

Materials at Extremes Research Group

Jan 20, 2022

ABSTRACT:

Materials are being asked to perform at “extremes” with increased inlet pressures and temperatures in industrial and aero gas turbines, the rise of hypersonic flight, and new Generation IV fission and ITER Fusion reactor concepts. There is a need to develop advanced manufacturing techniques to fabricate extreme environment materials, components, and geometries not possible with conventional techniques. To meet this challenge, government, academia, and industry has invested heavily in Additive Manufacturing (AM) technologies and Integrated Computational Materials Engineering (ICME) to achieve “designer” components with processing, structure, properties, and performance designed to survive harsh environments. The quest for new materials requires that we quickly manufacture, qualify, and model the performance of the candidate materials for service.

The Materials at Extremes Research Group (MERG) has focused on the development of advanced manufacturing, testing and characterization, theoretical models, and computational tools for various extreme environment applications. In this seminar, we will review the ongoing and future research projects at MERG, and conduct a deep dive into accelerated, parallelized, and miniaturized testing methods for new materials qualification and a probabilistic modeling framework for reliability-based design for extreme environments.

BIOGRAPHY:

Calvin M. Stewart is a tenured Associate Professor in the Department of Mechanical Engineering at the University of Texas at El Paso (UTEP), Provost Faculty Fellow, and Energy Engineering lead of the UTEP-NASA Aerospace Center. He obtained a BS, MS, and PhD in Mechanical Engineering at the University of Central Florida in 2008, 2009, and 2013 respectively. Dr. Stewart directs the Materials at Extremes Research Group (MERG) which focuses on the advanced manufacturing, accelerated testing, constitutive modeling, and simulation of materials subject to thermal, mechanical, and chemical extremes. Within the gamut of extremes creep, fatigue, thermomechanical fatigue, corrosion, oxidation, impact, and fracture are key focus areas. Dr. Stewart has authored over 80 articles in these areas. At UTEP, Dr. Stewart has generated over \$11M in research expenditure through grants/contracts with the U.S. Department of Energy, National Nuclear Security Administration, National Energy Technology Laboratory, Office of Nuclear Energy, Nuclear Regulatory Commission, Honeywell FM&T, Air Force Research Lab, among others. Current research involves the development of an accelerated creep test protocol for modern and advanced superalloys, the development of constitutive models for elevated temperature applications, FFF additive manufacturing of superalloys and refractory alloys for extremes environments, femtosecond laser machining development, and the additive manufacturing of proton-exchange membrane hydrogen fuel cells. Materials of interest include: conventional and additively manufactured (AM) superalloys, AM polymers, AM composites and multifunctional materials, among others. Computational interests include: probabilistic constitutive, damage, and life prediction modeling and genetic programming and symbolic regression of the mechanics of materials at extremes.



Calvin Stewart

*Associate Professor;
Provost Faculty Fellow of
Diversity, Equity, and
Inclusion;
Director, Materials at
Extremes Research Group;
Energy Engineering
Division Lead, NASA
Aerospace Center;
University of Texas at El
Paso*