MECHANICAL ENGINEERING SEMINAR

Monday, July 11 2022 at 14:30, D. Dan and Betty Kahn Building , Auditorium 1

Online: http://technion.zoom.us/BestSeminarEver

Computational design of ultra-strong high-entropy alloys manufactured via additive manufacturing processes

Mauricio Ponga, Ph.D.

Assistant Professor of Mechanical Engineering

The University of British Columbia, Vancouver, Canada.

Email: mponga@mech.ubc.ca ; Website: https://mech-modsim.sites.olt.ubc.ca

Hosted by: Prof. Gal Shmuel

Multi-principal elements materials (also known as high-entropy alloys (HEAs)) challenge the traditional alloy design techniques. Due to their large design space and ample mechanical, optical, electrical, and thermal properties, HEAs are exiting material systems to explore and replace some of the high-strength materials available such as steel. HEAs are gaining momentum in the materials science and mechanics communities as they open up new research opportunities. However, besides having larger lattice friction values than conventional metals, HEAs perform at significantly lower levels than most high-strength materials available. Thus, researchers explore novel compositions -including multi-phase HEAs- and manufacturing techniques to develop intricate microstructures. Computational frameworks open up the possibility of exploring these design spaces and manufacturing methods and can be combined with experimental approaches to reduce the time and cost of novel HEAs discovery. In this presentation, using ab-initio simulations and experiments, I will explore the design space of non-equiatomic CoCrFeNi and CoCrFeMnNi HEAs with additions of Mo and Nb. Remarkably, it is shown that the simultaneous combination of these two solute atoms leads to alloys with optimal electronegativity, reducing the size of the precipitates while providing solid-solution hardening. Further, these atomic-scale fingerprints can be combined with additive manufacturing processes to develop rich microstructures. In particular, it is experimentally and numerically shown how feedstock HEAs particles can dynamically recrystallize during cold-spraying additive manufacturing to create nano-sized grains. Lattice orientation and particle shape effects on DRX are shown, and they can be tailored to produce gradient nano-grained structures. We explore the mechanical and microstructural features of a CrFe0.75CoNiNb0.125Mo0.3 cold-sprayed, which shows remarkable mechanical properties surpassing most face-centered cubic HEAs and most high-strength steels.

Mauricio Ponga *is currently an Assistant Professor in the Department of Mechanical Engineering at the University of British Columbia. Before UBC, Dr. Ponga was a Postdoctoral Scholar in the Department of Mechanical and Civil Engineering at the California Institute of Technology under the supervision of Prof. Kaushik Bhattacharya and Prof. Michael Ortiz. Dr. Ponga graduated with a Ph.D. and M.Sc. from the University of Seville (2013, 2010) and a Bachelor's degree in Aeronautics from the University of La Plata (2007). Dr. Panga's research interests focus on developing novel modeling simulation techniques to understand materials at the nanoscale, including but not limited to large-scale ab-initio simulations, accelerated and classical molecular dynamics simulations, and dislocation dynamics. More recently, Ponga has focused on the combined computational and experimental design of high-entropy alloys for ultra-strength and toughness.*

Seminars Coordinator: Assoc. Prof. Matthew Suss.