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ANNUAL DAY - 2005

UGC-DAE Consortium for Scientific Research celebrated its Annual Day Function on Wednesday, December 14, 2005. The chief guest of the annual day function was Professor Ajay Sood, Department of Physics, Indian Institute of Science, Bangalore. He spoke on "Exciting Journey through Nanotubes". The other invited speakers for the day were: Professor Ajit Kembhavi, Inter University Centre for Astronomy and Astrophysics, Pune, Professor R. V. Upadhyay, Bhavnagar University, Professor Ajay Gupta and Dr. Ajit Sinha both Centre-Directors of the Indore and Kolkata centers of the Consortium. The occasion was used for presentation of the Prof. R. Srinivasan award for low temperature physics / cryogenics for the years 2002-03.

The function started with Dr P. Chaddah, Director, UGC-DAE CSR welcoming the guests. He reviewed the progress made by the institution since its inception in 1990. The significant achievements include the installation of a beam line at INDUS-1, at CAT, Indore, the progress on a neutron beam line on Dhruva reactor at BARC, Mumbai and the work on clover gamma detector array for nuclear experiments. The other achievements of the institute involves a large number of on going projects in association with university scientists and the consequent high quality research output indicated by publication of a number of research papers in prestigious international and national journals. He specifically mentioned the cooperation of the Devi Ahilya University in establishing the institute through making land available on its campus for the institute. Finally, he emphasized the fact that researchers create new knowledge and the Consortium and the University researchers will work together in this endeavor.

Dr Chaddah then introduced the chief guest of the Annual Day Function, Professor Ajay Sood, an eminent professor of physics from Indian Institute of Science, Bangalore. Professor Sood has over a couple of hundred research publications in various national and international journals, including 20 in very prestigious journals like Science and Physical Review Letters and also has five patents. Prof. Sood's curiosity driven research naturally covers basic and applied aspects. He is a fellow of both Indian National Science Academy, New Delhi and Indian Academy of Sciences, Bangalore and recipients of many prestigious awards including the Bhatnagar Award, Birla award and the UGC's Prof. C. V. Raman award.

In his address Professor Sood described the progress made in the field of materials at the level of nanometer dimensions and its possible applications – in nano-electronics, for hydrogen storage, flat displays, sensors. He also mentioned futuristic science fiction applications of space elevators using the very high mechanical strength of the carbon nanotubes. He went on to describe the details of work done in his laboratory in this field, particularly in the context of stability of nanotubes, interaction with DNA and organic

bases and fluid flow in these tubes generating electrical signals making possible a development of vibration sensor in liquid environment.

Professor Kembhavi gave a talk on "Black holes: from Newton to Einstein". Starting with Newtonian concepts of gravitational field and the possibility of so strong fields that even light cannot escape, thus creating a black hole; he went on to describe the fundamental changes in our understanding of the world with Einsteinian concepts of special and general theories of relativity and the singularities in space-time. He also described experimental searches for the black holes at the center of our galaxy.

Professor Upadhyay spoke on "Magnetic fluid research at the Bhavanagar University". He appreciated the support Prof. R. V. Mehta and he received from the Consortium over the years. Professor Gupta spoke on "X-ray standing waves in structural characterization with nanometer depth resolution" and Dr Sinha's talk dealt with "Exotic shapes and structures of atomic nuclei: studies using the Indian National Gamma Array".

Dr. R. G. Sharma, retired scientist from the National Physical Laboratory, New Delhi - the recipient of R. Srinivasan award - spoke on his research and development work.

A new feature this year was the 'Poster session' organized for displaying the research work done during the preceding year by the students of the Consortium. The lively enthusiasm of the students and the high quality of work presented was very much appreciated by the distinguished visitors and other guests.

Prof. Ajay Gupta proposed the vote of thanks. The day ended with a concert of classical music In the evening.

New Appointments in UGC-DAE CSR

Recently, Dr Mukul Gupta and Dr Ram Janay Chaudhary have joined the faculty of our Mumbai and Indore Centres, respectively.

Dr. Mukul Gupta did his Ph. D. at UGC-DAE CSR Indore during 1997-2002 under the supervision of Prof. A. Gupta. He joined Paul Scherrer Institute, Villigen, Switzerland in 2002 as a postdoctoral fellow and worked as an instrument scientist at a neutron reflectometer for three years. His field of research is hard condensed matter physics and centered on studies of thin films and multilayers of amorphous and nano crystalline alloys from the point of view to study the structural and magnetic properties and atomic self-diffusion in nano scale multilayers

Dr Ram Janay Chaudhary did M. Sc. (Physics) from Allahabad University in 1998 and Ph. D. from Pune University under the supervision of Prof. S. I. Patil (Department of Physics, University of Pune, Pune) and Dr. Ravi Kumar (Nuclear Science Center, New Delhi) in 2005. Collaboration with Nuclear Science Center, New Delhi, India and Center for Superconductivity Research, University of Maryland, College Park, USA was very fruitful in his doctorate work. His research topic was "Growth and Properties of Functional Magnetic Oxides and Their Irradiation Studies". He was a recipient of prestigious Embark Fellowship offered by Government of Ireland for Postdoctoral Fellowship in Science, Engineering and Technology (2005) and visited Department of Physics, Trinity College, Dublin, Ireland.

The Twelfth Workshop on "Neutrons as Probes of Condensed Matter" (NPCM-XII)

The twelfth workshop on "Neutrons as Probes of Condensed Matter" (NPCM-XII), jointly organized by UGC-DAE CSR and Solid State Physics Division (SSPD), BARC, was held at BARC, Mumbai on February 24-25, 2006. The workshop consisted of lectures covering all aspects of neutron scattering, and a visit to the neutron scattering facilities at the Dhruva reactor. The participation in the workshop was open to faculty and research students from universities and institutes in India. In addition to creating awareness about applications of neutron scattering techniques to materials science, the workshop aimed at generating fresh proposals for collaborative research through familiarity gained with these techniques during the workshop.

