
Advancing Facilities for Synergistic Liquid and Gas Environmental Testing of Materials at the University of New Mexico

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ABSTRACT:

Advanced reactor development and deployment will necessitate advanced materials and determination of their properties in emulated reactor environments. Current materials testing paradigms for advanced reactors couple temperature and irradiation, temperature and stress, corrosion and temperature, but rarely are temperature, stress, and corrosion coupled. This analysis is necessary to determine how materials will perform in advanced reactor environments, where structural materials will be exposed to synergistic corrosion under advanced coolants (FLiNaK, Pb, for example), other environmental conditions (gas exposure), temperature, and mechanical stress. This proposed work will establish a facility at the University of New Mexico (UNM) to perform coupled, in-situ mechanical testing in corrosive environments. This work will build on the existing mechanical testing capabilities at UNM to purchase environmental test chambers to augment the existing mechanical testing load frames to enable simultaneous exposure to liquids, including Pb or FLiNaK, and one to enable exposure to gases, including air and hydrogen gas. UNM will purchase two environmental test chambers to be attached to the existing in-situ SEM small scale load frame, one for in-liquid testing and one for in-gas testing. To enable proper use, UNM will purchase heaters to enable testing up to 600 °C, specimen grippers, a load cell, and a video extensometer for real-time strain measurements. In addition, UNM will purchase a liquid exposure cell for the Zwick-Roell bulk load frame for complementary testing on bulk-sized specimens.

In addition to corrosive environments, hydrogen interaction with materials is receiving renewed interest for its importance to microreactors. However, the ability to hydrogen charge specimens and test materials in hydrogen-containing environments remain limited. This work will establish a facility for hydrogen charging of materials to complement the above environmental cell for performing mechanical tests in a hydrogen environment. This project will purchase the equipment to establish hydrogen charging facilities at UNM to hydrogen charge specimens for microreactor research. In tandem, this work will advance the understanding of coupled materials degradation in stress and corrosive environments and the ability for understanding of H-material interactions.

The outcomes of this work include [1] Establishment of environmental cells on UNM's Kammrath-Weiss load frame for synergistic mechanical testing in gas and liquid environments, [2] establishment of a hydrogen charging apparatus for hydrogen charging of specimens. The scientific impact will be an understanding of the coupled environmental-mechanical stress interactions in materials. This work will increase the research and teaching capacity at UNM, a Hispanic serving institution, to train the next generation of students in coupled environment testing of advanced materials for advanced reactor development, aligned with DOE-NE's advanced reactor initiatives.