SAHAYOG

UGC – DAE CONSORTIUM FOR SCIENTIFIC RESEARCH

(An autonomous institution of the UGC, formerly IUC-DAEF)

Vol. 14 THE UGC – DAE – CSR BULLETIN Nov. 2005

THE ELEVENTH WORKSHOP ON "NEUTRONS AS PROBES OF CONDENSED MATTER" (NPCM-XI) HELD AT MUMBAI

The eleventh workshop on "Neutrons as Probes of Condensed Matter" (NPCM-XI), jointly organized by UGC-DAE CSR and Solid State Physics Division (SSPD), BARC, was held at BARC, Mumbai on January 27-29, 2005. The workshop consisted of lectures covering all aspects of neutron scattering. The duration of the workshop was shortened, as this time the participation was limited to only junior and intermediate level faculty members from universities and research institutes. The objective of the workshop was to generate fresh proposals for collaborative research through familiarity gained with neutron scattering techniques during the workshop.

A total of 37 persons, comprising 23 faculty members from various universities and institutes in India, and fourteen scientists nominated from various divisions of BARC, participated in the workshop.

The inaugural function for the workshop was held at the Multipurpose Hall, BARC Training School Hostel on January 27, 2005. Dr.V.C.Sahni, Director, CAT, Indore, was the Chief Guest. Dr. M.Ramanadham, Head, SSPD , BARC, welcomed the dignitaries and participants. Dr.P.S.Goyal, Centre-Director, UGC-DAE CSR Mumbai Centre, made some introductory remarks about the workshop. Professor V.N.Bhoraskar, Director, UGC-DAE CSR, delivered the presidential address. In his inaugural address, Dr.Sahni, gave a very interesting account of recent advancements in application of neutrons in studying quantum entanglement.

The sessions began with a talk by Prof.Bhoraskar describing the facilities and scope of research at UGC-DAE CSR. Dr.Ramanadham presented details of the National Facility for Neutron Beam Research at BARC. The role of UGC-DAE CSR in promoting neutron beam research was described by Dr.Goyal in his talk. The sessions included lectures by several scientists from SSPD, BARC, on principles and practices of neutron scattering, small angle neutron scattering, neutron diffraction from liquids and amorphous materials, neutron diffraction from single crystals, neutron powder diffraction, magnetic neutron diffraction, neutron inelastic scattering, and neutron quasi-elastic scattering. A visit to Dhruva reactor hall was also arranged and the participants could see the existing neutron spectrometers.

The workshop concluded on January 29 with a feedback session. The participants were satisfied with the workshop and many were interested in submitting research proposals for neutron beam studies that would help them in their research areas.

WORKSHOP ON THE APPLICATIONS OF HIGH MAGNETIC FIELD IN CONDENSED MATTER SCIENCES

A one-day workshop on The Applications of High Magnetic Field in Condensed Matter Sciences was organized by UGC-DAE Consortium for Scientific Research, Kolkata Centre and S.N.Bose National Centre for Basic Sciences, on 6th September 2005, at UGC-DAE, CSR, Kolkata Centre. The purpose of the workshop was to create a user base for the proposed low temperature and high magnetic field facility to be set up at the UGC-DAE,CSR, Kolkata Centre, and also to familiarize the potential users from universities and research institutes, about topics of current research interest using such a facility.

The keynote address was delivered by Prof. Arup Raychaudhuri (SNBose National Center for Basic Sciences), which was followed by several presentations on Strongly Correlated Electronic Systems, High Temperature Superconductors, Low Dimensional Electronic Systems, Magneto caloric effects, Mossbauer Spectroscopy in external Magnetic field, CMR/GMR Materials, Magnetic nanomaterials and nanocomposites. Some of the main speakers were Prof.R.Ranganathan (SINP), Dr.Alok Banerjee (UGC-DAE, CSR), Prof.Indrani Bose (Bose Institute), Dr.Ranjan Choudhury (SNBCBS), Dr.T.Som (IOP, Bhubaneswar), Dr.D.Das (UGC-DAE,CSR), Dr.Pintu Sen (VECC), Dr.K.K.Chattopadhyay (Jadavpur University), Dr.U.Dey (VECC).

The workshop ended with an interactive panel discussion consisting of Prof.D.N.Bose (Retd.Prof. IIT,Kharagpur), Prof. Arup Raychaudhuri (SNBCBS), Dr.A.K.Sinha (UGC- DAE,CSR), Prof.R.Ranganathan (SINP) and Dr.U.Dey (VECC). Many technical aspects of the proposed facility were discussed and several suggestions from the participants were noted. About 70 participants attended the workshop from various universities and research institutes of West Bengal and the neighboring Eastern and North Eastern States.

Dr Praveen Chaddah: New Director of UGC DAE Consortium for scientific research

Dr Chaddah took over as Director of our institute on Wednesday, May 25, 2005. His predecessor, Professor V. N. Bhoraskar, had relinquished the post on February 28, 2005 for personal reasons after holding it for a period of about two and a quarter years. Although relatively short, Professor Bhoraskar's tenure was quite eventful involving a new MOU between UGC and DAE and renaming the institute reflecting the new perspective. Professor Bhoraskar has started many new programs such as acquiring TEM and Micro-Raman facilities, pulsed laser and magnetron deposition systems to name a few (details of these are given elsewhere in this issue of Sahayog). DST has supported the research activities of the institute with sanction of projects on low temperature and high magnetic field studies of materials and INDUS-2 beam line development. The Institute has been fortunate to get a scientist of Dr Chaddah's caliber to lead and guide it at this critical stage.

Dr Praveen Chaddah had his early education in Delhi, and did his graduation from St Stephen's College, Delhi. He joined BARC through their Training School, in 1973. His Ph D work involved setting up a Compton Profile Spectrometer with a ?-ray source (the 1^{st} in India) for electron momentum density measurements. His work focused on electron states in structurally disordered materials, and on electron correlation effects. As a post-doc at University of Illinois at Urbana-Champaign, he initiated measurements of nuclear momentum densities in the quantum solid ^{4}He, using the spallation neutron source IPNS at Argonne. Dr Chaddah also worked on correlating the superconducting and martensitic transitions in A-15 superconductors. He worked on the development of superconducting magnets and of multifilamentary NbTi wires at BARC during 1982-87, and later made important contributions to the development and extension of Bean's Critical State model for the high T_C superconductors. He reformulated this as a 'minimum flux-change' hypothesis, and contributed to its application to sample-shapes having finite demagnetization factor. He has worked recently on 1^{st}-order phase transitions in vortex-matter in superconductors, as also in magnetic materials. His emphasis has been on understanding hysteresis associated with supercooling and superheating, as distinct from that associated with hindered kinetics. The theme of his current research effort is "Disorder-broadened 1^{st} order transitions".

