SAHAYOG

UGC-DAE CONSORTIUM *for* SCIENTIFIC RESEARCH

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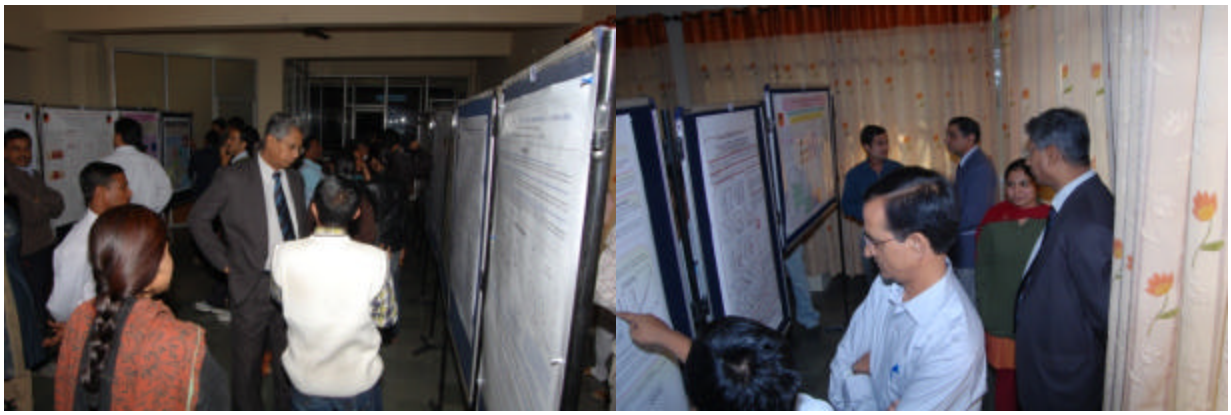
Annual Day 2010

The Annual day of UGC-DAE Consortium for Scientific Research (CSR) was celebrated on December 8, 2010. Prof. Sushanta Dattagupta, an eminent Scientist and Educationist, Director, Indian Institute of Science Education and Research (IISER), Kolkata was the Chief Guest. Prof. Dattagupta, a strong advocate for research in educational institutions commended the achievement of CSR in providing access to state of art research facilities to the university researchers. He said that providing such facilities to the university community is essential to raise the standard of basic research in India. He spoke on "Higher Education and Research: IISER Experience", where he discussed the genesis of IISER, its importance in developing fresh talents in science to further the research. He gave an insight to the course structure of IISER emphasising multidisciplinary character and integrating of teaching and research. As an illustration, he described how *diffusion* is important in various streams of science like physics, chemistry, biology, earth science, information technology etc. He described the historical character of science by highlighting the conceptually different approach to diffusion by eminent scientists and mathematicians like Fourier and Laplace and later Albert Einstein. He also highlighted how research activities are built in the course structure and brought to the notice of the gathering the quality outcome from the research activities of some IISER students.

The function started with Dr. P. Chaddah, Director, UGC-DAE CSR, welcoming the guests. He highlighted the activities of the three centres and the node at IGCAR, Kalpakkam. He informed the specific achievements of the consortium such as utilization and development of various facilities and its research activities. He highlighted the low temperature high magnetic field studies in all the three Centres of CSR describing notable research work arising out of it and described the ongoing utilization of Indus – SRS, Dhruva and VECC facilities.n He then introduced the chief guest to the gathering, highlighting his scientific achievements, recognitions and awards. Prof. Ajay Gupta, Centre-Director, UGC DAE CSR, Indore centre, proposed vote of thanks.

The function was attended by scientists and academicians from RRCAT, DAVV and other institutions and scientists and students of CSR. The address of Prof. Dattagupta was followed by a poster session highlighting the research activities / facilities of the three Centres at Indore, Kolkata, Mumbai and the Kalpakkam Node. In the afternoon session the CSR award was presented to Dr. V. Ganesan of the Indore centre. Prof. Dattagupta gave a second talk – Domain dynamics in ferroelectric films – in which he highlighted his recent research activities in this area. Following this talk, five senior research students – Bhavya Bhushan, Deepti Kothari, Suryanarayana Dash, Swati Panya and Vaishali Phatak - presented their Ph.D. thesis work and Ms. Vaishali Phatak received the best presentation award. The day ended with a classical hindusthani vocal recital by Ms. Vaishali Bakore.



Dr. S. R. Barman is elected as Fellow of Indian Academy of Sciences

Dr. Barman works in the area of electron spectroscopy and surface science. He has worked on embedded rare gas nano-bubbles in Al metal, Ni-Mn-Ga ferromagnetic shape memory alloys and alkali metal adlayers on icosahedral Al-Pd-Mn.

Resonant Photoemission spectroscopy (RPES) study using AIPES beamline installed on Indus-1 synchrotron source: Some recent results.

Considering the most abundant photon flux available from Indus-1, a beamline in the energy range of 10–200 eV for photoelectron spectroscopy experiment was developed by CSR scientists in year 2000. In this energy region, the choice of monochromator was mainly restricted to: (i) spherical grating monochromator; (ii) plane grating monochromator and (iii) toroidal grating monochromator. Toroidal grating monochromator are known for good photon flux and moderate resolution. Accordingly the beamline was developed around toroidal grating monochromator. The best way to utilize this beamline having moderate resolution is by way of doing resonant photo emission experiments. In this article we give a brief description of the resonant photoemission process. Then we describe some of the recent in-house measurements as well as the measurements carried out by different user community.

Photoemission Spectroscopy (PES), also known as **photoelectron spectroscopy**, refers to energy measurement of electrons emitted from solids, gases or liquids by the photoelectric effect, in order to determine the binding energies of electrons in a substance. The term refers to two separate techniques, depending on whether the ionization energy is provided by an X-ray photon or an ultraviolet photon.

