Basic course on Thermoelectric materials

Unit 1: Thermal properties

Introduction, specific heat- thermal conductivity thermal expansion, thermal stress, thermal stability - Thermal radiation, emissivity, thermal diffusivity - Relationship between structure and thermal properties of materials - Experimental methods for thermal analysis of materials

Phonons- phonon heat conduction in solids-phonon thermal conductivity-combined electronic and phononic thermal conductivity

Unit II: Electronic transport properties

Different types of solids-energy band structures in solids- density of states and carrier density- Heat conduction-Electrical conduction-charge transport-Transport by electrons-metals and semoconductores-bipolar effects-optimal band structure- Fermi level-band gap, optimal concentration of current carriers.

Unit 1II: Basics of thermoelectricity

Introduction to thermoelectricity-seebeck effect-peltier effect-thomson effect- heat conduction in thermoelectric materials-performance of thermoelecrtic devices ((generators, cooling systems and heat pumps)- thermoelectric actuators (thermocouples, heat-flux actuator)s; efficiency of thermoelectric devices, thermoelectric figure of merit ZT, optimisation of materials parameters.

Unit 1V: Thermoelectric materials and preparation techniques

Classical thermoelectric materials- Bulk TE materials -oxides- half husler - Si-Ge alloys-commercial materials -nanostructured thermoelectric materials-thermoelectric

Thermoelectric materials; Preparation methods of polycrystalline materials and single crystals, optimization of structural and mictrostructural parameters – doping, alloying, superlattices, quantum dots; technologies of single-crystals and thermoelectric layers, measurements of thermal parameters: (thermal conductivity: hot plate, guard plate, Lees, Angstrom's, 3-omega, laser-flash methods.

Unit V: Microscopic formulation of thermoelecrtic properties

Phenomenological description of thermoelectric phenomena (Seebeck, Peltier, Thomson effects). Basis of non-equilibrium thermodynamics, Onsager's equations, relation between kinetic parameters and transport parameters, generalized Ohm's and Fourier equations, mechanisms of creation of thermoelectric power, diffusive mechanism, phonon drag, magnon drag, phonon and electron equilibrium, influenece of external magnetic field.