channelling helps to understand crystalline quality, strains, defects and lattice location of impurities in crystalline samples. A general-purpose scattering chamber/external PIXE line is being used for biological applications.

Accelerator Mass Spectrometry (AMS): This facility has potential for applications such as radiocarbon dating using ^{14}C and ^{10}Be. Data collected by IOP scientists on standard samples for $^{14}C/^{12}C$ ratio show an accuracy of 1%. AMS could be used for a wide variety of dating and trace applications in geological and planetary sciences, archaeology and biomedicine.

The other beamlines are for ion implantation and for study of surface physics. In addition, the ion micro-beamline facility, with a spatial resolution of 2 μm, has several uses from lithography to cell biology. The setting up of the peripheral stations and beamlines has been achieved with the expertise available within IOP itself. With the successes and utilization trends of the pelletron accelerator facilities at IOP, plans are afoot for setting up an 8 MeV terminal.

In the last few years, the Cluster and Nanostructure Laboratory has been established for synthesis of semiconductor nanostructures and metal clusters. Metallic cluster-assembled materials have been prepared using the low energy cluster beam deposition (LECBD) technique. Some of the research work conducted is in the area of Sb-cluster films, electrodeposited nanostructure semiconductors such as PbS, HgS and CdSe, and characterization of a nano-CdS/Au Schottky junction device.

In the year 2000–2001, several new experimental facilities were installed at IOP, augmenting the existing facilities. These facilities are the X-ray Photoelectron Spectrometer, the 200 keV High Resolution Transmission Electron Microscope and a Molecular Beam Epitaxy material growth facility. Research is ongoing in the area of gold silicides and Ge nanostructures along with investigation of Pt/C multilayers using X-ray reflectivity and Pt fluorescence yield excited by X-ray standing waves. Self-assembled nano-islands on thin Ge layers deposited on Si substrates are another area of interest.

R. K. Choudhury, the Director of IOP, said that the experimental programmes at the institute were unique in the country with facilities such as accelerator mass spectrometry, microbeam and ion beam-based surface physics research, with the 3 MeV pelletron accelerator being the mainstay of these research activities. The research programmes on clusters and nanomaterials had been extended to the synthesis and characterization of various metallic and semiconductor nanostructures. He also added that IOP has been making strides in international collaboration programmes on the relativistic heavy ion collision experiments being conducted in the ALICE experiment at LHC in CERN, Geneva and STAR experiment at Relativistic Heavy Ion Collider (RHIC) in BNL, USA. This is being done together with VECC, Kolkata and many Indian universities. IOP is thus part of the ALICE-India group comprising institutions and universities like SINP and VECC, Kolkata, IIT Mumbai and the Aligarh, Chandigarh, Jammu and Rajasthan universities.

In the year 2000–2001, there was the signing of a Memorandum of Understanding for the participation in STAR collaboration at the RHIC in BNL. In both these collaborations, IOP would be involved in the fabrication and development of photon multiplicity detectors. Facilities for prototype fabrication and testing have been set up for this purpose. IOP is developing and fabricating superconducting hexadecapole magnets, liquid nitrogen storage tanks and accelerator levelling jacks. IOP is also in the process of developing simulation and other software required for analysis of the experimental data from these experiments. IOP would be hosting the 20th International Conference of Atomic Collisions between 19 and 24 January 2003, this being held for the first time in India.

In spite of all the successes of IOP (research output in the form of 120 papers for the period 2000–2001 in internationally refereed journals), there appears to be an absence of larger research projects in identified fields of national interest, using the cross-disciplinary approach of expertise from within the institute itself. This would be quite feasible as the institute is flush with various experimental facilities and several theory groups.

Nirupa Sen

MEETING REPORTS

Physics at surfaces and interfaces*

Set against the backdrop of the Konark and Puri Jagannath temples, the International Conference on Physics at Surfaces and Interfaces (PSI 2002) was held at Toshali Sands, Puri. Study of the structure of surfaces and interfaces is important for understanding catalytic properties, multilayer systems, materials modified by swift heavy ions, semiconductor surfaces, nanoscale and quantum structures. There are a considerable number of experimental techniques, including those using synchrotron radiation sources used for characterizing these structures. These broad areas of materials science formed the basis for discussion at the conference.

Synchrotron radiation sources for X-ray diffraction and their use in application to surfaces and interfaces have produced advances in technology, with experimental techniques now well developed. A recent application of the use of synchrotron radiation was presented at the conference by Ian Robinson, Univer-

*A report on the International Conference on Physics at Surfaces and Interfaces, organized by the Institute of Physics, Bhubaneshwar and held during 4–8 March 2002 at Toshali Sands, Puri.

sity of Illinois for the understanding of the quantum physics of one-dimensional electronic structures such as the Au/Si (557) surface. The template is the vicinal semiconducting surface of Si (557) on which gold is evaporated in an ordered array of metallic wires. The gold atom makes possible the use of the 'heavy atom' method of X-ray crystallography for determining the structure of the quantum wire on stepped silicon templates.