A total of 36 persons, comprising 25 faculty members and 11 research students from various universities and institutes in India, participated in the workshop. Dr. R. Mukhopadhyay, SSPD, BARC, and Dr. S. K. Deshpande, UGC-DAE CSR Mumbai Centre, were the coordinators.

The workshop began with some introductory remarks by Dr. J. V. Yakhmi, Associate Director (S), Physics Group, BARC, during a brief and informal function at the B-block Auditorium, Modular Labs, BARC, on February 24. After some remarks by Dr. P. Chaddah, Director, UGC-DAE CSR, by Dr. S. Kailas, Associate Director (N), Physics Group, BARC and by Dr .S. L. Chaplot, Head SSPD, BARC, the sessions began with a talk by Dr. Chaplot on "Neutron Scattering- Principles and Facilities", followed by a talk on "Neutron Experiments under Collaborative Research Schemes" by Dr. P. S. Goyal, Centre-Director, UGC-DAE CSR, Mumbai Centre. Dr. Goyal described some results obtained by university researchers with the Dhruva reactor. This was followed by a visit to Dhruva reactor hall where the participants could see the existing neutron spectrometers and interact with SSPD scientists.

The second day's sessions were held at Multipurpose Hall, BARC Training School Hostel. They included lectures by several scientists from SSPD, BARC on neutron powder diffraction, magnetic neutron diffraction, neutron diffraction from disordered materials, single-crystal diffraction, small angle neutron scattering, neutron inelastic scattering, neutron quasi-elastic scattering, and neutron reflectometry.

The workshop concluded with a feedback session. The participants were satisfied with the workshop and many faculty members showed interest in utilizing the neutron scattering facilities through collaborative research schemes.

Orientation Seminar on Applications of Radiation in Inter-disciplinary Sciences

A one-day seminar on "Applications of Radiation in Inter-disciplinary Sciences" was held at the Anand Mohan College, one of the leading undergraduate colleges of Kolkata on 10th October 2005. The purpose of the workshop was to create awareness among students and faculty of undergraduate colleges about the various applications of radiation in interdisciplinary sciences, with special emphasis on various types of interdisciplinary research being carried out at the UGC-DAE CSR, Kolkata Centre.
Presentations were made by the faculty of the UGC-DAE CSR, Kolkata Centre on various topics such as Radiation detectors; Use of radio-isotopes and ion beams in material characterization/modifications; Irradiation studies in Chemical and Biological; Elemental characterization using X-rays & Ion beams. Presentations, which were made more on a popular level, were widely appreciated both by students and faculty with interactive question answer sessions. In all, 95 students and teachers from 12 undergraduate colleges participated in this seminar.

Awareness Workshop on the Facilities of UGC-DAE CSR, November 18-19, 2005
Department of Physics, University of Rajasthan, Jaipur

An awareness workshop on "The facilities of UGC-DAE Consortium for Scientific Research" was held at the Department of Physics, University of Jaipur, Rajasthan during November 18-19, 2005. The workshop started with a brief inaugural function. Prof. B. K. Srivastava, Head of the Department of Physics welcomed the participants and speakers. Prof. B. K. Sharma, Dean inaugurated the workshop and assured the Consortium of his continued support. Dr. P. Chaddah, Director, UGC-DAE CSR invited researchers from universities and colleges to actively participate in the research programs of the Consortium for mutual benefit. He emphasized that collaborative research would yield quality output in terms of peer reviewed publications and generate expertise hitherto not available. Dr.R.V.Nandedkar, Head, Synchrotron Utilization Division, RRCAT Indore, Prof. Ajay Gupta, Centre Director, CSR Indore Centre, Dr. P. S. Goyal, Centre Director, CSR Mumbai Centre also attended the inaugural function.

The workshop was attended by 20 outstation and 77 local participants including the faculty of the Physics Department, Research students and teachers and interested researchers from local colleges in Jaipur. Dr.R.V.Nandedkar, RRCAT, Prof. B.K.Srivasatava, Dr. Y. K. Vijay and Dr. Y. K. Sharma, Jaipur, and the Scientists of the Consortium delivered scientific talks. Dr. Nandedkar gave his talk on synchrotron radiation sources at RRCAT, Indore and highlighted the importance of large-scale accelerator facilities and the need for an active participation by the university researchers. Prof. Ajay Gupta briefed about the different collaborative research programs through which university researchers can interact, and the modalities of functioning. Dr. Ganesan talked on scanning probe microscopy, Dr. Lalla on SEM and TEM facilities and XRD; Dr. Shripathi and Dr. Barman on PES, and Dr. Sathe on EXAFS and Raman spectroscopy. Dr Goyal and Dr Ghugre gave overviews of research facilities at Mumbai and Kolkata Centres of the Consortium respectively. The workshop had an interactive session with the participants of the workshop and students along with the scientists convened by Dr. Nandedakar and Dr. Goyal and the participants considered it as a very useful event.

