DIFFUSION IN MULTICOMPONENT SOLIDS

TYPE OF COURSE : Rerun | Elective | UG/PG
COURSE DURATION : 12 weeks (18 Jan' 21 - 09 Apr' 21)
EXAM DATE : 25 Apr 2021

PRE-REQUISITES : Preliminary knowledge of materials thermodynamics and structure of materials is desirable

INTENDED AUDIENCE : Metallurgical Engineering, Materials Science, Mechanical Engineering, Chemical Engineering

INDUSTRIES APPLICABLE TO : The industry working on design and development of alloys and processes may benefit from this course e.g. to name a few are General Electrics, General Motors, Tata Steel, Boing etc.

COURSE OUTLINE : Diffusion is the fundamental process controlling most of the phase transformations and hence, is of great interest through both theoretical and application perspectives. Knowledge of diffusion behavior of materials is essential for control as well as design of new processes. Moreover, most of the industrially important systems are based on three or more components and thus, the understanding of diffusion in multicomponent systems is particularly of greater interest. This course will treat both the phenomenological and atomic theory of diffusion in multicomponent systems. This course is an attempt to take the multicomponent effects in diffusion, which so far have been discussed only within restricted community of researchers working on diffusion, to the broader audience of metallurgical and materials engineering.

ABOUT INSTRUCTOR : Prof. Kulkarni finished his PhD from Purdue University on the topic of multicomponent diffusion. He worked in industry for four years before joining IIT Kanpur in 2012. His research mainly focusses on understanding of multicomponent effects in diffusion kinetics and applying those for designing advanced materials and processes.

COURSE PLAN :

**Week 1:** Basics of thermodynamics: laws of thermodynamics, concept of chemical potentials and criteria for equilibrium

**Week 2:** Refresher on Solution Thermodynamics and Phase Stability

**Week 3:** Phenomenology of multicomponent diffusion and various frames of reference used for measuring diffusion fluxes

**Week 4:** Solving diffusion equation for various boundary conditions including solution of multicomponent diffusion equation

**Week 5:** Self diffusion, impurity diffusion, interdiffusion and intrinsic diffusion; Experimental determination of interdiffusion and intrinsic diffusion coefficients

**Week 6:** Point defects in crystalline solids and mechanisms of diffusion

**Week 7:** Random walk, diffusivity and correlation effects in diffusion

**Week 8:** Derivation of correlation factors in some crystalline lattices

**Week 9:** Derivation of fundamental driving forces for diffusion: chemical potential gradients and atomic mobilities; cross effects in multicomponent diffusion driven by defect mechanisms

**Week 10:** Interrelation between multicomponent diffusion coefficients, atomic jump frequencies and thermodynamic factors

**Week 11:** Multiphase diffusion, diffusion structures and phase diagrams

**Week 12:** Experimental determination of activation energies for diffusion; Fast diffusion paths: Grain boundary and pipe diffusion