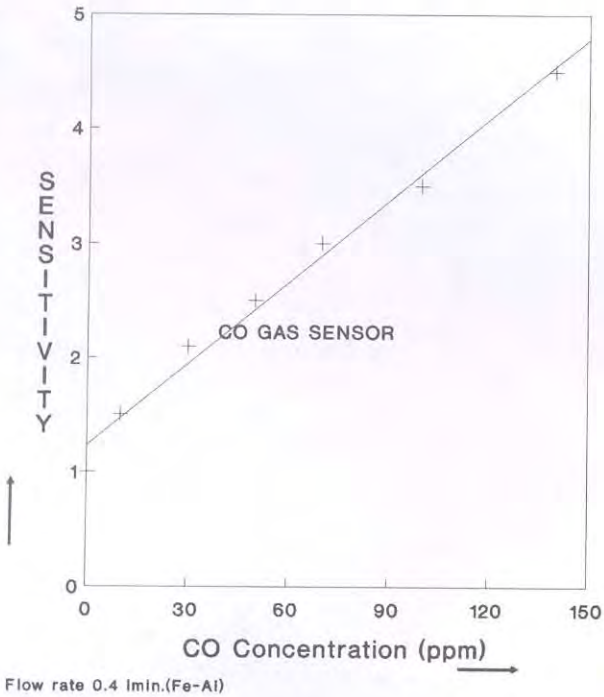
1. Polypyrrole based conducting membranes developed. Surface resistance being optimized.

2. Virus retention on the membranes examined by AIIMS. Almost 100% viruses arrested on the membranes.

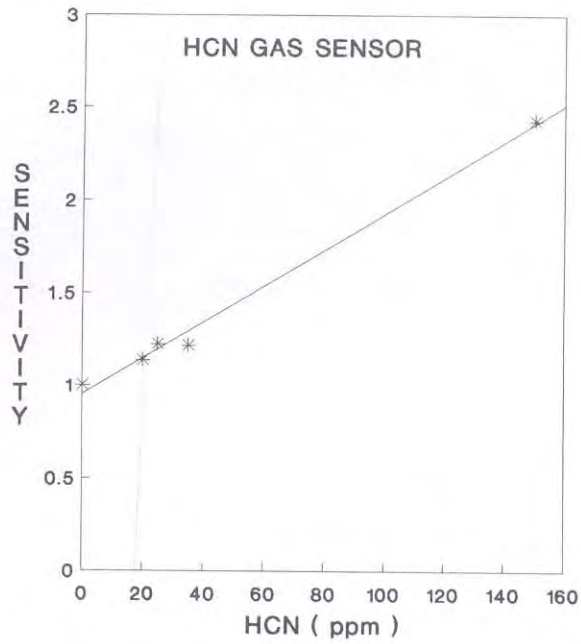
POLYMERIC GAS SENSORS

Polymeric thin film based gas sensors have been developed for monitoring of toxic and effluent gases from semiconductor industry, environment, coal mines and other industries, where a continuous and insitu monitoring is required. The main constituent of the gas sensor is the gas sensing element, which is made up of thin film of polymer. The sensitivity of this gas sensing element depends upon the amount and the type of gas absorbed by the polymer. These gas sensors have been tested for their sensitivity towards ammonia, HCl, carbon monoxide, carbon dioxide and HCN. The polymeric thin film gas sensors are operated at I.5 V and their sensitivity is excellent at room temperature. The response time of the polymeric gas sensors is 2 sec., decay time 20 sec. and recovery time is about 1 min. Polymer based mircobiological sensors have also been prepared and their sensitivity towards biological species, virus and bacteria have been studied.

Response Time = 1sec. Decay Time = 2 sec. Recovery Time = 4 sec.



Flow rate 0.4 lmin.(Fe-Al)



Operating Temperature = Room Temp.

CARBON PRODUCTS

Carbon Fibers

1. Provided consultancy to M/s. Machining Centre, Bombay for putting up 5TPA capacity carbon fiber plant
2. Provided consultancy to put up Activated Carbon Fiber Cloth Pilot Plant at HEG, Bhopal under collaborative programme.
3. Studied the stabilisation of PAN fibers under fludised bed

Composites

1. Developed carbon fiber, kevlar fiber, polyethylene fiber based composites using various matrics such as PEEK, PS and HDPE. Supplied composite test samples to DMSRDE, Kanpur for field trials. Characterisation was carried out for physical and mechanical properties, microstructure, impact strength and fracture behaviour. The above work was carried out under sponsored project from defence.
2. Preliminary experiments conducted for densification of C/C composites on Plasma Enhanced Chemical Vapour infilteration set up established last year.
3. Work initiated on the project sponsored by IFCPAR on the influence of surface energetics on the development of matrix microstructure and mechanical performance of composites.
4. Studied effect of heat treatment temperature on the development of microstructure in carbon/carbon composites. Studied the effect of Fe as catalyst for graphitisation of pitch based carbon/carbon composites.
5. Developed SiC incorporated carbon/carbon composites by sol gel technique.
6. Developed silica monoliths and doped sol gels to be used as catalyst.

Specialty Carbons

Suitable green coke was prepared from special Coal-tarpitches which was then used to produce high density - high strength isotropic graphite. A density of 1.9 g cm^{-3} and strength of more than 60 MPa were achieved. Efforts are continuing to transfer the technology to the industry. Further work is continuing to improve the propoerties of this graphite.

R and D studies were carried out on the phenol formaldehyde - synthetic graphite based carbons.

Brushes

Supplied 250 Nos. of each grade of Brushes to HAL, Nasik.

1. MGS-8 Category PR 72007
2. MGS-8 Category PR 72005

THIN FILM SYSTEMS

(i) IRDE Large Area DLC Reactor, Process Stabilised, Demonstrated and plant transferred to IRDE, Dehradun.

(ii) CEERI, Multizone Semiconductor Processing System, Plant fabricated and transferred to CEERI after trial runs.

(iii) Load Locked PECVD reactor Dept. of Electronic Science, Kurukshetra University.
- Plant fabricated

(iv) Optical Coatings :
- Designs of several types of multilayer optical coatings like broadband anti-reflection coatings and anti-glare coatings (for OLF, Dehradun) narrow-band IR filters, etc. (DST project) completed and small batch fabrication taken up for certain items.

Course of "Thin Film Optical Coatings, Applications and Marketing" conducted on 2-3 Nov., '95 at Optoelectronics Factory, Dehradun (Min. of Defence) for about 30 Defence personnel.

HIGH PRESSURE TECHNOLOGY

During the year the work on the preparation of low ordered boron nitride and its transformation to harder polymorphic forms was carried out. Amorphous boron nitride (aBN) was prepared chemically by heating a mixture of potasium borohydride and ammonium chloride above 800°C in the presence of nitrogen. The samples were characterized for the amorphousity using XRD technique. The as prepared starting material was subjected to high pressure and high temperature in the presence of a suitable catalyst solvent. The P-T region explored for the aBN-$Mg_3 B_2 N_4$ system was 20 to 70 Kb and 800 to 1800°C. The characterization of the reaction product was carried out using XRD technique and morphology of the crystals formed studied using scanning electron microscopy.

The study revealed that the amorphous boron nitride (aBN) undergoes various polymorphic transformations such as hexagonal, cubic and wurtzitic boron nitride (hBN, cBN, wBN) in the presence of a catalyst ($Mg_3 B_2 N_4$) under high P-T conditions. The crystals formed were mostly shapeless with a size range of 10 to 100 µm. However at higher pressures (65 & 70 Kb) and temperature (1500-1800°C) the cBN crystals syntheized were octahedral and tetrahedral in shape with occasional appearance of cubooctahedral variety in the size range 100 to 200 µ.

A new project entitled "The study of the pyrope-knorrongite garnet system at 50 - 100 kb and variable temperatures and its significance in the genesis of natural diamond" has been submitted to DST for funding.

METALS & ALLOYS

Work was initiated on the extrusion of light weight/high strength Metal Matrix Composites (MMCs) of Al-Li alloys reinforced with SiCp. This work was done in joint collaboration with Fraunhofer Institute, Germany. The main advantage of using Al-Li alloys is that the addition of Li increases the elastic modulus and decreases the density, thus making this material suitable for aerospace applications. Preliminary extrusion trials of (Al-Li+SiCp) MMC, using billets obtained from powder metallurgy route, were carried out at different temperatures, extrusion ratios and strain rates. The physical and mechanical characterization of these extruded MMCs gave quite encouraging results.

Exploratory work has been done on the development of Magnesium alloy square tubes to be supplied to Vikram Sarabhai Space Centre, Trivandrum, for their space programme. In the first phase, circular tubes of Magnesium alloy have been sucessfully developed employing hot extrusion process. Various extrusion parameters were optimized to obtain these circular tubes with good surface finish and concentricity (Figure). Currently work is underway for the design/fabrication of tooling such as die, mandrel, pressing discs, etc., to extrude square tubes of this light weight material.

The sponsored project on "Spray Deposition and Property Evaluation of Aluminium Matrix Composites" has been sanctioned by Aeronautical Research and Development Board. Under this project, work will be carried out on the synthesis of Metal Matrix Composites using Spray Atomization and Deposition process.

Further work was continued on the synthesis of MMCs, of Al-alloy reinforced with SiCp, using stir-casting technique. The mixing technique, for the dispersion of reinforcement in the matrix material, has considerably been improved by changing the design of the mechanical impeller.

Work was continued in the DST sponsored project on "Deformation Behaviour of Composite Materials". A number of extrusion runs, using the billets obtained from powder metallurgy route, were made to make more

(Al-alloy+SiCp) MMC tubes in order to evaluate the reproducibility of the process and further improve the mechanical properties of these extruded tubes by optimizing various processing parameters.

The existing project on the "Development of Warm Forging/Hot Extrusion of Metal Matrix Composites", which was sponsored by AR & DB, has been sucessfully completed. Under this project various process parameters were optimized for 2124 Al+SiCp (10, 15 & 20%) MMC in the form of extruded rods to obtain acceptable properties and good surface finish of the extruded product. Forged component of MMC with 15% SiCp has also been made achieving 150% upsetting.

A AIST (Japan)-CSIR (India) workshop on "Precision Forming" was organized during February 26 to March 1, 1996, to explore the possibility of joint collaboration on Precision Forging between the two countries. A joint collaborative project on "Development of Near Net Shape Components using Closed Die Forging" with Mechanical Engineering Laboratory, Japan, has been approved for a period of five years.

Magnesium-alloy circular tube for space applications.

MATERIALS CHARACTERIZATION

CHEMICAL METHODS

Provided services to users like industries, governments departments, C.S.I.R. labs and various projects of the lab viz. IRM development & electrochromic display devices. 380 samples analysed for industries and C.S.I.R. lab projects particularly polyaluminium chloride used for water purification and indelible ink for election. Indirect method was developed for NO_2, MnO_2 and boron using AAS.

NO_2 - - - ppb LEVEL (25ppb ambient)
MnO_2 NO_2 Mn^{+2} (soluble)
B - - BF Aq_2 $(Ph)_3$ NO Ag (Ph) BF --Ag:B::1:1

Methane emission from paddy fields and calculation of methane budget from Indian paddy fields has been done. Methane and CO2 from Biomass burning. Rain water and Dry deposition studies, Aerosol & Gas sample collection in the index precampaign.

INDIAN REFERENCE MATERIALS

Work on preparation of Certified Reference Materials (Indian Reference materials) of Fluoride and Nickel in high purity water was completed during the year. The stock solutions of these materials were prepared at NPL. Stability of these solutions w.r.t. container materials and storage were studied in detail and optimum conditions were worked out. Analytical evaluation of these solutions was carried out by using different techniques i.e. ICP emission spectrometry, ICP-mass spectrometry, DCP-emission Spectrometry, Atomic absorption spectrometry, uv-visible spectrometry, Ion-Chromatography and Ion selective electrode. These solutions were provided to thirteen CSIR laboratories and two public sector laboratories for measurement of concentrations of the elements at different time intervals. Measurement data obtained from these laboratories was compiled and statistically analysed. The certified values assigned of these materials are (i) Fluoride solution: 1.00 mg/litre (ppm) with standard deviation ±0.03 and random uncertainty 0.04 (ii) Nickel solution : 1.01 mg/litre (ppm) with standard deviation ±0.03 and random uncertainty 0.03. These had been formally released and are now being made available to user organizations.

To publicise the utility of Indian Reference Materials a get-together with user organisations was organised. Twenty five Scientists from different laboratories/ industries had attended the meeting.

SURFACE AREA & POROSITY

Four samples received from various industries were tested for their bet-surface area. Materials tested were:

Activated Carbon Granules	N.T.P.C. Ltd. Noida
Precipitated Silica	SRP Industries New Delhi
Catalyst for carbon monoxide	Defence Science Centre, New Delhi

Work was done with HEG-LTD under the collaborative project on the preparation of activiated carbon cloth. About 51 samples were prepared out of which 19 samples were characterized.

International Collaboration

Participated in international effort on international inter comparison of precise chemical analysis organised by National Association of Testing Authorities (NATA), Australia. In first phase of the programme

measurement of concentrations of total organic carbon (TOC) contents of four samples were carried out.

FTIR & EMISSION SPECTROSCOPY

FTIR spectroscopic characterisation of materials was done for the samples received from outside institutions and from NPL projects. This includes zeolite samples from National Aluminium Co. Ltd., Bhubneshwar. Six reports were prepared. Emission spectroscopic characterisation was done for the determination of trace elements (ppm level) for different samples from R&D projects.

Infrared high resolution FTIR spectroscopy was used to study the molecular structure of Neodymium Sulphate Octahydrate and its dehydrated crystals in the region 4000-400 cm^{-1}. Variational spectra showed the following results:

(i) Sulphate ions lie at low site symmetry.

(ii) Ions are linked through strong hydrogen bonding.

(iii) Dehydrated crystals showed
  (a) Strong bondings of sulphate ions.
  (b) Reduction in structural deformation and increase in covalent character.
  (c) Vibrations pertaining to lattice water were not observed in dehydrated crystals.

(iv) Measurements at low temperature and ambient temperature showed Jahn Teller distortion of complex ion formed by Neodymium, Sulphate ions and water molecules.

FTIR spectroscopic studies were performed in the Far infrared (500-50 cm^{-1}) region on hydrated and dehydrated crystals at various low temperature and at ambient temperature. Measurements regarding Stark effect in dehydrated crystals for bending modes of octahedra complex ion, showed very weak splittings. The Stark effect results from variable electric field of sulphate ion and water molecules around neodymium. Low temperature FIR spectra showed removal of degeneracy and enhancement of intensity for certain IR absorption bands.

The work on polysilicon solar cells was initiated by ex-scientists Sr. S.B. Manmohanan and Sri S. Parthasarthi. Elemental analysis of impurity contents is essential to correlate its effect on the spectral response and diffusion length of minority carrier and to determine solar cell process reliability. Impurity contents of metallurgical grade silicon and solar grade silicon were measured by emission and Fourier Transform Infrared spectroscopy. Spectral response and diffusion length for float zone silicon solar cell were determined and used to analyse the results of polysilicon solar cells.

Collision induced non-radiative transitions in neon plasma were studied using intra-cavity radiation field of 633 nm He-Ne laser. The transitions induced from 3s energy level to 4s and 5s were detected as variations in intensities of these spectral lines. From these measurements, the quantities governing the transitions were calculated. The results are required in a varieity of practical problems related with the transitions between excited states.

EPR SPECTROSCOPY

a) EPR spectroscopic characterization of different materials was continued. Glasses having composition

x CoO. (0.25-x) CaO. 0.75 B_2 O_3 ($0 \leq x \leq 0.25$) containing 2 mole % V_2 O_5 were investigated. The octahedral symmetry around V^{4+} ion was found to improve when CaO was replaced by CoO keeping B_2 O_3 constant similar to the results obtained earlier in CoO. BaO. B_2 O_3 glasses. These observations confirm that change in site symmetry around V^{4+} takes place only when diamagnetic modifier is replaced by paramagnetic modifier. Further no change in microstructure around V^{4+} was found on interchanging CaO and

CoO. The study of angular dependence of EPR ions in Mn^{2+} ion doped single crystals of Magnesium Bis (Hydrogen Maleate) Hexahydrate (MHMH) shows that Mn^{+} ions prefer to enter the lattice substitutionally at Mg^{2+} sites and the metal-water octahedra have orthorhombic distortion. Two differntly oriented but otherwise identical complexes of Mn^{2+} ions were found in these crystals. The higher values of ZFS parameters imply greater bonding between Mn^{2+} ion and water dipoles surrounding it. Samples received from outside and different projects of the laboratory were also characterized.