Awareness Workshop on the Facilities of UGC-DAE CSR, March 4-5, 2006
Department of Physics, Osmania University, Hyderabad

An awareness workshop on "The facilities of UGC-DAE Consortium for Scientific Research" was held at the Department of Physics, Osmania University, Hyderabad during March 4-5, 2006. The workshop started with a brief inaugural function. Prof. P. Yadagiri Reddy, Department of Physics, Osmania University (O.U.), welcomed the participants and speakers. Dr. P. Chaddah, Director, UGC-DAE CSR inaugurated the workshop. Prof. Mohd. Suleman Siddiqi, Vice-Chancellor, O.U., was the chief guest and Prof. B. Ramaprasada Rao, Dean, O.U. presided over the inaugural function of the workshop. Dr. Chaddah delivered his 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. Prof. Siddiqi was appreciative of the Consortium's work and encouraged the participants to utilize the help of the Consortium to the fullest. Prof. Ajay Gupta, Centre Director, CSR Indore Centre, briefed about the different collaborative research programs through which university researchers can interact and the modalities of functioning. Prof. K. Rama Reddy, Emeritus Scientist, O.U., Prof. R. Murthy, Head, Physics Department, O.U. and Dr. R.V.Nandedkar, Senior Scientist, RRCAT, Indore also attended the inaugural function,

About 75 participants attended the workshop from all the major universities of Andhra Pradesh and there were a few participants from Gulbarga University, Gulbarga. Invited lectures were delivered by the Scientists of Consortium and also by Dr.R.V.Nandedkar, RRCAT, Indore, Dr. Amarendra, IGCAR, Kalpakkam and Prof. R. Murthy, O.U. Dr Nandedkar described the synchrotron sources at RRCAT and Dr Amarendra gave an overview of the facilities at MSD, IGCAR. Prof. Gupta talked on the general facilities at the Indore Centre of CSR and also discussed XRR, GIXRD, standing wave based experiments and high resolution XRD. Dr Alok Banerjee described cryogenics and low temperature facilities, Dr D. M. Phase, PES on INDUS-1 and thin film deposition techniques; Dr. N. P. Lalla SEM, SPM and TEM facilities and Dr. V. R. Reddy dwelt on MOKE, Mossbauer and Raman spectroscopy. Dr. A. K. Sinha and Dr. V. Siruguri described overviews of facilities at Kolkata and Mumbai Centers of the CSR. Prof. R. Murthy described the facilities at Osmania University. Prof. Ajay Gupta chaired the interaction session of the workshop with the participants. The participants raised questions about various current scientific issues, which were answered by the senior scientists in the gathering.

Light Scattering Facilities at Mumbai Centre

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1. Introduction

Neutron Beam Facilities at Dhruva reactor are routinely used by University scientists under the Collaborative Research Schemes of Mumbai Centre of UGC-DAE CSR. A large fraction of above projects deal with use of Small Angle Neutron Scattering (SANS), which is a technique for studying the structure of materials on a length scale of 1-10 nm. In particular, several groups have used SANS for studying structural aspects of micellar solutions, block-copolymer and gels etc.

Mumbai Centre has developed Light Scattering Laboratory for carrying out (i) Static Light Scattering (SLS) and (ii) Dynamic Light Scattering (DLS) experiments as they often provide information, which is supplementary to those obtained by SANS. This article provides a brief introduction to above techniques and gives the salient features of the available SLS and DLS facilities at Mumbai Centre. Results of some of the studies carried out using above facilities are also shown.

2. Static Light Scattering (SLS)

Static Light Scattering (SLS), SANS and SAXS are exactly identical experiments except the radiation used. The experiment involves scattering of a monochromatic beam of radiation (e.g. laser light for SLS) from the sample and measuring the scattered photon (or neutron) intensity as a function of the scattering angle (θ). That is, one measures the scattered photon intensity I(Q) as a function of the wave vector transfer Q (= $4\pi\sin(\theta/2)/\lambda$, where λ is the wave length of incident radiation).

The fact that laser-photon has a wavelength (~ 500 nm) which is much larger than the wavelength (~ 0.5 nm) of neutrons / x-rays used in above studies, the accessible Q range in SLS is much smaller than that in SANS or SAXS. This, in turn, implies that while SLS is used for studying large size (= 100 nm) particles, SANS / SAXS are used for studying smaller particles (~ 10 nm).

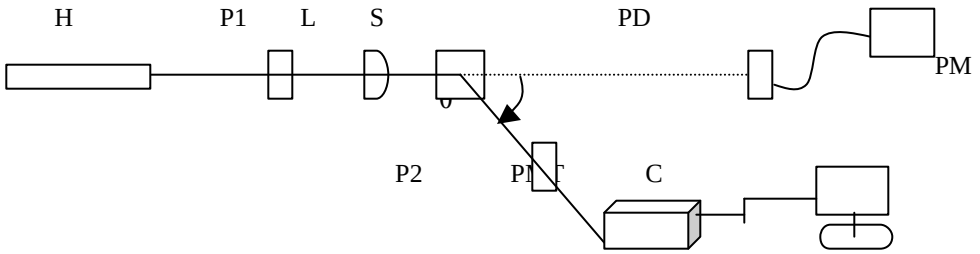
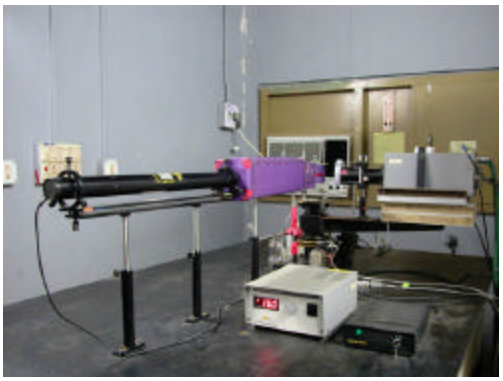


Fig. 1 Schematic diagram of the Light Scattering set up

Mumbai Centre has developed SLS facility indigenously. Fig. 1 is schematic diagram of SLS. The source (H) is a 15 mW He-Ne laser (λ = 632.8 nm). P1 and P2 are Glenn-Thomson polarizers at the incident and scattered beam sides respectively. A plano-convex lens (L) of focal length 25 cm is used to focus the incident beam at the sample and reduce the coherence area of scattering. Light photons scattered from the sample are counted using a photomultiplier tube (PMT). PMT is cooled to 5 °C to improve the signal to background ratio. PMT rests on a goniometer arm, which can be rotated about the sample. That is, sample sits at the symmetric axis of the goniometer. The goniometer rotation is controlled (accuracy is within ± 0.1°) using a stepper motor controller and the scattering angle (θ), i.e., the angle between the incident beam and the scattered beam, is read through an encoder from the controller unit. The sample (S) is loaded inside a glass curette (filled with index matching liquid, e.g., decalene). PD is a photo-diode, which is connected to a power meter (PM) to monitor any fluctuation in the incident beam. The whole set up rests on a vibration-free table. The photon counting electronics units and a PC based data acquisition card were developed by the Electronics Division, BARC. Fig. 2 shows the photograph of the instrument.



