23CL801 Physics and chemistry of surfaces and interfaces 4 0 0 4

Course Objectives:

- Describe the general chemical and physical properties of surfaces of crystalline materials.
- Develop the procedure of atomic level construction of surface from bulk crystals and correlate the nomenclature of different surfaces.
- Analyse the formation of different types of interfaces, like metal-metal, metal-semiconductor, metal molecule, etc., and explore their significance in applications.
- Analysis of interfaces and surfaces using microscopic (scanning tunnelling and atomic force microscopy) and spectroscopic (X-ray and UV photoelectron spectroscopy) techniques.

Syllabus:

General introduction to solid surfaces and interfaces of materials. Why surface is different or essential? Applications of surface and interfaces in modern technology. The microscopic structure of different clean surfaces and the construction of surfaces from bulk crystals. Elementary processes of gas-surface interaction, adsorption (physical and chemical) and interface formation. 2D Bravais lattices, the nomenclature of clean surfaces, reconstructions on surfaces, stepped and corrugated surfaces, and its reactivity. Ultra-high vacuum (UHV) technology and its importance in surface science, adsorbates on surfaces, adsorbate lattice and the microscopic understanding, nomenclature of adsorbate layer on surfaces. Type of interfaces like metal-metal/semiconductor and metal-molecule interfaces. Self-assembly of molecules on surfaces. Methods for preparation of thin polymer films (Physical and chemical methods). Scanning tunneling microscopy (STM) and atomic force microscopy (AFM). Operation and principle. Application of STM and AFM in characterizing the microscopic structure of different surfaces and interfaces. Electronic structure of surfaces and interfaces using STM. X-ray photoelectron spectroscopy (XPS) and UV-Vis photoelectron spectroscopy (UPS), principle and significance as a surface analysis tool. Applications of UPS in understanding the electronic structure of surfaces and interfaces. Application of XPS: revealing the chemical properties of surface and interfaces.

Evaluation Pattern:

Mid Term Examination (30 Marks), 4 Continuous Assessments (30 Marks), End Semester Examination (40 Marks)

Textbooks/References:

1. Hans Luth, Surfaces and interfaces of solids (second edition), Springer Verlag Berlin Heidelberg GmbH publisher, 1993.
2. Gerald H Meier, Thermodynamics of Surfaces and Interfaces Concepts in Inorganic Materials, Cambridge University Press, August 2014.
3. Hans-Jurgen Butt, Karlheinz Graf, Michael Kappl, Physics and Chemistry of Interfaces, Wiley,2006.
4. Kurt W. Kolasinski, Surface Science: Foundations of Catalysis and Nanoscience (fourth edition), Wiley, November 2019.
5. Hans Lüth, Solid Surfaces, Interfaces and Thin Films (Graduate Texts in Physics), Springer, 2014