X-RAY DIFFRACTION & FLUORESCENCE

X-ray diffraction and fluorescence techniques were used for the characterization of materials of various projects of NPL, research institutes and private industries. More than 335 samples have been analysed. Assistance was provided to M/s. G Surgiwear Ltd., Shahjahanpur, M/s NALCO, Bhubaneswar, M/s. Dabur, Ghaziabad, M/s. Tanfac Industries, Madras and DPCC, Bombay regarding the crystalline phase and elemental analysis of their materials.

X-ray diffraction and fluorescence techniques were used to study the crystalline behaviour and compositional analysis in gallium rich alloys of $Ga_{2+x}\ Te_{3-x}$ compositions ($O \leq x \leq 0.2$). The gallium rich preparations upto 40.6 at % Ga crystallize on zinc blende cell with no appreciable change in lattice parameter. Beyond this two phases zinc blend $Ga_2\ Te_3$ and monoclinic GaTe were identified which revealed that 0.6 at % excess Ga could be accommodated in the lattice of $Ga_2\ Te_3$. For quantitative analysis, a calibration curve was drawn between the intensity ratio GaKα/ TeKα and Ga wt. % using GaTe, $Ga_3\ Te_4$, $Ga_2\ Te_3$ and $Ga_2\ Te$ as standard samples. The curve was found to be a straight line. The maximum relative error in determination of Ga wt.% was found to be 4.2% and the standard deviation is of the order of 0.75 in Ga. Also, CuInSeTe synthesized earlier was found to be stable after ~ 3 years. The powder x-ray diffraction patterns were indexed on a tetragonal cell with space group 142d and lattice parameters as a=5.985A° and c=11.984A°.

An ionic ferrofluid (density 1.054 gm/m³, saturation magnetisation 60 Gauss)- polymer (PVA) composite films were prepared under the influence of magnetic field and without magnetic field. XRD/SEM studies were carried out and work is in progress for their physical characteristics. Also, quantitative XRF analysis of trace and minor elements like Cu, Mn, Mo, Cr and Ni in NBS steel standard samples has been carried out using inbuilt software programmes. Minor element results are accurate within ± 2.5wt% but in trace element deviation are more.

The new soller slits with tantalum strips have been made and integrated with the goniometer. The stepper motor driver unit, comprising of two stepper motor driver PCB cards and ± 12 volts power supply have been designed and developed. The complete goniometer has been aligned and tested using CuKα radiation. X-ray diffraction patterns from (111) Si single crystal have been recorded and reproducibility of the patterns has been checked.

ELECTRON MICROSCOPY

Nanostructured films have attracted much attention these days due to their size quantisation. Therefore thin films of Zn Te deposited at temperatures of 238, 273 and 283 K by high pressure d.c. magnetron sputtering on to NaCl substrates were analyzed for their structure using transmission electron microscopy. It was found that the films had nanocrystalline structure and crystallites were more or less uniformly dispersed throughout the film. The films deposited at lower temperatures (<270K)

showed larger crystallite size with a tendency of agglomeration at few places. Films deposited at >270 K revealed nearly uniform crystallite size of 4-5 nm. The corresponding diffraction pattern indicated zinc blend structure.

The work on the specimen preparation for cross TEM investigation was carried out. For this purpose 3 mm diameter discs were cut from SiO_2/Si staked samples which were subjected to argon ion thinning having ion energies ranging between 2 to 4 kev for different span of time. The specimen thus prepared were examined by TEM. The study revealed that the thickness of the specimen was inadequate for detailed structural investigation. The work is in progress and would be continued further.

The samples of gold colloid, zinc oxide, carbon black, precipitated silica, ores of manganese etc. received from industries and outside agencies have been examined with transmission electron microscope. In addition several samples from different projects from within NPL have been characterised for structural investigation. About 270 samples have been characterized in respect of surface structure/morphology and deformation with SEM. The samples investigated had been received from M/s NACL Bhubaneswar, M/s Wadco Schleger Automotive Pvt. Ltd., New Delhi, National Art Gallery, New Delhi in addition to the samples received from within NPL. As a part of collaborative effort with other groups in NPL microstructure of ferrofluid polyvinyl alcohol composites and Pb-doped bismuth strontium calcium copper oxide samples have been studied using scanning electron microscopy.

CRYSTAL GROWTH AND CHARACTERIZATION

The five crystal X-ray diffractometer, designed and developed at NPL has been extensively used for characterization of defects in bulk crystals, thin films and interfaces. Bulk crystals of GaAs and ultra thin films of silicon-germanium have been investigated. The silicon-germanium films were prepared on 100 silicon substrates with a silicon buffer of 50 nm. The thickness of the films was ~ 40 nm. Fig. 1 shows a typical diffraction curve of a silicon crystal with SiGe film. This curve is for the interface and has a half width of ~ 25 arc sec showing that the interface has strong influence of the epitaxial film. The diffraction peak of the SiGe epitaxial film was observed at a large angular separation from the silicon peak (560 arc sec). Fig. 2 shows a diffraction curve of the film. From this experiment, the value of $\Delta d/d$ was found to be 0.0103. The composition of the film was determined as $Si_{82.4}Ge_{17.6}$. High Resolution X-ray diffraction topography examination confirmed these results.

High resolution X-ray diffractometric and topographic method was employed for evaluation of crystalline perfection of large size GaAs single crystal wafers (75 mm diameter). Experiments were performed with (400), (511) and (022) diffracting planes. Extensive diffractometric studies from different regions showed that the half width varied from 12.7 arc sec to 16.5 arc sec. It was observed that small regions of the specimen had moderate perfection. If these results are compared with those obtained with high quality GaAs crystals, it is found that this half width is larger than those (~7.2 arc sec). Stationary topographs also confirm the diffractometric results. High resolution X-ray diffraction topograph was recorded with a symmetric (511) diffracting planes to cover the entire volume of the specimen. Large variation in the X-ray intensity indicated that the level of crystalline perfection is not so high. Curvature measurements were made with (400) and (511) lattice planes. The results were broadly in agreement with those of diffractometric and topographic evaluation.

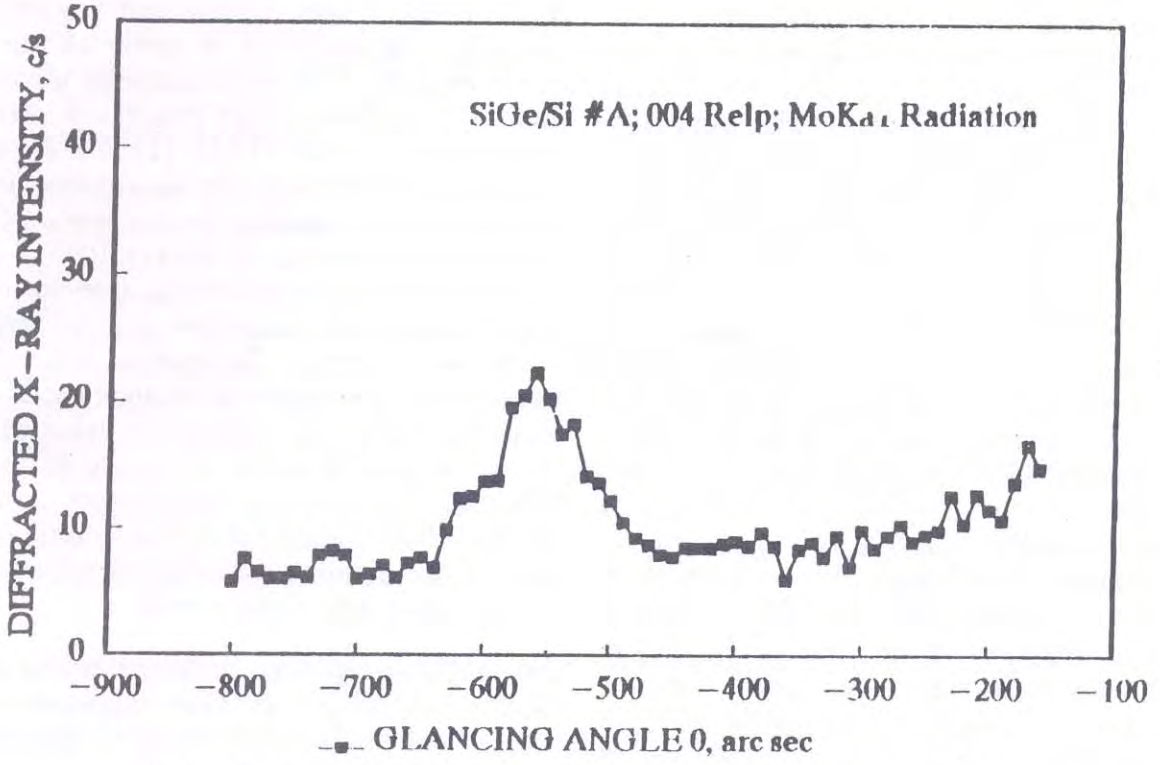


Fig. 1 : A typical diffraction curve of silicon-germanium thin epitaxial film grown on a (001) silicon single crystal.

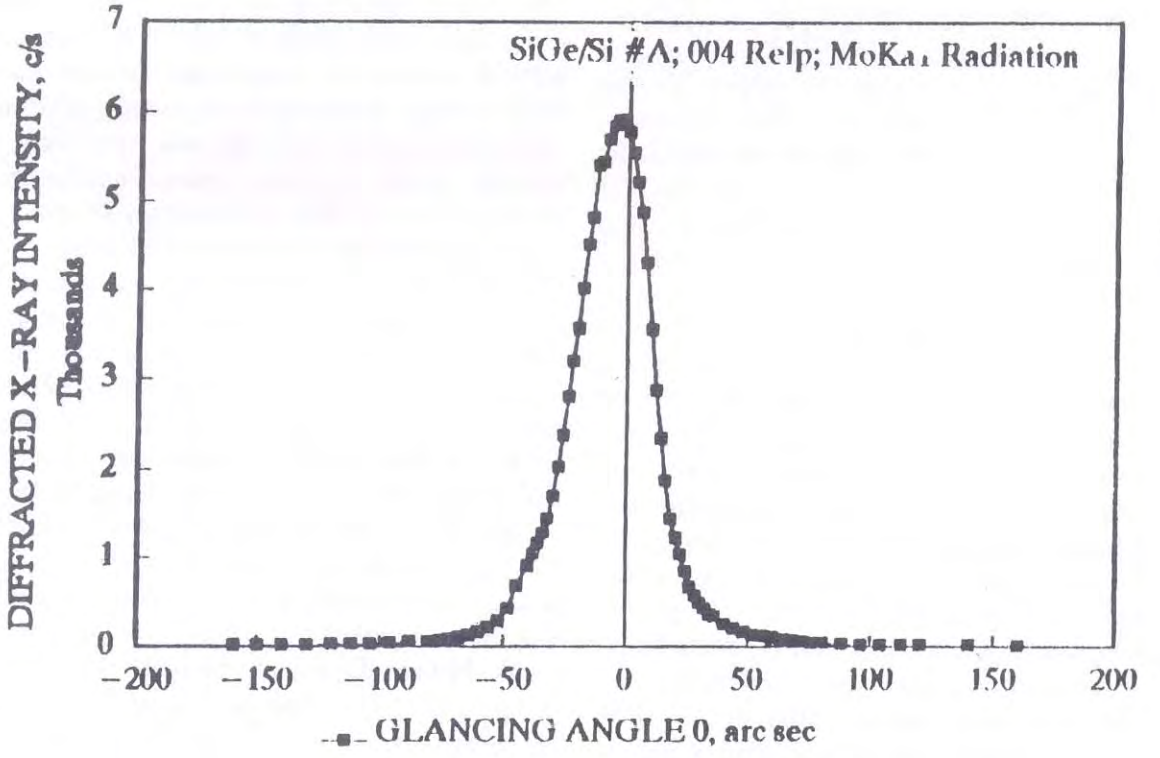


Fig. 2 : A typical diffraction curve of a (001) silicon crystal with a SiGe epitaxial film

High resolution X-ray diffractometry, absolute integrated intensity measurements, high resolution traverse topography and diffuse X-ray scattering measurements were employed to evaluate gross perfection of natural diamond crystals and study of point defects and their clusters in selected regions of crystals of varying degree of perfection. In this investigation, both five crystal X-ray diffractometer and the multi-crystal X-ray diffractometer, developed earlier in the group were employed. FTIR measurements were employed to determine whether the specimen crystals belong to type I or type II. It was found that all the specimens were of type Ia variety. From the quantitative measurements of absorption coefficient, the concentration of nitrogen was estimated as 200-800 atomic ppm in different specimens. The X-ray diffractometric evaluation showed that the perfection of crystals varied significantly from one specimen to the other. In the case of imperfect crystals, large variations in the degree of perfection from one region to the other were observed. Half width of diffraction curves recorded with (111) diffracting planes and $MoK_{\alpha 1}$ radiation were in the range : 18-500 arc sec. Absolute values of integrated intensity was also determined. Its magnitude varied in the range : 2.5×10^{-5} rad to 70×10^{-5} rad. The theoretical value of integrated intensity for highly perfect crystals was 1.2×10^{-5}. These results showed that some of the crystals were reasonably perfect. However, in our own group, some of the diamonds from famous collection of C.V. Raman were found to give sharp diffraction curve with half width of ~7 arc sec. High resolution projection topographs as well as stationary topographs revealed the presence of low angle boundaries and some dislocations. It was observed that if stationary topographs were recorded by step scanning, the specimen and covering entire volume, contrast was considerably better than that observed with projection topographs. High resolution diffuse X-ray scattering measurements were carried out around 111 reciprocal lattice point of some of the diamond crystals. The measurements were limited to the following four directions in reciprocal space : [111], $[\bar{1}\bar{1}\bar{1}]$, $[\bar{1}10]$ and $[1\bar{1}0]$. Analysis of DXS intensity distribution in reciprocal space revealed the presence of isolated vacancies and interstitials. The interstitials were presumably due to nitrogen. Clusters of vacancies and interstitials were also observed. To analyse the experimental data, a phenomenological model was used. This analysis yielded the value of size of interstitial clusters in the range 40 nm to 200 nm. The vacancy cluster sizes were 60 nm to 140 nm. In addition, the volume of the clusters and a number of defects within each cluster were also determined.

Detailed investigations on super lattice structures of $Al_xGa_{1-x}As$ on GaAs substrates had been investigated in our group by using high resolution X-ray diffractometry and topography. These investigations showed, for the first time, physical misorientation between substrates and films in addition to the usual lattice mismatch. However, it was realized that many investigators used germanium monochromator whereas we had been using silicon single crystals monochromator. For this purpose (100) germanium single crystal monochromator was prepared from a single crystal boule of germanium. Its surface was ground, lapped and polished to yield high level of crystalline perfection. Experiments were performed on superlattice structures with 10 periods each having a thickness of 1140 ± 25Å. $MoK_{\alpha 1}$ radiation obtained by diffraction from the germanium monochromator was used as the exploring beam and 400 reflection of GaAs was investigated in detail. Two satellite peaks were observed at the lower glancing angle side of the main peak. No satellite was observed on the higher angle side. The half width of all the peaks were approximately 20 arc sec. The angular separation between the main peak and the

satellites were the same as observed earlier by using $CuK_{\alpha 1}$ exploring radiation. This study has confirmed the results obtained earlier in our laboratory by using silicon monochromator crystals.

High resolution X-ray diffractometry and topography was employed to characterise expitaxial films of mercury cadmium telluride (MCT) grown on cadmium telluride substrate crystals. A double crystal X-ray diffractometer having a (111) silicon monochromator with $CuK_{\alpha 1}$ radiation was used in (+, +) setting. The half width of the diffraction curves were found to be fairly large - 85 arc sec (films) and 75 arc sec (substrate) indicating that the crystalline perfection of the film and the substrate was not of high quality.

The new interesting results regarding substantial loss in absorption of X-rays at and near Laue diffraction maxima has been discovered in this group with diamond specimen crystals. It has been decided to investigate this effect in other crystals. For this purpose, a new three crystal X-ray diffractometer has been set up with two silicon monochromators together with a long collimator providing a highly monochromated $MoK_{\alpha 1}$ radiation. Using this system, total transmitted X-ray intensity, a sum of three beams namely the normal diffracted beam, the forward diffracted beam and the residual direct beam is measured directly with one detector as it function on glancing angle around Laue diffraction maxima. This experiment directly yields variations in absorption of X-rays as a function of angle around the diffraction maxima. Experiments have already been performed with silicon single crystals and the work on other crystals will be taken up after this.