X-ray photoelectron spectroscopy (XPS) was developed by Kai Siegbahn in 1957 and is used to study the energy levels of atomic core electrons, primarily in solids. Siegbahn referred to the technique as Electron Spectroscopy for Chemical Analysis (ESCA), since the core levels have small chemical shifts depending on the chemical environment of the atom which is ionized, allowing chemical structure to be determined.

Figure1 . *The AIPES beamline and workstation at Indus-1.*

Ultra-violet photoelectron spectroscopy (UPS) is used to study valence energy levels and chemical bonding; especially the bonding character of molecular orbitals. The method was developed originally for gas-phase molecules in 1962 by David W. Turner, and other early workers included David C. Frost, J.H.D. Eland and K. Kimura. Later, Richard Smalley modified the technique and used a UV laser to excite the sample, in order to measure the binding energy of electrons in gaseous molecular clusters.

The physics behind the PES technique is an application of Einstein's photoelectric effect. The sample is exposed to a beam of UV or XUV light inducing photoelectric ionization. The energies of the emitted photoelectrons are characteristic of their original electronic states, and also depend on vibrational state and rotational levels. For solids, photoelectrons can escape only from a depth of about 1-3 nm, so that only it's surface is analyzed.

The basic process of photoemission involves the absorption of a photon of energy $h\nu$ by the sample and ejection of an electron from the sample into the continuum. In terms of energy conservation this process can be written as

$$E^I(N) + h\nu = E^F(N-1) + E_{kin}$$

where, $E^I(N), E^F(N-1)$ and E_{kin} are the initial energy of N-electron system, final energy of (N-1)-electron system and kinetic energy of the ejected photoelectron, respectively. The photoelectrons that actually escape into the vacuum are collected, slightly retarded, energy resolved and counted, which results in a spectrum of electron intensity as a function of the measured kinetic energy. Because binding energy values are more readily applied and understood, the kinetic energy values, which are source dependent, are converted into binding energy values, which are source independent. This is achieved by applying Einstein's relation $E_k = h? - E_B$. The $h?$ term of this equation is due to the energy (frequency) of the UV light that bombards the sample.

PES is mainly divided into two categories: (i) x-ray photoemission spectroscopy (XPS) and (ii) ultraviolet photoemission spectroscopy (UPS) depending on the energy of the incident photon. Typically, for XPS it is more than 100 eV and for UPS it is less than 100 eV. The standard laboratory sources for XPS are Mg K_α ($h\nu$ = 1253.6 eV) and Al K_α ($h\nu$ = 1486.6 eV) radiations, whereas for UPS these are He I ($h\nu$ = 21.2 eV) and He II ($h\nu$ = 40.8 eV) radiations. With the use of synchrotron radiation, it is possible to cover almost all the photon energy, from a few eV to KeV.

The first Indian electron synchrotron produced radiation from its storage ring, Indus-1 at RRCAT, during April, 1999. The UGC-DAE Consortium for Scientific Research with university scientists designed and constructed an angle integrated photoelectron spectroscopy (AIPES) beamline on this 450 MeV electron storage ring. The successful commissioning of the beamline on Indus-1, was done in November, 2000, and after that various users from universities and national institutes carried out different experiments on this beamline. In this article we give a brief description of the beamline followed by report on some recent Resonant Photoemission studies carried out by different groups using this beamline.

Beamline

The angle integrated photoelectron spectroscopy beamline is designed to utilize photons in the energy range of 10 to 200 eV. The beamline operates at a vacuum better than of 10^{-9} Torr. The basic requirements for carrying out photoemission experiments are good photon flux and moderate resolution. Since toroidal grating monochromators (TGM) fulfil these two requirements, the present beamline is developed around it. Optical components of beamline consist of a pre-mirror to focus the incident radiation, a monochromator to select the desired wavelength (energy) and a post-mirror to focus the monochromatic beam on the sample.

The experimental station of this beamline is an angle integrated photoelectron spectrometer It consists of (i) an energy analyzer, (ii) an experimental chamber with XYZ sample manipulator, (iii) preparation chamber equipped with magnetic sample transfer rod, ion gun and diamond file scrapper, and (iv) the associated electronics with data acquisition system. The actual photograph of AIPES beamline shown in Figure and its specifications are available on website http: www.csr.res.in.

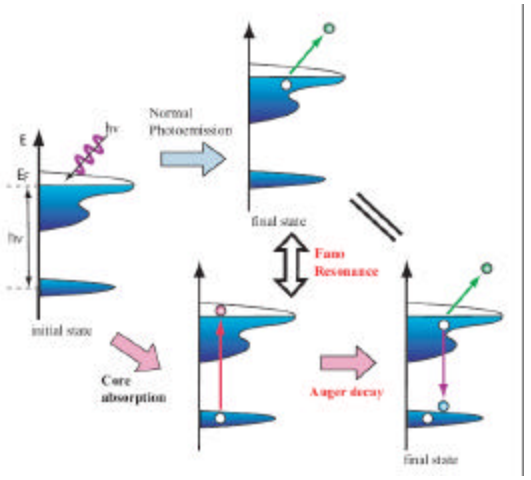


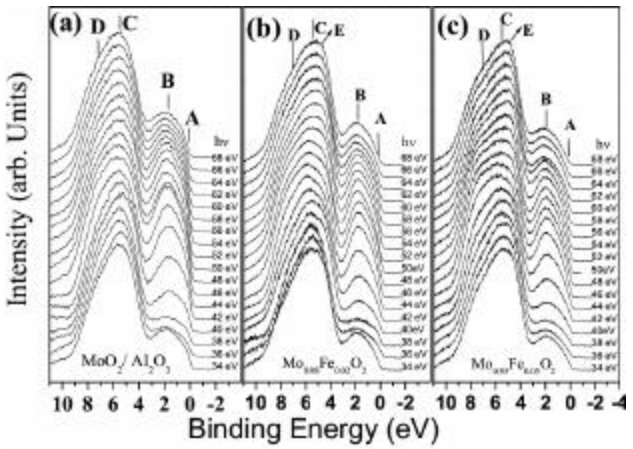
Figure 2: Schematic diagram of resonant photoemission spectroscopy (RPES). Recent measurements :

Before discussing the results on resonant photoemission spectroscopy (RPES) studies, first we will describe the resonant photoemission process. A schematic diagram of RPES is depicted in Fig 2.