Dr Praveen Chaddah received the INSA Young Scientist medal in 1978, and the MRSI-ICSC Prize for Superconductivity in 1993. He is a Fellow of the Indian Academy of Sciences, and also a Fellow of the Indian National Science Academy.

It is hoped that under Dr Chaddah leadership the institute will succeed in meeting the expectations of the scientific community.

Discussion meeting on "Phase coexistence at first order transition " on 26^{th} September, 2005

Dr. Chaddah dedicated this meeting to the memory of Late Dr. Suresh Manohar Chaudhari and recollected his significant contributions to the growth of the Consortium in general and his zeal to promote thin-film as well as synchrotron based collaborative research in particular. The Chairman of the Scientific Advisory Committee of CSR, Prof. D.D. Sarma mentioned in the beginning of his talk about the long association with Late Dr. Chaudhari and paid tribute to his enthusiasm in research.

The first talk of this meeting by Dr. Chaddah introduced the topic of the 'first order phase transition' and 'phase coexistence'. He emphasized the need of two control variables for the First order transitions and described the importance of disorder as well as fluctuations for the superheated and supercooled states. The evidence of the phase coexistence at mesoscopic length scale was shown from the scanning micro-Hall probe measurements on the $Ce(Fe, 5\%Ru)_2$ across the first order ferro- to antiferromagetic transition. He discussed about the hysteresis, minor hysteresis loops and the consequence of path dependence across the 1^{st} order transitions in various systems and presented a few case studies. Thereafter, he discussed about the glass transitions leading to frozen phase or kinetically arrested transformation.

Prof. D.D. Sarma talked about 'phase separation' in manganites, which was probed using a very unique technique like spatially resolved photoemission spectroscopy. He discussed about the evidences of phase coexistence at different length scales in the context of manganites, observed through a wide variety of probes like bulk magnetization measurements, neutron scattering, resistivity, scanning tunneling spectroscopy, electron microscopy, holography, magnetic force microscopy etc. He discussed his study of the phase coexistence in single crystal of $La_{1-x-y}Pr_yCa_xMnO_3$ ($x = y = 0.375$) by ESCA microscopy (resolution ~ 0.5 µm). Prof. Sarma also presented a case of chemical phase segregation in $(La_{5/8}Sr_{3/8})_{0.21}Lu_{0.79}MnO_3$, where presence of nearly pure $(LaSr)MnO_3$ and $LuMnO_3$ phases were identified from the ESCA microscopy.

Prof. E.V. Sampathkumaran discussed about field-induced first-order magnetic phase transition and associated anomalies in Nd_7Rh_3. This sample showed two magnetic transitions at 10K (ferro- to antiferromagnetic, 1^{st} order) and at 32K. Other interesting features of this as well as similar compounds were also discussed.

Dr. S.B. Roy discussed about disorder induced 1^{st} order phase transition resulting into phase coexistence and metastability in different classes of magnetic systems. He discussed in details about the 1^{st} order field- and temperature-induced magneto-structural FM to AFM transition in doped $CeFe_2$ alloys. where the H-T phase diagram was drawn. The phenomena of kinetic arrest leading to glass like non-ergodic states were discussed and its effect on the magnetic relaxation process was demonstrated in the context of doped $CeFe_2$ system.

Dr. Vasant Sathe talked about the co-existence of phases across the martensitic transition in GdCu alloy, which crystallizes in CsCl structure at room temperature. It shows a first order martensitic transition to FeB type structure below 250 K with pronounced volume change and large thermal hysteresis. Spatially resolved Raman spectroscopy and optical microscopy images in heating and cooling cycles were used to show phase coexistence in this system.

Dr. S.R. Barman discussed about the electronic structure and physical properties of Ni_2MnGa system. He discussed aspects and experiments on the martensitic transformation in shape memory alloys and showed the signature of 1^{st} order martensitic transformation mainly from thermal hysteresis and ac-susceptibility measurements.

Dr. Alok Banerjee discussed about field- and temperature-induced 1^{st}-order FM to AFM transition and the phenomenon of kinetic arrest in Ce(Fe, 2% Os)$_2$ system, which was studied from path dependent magnetization behaviour. Some recent experiments on half-doped Pr-Sr-Mn-O system were described. It was also shown that the spontaneous magnetization has thermal hysteresis across the transition in this system. Another system studied was a electronic phase separated half-doped charge-ordered manganite (Pr-Ca-Mn-O).

Dr. M.K. Chattopadhyay discussed in detail about Gd_5Ge_4 alloy exhibiting giant magnetocaloric, magnetostrictive, and magnetoresistive effects. All these are believed to originate from a 1^{st}-order magnetic phase transition accompanied by a martensitic like structural change, which may be driven by magnetic field, pressure, and temperature. Dr. Chattopadhyay focused on their magnetization and magnetic relaxation studies on this system. Analogy with other systems like manganites was drawn from these experimental observations.

Dr. N.P. Lalla discussed about transmission electron microscopic (TEM) studies on $La_{0.33}Ca_{0.67}MnO_3$ and showed the evidence of charge ordering and co-existence of orthorhombic and monoclinic phases. He showed the electron diffraction patterns where orthorhombic to monoclinic transformation could be seen, and this coexistence was tracked across the temperature range.

Dr. V. Ganesan discussed about the first order phase transition in $FeSi_{1-x}Ge_x$ system from resistivity and thermoelectric power studies.

The outstation participants for this meeting were Dr. C.S. Sundar (IGCAR, Kalapakkam), Dr. Anjan Gupta (IIT, Kanpur), Prof. (Mrs.) S. Kulkarni (University of Pune), Dr. D. Kanjilal (NSC, New Delhi), Dr. P.S. Goyal (CSR, Mumbai) and Dr. A.K. Sinha (CSR, Kolkata) .

Dr. S. M. Chaudhari, Scientist-G, UGC-DAE Consortium for Scientific Research, Indore centre died of heart problem on Saturday, September 10, 2005.

Dr Chaudhari had joined this Institution in July 1992 and contributed immensely towards its growth. He worked on the development and installation of the INDUS-1 photoelectron spectroscopy beamline and the corresponding experimental station. He also contributed to the development of laboratory for thin film deposition. Just before his demise he had been planning to develop a beamline for magnetic dichroism studies on INDUS-2.

Dr Chaudhari had his early education in Satara and Jalgaon and he did his M.Sc.and Ph.D. from the Department of Physics, University of Pune.