Efforts to grow large size crystals of lithium niobate were continued. For this purpose, a 150 mm dia RF coil was fabricated indigenously and conditions of post-growth annealing were optimised. This will enable growth of crystals with large diameters

Characterization of GaAs and CdTe bulk crystals and thin films of mercury cadmium telluride have been carried out under a consultancy agreement with SSPL, Delhi.

LOW TEMPERATURE PHYSICS

HIGH TEMPERATURE SUPERCONDUCTIVITY

(i) Tc Degradation in Y-124 Doped with Fe & Ni

Systematic measurements of the resistivity of the polycrystalline samples of Y-124 system with Fe and Ni substitution have been carried out. The resistivity behaviour depends strongly on the dopant concentration and for Fe 6 at% sample there is no metallic behaviour in the resistivity, but for T exceeding 50K the resistivity decreases very slowly with temperature. The resistivity behaviour of Fe 10% and Ni 5% samples is analysed and it is found that the variable range hopping process may occur in these samples below 30K. While the Ni 5% sample is found to show signs of the nearest neighbour hopping process of conductivity above 150K, the Fe 10% sample does not show such behaviour upto 300 K. It seems that localization may not be the reason of the Tc depression in these doped samples. We have examined the possibility of Tc degradation due to carrier-impurity potential scattering by using a single crystal analog of the polycrystalline sample and have found that this may not be a reasonable source of Tc degradation of Ni and Fe doped 1-2-4 samples.

(ii) Thermoelectric Power of Bi-2212 System

The thermoelectric power of optimised (Tc of 90K) and oxygenated (Tc of about 70K) samples of Bi-2212 system has been measured and analysed using a two band model. The analysis shows that intercalation

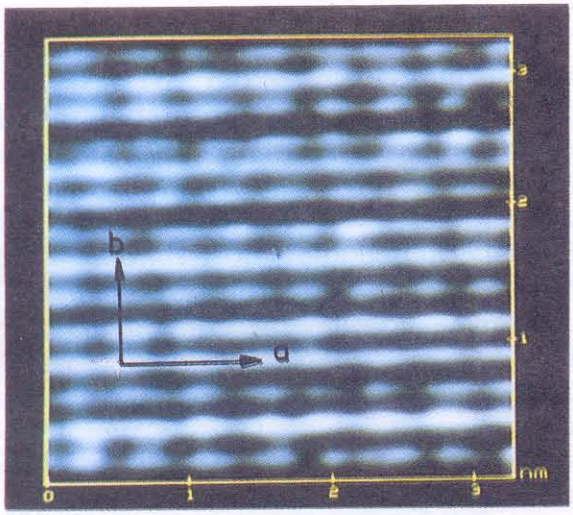


Figure shows STM image of Ba-O plane of YBCO unitcell

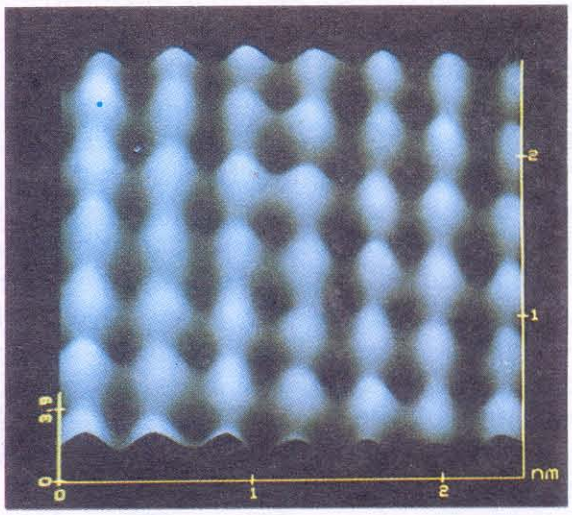


Figure shows STM image of Cu-O chains in YBCO unitcell

of oxygen in Bi-O layers plays an important role in determining the thermopower of the system. Scanning tunnelling microscopy of optimized and oxygenated samples provide qualitative support to the model.

(iii) Low Field A.C. Susceptibility Studies of Flux Creep & Jc :

Low field a.c. susceptibility studies of pure Er-123 and substituted samples with Fe, Co, Ni and Ga as dopants have been carried out in the frequency range up to 1 kHz. The activation energy for flux creep in the case of doped samples is considerably lower than that for the undoped sample. The analysis of the data within the framework of Muller's model shows that the intergrain critical current density gets considerably supressed by dopants. Using STS junction model it is argued that this can be attributed to the reduction in the Fermi energy of the system due to the localization caused by the presence of dopant atoms.

The studies of the above samples have been made at various a.c. field amplitudes. Analysis of the temperature dependence of susceptibility at these fields has been done using Kim's model of critical state. The dopants are found to lower the temperature dependent intergranular critical current density of Er-123 system at different rates; Fe having the maximum degradation effect while Ni, the least. The results are in full accord with those given in the above para and the observed decrease in Jc of the doped samples is the result of reduction in the zero temperature pinning potential brought about by the metallic dopants.

(iv) Effect of Fe Substitution on Magnetism and Superconductivity of YBCO System with Variable Oxygen content

Magnetic and superconducting behaviours of fully oxygenated and oxygen-deficient YBCO samples containing doped Fe atoms have been studied for different doping levels. With increasing Fe content, orthorhombic distortion of fully oxygenated samples decreases while it recovers partly for oxygen-deficient samples. In the normal state the effective paramagnetic moment per Fe is found to get lowered with oxygen depletion. Tc depression with Fe substitution is altered with oxygen content and the magnetic moment of Fe does not seem to be the prime cause of Tc depression which could be due to hole filling and direct supression of pairing interaction.

(v) Scanning Tunnelling Microscopic Studies of Fullerene C-60 & its Intercalated Cuprate Superconductors

Various types of anomalies in the carbon cage morphology of C-60 molecules are described and unusual situations, such as merging of two buckyballs, theoretically envisaged previously by other authors, have been experimentally corroborated using STM. The samples prepared at the Institute of Molecular Science, Japan where C-60 molecules were intercalated in Bi-O layers of Bi-2212 cuprates were also investigated and the intercalated such molecules have been experimentally detected by high resolution STM technique. Tc of the intercalated samples is briefly discussed.

(vi) Nanostructure Morphology of Atomically Resolved Chains and Planes of YBCO Single Crystals Grown with Different Additives: (With Clarendon Laboratory)

Bulk single crystals of superconducting YBCO grown with different additives, eg., barium fluoride, boron oxide, bismuth oxide have been investigated to gain insight into the problem of combating Tc degradation due to aluminium contamination from crucible material. The crystals have been subjected to high resolution imaging of chains and plaines using STM, while the changes in the conduction spectra of chains due to Al con-

tamination were studied by STS technique. The contamination of Cu-O chains is corroborated by chains becoming quasi insulating due to substitutional disorder. Further support is provided by increase in the roughness parameter on nano scale of chains with Al-adulteration. The role of different additives is discussed and the observed Tc variation is linked with the relative changes in adulteration and disordering of Cu-O chains. The results are in general accord with the role of interlayer coupling between Cu-O planes and other effects that are known to control Tc of layered cuprates.

(vii) SIM Studies of other Materials and Collaboration

With the Display Group of NPL, SIM studies were extended to study liquid crystal samples. Also with I.I.T. (Kanpur), Kumoun University and North Carolina State University, U.S.A., SIM investigation was carried out on DLC films. Similarly, AFM studies were carried out on ferroelectric samples prepared at the Metallurgy Department of B.H.U.

Several samples prepared at different universities were characterised for superconductivity as part of UGC program.

High Homogeneity superconducting Magnet for 100 MHzNMR System

A 2.35 T superconducting magnet with axial and radial shim coils tested earlier separately was integrated with the long hold liquid helium dewar after cutting open the dewar. The entire operation of leak detection, liquid nitrogen testing and finally liquid helium testing was carried out satisfactorily. The magnet was energized and put in persistent mode for long periods at a field level of 2.6T. The stability monitored on NMR Gaussmeter was 0.3 ppm/hr. The boiling rate of helium under equilibrium situation was 1.35 litres/day as per our design calculation and a targetted refil time of 90 days.

Consultancy on the Development of a Test Rig for Cryogenic Valve

Consultancy agreement with a leading Indian Valve manufacturing unit was under negotiation during the year. NPL will provide consultancy for the development of test facilities for cryogenics valves as per BS 6364-1984.

Basic Studies on High Tc Superconductors

Last year we showed that substitution of Hg (O) in place of Ba in the Y-Ba-Cu-O system leads to a well oxygenated Y_1 Ba_2 Cu_3 O_{7-X} compound. We continued these studies further and established that HgO addition (1 wt%) is good enough to synthesize Y_1 Ba_2 Cu_3 O_{7-Y} in ambient is found to have a very sharp 91K Tc and a very uniform oxygen stoichiometry within the bulk of the material. We feel it is a break through in the preparation technique.

Most interesting thing is that HgO dissociates into Hg-metal and highly reactive atomic oxygen. The compound formation is so stable that the material does not loose oxygen on repeated heating in sharp contrast to the coventional technique of preparing YBCO in flowing oxygen.

The technique has now been used successfully for synthesizing other 90K superconductors viz. Dy_{123}, Eu_{123} and Gd_{123}.

In the B(P) SCCO system we substituted vanadium in place of Sr and Cu and found that a small concentration of V (0.05) leads to an increase in Tc whereas larger concentration bring down Tc. The results have been interpreted in terms of the optmizing hole concentration through oxygen balance as the pentavalent V substitutes at the divalent sites and takes care of the excess oxygen residing in the Bi-O layers. Excess V leads to lattice disorder and brings down Tc.

CONDENSED MATTER

An efficient variational procedure has been worked out for calculating the ground state properties of the periodic Anderson model. Within a one-site approximation the ground state energy is found to be identical to that obtained by the Gutzwiller approach. The two-site correlations lead to lower ground state energy.

THEORETICAL STUDIES

The $(T_{1u} + T_{1g}) \otimes (\varepsilon_g + \tau_{2g} + \tau_{1u})$ vibronic problem of C_{60}^-, both in isolation and in the presence of the surrounding alkali ion ligands, is analysed. The analysis fully explains the experimental ESR results, which show a broad signal with a narrow spike becoming anisotropic at liquid helium temperature.

CRYOGENICS SYSTEMS

A project on the development of suitable hermetically sealed (two) glass receptacles for the long term preservation of the original manuscript of the Constitution of India, in collaboration with the Getty Conservation Institute USA, has been completed. In this connection a formal handing over ceremony was held on 27th October, 1995 at the Parliament House Annexe where Director NPL alongwith Director GCI, USA have handed over the total system to the Parliament Library officials. The measurement of the oxygen leak rate of these display cases confirms the very high quality of receptacles. Total system is now installed at the Parliament House and the readings of the presence of oxygen and humidity inside the display cases are being monitored periodically.

Liquid nitrogen based cryo-surgical probe system has been designed and fabricated during this period. The liquid nitrogen transfer system for this unit has been assembled and tested. Preliminary studies of temperature profile measurements with this unit on goat liver pieces have also been done.

Cryogenic heat pipe design studies have been done during the year 1995-96. Design calculations for optimisation of Cryogenic heat pipe and fabrication of a proto-type has been completed. Detailed tests on the performance are being pursued.

A DST funded project on the development of special icelined refrigerators for the long term storage of life saving vaccines has been completed during this year. Two refrigerators with capacity of 125 litres and 275 litres have been fabricated. The measurement of holdover period in one of the units indicates that it can hold the vaccines safely for a period of more than 70 hours in the absence of power supply once it has stabilised and attained the assigned temperatures. These refrigerators find use in primary health centres in Indian villages.

Under another DST funded project on cryosurgical system for ENT, a proto-type unit has been designed and developed. This unit has been handed over to an ENT surgeon at Safdarjang Hospital for its evaluation in the destruction of malignant tumours

We hava a DST project in collaboration with BHU on the development of module hydrid air-conditioner. In this project we have developed an improved version of sequentia timer for actuation of solenoid valves.

The design of a 10 litre capacity Lithiur Bromide - Water based vapour absorptio system (water cooler) has been completec The fabrication and assembly of such an un is under progress.

RADIO & ATMOSPHERIC SCIENCES

1. GLOBAL CHANGE

Global warming and changing Ionosphere

A cooling of 50 k in the thermosphere, predicted due to doubling of CO_2, is expected to produce some permanent changes in the ionospheric F2 region. We have examined 32 years of F2 layer critical frequency (foF2) data for three ionospheric stations namely Boulder, Washington D.C. and Moscow in this connection. No significant longterm changes in foF2 could be identified. This is not a surprising result because CO_2 has increased only by about 15% during that period. Even a doubling of CO_2 would result in a small change in the F2 layer electron density. We conclude that no detectable permanent change has yet occurred in the F2 layer during the last thirty years.

Data Center on Global change

Data Center on Global change and other Atmospheric and Space science research areas has been initiated as a component of the NPL's Center on Global Change for use by Indian scientific community as well as for the use under the various international networks for global change studies. Apart from middle atmospheric and space science data, it is also a major storehouse for data useful for the preparation and updating of the GHG inventory of the Indian region.

Estimation of CH_4

Revised estimates of CH_4 emission from paddy fields, livestock population, agricultural residues and coal mines, CO_2 emission from coal, oil, petroleum, industrial sectors and forestry/land use change have been prepared under a multi-institutional effort coordinated by NPL's Center on Global Change.

Solar Infrared Spectroradiometer

IR solar absorption spectra for the years 1992-93 and 1994-96 have been analysed to determine integrated columns of CO_2 and methane to study their seasonal dependence and their impact on global warming. It has been found that CO_2 and methane exhibit large seasonal variation.

Aerosol optical depth calculated during Solar Eclipse of 24th October, 1995 at NPL, New Delhi shows that aerosol optical depth increases during the maximum obscuration of solar eclipse.

Solar UV-B Radiation and Aerosol Measurements

In addition to normal spectral measurements of Solar UV-B radiations, a new feature of measurements for these radiations through UV-B Biometer instruments, which measures the total UV-B energy in the UV-B band in the form of Minimum Erythemal dose which are directly relevant to biological applications, was introduced. The data was collected throughout the year and was found that the Minimum Erythemal dose was three times more during the summer months compared to dose during the winter months.

The Spectral and Minimum Erythemal Dose measurements of UV-B radiation were carried out during the solar eclipse period (Oct. 24, 1995) both at New Delhi and Neem Ka Thana (Rajasthan).

The observations of solar radiation measurements in visible and near Infrared region related to atmospheric aerosol optical depth

was analysed in relation to vehiclular traffic pollution conditions over Delhi. It was found that under certain meteorological conditions the aerosol optical depth was found to be related very strongly with the vehicular traffic pollution conditions.

Infra-Red Sun Photometer

The IR Sun photometer has been used to study the absorption spectrum of the Earth's atmosphere. In addition to regular observations, special observations were taken during total solar eclipse of October 24, 1995 at Neem Ka Thana, where drastic change in the IR solar radiation at all wavelengths region has been observed during the eclipse. It was found that water vapour was reduced during the solar eclipse compared to the control days. The humidity increased while temperature decreased during the eclipse.

Stratosphere-Troposphere Exchange of Trace Species

SAGE II observations of water vapor profiles at mid latitudes (40-60 deg N and S) have been analysed for the period December, 1986 to July 1987. Many profiles were identified as having alternate maxima and minima very similar to the ones observed in water vapor profiles in the tropical latitudes. The average altitude of the characteristic maximum in the profiles shows an upward movement with time which seems to be faster in the northern latitudes than at the southern latitudes. This analysis may indicate that contrary to conventional wisdom, entry of air into the stratosphere does take place even at mid latitudes although in a sporadic manner. Further analysis is being carried out to ascertain this interpretation.

MST Radar

In continuation with the experiment performed during July/August 1994 to study E-region irregularities, the radar was operated on 6-7 February to observe any seasonal changes in these irregularities. More experiments will be performed in summer and winter of 1996 for this purpose. An experiment was performed during January 30 to February 4, 1996 to study the characteristics of Inertia Gravity Waves.

Planetary Atmospheres

From the Pioneer Venus measurements, it was found that total EUV flux changed by about 60% during the solar cycle 21 and by about 100% in the solar cycle 22. This flux was also compared with other solar activity indicators like F10.7, Lyman-alpha and solar magnetic field. It was found that while the daily values of Elpe were highly correlated with F10.7 (correlation coefficient 0.87), there was a large scatter in Elpe for any value of this earth based index. A comparison of Elpe with SME and UARS SOLASTICE Lyman-alpha measurements taken during the same period showed that Elpe tracked Lyman-alpha quite faithfully, with a correlation coefficient of 0.93. Comparison of Elpe with solar magnetic field and total solar irradiance showed good correlation with these indices.

