

CH H 513: SOLID STATE CHEMISTRY

Course Outcome

- It is an interdisciplinary course falling at the boundary of physics and chemistry.
- It is aimed at understanding the properties of solids and their possible applications in materials science as superconductors, semiconductors, liquid crystal materials and as magnetic materials.
- Emphasis has been given to the methods of preparation of solids, understanding the structure-property relationships and their possible applications.
- Preparation, properties and applications of nanomaterials has also been considered.

UNIT-I

[12 hours]

Crystal Defects and Non-Stoichiometry: Imperfections and defects in crystals. Vacancy, Schottky and Frenkel defects, Dislocations. Thermodynamics of Schottky and Frenkel defect formation, colour centres, non-stoichiometry and defects.

Solid State Reactions: General Principles, Wagner's theory. Order - disorder transitions in solids- Bragg- William's theory Mechanism of diffusion, Kirkendall effect.

Preparative Methods: Ceramic, sol-gel, precursor and chemical vapour deposition (CVD) methods. Nucleation & crystal growth techniques; pulling, zoning, flame fusion & skull melting. Basic methods of preparation of thin films (PVD and CVD techniques).

UNIT-II

[12 hours]

Electronic Properties and Band Theory: Free electron theory to band theory of solids, electrical conductivity, Hall effect. Metals, Insulators and Semiconductors. Intrinsic and extrinsic semiconductors, hopping semiconductors. Metal - semiconductor and p-n junctions.

Ionic Conductors: Types of ionic conductors, mechanism of ionic conduction, diffusion superionic conductors; phase transitions and mechanism of conduction in superionic conductors, examples; β -alumina, AgI, halide and oxide ion conductors.

UNIT-III

[12 hours]

Superconductivity: Meissner effects; Types I and II superconductors, Features of superconductors, isotope effect, high T_c materials. Basics of low temperature superconductivity.

Magnetic properties: Classification of magnetic materials; dia, para, ferro, ferri, antiferro & antiferri magnetic types, Langevin diamagnetism. Selected magnetic materials such as spinels & garnets.

Insulators: Dielectric properties, Piezo and inverse Piezo electric effect, ferroelectricity, ferroelectric transitions in BaTiO_3 .

UNIT IV

[12 hours]

Liquid Crystals: Mesomorphic behaviour, thermotropic liquid crystals, positional order, bond orientational order, nematic and smectic mesophases; smectic - nematic transition and clearing temperature- homeotropic, planar and schlieren textures, twisted nematics chiral nematics, molecular arrangements in smectic A & C phases. Optical properties of liquid crystals.

Nanomaterials: Types (Nanolayers, Carbon nanotubes, Nanowires, Quantum dots) and importance. **Synthesis of metal nanomaterials:** Physical methods (Laser Ablation, Evaporation, sputtering and solvated metal dispersion), chemical methods (Thermolysis, Sonochemical approach, reduction of metal ions by hydrogen and methanol). Characterization: morphology, geometric structure, electronic structure, optical properties). Applications of nanomaterials.

References

1. Solid State Chemistry, D. K. Chakrabarty, 2nd edn., New Academic Science (2010).
2. Principles of the Solid State, H. V. Keer, Wiley Eastern (1993).
3. Solid State Chemistry and its applications, 2nd edn., A. R. West, Wiley (2014).
4. Solid State Chemistry - An Introduction, 4th edn., L. Smart and E. Moore, Chapman & Hall Press (2012).
5. Introduction to Solids, L. V. Azaroff, India Tata Mc Graw Hill (1977).
6. Material Science and Engineering- A first course, 6th edn., V. Raghavan, Prentice Hall India (2015).
7. Thermotropic Liquid Crystals, Ed. G.W. Gray, Wiley (1987).
8. Liquid Crystals, 2nd edn., S. Chandrasekhar, Cambridge University Press (1992).
9. Introduction to Nanotechnology, 1st edn., C. P. Poole and F. K. Owens, Wiley-Interscience, (2003).
10. Nano: The Essentials: Understanding Nanoscience and Nanotechnology, 1st edn., T. Pradeep, McGraw Hill Education, New Delhi (2017).
11. Basics of Nano Chemistry, Mamta V. Sachdeva, Anmol Publications Pvt Ltd, New Delhi, (2011).
12. Modern Heterogeneous Oxidation Catalysis: Design, Reactions and Characterization, 1st edn., Ed. Noritaka Mizuno, Wiley (2009).
13. Nanoscale materials in Chemistry, 2nd edn., Ed. K. J. Klabunde and R. M. Richards, Wiley (2009).
14. Introduction to Nanotechnology, C. P. Poole and F. J. Owens, Wiley-Interscience, (2003).