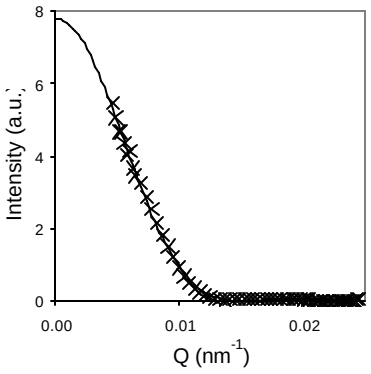


Fig. 2 Photograph of Light Scattering Set up **Fig. 3** SLS data and fit for 300 nm Polystyrene latex

The expression for the scattered light intensity for the case when a light beam propagating in medium of refractive index n_o is scattered by a particle of radius R, refractive index n_1 (relative refractive index = n_1/n_o), was obtained by Rayleigh, and is given by:

$$I \sim \frac{16p^4R^6}{l^4}\left(\frac{n^2-1}{n^2+2}\right)^2 \quad (1)$$

However, when particle size is somewhat smaller (R<< λ), as per Rayleigh-Gans-Debye's theory, I is given by:

$$I \sim P(Q) \quad (2)$$

Here P(Q) is the form factor of the particle, which depends on the shape and size of the particle and Q is (4 π n sin(θ/2)/λ). For a sphere of radius R, P(Q) is given by

$$P(Q) = V^2\left[\frac{3(\sin QR - QR\cos QR)}{(QR)^3}\right]^2 \quad (3)$$

where V is the volume of the particle. For the case of arbitrary shapes, it can be shown that if R_g is the radius of gyration of the particle, then P(Q) is given by

$$P(Q) = 1 - \frac{1}{3}(R_g Q)^2 \quad (4)$$

Thus, we note that SLS can be used for studying sizes and shapes of colloidal particles. The accessible Q range on our instrument is 0.0035 to 0.02 nm^{-1} and thus particle size in range of 100 – 400 nm can be studied using this technique. Fig. 3 shows measured (cross points) and fitted (solid line, using Eq. (3)) SLS distribution from a suspension of spherical Polystyrene latex particles (R = 300 nm).

3. Dynamic Light Scattering (DLS)

The atoms and molecules (or colloidal particles) in a liquid are diffusing (Brownian motion) and as a result the scattered light intensity fluctuates with time. SLS measures the time averaged scattered photon intensity. With the availability of lasers, it is now possible to record the temporal variations of the scattered light, allowing its spectral analysis. As the temporal variation of the scattered light is caused by dynamical properties of the system, for instance by the diffusion of the dispersed particles, the latter can be studied. The first dynamic light scattering experiments were performed with spectrum analyzers. The accuracy was improved shortly afterwards by the use of digital autocorrelators instead of spectrum analyzers. This gave rise to the name Photon Correlation Spectroscopy (PCS), which is used as a synonym for Dynamic Light Scattering (DLS). The method is also called Quasi Elastic Light Scattering (QELS) since the frequency change involved in the scattering processes are usually very small compared to the frequency of the incident light.

DLS experiment involves scattering of monochromatic beam of light from the sample (say a colloidal solution) by a scattering angle θ and then recording the scattered photon intensity at small intervals (e.g., 50 n sec) of time. A photon correlator card is used to store these intensities in different channels and to generate the intensity correlation function (ICF) $g^2(Q,\tau)$, the details of which are given below. The diffusion coefficient D of the colloidal particle is obtained from $g^2(Q,\tau)$ (see below) and the radius of particle is obtained from D using *Einstein-Stokes relation*. This way, DLS can also be used for studying the particle size. Unlike SLS, where one can study particles having sizes larger than 100 nm (for λ = 632.8 nm), DLS can be used for studying particle sizes as small as 2 nm. In suitable cases, DLS provides information about shape of particle also. DLS is preferred over SANS / SAXS, when refractive indices of the particle and the solvent are widely different.

The existing SLS set up (discussed in previous section) at Mumbai Centre can be used for DLS experiments also. A photon correlator card (Malvern, Autosize 4700 version) has been installed on above instrument and this allows recording of scattered photon intensities at a minimum intervals of 50 n sec over a time range of upto 0.5 μ sec or more and generating the function, ICF, $g^2(Q,\tau)$.

