Te Tari Pūhanga Pūrere|Mechanical Engineering Department

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

MECH Seminar Series 2024

Thursday, 15 February 2024
2 pm
E16 (Rātā Bldg)

Compositionally and structurally modulated materials for exceptional functional and mechanical properties

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Abstract:
Shear deformations carried by dislocations, mechanical twinning and martensitic transformations in crystalline solids and by shear banding in metallic glasses share key common characteristics. These include autocatalysis driven 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 controlled strain release during both superelastic and plastic deformations. This presentation provides an overview of our recent design strategies focused on developing compositionally and/or structurally modulated alloys to regulate strain release during shear deformation. Employing a combination of theoretical modeling, computer simulation, and experimental testing and characterization, our research highlights several key findings. Firstly, we demonstrate 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 minimal hysteresis, ultralow modulus, and Invar and Elinvar anomalies. Secondly, our work reveals 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 functional and mechanical properties.

Bio Sketch:

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 over 300 refereed journal articles (with over 130 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, and Distinguished Scientist/Engineer Award, Cyril Stanley Smith Award, William Hume-Rothery Award, and Fellow Award from TMS.

All are welcome!