With synchrotron radiation, one can use photons of variable energy. When the energy of the incident photon is equal to the energy difference between the core level and the valence states, beside the direct photoemission of a valence electron, the photo-absorption and subsequent Auger-type decay, called super Coster- Kronig decay occurs. The final states of these two processes have the same electron configuration, and therefore a quantum-mechanical interface occur. The photoemission intensity is resonantly enhanced and shows a so-called Fano profile.

a) **Electronic structure of Fe doped MoO_2 thin film**

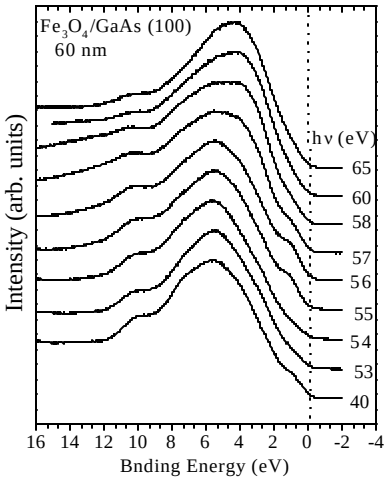
In order to understand the electronic structure of MoO_2 thin film and effect of Fe doping RPES measurements on both undoped and doped MoO_2 films were carried out by varying the incident photon energy in the Mo 4p? 4d absorption region. Figures (a, b and c) show valence band spectra of undoped, 2% Fe doped, and 5% Fe doped MoO_2 thin films taken at various photon energies respectively. It is evident from the figure when the photon energy is varied from 34 to 38 eV, a marginal decrease in the intensity of features A, B and D is noticeable. The intensity of these features increases monotonically for photon energy between 42 and 48 eV. In all the samples a broad Fano-like resonance peak at ~46 eV (Mo 4p? 4d absorption region) is observed in the whole area of the valence band, which indicates the contribution of the Mo 4d states in the entire valence band region. The doping of Fe in these films leads to a decrease in Mo 4d states



contributing to electronic states at lower binding energy region. In addition to this, we also observe a shoulder at 4.9 eV in the valence band spectra of doped samples. From the observed resonance spectra, it is proposed that the origin of this shoulder is due to the Fe hybridized states.

J. Phys. Cond. Matter.20 (2008) 335225.

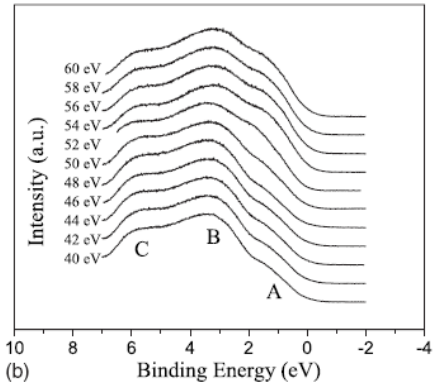
b) **Electronic structure of Fe_3O_4 thin films grown on GaAs substrate**



Fe_3O_4 is a mixed valence compound with the cubic inverse spinel structure containing Fe^{3+} and Fe^{2+} cations in the ratio 2:1. To study the electronic structure of Fe_3O_4 thin films deposited on GaAs substrate, valence band spectra were recorded near the Fe 3p? 3d absorption edge in the photon energy range of 40 to 65eV. The valance band spectra of Fe_3O_4 thin films taken at room temperature are shown in Fig. There is finite photoemission intensity at Fermi level in all the spectra, which is clearly due to the feature at the lowest binding energy, as expected since Fe_3O_4 is metallic at room temperature. In the studied binding energy range, several feature visible in the valence band spectra. The valence band derived from Fe 3d and O 2p orbitals between 0 and 10 eV binding energy show considerable variation in line shape and intensity with photon energy. The valence band spectra contain various unresolved features at various binding energy positions. All the features clearly show resonance peak at photon energy 58 eV except the feature at 1.2 eV which shows resonance at photon energy 56 eV.

Ph.D. thesis by Ram Prakash, Devi Ahilya University, Indore (2009).

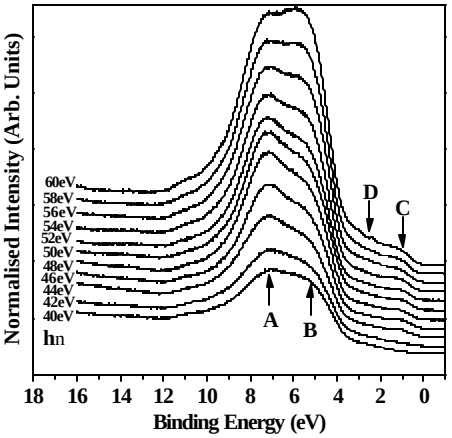
c) **Electronic structure of $La_{0.7}Ca_{0.3}MnO_3$ thin film :**



The effect of photon energy on the density of states near Fermi level of pulsed laser deposited $La_{0.7}Ca_{0.3}MnO_3$ thin film has been studied to investigate the possible origin of change in the conductivity of these manganites upon photon exposure. For this purpose the resonant photoelectron spectroscopy measurements were carried out. The valance band spectra were measured at room temperature with photon energy ranging from 40 to 60 eV (Fig.). We could see huge change in the density of states near Fermi level and this change is observed to be highest at 56 eV which is due to the resonance between Mn 3p to Mn 3d level. Our results suggest that the probability of electron transfer from deep Mn 3p level to Mn 3d-eg level which is higher than that of Mn 3d-t2g level. It appears that this transfer of electron from deep Mn level to Mn 3d-eg level not only modifies the density of state near Fermi level but also changes the mobility of electrons by modifying the electron lattice coupling due to presence of Mn^{3+} Jahn–Teller ion.

