Targeted Materials Characterization and Testing of Additively Manufactured Metals and Ceramics to Inform Print/Build Data Analytics

PI: Elizabeth S. Sooby – University of Texas at San Antonio

Collaborators: Brian Jaques – Boise State University; Amanda Fernandez – University of Texas at San Antonio; Ana Stevanovic –University of Texas at San Antonio; Allyssa Bateman-Draves – Boise State University

Program: CT-3.2 Materials Characterization of Additively Manufactured TCR Core Structural Materials

ABSTRACT:

A collaborative program between the University of Texas at San Antonio (UTSA) and Boise State University (BSU) is proposed to supply materials testing and characterization data sets on additively manufactured core materials to be produced and leveraged by the TCR program to inform build/print data analytics methods. Specifically, the team will perform high temperature steam oxidation testing characteristic of steam ingress from a depressurized loss of coolant accident in either a light water reactor (LWR) or an advanced gas reactor (AGR) within a steam secondary cycle. This type of data is not currently available for data analytics efforts of AM parts, though it is essential for reactor structural material qualification. The steam oxidation performance data sets will be complemented by micromechanical and phase composition characterization. Complementing the materials testing and characterization efforts are partnered computer science and data analytics assessments led by UTSA and advised by the TCR analytics team. With the importance of tracking build location and orientation as accurately as practical at the forefront of experimental design and planning, it is the objective of the proposed work to complement and expand upon the existing TCR data sets by supplying:

- Types of performance data yet to be incorporated into the TCR data analytics frame work, specifically correlated thermogravimetric (TGA) and mass spectrometry (MS) data collected dynamically during high temperature steam oxidation of tracked and labeled coupons segmented from larger AM builds
- Mechanical testing and Raman spectroscopy data labeled with enhanced build location accuracy, enabled by precision tracking of segmentation steps and the implementation of high-resolution characterization techniques, namely micro- indentation and -Raman of samples pre and post oxidation,
- Light element (carbon and oxygen) analysis of both pre-cursor powders used in the build and segmented coupons from the larger AM build, labeled with accurate part/sample identifiers to be correlated back to exact build locations.

Using these techniques in a targeted approach, the proposing team will supply tens of thousands of location specific data points that are labeled, tracked and correlated to within $\pm$50 microns of the known print location within the bulk part. These data sets will span both precise volumes of bulk samples (TG, MS, and C/O data), typical of the current bulk mechanical data used by the TCR program, as well as point data sets taken at submillimeter (10-100's of microns) length scales (micro indentation and supporting Raman spectroscopy characterization of oxidized samples). The proposed work will also include a data analytics arm to bridge the mesoscale gaps between bulk coupon and point data collected, correlate preliminary image and testing data sets, and collaborate on the predictive and prescriptive efforts of the TCR program.