Materials Science and Engineering Department

Winter Seminar Series

Compositionally and Structurally Modulated Materials for Exceptional Functional and Mechanical Properties

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February 15, 2023
3-4PM | Hill Seminar Room (LeBow 240)

Shear deformations carried by dislocations, mechanical twinning and martensitic transformations in crystalline solids and by shear banding in metallic glasses share key common features including autocatalysis by long-range elastic interactions and strain avalanche. In order to achieve desired stress-strain behaviors for a given application, alloy composition and microstructure need to be tailored judiciously to have precisely controlled strain release during both superelastic and plastic deformations. In this presentation, we give an overview of our recent design strategies to create compositionally and/or structurally modulated alloys to regulate strain release during shear deformation. Using a combination of theoretical modeling, computer simulation, and experimental testing and characterization, we first show that nano- and micro-meter scale concentration modulations created by different means are highly effective in converting strongly first-order, sharp martensitic transformations into apparently continuous transformations, offering linear superelasticity with nearly zero hysteresis, ultralow modulus, and Invar and Elinvar anomalies. Secondly, we demonstrate that fine-scale phase stability modulations accompanying the concentration modulations can also conduce to microstructure modulations by activating different phase transformation mechanisms, offering synergistic combinations of strength and ductility and prolonged TRIP effect. Finally, we illustrate that twin boundaries and stacking faults created during deformation can harbor embryos of new phases, either activating new deformation mechanisms or suppressing continued deformation, which could be utilized in alloy design to achieve exceptional functinoal and mechanical properties.

Dr. Wang's research interests span the areas of modeling and simulation of microstructure evolution during phase transformation and deformation in structural materials, SMAs and metallic glasses. Dr Wang received his Ph.D. (1995) in Materials Science from Rutgers University. He has published ~ 300 refereed journal articles (with ~ 120 in Acta Materialia). His major awards include NSF CAREER Award, Harrison Faculty Award for Excellence in Engineering Education from Ohio State University, Fraunhofer Bessel Research Award from Alexander von Humboldt Foundation of Germany, Cyril Stanley Smith Award, William Hume-Rothery Award, and Distinguished Scientist/Engineer Award from TMS.

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