Journal of Applied Physics 107, 023709 (2010).

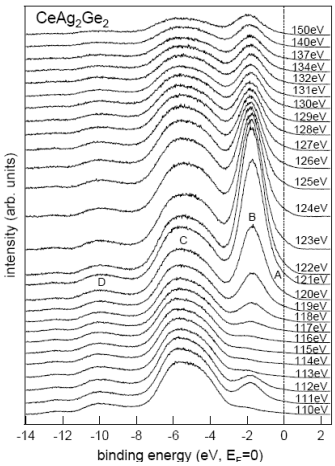
d) Electronic structure of Fe doped TiO_2 thin film :



To elucidate the effect of Fe doping in TiO_2, it is imperative to look into the modifications in the electronic structure of TiO_2 to further substantiate on the origin of magnetization in such a system. Here we study the effect of 4 at% Fe doping on electronic properties of pulsed laser deposited TiO_2 thin films on Si (111) substrate. To study electronic properties valence band spectroscopy (VBS) and resonant photoelectron spectroscopy (RPES) measurements are performed. VBS provides us the opportunity to understand the nature of the bonding associated within the surface atoms. In RPES measurements, VBS is recorded for various incident photon energies and Constant Initial State (CIS) is plotted with respect to incident photon energy. VBS and RPES studies confirm the substitutional nature of Fe ions and their participation in TiO_2 matrix as Fe ions are hybridized with O and Ti orbitals.

Proc. of DAE Solid State Symp., 54, 665 (2009)

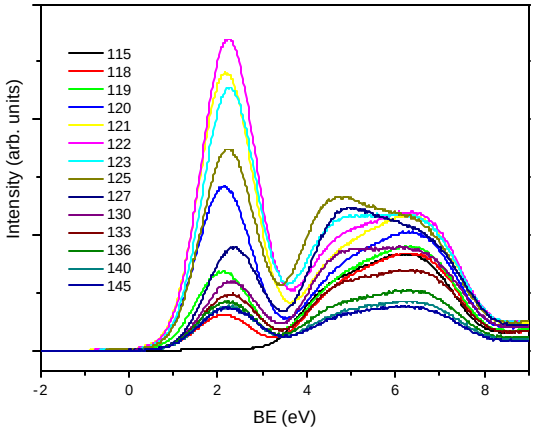
e) Electronic structure of $CeAg_2Ge_2$ single crystal



The electronic structure of $CeAg_2Ge_2$ single crystal has been investigated by using valence band photoemission at different photon energies ranging from 110 eV to 150 eV. Resonant photoemission has been observed near the 4d threshold of Ce at 121 eV. The constant initial state spectra shows two photoemission features having 4f character near the Fermi level at -0.4 eV and -1.7 eV which exhibits Fano-like sharp resonance character. The experimental spectra have been interpreted with the help of calculations based on full potential linear augmented plane wave method using density functional theory. Excellent agreement has been obtained between the theory and the experiment. The origin of the feature near to Fermi level is related to the Ce 4f states and the feature at -1.7 eV is related to the strong hybridization between the Ce 4f and 5d, Ag 4d and Ge 4p states.

Physical Review B 82, 113107 (2010).

f) Electronic structure of CeO_2 thin films prepared by pulsed laser deposition.



CeO_2 thin films on single crystal Si substrate were prepared by pulsed laser deposition technique. The single phase nature and compositions of film was examined by X-ray diffraction (XRD). Valence band spectra (VBS) measurements were performed for the electronic structure characterization of these samples. The RPES measurements on these samples were carried out at the Photoelectron spectroscopy (PES) beamline on the INDUS-I synchrotron radiation source. The valence band photoemission spectra were recorded using photon energy of 115-133 eV (see fig.). The VB spectra consists of three dominant bands of energy 2.1 eV, 4.4 eV and 6.9 eV. The lower binding energy band is mainly derived from Ce-4f states, the energy band corresponds to binding energy of 4.4 eV is derived from Ce-5d states, while the higher energy band is mostly derived from O-2p states. Resonant enhancement of the valence band emission shows a strong dependence of the valence state which makes RPES a powerful tool for the investigation of the Ce^{4+} - Ce $^{3+}$ transition and which exhibits considerable higher sensitivity than XPS of the Ce3d level. We can see that features at 2.1 eV and 4.4 eV show an enhancement in intensity for photon energies hv = 122 eV and 125 eV respectively. We note that these energies correspond to the resonance energy for Ce^{3+} and Ce^{4+} ($4f^0$) valence states.

J. Appl. Phys. 108, 103712 (2010).

Summary

Recently, a number of resonant photoemission spectroscopy measurements were performed on bulk metal, and thin films of semiconductor and oxide systems with variable incident photon energy from 30 to 200 eV using AIPES beamline on Indus-1. The reported spectra demonstrate that good quality data can be generated with the present beamline. The beamline is open for user community. For details contact Dr. D. M. Phase (email: dmphase@csr.res.in) or Dr. T. Shripathi (email: shri@csr.res.in).