The ASPERA (automatic space plasma experiment with a rotating analyser) instrument aboard the Russian spacecraft Phobos 2 had detected a large outflow of molecular ions (possible 02+) from the Martian environment. This molecular outflow results from horizontal transport of O2+ ions from the dayside. It was demonstrated that the in-situ profiles of O2+ ions as observed by the Viking 1 and 2 landers at Mars are eroded by the solar wind interaction down to an altitude of about 150-160 km. The profiles are considerably depleted compared with the corresponding diffusive equilibrium profiles. The difference between the diffusive equilibrium and the observed profile is the likely amount of O2+ ions which flow over to the nightside, a part of which would escape the gravity of the planet. However the estimated escape rate by about an order of magnitude and that of the molecular ions by

1 to 2 orders of magnitude. This suggests that there is possibly a missing component in the observed molecular ion outflow from Mars.

2. ANTARCTIC STUDIES

NPL deputed a team of three scientists who conducted experiments related to UV-B, Planetary Boundary Layer over the icy continent. The mm-wave Ozone radiospectrometer was operated at the Indian station, Maitri at Antarctica throughout the year. Its data is being analysed.

A PC based gyrostabilised shipborne monostatic acoustic sounder was designed and developed and was deployed onboard the ship MS Brinknes. The system was operated in Antarctica. This is the first ever development in India and for the first time two closely separated sodars have been operated in Antarctica. The indigenous development of shipborne acoustic sounder makes India as one of the six nations to have this technology.

The atmospheric turbidity due to suspended particulate matter can be obtained from the spectral measurement of direct solar radiation. 'Eko' Japan make four wavelength sunphotometer working at 368nm, 500 nm, 675nm and 778 nm was used on all sunny days in Antarctica during the year. Analysed data show that values of extinction coefficients found during 1995 are quite small compared to 1992 values but are at par with 1987 values, indicating thereby the existence of a loaded atmosphere during 1992.

UV-B Biometer was taken for the first time to Antarctica and the observation were recorded in route and on continent for whole year. The data has great practical importance as it provide day to day guidance to the expedition members for precaution against UV-B radiations. Analysing of data shows total irradiance increases as the sun's elevation increases. The presence of ozone hole can be noticed in the form of erythemal dose.

Spectral global measurements were undertaken with the UV-B Photometer at wavelength 280nm, 290nm, 300nm and 310nm. The data is being analysed.

3. RADIO COMMUNICATION

HF Propagation during Total Solar Eclipse of 24 Oct. 1995

Several shortwave broadcast transmissions of All India Radio with their paths in the near-totality, were monitored during the Total Solar Eclipse of 24 Oct. 1995 to study the effects of eclipse on HF radio signals. The study of D-region absorption, from the HF field strength measurements, conducted during the present solar event indicated that the increase in signal strength observed during the maximum obscuration period is not compatible with the predicted values suggesting that the latest ITU-R formula underestimates the ionospheric absorption particularly for long path circuits. This important result has relevance in planning of high reliability ionospheric radio systems.

Ionospheric Scintillations

A computer software has been developed which calculates the diffraction pattern produced on the ground for a plane radio wave traversing through elongated plasma irregularities. Multifrequency scintillation patterns have been computed for a given set of irregularities by placing them at two different heights namely 250 km and 400 km. The present study shows that amplitude scintillations, (upto 4 GHz frequencies) can be caused by a number of discrete but dense irregularities at frequencies upto 4 GHz.

Mobile Radiowave Propagation

Studies on 'mobile' radiowave propagation have been initiated for the first time ever in India during this year. These studies have

application potential in personal communication systems. Measurements were conducted at VHF and UHF in different environmental zones in the southern India over varying distances for various base station antenna heights. The data is being analysed.

Interference Predictions in VHF & UHF

A detailed analysis of interfering signals at different frequencies in VHF and UHF bands in India has indicated that the ITU-R interference predictions is not suitable for tropical conditions where abnormal propagation conditions prevail for large time percentages. A new prediction technique taking into account all the propagation mechanisms is being developed for India.

Studies on Rain Attenuation

Information on rain height is an important parameter for deducing rain attenuation which is a major contributing factor accounting for link outages in earth-space paths (satellite communication). Rain height information from several tropical stations including north-east region of India have been obtained for assessing the rain attenuation.

The design and development of the front end of the microwave radiometers in the portable commercial mode at 9.6 and 11 GHz has been completed with a perfection in an absolute calibration mechanism. Also, completed the fabrication of an additional microwave receiver on the PC boards using CAD software. This included 60 MHz pre and I.F. amplifier with a detector, low noise amplifier and a phase sensitive detector. A set of attenuation values using Microwave Radiometric measurements at 19.4 GHz were evolved for clear weather, cloudy and rainy conditions which can be used by those planning for reliable communication systems in the microwave/mm wave regions.

Troposcatter Link Performance

A special study undertaken to assess the performance of a troposcatter link operating in the desert region showed the link to suffer total fade out during 1800-2200 hrs local time for the month of March, April and May. The refractivity gradients deduced from radio sonde and slow rising balloon measurements are found to be low. Based on this information remedial measures like changing the antenna height and increasing the scattering volume were suggested.

Short-term Forecasting and Consultancy Services

RWC (New Delhi) continued to provide short term forecasts on solar-geophysical conditions to various users in India during this year. Special forecasts were issued during the total solar eclipse event of 24 October 1995 to aid the scientific community in the planning of their experiments. RWC also continued to cater to the needs of ISRO by providing daily predictions on solar and magnetic indices.

4. IN-SITU SPACE OBSERVATIONS

The Retarding Potential Analyser (RPA) Aeronomy experiment aboard Indian satellite SROSS-C2 completed almost 2 years of successful operation in the orbit. During this period ionospheric data over the Indian region was recorded for more than 1400 orbits from the RPA payload. Limited data was processed to retrieve F-region plasma parameters of total ion density distribution, ion & electron temperatures and composition of heavier (O^+ & O_2^+) and lighter ions (H^+ & He^+) over the Indian region in the altitude range of 430 to 630 km. The diurnal variation of upper transition height, where the concentration of lighter & heavier ions is equal, was derived from the two months of data when the satellite was in a higher altitude orbit of 930 x 430 km. Transition height showed a minimum around 500 km before sunrise and increased gradually to 900 km around 1400 hrs.

The data processing and analysis software were upgraded. A new PC based software was developed providing complete automation for non-linear curve fitting for 6 unknown parameters for Ion RPA data reduction. This software removed subjective errors in data reduction which were very serious in the then existing software. Since the amount of data collected is very large and more data is likely to be collected during remaining period of mission life, plans are made to involve different universities and institutions in data analysis task.

5. RADIO & SPACE PHYSICS

Total Electron Content and Scintillation Measurements

Total Electron Content (TEC) measurements have been restarted using Global Positioning System (GPS) signals. A codeless dual frequency GPS receiver measures differential group delay on signals at 1227.60 and 1575.40 MHz which, in turn, is used to derive TEC. Using this receiver useful data have been collected during the total solar eclipse of Oct. 24, 1995. Analysis of this data shows the effect of the eclipse clearly on TEC observed along the line of sight of the satellites 6 and 26 which were near the line of totality. A decrease of up to 9 units of TEC has been observed (1 tec unit = 10^{16} el/m^2). A morphological study of Traveling Ionospheric Disturbances (TIDs) observed at Hyderabad shows that their occurrence is more in winter than in summer and more during day as compared to night time. Comparison of Faraday rotation (FR) data observed at Delhi with FR computed from option II of the International Reference Ionosphere (IRI) shows that both during low and high solar activity IRI model overestimates. An analysis of scintillation data observed at Delhi shows that the effect of magnetic storms on the occurrence of scintillations is local time dependent on the recovery phase commencement of the storm at the observing station. Analysis of Fleetsat VHF (244MHz) scintillations recorded at Bangalore, Hyderabad and Delhi during AICPITS campaign show that scintillations at Bangalore bear a strong equatorial control and at Delhi show strong (evening) equatorial anomaly influence. A station like Hyderabad, though not so close to the equator, more or less follows Bangalore. The scintillation fading rates derived from autocorrelation confirm that the duration of the fades are comparable at Bangalore and Hyderabad, being in the range of 1.5 to 5 seconds, while it is of the order of 0.2 to 2.5 seconds at Delhi. The cumulative amplitude distribution more or less follows the Nagakami-m distribution for $m>1.0$. It is seen to approach the limiting case of Rayleigh distribution for $m = 1.0$.

IRI : Inputs for Improvement

In the IRI model foF2 'saturates' when R12 - the 12 months running mean solar sunspot number exceeds 150. This is a surprising result, since with increase in sunspot number, solar EUV flux should increase, which should enhance the ion production rate. Consequently, foF2 should increase. To examine this discrepancy, ionospharic data from two Indian stations, namely Kodaikanal and Ahmedabad for solar cycles 19, 20 and 21 was analysed. It was found that foF2 did increase with solar activity, though the increase was faster at lower levels and slower at higher levels. From a 2nd degree polynomial fit to the R12-foF2 relationship for these stations, it was found that foF2 generally saturated for R12 above 150.

The size and shape of valley region between E and F layers was studied for nighttime conditions by using high resolution electron density profiles measured by the incoherent scatter radar at Arecibo. By combining the earlier day--time model, a complete model for the diurnal variation of the E-F valley parameters was constructed. Comparison

with IRI-90 indicated significant differences between the two models.

VHF Propagation Mechanisms

Contour diagrams over India for percentage occurrence of sporadic-E (foEs> 5MHz) and the gradient of cumulative distribution of Es drawn from already existing data. Point to point propagation can be predicted from under various conditions. Spread-F occurrence have been compared for high and low activity periods for Indian stations. There is an increase in the premidnight spread-F occurrence with increasing solar activity while reverse is true after midnight. This is similar to range spread-F frequency spread-F respectively.

TECHNICAL INFRASTRUCTURE

LIBRARY

A sum of Rs 66.10 lakh was spent towards enriching the library collection in physics and related areas in sciences, acquiring a total of 323 books, and subscribing 189 journals. Usually the major share of acquisitions budget goes into journal subscriptions. The rise in journals subscriptions registered this year was high as 24 per cent, and it neutralised whatever rise the library got in its acquisitions budget.

The CD-ROM databases which the library subscribed this year are: INSPEC, Current Contents on Disk - Physical, chemical, and earth sciences (with abstracts), Current Contents on Disk-engineering, technology, and applied sciences, Materials Science Citation Index.

The Library used these databases extensively for rendering information services especially to its external customers from universities, and industry. It has designed a set of package services especially for the benefit of its external customers. Christened as ACLIPS, this package service is gaining acceptance with the customers. The library also used these databases for offering services to scientists within the Laboratory. The services offered were : Selective Dissemination of Information (SDI) service, bibliography service, literature search, current contents of journals. In addition, the library also provided photocopy service. It compiled 17 bibliographies on demand, conducted 84 literature searches downloading as many as 21528 references from CD databases. In its photocopying service the library provided 1,14,082 pages.

The library used its network linkages with DELNET for resource sharing, document access, and e-mail facility.

The Library got a research project sponsored by NISSAT on mapping on science using INSPEC - Physics database.

CENTRAL COMPUTER FACILITY

The computing facilities at NPL based on the HP 9000/735 workstation were upgraded with the addition of a color inkjet printer and scanner and 2GB of hard disk space. Email facilities were upgraded with a dial-up connection to NIC. Many graphics and other application packages were installed for general use.

Development of software for image enhancement and processing was continued. More functions and filters were added and tested. Consultancy services for upgrading computing facilities were provided to the Institute of Hotel Management and Catering, New Delhi.

Computer simulations on dynamics of vortices in two-dimensional Josephson junction arrays were continued. In particular ballistic motion of vortices and vortex-vortex interactions were studied. Nucleation and pinning of vortices, and critical currents of arrays with defects were also examined. Similarities with hydrodynamics were explored. These and other previous studies were presented in an invited lecture and posters at the International Centre for Theoretical Physics, Trieste, Italy.

GLASS WORKSHOP

This unit has continued activities in the field of Scientific Glass Instrumentation to design and development, fabrication and reparing of Scientific Corning Glass and Quartz Glass

Apparatus & Equipments for the uses within our own Laboratory and our sister Laboratories as well as for outside Institutions, Industries, R&D Organisations. During the year 259 Internal Jobs were undertaken of various division/projects of our own laboratory.

The following are the representative organisations/Institutions benefited by the work carried out for use in their Research & Development works.

(i) M/s. S.J.C.T. Ltd. Hoshiarpur (Pb.)

(ii) M/s. Pilani Electronics Ltd. Sangrur (Pb)

(iii) Division of Mycology, IARI, New Delhi.

(iv) M/s. Crompton Greaves Ltd. Nasik.

(v) Indian Association for the cultivation of Sciences, Jadavpur-Calcutta.

(vi) Bharat Heavy Electricals Ltd. Hardwar (U.P.)

(vii) Sardar Patel University, Vallabh Vidyanagar (Gujrat)

(viii) Directorate of Wheat Research-Karnal.

(ix) Saha Institute of Nuclear Physics-Calcutta.

(x) Institute of Physics - Bhubaneshwar.

(xi) Birla Institute of Scientific Research-Jaipur.

INSTRUMENTATION

Cancer Hyperthermia System

A high power ultrasonic transducer by using 1 MHz, 25mm diameter discs of PZT-4 (lead zirconate titante) has been developed. Different lens materials, both solids and liquids, have been developed for tumour therapy. As reported earlier, among the metals, aluminium, steel, and bronze were selected for making the lenses while among the plastics, polyethylene and perspex have been found to be the best. Liquid gylcerine lenses have also been used. Intensity in the gaussian beam of focussed ultrasound transducer has been studied and a thermal model for intensity distribution has been developed.

Transducers and Sensors

Special piezoelectric transducers and sensors were made for low power diagnostic (0.5 to 12 MHz) and high power (0.5 to 1 MHz) therapeutic applications. The transducer systems were optimized for use in precision scientific measurements and particularly in standards. Focussing is important to focus the ultrasound beam at a particular focal lobe, to get higher intensity for lithotripsy and cancer therapy etc. A special novel multi-focal length multi-frequency, multi power transducer system has been developed to get variable power output from the same single transducer.

Acoustic Lithotripsy

Basic measurements on crushing strength, porosity and density etc. were made on invitro kidney stones.

Bone Fracture Diagnosis

A new stress wave propagation technique was developed in the normal and fractured bones in relation to the bone anatomy. Actual fracture size and its location in the bone is investigated with this technique very reliably. An instrument based on the technique is planned to be developed for para-medical emergencies. This would be very useful in case of road accidents to know about the state of seriousness of the fracture. Bone quality assessment studies have also been studied.

Based on ultrasonic velocity measurement and other parameters, quality of food materials was assessed for better health care.

Design of electronic smoke instrument for measuring vehicular exhaust smoke density, for M/s Enviro-Tech Industries, New Delhi, was improved for better stability.

224 instruments were tested, evaluated and checked for their workability and performance before return to Central Stores. The

work involved testing of their electronic circuits and associated sub-system. The major repairs undertaken during the year, were different types of transducers, temperature controllers, computers, electronic microbalance, IF systems etc.

From time to time routine technical assistance has been rendered to various scientists for in house projects in the design of electronics circuits and subsystems for their measuring systems.

Inward inspection was made for Electronic and Electrical Stores when the materials were procured in the Central Stores. More than 40 test reports were prepared and submitted to the Central Stores during the year for various electronic components, ICs, devices and sub systems, by the Group.