The function, ICF, $g^2(Q,\tau)$ of the scattered intensity I (Q, t) is an average value of the product of the intensity registered at an arbitrary time, I (t), times the intensity registered at a time delay τ later I (t+ τ) :

Figures 4 (a) and 4 (b) show typical distributions for I (Q,t) and $g^2(Q,\tau)$.

$$g^{(2)}(Q,t) \equiv \frac{1}{\langle I_s\rangle_t^2}\lim_{T\to\infty}\frac{1}{2T}\int_{-T}^{T} I_S(t)I_S(t+t)\,dt = \frac{\langle I_S(t)I_S(t+t)\rangle_t}{\langle I_S\rangle_t^2}. \quad (5)$$

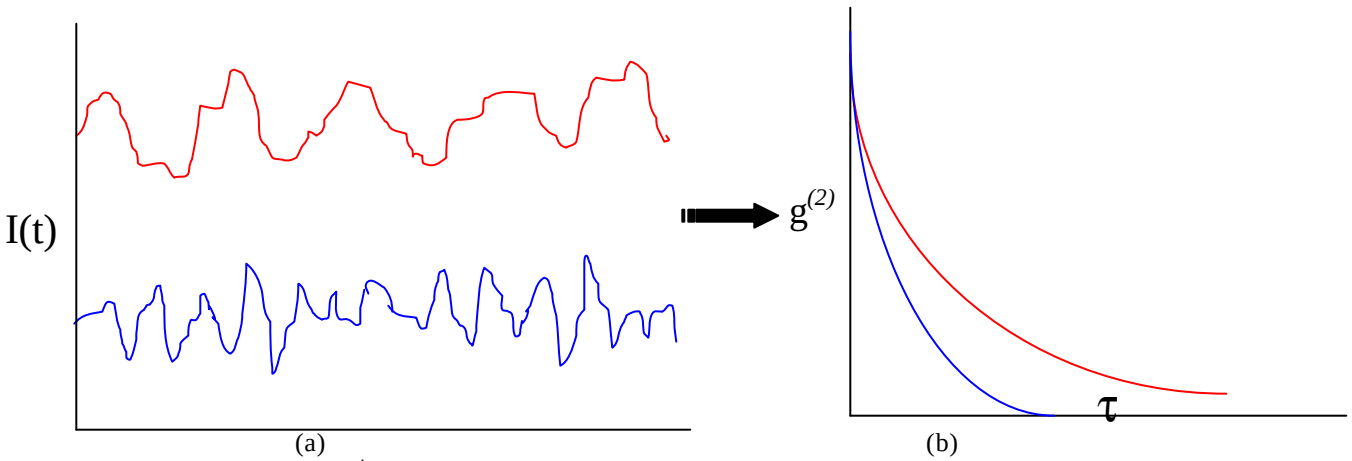


Fig. 4 **(a) DLS spectrum with time; (b) Intensity correlation function with delay time**

For sufficiently dilute solution, particle-particle interaction is neglected and one can attribute the fluctuation-rate (Fig. 4 (a)) or the decay-rate (Fig. 4 (b)) to the particle size. The correlation function, $g^2(\tau)$ at a constant Q, shows a single exponential decay corresponding to monodispersed and spherical particle distribution, and can be fitted with

$$g^2(t) = 1 + \exp(-2Q^2Dt) \tag{6}$$

D is the translational diffusion coefficient. It is customary to use field-correlation function (FCF), $g^1(\tau)$, instead of intensity-correlation function (ICF), $g^2(\tau)$, which can be obtained fromthe later by using the Siegert's relationship.

$$g^2(t) = 1 + b \times \left| g^1(t)^1 \right|^2 \tag{7}$$

where β is known as the coherence factor of the instrument, which is obtained by extrapolating $g^2(\tau)$ at $\tau = 0$. Therefore $g^1(\tau)$ is given by

$$g^1(t) = \exp(-Q^2Dt) / b^{0.5} \tag{8}$$

The particle size is obtained from D using the *Stokes-Einstein relation*,

$$D_o = k_B T / (6\pi \eta R_h) \tag{9}$$

where D_o is the diffusion coefficient at infinite dilution and related to D as

$$D = D_o(1 + k_d \times f) \tag{10}$$

k_d is known as the interaction parameter, which contains both thermodynamic and hydrodynamic interaction parameters and it can be both negative (unstable system) or positive (stable system), and ϕ is the volume fraction of the particles in the solvent. R_h is the hydrodynamic radius of particles, η is the viscosity of the solvent, k_B is the Boltzmann constant, T is the temperature in absolute scale. It may be noted that hydrodynamic radius R_h is somewhat larger than the 'actual' size of the particle.

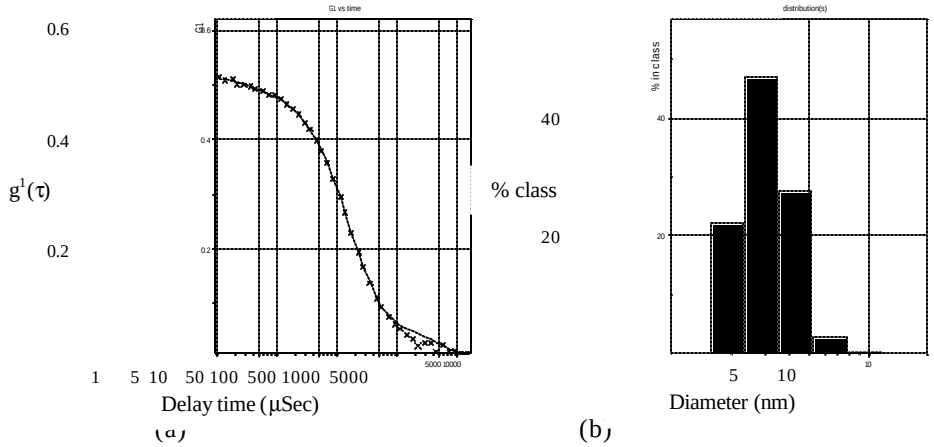
In practice, it is difficult to have a dispersed system of particles with zero polydispersity in their size distribution. Therefore, instead of using Eq. (8) to obtain the value of D, the following equation is used to obtained a distribution function of D,

$$g^1(t) = \int_0^\infty G(\Gamma) \exp(-\Gamma t) d\Gamma \tag{11}$$

where $G = Q^2D$, is known as the decay-rate of the exponent. Eq. (11) has the well-known form of the Laplace transformation. Inversing this transformation equation one obtains the distribution of G, i.e., the distribution of particle size.