List of faculty whose groups are users:

1. Prof.S.I.Patil, Pune University
2. Dr. S. Kale, D.IT Pune
3. Prof. P.C. Shrivastava, B.H.U
4. Prof. B.L. Ahuja, M.L.S. University, Udaipur
5. Prof. Pratima Sen, Devi Ahilya University, Indore
6. Dr. Ratnesh Gupta, DAVV, Indore
7. Prof.. Sundara Raja, Tirupati University
8. Prof. Subramaniam, IIT, Chennai
9. Dr. S.K. Kulkarni, Pune University / Banasthali
10. Prof. Sanyal, Baraktullah,Bhopal

D.M. Phase

AWARENESS WORKSHOP ON
"THE FACILITIES OF UGC-DAE CONSORTIUM FOR SCIENTIFIC RESEARCH"

An awareness workshop on "The facilities of UGC-DAE Consortium for Scientific Research (UGC-DAE CSR)" was held at the Department of Physics, Manipal Institute of Technology (MIT), Manipal – 576104, Karnataka during September 6-7, 2010. The workshop started with a brief inaugural function. Dr G K Prabhu, Registrar, Manipal University was the chief guest. Dr Ajay Gupta, Centre-Director, UGC-DAE-CSR, Indore was the guest of honour. Dr R S Aithal, joint director, MIT, Manipal presided over the inaugural function of the workshop. Prof. Ashok Rao, head of the physics department, MIT welcomed the gathering. Dr Y Raviprakash of MIT, physics department was was the master of ceremony.

Prof. Ajay Gupta delivered his inaugural address highlighting the motive of the workshop and invited researchers from universities and colleges to actively participate in the research programs of CSR that will be a mutually beneficial one. About 40 participants attended the workshop from all the major universities of region close to Manipal, apart from the local participants. Lectures were delivered by the Scientists of Consortium, Dr.S.K.Deb, Dr.A.K.sinha and Dr.S.S.Jha of RRCAT and Prof.Ashok Rao of MIT. The participants raised questions about various current scientific issues that were answered by the speakers and senior scientists in the gathering. Prof.P.R.Ramesh of MIT, Physics department proposed the vote of thanks.

Prof. Ajay Gupta delivered two talks covering "Overview of facilities at UGC-DAE CSR, Indore Centre" and "Thin film preparation and characterization techniques viz., XRR, GIXRD and MOKE". Dr. A.V.Pimplae delivered a talk covering "Overview of facilities at UGC-DAE CSR, Mumbai Centre". Dr.S.K.Deb delivered talk covering "Synchrotron Radiation facility at RRCAT, Indore". Dr.V.Ganesan delivered two talks covering "Low temperature and high magnetic field facilities & Scanning Probe microscopy". Dr. N.P. Lalla delivered a talk on "Transmission Electron and Scanning Electron Microscopy". Dr.T.Shripathi delivered a talk on "Photoelectron microscopy". Dr.M.Sudarshan delivered a talk on "Overview of facilities at UGC-DAE CSR, Kolkata Centre". Dr.V.R.Reddy delivered a talk on "Mossbauer and Raman Spectroscopy" and Prof.Ashok Rao delivered a talk on "Overview of facilities at Manipal Institute of Technology".

AWARENESS WORKSHOP AT IIT MADRAS

The Mumbai Centre of the UGC-DAE CSR organized an awareness workshop at IIT Madras in collaboration with the Department of Physics of the IIT during September 27-29, 2010. The theme of the workshop was on condensed matter research facilities at the different centres of the CSR – Mumbai, Indore and Kolkata with special emphasis on neutron scattering facilities at the Dhruva reactor, BARC available through the Mumbai Centre. The workshop was meant primarily for the young faculty and research students working in the different areas of condensed matter research at the colleges and institutions in and around Chennai. About forty such participants plus about ten research students of IIT Madras attended the workshop. One day of the workshop was devoted to a visit to IGCAR, Kalpakkam to acquaint the participants with the upcoming node of UGC-DAE CSR and research facilities being established there. The speakers at the workshop were drawn from the faculty of all the three centres of UGC-DAE CSR, DAE laboratories BARC, Mumbai, RRCAT, Indore, IGCAR, Kalpakkam and IIT Madras.

The workshop began with Dr P. Chaddah, Director, UGC-DAE CSR, Indore stressing the mandate of the CSR – to improve the quality of research at universities and colleges by making available mega research faculties of DAE such as the neutron

scattering facilities at the Dhruva reactor at BARC, Mumbai, synchrotron radiation sources INDUS1,2 at RRCAT, Indore, high energy accelerated ions from Variable Energy Cyclotron Centre, Kolkata as well as various accelerators and other experimental facilities at IGCAR, Kalpakkam and IOP, Bhubaneshwar. These facilities are supplemented by characterization and sample preparation facilities as well as other middle level but unique experimental research facilities available at the laboratories of CSR, particularly at Indore centre. He highlighted the sample environment of low temperatures available from in house liquid helium plant and high magnetic fields up to 14 Tesla for doing various measurements – electrical, magnetic and thermal properties as well as spectroscopic, structural and microscopic studies. He invited the participants to visit the CSR laboratories and interact with the various scientists to enlarge the scope of their research work.

Dr. R. Mukhopadhyay, BARC described in detail the various neutron scattering instruments installed and commissioned at the Dhruva reactor. These are collectively termed as NFNBR or National Facility for Neutron Beam Research and include three powder diffractometers for different types of crystal structure studies, two small angle neutron scattering set ups for studying structures of large molecules over distances of several nanometers, a high q-diffractometer for studying alloys and glasses, a spectrometer and a reflectometer both using polarized neutrons, a quasi elastic spectrometer, a triple axis spectrometer, neutron radiography facility and a host of other instruments. He also described some specific physics applications of these instruments such as study of voids in zeolites by using quasi elastic scattering of neutrons, magnetic structures in manganites and other novel compounds etc. All these instruments are available to the university academic community and CSR-Mumbai Centre provides a mechanism for doing collaborative research projects using these facilities. Dr. V. K. Aswal, BARC described the SANS – small angle neutron scattering facilities at the Dhruva reactor, BARC. There are two such instruments, both use neutrons from guide tubes. One set up utilizes a BeO filter as monochromator and a set of slits for defining incident neutron direction. Typical problems studied include protein crystallization, gelation studies and studies of surfactants etc. The other set up utilizes two Si (111) crystals in anti parallel mode for getting monochromatic neutrons and it has a some what higher resolution in comparison to the former set up.