Dr Chaudhari will be remembered by all his friends and collaborators for his warm and friendly nature and zest in life and doing experimental physics research

Novel route to biofunctionalized ferrogels

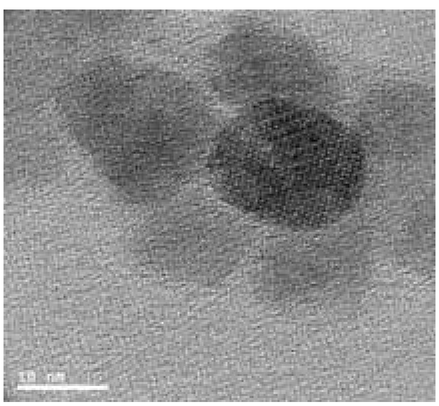
S.Mukherjee, J. Basu, D. Das
UGC-DAE Consortium for Scientific Research, Kolkata Centre

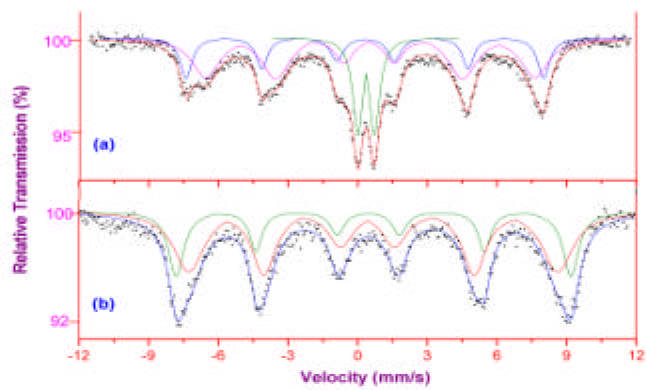
Ferrogels belong to a new class of magneto-controlled elastic materials, which are chemically cross-linked polymer networks swollen with a ferrofluid. Coupling the elastic medium with the magnetic properties allows one to manipulate the elastic behavior of ferrogels by external magnetic field and/or gradients. This feature offers opportunities for various applications as e.g. soft actuators, micromanipulators and artificial muscles. We report a novel synthesis of nanocrystalline magnetite (Fe_3O_4) and gamma iron oxy-hydroxide (γ-FeOOH) in polyvinyl alcohol (PVA) gel matrix. No cross-linking agent such as the most commonly used, glutaraldehyde was used in the present synthesis. Instead, we used high-pressure environment of an autoclave for the synthesis of the aforesaid gels.

Magnetite and lepidocrocite were prepared by standard chemical techniques in the presence of calculated amounts of PVA. The as synthesized product was then transferred into a sealed autoclave and kept at a constant pressure for a specific amount of time. Uniform gel formation resulted with excellent uniformity.

The gels were characterized by Mössbauer spectroscopy technique in the as-prepared state at low temperatures and also in the dried state at room temperature. Heat treatment was avoided to prevent damages to the polymer network. The hyperfine parameters obtained tallied well with those reported for pure magnetite and lepidocrocite. Transmission electron micrographs gave an idea of the particle morphology and size. It was concluded that the gels showed superparamagnetism, which was reflected in the Mössbauer spectra and also corroborated by the transmission electron micrographs.

The TEM and Mössbauer spectra of the magnetite gel at (a) RT and (b) 20 K are given below.



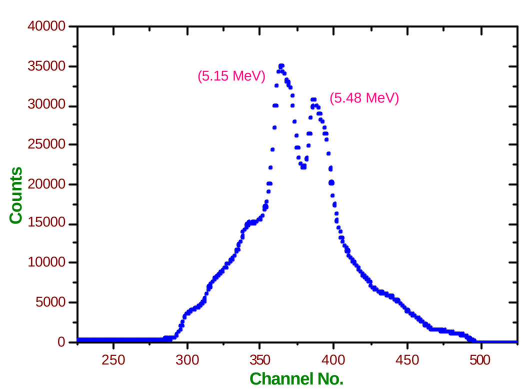


A step forward in the fabrication of radiation-hard SSB detector using oxygen ion-implanted silicon wafer

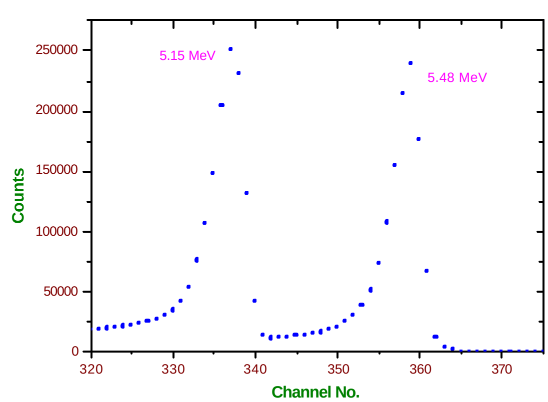
S.K. Chaudhuri, P.V. Rajesh, S.S. Ghugre and D. Das

UGC-DAE Consortium for Scientific Research, Kolkata Centre

Silicon surface barrier (SSB) detectors have been fabricated with oxygen enriched, high-resistivity, detector grade, n-type FZ silicon. Oxygen enrichment of the wafer was done by high-energy (140 MeV) oxygen ion implantation. Oxygen atoms are known to act as sink for vacancies, thereby reducing the chance of formation of vacancy clusters that affects the performance of the detector adversely. SSB detectors fabricated out of such crystals are known to act as radiation hard detectors. Annealing of the irradiated silicon wafer was done to minimize the irradiation-induced defect concentration. Positron annihilation lifetime studies were used to select the annealing temperature (750^0C). Detector made from the annealed wafer worked satisfactorily and its performance was comparable with that of a detector made from as-grown crystal.



Energy spectrum of SSB detector made from as-irradiated wafer using an alpha source



Energy spectrum of SSB detector made from irradiated silicon wafer

Above figures show the performances of two detectors made out of as-irradiated and annealed silicon wafer. The as-irradiated wafer did not show well-resolved lines but the annealed wafer acted well and showed a resolution close to normal detectors (60keV at 5.48 MeV). The leakage current was also normal (0.62 μA) with optimized operating voltage 75V.