PUBLICATIONS

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APPENDICES

Sponsored/Supported Projects

S. No.		Agency	Amount Received (Rs. in Lakhs)
NEW			
1.	Electro-Optical and Structural Studies of Oriented Nematic Dispersions with Low Cross-Over Frequency in a Polymer Matrix	Tech. Univ. (Barlin)	in kind
2.	Development of Electroluminescent Display Devices (DST)-GA	DST	6.776
3.	Continuous Measurement. Updating. Modelling and assessment of Greenhouse Gases	ME&F	1.243
4.	Global Atmospheric Science Programme on Centre on Global Change (DST) (GA)	DST	25.000
5.	Development of an Automatic Self Locking NMR Gaussmeter (DST) (GA)	DST	4.000
6.	Development of Process Technology for Electro-Deposited CdTe Solar Cells/Modules-GA	MNES	25.000
7.	Deposition and Properties of Mixed Composition Infrared Optical Thin Films (DST) (GA)	DST	13.193
8.	To Investigate a New Category of Catalyst used for the Synthesis of Diamond Under High Pressure and Temperature (DST)	DST	3.600
9.	Development of Single Chamber PECVD System for Fabrication of Thin Film Transistors (GA)	Kurushetra Univ.	2.500
10.	Amorphisation of Boron Nitride and Study of its behaviour under pressure and temperature. (GA)	DST	5.600

11.	Third SERC School on Uper Atmospheric Studies on "Chemistry of the Atmospheric Environment" (30 days School) (GA)	DST	6.500
12.	Standardization of Techniques for Immobilization of Proteins and Enzymes in conducting Polymers (CP)	Indo-US	8.420
13.	Ozone Over India - Change in the Past & Future (GA)	ME&F	3.185
14.	Weight, Measures & Dimensional Metrology Instrumentation & Techniques (a book on Dimensional Metrology)	DST	1.000
15.	Characterisation of Tropospheric and Ionospheric Media to Aid in Radio Communication	DST	9.860
16.	Spray Deposition & Property Evaluation of Aluminium Matrix Composites	ARDR	19.550
17.	Asian Workshop and Training Course on Measurement Techniques and Inventories of Green-House Gases (Seminar from 30.10.95 to 4.11.95) (GA)	International Start Secretariat	0.710
18.	A Regional Workshop cum Training Course-(Asian Dev. Bank) (GA)	Asian Dev Bank	2.840
19.	Study of Least Cost Green-House Gas Abatoment Stratov for Asia (GP)	AES	USD2000
20.	Development of a Long Decay Phosphor and Phosphor Coated Plastic Tapes for the Army (SP)	DRDO	3.000
21.	Influence of the Surface Energetics of Micro-Structure of Matrix and Fibre/Matrix Interaction in Composites	Indo-French	4.120
22.	On Line Determination and systematic Recording of Sugar Content in Sugarcane Juice and Sugarcane Solids (DST) (CP)	DST	13.800
23.	Electron Paramagnetic Resonance Optical Absorption and Electrical Conductivity	DST	5.000

	Investigations in Glasses		
24.	Development of Operational Front End of the Radiometer at 37 GHz (CP)	Allahabad. Univ.	3.500
25.	Planning Commitee Meeting on 3rd SERC School on "Chemistry of Atmospheric Environment" (Two days meeting)	DST	0.450

CONTINUING

1.	Development/Fabrication of Zeeman Solit Frequency Stabilized 633 nm He-Ne Laser Source for Precision Laser Based Instrument (DST)	DST	—
2.	Development of HTSC RF SQUID Basic System Suitable for Operation at Liquid Nitrogen Temperature. (6 Nos) (DST) (GA)	DST	10.100
3.	Development of a Superconducting Magnet System with a Long Hold Dewar for a 100 MHz NMR Spectrophotometer (DST)	DST	—
4.	Laser Heterodyne System for the Study of Ozone and Other Minor Constituents in Antarctica (DOD)	DOD	—
5.	Electron Acceleration using Radiation Characteristics and Development of Solar Flare Model (DST)	DST	0.750
6.	National Methane Campaign for Actual Methane Measurements (M E&F)	Min of Environment & Forest	—
7.	Monitoring of Solar Ultraviolet Radiation at the Ground in the UV-B Region (ISRO-RESPOND)	ISRO-RESPOND	—
8.	Deformation Behaviour of Composite Materials (Aluminium Alloy Matrix Composites) (DST)	DST	4.000
9.	Investigation of Materials Under Ultra High Pressure for Metrological Applications (DST)	DST	—
10.	Simple Technology Development for a	DST	—

	Heat Pipe Room Heater from Ground Heat (DST)		
11.	Hydrogen Maser for VLBI Studies (NGRI)	NGRI. Hyderabad	—
12.	Studies on Reliability and Availability of GPS Signals in India (DDE)	DDE	2.000
13.	A Study on the Deteriorating Effect of Selective Availability on Precise Positioning and Timing in Normal GPS and DGPS Modes (DRDO) (GA)	DRDO	1.760
14.	Development of Two Dimensional STEPS Package - Diffusion Module (DOE)	DOE	1.000
15.	Development of Ultrasonic Biometry Equipment (DST)	DST	—
16.	Calibration Service Programme under the NABL Programme (DST) (GA)	DST	5.000
17.	Development of a Powder X-ray Diffractometer (DST)	DST	—
18.	Development of Solid State Electrochromic Devices (ECDS) for Display Applications (DOE)	DOE	—
19.	Development of Conducting Polymeric Filters for Virus Monitoring in Water (DBT)	DBT	0.350
20.	Development of Polyaniline Based Gas Sensors (DOE)	DOE	1.294
21.	Laboratory Level Technology Development of some Biosensors and Related Bio-Materials (DST)	DST	7.700
22.	Manufacture of 50 Prototypes of Glucose Biosensors and 50.000 Glucose Biosensor Strips for Full Scale Field Trials (NRDC)	NRDC	—
23.	Development of Module Hydride Air-Conditioner (MNES)	DST	0.650
24.	Fabrication and Supply of Underwater	NSTL	—

	Pinger Unit (NSTL)		
25.	Synthesis, Characterization and Application of some Conducting Polymers (Phase-II) (Indo-EEC)	Indo-EEC	—
26.	Establishment of Surface Analytical Facilities (UNDP)	UNDP	—
27.	Programme of Technical Cooperation in Metrology with the Saudi Arabia Standards Organisation. Saudi Arabia (SASO)	SASO	—
28.	Use of the Laser Heterodyne System with Acousto-Optic Spectrometer for Atmospheric Studies over Tropical Latitudes Indo-French)	Indo-French	—
29.	Aviation Grade Brushes - Field Trials (HAL. NASIK)	M/S HAL. Nasik	—
30.	Augmentation of National Standards of Measurement at NPL under the Programme of Technical Collaboration with PTB. Germany - Phase-II	PTB. Germany	—
31.	Growth of Nearly Perfect Single Crystals of Oxides Like Lithium Niobate (Indo-Russia)	Indo-Russia	—
32.	Interaction with Universities/Laboratories in the Area of Superconductivity (UGC)	UGC	2.000
33.	High Resolution X-ray Diffraction Imaging for Advanced Materials Characterization (Indo-US)	Indo-US	—
34.	Charge Carrier Transport in Crystalline Materials - Metrological Applications (Indo-US)	Indo-US	7.150
35.	Master Slave Analog Clocks (Trinity Control System, New Delhi)	M/S Trinity Control System, New Delhi	—
36.	Synthesis of High Silicon Steel by CVD (TISCO) (CP)	M/S TISCO, Jamshedpur	0.500
37.	Design, Development & Fabrication of	CRRI, New Delhi	—

	Piezoelectric Accelerometers (5 nos) (CRRI)		
38.	Development of Back Contact and Encapsulating Technology on Large Area CdS/CdTe Solar Cells (Eco-Solar)	M/S Eco-Solar, Pune	—
39.	Development of Activated Carbon Cloth on Experimental Set-up (HEG. Ltd)	M/S HEG Ltd. Bhopal	—
40.	Optical and Electrical Properties of Langmuir Blodgett Films (DST)	DST	1.000
41.	Nitrous Oxide Emission from Agricultural Fields and Wet Lands in Northern India (DST)	DST	—
42.	Development of Suitable Antimine Material for Boot Antimine (DRDO)	DRDO	—
43.	Development of TGS Pyroelectric Detector (DST)	DST	2.300
44.	Spectral Shift Due to Source Correlation and its implication in Optical Measurements (DST)	DST	—
45.	Development and Fabrication of a System for Ion Beam Microetching of Materials for Microstructure Analysis by Transmission Electron Microscopy (DST)	DST	—
46.	Fabrication & Characterization of Prototype Hydrophones using PZT Polymer Composite Material Developed by NCML, Bombay (NCML)	NCML, Bombay	—
47.	Development of a Unit for the Destruction of Benign and Malignant Tumors in the Region of ENT. Based on High Refrigeration apicity J.T. Cryo Probes (DST)	DST	—
48.	Development of a Focussed Ultrasound System for Tumour Therapy (DST)	DST	—
49.	Measurement of Thermospheric wind and Temperature with Ground-Based Fabry-Perot Interferometer (DST)	DST	—

50.	A Study of Biomass as Energy Source and Technical Option for Greenhouse Gas Emission Reduction (Asian Institute of Technology, Thailand) (C.P)	AIT. Thailand	1.70
51.	Development of Process and Coating System for Fabrication of Infrared Optical Filters for use in Environmental and Pollution	DST	—

COMPLETED

1.	Development of Ultrasonic Transducer for the Development of a Portable Low Cost Ultrasound Scanner (CSIO Chandigarh)	CSIO, Chandigarh	—
2.	National Superconductivity Fellowship (DST)	DST	—
3.	Design, Development & Fabrication of Doppler Mini-Acoustic Sounder (MINI SODAR) for Studies of the Atmospheric Boundary Layer Over Sea Surface (DST)	DST	—
4.	Environmental Impact Assessment Studies of Noise Pollution (M E&F)	Min of Environment & Forest	0.400
5.	Development of a Semiconductor Processing Equipment (Multizone PECVD Based) (CEERI)	CEERI, Pilani	—
6.	Development of Process for Fabrication of 15% Efficiency Single Crystal and Multicrystalline Silicon Solar Cells (MNES)	DNES/MNES	—
7.	Development of a Vapour Compressor Based Refregerator for Storage of Life Saving Vaccines Like DPT etc. for the National immunisation Programme (DST)	DST	—
8.	Indigenous Development of Ultrasonic Transducers for Seismic Physical Modelling Studies (ONGC)	ONGC	—
9.	Atmospheric Studies using Microbarograph (Pondichery University)	Pondichery University	—

10.	Development of High Critical Current High Tc Superconducting Thin Films for Fabrication of SQUIDS and Infrared Detectors Indo-French)	Indo-French	0.750
11.	Estimation of Aluminium in Sera. Water. Bore and Dialysite by Flameless Atomic Absorption Spectrophotometer (AIIMS)	AIIMS, New Delhi	—
12.	Basic Aspects of High Temperature Superconductivity (DST)	DST	—
13.	Low Cost Terminal for the Reception of Standard Time & Frequency Signal (STFS) through INSAT (ER&DC, Thirunanthapuram)	STFS	—
14.	Planning Commitee Meeting on 3rd SERC School on "Chemistry of Atmospheric Environment" (Two days meeting)	DST	0.450

R & D COLLABORATION

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

INDIA

1. Guru Nanak Dev University, Amritsar (Display Devices)
2. CEERI, Pilani (Characterization)
3. Physics Deptt, M.D. Univ., Rohtak (Characterization)
4. ISRO Satellite Centre, Bangalore

   ISRO TM/Tracking Centre, Bangalore (Radio Science)

   CRRI, CBRI

   Universities - Delhi, Calcutta, BHU & Saurastra
5. All India Institute of Medical Sciences, Delhi (For Analysis of aluminium in Blood)
6. Agricultural University, Assam (Chemical Analysis)
7. Institute of Space Physics & Electronics, Calcutta (Radio Standard)
8. Private Sector Company M/s HEG-ltd, Mandideep (Near Bhopal) (Surface area & porosity)
9. DMRL, Hyderabad (Development of MMC Tubes)
10. HAL, Bangalore (Al-li light weight inserts for ISRO & Pultrusion of long fibre products)
12. VSSC, Trivandrum (Development of Mg tubes for ISRO)
13. Indian Institute of Technology, New Delhi (Superconducting ceramics)
14. Tata Iron & Steel Co., Jamshed Pur (High silicon steel by CVD)

10.	Development of High Critical Current High Tc Superconducting Thin Films for Fabrication of SQUIDS and Infrared Detectors Indo-French)	Indo-French	0.750
11.	Estimation of Aluminium in Sera. Water. Bore and Dialysite by Flameless Atomic Absorption Spectrophotometer (AIIMS)	AIIMS, New Delhi	—
12.	Basic Aspects of High Temperature Superconductivity (DST)	DST	—
13.	Low Cost Terminal for the Reception of Standard Time & Frequency Signal (STFS) through INSAT (ER&DC, Thirunanthapuram)	STFS	—
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12. VSSC, Trivandrum (Development of Mg tubes for ISRO)
13. Indian Institute of Technology, New Delhi (Superconducting ceramics)
14. Tata Iron & Steel Co., Jamshed Pur (High silicon steel by CVD)

15. DST, Delhi
16. Defence Laboratory, Jodhpur
17. IGCAR, Kalpakkam, BARC, Bombay
18. ADA, Bangalore, Hind High Vacuum Bangalore (Superconducting & Magnetic Materials)
19. M/s Machining Centre, Bombay (Carbon fibre)
20. HEG, Bhopal (Carbon fibre cloth)
21. Centre for Biochemicals Technology, Delhi (Biosensors)
22. Department of Materials Science, Madurai Kam Raj university, Tamil Nadu (Liquid crystal materials)
23. Department of Chemistry, I.I.T., New Delhi (Synthesis & characterization)
24. IIT, Delhi & IRPF Calcutta, Solar Energy Centre (Reil, Udhaya Semiconductor)
25. University of Delhi : PZT films for memory devices
26. IIT Delhi : Dilute magnetic semiconductors

OVERSEAS

1. Iwan N. Stranskii Institute

   Technical University Berlin Germany (Liquid crystal materials & devices)
2. Lawrence liver-more National Laboratory University of California, USA
3. National Institute of Standards and Technology, USA (Pressure & Vacuum)
4. Indo-French collaborative project, France (Catalytic & photochemical properties of metal oxides)
5. Indo-Russian research agreement vladirostok, Russia
6. NIST, Boulder, Colorads, USA (Radio Science)
7. Slovak Institute of Metrology (Slovakia) High precision admittance bridge)
8. PTB, Germany (Facility for tan δ measurement of capacitors & inter-comparison of LF & HF impedance standards)
9. PTB, Germany (Augmentalation of standards & strengthening of calibration facility)
10. Institute of Inorganic Chemistry, Novosobirsk, Russia (metal organic compounds)
11. National Institute of standards and technology (NST), USA (International comparison of certified materials)
12. National Association of testing Authorities (NATA) Australia (Comparison of certified materials)
13. Clarendon laboratory, University of Oxford, U.K. (Synthesis & characterization of conducting polymers)
14. National Institute of Standards & Technology, Gaithersburg, Maryland U.S.A (Conducting polymers)
15. MEL/AIST, Japan (Technology for near net shape component)
16. Fraunhofer Institute, Germany (Development of lightweight high strength Al-Li/SiCp MMC
17. UCI, Irvine, USA (Development of MMC using spray atomization & deposition technique

CALIBRATION/TESTING CHARGES
(Realised during 1.4.95 to 31.3.96)

ACTIVITY	AMOUNT (Rs)	REPORTS (No.)
I. CALIBRATION		
i. Physico Mechanical Standard		
Length Standards	95400	23
Dimensional Metrology	2170900	854
Mass, Density, Volume & Viscosity	983850	647
Force & Hardness Standards	1809450	758
Pressure & Vacuum Standards	1613700	249
Temperature Standards	1796900	753
Optical Radiation Standards	1192475	353
IR Radiation Meas. & Calib.	24000	5
UV Radiation Meas. Stds.	16850	10
Acoustic Standards	422400	115
Ultrasonics Standards	32450	19
Total	**10158375**	**3786**
ii. Electrical Standards		
AC & LF Standards (Up to 1 KHz)	894300	144
LF & HF Impedance Standards	156150	109
D.C. Standards	336800	93
HF & Microwave Attenuation and impedance Standards	59750	10
HF & Microwave Standards of Power, Voltage, Frequency & Noise	583800	92
Magnetic Measurement Activity	20750	10
Time & Freq. Standards	265050	61
Total	**2316600**	**519**

II.	**TESTING**		
	Material Characterisation	5000	0
	Chemical Analysis	223550	69
	Indian Std. Material	17100	6
	X-Ray Analysis	41000	6
	Electron Microscopic Analysis	38700	10
	E.P.R. Analysis	11700	1
	Surface Area & Porosity Analysis	22400	5
	Spectroscopic Analysis	28700	5
	HEPP	19700	11
	Material Division	15725	4
	Carbon Technology	5850	1
	Solar Cell	2000	1
	Electrical Engg.	20000	2
	Total	**451425**	**121**
III.	**JOB WORK**		
	Central Workshop	653400	47
	Thin Film	3800	2
	Total	**657200**	**49**
	Grand Total	**13583600**	**4475**

ACTUAL EXPENDITURE
(1995 - 1996)

Budget Head	Rs. (Lakhs)
Salaries	993.240
Contingencies	213.553
Maintenance	26.350
Chemicals	143.041
Work etc.	16.782
Equipment	258.784
Other	69.939
Total	1721.689
Sponsored Projects	231.300

PROCESS RELEASED

PROCESS	LICENCEE	TERMS & CONDITIONS
Carbon fibre for braiding application	M/s Machining Centre (India) Pvt Ltd Wagle Industrial Estate Thane	Premium-8 lakhs Royalty-3% Licence Period-10 years

KRISHNAN MEMORIAL LECTURE

XXV Krishnan Memorial Lecture was delivered by Prof. Govind Swarup, FRS, Director, GMRT project, National Centre for Radio Astrophysics, Pune on Oct. 26, 1995 in the NPL Auditorium. The title of the lecture was "Large scale structure of the universe".

