Unit III

Materials characterisation: Electron microscopy- Interaction of electron with matter. Transmission microscopy (TEM) - principles, sample preparation. Kinematic theory of contrast. Imaging modes – bright and dark field modes. Scanning Microscopy (SEM) - principles, beam diameter, image contrast. Applications to microstructure determination. Scanning probe microscopy- principles and applications.

Atomic and molecular spectroscopies: atomic absorption, Infrared, and Raman spectroscopies for the determination of impurities. Low energy electron diffraction (LEED), X-ray photoelectron spectroscopy (XPS/ESCA) and Auger electron analysis - principles and applications for surface studies. Electron probe micro analysis (EPMA) and Energy dispersive analysis of X-rays (EDAX) - principles and applications for compositional analysis. 14 hours

References

1. Fundamentals of Vacuum Techniques - A Pipco et al (MIR, 1984)
2. Vacuum Technology - A Roth (North Holland Pub. Co., 1982)
3. Modern Vacuum Physics - Austin Chambers (Chapman and Hall, 2005)
4. Ultrasonics - B Carlin (Mc Graw Hill, 1960)
5. Applied X– Rays - George L Clark (Mc Graw Hill, 1955)
6. Principles of Neutron Radiography - N D Tyufyakov and A S Shtan (Amerind, 1979)
7. Modern Metallographic Techniques and Their Applications - V A Phillips (Wiley Interscience, 1971)
8. Handbook on Ultrasonic Testing of Materials - Ramesh B Parikh (Electronic & Engineering Co., 1984)
9. Testing of Metallic Materials - A V K Suryanarayana (Prentice Hall India, 1990)
10. Physical Metallurgy Part 1 - R W Cahn and P Haasen (Ed) (North Holland, 1983)
11. Ultrasonic Testing of Materials - Krautkramer, (Narosa Publishers, 1990)
12. Instrumental Methods in Chemical Analysis - G W Ewing (Mc Graw Hill, 1975)
13. Scanning Electron Microscopy and X-ray Micro Analysis - Joseph I Goldstein, (Plenum Press, 1992)
14. The Principles and Practice of Electron Microscopy: Ian M Watt, (Cambridge Univ. Press, 1997)

MSS 453 SURFACE PHENOMENA AND ELECTROCHEMISTRY (3 Credits)

Objectives: This course aims to (i) provide a comprehensive structure-property relationship between the surface of a material and the chemical and physical phenomena. (ii) introduce various catalytic reactions of industrial use. (iii) interpret kinetics and mechanisms in solid-state reactions. (iv) explain the theory of electrolytic conductance and electrochemical phenomena of strong electrolytes on electrode surfaces and their applications (iv) teach corrosion behaviour in materials and protection from corrosion.

Expected course outcomes: By the end of the course, students will be able to (i) distinguish between physical and chemical adsorption phenomena in different catalytic processes in industry and research. (ii) measure the surface area of catalytic powders and classify them based on their porosity. (iii) apply the principles of electrochemical measurements to develop electrode materials for sensors and battery applications in their careers. (iv) describe the nature of corrosion in materials and protection.

Unit I

Surface phenomena - Adsorption, characteristics of adsorption, classification of adsorbents, molecular interactions in adsorption, desorption and energetics, physical and chemical adsorption. Types of adsorption curves- porous, mesoporous and nanoporous materials. Adsorption isotherms- Freundlich, Langmuir, BET, determination of surface area of adsorbent, application of adsorption. Related problems.

Catalysis: Characteristics of catalytic reaction, activation energy, Classification of catalyst and examples, kinetics of homogeneous and heterogeneous catalytic reactions, Catalytic poisoning and retarders. Application of catalysis in industries, hydrogen production.

Solid-state chemical reactions: Introduction, classification, and thermodynamics. Chemical transport in solid-state reaction- Wagner's theory, Kirkendall effect, diffusion mechanism, kinetic features. Methodology in solid-state reaction, experimental techniques to study solid-state reactions. Factors affecting the reactivity of solid-state reaction. 14 hours

Unit II

Electrochemistry: Electrolytic conduction- equivalent conductance, ionic atmosphere, Debye-Huckel theory of interionic attraction, Debye-Huckel limiting law. Electrochemical reactions- Electrode potential and EMF, thermodynamic parameters of a cell reaction, application of EMF measurements- potentiometric titration. Electrochemical devices: Galvanic cells (primary and secondary)- concentration cells and fuel cells and recent developments. Polarisation, over-voltage, decomposition potential, and electrodeposition techniques. Problems. 14 hours

Unit III

Corrosion – Introduction, importance of corrosion studies. Theories of corrosion-factors influencing corrosion, corrosion of iron, copper. Classification- types- Forms of corrosion. Corrosion control measures - paints, metal coatings, anodic and cathodic protection, inhibitors. Polarization studies - corrosion rate measurement, Tafel extrapolation, passivity, analysis of corrosion failure, nanotechnology in corrosion protection. Related problems. Design and selection of materials for application. 14 hours

References

1. Principles of Material Science and Engineering – William F Smith (McGraw Hill, 1988)
2. Material Science and Engineering – V Raghavan (Printice Hall, 1998)
3. An Introduction to Metallic Corrosion and its Prevention – Raj Narayan (Oxferd and IBH, 1983)
4. Introduction to Electrochemistry – S Glasstone (East West, 1942)
5. Advanced Physical Chemistry – Gurudeep Raj (Goel, 1992)
6. Solid State Chemistry – Hannay (Printice Hall, 1967)
7. Text Book of Material Science and Metallurgy – O P Khanna (Dhanpat Rai & Sons, 1984)
8. Engineering Chemistry – Jain & Jain (Dhanpat Rai and Sons, 1993)
9. Solid State Chemistry – Ram Prakash (Radha Publications, 1989)
10. Adsorption – J Oseik (Chichester: Ellis Horwood, 1982)
11. Thermodynamics of Surface Phenomena – Dadesher R K (Viva Books, 2009)