AFM Study of Cancerous Blood Cells

D. Mishra[1], S. Chatterjee[1], D. Jain[2], M. Gangrade[2], V. Ganeshan[2], A. Chakraborty[1]
[1] UGC-DAE Consortium for Scientific Research, Kolkata Center
[2] UGC-DAE Consortium for Scientific Research, Indore Center

Iron as a major component of blood cells is associated with cancer process. Iron in its free form is a potential cause of damage to biological molecules via free radical generation**.**

We have observed deposition of iron during initiation phase of chemical carcinogenesis by PIXE as well as EDXRF technique in mice tissue and in the present investigation we have used AFM to study the possible cause of such iron overloading on structural integrity of Red Blood Cells. AFM images give additional details into the shape and has the advantage of high resolution, reliable size and height measurements compared to other available techniques. This is suitable for measuring frictional properties of biological surfaces, which enables us to detect alterations in membrane integrity at atomic resolution. The blood cells collected from heart of anaesthetized mice administered with chemical carcinogen was fixed in 2.5% glutaraldehyde and the blood was dropped on a clean glass surface to make a thin uniform smear of blood cells and then scanned with Nanoscope IV (Vecco Instruments Co.) The images were obtained in normal topographic mode as well as Lateral force mode. The same was done from blood of control group animals.

We observed characteristic blebs in the damaged RBC and holes in their membrane. The damage observed in more pronounced in image obtained by lateral force microscopy mode (Fig. 1).

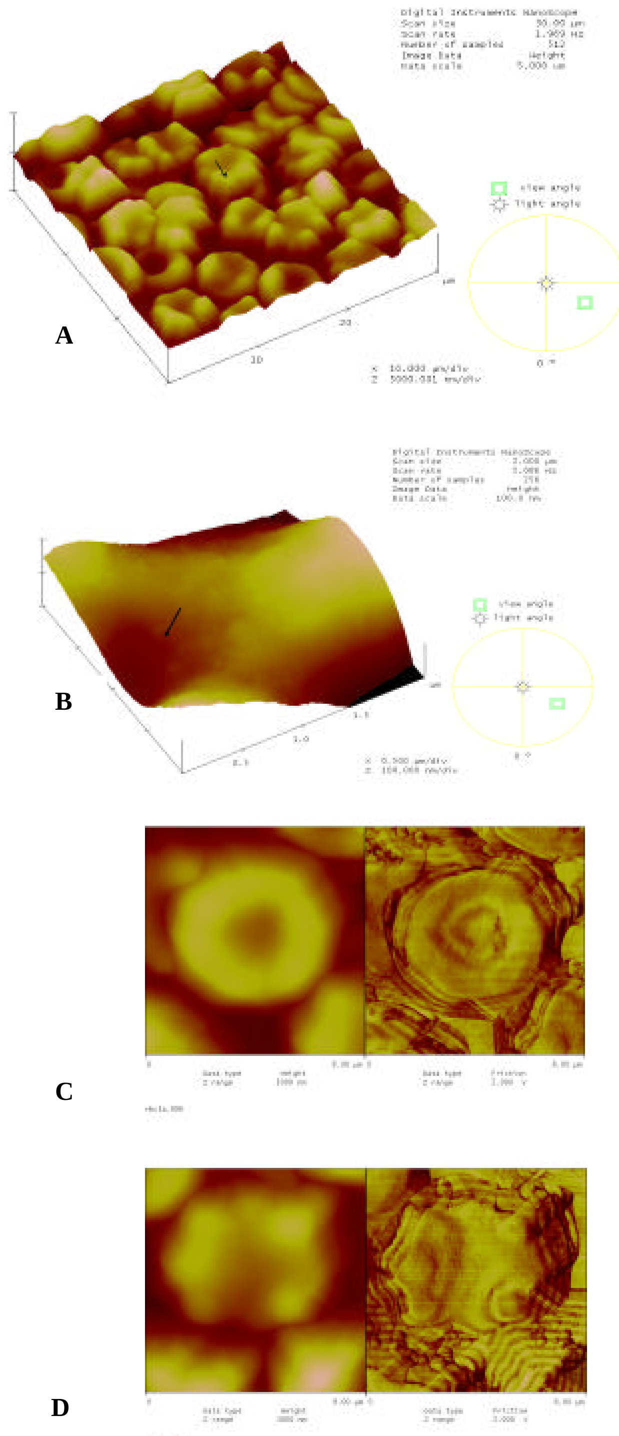


Fig. 1. Damage profile of RBC in Topographic mode (A, B) showing surface blebs and holes (indicated by arrows) which are more pronounced in lateral force mode (C, D).

Installation of Gamma Irradiation Chamber

A 2 kCi Co-60 Gamma Irradiation Source has been installed in the centre. Average absorbed dose rate has been determined to be around 4 kGy/hr. Installation of this chamber may be considered one of major developments in the field of radiation research in the center. . About 12 research groups from different Universities/Institution have used this facility in different fields like chemistry, biosciences and material sciences.

GAMMA IRRADIATION CHAMBER

Gamma Irradiation Chamber commissioned at UGC-DAE CSR, Kolkata Centre is the GC 900 model, procured from BRIT, Mumbai. Both solid and liquid samples can be irradiated. A liquid sample holder for 12 samples in test tubes of 10 mm diameter is fabricated. Following are some other details of the Radiation Facility :

Gamma - Source	**2 kCi Co-60**
Dose rate	**~ 4 k Gy /hr on average**
Dimension of sample chamber	**Cylindrical – Internal Dia. 100 mm, Height 143 mm.**
Timer Range (Auto)	**6s – 6hr**

FOREIGN VISITS BY UGC-DAE CSR FACULTY

Dr. P.S. Goyal visited Trieste, Italy, during May 11-19, 2004, to carry out SAXS experiments at Elettra He also visited National Nuclear Energy Agency (BATAN), Serpong, Indonesia during Aug.1-11, 2005 as an IAEA Expert. Dr. Goyal carried out several SANS experiments on the SANS machine at BATAN and showed that the above machine can be fruitfully used for studying micellar solutions, block-copolymers etc. He also trained the scientists at Neutron Scattering Lab., BATAN in Data Analysis of SANS Experiments. During his stay at BATAN, Dr Goyal gave several lectures dealing with different aspects of SANS research. He also delivered a lecture on "Use of SANS in Soft Condensed Matter Research" as a keynote speaker during the "National Seminar on Neutron and X-ray Scattering", which was held at Serpong on Aug.03, 2005.

Prof. Ajay Gupta visited France, Switzerland and Germany in June – July 2005 and Italy in October 2005. In France he did experiment on X-ray standing wave at ID32 beam line, ESRF, Grenoble during June 23 – 28; in Switzerland he visited Paul Scherer Institute during June 28 to July 05 and in Germany he visited University of Potsdam under DST project on time resolved X-ray scattering for experiment at BESSY-II during July 05 - 13. In Italy he did experiments at ELLETRA, Trieste during October 13 – 19 under the ICTP – ELLETRA users' programme.