B. A. Dasannacharya, Inter University Consortium for DAE Facilities (IUC-DAEF), Indore described the INDUS-1 synchrotron facility. This facility is available for use to universities and research institutions for conducting experiments in surfaces and interfaces using photon energies up to 800 eV. He pointed out that more collaborative research with greater use of these facilities was required. R. V. Nandedkar, Centre for Advanced Technology, Indore gave details of the different beamlines in operation, such as the two beamlines based on toroidal grating monochromator that could be used for reflectivity and angle-integrated photoelectron spectroscopy. He spoke of the angle-resolved photoelectron spectroscopy beamline that is almost ready and the INDUS-2 that has a 2.5 GeV synchrotron that is in the process of becoming operational. Calling this a successful team effort, he felt Indian scientists could now begin to use this facility more intensively. Ajay Gupta, IUC-DAEF, Indore described the development of nuclear resonant monochromators for synchrotron radiation, that would allow for operating at desired bandwidths. These, he showed, could be based on isotopic multilayers tailored to serve as nuclear Bragg monochromators.

Precise determination of interface structure can also be made using the technique of grazing incidence diffuse X-ray scattering. This technique was used by J. Daillant, University of Paris for investigating the nanoscale structure of liquid surfaces and liquid–liquid interfaces and for looking closely at fluctuations in the molecular length scales. In the research area of multilayered microstructures such as those of magnetic multilayers, the determination of magnetic impurity in the non-magnetic layer is significant. This could cause the properties of magnetic coupling and magnetoresistance to change appreciably. For studying small concentrations, use was made by B. N. Dev, Institute of Physics, Bhubaneshwar of the technique of X-ray standing-wave analysis for layer composition and X-ray reflectivity for determining interface roughness. G. Materlik, Rutherford Appleton Laboratory, who had earlier worked extensively on the X-ray standing-wave technique, detailed his new area of interest – the real space imaging of atoms. J. Zegenhagen, European Synchrotron Radiation Facility, France said that due to inadequate analysis tools, processes at semiconductor electrodes which were in contact with aqueous electrolytes are still insufficiently understood at the microscopic level. He described the experiments which used X-ray standing waves and grazing incidence X-ray diffraction for understanding the structure of electrodeposited Cu on GaAs (001) and Pb on hydrogen terminated Si (111).

The work of Y. Tawara, Nagoya University was a study of multilayers for the purpose of developing X-ray optical instruments for X-ray astronomy. According to Tawara, he has been successful in making a hard X-ray telescope using platinum–carbon multilayer super-mirror with an effective energy band up to several tens of keV for the first balloon experiment. The evaluation of the X-ray reflection performance was measured both at his laboratory as well as at the synchrotron facility at SPRING8, Japan.

Walter M. Gibson, University at Albany State, New York showed how new analytical opportunities based on compact X-ray source–optics combinations were being used. Polycapillary and doubly-curved crystal optics, when used in existing X-ray analytical instruments, X-ray spectrometers and diffractometers, could enhance performance. Recently, compact X-ray sources have led to fabrication of portable systems for new applications.

It is possible to follow heteroepitaxial growth by *in situ* techniques such as Auger Electron Spectroscopy, X-ray Photoelectron Spectroscopy, Low Energy Electron Diffraction and Scanning Tunnelling Microscopy (STM). Using these techniques, S. M. Shivaprasad, National Physical Laboratory, New Delhi has studied the adsorption of Pt on W (110), W (111) and Mn/Si (111), and Ag on Si (100) and (111) systems.

F. J. Cadete Santos Aires, CNRS, France, with the help of experiments based on a modified STM, that had the added advantage of varying temperature and pressure of the gas for producing conditions close to the real situation in catalysis, studied the surface changes taking place under ultra high vacuum conditions. He described carbon monoxide adsorption as a function of pressure (up to 1 bar) on Au (110) which showed changes in the morphology of the surface. This, when correlated with STM images, lent an insight into processes of heterogenous catalysis. Bert Voigtlaender, Forschungszentrum Juelich has used STM to study heteroepitaxial growth processes in Si/Si and Ge/Si during Molecular Beam Epitaxial (MBE) growth at high temperatures. He has imaged the growing layer and studied the effect of surface reconstruction on growth; these can be viewed on the internet site: http://www.fzjuelich.de/video/voigtlaender/.

Using electro reflectance and surface voltage spectroscopies, strained quantum structures have been investigated by B. M. Arora, Tata Institute of Fundamental Research, Mumbai, that have wide potential in band-structure engineering and applications. The strained quantum structures such as wells and dots have been synthesized using metal organic vapour phase epitaxy. An indigenously developed *in situ* high vacuum STM was used by D. Kanjilal, Nuclear Science Centre, New Delhi for studying highly oriented pyrolytic graphite irradiated by swift heavy ions. Transmission electron microscopy has been utilized by L. D. Marks, Northwestern University for study of structures of a range of materials from nanotubes, strontium titanate to Si (111) 7×7. Raman measurements of Ge clusters grown by cluster-evaporation techniques on Si substrate were described by Anushree Roy, IIT Kharagpur. The main point of interest was the study of elastic strain in diffused, disordered Si at the interface between Ge clusters and the substrate.