A memento "Sandal wood Saraswati" was presented to Prof. Govind Swarup by Prof. E.S.R Gopal, Director NPL, New Delhi. Large number of Scientists, research scholars and oter staff members from NPL attended the lecture.

XXV Krishnan Memorial Lecture delivered on 26th Oct. 1995.

Technology Transfer Ceremony for "Manufacture of carbon fibres for braiding application" on 2nd May 1995.

Handing over of a NPL designed and fabricated hydraulic piston gauge pressure standard upto 60 MPa to measure pressure within an accuracy of + 0.025% to M/s Waaree Instruments Pvt. Ltd. Bombay

PREMIA & ROYALTIES
(1994 - 95)

PROCESS	LICENSEE	TOTAL AMOUNT (Rs.)	LAB SHARE (Rs.)
Carbon Fibre for braiding application	Precision Graphite (INDIA) Ltd., Bombay	8,00,000	—
Interferometer, Ultrasonic	Sandeep Enterprises, New Delhi	10,000	4,000
Tapes and Sheets, Flexible Graphite	Ranbro Industrial Maintenance, New Delhi	2,00,000	—
Components S Band, Microwave	Towade Engg. Bombay	5,783	2,313
Ink Indelible	Mysore Lac & Paint Works Ltd., Mysore	11,56,228	4,62,491
Tapes & Sheets, Flexible Graphite	I.D. Jones & Co. (P) Ltd., Calcutta	3889	—
Probes Angle Beam Surface Wave	Vibronics (P) Ltd., Bombay	16,384	6,553

CONSULTANCY

Nature of Consultancy	Party	Amount (Rs.)
1. Programme Development and Modelling of 21" MF	M/s Samtel Colour Ltd., Bulandshahar Road, Village Chhapraula, Ghaziabad.	10,000
2. Trouble Shooting of DC sputtering Power Supply	M/s Samtek Systems, R-16 Inderpuri, New Delhi.	13,450
3. Machining of Mechanical Components	M/s Crompton Greaves Ltd., Vandana 11 Tolstoy Marg, New Delhi.	25.000
4. Optimisation of Medical Flowmeter for Oxygen Delivery	M/s Medical Systems and Services H-251 Ashok Vihar, Phase-I, Delhi.	8,500
5. Modelling & Machining of 6" - adjustable Wrench	M/s Mascot India Tool and Forging Pvt. Ltd.	18,500
6. Modelling & Machining of 20" MF support	M/s Samtel Colour Lab Ltd., Village Chhapraula Bulandshahar Road, Ghaziabad (UP).	40,000
7. Modelling and Machining of 4 PCs of Microwave components	M/s Crompton Greaves Ltd., Defence System Group 27 Rani Jhansi Road, New Delhi.	24,000
8. Putting Rb Vapour Frequency reference (RVFR) of Hewlett Packard Rb Frequency Standard to optimum working condition.	Sh. VKN Basavanna Manager AVDB (Test Deptt.) HAL, Post Bag Office, Hyderabad.	99,800
9. Acoustic Design of Auditorium Building	Sh. S.L. Jain, Ex-Engineer Division No. II Guru Teg Bahadur Medical College Hospital Project GNCT, Shahadara, Delhi.	50,000
10. Modelling and Machining of 2mm microwave components (1) 2 PCs as pirdrawing w 783 (2) 2 PCs as pirdrawing w 689	Air Marshal Lakhmir Singh Crompton Greaves Ltd., Vandana, 11 Tolstoy Marg, New Delhi.	21,000
11. Modelling and Machining of 14" MF Support	M/s Samtel Colour Ltd., Bulandshahar Road, Village Chhapraula, Ghaziabad (UP).	30,000

12.	(1) Upgradation/rectification of the large size Oedometer to make it fully computer controlled system (2) Upgradation of Triaxial equipment to make it fully computer controlled.	Sh. Aminesh Roy Chief Research (RFR) Material Research Station Olof Palme Marg, Hauz Khas, New Delhi.	88,650
13.	Upgradation CPCB Soar to DC configurable sodar	Sh. J.S. Kamyotra, I/c (AIR LAB) Central Pollution Control Board, Parivesh Bhavan, CBD Cum Office Complex, East Arjun Nagar Delhi.	73,275
14.	(1) Programme Development Modelling for technology development of technology for renosing of Funnel Plunger (2) Technical Services for Machining and Renosing of used Funnel Plunger	M/s Samcor Glass Ltd., 50-51 Community Centre New Friends Colony, New Delhi.	50,000
15.	Testing of New Installations Hardware and Software	Sh. Bhagat Singh Dy. Director National Council for Hotel Management and Catering Technology Library Avenue, Pusa Complex, New Delhi.	2,800
16.	3-D Surface profile measurement programme	Samtel Colour Ltd., Ghaziabad.	22,000
17.	Acoustic treatment in Central State Public Library, Patiala	Executive Engineer, Provisional Sub-Division PWD B&R, New Delhi.	35,000
18.	Characterisation of Mercury Telluride Crystals by High Resolution X-ray Diffraction	Solid State Physics Lab., Lucknow Road, New Delhi.	1,50,000
19.	Development of Die Cavities for three Hangers	M/s Sterling Finance and Leasing Co. Golf Link, New Delhi.	1,10,000
20.	Modelling of Electrodes for base magnets	M/s Escorts Employee Ancilliary Ltd., 20/4, Mathura Road, Faridabad.	12,000
21.	Development of 20 MF Retainer	M/s Samtel Colour Lab., Village Chhapraula, Bulandshahar, Ghaziabad	20,000
22.	Development of Ultrasonic Probes for NDT	M/s Aeronautical Development Agency, Bangalore.	75,000
23.	Development of Foam cutting Brass Mouldes and Electrodes	M/s Samta Enterprises, Madan Puri, Gurgaon.	42,000

HUMAN RESOURCES

SCIENTISTS OFFICERS

(In order of Gp. IV to Gp. III as on 1.4.96)

DIRECTOR

ESR Gopal

PHYSICO MECHANICAL STANDARDS

LENGTH & DIMENSIONS

RP Singhal, Sc EII
VG Kulkarni, Sc EI
LS Tanwar, Sc EI
Shanta Chawla (Smt), Sc C
M Karfa, Sc C
Rina Sharma (Smt), Sc B
V Roonwal (Smt), TOEI
NK Aggarwal, TOC
BK Roy, TOC
AK Kanjilal, TOC
SL Thind, TOC

MASS

DC Sharma, Sc EII
SN Nangia, Sc EI
Tripurari Lal, Sc EI
ML Das, Sc EI
S Sinha, Sc B
T.K. Parameshwaran, TOB

FORCE

MK Dasgupta, Sc F
RS Sharma, Sc EI
JK Dhawan, Sc EI
MK Chaudhary, Sc EI
Anil Kumar, Sc C
Ganga Prasad, Sc C
VD Arora, TOA

PRESSURE & VACUUM

AC Gupta, Sc EII
KK Jain, Sc EII
AK Bandyopadhyay, Sc EII
BR Chakraborty, Sc EII
DR Sharma, Sc EII
Pardeep Mohan, Sc EI
SM Sivaprasad, Sc C
C Anandan, Sc C
Arjun Vijaykumar, Sc B

TEMPERATURE

RK Luthra, Sc EI
NK Srivastava, Sc EI
YP Singh, Sc EI
Mansha Ram, Sc C
OP Bhola, TOEI
NK Kohli, TOC
SK Nijhawan, TOB
PR Sengupta, TOA
Gurcharanjit Singh TOA

OPTICAL RADIATION

KC Joshi, Sc F
JS Vaishya, Sc EII
S Manrai (Smt), Sc EI
HC Kandpal, Sc EI
Jai Bhagwan, TOB

INFRARED RADIATION

SP Varma, Sc F
Joginder Singh, Sc EII
D Gupta, Sc EI

ULTRAVIOLET RADIATION

RS Ram, Sc EII
Om Prakash, Sc EI

ACOUSTICS

V. Mohanan, Sc EII
DR Pahwa, Sc EII
SUM Rao, Sc EII
BS Gera, Sc EI
Omkar Sharma, Sc EI
RM Khanna, Sc EI
HLB Bhaskar, Sc C
Mahavir Singh, Sc B

ULTRASONICS

Janardan Singh, Sc EII
Ashok Kumar, Sc EII
SK Jain, Sc EI
Ved Singh, Sc EI
Harish Bahadur, Sc EI
Mukesh Chandra, Sc EI
NN Swamy, TOC
Subhash Chandra, TOC
Jagdish Lal, TOB
Reeta Gupta (Smt), TOA
NC Soni, TOA

HUMIDITY STANDARDS

Hari Kishan, Sc EI
SS Verma, Sc EI
TK Saxena, Sc C

FLOW MEASUREMENTS

JN Som, Sc EII
Raj Singh, Sc EI
Virendra Babu, TOEI

ELECTRICAL STANDARDS

TIME & FREQUENCY

BS Mathur, Sc G
P Banerjee, Sc EII
A Sengupta, Sc EII
GM Saxena, Sc EII
AK Hanjura, Sc EI
M Saxena (Smt), Sc EI
A Chatterjee (Smt), Sc C
C Sri Kumar, Sc B
Gurdial Singh, TOB
AK Suri, TOB

JOSEPHSON VOLTAGE

Ashok K Gupta, Sc F
VS Tomer, Sc EII
ND Kataria, Sc EI
VN Ojha, Sc EI
Manmohan Krishna, Sc C
VK Gumber, Sc C
Neeraj Khare, Sc C

DC MEASUREMENT

SK Mahajan, Sc EII
Ajit Singh, Sc B
PK Mittal, TOC
B Sircar, TOB

HF IMPEDANCE & AC, LF

Omkar Nath, Sc EII
Gurmej Ram, Sc EI
SR Gupta, Sc EI
MK Mittal, Sc EI
MR Nagar, Sc EI
AK Saxena, Sc EI
Kewal Krishna, Sc C
Naib Singh, Sc C
JC Biswas, Sc B
AR Kaushik (Smt) TOB

HF & MW VOLTAGE, POWER FREQUENCY & ATTENUATION

VK Agrawal, Sc F
RS Yadava, Sc F
Ram Swarup, Sc EII
VK Rustagi, Sc EII
AK Govil, Sc EI
Ritander Aggarwal, Sc EI
PS Negi, Sc EI
Ranjit Singh Sc C
RL Mendiratta, TOB

MAGNETIC MEASUREMENTS

PC Kothari, Sc F
RK Kotnala, Sc EI
HM Bhatnagar, Sc C

CALIBRATION SERVICES PROGRAMME

Mahesh Chandra, Sc EII
HS Dahiya, Sc EI
NS Natarajan, Sc EI
CP Singh, TOEI
SP Sharma, TOB
PC Sharan, TOA
GK Kapoor, TOA

MATERIALS DEVELOPMENT

SILICON, CERAMICS & SUPERCONDUCTORS

BK Das, Sc F
SK Sarkar, Sc F
AC Rastogi, Sc EII
SN Singh, Sc EII
RB Tripathi, Sc EII
ST Lakshmikumar, Sc EII
Mohan Lal, Sc EI
BR Awasthy, Sc EI
BC Chakravarty, Sc EI
SN Ekbote, Sc EI
NK Arora, Sc EI
PK Singh, Sc EI
ML Sharma, Sc C
Kiran Jain (Smt), Sc C
S Singh (Smt), Sc B
SM Khullar, TOEI
HS Kalsi, TOEI
NS Bangari, TOEI
RC Goel, TOC

Prem Prakash, TOC
KS Balakrishnan (Smt), TOC
BS Khurana, TOC
SK Sharda, TOC
Ravi Kumar, TOB
HP Gupta, TOB
MK Banerjee, TOB
TR Pushpangadan, TOB
Mukul Sharma, TOA

LUMINESCENT MATERIALS

PK Ghosh, Sc F
V Shankar, Sc EI
Harish Chander, Sc EI

DISPLAY DEVICES

Subhas Chandra, Sc F
SC Jain, Sc EII
SS Bawa, Sc EII
MN Kamalasanan, Sc EII
SCK Misra, Sc EII
Suresh Chand, Sc EI
AM Biradar, Sc EI
CP Sharma, Sc EI
SA Agnihotri (Smt), Sc EI
Ramadhar Singh, Sc EI
VS Panwar, Sc EI
BD Malhotra, Sc EI
KK Saini, Sc C
NS Verma, Sc C
Ranjana Mehrotra (Ms), Sc C
RK Sharma, Sc C
SK Dhawan, Sc C
RC Bhateja, TOC

CARBON PRODUCT

OP Bahl, Sc F
Gopal Bhatia, Sc EII
RK Aggarwal, Sc EII
RB Mathur, Sc EII
TL Dhami, Sc EI
V Raman (Smt), Sc EI
Chhote Lal, Sc C
DP Bhatt, Sc C
P Sivaram, Sc C
SR Dhakate, Sc B

THIN FILM SYSTEMS

R Bhattacharya, Sc F
Devindra Singh, Sc EII
A Basu, Sc EII
BS Verma, Sc EII
M Kar (Smt), Sc EI
PN Dixit, Sc EI
OS Panwar, Sc EI
SS Rajput, Sc EI
TK Bhattacharya, TOA

HIGH PRESSURE TECHNOLOGY

AK Aggarwal, Sc EII
BP Singh, Sc EI
SK Singhal, Sc EI
Rajeev Chopra, Sc EI
KD Sharda, TOA

METALS & ALLOYS

Anil K Gupta, Sc F
RC Anandani, Sc EI
Ajay Dhar, Sc C

AK Padma (Km), Sc B
IA Malik, TOEI
Rajiv Sikand, TOB
HB Singh, TOB
Jaswant Singh, TOB
Rakesh Khanna, TOA

LOW TEMPERATURE PHYSICS

SUPER CONDUCTIVITY

AV Narlikar, Sc G
RG Sharma, Sc F
YS Reddy, Sc EII
RB Saxena, Sc EI
BV Reddi, Sc EI
BV Kumaraswami, Sc EI
PK Dutta, Sc EI
UC Upreti, Sc C
Ratan Lal, Sc C
SK Aggarwal, Sc C
PL Upadhyay (Km), Sc C
SB Samanta, TOC
VS Yadav, TOB

CRYOGENIC SYSTEMS

S.C. Gera, Sc EII
NK Babbar, Sc EI
GS Bhambra, TOB

MATERIALS CHARACTERIZATION

CHEMICALS & POROSITY

DC Parashar, Sc F
HP Narang, Sc EII
JN Bohra, Sc EII
JC Trehan, Sc EII
AK Sarkar, Sc EII
VK Amar, Sc EI
R Ramchandran (Smt), Sc EI
AK Aggarwal, Sc EI
PK Gupta, Sc EI
Ranjan Kothari, Sc B
MK Dasgupta, TOA
RC Sharma, TOA
Niranjan Singh, TOA

IR & EPR SPECTROSCOPY

MM Pradhan, Sc EII
SK Gupta, Sc EII
RK Garg, Sc EI

X-RAYS

DK Suri, Sc EII
U Dhawan (Smt), Sc EI
Rashmi (Km), Sc C
RP Pant, Sc B

ELECTRON MICROSCOPY

SK Sharma, Sc F
Narendra Kumar, Sc EII
Ram Kishore, Sc EI
Kasturi Lal, Sc EI
Sukhbir Singh, Sc B

CRYSTAL GROWTH

Krishan Lal, Sc Dir Gd
RV Ananthamurthy, Sc EI
Vijay Kumar Kohli, Sc EI
SK Haldar, Sc EI

