IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Multiscale and Multiphysics Modeling for the Analysis, Design and Manufacturing of Advanced Materials

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Abstract

Over the past few decades, multiscale/multiphyics modeling and simulation based design have seen tremendous progress, and are being further catalyzed by the growing interest in integrated computational materials engineering (ICME) and advanced manufacturing. Among our research activities that align with this trend, we will first present the Eigen deformation-based Reduced Order Homogenization Method (EHM) for polycrystal plasticity. EHM first establishes a reduced-order representation of the response at the material microstructure (i.e.. at the polycrystalline represent volume element (RVE) scale), by employing the idea of precomputing certain information on the material microstructure such as the influence functions, localization/interaction operators and coefficient tensors through RVE scale simulations. During the multiscale analysis, EHM then concurrently couples the reduced-order representation of the response at the RVE scale to a structural simulation, and endows the structural response with microstructure information (e.g., grain level stress, slip, grain boundary concentrations) throughout the structural domain. The capability of EHM is further enhanced by being selective in what "physics" we choose to embed at the fine scales, as well as by developing sparse and scalable computational algorithms for efficiency. In the second part of this talk, a novel composite manufacturing process called frontal polymerization (FP) will be first introduced, together with a coupled thermo-chemo-mechanical modeling framework for the modeling and design of FP-based manufacturing process. Representative FP-based manufacturing processes including composite manufacturing and 3D printing, as well as the effectiveness of the developed multiphysics modeling technique for the analysis and design of these manufacturing process will then be demonstrated.

Biography

Dr. Zhang is currently a Postdoctoral Fellow in the Aerospace Engineering Department at the University of Illinois at Urbana-Champaign. He obtained his Ph.D. in Civil Engineering from Vanderbilt University (2017), M.E. in Solid Mechanics from Beihang University (2012) and B.E. in Engineering Mechanics from Northeastern University (2009) in China. He has been focused on developing advanced multiscale and multiphysics modeling technique, and actively interacting with experimentalists, to investigate the deformation and damage in high-performance materials under extreme conditions, and to model and design advanced manufacturing process. His work has been recognized by multiple awards, including being a Finalist of 2017 Robert J. Melosh Medal Competition, a Best Paper Award from 2016 Engineering Mechanics Institute Conference Modeling Inelasticity & Multiscale Behavior Committee Student Competition, and a Best Poster Award in Materials Science and Technology category from 2016 American Nuclear Society Winter Meeting and Nuclear Technology Exposition.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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