

JCL 316 (Aug) (3-0-0)**Solid State Chemistry*****Instructor: Premkumar Senguttuvan***

Chemical bonding in solids; ionic, covalent, metallic, van der Waals and hydrogen bonded crystals; metallic, non-metallic, semi-metallic and inorganic compounds; porous solids; Organic crystals; quasicrystals; clathrates; non-crystalline or amorphous solids.

Preparative methods: Solid state reaction, Chimie douce/soft chemistry routes; hydro- and solvo-thermal; single crystal growth (Melt Growth-Bridgeman, Czochralski, Kyropoulos); Molten salt synthesis; Electrosynthesis; High pressure synthesis; Arc techniques; combustion synthesis; mechanochemical and sonochemical methods; chemical vapor deposition and atomic layer deposition.

Phase transition: Thermodynamics; critical phenomena; structural changes and mechanism of phase transitions; incommensurate phases; cooperative Jahn-Teller effect; spin-state transitions; Plastic and liquid crystalline states; plastic and liquid crystalline states; non-crystalline state and glass transitions.

Defects and non-stoichiometry: Point defects; Color centers; Dislocations; Extended defects; superstructures; Clusters and aggregates, Non-stoichiometric compounds, Crystallographic shear (CS); block structures; Lattice dynamics; Diffusion mechanisms, Fick's law, Solid-state Ionics; Kirkendall effect.

Characterization: X-ray, electron and neutron diffraction; Electron microscopy; X-ray absorption spectroscopy; Nuclear magnetic resonance spectroscopy. Electron spectroscopy; scanning tunneling microscopy.

Electrical properties: Band theory of solids; Metals, semiconductor and insulator; localized electron model; chemical bond approach; Hall effect; Two / Four probe methods and thermal conductivity and Optical band gap; thermoelectric effects; insulators – dielectric, ferroelectric, pyroelectric and piezoelectric properties, multiferroics. Superconductivity: Meissner effect; High T_c superconductors. Case studies on various metal oxide/sulfide/telluride/nitride compounds.

Magnetic properties: Dia, para, ferro, ferri, and antiferro magnetic types; Magnetic materials and measurements; magnetoresistance.

Reactivity of solids: Solid-state reactions; Solid-solid, solid-liquid and solid-gas reactions. Reactions of organic solids. Heterogenous catalysis

Intergrowth structures and misfit compounds; Intermetallic compounds; Zintl Chemistry.

Reference Books:

1. A. R. West, Solid State Chemistry and Its Applications, 2nd Edition, Wiley 2022.
 2. C. N. R. Rao and J. Gopalakrishnan, New Directions in Solid State Chemistry, 2nd Edition Cambridge University Press 1997.
 3. C. N. Rao and K. Biswas, Essentials of Inorganic Materials Synthesis, Wiley 2015.
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