

FOUNDATION DAY LECTURE

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MICROSTRUCTURAL EVOLUTION IN ENGINEERING MATERIALS

Indranil Manna, JC Bose Fellow

Indian Institute of Technology Kharagpur
imanna@metal.iitkgp.ac.in; www.imanna.in

Abstract

The success of design, development and performance of engineering solids, based on metallic, ceramic, polymeric materials, or their combinations in the form of composites, principally depends on our ability to create and utilize effective understanding of the correlation in their microstructure-composition-properties-process parameters. For a material of a given composition, properties largely depends on microstructure, a complex concept comprising information related to bonding characteristics and origin/type of atomic aggregate (crystalline/amorphous), identity/ shape/ size/ morphology/ orientation/ distribution of the constituent phases, prior fabrication history, and influence of environment or external stimuli. Both stable (equilibrium) or metastable microstructure in solids evolves through large scale rearrangement of atoms, called phase transformation during various stages of synthesis or processing and is principally dictated or controlled by the relevant thermodynamic and kinetic parameters. The aforesaid philosophy and approach based on phase transformation has always been practiced for and applicable to all classes of engineering materials including metals, ceramics, refractory, semiconductors, insulators, nano-materials, glass and amorphous/glassy solids, aimed either for structural or functional applications in the form of bulk solids, particulates, thin/thick films, coatings, laminates, sponges and hybrids/composites.

An alloy with same composition but synthesized by or processed through different routes to yield different microstructure can manifest entirely different sets of properties. Tailoring microstructure to nanometric length scale maintaining the same composition has enabled development of a new breed of engineering materials, so called nano-structured materials, which to the limit may contain nearly equi-proportion of atoms in interfaces as in grain-core and thereby, manifest new set of size dependent properties, not seen in their coarse grain counterparts. Thus mystery of materials is best

understood by deciphering the microstructure. Indeed successful application of engineering materials entirely depends on the principal theme of microstructure-property-parameter correlation. In the proposed talk I wish to offer a few illustrations of understanding/interpreting microstructural evolution concerning mostly metallic systems of both crystalline and amorphous nature aimed at some selected structural and functional applications.

About the speaker



Professor Manna, formerly Director of IIT Kanpur and CSIR-CGRI, is an educationist and materials engineer with wide ranging research interests covering structure-property correlation and modeling in structural and functional materials including nanometric metals, laser/plasma assisted surface engineered components, nano-fluid and bainitic steel. His studies on amorphous Al-alloys, laser surface engineering of steel/Mg/Al alloys, and thermal conductivity of nanofluid are highly cited.

He teaches subjects related to physical metallurgy. As a guest scientist, he visited different renowned Institutions/Universities abroad like Max Planck Institute at Stuttgart, Technical University of Clausthal, Liverpool University, Nanyang Technological University and University of Ulm. Prof Manna has over 250 journal publications, supervised 25 PhD theses, completed over Rupees 16 crore worth sponsored research at IIT-Kharagpur during 1990-2008 and received several national/international awards and recognition. Since 2010, he is actively involved in several technology development initiatives including IMPacting Research INnovation and Technology or IMPRINT (www.imprint-india.org, www.imprint-2.in). Professor Manna is a Fellow of all the national academies of science (INSA, IASc, NASI) and engineering (INAE) in India, a J C Bose Fellow of DST since 2012 and a recipient of TWAS prize for engineering sciences (2013). IEST, Shibpur in 2015 and IIT Kharagpur in 2016 presented him Distinguished Alumnus Award. Kazi Nazrul University, Asansol and Kalyani University conferred DSc (hc) on him in 2016 and 2017, respectively. He is a former President of the Indian Institute of Metals (IIM) and current Vice President of the Indian National Academy of Engineering. He is also a Fellow of The World Academy of Sciences and a Member of the Asia Pacific Academy of Materials.