ALUMINIUM BASED ALLOYS AND METAL MATRIX COMPOSITES

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PRE-REQUISITES : Basics of Materials Science & Engineering

INDUSTRY SUPPORT : TVS motors, Rane Group, Ashok Leyland, Mahindra and All other major automotive manufacturers

COURSE OUTLINE :

Aluminium and its alloys are one of the most important classes of engineering materials which are used in many applications starting from household to aircrafts. Given the wide range of applications of Al alloys the property requirements are also quite diverse. Therefore, understanding the structure-property correlation i.e. the Physical metallurgy of Al alloys is very important.

Composites on the other hand supplement many of the properties needed in a particular application.

This course will cover the aluminium alloys and their composites in the entirety. The objective is to learn about Al alloys and composites with an emphasis on the physical metallurgy and the structure-property correlation. It is expected that at the end of the course students will develop a clear understanding on Al alloys, Physical metallurgy and Metal matrix composites.

ABOUT INSTRUCTOR :

Prof. Ranjit Bauri is a Professor in the Dept. of Metallurgical and Materials Engineering, IIT Madras. He has more than a decade of experience in teaching and research. The broad areas of his expertise include Powder Metallurgy, Ceramics, Composite materials, Energy Materials, Aluminum alloys, Friction stir welding and processing, and Microscopy.

COURSE PLAN :

Week 1: Introduction, Pure Aluminium, Extraction of Aluminium, Removal of impurities, Alloy Designations, Cast Alloys, Al-Si alloys, Modification of Al-Si alloys

Week 2: Modifying Al-Si alloys, Alloy designations, Solid solution strengthening, Mechanisms of Solid solution strengthening. Buildup of solute atmosphere, Yield point phenomena, Strain aging, Cottrel-Bilby theory of strain aging.

Week 3: Portevin–Le Chatelier (PLC) effect, Dynamic Strain Aging (DSA), Penning theory of DSA, Precipitation hardening – Introduction.

Week 4: Precipitation hardening, T-T-T diagram of precipitation, Alloy tempers, GP zones, Natural Aging. Mechanisms of Precipitation hardening, Precipitation hardenable Alloys, Precipitation sequence.

Week 5: Properties of 7XXX series alloys; Precipitation sequence in 8XXX series alloys, Order strengthening in Al-Li alloys, Strain Hardening. Recovery & Recrystallization.

Week 6: Nucleation and Growth in Recrystallization, Dynamic Recrystallization, DDRX, CDRX, GDRX.

Week 7: Grain refinement strengthening, Grain refinement methods, Homogeneous and Heterogeneous Nucleation, Grain refinement by Melt inoculation.

Week 8: Mechanisms of grain refinement by melt inoculation, Fading & Poisoning, Grain refinement by melt vibration, Severe Plastic Deformation (SPD), Dynamic recrystallization in SPD.

Week 9: Metal Matrix Composites (MMC): Definition of composite, Processing of MMCs: Liquid state processing, Stir casting, Melt infiltration. Spray deposition, Solid state and Vapor state processing, Spray deposition, CVD and PVD. Insitu Composites. Particle bonding and distribution in MMCs.

Week 10: Properties of Metal Matrix Composites, Rule of mixtures, Strengthening Mechanisms in MMCs.

Week 11: Fracture Behavior of composites, Ductile Fracture of Metals, Fracture Behavior of Discontinuously Reinforced Composites.

Week 12: Fatigue, Fatigue Behavior of MMCs