G Bhagawannarayana, Sc EI
SNN Goswami (Smt), Sc C

THEORY

Ramji Rai, Sc EI

RADIO AND ATMOSPHERIC SCIENCES

KK Mahajan, Sc G
TR Tyagi, Sc F
SC Garg, Sc F
M.K. Tiwari Sc F
YV Ramanamurthy, Sc EII
S Aggarwal (Smt), Sc EII
DR Lakshmi (Smt), Sc EII
RC Saksena, Sc EII
SL Jain, Sc EII
PK Banerjee, Sc EII
AB Ghosh, Sc EII
HN Dutta, Sc EII
MK Raina, Sc EII
SK Sarkar, Sc EII
R Venkatachari, Sc EII
Lakha Singh, Sc EII
RK Pasricha, Sc EII
KS Zalpuri, Sc EII
RS Arora, Sc EI
MC Sharma, Sc EI
PN Vijaya Kumar, Sc EI
PL Malhotra, Sc EI
MK Goel, Sc EI
Mahendra Mohan, Sc EI
N Kundu (Smt), Sc EI
Madhu Bahl (Smt), Sc EI
JK Gupta, Sc EI
SD Sharma, Sc EI
RS Dabas, Sc EI
DR Nakra, Sc EI
VK Pandey, Sc EI
P Subrahmanyam, Sc EI
MVSN Prasad, Sc EI
BC Arya, Sc EI
NK Sethi, Sc EI
SK Singhal, Sc EI
HK Maini, Sc EI
CB Tandel, Sc C
Jayanta Kar, Sc C
VK Vohra, Sc C
P Chopra (Smt), Sc C
VP Sachdeva, Sc C
John Thomas, Sc C
Risal Singh, Sc C
Meena Jain (Smt), Sc C
G. Beig Sc B
RS Tanwar, Sc B
SK Shastri (Smt), TOC
Abdul Hamid, TOB
Didar Singh, TOB
JP Sharma, TOB
Raksha Marwah (Smt), TOB
VS Yadav, TOB
SK Bhatia (Smt), TOA
R Kohli, TOA
Ahmed Iqbal, TOA
DB Sharma, TOA

TECHNICAL INFRASTRUCTURE

PLANNING & COORDINATION

RS Khanduja, Sc EII
FC Khullar, Sc EI
PK Ashwini Kumar, Sc EI
Satbir Singh, Sc EI
TK Chakraborty, Sc C
SK Sharma, Sc C
Shikha Mandal (Smt), Sc C
Indra Tewari (Smt), Sc C
MK Chibber, TOC
SS Bhakri, TOB
TR Tomer, TOB
SC Verma, TOB

LIBRARY

SM Dhawan, Sc F
SK Phull, Sc EII
DK Tewari, Sc C
Hasan Haider, TOB

COMPUTER

VK Batra, Sc F
Ravi Mehrotra, Sc EII
Sanjay Raizada, Sc C

INSTRUMENTATION

VR Singh, Sc EII
S Dwivedi, Sc C
DS Sachdeva, TOC
YPS Negi, TOB

WORKSHOP

JR Anand, Sc F
HNP Poddar, Sc EI
Ravi Khanna, TOB
Kewal Krishan, TOB
Dharam Chand, TOB
Ram Swarup, TOB

GLASS WORKSHOP

VP Varma, Sc EII
MC Jusht, TOEI
Shashi Bhushan, TOEI
Mohan Lal, TOC
JP Vashist, TOC
Karnail Singh, TOC
GS Hans, TOB

SERVICES

CSP Kumar, Sc F
JC Sharma, Sc C
JS Dhama, Sc B
OP Tagra, TOC
RS Singh, TOC
SL Sharma, TOC
KL Ahuja, Asstt. Executive Engineer
SL Kulshrestha, Asst. Engineer
BS Negi, TOA
Damodar Prasad, TOA

STAFF ON DEPUTATION

VD Dandawate
VT Chitnis
AR Jain
RP Tandon
K. Vardan (Smt.)

SCIENTISTS, FELLOWS, RESEARCH ASSOCIATES & POOL OFFICERS

AP Mitra, Bhatnagar Fellow
SK Joshi, Emer Distinguished Sc CSIR
B Buti, Emer Sc
TR Anantha Raman, Emer Sc
Sanyeeta Khare (Smt), Sc
VPN Padmansan, Sc
R. Murli Krishna, Y.Sc (DST)
Anindya Bose, Fellow
VC Nagar, Fellow
Y. Aparna (Smt), RA
Sumana Bhattacharya (Km), RA
Subrata Bose, RA
Indu Dhingra, RA
Suchitra Ghosh (Km), RA
RK Gowswami, RA
Kudari Timothi, RA
VC Kulshrestha, RA
RK Mandalappu, RA
SK Mongia (Km), RA
VK Parashar, RA
Rashmi Paul (Km), RA
Poonam C. Kumar (Km), RA
Rajinder Singh, RA
Rajiv Kumar, RA
Sarat Chandra, RA
Satyendra Sharma, RA
Naseem Seth, RA
H.S. Tiwari, RA
Harsh Vardhan, RA
Hari Om Upadhyay, PO

ADMINISTRATION, ACCOUNTS, STORES/PURCHASES

HR Gupta, COA
P Dass, AO
HR Mehta, Sr F & AO
BB Chopra SPO
JP Sharma, F & AO
C Ramesh, SO (F & A)
Satish Kumar, SO (F & A)
OP Yadav, SO (F & A)
H Chongloi, SO (F & A)
NA Khan, SO
Dharam Raj, SO
OP Meni, SO
Jitender Parasar, SO
Vijayalakshmi D, (Km), SO
Sardara Singh, SO
AK Ghosh, TOB
KGM Pillai, TOA
S Sharma (Smt), Hindi Offr.
Lamba Prem (Smt), Dy. SPO
RC Gupta, Dy. SPO
RK Bhasin, PS
Mange Ram PS
SA Joseph (Smt), PS
Jagdish Kumar, PS
Shish Ram, PS
DV Sharma, PS
Vijay Kumar, Security Officer
Lakhpat Singh, Security Officer

RETIRED

Shambhu Nath, Tech. VIII, April

G.K. Arora, Sc F, April
O.P. Sharma, TOA, April
S.B.S.S. Sarma, Sc F, May
S. Parthasarthy, TOC, May
Ram Narain, TOB, May
A.K. Ravinathan, Tech. VIII, May
P.S. Subramaniam, Tech. VIII, June
Prem Puri (Smt.), SPA III, June
Raja Ram, Tech. VIII, June
Chandan Singh, TOC, June
P.K. Gupta, Sc. F, July
Babu Ram, Tech. VIII, July
M.M. Bindal, Sc. EII, July
V.D. Sharma, TOA, August
Kundan Lal Vaid, Tech. VIII, August
Lakhi Ram, Tech. VIII, August
D.R. Chawla, Tech. VIII, August
Sudarshan Kumar, Sc. EI, September
Swaran Kanta (Smt) S.M.A., September
Murli Dhar Saklani, Tech. VIII, September
Gopal Krishan Goel, TOC, September
S.S. Kapoor, Asstt. Engineer, November
Ram Kishan, W/shop Asstt., November
Joga Singh, Tech. VII, November
Sita Ram I, Tech. VIII, November
I.D. Negi, S.M.A., November
Ram Achal, W/shop Asstt., December
J.M. Sardana, Sr. SPO, December
Ashok Kumar Chopra, Asstt. G. December
R.B.S. Chauhan, Asstt. G, January
Santosh Anand (Smt), Asstt. G, January
Malti Sharma (Smt), U.D.C., February
R.K. Nayar, TOEI, February
G.S. Hans, TOC, March
Pran Nath, P.S., March
Hazari Lal, Tech. VII, March

VOLUNTARY RETIREMENT

Ashwani Kumar, TOA, June

OBITUARIES

Ram Kewal, Tech. VII, May 9
P.K. Kohli, Sc. EI, August 14
I.J. Banaudha, TOC, November 5
S. Verma (Smt), TOB, January 27
Surindar Singh, S.M.A., December 8
Sati Ram, Bearer, March 2

Ph.Ds. Awarded

S. No.	Name	Title	University	Guides
1.	Nigvendra Kumar	Preparation and characterization of high Tc superconducting materials.	Ch. Charan Singh University, Meerut	Dr. S.K. Sharma NPL Dr. N.P. Gupta Meerut University
2.	Rajeev Chopra	Experimental study on the system Mg SiO_3 - Al_2O_3 - Cr_2O_3 between 40 to 60Kb at variable temperatures and its significance in the genesis of chromium garnet, corundum and aluminous orthopyroxene bearing Kimberlites.	Allahabad University	Dr. M.M. Bindal NPL Prof. Alok Gupta Allahabad University
3.	Manoj K. Ram	Optical and electrical properties of conducting polymer films,	BITS, Pilani	Dr. B.D. Malhotra NPL
4.	Kumaran Ramanathan	Applications of some conducting polymers to glucose Biosensor.	IIT, Delhi	Dr. B.D. Malhotra NPL Prof. A.S.N. Murthy I.I.T. Delhi
5.	Shaleen Gopal	A study of Ionic conduction and phonon dispersion in some polymeric systems.	Lucknow University	Dr. S.A. Agnihotry NPL Prof. V.D. Gupta Lucknow University
6.	Tanay Seth	Studies on Hydrogenated amorphous silicon films grown at high deposition rates.	Punjab University	Dr. V.V. Shah NPL Prof. K.K. Srivastava Punjab University

7.	Jaya Kumar	Microwave surface resistance studies in high temperature superconducting bulk and thin films	Delhi University	Dr. N.D. Kataria NPL Prof. G.P. Srivastava Delhi University
8.	R. Malik	Studies on focussing of ultrasound beam	Delhi University	Dr. V.R. Singh NPL V.P. Bhatnagar Delhi University
9.	Ranvir Singh	Studies on smart sensors.	Ch. Charan Singh Meerut University	Dr. V.R. Singh NPL Dr. N. Singh Meerut University
10.	V.C. Nagar	Study of stratospheric ozone using millimeter wave ozone radiospectrometry.	BITS, Pilani	Dr. R.S. Arora NPL
11.	Y.P. Singh	Accurate Determination of temperature in the light of spectral shift due to source correlation.	Jamia Millia Delhi	Prof. Z.H. Zaidi JMI, Delhi
12.	D.P. Singh	Synthesis and X-ray diffraction study of Ga_2Te_3 and its non-stoichiometric composition.	Jamia Millia Delhi	Prof. K.D. Kundra NPL Prof. M.Y. Khan JMI, Delhi

VISITS ABROAD

1. Dr. Anil K. Gupta visited Fraunhofer Institute, Dresden, Germany to chalk out a project proposal for joint development work on Al-Li+SiCp MMC December 1995 two weeks.

2. Dr. A.K. Gupta, visited france under Indo-French project from 2-6-95 to 1-7-95. During this period he worked at CNRS - Laboratoire De Physique Des Solides and Laboratoire De Genie Electrique De Paris.

3. Dr. D.R. Lakshmi visited Japan Solar terrestrial prediction workshop and Co-Chair, Ionospheric working group forecasters meeting (IUWDS), Jan. 1996.

4. Dr. B.S. Gera visited Italy for 11 month ICTP, Trieste Fellowship.

5. Sh. Anil Kumar visited Germany under NPL-PTB training programme from 6th Nov. to 15th Dec. 1995.

6. Dr. S.C. Jain visited Technical University Berlin, Germany from 1-9-95 to 4-10-95 to work under joint research proposal sponsored by Volkswagen Foundation, Germany and to procure equipments under the above project.

   Dr. S.C. Jain visited San Jose Convention Centre, San Jose, CA, USA and other laboratories from 28 Jan - 10 Feb. 1996 to participate in IST/SPIE Symposium on Liquid Crystal Materials Devices and Applications Naval Research Laboratory, Washington DC, and optrex Europe GmbH, Germany.

7. A.M. Biradar visited THD, Germany for 10 months Nov 1994 to Aug 1995 under Germany - India Bilateral Cooperation Programme.

8. Dr. S.K. Jain visited Edinburgh UK, 5th July to 17 July 1995 to attend and present paper in Ultrasonics International '95.

9. Dr. D.C. Parashar and U.C. Kulshrestha visited Gottenberg Sweden from June 24-29, 1995 Acid Reign Meeting.

   Dr. D.C. Parashar visited Bangkok, Thailand from Sept. 9-14, 1995 GCTE Rice Network Experimental Planning Workshop.

   Dr. D.C. Parashar visited Beijing, China from Oct. 9-14, 1995 Start-IGAC and WMO-IGAC Conference on Measurement of Atmospheric Composition Change.

   Dr. D.C. Parashar visited Malaysia from Nov. 13-15, 1995 Meeting on CSC Project of Chemical Research and Environemental Needs (CREN).

   Dr. D.C. Parashar and Mr. H.P. Narang visited Bangkok. Thailand from 23.11.95 to 25.12.95. Review Meeting of Ait Project on Asian Regional Research Programme in Energy Environment and Climate.

   Dr. D.C. Parashar visited Geneva from Dec. 1995 OECD/IPCC/IEA workshop on Greenhouse Gas Emission from Agricultural Soils, Waste and Industrial Processes.

10. C. Sharma visited Germisch, Partenkrinchen, Germany from Sept. 25-29, 1995 First Gaim Science Conference.

11. Dr. V.R. Singh visited Canada from June, 1995 Invited Speaker UNI of Manitoba (Acoustic Lithotripsy) and PTC Seminar on Elect. Insturments and Netherlands TU-D for collaborative work in sensors.

    Dr. V.R. Singh visited Serbia from Sept., 1995 Invited Talk Intl. Conf. on Micro-Electronics and Netherlands for Collaborative Research with TU-D.

12. T.K. Mandal visited Clemson University, USA from Nov 5-11 to attend the Second International School of Atmospheric Radar and the Seventh Workshop on MST Radar.

13. Dr. Omkar Nath visited Slovak Institute of Metrology under exchange programme during March-April 1995. In connection with the setting up of 1000 MHz admittance bridge at NPL.

14. Dr. S.K. Mahajan visited PTB, Berlin in connection with the training programme for extension of DC voltage range up to 100 KV and to identify various equipment for procurement under NPL-PTB programme from August 15 - Nov. 11, 1995.

15. Dr. S.K. Mahajan visited NIST USA for attending a workshop on 'Standards in Trade' from May 19 to June 1,95 and to identify the various barriers to trade between USA and India.

16. Dr. B.S. Mathur Sci 'G' visited China from 18-22 April, 95 to attend expert group meeting on Quality Standardization, Metrology.

17. Dr. P.K Pasricha Sci 'E-I' is presently visiting USA from 1-5-95 to 31-7-95 to work on Solar Radiation and Cloud Physics in relation to IGBP at Scrips Institute of Oceanography, USA, California.

18. Dr. B.D. Malhotra Sc 'E-I' was deputed to UK from 2-5-95 to 1-6-95 under EEC collaboration project on Synthesis Characterization and Application of some Conducting Polymers.

19. Dr. H.C. Kandpal Sc 'E-I' was deputed to USA from 7-6-95 to 10-6-95 to attend 7th Rochester Conference and Quantum Optics.

20. Dr. R.P. Tandon Sc 'E-I' is presently visiting Canada for three months from 15-6-95 to 14-9-95 to do research work at Queen University, Kingston.

21. Dr. C Anandan Sc 'C' is presently visiting France for six months from 12-6-95 on UNDP fellowship under the ongoing project "Establishment of Surface Facilties".

22. Dr. B.S. Mathur, Sc 'G' visited Russia from 8-10 Oct. 1995 to attend subworking group meeting between BIS & GOSSATA DART.

23. Dr. O.P. Bahl, Sc 'F' visited Checz Republc from 10-13 Oct. 95 to attend Int Conference on "Carbon & Carbonaceous Composites Materials" at Malenovoice.

24. Dr. Krishan Lal, Sc (Dir Grade) visited South Korea from 20-10-95 to 3-11-95 as a member of INSA delegation.

25. Dr. K.K. Jain, Sc E-11 is presently visiting Saudia Arabia for 6 months from 11-11-95 to take up assignment as an expert in the area of temperature meterology.

26. Prof. E.S.R. Gopal, Director, NPL visited Japan from 18-11-95 to 10-12-95 to undertake study under UNDP sponsored project titled "Establishment of Surface Analytical Facilities".

27. Dr. (Mrs) S.A. Agnihotry, Sc E-I was deputed to Singapur and Malaysia from 3-12-95 to 13-12-95 to attend conference on solid state ionics and deliver lectures on "Electrochromism its Application" at the University of Malaya and University of Kebangsaan.

28. Dr. A.K. Gupta, Sc E-II visited Germany for two weeks from 4-12-95 to 17-12-95 under the joint collaborative project programme NPL FRG-IAAM.

29. Mr. N.K. Aggarwal and Mr. Mukesh Kumar Visited PTB, Germany for about 4 months (Aug. - Dec. 95) for industrial training at PTB Braunschweig in the field of (i) Slip Gauge Calibration (ii) Form & Roundness Testing (iii) Angle measurement

30. Dr. S.K. Gupta, Sc E-II visited the Chemistry Department, University of Southampton, U.K. for four months (Aug-Nov 95) under Scientist Exchange Programme of INSA, New Delhi with the Royal Society London.