M. P. Das, Australian National University spoke about the occurrence of superconductivity on the interface of the device with pairing taking place when the system was in a nonequilibrium state. 'Growth and characterization of quantum well and P-HEMT structures grown by Molecular Beam Epitaxy' was the subject of the talk by R. Muralidharan, Solid State Physics Laboratory, New Delhi. Quantum well structures are being synthesized by advanced material preparation techniques such as Molecular Beam Epitaxy and Metal Organic Vapour Phase Epitaxy. He described the growth of heterostructures like AlGaAs/GaAs, AlGaAs/InGaAs/GaAs and InGaAs/GaAs multiquantum well structures. These multilayers have been characterized by him using high-resolution X-ray and high-resolution transmission electron microscopy, and photoluminescence and some of their device characteristics explained.

T. P. Pareek, Max Planck Institute, Germany described spin transport in a two-dimensional electron gas. 'Physics on a quantum cascade laser' was a talk given by Tapash Chakraborty, Institute of Mathematical Sciences, Chennai. The quantum cascade laser could be used for quantum engineering of new laser materials and light sources. It is a new nanostructured light source in the mid-infrared range. Anand P. Pathak described the ion beam irradiation effects on the strains in GaAs/InGaAs multilayers of semiconductors. Strained layer superlattices have potential device applications. Ion irradiation can induce lattice strains, with the strains produced depending on the extent of lattice mismatch and layer thickness. The induced strain can be used to engineer devices by tailoring the band structure of interest to materials scientists for varied applications.

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Mevalonate-independent pathway of isoprenoids synthesis: A potential target in some human pathogens

Vinod Shanker Dubey

The rapidly increasing resistance of many human pathogens to all currently available drugs has become a serious health problem around the globe. Among these pathogens, *Mycobacterium tuberculosis* still poses a major human threat causing tuberculosis in the lung, and is responsible for more than one-quarter of all preventable adult deaths in the world[1]. In addition, the emergence of various multidrug resistance mycobacterial strains, generates an urgent demand for novel therapeutic approaches. Another leading human pathogen, *Plasmodium falciparum* causing malaria, also accounts for one of the world's worst health problems leading to 1.5 to 2.7 million deaths annually. These deaths are primarily among the children and pregnant women[2]. *Helicobacter pylori*, a human gastric pathogen, is an etiologic agent of chronic active gastritis, peptic ulcer disease, gastric adenocarcinoma and gastric mucosa-associated lymphoid tissue (MALT) lymphoma; 70 to 90% of the population in developing countries carries this pathogen[3]. Therefore, it has become more important to understand the operation of various metabolic pathways existing in these pathogens, to find a suitable target that can be used in developing drugs against them. One such metabolic process occurring in these microorganisms is that they all utilize the same common mevalonate-independent (non-MVA) pathway of isoprenoids synthesis that was first discovered by Rohmer and coworkers in the early nineties, while studying the biosynthesis of hopanoids (a pentacyclic triterpenic sterol surrogates) from different bacterial species[4].

All isoprenoids in various systems are synthesized through the two common precursors, isopentenyl diphosphate (IPP; C_5 unit) and its isomer dimethylallyl diphosphate (DMAPP; C_5 unit)[5,6] (Figure 1). Among the various systems, plants contain majority of isoprenoids, e.g. mono-, sesqui- and diterpenes and carotenoids. Major isoprenoids found in several bacteria are various quinone derivatives having prenyl side-chains such as ubiquinones and menaquinones, along with polyprenol (bactoprenols) molecules, while in the human system cholesterol, various steroid hormones and bile acids are synthesized via a common precursor, squalene – a triterpene. All these isoprenoids and their derived components in various systems have several known physiological and biological functions as well[5,6]. More recently, the long accepted common view that all isoprenoids are synthesized through the acetate–mevalonate pathway is being questioned[7–10], and the whole story has been changed after the discovery of the non-MVA pathway for biosynthesis of certain class of isoprenoids in several bacteria, green algae and various plant species[11–14]. The synthesis of IPP and DMAPP via non-MVA pathway starts with the formation of 1-deoxy-D-xylulose-5-phosphate (DOXP) by two glycolytic intermediates, pyruvate and glyceraldehyde-3-phosphate. DOXP is also known to be used as precursor in the biosynthesis of thiamine (vitamin B1) and pyridoxol (vitamin B6)[15,16] (Figure 2).

In recent years, using *E. coli* as a model system, extensive efforts have been made to elucidate the sequential steps involved in this novel non-MVA pathway, and various genes, enzymes and their reaction mechanisms along with all possible intermediates have been discovered[5,14,17] (Figure 2). A bioinformatics approach has been used to identify various non-MVA-route genes in *E. coli*[18–20], and orthologous sets of genes in various other organisms, including some human pathogens[21,22] such as *M. tuberculosis*, *P. falciparum*, and *H. pylori*. Whole genome sequence comparisons