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Inverse Methods in Materials Design and Processing

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ABSTRACT:

The field of materials and microstructure design has progressed significantly in the past two decades. Materials and processing design methodologies effectively utilize the incomplete materials knowledgebase to link final product properties to initial microstructure. Today, we are witnessing a paradigm shift in materials modeling research and development from initial Materials--> Final Property to Final Property --> Initial Materials and Microstructures. It is clear that Inverse Materials Design is at the heart of the initiatives by the White house presently known as Materials Gnome. Methodologies that can make the Inverse Materials Design a reality requires novel mathematical and computational frameworks and methodologies in addition to experimentally based knowledge creation to integrate computational-prediction and experimental-validation approaches. This talk will present current advances in multiscale computational materials frameworks based on Microstructure Sensitive Design and statistical homogenization techniques. Microstructure representation and digitization using spectral techniques are at the heart of such methodologies. Experimental techniques to acquire pertinent statistical information about microstructure and the representation of processing as a continuous path in a microstructure hull are other aspects that will be discussed. Application of the present methodologies in thermo-mechanical processing of advanced magnesium alloys, the effect of machining and processing of textured silicon solar cells and solid Oxide Fuel Cells are discussed with respect to inverse methodologies.

BIOGRAPHY:

Prof. Hamid Garmestani, faculty since 1991, is a Professor of Materials Science and Engineering at Georgia Institute of Technology. He has developed methodologies in Microstructure Sensitive Design (MSD) framework that addresses an inverse methodology and innovations in various aspects of processing, structure-property relationships, and simulation-based design of materials. He has contributed years of work to statistical homogenization in composites and polycrystalline materials. He has recently been involved in microstructure sensitive design of porous ceramic cathode materials resulted in the development and synthesis of porous gradient LSMO cathode microstructures for Solid Oxide Fuel Cell (SOFC). The theoretical modeling using statistical approaches provided a framework to identify the gradient and the required porosity in the ceramic structures. Dr. Garmestani has been heavily involved in leadership roles in both the American Society of Mechanical Engineers Materials Division and ASM. He is a member of the texture, forming and composite committees of ASM and TMS. He has organized more than 30 workshops and symposia in the emerging subject of materials design. He was awarded “Superstar in Research” by FSU-CRC in year 2000. He was also the recipient of the 2000 Engineering Research Award of FSU College of Engineering and recipient of the Faculty Award for Research from NASA. He is presently funded through DOE, Boeing and NSF. Dr. Garmestani is a member of the editorial board of International Journal of Plasticity, Journal of Mechanics of Materials, Computers, Materials and Continua and Theoretical and Applied Multi-scale Modeling of Materials.