4. Results

DLS at Mumbai Centre has been used for obtaining sizes of micelles of Sodium Dodecyl Sulphate in 2% (w/v) solutions in water. Figure 5 (a), shows field correlation function (FCF), $g^1(\tau)$ as function of delay time (τ), for a 2% (w/v) SDS solution and Figure 5 (b) the corresponding particle size (mean size ~ 3.5 nm) distribution as obtained using present data.

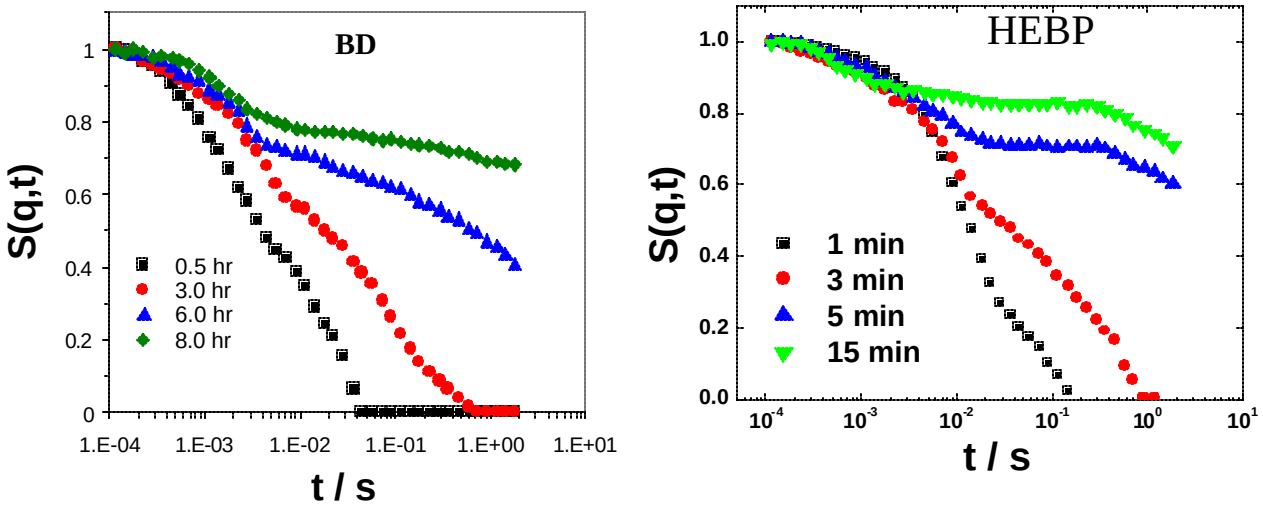


(a) (b)

Fig. 5 (a) Field correlation function with delaytime; (b) Size distribution of SDS micelles

Different regularization methods are used to obtain the size distribution, i.e. to get the inverse Laplace transformation, from Eq. (11). The method of cumulants and the CONTIN regularization method are the most popular among all. University users (P. Bahadur from South Gujarat University, Surat and Kabir-ud-Din from Aligarh Muslim University, Aligarh) have carried out DLS experiments on other micellar solutions especially the ones where spherical micelles transform to rod-like micelles on addition of salt etc. to the solution.

In the above case, particles are spherical and the DLS experiment is performed in VV mode, i.e. both incident and scattered beams are vertically polarized. This is because of the fact that in this case, only the translational diffusion coefficient contributes to the dynamics of particles in the solution. If particle shape is non-spherical, e.g., elliptical or cylindrical, the rotational diffusion coefficient needs to be considered in addition to the translational diffusion coefficient. As a result, the scattered beam from particles will have both vertical as well as horizontal polarization component (contribution due to the particle anisotropy) from the scattered beam and one need to perform the DLS measurement in VH mode. This is possible by rotating the polarizer at the scattered beam by 90°. Detail discussion about the shape analysis of particles is beyond the scope of this article. DLS has also been used for studying the kinetics of gelation process in polyurethane polymers modified with different chain extenders, e.g., butane diol (BD), which was purchased commercially, and bis(hydroxyethyl biphenol) (HEBP), which was synthesized by P. Maiti of Banaras Hindu University, Varanasi.



(a) (b)

Fig. 6 Dynamic structure factor for polyurethane gels for different chain extenders (a) BD; (b) HEBP

Figures 6 (a) and (b) show the change in dynamical structure factors, S (Q,τ), which is same as g^1(Q,τ), with time from the solution state to the gel state for the above two samples (as recorded at different intervals of time).

These studies show that gelation process is much faster in HEBP modified polyurethane as compared to that in BD modified polyurethane.

TRACE ELEMENTS AND OXIDATIVE STATUS IN CANCER INITIATION

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Recent reports have shown that trace element levels and their ratios play an important role as diagnostic or prognostic markers for health evaluation. With this perspective several research programs have been initiated at the Kolkata Centre of UGC-DAE Consortium for Scientific Research, with specific emphasis on its role in the initiation and progression of cancer.
An attempt was made to investigate status of iron in association with other biologically important metal ions, free radical generation process and antioxidant profile during pre initiation stage of induced hepatocarcinogenesis, a work which has been accepted for Oral presentation in "UICC World Cancer Congress" July 2006, Washington DC. Swiss albino mice, administered with dietary p-dimethylaminoazobenzine(p-DAB), were used as the model system. Initiation stage was considered after five weeks of p-DAB administration. Energy Dispersive X-Ray Fluorescence (EDXRF) spectrometer was used to assess trace elements in lyophilized liver tissues. Intra-cellular oxidative stress was determined microscopically and using luminescence spectrometer in whole blood spiked with dihydrorhodamine 123. Activity of antioxidant enzymes like superoxide dismutase(SOD), and catalase(CAT) were determined spectrophotometrically.
Remarkable increase (>3-10 folds) of iron level, noted in liver and its sub-cellular organelles of the p-DAB administered animals, show possible association of iron overload with carcinogenic progression. Similar trend (~6 fold) was observed for nickel,

