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Grantee: Auburn University
Title of Grant: A High-Throughput Approach to Establish the Regulatory Basis for Qualifying Laser Additive Manufactured (AM) Stainless Steel for Nuclear Applications
Period of Performance: 9/28/2021-9/27/2024 (FY21 Notice of Funding Opportunity NOFO)

Executive Summary

This project takes a high-throughput and integrated approach by using microstructurally-graded specimen design, small-scale mechanical testing, proton irradiation, and high-throughput testing, and material characterization to accelerate the data development and understandings of (1) irradiation-assisted stress corrosion cracking (IASCC), (2) deformation behavior, (3) microstructural evolution of irradiated additive-manufactured (AM) 316L stainless steel (SS) in light water reactor environments. The study aims to fulfill the data need to identify the safety concerns of laser AM for nuclear and support NRC to develop guidelines for reviewing industry proposals and licensing of laser AM. The research contributes to NRC's regulatory activities through rapidly developing a large dataset of radiation properties of proton-irradiated AM 316L SS, revealing the fundamental mechanisms of IASCC and irradiation behavior, surveying different post-process treatments to AM SS to support industry's interests, demonstrating the validity of the proposed high-throughput approach for other radiation experiments including neutron irradiation.

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Presentations and Publications

The list of publications was submitted with the final report after grant expiration.

- J Yang, L Hawkins, Z Shang, E McDermott, B Tsai, L He, Y Lu, M Song, H Wang, X Lou, "Dislocation channel broadening – a new mechanism to improve irradiation-assisted stress corrosion cracking resistance of additively manufactured 316L stainless steel", Acta Materialia, 119650, 2024

- J. Le, J. Yang, H. Yin, V. Samarov, D. Gandy, X. Lou, "SA508 low alloy steel to 316L stainless steel dissimilar metal joint made by powder metallurgy hot isostatic pressing", Materials Science and Engineering A, 875, 145060, 2023

- Joshua Le, M.S. Thesis (Auburn University), "Joining Ferritic SA508 Low Alloy Steel to Austenitic 316L Stainless Steel by Powder Metallurgy via Hot Isostatic Pressing", 2023

- J. Snitzer, X. Lou, “Sensitization of 316L stainless steel made by laser powder bed fusion”, CORROSION, 79(2), 240–251, 2023

- Laura Hawkins, Ph. D Dissertation (Texas A&M University), “Radiation response and corrosion behavior of high throughput additively manufactured 316L stainless steel doped with hafnium”, 2023

- Aaron French, Zhihan Hu, Yongchang Li, Frank A. Garner, Lin Shao, “Identification of experimental parameters to avoid the appearance of surface swelling peak as an artifact in accelerator-based void swelling testing”, Submitted to Materials Characterization, under review

- Evan McDermott, Jingfan Yang, John Snitzer, Xiaoyuan Lou, “A parametric study of irradiation assisted stress corrosion cracking of additively manufactured 316L stainless steel by using microstructurally-graded specimen”, Journal of Nuclear Materials, in preparation

- Yongchang Li, Yinyin Hong, Benjamin E. Mejia Diaz, Alec Pfundheller, Frank A. Garner, Lin Shao, "Reduced swelling in proton-irradiated additively manufactured 316L stainless steel", in preparation.

Patents
N/A