Challenges in addressing length and time scale transitions in models for inelastic behavior of metals will be identified and discussed in the context of (i) scale bridging in terms of hierarchical and concurrent multiscale modeling and (ii) scale specific modeling with bridging via informatics and decision-based design. The former supports modeling of material response in structures at various scales and the latter supports multi-level design of materials. This talk will focus on several key challenges that hinder multiscale models for metallic polycrystals, including the role of grain/phase boundaries in nucleation and slip transfer for grain sizes from the nanoscale to the micron scale, development of dislocation substructure under non-equilibrium conditions, dislocation density based constitutive relations for higher order continua in the submicron length scale regime, and the reduction of model degrees of freedom under coarse-graining. In terms of goals of multiscale modeling, both homogenization and localization are considered with regard to mean field properties and extreme value fracture and fatigue phenomena, respectively. Multi-level design is supported by scale-specific models that minimize uncertainty in terms of representing mechanisms and passage of information, and is relevant to materials design and development objectives.

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Regents’ Professor and Carter N. Paden, Jr. Distinguished Chair in Metals Processing, Dave McDowell joined Georgia Tech in 1983 and holds appointments in both the GWW School of Mechanical Engineering and the School of Materials Science and Engineering. He served as Director of the Mechanical Properties Research Laboratory from 1992-2012. In August 2012 he was named Founding Director of the Institute for Materials (IMat), one of Georgia Tech’s interdisciplinary research institutes charged with enhancing a materials innovation ecosystem for research and education.

McDowell’s research focuses on the synthesis of experiment and computation to develop physically-based, microstructure-sensitive constitutive models for nonlinear and time-dependent behavior of materials, with emphasis on wrought and cast metals. Topics of interest include finite strain inelasticity and defect field mechanics, constitutive relations and microstructure-sensitive computational approaches to deformation and damage of heterogeneous materials, including metal fatigue, atomistic simulations of dislocation nucleation and mediation at grain boundaries, and multiscale modeling.