Dr.P.D.Babu is on EOL from 1-4-2004 and is working at Tam Kang University in Taiwan as Visiting Scientist.

Dr.V.Siruguri is on EOL from 20-12-2004 and is working at University of Bilbao in Spain as a Visiting Scientist.

Dr S. R. Barman visited BESSY, Berlin for experiments on metallic adlayers using photoemission on UE56/2 beamline during 19.4.2005 to 21.5.2005. The visit was supported by Fritz-Haber-Institute; Berlin and the work was done in collaboration with Prof. K. Horn. He also attended ECOSS23 conference at Berlin, Germany (two posters presented) and Workshop on Magnetic shape memory alloyd at Ascona, Switzerland during 1.9.2005 to 18.9.2005, the visits being suppored by Fritz-Haber-Institute, Berlin.

Dr.V.R.Reddy visited University of Potsdam, Germany and energy dispersive X-ray reflectivity (EDXRR) beam line at BESSY-II during 5th January to 5th February, 2005 under DST sponsored project.

FOREIGN VISITS BY UGC-DAE CSR RESEARCH STUDENTS

Dr. Archna Jaiswal (UGC-DAE CSR/CAT, Indore) visited Iowa State University, Ames during 22nd-26th May 2005 for participating in the 9th International Conference on Quasicrystals. She presented two papers related to her Ph.D. work. in this conference.

Ajay Shukla and R. S. Dhaka did experiments at BESSY, Berlin on photoemission studies on metallic adlayers during 19.4.2005 to 17.5.2005 in collaboration with Prof. Karsten Horn, Fritz-Haber-Institut der Max Planck Gesellschaft, Berlin.

Dileep Kumar visited Italy and Germany for experimental work. He was at ELETTRA, Trieste (Italy) during 11 - 20 Oct., 2005 for work on SAXS beamline under the ICTP-ELETTRA user programme. He spent 20 - 23 Oct. 2005 in University of 'Roma Tre' ROME (Italy) to analyse EXFAS data of Fe/Tb multilayers. During 23 Oct. to 6 Nov. he was at BESSY, Berlin (Germany) for experiments on energy dispersive beamline at BESSY II under DST- DLR proposal 'Irradiation of the thin film samples at HMI' ,

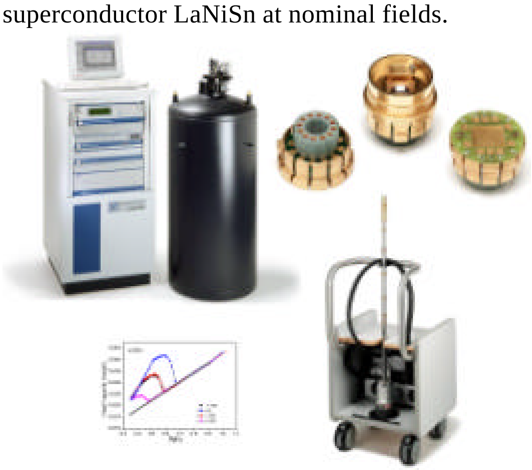
SOME NEW FACILITIES AT INDORE CENTRE

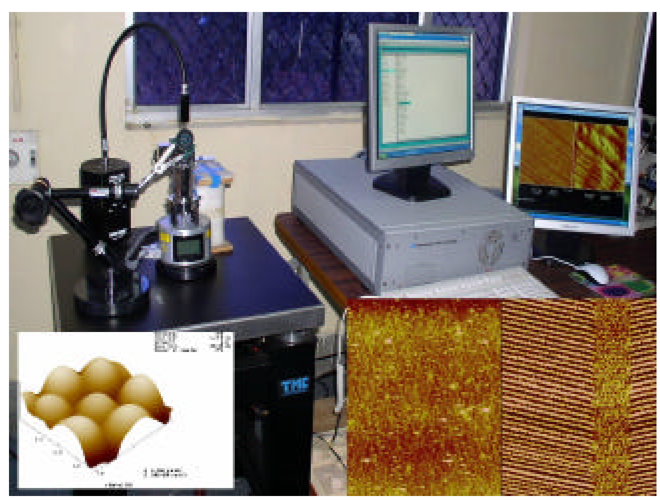
Low Temperature and High Magnetic Field facility

Experimental facilities at extreme environments are required to probe and understand a variety of exotic phenomena that are observable only at these extreme environments. Quantum fluids that include superconductivity, superfluidity and Quantum Hall Effects, CMR and so on are a few worth to mention. Material systems may include correlated electron systems, heavy fermions, Non-Fermi Liquids, quantum confinement schemes, manganites and cuprates, several inter-metallic and other systems of interest.

By extreme environments one mean high pressures, high magnetic fields and very low temperatures etc. All these areas need an infrastructure which is quite broad and involved. In view of current progress in condensed matter physics, Department of Science and Technology (DST) has planned and established such major facilities in India. Consortium for Scientific Research (CSR, Indore), [the erstwhile Inter University Consortium for DAE facilities} took initiatives along with DST to have such facilities in its Indore centre which may help universities to go for frontline research in condensed matter physics. Subsequently two of the major facilities were commissioned at CSR, Indore. This article deals with one such facility for transport and thermal arena.

Presently acquired Quantum Design 14T/0.3K PPMS for Resistivity and Specific heat measurements is a part of above said project. A highly user friendly state of art system with out much compromising on accuracy, this system will be a great potential for low temperature physicists. The system can reach a temperature of 1.9K with standard configuration while can reach less than 0.5K using ^{3}He insert. The CLTC option facilitates a smooth transition at 4.2K, a single experiment can take measurements from 300K down to 1.9K or 0.5K. Resistivity holders can accommodate at least two samples at a time of nominal size of 1 x 1 x 8mm rods and can measure resistances over a wide range from few tens of micro ohms to 4Mohms. A typical mass of 20mg can be used to measure specific heat to a good accuracy of <5%. Interested researchers are advised to look at the Institutional website for more information. The figure shows the cryostat, measurement panel, pucks for resistivity and specific heat measurements and a ^{3}He insert. The data shown is the heat capacity for a representative sample, viz. 0.6K superconductor LaNiSn at nominal fields.





