SCANNING ELECTRON/ION/PROBE MICROSCOPY IN MATERIALS CHARACTERIZATION

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TYPE OF COURSE : Rerun | Core | PG
COURSE DURATION : 8 Weeks (21 Feb' 22 - 15 Apr' 22)
EXAM DATE : 23 Apr 2022

PRE-REQUISITES : M.Sc./BE

INTENDED AUDIENCE : B.Tech./M.Tech./Ph.D. students and researchers from academics and industries.

INDUSTRIES APPLICABLE TO : Any industries related to materials

COURSE OUTLINE :
This course Scanning Electron / Ion / Probe Microscopy in Materials Characterization will provides in-depth understanding on three different microscopy techniques to students as well as engineers, technicians, and researchers (material and biological scientists). These three scanning microscopy techniques are widely used to obtain the surface morphology of solid materials (primarily) at nanometer range. The topics will cover not only basic principles of these techniques and different parameters that affect the image quality but also preparation of different types of samples and the interpretation of results/data. The advancements to these microscopic techniques will be briefed with examples.

ABOUT INSTRUCTOR :
Prof. Debabrata Pradhan has been serving as Assistant and Associate Professor at Materials Science Centre, IIT Kharagpur since 2010. He received his PhD degree from IIT Bombay, and did postdoctoral research at Tamkang University, Taiwan, for 2 years and University of Waterloo, Canada, for 4 years. He also served Electron Microscopy facility at SAIF, IIT Bombay, for a year after completion of PhD work. He has received Adani Award for Excellence in Teaching Physical Chemistry to the B. Tech. students at IIT-Bombay (2001-2002), MRSI Medal 2019 by MRS, India, in recognition of significant contributions to the field of Materials Science and Engineering, and Faculty Excellence Award 2019 by IIT Kharagpur for outstanding contributions towards Teaching, Research, and Institutional Development. He has published more than 130 research papers, 1 book, 2 book chapters, and 2 patents. His current h-index is 40 with citations >5500.

COURSE PLAN :

Week 1: Introduction to microscopy in general. Resolution, Light versus electron versus ion as source. Lens aberrations, Main components of scanning electron microscope (SEM), Electron beam-specimen interaction

Week 2: Generation and detection of signals, Imaging modes, Major parameters that affect the SEM image quality, Additional capabilities of SEM, Specimen preparation.

Week 3 : Introduction to helium ion microscope (HIM), Electrons versus ions, Ion source and operation of ion microscope, Ion-solid interaction, Signal generation, Image formation, and contrast mechanisms.

Week 4 : Imaging techniques, Scanning transmission ion microscopy, Microanalysis with HIM, ToF-SIMS on HIM, Modification of materials using ion microscope.

Week 5: Introduction to scanning probe microscopy (SPM), Important parts of scanning tunneling microscope (STM), STM Tip fabrication, Working principles, Different modes of operation, Image processing and analysis, Artifacts.

Week 6: Work function measurement, Scanning tunneling spectroscopy, and Imaging the surface states. Atomic force microscopy (AFM), fabrication of cantilevers, calculation of spring constant.

Week 7: Different forces and their interaction with the sample, Modes of AFM operation and their principle, Noises in AFM, Advanced imaging modes, Work function and surface potential measurements, other force microscopy.

Week 8: Mechanical, chemical, and electric properties measurement using probe microscope, Manipulation of atoms and molecules using AFM and STM, Industrial applications.