

CY 551 - CHEMISTRY OF MATERIALS

SOLID STATE STRUCTURE

Types of solids; Order - spatial, orientational; Symmetry in crystals - primitive lattice vector – Wigner-Seitz cell - crystal systems - Bravais lattices - crystallographic point groups and space groups; X-ray diffraction - systematic absences - reciprocal lattice - Ewald construction - structure factor - crystal structure solution and refinement - common crystal structure motifs; quasicrystals. [6 h]

DEFECTS AND NONSTOICHIOMETRY

Point, line and plane defects; Intrinsic and extrinsic defects - vacancies, Schottky and Frenkel defects - charge compensation; Nonstoichiometry and defects - thermodynamic and structural aspects; Color centres. [3 h]

THERMAL PROPERTIES

Lattice vibrations - phonon spectrum; Lattice heat capacity; Thermal expansion; Thermal conduction. [3 h]

ELECTRICAL PROPERTIES

Free electron theory - electrical conductivity and Ohm's law - Hall effect; Energy bands - band gap - metals and semiconductors - intrinsic and extrinsic semiconductors; Hopping semiconductors; p-n junctions; Semiconductor/metal transition; Superconductivity - Meissner effect - type I and II superconductors - isotope effect - basic concepts of BCS theory - manifestations of the energy gap - Josephson devices. [10 h]

MAGNETIC PROPERTIES

Classification of magnetic materials; Langevin diamagnetism; Quantum theory of paramagnetism; Cooperative phenomena - ferro, antiferro and ferrimagnetism - magnetic domains and hysteresis; Superparamagnetism. [4 h]

OPTICAL PROPERTIES

Optical reflectance - plasmon frequency; Raman scattering in crystals; Photoconduction; Photo and electroluminescence; Lasers; Photovoltaic and photoelectrochemical effects. [3 h]

GENERAL CONCEPTS IN MATERIALS SYNTHESIS

Phase diagrams; Preparation of pure materials; Nucleation and crystal growth; Crystal growth techniques; Zone refining. [4 h]

INTRODUCTION TO DIFFERENT CLASSES OF MATERIALS

High T_C superconductors, Ionic conductors, Polymers, Liquid crystals, Molecular materials, Nanomaterials [14 h]

Reading material

1. H. V. Keer, Principles of the Solid State (541.0421 K25P)
2. L. E. Smart and E. A. Moore, Solid State Chemistry: an Introduction (541.0421 Sm295)
3. M. T. Weller, Inorganic Materials Chemistry (546 W45I)
4. K. J. Klabunde, Nanoscale Materials in Chemistry (660 K66N)
5. W. D. Callister, Materials Science and Engineering, An Introduction (620.11 C13M)
6. C. Kittel, Introduction to Solid State Physics (530.41 K65I)
7. T. P. Radhakrishnan, Core Concepts for a Course on Materials Chemistry (620.112 R11C)
8. Journals like Chemistry of Materials, Journal of Materials Chemistry, Advanced Materials etc..

Web resource: <http://chemistry.uohyd.ac.in/~CY551/>

Examinations

Minor 1: February 10, 2025

Minor 2: March 17, 2025

Minor 3: April 28, 2025

Final: (to be announced)