

CHARACTERIZATION OF MATERIALS	
CHY 311 (B)	Credits: 3
Instruction: 3 periods & 1 tutorial/week	Sessional marks: 40
End exam: 3 Hours	End exam marks: 60

Target group: Chemical Engineering, Mechanical Engineering, Electrical and Electronics Engineering, Electronics and Communication Engineering.

Prerequisites: Basics of chemistry and physics.

Course Objectives

- To provide basic knowledge on synthesis and fabrication of materials.
- To understand the surface characteristics of materials.
- To create awareness on morphology of materials by electron microscopy.
- To understand the principles of X-ray diffraction.
- To acquire knowledge on thermal studies of materials.

Course outcomes

By the end of the course, student will be able to:	
1	Select an appropriate method of synthesis based on the basic knowledge about synthesis of material.
2	Apply the suitable adsorption isotherms to determine the surface area, pore size and pore volume of materials.
3	Analyze the surface morphology of the samples from SEM and TEM images.
4	Interpret the XRD patterns for phase identification, lattice parameter and crystallite size determination.
5	Understand the principle of thermo gravimetric analysis, Differential scanning calorimetry and its applications.

SYLLABUS

Unit-I Introduction to material synthesis and fabrication

14 Periods

Synthesis of bulk phase materials-Solid state reaction route, introduction to precipitation & co-precipitation, sol-gel technique, hydrothermal; Semi Conducting materials – Stoichiometric GaAs, Non-Stoichiometric- ZnO and Hopping Semi Conductors-CdSe; Conducting polymers-polyacetylene.

Synthesis of nanoparticles-Bottom-Up approach- thin film growth by physical vapour deposition and chemical vapour deposition; Top-down approach- ball milling, Microfabrication-lithography- UV, electron beam and ion beam lithography; Energy applications of Nano metal oxides-cells

Unit-II Surface characterization

8 Periods

Adsorption - types of adsorption; adsorption isotherms-Langmuir, Freundlich, BET, Polyani's theory of adsorption.

Surface area determination from BET equation, Adsorption on porous solids; Pore size distribution- adsorption and mercury porosimetry.

Unit-III Electron microscopy**10** Periods

Introduction to Electron Microscopy - electron beam specimen interaction; Scanning Electron Microscopy (SEM) – instrumentation, specimen preparation, image interpretation and applications.

Transmission Electron Microscopy (TEM) – instrumentation, specimen preparation, image modes- intensity contrast, diffraction contrast, phase contrast and applications; Scanning Transmission Electron Microscopy (STEM) - image interpretation and applications.

Unit-IV X-ray diffraction**8** Periods

X-rays generation; crystal lattice, diffraction-Brags equation; X-ray diffractometer – instrumentation; Small and Wide angle X-ray diffraction.

Applications of Powder X-Ray Diffraction (PXRD)-identification of phases, crystallite size determination, intercalation in compounds; Quantitative X-ray diffraction-quantification of clay minerals.

Unit-V Thermal analysis**10** Periods

Introduction to thermal methods of analysis, Thermogravimetry- instrumentation, factors influencing TG, applications of TG.

Differential thermal analysis (DTA), block diagram of DTA apparatus, applications of DTA; Differential scanning Calorimetry- instrumentation and applications.

Prescribed Books

1. Nano science and Nanotechnology : fundamentals to frontiers by M.S. Ramachandra Rao, Shubra Singh, Wiley publications, 2014
2. Heterogeneous catalysis by D.K.Chakrabarthy, B.Viswanathan, New age international publishers, first edition 2008
3. Catalysis by John R. Anderson and Michel Boudart, Vol.7, published by Springer-Verlag, Berlin Heidelberg 1985 (for Unit III)
4. Engineering Chemistry by P.C.Jain and M.Jain, Dhanpat Rai publishing company (P) LTD. (for Unit V)
5. Hand book of Heterogeneous Catalysis, G.Ertl, H.Knowinger, F.Schuth, J.Weitkamph, second edition, Vol.1, Wiley-VCH.

Reference Books

1. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, by Yang Leng, John Wiley & Sons, 2013.
2. Materials Characterization Techniques, Sam Zhang, Lin Li, Ashok Kumar, CRC press 2008.
3. Synthesis and Characterization of Advanced Materials, Michael A. Serio, Dieter M. Gruen, Ripudaman Malhotra, ACS publications, 1997.
4. Solid state Chemistry and its applications, Anthony R.West, Wiley India, New Delhi 2014.