

## PPH317: CHARACTERIZATION TECHNIQUES

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**Course Objective(s):** To introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques.

**Introduction:** Need of materials characterization and available techniques.

**Optical Microscopy:** Optical microscope - Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Stereomicroscopy, Photomicroscopy, Colour metallography, Specimen preparation, Applications.

**Electron Microscopy:** Interaction of electrons with solids, scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy.

**Diffraction Methods:** Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Electron diffraction.

**Surface Analysis:** Atomic force microscopy, scanning tunneling microscopy, X-ray photoelectron spectroscopy.

**Spectroscopy:** Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy.

**Thermal Analysis:** Thermogravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermomechanical analysis and dilatometry.

### Laboratory Assignments:

Metallographic preparation and grain size measurement of metallic sample. Determination of crystal structure and lattice parameters using X-rays diffraction technique, Determination of crystal structure and lattice parameter from electron diffractions, Study of the UV visible absorption spectra of inorganic substance, Thermal analysis of alloys, to study the thermal expansion coefficient of various specimen using dilatometer, Determination of functional group and nature of bonding by FTIR, Study of surface roughness and morphology of thin films by using AFM.

### Course Learning Outcomes (CLO):

Students will be able to:

1. apply appropriate characterization techniques for microstructure examination at different magnification level
2. understand the crystal structure determination and phase analysis of the materials
3. able to examine the electronic structure, and the thermal behavior of the materials

***Recommended Books:***

1. *Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).*
2. *Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction," Prentice-Hall, (2001).*
3. *Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).*
4. *Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).*
5. *Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).*
6. *Wachtman, J.B., Kalman, Z.H., Characterization of Materials, Butterworth-Heinemann, (1993).*