31. Dr. V.T. Chitnis, Sc E-II visited PTB Germany for one month in Aug-Sep 95 to discuss the Programmes of Length Standard Activity.

32. Dr. Santa Chawla, Sc 'C' visited PTB, Germany for four months from Aut-Dec 95 to get training in Beat Frequency Experiments.

33. Sh. A.C. Gupta was on deputation under UNDP fellowship from 8th July to 31st Oct 95 to NIST, Gaitherburg, USA.

34. Dr. B.R. Chakraborty was on deputation under UNDP fellowship from 6th July to 21st Oct 95 to North Carolima State University Raleigh, U.S.A.

SPECIAL LECTURES

DATE	SPEAKER	TOPIC
5.5.95	Prof. A.K. Raychaudhur, Physics Department Indian Institute of Science, Bangalore	Gaint Magnetoresistance Perovskite Oxides : Physics and Application.
8.5.95	Dr. R. Suryanarayanan, CNRS, ORSAY, France	Restoration of Superconductivity in some Substituted Copper Oxides
21.6.95	Dr. V. Venkatchalam, Senior Surgen E.N.T. Safdarjung Hospital, New Delhi	Head and Neck Cancer-As Overview
31.6.95	Dr. Jain Shah, Bristol University, U.K.	High Pressure Scanning Electron Microscope-What this Facility do for Material Science
31.8.95	Dr. V.K. Gupta, Nistads	Basic Concepts of Intellectual Property Rights (IPR'S) and the Management in R & D
29.9.95	Dr. N.K. Jain, Emeritus Scientist of CSIR at NISTADS	Tea in India
17.10.95	Dr. P. Bauer, Director Centre d, Etudes Spatials de la Biosphere-UMR 141 (CNES-CNRS-UPS), France	Remote Sensing Studies of the Earth Biosphere
18.10.95	Prof. E Gmelin Max Plank, Institute Stuttgart, Germany	Low Temperature Calorimetry as Necessary Tool for Solid State Research-recent Results
19.10.95	Prof. E Gmelin Max Plank, Institute Stuttgart, Germany	Physics of Semiconducting Point Contacts
31.10.95	Dr. Rainer Kohler, Head Radiometry, Photometry B.I.P.M, France	BIPM and Optical Radiometry
17.11.95	Prof. S. Dattagupta, Jawaharlal Nehru University, New Delhi	Defect Mediated Structual Transition with Particular Attention to YBaCuo
17.11.95	Mr. Terry Jones Application Director Data Electrons, Australia	Logging of Physical Parameters

20.11.95	Dr. Dieter Briffis, Associate Director Analystical Instrumentation Facilities, North, USA	Secondary Ion Mass Spectroscopy Principle and Applications
21.11.95	Prof. Ari T. Friberg, Material Physical Laboratory Helsinki University of Technology, Finland	Optical Coherence Partially Coherent Beams.
23.11.95	Prof. Ari T. Friberg, Material Physical Laboratory Helsinki University of Technology, Finland	Generalised Radiometry and Twisted Fields
18.12.95	Dr. H. Hemminger, PTB, Germany	Activities of the PTB Thermodynamics Division
27.12.95	Dr. B.S. Mathur, Scientist, NPL	Evolving Strategy & Structure for Standards Activities at NPL in view of CSIR Emphasis on External Cash Flow (ECF)
9.01.96	Dr. P.K. Roy, AT & T Laboratories, USA	Ultra Thin Oxides in Silicon ICs
10.01.96	Dr. Renu Sharma, Associate Professor of Science & Engineering Deptt., Arizona State University, USA	In site study of Dynamic Reaction By Environment Cell Transmission Electron Microscopy
15.01.96	Prof. A Maslowski, Research Institute for Automation and Measurement Warsaw, Poland	Central System and Intelligent Robots
15.01.96	Prof. V. Kucller, Institute of Central Science Mosco, Russia	Automation of Impedance Measurements
30.10.96	Prof. Bogdon Pososz, High Pressure Research Centre Warsaw, Poland	Polytpism in SIC Ceramic Structural Analysis
31.01.96	Dr. Stanislaw Gierlotko, High Pressure Research Centre, Warswa, Poland	Nanometric Materials

09.02.96	Prof. (Mrs.) F. Brocvord, Prof. of Physical Chemistry University P. and M. Curie, France	Dynamics of Dewelting
16.02.96	Prof. C. Dong, Dalion Technology University, China	Quasi Crystals
19.02.96	Mr. Robest Kaarle, Director, Institute of Metrology, Netherland	Traceability in Chemical Measurements Strategy and Developments by the Consultative Committee for amount of substance CCOM
27.02.96	Prof. Oleve Mathiesen, Swedish Board for all Rediation and Canformity Assessment Sweden	Uncertainty in Measurement
27.02.96	Prof. C. Bonnelle, Laboratoire de Chimic Physique, France	X-ray Spectrometry in Physics and Physical Chemistry
12.03.96	Mr. Paul Beveller President, M/s. Camel Labs, USA	EM/RFI Metors and after products for measurement of Radio Frequency Interference
13.03.96	Prof. V.G. Lighsits Sorors, Professor and Head Science Technology, Centre for Semiconductor Microelectronics, Institute for Automation & Central Processor, Russia	Surface Phases and Surface Professes on Silicon
15.03.96	Dr. N.R. Subbaram, Scientist, Intellectual Property Management Divison, INSDOC, INDIA	India Patent Act and GATT-WTO Agreements
19.03.96	Prof. A. Robatgi, Georgia Institute of Technology, USA	Progress in High Efficiency Multi Crystalline Silicon Solar Cells
26.03.96	Mr. E. Faz, DKD, Germany	Accreditation of Calibration Laboratories in Germany and Europe.

RESEARCH COUNCIL

Prof. B. V. Sreekantan, Chairman
FNA, FASc, National Institute of
Advanced Studies,
Indian Institute of Science Campus,
Bangalore-560012

Shri R. Muralidharan, Member
Al Futtaim Electronics - Toshiba
P.O. Box 5866, Dubai (UAE)

Dr. J.M. Garg, Member
Managing Director,
Garg Associates Pvt. Limited,
D6, Industrial Area, Meerut Road,
Ghaziabad - 201 003

Prof. D. Chakravorty, FNA, Member
Director, Indian Association
for the cultivation of Science,
Jadavpur, Calcutta - 700 032

Prof. N. Kumar, FNA, FASc, Member
Director, Raman Research Institute,
Bangalore - 560 080

Dr. V. Kumar, Member
Director, Solid State
Physics Laboratory, Lucknow Road,
New Delhi-110 054.

Dr. A.K. Chakrabarty, Member
Adviser,
Department of Science & Technology,
Technology Bhavan,
New Mehrauli Road, New Delhi

Dr. K.R. Sarma, Member
Director, Central Scientific
Instruments Organisation, Sector 30,
Chandigarh - 160020

Dr. R.N. Biswas, Member
Director,
Central Electronics Engineering
Research Institute,
Pilani-333 031 (Rajasthan)

Prof. E.S.R. Gopal, FNA, FASc, Member
Director,
National Physical Laboratory,
New Delhi-110 012

Dr. H.R. Bhojwani, Member
Head, R&D Planning & Business
Development Division
Council of Scientific & Industrial Research,
Anusandhan Bhawan, Rafi Marg,
New Delhi - 110 001

MANAGEMENT COUNCIL

Prof. E.S.R. Gopal, Chairman
Director,
National Physical Laboratory,
New Delhi-110 012

Dr. K.V. Ramakrishna Member
Scientist,-in-Charge
CEERI Centre, CSIR Complex
Dr. K.S. Krishnan Marg,
New Delhi - 110 012

Dr. Krishan Lal Member
Scientist Director's Grade NPL
New Delhi

Dr. V.S. Tomer Member
Scientist, NPL
New Delhi

Dr. J.N. Bohra Member
Scientist, NPL,
New Delhi

Dr. T.K. Saxena Member
Scientist, NPL,
New Delhi

Dr. (Mrs.) Rina Sharma Member
Scientist, NPL,
New Delhi

Sh. H.R. Mehta Member
Sr. FAO, NPL,
New Delhi

Sh. H.R. Gupta Member Secty.
COA, NPL,
New Delhi.

TRAINING PROVIDED

1. Training was provided to Mr. Mandeep Singh of BITS, Pilani in connection with his project report from 22nd May to 14th July, 1995.
2. Ms. Richa Saxena, Dept of Electronic Sciences, Delhi University-South Campus worked for 6 months for her M. Tech thesis titled "Design Fabrication and Study of Miniaturized Hairpin Resonator Filter for mobile communications".
3. Mr Vijay Mittal, M.Sc (Prev), Dept. of Electronic Sciences, Delhi University-South Campus took 2 months training and worked on Electromigration Studies in CU-AL films.
4. CIMET group trainees, BIS group trainees and two persons from M/s Warnee Instruments Co. Ltd. Bombay were imparted training in the field of temperature standard.
5. Three scientists from IRDE, Dehradun were trained on DLC plant for a period of four days.
6. Training was given to the following in the field of Force measurement :

Name & Desig.	*Organisation*	*Period*
Sh. D.K. Sinha Asst. Director	RTL, Okhla New Delhi	25.9.95 to 29.9.95
Sh. S. Kumar SIPO (MET)	RTC, Calcutta	15.1.96 to 19.1.96
Sh. S.K. Kar INV (MET)	RTC, Calcutta	15.1.96 to 19.1.96

7. Training imparted to two scientists from SriLanka for Greenhouse Gas Emission Studies from Biomass Burning.

   Training provided to the trainees of AWTC-95 workshop.

   Training provided to the participants of Algas Workshop.
8. Training provided to the personnel of various Govt. departments in the field of AC and LF standards.
9. Training in Mass, Volume, Density measurements was given to the persons from:
   (i) CIMET
   (ii) B.I.S, N.T.H.
   (iii) IILM, Ranchi
   (iv) Sh. Ram Institute, New Delhi, etc.
10. Four BE/B. Tech and Two M. Tech Students were given training for fulfilment of their course.
11. Sh. R.K. Luthra has undergone NAMAS (NPL, UK) Laboratory Accessor's training course, held at NPL during 9-13 Oct. 95.
12. Dr. Y.P. Singh has taken training in trainer's tutor's course during 16-20 Oct. 95 held at NPL.
13. Miss Florence Soutric from CEMES, toulouse, France started training in the field of C/C composites under Indo-French cultural Exchange Programme from November 1995.
14. Training was provided to Engineers from M/s Machining Centre, Bombay on Carbon fibre pilot plants
15. Training was provided to CIMET participants and Engineers from Several Industries/bodies like BHEL, National Test house (Calcutta) on Pressure & Vaccuum Techniques.

SYMPOSIA/WORKSHOP/SEMINAR

1. Advances in Metrology and its Role in quality Improvement and Global Trade - 20-22 Feb. 96.
2. AIST-CSIR Workshop on Precision Forming - 26 Feb, 96 to Ist. March, 96.

3. "Chemistry of Earth's Atmospheric Environment" NPL-CIMET Group Training Programme. 5th to 19th Feb, 96.
4. An international Workshop on Physics of Semiconductor Devices was held at National Physical Laboratory during December 11-16, 1995 under the Chairmanship of Dr. Krishan Lal.
5. Asian Workshop Cum-Training Course on Measurement Technique & Invention of Green House Gases held at NPL during 30-10-95 to 4-11-95.
6. ALGAS, Green House Gas Emission Inventory Workshop held at NPL from 6-10 November, 95.

STAFF STRENGTH
(as on 1.4.96)

Category		Grade	Number
(A)	**SCIENTIFIC & TECHNICAL STAFF**		
1.	Scientific Staff	Gr IV	282
2.	Technical Staff	Gr III	151
		Sub- Total (1+2)	**433**
3.	Engineering Cadre Staff	Gr V	—
4.	Supporting Technical Staff	Gr II	359
5.	Supporting Technical Staff	Gr I	116
		Sub- Total (3+4+5)	**475**
		Total (A)	**908**
(B)	**ADMINISTRATIVE & NON-TECHNICAL STAFF**		
6.	Administrative (Gazetted)	Gr A	5
7.	Administrative (Gazetted)	Gr B	21
8.	Administrative (Non-Gazetted)	Gr C	141
9.	Non-Technical Staff	Gr D	128
		Total (B)	**295**
		Grand Total (A) + (B)	**1203**

HONOURS AND AWARDS

1. Dr. Krishan Lal was nominated as leader of Indian Delegation to the International Congress and General Assembly of the International Union of Crystallography, Seatle, USA (1996)
2. Dr. Krishan Lal has been awarded the Daulat Singh Kothari Mamorial Lecture (1996) Award of Indian National Science Academy, New Delhi.
3. Dr. Rina Sharma received the Young Scientist Award (CSIR) for her work on the development of computer controlled mask alignment technology
4. Dr. K.K. Mahajan's and Dr. O.S. Panwar's names have been included in the 14th Edition of Marquis "WHO's WHO in the World" to be published Dec. 1996.
5. Dr. D.C. Parashar has been on the International Panel of Experts for IPCC/ CEVD Emission Inventory for methane and nitrous oxide.
6. Dr. Subhas Chandra and Dr. R.G. Sharma have been awarded Material Research Society (MRSI) Lecture Medal Awards (1996).
7. Dr. V.R. Singh has been elected Fellow of IEEE (USA).
8. Dr. V.R. Singh has been elected Joint Secy. Instrument Soc. of India.
9. Dr. S.D. Sharma, Scientist EI, was deputed to Antarctica as the leader of the 14th Indian Antarctic Expedition
10. Prof. E.S. Raj Gopal, Director, NPL, was nominated as Chairman of the Indian delegation for xx Congress on Weights and Measures, Paris (October 1995).
11. Prof. E.S. Raj Gopal, Director, NPL was re-elected President of Ultrasonic Society of India, Instrument Society of India and Metrology Society of India.
12. Dr. B.S. Gera was awarded a fellowship from ICTP, Trieste, Italy for working at Instituto di Fisica dell Atmosfera for 11 months.
13. Dr. V. Mohanan, Scientist E-II was elected as Treasurer of Acoustical Society of India.
14. Dr. D.C. Parashar & Mr. H.P. Narang identified as National Experts for Algas Workshop.
15. Dr. S.M. Shiva Prasad and Dr (Mrs) Y. Aparna were awarded the best Poster award at the 7th annual meeting of the Material Research Society of India, Banglore, Feb 1996.
16. Dr. D.R. Sharma and Dr. S.M. Shiva Prasad have been nominated by IVS as divisional representatives of IUVSTA for Vacuum Science and Applied Surface Science Respectively for the period 1995-98.

ABBREVIATIONS

AIIMS	:	All India Institute of Medical Sciences.
ARDB	:	Aeronautical Research Development Board
ASCA	:	Asian Crystallographic Association
BARC	:	Bhaba Atomic Research Centre.
BHEL	:	Bharat Heavy Electricals Ltd.
BIS	:	Bureau of Indian Standards.
BITS	:	Birla Institute of Science & Technology.
CCIR	:	International Radio Consultative Committee.
CEERI	:	Central Electronics Engineering Research Institute.
CECRI	:	Central Electrochemical Research Institute
CEL	:	Central Electronics Ltd.
CFC	:	Chloro Fluoro Carbon.
CSIRO	:	Commonwealth Scientific and Industrial Research Organisation.
CSIR	:	Council of Scientific and Industrial Research.
CSIO	:	Central Scientific Instruments Organisation
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.
DXS	:	Diffuse X-ray Scattering.
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.
IPCL	:	Indian Petrochemicals Corporation Ltd.
IRDE	:	Instrument Research Development Establishment.

ISRO	:	Indian Space Research Organisation.
JNU	:	Jawaharlal Nehru University.
KDMIPE	:	K D Malviya Institute of Petroleum Exploration.
MCF	:	Master Control Facilities.
MST	:	Mesospheric Stratospheric & Tropospheric.
LOS	:	Line Of Site.
NBRI	:	National Botanical Research Institute.
NEERI	:	National Environmental Engineering Research Institute.
NCTCF	:	National Coordination of Testing and Calibration Facilities.
NGRI	:	National Geophysical Research Institute
NIAES	:	National Institute of Agro-Environmental Studies.
NIST	:	National Institute of Standards & Technology.
ONGC	:	Oil and Natural Gas Commission.
PTB	:	Physikalisch Technische Bundes-anstalt Braunschweig.
SEM	:	Scanning Electron Microscope.
SHAR	:	Shriharikota Rocket Launching Station.
STFS	:	Standard Time & Frequency Signal.
UCMS	:	University College of Medical Sciences.