A new Scanning Probe Microscopy for CSR,Indore

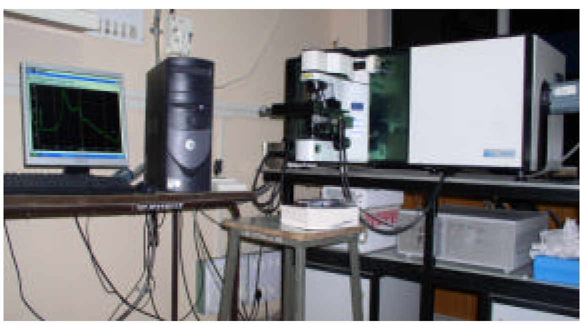
Scanning Probe Microscope has become an inevitable surface characterization tool owing to its multi function capability with out compromising the resolution. The tip –surface (sample) interaction in suitable configurations at nanometer level can reveal not only surface morphology but also the other physical properties such as magnetic, electric, elastic and mechanical properties etc. SPM is one of the powerful tools for studies related to phase transitions in different physical properties under compositional variance. Growth modes, irreversible transformations, irradiation effects, changes due to various treatmentscan be probed very easily. The electrical, magnetic, mechanical and chemical contrast at the local levels can be probed easily

with high precision (nano meter level in some cases). In essence a study on low dimensional systems may not be complete a one with out a SPM characterization.
In view of the fascinating research output around the world in nano-sciences, CSR, Indore made available such a facility namely Atomic Force Microscope a decade ago. In an up-gradation process, a new Mutli Mode Scanning Probe Microscope with advanced Controller Nanoscope IV from Digital Instruments has been acquired recently with several of the state of the art facilities. The unit can work with both contact and tapping mode. Atomic resolution can be achieved with contact mode AFM and STM options. Tapping mode is more suitable for biological studies and soft samples. One of the important and attractive options is the Magnetic Force Microscopy (MFM) mode in which a magnetic tip scans the surface that can deliver information on magnetic state at local level (micron and nano meters). Examples are the magnetic domain structures.

The unit is also capable of carrying out several other function listed below but with a restricted access owing to its complexity. The high temperature attachment is an added advantage to study structural and magnetic phase transitions, in general the so called “melting processes”. Options for imaging biological samples, conductive AFM and Nano-indentation etc are a few worth to mention. The figure shows the newly installed Scanning Probe Microscope. The inserts show the growth of a bacteria Staphylococcus (left) and a MFM image of standard Magnetic tape (right)

Micro Raman Spectroscopy System

A Micro-Raman System LABRAM-HR is installed at the end of April 2005 in the newly developed Raman Laboratory at the Indore Center. The LabRam HR system provides ultra high spectroscopic resolution (~ 1-2 Cm^{-1}) and a unique wavelength range capability that provides both great flexibility and high performance.
It is an integrated, simple to use, and high stability benchtop instrument designed to undertake reproducible Raman measurements at high and medium spectral resolution. The high resolution mode is uniquely ideal for subtle band analysis such as that for phase (crystalline/amorphous), of proteins, nano particles, wires and weak bonding forces and semiconductor stress measurements, infect most applications where it is important for the precise characterisation of position or shape of the Raman spectral features. Band analysis in the order of 0.3cm-1 to 1cm-1 is particularly suited to the high-resolution mode. Its dual capabilities also enable more routine Raman analysis and even broader band laser induced luminescence to be conducted all upon the same bench top instrument.



Some of the salient features of the system are as follows:

- Unique high, medium and low resolution multichannel spectral modes.
- Suitable for Raman and luminescence measurements.
- True confocality - maximum spatial resolution and better defined images.
- Multiple laser capability (visible) 488 nm Argon and 633 He-Ne laser.
- Ultimate stability.
- Large 1024 pixel CCD chip dimensions.
- Unique adjustable angle notch filter technology.
- Automated software operation including external cooling stages (upto 90K).

The standard spectra of Si-111 wafer Collected with the instrument for one-second acquisition time is shown in figure 1. Figure 2 shows the Raman bands of porous Silicon nano-particles. The shift in the Raman bands is normally correlated with the particle size.

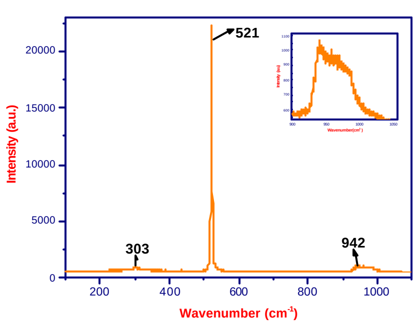


Fig. 1: Raman spectrum of Si(111) wafer.

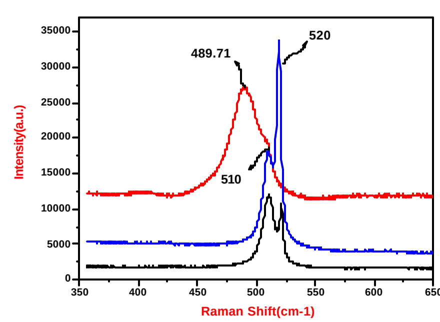
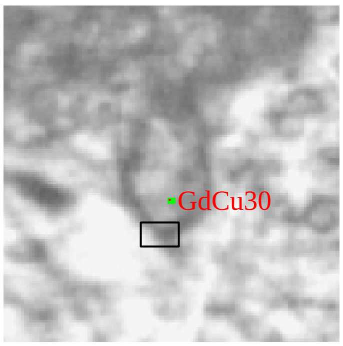
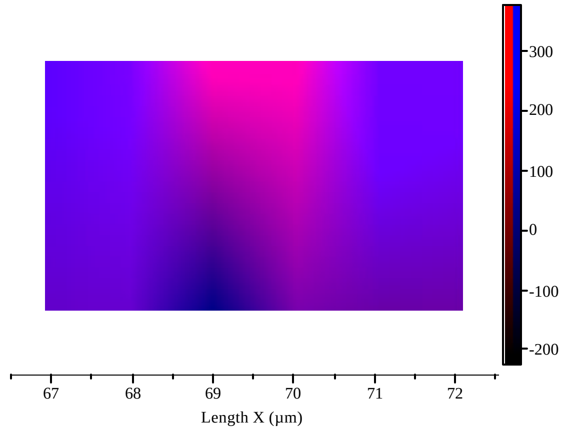


Fig.2: Raman spectrum of porous Si nano-particles.

Raman Mapping

An automated X-Y sample stage is equipped with the instrument that provides Raman maps with a resolution limited by the diffraction limit (~ 1micron) in the lateral direction of the sample. In this technique process the sample is moved with the help of motorised X-Y stage in steps defined by the user and Raman spectrum is collected at each position. The intensity and/or intensity ratio of Raman bands is than compared with the help of a software and a Raman map distinguishing different chemical species, phases is produced. A typical Raman map showing presence of both the martensitic (Red) and Austenite (blue) phase in GdCu sample at 100K is shown in figure below along with the optical image of the sample. The small black ractangle in the optical image denotes the area where Raman mapping has been carried out with a step size of 1 micron.