Dr S. K. Deb, RRCAT, Indore described the synchrotron radiation sources INDUS-1,2 and the various beam lines and experimental stations installed and under development on these for doing research work. INDUS-1 is a 450 MeV electron storage ring giving light mostly in the xuv region of the electromagnetic spectrum with a critical wavelength of about 60 Å. A number of beam lines, including one by CSR, Indore centre, are installed and commissioned at bending magnets on INDUS-1. These include beam lines for doing angle integrated and angle resolved photoelectron spectroscopy studies in the photon energy range 10 to 200 eV, a photo physics beam line in the vuv range for studying atoms and molecules in the gas phase. INDUS-2 is a storage ring with electron energy of 2.5 GeV. INDUS-2 can thus give radiation in the hard X-ray region of the electromagnetic spectrum. A number of beam lines on INDUS-2 are at various stages of development. Three beam lines are almost complete and undergoing various evaluation tests – EXAFS beam line using an elliptically bent single crystal to focus a polychromatic beam just in front of a sample and a linear position sensitive detector put a little distance behind the sample, so that absorption at different wavelengths could be monitored as a spectrum on the linear detector, energy dispersive x-ray diffraction beam line and angle dispersive multipurpose diffraction beam line. CSR Indore Centre is involved in developing two beam lines on INDUS-2: a magnetic circular dichroism beam line for studying absorption of polarized x-radiation and an imaging beam line.

Professor A. Gupta gave a bird's eye view of the large number of sophisticated experimental facilities available at the Indore centre of the CSR. These include sample preparation techniques – a number of furnaces including arc furnace, a planetary ball mill, thin film deposition systems using magnetron sputtering, pulsed laser deposition, thermal evaporation, electron beam and ion beam assisted evaporation, X-ray diffractometer for sample characterization and structural studies, scanning electron microscope and transmission electron microscope, various atomic force microscopes and a confocal microscope, spectroscopic techniques of laser Raman, UV-vis_NIR, Auger and photo electron as well as inverse photo electron spectroscopies, Mossbauer and EXAFS, using Kerr effect to do magnetic studies, and bulk condensed matter studies of electrical, magnetic and thermal properties including VSM and squid magnetometer . The centre has well equipped low temperature facilities –liquid helium and liquid nitrogen plants, a dilution refrigerator and a host of dedicated CCR's so that almost all studies can carried out at temperatures down to liquid helium. High magnetic field (up to 14 Tesla) sample environment coupled with these low temperatures is also available for measurement of some electric and magnetic properties.

Dr A. V. Pimpale gave a talk on basic interaction between neutrons and condensed matter. Before coming to this main topic of his presentation, he described in brief the Mumbai centre of the CSR and mentioned about their regular programs of neutron school for fresh researchers entering the field of neutron studies of condensed matter and collaborative research projects in this area supported by CSR. He then discussed the nuclear and magnetic interactions of low energy thermal neutron with a nucleus. The neutron nucleus interaction is described by just one parameter - the scattering length. He pointed out the advantages of neutron scattering as compared to X-ray scattering arising from irregular dependence of the cross section on

atomic number and the relative sensitivity of neutrons to low atomic number nuclei. The magnetic scattering of neutrons yields unique information about magnetic order in the scatterer.

Dr V. Siruguri described the neutron powder diffractometer (PD3 of NFNBR) put up at the Dhruva reactor by the CSR Mumbai centre. This instrument has several unique features – open geometry, toroidally bent crystal monochromator focusing neutrons at the sample position in both vertical and horizontal planes, oscillating radial collimator in the path of neutrons diffracted by the sample to improve signal to noise ratio, an array of overlapping linear position sensitive detectors to cover a wide angular range and a sample environment of low temperatures down to 2.2K and high magnetic fields up to 7 Tesla It is thus a very powerful instrument (because of high flux and resolution) to study magnetic structures and Dr Siruguri described some interesting results obtained using it by university researchers studying multiferroic materials, shape memory alloys etc.

The last talk on the first day of the workshop was delivered by Dr A. K. Sinha. He described the experimental research facilities available at the Kolkata centre of the CSR and the various collaborative projects undertaken by the university researchers at the variable energy cyclotron centre, Kolkata, Institute of Physics, Bhubaneshwar and the Indian National Gamma Array comprising a large number of clover nuclear detectors along with ancillary equipment located at present at TIFR, Mumbai. The Kolkata centre specializes in using nuclear experimental techniques for study of physical, chemical, biological and environmental problems. Illustrative studies include behaviour of biological cells under radiative stress conditions, distribution of trace elements in environment, radiation induced synthesis of inorganic and organic nano composites, nuclear level structure in some nuclei of current interest etc. Recently Kolkata centre has been identified by DST, New Delhi as a special centre for low temperature high magnetic field studies for the north east area of the country and a 7 Teasla squid magnetometer has been commissioned. Other experimental facilities at Kolkata centre include positron life time set up, Mossbauer spectroscopy system and various facilities in biology and chemistry as well as condensed matter and nuclear physics laboratories. Dr Sinha also described the work under development at VECC for installing and commissioning a beam line at VECC for condensed matter studies.