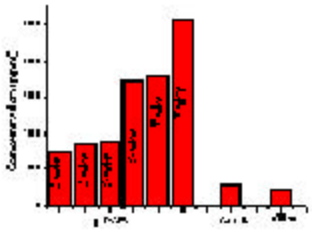

Fig.1. Fe overload in p-DAB treated mice liver

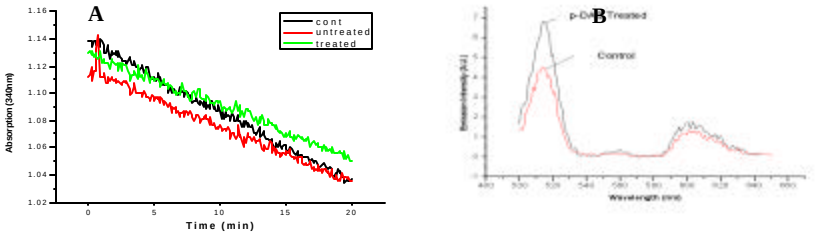

Fig.2. Oxidative stress & antioxidant status in p-DAB treated mice liver. **A**: Effect of Superoxide dismutase (SOD) on the rate of NADH oxidation in liver: **B**: Fluorescence intensity of 123 DHR as an index of intracellular oxidative stress in whole blood

but, only in the whole liver. Interestingly selenium and copper levels were depleted in the sub cellular organelles. The enhanced production of Reactive Oxygen Species (ROS) complimented the noted alterations in SOD and CAT.
These results indicate that alterations in trace elemental constituents in functional tissues and sub cellular organelles along with oxidant-antioxidant profile are critical factors to ascertain initiation of carcinogenic development.

A Novel Synthetic Route To Biofunctionalized CdTe Nanorods and Quantum Dots

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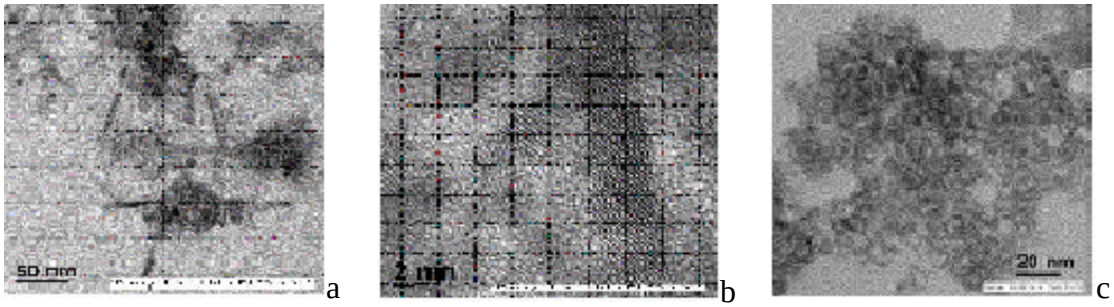
As part of nanoscience activites of the Centre, we have been focussing on the synthesis of surface-modified fluorescent semiconductor nanoparticles and investigating their interactions with molecules of biological significance, which can have immense implications in developing new protocols for biosensing, luminescence imaging. This particular work was accepted in 2005 MRS Fall Meeting held at Boston, USA on November 27 – December 2, 2005.

CdTe nanoparticles are one of the most interesting II-VI semiconductor nanoparticles exhibiting steady luminescence, high PLQE and greater photochemical stability. Its Bohr exciton diameter is among the largest (~15nm) for II-VI semiconductors and therefore, it also offers a possibility to study the quantum confinement effect in larger sized clusters as well. Recently, great research interests have been aroused in synthesis of fluorescent nanoparticles with high aspect ratio and their potential applications are also being explored.

Synthesis of CdTe nanoparticles or quantum dots has been developed significantly in the past decade. But, the reports for synthesis of CdTe nanowires and nanorods are rather scarce. Most of these methods use a rigid template to restrict the lateral growth of the particles. In these methods the nanorods so formed are hardly dispersible and of poor uniformity in the morphology. Moreover, the solvothermal processes are inherently complex and monitoring the growth of these 1-D materials in autoclaves is rather difficult.

In the present work, we report a facile synthesis of luminescent CdTe nanorods biofunctionalized by cysteine. The thiol group of cysteine (2-amino,3-mercapto propanoic acid) binds to the surface of CdTe nanoparticles and -COOH & $-NH_2$ groups remain free which can be further utilized for conjugation with other important biomolecules. Our soft chemistry technique obviates the use of any rigid template or extreme conditions of high temperature and pressure. In our method, telluric acid was used as a source of telluride. On addition of Cd^{2+}- cysteine solution to telluride solution and on subsequent reflux, orange coloured CdTe nanorods (length = 50 nm, diameter =6 nm) were



a b c

Fig. 1. (a) Typical TEM image showing the CdTe nanorods; (b) HRTEM images of CdTe nanorods showing lattice fringes and (c) TEM images of CdTe quantum dots

