TOWARDS NEXT GENERATION, LOW COST, HYDROGEN RESILIENT AUSTENITIC STEELS: RELATING COMPOSITION, MICROSTRUCTURE AND DEFORMATION MODES ACROSS LENGTH SCALES

Jessica A. Krogstad, Department of Materials Science and Engineering, University of Illinois Urbana Champaign
jakrogst@illinois.edu
Po-Cheng Kung, Department of Materials Science and Engineering, University of Illinois Urbana Champaign
Quinten Yurek, Department of Materials Science and Engineering, University of Illinois Urbana Champaign
Tianyu Su, Department of Materials Science and Engineering, University of Illinois Urbana Champaign
Elif Ertekin, Department of Mechanical Science and Engineering, University of Illinois Urbana Champaign
Brian Somerday, Department of Mechanical Science and Engineering, University of Illinois Urbana Champaign
Petros Sofronis. Department of Mechanical Science and Engineering, University of Illinois Urbana Champaign
Hoon Lee, Department of Nuclear, Plasma and Radiological Engineering, University of Illinois Urbana Champaign
Dominic Piedmont,Department of Nuclear, Plasma and Radiological Engineering, University of Illinois Urbana Champaign
James Stubbins, Department of Nuclear, Plasma and Radiological Engineering, University of Illinois Urbana Champaign
Toshihiro Tsuchiyama, Department of Materials Science and Engineering, Kyushu University

Development of robust, cost effective, and reliable hydrogen applications requires a new generation of low-cost austenitic steels. In this talk we will review recent collaborative efforts to achieve this goal by intimately coupling experiments with modeling and simulation to establish how the intrinsic chemical composition, in concert with hydrogen, governs microstructural evolution and ultimately leads to fracture initiation and failure. Classical metrics of embrittlement have proven to be insufficient on their own to explain failure and thus guide the design of optimum alloy composition. We have developed a suite of four model alloys, all of which satisfy the aforementioned classic metrics of hydrogen resilience. Comparing the deformation response of these alloys, in both annealed and hydrogen charged conditions, combined with insight from atomistic and micromechanics models, has allowed us to consider a range of possible contributions from nanoscale chemical heterogeneities and ultimately provide guidance for more hydrogen resilient alloys.