Physical and Electronic Structure Characterization of Materials for Energy and MOS devices

Overview

The search for advanced functional materials, whether to address the need for efficient energy conversion and storage, or continue the downscaling of electronic devices, is the focus of many leading laboratories around the world. Solid-state physics and chemistry play a vital role in the development and application of new materials and provides an understanding of the electronic structure of materials that is crucial to understanding the properties of the material. This determines what we can do with new materials. For example, energy conversion and storage technologies or modern MOS devices require semiconductor materials for which the characterization or determination of their bandgap and band edge energy level alignment are of crucial importance. On the other hand, novel semiconductors are made from many different elements, so to design the required phase with the correct bandgap for instance, measurement of the electronic bonding among the constituent elements provides important information for improving the synthesis process. The research into these novel materials thus involves measurement of the electronic levels, not only of the core levels, but also the valence and conduction states around the Fermi level of the material. This course covers the basics of the electronic structure of materials and the experimental techniques used. Specifically, the focus is on photoemission technique but briefly covers other techniques such as inverse photoemission that probes empty density of states, and scanning probe microscopies. Many aspects of modern electron spectrometers will be covered, and examples of measurements will be given to understand the basic principles of the techniques. The module delivery will be in the form of formal lectures combined with tutorials and will cover the following topics:

1. A brief introduction and overview of condensed matter physics.

2. Electron energy bands and core levels in materials. Principles of bandstructure, filled and empty electron energy states. Valence and conduction band line-ups in heterostructures.

3. Physical principles of XPS, Angle resolved photoemission, Inverse photoemission.

4. Photoemission Spectroscopic Instrumentation for measuring energy levels in materials. UHV, X-ray and UV sources, Electrostatic lenses and Electron energy analysers. Detailed consideration of electrostatics of analysers, Brief introduction to Synchrotron based techniques.

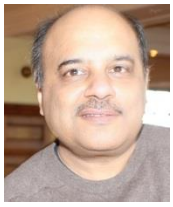
5. Interpretation of XPS data with examples in energy materials interfaces in MOS devices.

6. Scanning probe microscopies for spectroscopic and physical characterization.

NB: Participants may request 1 Credit against successful completion of this course

Dates	**Monday 19th December to Saturday 24th December**
You Should Attend If…	▪ **You have an interest in spectroscopic characterization of materials and you are** ▪ a scientist, engineer or researcher in industry/academia and R&D laboratories ▪ You are a student at B.Tech./M.Sc./M.Tech./Ph.D. level ▪ You are a faculty member in educational/academic institute
Fees	The participation fees for taking the course is as follows: **Participants from abroad : US $100** **Industry/ Research Organizations: INR 5000/-** **UG/PG students: INR 1500/-** **Ph.D. students or above: INR 2000/-** The above fee includes all instructional materials. The participants may be provided with budget accommodation on payment basis upon advance request.

The Faculty:



Dr. Vin Dhanak is a graduate of Bristol University and Imperial College London, where he did his PhD work. He is currently a Reader in Physics and a principal scientist in the Surface Science Research Center and the Stephenson Institute for Renewable Energy at University of Liverpool, UK. This followed positions in the industry developing spectroscopic instrumentation (1982-1990), research and development scientist at Elletra Sincrotrone Trieste (1990-1994) and Daresbury Synchrotron source (1994-2008). Since 2008 he is based at University of Liverpool where he has built a laboratory with state of art surface science instrumentation. He has over thirty years of experience in surface and nanoscience, and related instrumentation and has published over 200 research papers in the field. Dr Dhanak is a member of the Institute of Physics (IoP) and associate member of the higher education academy for his teaching at the university. He has designed and teaches core physics modules at the university, including condensed matter physics, nanoscience and practical physics, all accredited to the IoP.

His research interests are aligned along characterization of novel materials for energy and MOS devices. Recent research highlights include STM and LEED structural studies of TCOs (including In_2O_3) which play an essential role in every PV device, band-lineup and interface studies of efficiency enhancing layers in PV devices, electronic and structural studies of surface and bulk alloys of materials such as Te/Cu and Bi/Ag that are relevant to interface studies of the back-contacts in PV devices, interface and band line-up studies on high-k stacks on Ge and SiO_2, and characterization of materials for super-capacitor and fuel cell energy storage devices, and photocatalysis. He has also made STM and photoemission studies of organic-inorganic interfaces which broadly play a central role in the field of molecular electronics and molecular self- assembly.

Dr. Amit K. Chakraborty is an Associate Professor of National Institute of Technology, Durgapur. He received his PhD from University of Nottingham (U.K.) in 2005. He then worked as Research Associate at Durham University during 2005-2008, and at Empa, Swiss Federal laboratories for Materials Science & Technology, Duebendorf, Switzerland during 2008-2010 before joining NIT Durgapur as Associate Professor in 2010. His research interest is carbon based nanostructures (graphene, carbon Nanotubes) and their composites with metal oxides, polymers, etc. for applications in solar photovoltaics, supercapacitors, and others.

Course Co-ordinator

Dr. Amit K. Chakraborty
Phone: +91 9434 788 137
E-mail: amitkc61@gmail.com

.....

For registration visit

http://www.gian.iitkgp.ac.in/GREGN/index