Confocal Microscope

The instrument is equipped with a confocal microscope with a Video camera for optically observing the sample surface before measurements. Optical microscopy with objective lenses of 10x, 50x and 100x magnification is possible. This also helps in quick and accurate focusing of the sample during Raman measurements. The confocal optics provides a depth profile with a resolution of couple of microns.

In conclusion, this is a powerful tool to investigate elementary excitations in crystalline and amorphous solids, liquids, nano particles, thin films, composites etc. This facility is now open for the users.

Pulsed Laser Deposition system

Thin films of a wide variety of materials may be prepared by the technique of pulsed laser deposition (PLD). Material is removed from the surface of a target by irradiation with a high power laser beam and collected on a suitably positioned substrate. Interest in this technique escalated when it was found to be very well suited to the preparation of high T_c oxide superconductors, but more widespread applications are emerging such as the deposition of permanent magnets, magneto-optic and piezoelectric materials. Recently there are many reports showing that PLD can significantly improve the growth of even simple metallic thin films and multilayers. The improved growth, in particular for the first several monolayers, provides great opportunities to design artificial thin film structures that have promising physical properties.

At UGC-DAE CSR, Indore center, we had designed and developed a pulsed laser deposition system. In this set-up an excimer laser from Lambda-Physik, Germany (Model: Compex-201) is used as a source. It has following specifications:- Wavelength : 248 nm; Gas : Kr-F; Pulse energy at 248 nm: 600 mJ/pulse; Maximum repetition rate: 10 Hz; Average power: 5W; Pulse duration: 25 ns; Pulse-to-pulse stability at 248 nm: ±3%

At present a SS chamber of dia 12” is set for the single layer deposition. It has different ports at various angles on which different accessories required in PLD are mounted. On one of the port rotary motion feedthrough having a 1” target holder is mounted. Substrate holder with heater assembly (up to 600 ^{o}C) is mounted on linear motion feedthrough. This assembly is mounted on a port, which is opposite to the target holder port. Linear movement ~ 5cm is use to change the distance between target and substrate. A port making an angle of 45^{o} with target holder port is used as a laser entry port. It is fitted with quartz window. Remaining ports are used for vacuum accessories viz. Turbo pump, ionization gauge, gas leak valve etc. Vacuum performance of the complete set up is tested using turbo-molecular pump and vacuum ~ 10^{-7} mbar is routinely obtained in the chamber. Some trial depositions of magnetite thin films from a-Fe_2O_3 target are carried out and the performance of the system is checked. In order to deposit multilayer structures an ultra high vacuum chamber is designed which consist of multi-target holder (4 nos.). Installation and vacuum testing of this chamber is in progress.

Faculty Seminars 2005

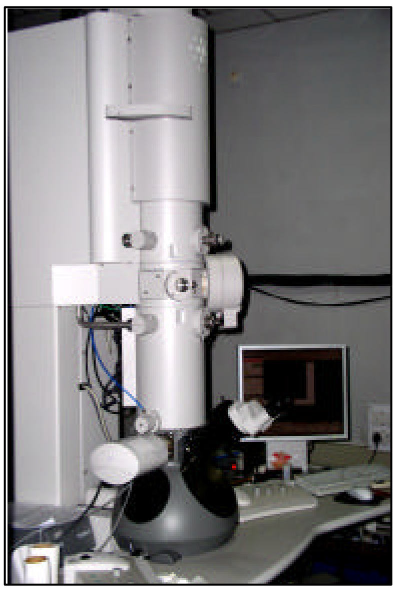
#	SPEAKER	AFFILIATION	TITLE	DATE
1.	Prof. A. Niyogi	U. Texas (USA)	Nanostructured Photonic Devices	27 Jun ’05
2.	Dr. N.P. Lalla	CSR	TEM: A Tool for Structural Characterization of Materials	25 Jul ’05
3.	Dr. A.M. Awasthi	CSR	Molecular Tunneling and Two-Level Excitations in Chalcogenide Glasses	8 Aug ’05
4.	Dr. G.S. Okram	CSR	Vortices in Layered Superconductors	5 Sep ’05
5.	Prof. R. Prasad	DAVV	Nanostructured Materials and Green Chemistry	19 Sep ’05
6.	Prof. A. Venkataraman	Gulbarga University	New Tools of Materials Synthesis	3 Oct ’05
7.	Prof. R. Nath	CSR	Trends in Bioelectrets and their Biomedical Applications	17 Oct ’05
8.	Dr. Arup Banerjee	CAT	Quantum Theory of Coherence: Nobel Prize 2005	22 Nov ’05

वर्ष 2005 में ‘*हिन्दी पखवाड़ा*’ के अवसर पर इस संस्थान द्वारा **28 सितम्बर’05** को भौतिक विज्ञान शोध सम्बन्धी निम्न व्याख्यानों को सम्पन्न कराया गया :-

व्याख्यान विषय	वक्ता
‘छद्म रवा (क्वासी क्रिस्टल): संरचना व गुण-धर्म’	डा0 एन. पी. लल्ला
‘चुम्बकोष्मीय प्रभाव’	डा0 राजीव रावत

Transmission Electron Microscope

The need of structural characterization of materials has been demanding right from the advent of material science. Out of other such techniques like x-ray diffraction, and neutron diffraction, it is the transmission electron microscope (TEM), which helps in characterizing many aspects of materials. It is so because it characterizes the defect structures of materials by seeing through it with high-resolution imaging and diffraction modes both. Although TEM has been used for materials characterization since long but its need has increased after the realization of vast scope of property tailoring with decreasing length scale of materials in various dimensions like thin-films, nano-tubes/nano-rods/quantum wires, nano-particles/quantum-dots. For characterization of these materials TEM plays a crucial role. It is the TEM, which can perform the structural and chemical characterization of very tiny volume (only few nanometers in size) by electron diffraction and EDAX techniques. Although there are various TEM machines all over the country but there was none in a consortium like system such as UGC-DAE consortium for scientific research whose mandate is to help university users. Looking into the increasing demand, CSR Indore has only recently acquired the new facility of transmission electron microscope, which is installed, and working since June 2005. This is a 200 KV TEM, TECNAI 20 G^2 model manufactured by FEI as shown in the figure below. Resolution of this microscope is 2.4Å. This is equipped with a CCD camera for acquiring images and EDAX for doing elemental analysis.