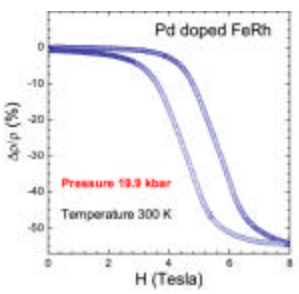
The second day of the workshop was devoted to a visit to the laboratories at IGCAR, Kalpakkam. Drs G. Amarendra and C. S. Sundar, IGCAR helped in organizing this visit. CSR has set up a node at IGCAR for helping university researchers to better utilize the experimental facilities at IGCAR.. Dr Amarendra described the new high end experimental facilities that are being set up at this node. These include transmission electron microscope, scanning electron microscope, X-ray diffractometer, infrared single crystal growth furnace, ball mill, hot isostatic press, ball indentation etc. Dr Sundar gave an overview of the research activities of IGCAR, particularly from material science perspective. He discussed the problem of swelling of materials in the radiation environment and various approaches to study and develop materials that can be used in and around a nuclear reactor.

On the third and last day of the workshop Drs P. D. Babu, S. K. Deshpande from CSR, Mumbai centre and Professors Harish Kumar and P. N. Santosh both from IIT Madras gave talks. Dr Babu discussed magnetic neutron diffraction – the basic theory, data analysis and some illustrative examples. Dr. Deshpande discussed complementary X-ray diffraction techniques and the dielectric spectroscopy studies available at the CSR Mumbai Centre, the latter extending over a frequency range of micro hertz to mega hertz. Prof. Santosh's talk dealt with his recent work on structure – property correlation in oxide materials, particularly perovskites. Prof. Harish Kumar described the physics department of IIT Madras – the faculty, experimental facilities available and the kind of research work that is being done.

Finally, a concluding session was organized to get the feedback from the participants. All the participants were highly appreciative of the information received from various presentations at the workshop. Dr. P. D. Babu, CSR, Mumbai Centre and Prof. Harish Kumar, IIT Madras had jointly borne the burden of organizing the workshop.

New Instruments:

High Pressure cell for resistivity/magnetoresistance from easyLab Technologies, UK has been installed. With this addition resistivity and magnetoresistance measurements (1.5 K – 300 K and up to 8 Tesla magnetic field) are now possible in the presence of up to 25 kbar pressure. Figure shows giant magnetoresistance in Pd doped FeRh at room temperature under 19.9 kbar pressure. At ambient pressure it shows spontaneous AFM-FM transition around (T_N) 200 K. The application of pressure shifts T_N to higher temperature resulting in AFM state at room temperature. With the application of magnetic field induced first order transition from AFM to FM state give rise to giant magnetoresistance.



Rajeev Rawat

Foreign Visits by Faculty and Students of CSR:

S No	Name	Place visited	Date	Purpose
1	Dr. Archana Lakhani	UC Kavli Institute for theoritical Physics, Santa Barbara, USA	April 12, 2010 - Jul 9, 2010	To attend the programme on Physics of Glasses: Relating Metallic Glasses to Molecular, Polymeric and Oxide Glasses
2	Mr. Sadhan Ch Das	University of Greifswald, Germany	July 1-31, 2010	Academic and Engineering
3	Dr. Mukul Gupta	(i) ILL, Grenoble, France (ii) PSI, Switzerland	July 12-30, 2010	Neutron reflectivity experiments
4	Mr. S. M. Amir	(i) ILL, Grenoble, France (ii) PSI, Switzerland	July 12-31, 2010	Neutron reflectivity experiments
5	Ms. Ranjeeta Gupta	ILL, Grenoble, France	July 12-22, 2010	Neutron reflectivity experiments
6	Dr. Mukul Gupta	Horiba Jobin Yvon, France	September 27-October 3, 2010	Technical inspection of polarized light beam line
7	Dr. D. M. Phase	Horiba Jobin Yvon, France	September 27-October 3, 2010	Technical inspection of polarized light beam line
8	Dr. Mukul Gupta	PSI, Switzerland	October 12-19, 2010	Neutron reflectivity exp eriments
9	Prof. Ajay Gupta	Elettra Synchrotron Radiation source, Trieste	October 17 – 25, 2010	Experiment at SAXS beamline
10	Dr. Archana Lakhani	Paul Scherrer Institute, Villigen, Switzerland	October 17-26, 2010	Experiments on FOCUS spectrometer on Spalation Neutron Source SINQ
11	Ritwika Chakrabarti	American Physical Society Division of Nuclear PhysicsSanta Fe, New Mexico, U.S.A	November 2-6, 2010	Presentation at the 2010 Annual Fall Meeting of American Physical Society
12	Dr. Anindita Chakraborty	Chongqing, China	November 13 - 14, 2010	To attend EPS Global International Cancer Forum Conference..
13	Dr. S. Kaushik	Atlanta, Georgia, USA	November 14-18, 2010	55th conference on Magnetism and Magnetic Materials
14	Ms. Pallavi Kushwaha	Warwick University, Coventry, UK	December 14-16, 2010	Conference on Condensed Matter and Materials Physics (CMMP10)

Talks by CSR faculty / Students:

1. Cultivation of Research in MP - A 'Nano' Perspective, Dr. V. Ganesan, at MPCST council meeting at Bhopal on August 28, 2010.
2. UGC-DAE Consortium for Scientific Research: Fostering Academia for Prosperity through Atomic Energy, G. S. Okram at Centenary Hall, Manipur University, Imphal in one day national seminar on "Atomic Energy for Peace, Power and Prosperity" organized by Indian Nuclear Society and Department of Physics, Manipur University, August 28, 2010.
3. Material characterization and physical properties measurement facilities at UGC-DAE CSR, Indore, G. S. Okram *at* Department of Physics, Manipur University, Imphal, September 6, 2010.
4. Motivating young minds through scientific approach, *G. S.* Okram at Brilliant Academy, Thoubal, Manipur, September 9, 2010.
5. Recent Trends in Nanotechnology, Dr. V. Ganesan, at a "National Level Technical Symposium (TECHNO-SCET 2K10)" at Swarnandhra College of Engineering and Technology, Narasapur, AP on September 15 2010.
6. Phase-coexistence in half-doped manganites and in other magnetic materials, P. Chaddah at International Conference on Physics of Emerging Functional Materials September 22-24, Mumbai.
7. Invited talk at the International Conference on 'Swift Heavy Ions in Materials Engineering and Characterization', New Delhi, October 6-9, 2010.
8. Glasslike arrest of first order magnetic transitions : studies using CHUF protocol,P. Chaddah at International Conference on Magnetic Materials (ICMM-2010), October 25-29, 2010, Kolkata.
9. Differential modulation of xenobiotic metabolizing enzymes by vanadium during diethylnitrosamine-induced hepatocarcinogenesis in Sprague-Dawley rats, Anindita Chakraborty , at EPS Global International Cancer Forum Conference, Chongqing, China, November 13 -14, 2010.
10. X-ray Photoelectron Spectroscopy, T. Shripathi at National Conference on Experimental Tools for Material Science Research: State of Art, Mahila Mahavidyalay, Banaras Hindu University, December 03- 04, 2010
11. Current Status of Nano Research in Indian University System and possible remedies, Dr. V. Ganesan, at Nano-2010 (Panel Discussion, held at KSR Group of Institutions at Tiruchengodu, TN., December 15, 2010.
12. Characterization of Semiconducting materials, Dr. V. Ganesan, at the National Level Seminar at N.M.S.S.Vellaichamy Nadar College, Madurai on 16 Dec 2010.

13. Study of magnetic phase separation and metastability across first order magnetic transition, Pallavi Kushwaha at Condensed Matter Physics Division, Warwick University, Coventry, UK on December 17, 2010.
14. Observation of M-Smegmatis (Tuberculosis) – D29-nano-phages interaction using Atomic Force Microscopy, Dr. V. Ganesan, at the 12th International Conference of International Academy of Physical Sciences (CONIAPS XII) on Emerging Interfaces of Physical Science being organized by the University of Rajasthan during December 22-24, 2010.

New Appointments:

Dr. Gopalkrishna M. Bhalerao joined CSR in Sept 2010 as Scientist-D.

After completing MSc from Maharshi Dayanand Saraswati University Ajmer in 2000, he started his doctoral studies on growth of carbon nanostructures, their characterization and annealing studies at Raja Ramanna Centre for Advanced Technology Indore in 2003 under the supervision of Dr. R. V. Nandedkar. His post-doctoral work includes : (synchrotron radiation based at ELETTRA and SOLEIL) high-pressure XRD and EXAFS studies on ternary $Zn_{1-x}Be_xSe$ alloys at IMPMC, Université Pierre et Marie Curie, Paris (2008-2009); and growth of high performance piezoelectric single crystals with hydrothermal technique and their structural, elastic and dynamic disorder studies as a function of temperature at Université Montpellier-2 (2009-2010). Presently he has been posted at the Kalpakkam Node of the Consortium.

Dr. Sujoy Chakravarty joined CSR in Oct. 2010 as Scientist-D.
After completing M.Sc. (Physics) from St. Andrews Degree College (Affiliated to D. D. U. Gorakhpur University) in Year 2001 he joined UGC-DAE CSR as a research student. He obtained his Ph.D. from DAVV in the year 2008. From Year 2007 to 2010 he worked as a scientific coworker at Institute for Metallurgy, Technical University, Clausthal (Germany) in a project entitled "Selbstdiffusion in nanokristallinen Metallen bei niedrigen Temperaturen" (Projektnummer: SCHM1569/10-1,2). The project was sponsored by German research foundation (DFG). Presently he has been posted at the Kalpakkam Node of the Consortium.

Dr. Shamima Hussain joined CSR in Oct. 2010 as Scientist-D.
She is a Ph.D of the year 2007 from the Indian Association for the Cultivation of Science, Kolkata under the Jadavpur University. Thereafter she joined the Indian School of Mines University, Dhanbad, as a faculty in the Department of Applied Physics. After that, she joined the Solid State Physics Center at National University of Korea where she was associated with the programme on GaN based LEDs. She then joined the research group at King Abdullah University of Science & Technology at Thuwal-Jeddah where worked in close association with the Department of Materials, Imperial College London, UK. She has her expertise in synthesising thin films using various techniques. She also has experience in the characterization of thin films. She is also posted at the Kalpakkam Node of the Consortium.

Other Appointments:

Rajeev Bhagwat
Administrative Officer-I

Vinod Savaner
Scientific Asst. B

Rakesh Kumar Sah
Scientific Asst. B

Jaganmoy Biswas
Scientific Asst. B

Resignation: Mr. D Gupta resigned from CSR in December 2010 to join Gharwal University as Deputy Registrar. He has been working in the Consortium's Indore Centre as Administrative Officer I for 11 years. We wish him the very best in his future career.

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- Patil KC, Hegde MS. Tanu Rattan, ST. Chemistry of namocrystalline oxide materials: combustion synthesis, Properties and applications, Singapore: World Scientific; 2008.

Awards (Users):

Mr. Savan R. Mankadia, Department of Physics, Saurashtra University, Rajkot received the best poster award presentation at the International Symposium for Research Scholars on Metallurgy, Material Science and Engineering (ISRS 2010) held at IIT Madras, Chennai during Dec. 20-22, 2010.

PhD awards:

1. Ms. Sharmistha Bagchi, has been awarded Ph.D. degree from DAVV under the supervision of Dr. N. P. Lalla. Thesis Tiltle: Structural and Electrical Characterization of Metallic Thin films and Multilayers
2. Ms. Aparna Datta has been awarded Ph.D. degree from Jadavpur University under the supervision of Dr. Abhijit Saha and co-supervision of Prof. K. K. Mukherjea. Thesis Tiltle: Synthesis of CdS Nanoparticles in Aqueous and Organic Phase by Chemical and Radiolytic Techniques and its Possible Interactions with Molecules of Biological Relevance.

Edited by: Dr. T. Shripathi