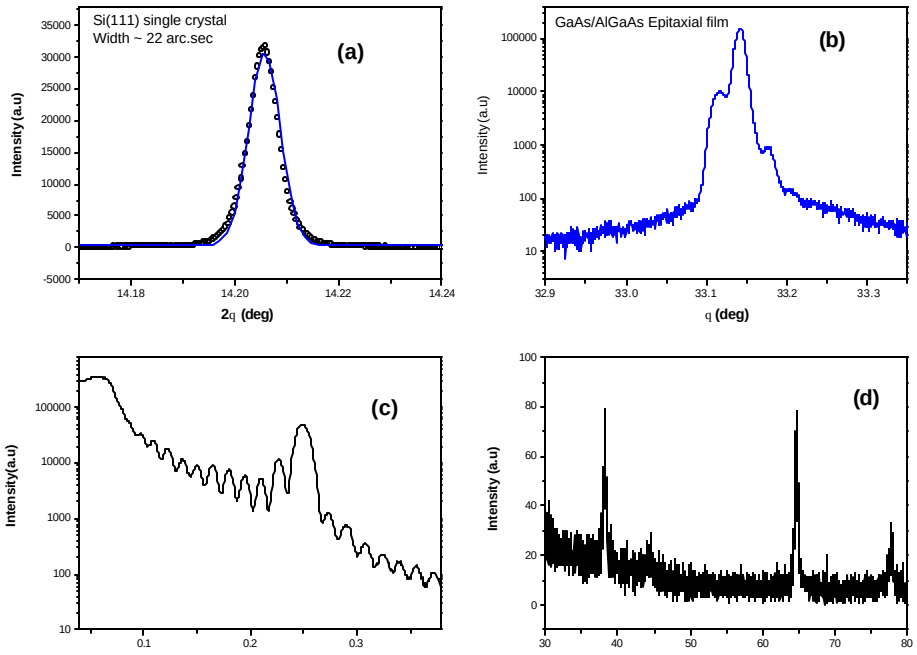
obtained. These nanorods posses high degree of crystallinity and luminescence. Interestingly, on reversing the order of mixing of two reagents i.e., on addition of telluride to Cd^{2+}- cysteine solution, spherical nanoparticles were obtained. The results are exciting and further investigation regarding the mechanism and factors controlling the shape, size and luminescence of the particles is in progress.

Faculty Seminars at Indore Centre

No.	Speaker	Affiliation	Title	Date
1	Dr. Vitalij K. Pecharsky	Ames Laboratory & Iowa State University, U.S.	Advanced Magnetocaloric Materials: What does the future hold?	10 December 2005
2	Dr. (Mrs.) Chandana Rath	School of Materials Science and Technology, BHU	Ferrimagnetic to superparamagnetic phase transformation in nanoparticles of ferrites on annealing	13 January 2006
3	Dr. W. Leitenberger	Univ. Potsdam, Germany	Current Status of the EDR Beamline at BESSY	11 February 2006

New Facility at Indore Centre: High resolution X-ray diffraction set-up

One Bruker make (model D8-Discover) high resolution X-ray diffraction machine has been installed recently. The following are some representative examples of the measurements and specifications of the machine.



(a) ω-scan of Si(111) single crystal
(b) ω-scan GaAs/AlGaAs epitaxial film
(c) X-ray reflectivity pattern of Fe/Pt multilayer
(d) In-plane XRD pattern of Au (60nm) thin film

Specifications:

i) θ-θ goniometer with 0.0001 deg step size
ii) 3kW X-ray generator with Cu and Mo targets
iii) Incident beam optics: Gobel mirror and double crystal monochormator for Cu and Gobel mirror for Mo radiations
iv) LiF monochromator in the diffracted beam arm
v) Possibility of doing X-ray Reflectivity and grazing incidence X-ray diffraction measurements for thin films
vi) Possibility of mapping the reciprocal space
vii) Possibility of doing high resolution X-ray diffraction (width of Si(111) peak ~26 arc.sec at 22.4 deg) measurements
viii) Possibility of doing in-plane X-ray diffraction measurements

Faculty : Prof. Ajay Gupta ; e-mail: agupta@csr.ernet.in
Dr.V.Raghavendra Reddy; e-mail: vrreddy@csr.ernet.in

Foreign Visits by Faculty

Dr.P.D.Babu, Mumbai Centre was on EOL from 1-4-2004 till 1-1-2006 working at Tam Kang University in Taiwan as Visiting Scientist

Dr.V.Siruguri, Mumbai Centre was on EOL from 20-12-2004 till 20-12-2005 working at University of Basque Country, Bilbao in Spain as a Visiting Scientist

Prof. Ajay Gupta, Indore Centre visited Trieste, Italy for experiments at ELETTRA Synchrotron during March 25 – April 1, 2006

Dr. S. R. Barman, Indore Centre visited Trieste, Italy for experiments at ELETTRA Synchrotron during Dec. 2-14, 2005.

Dr D. M. Phase, Indore Centre visited BESSY, Berlin, Germany to work on EDR beamline under Indo-German DST-DLR project during Nov. 15 to Dec. 15, 2005.

Foreign Visits by UGC-DAE CSR Research Students

Krishichayan participated in the Gordon Research Conference on Nuclear Chemistry-2005, held at Colby Sawyer College, New London, New Hampshire, USA from 26th June-1st July 2005. He presented a paper entitled, "Polarisation measurements for Neutron Rich N ~ 20 Nuclei, produced in Heavy ion transfer reactions." These results were obtained from the experiments carried out using the Indian National Gamma Array.

Jyoti Prakash Maity participated in the International Symposium on New Frontiers for Irradiated food and non-food products, organised by School of Bioresources and Technology, King Mongkut's University of Technology Thonburi, Thailand, from September 22-23, 2005, at Bangkok. He made an oral presentation entitled "Effect of Ionising Radiation on Surface infesting Microbes of Stored Grains", based on his PhD work.

Somsundar participated in a collaborative experiment with Prof.Umesh Garg, University of Notre Dame, using the Gammasphere at Argonne National Laboratory under the framework of joint, US-India collaborative effort. The experiment " Lifetimes in Chiral Bands in ^{135}Nd" was carried out during 9-15, October, 2005, after which he carried out data analysis at the University of Notre Dame for about one and a half months.

Soma Banik visited Trieste, Italy for experiments at ELETTRA Synchrotron during Dec. 1-14, 2005.