200 KV TECNAI 20 G^2 Transmission Electron Microscope installed at UGC-DAE-Consortium for Scientific research at Indore

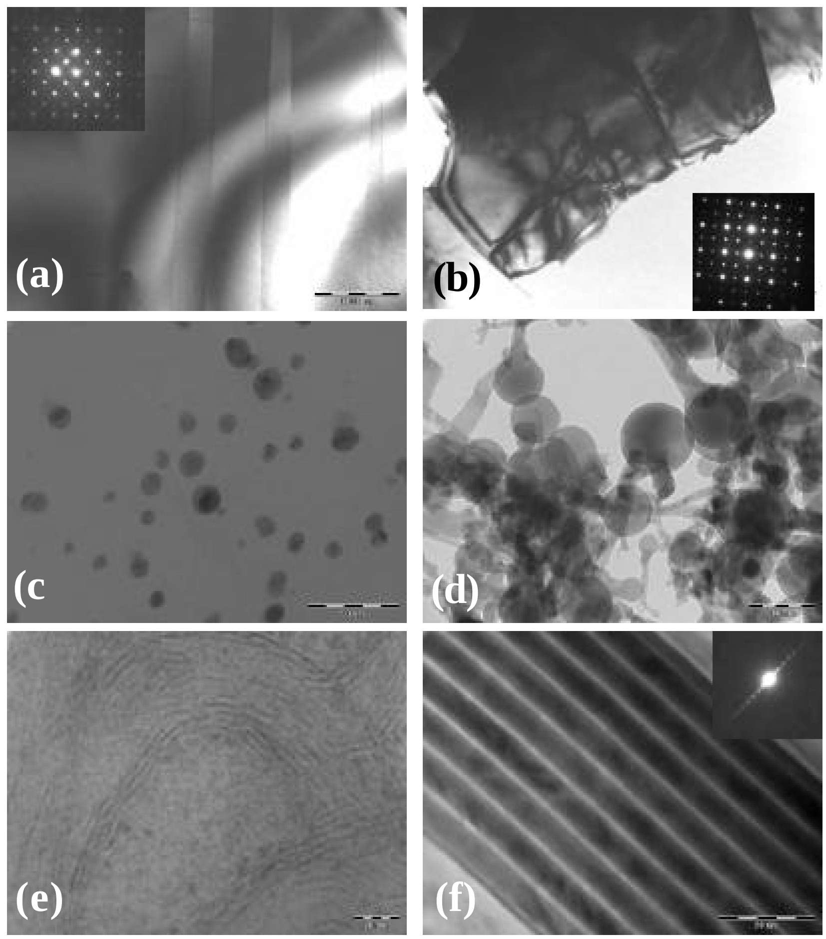


Fig. (a) Microstructure and diffraction from twined domains in $Sr_{0.7}Ca_{0.3}TiO_3$

Fig. (b) Domain structure and diffraction pattern of LCMO manganites

Fig. (c) Nearly spherical Ag nano particles

Fig. (d) Nano structures in AlN

Fig. (e) Organized Nano particles of ZnS

Fig. (f) Cross sectional TEM image and diffraction of Fe-Si Multilayer

Research Students Seminars 2004-2005

S. No.	Name of the speaker	Date	Title of the seminar
1	K. Mukherjee	08/10/04	Magnetic and transport of Manganites.
2	P. R .Sagdeo	15/11/04	Structural and transport studies of Ca doped $LaMnO_3$
3	R.S.Dhaka	10/12/04	Plasmon excitation on metal surface probed by photoemission spectroscopy
4	S. K. Pandey	11/02/05	Orbital Ordering in Transition Metal Oxides
5	Anupam Sharma	10/06/05	XPS study of anneale Mg/GaAs (100) interface
6	Dileep Kumar	24/06/05	The Role of interface structure in magnetic multilayers
7	Ashim Kr. Pramanik	15/07/05	Investigation of Magnetic and Transport properties in the Charge-Order Half-Doped Manganites
8	Ram Prakash	25/07/05	Study of ion beam induced mixing in nano-layered Si/C multilayer structures
9	Ranjeet Brajpuriya	29/07/05	Thermally induced changes in magnetic, transport and electronic properties of Fe/Al multilayers
10	Shahid Anwar	05/08/05	Structural and Dielectric studies of $Ba(Ti_{1-x}Hf_x)O_3$ relaxor
11	Parasmani Rajput	30/09/05	Depth profiling of marker layers using x-ray waveguide structures
12	Soma Banik	12/10/05	Study of ferromagnetic Heusler alloy: Ni-Mn-Ga

Some recent Ph.D.'s from UGC-DAE-CSR, Indore Centre

Sunil Nair carried out his research work for Ph.D. under the guidance of Dr. Alok Banerjee at CSR, Indore. The title of his thesis was *Magnetic and Transport Properties of Charge Ordered and Layered Manganites.* He got the '*Best Thesis Award* in the DAE Solid State Physics Symposium 2004. At present, Dr. Nair is working in the Low Temperature Physics Group, Dept. of Condensed Matter Phys. & Material Science, Tata Institute of Fundamental Research, Mumbai. He will be shortly joining Max Planck Institute for Chemical Physics of Solids, Dresden, Germany.

Deepak Sharma did his Ph.D. under the supervision of Dr. A.M. Awasthi. The title of his thesis was *Dynamical Investigations of Network Evolution in Chalcogenide Glasses*. Currently he is a Project Scientist at Nanophosphor Applications Centre (NAC), Allahabad University, Allahabad.

R. Bindu worked on $LaSrMnO_3$ system for her Ph.D. under the supervision of Dr. A.V. Pimpale. The title of her thesis was *X-Ray Spectroscopic Studies of Rare-Earth Transition-Metal Oxides of ABO_3 Type.* After her doctorate on structural and spectroscopic studies on this system, she joined NCBS, Bangalore as post-doc.

Rachana Thakur worked with Dr S.M. Chaudhari for her Ph.D. thesis topic *Study of Thermal Behaviour in Thin Film and Multilayer Structures.* After her Ph.D. she has been working as a Visiting Scientist at Paul Scherrer Institut, Villigen, Switzerland.

Archana Lakhani worked for her Ph.D. on *Physical Properties of Highly correlated Electron Systems* under the guidance of Dr. V. Ganesan. Presently she is working at Institute of Plasma Research, Gandhinagar.

Archana Jaiswal did her doctorate work on quasicrystals under the supervision of Dr. N. P. Lalla. Currently she is a visiting scientist at Centre for Advanced technology, Indore.