DOE-ID NEPA CX DETERMINATION
Idaho National Laboratory

CX Posting No.: DOE-ID-INL-21-168

SECTION A. Project Title: GENIE-AH Experiment

SECTION B. Project Description and Purpose:

University of Michigan along with Idaho National Laboratory are working together to perform an assessment of irradiatied microstructure and mechanical properties of FeCrAl Alloy fabrication routes. The Irradiation facilities are Proton Irradiation at Michigan Ion Beam Laboratory (MIBL) and neutron irradiation at Advanced Test Reactor (ATR). The PIE facilities will be Hot Fuels Examination Faciltiy (HFEF), Irradiated Materials Characterizaion Laboratory (IMCL), and MIBL.

The objective of this proposal is to determine how the FeCrAl alloy fabrication route determines the microstructure and mechanical properties following neutron irradiation. FeCrAl alloys are fabricated through conventional melting/forging, additive manufacturing, and powder metallurgy (PM). Irradiation effects on microstructure (irradiation induced defect clusters and precipitation) and the corresponding impact on mechanical properties (hardness and embrittlement) will be evaluated. The information obtained by this study will be combined with on-going corrosion and mechanical property studies on non-irradiated samples to help guide programmatic decisions on development of fabrication methods for commercial FeCrAl alloys for accident tolerant fuel (ATF) cladding.

In directly comparing proton irradiation to neutron irradiation at the same dose levels, information can be gathered about the potential for using proton irradiation for screening of new commercial concept alloys. In particular the precipitation of α' is of interest and will be one of the primary focuses of this work. If precipitation and other microstructural changes are comparable between neutron and proton irradiation for the FeCrAl alloy system, then proton irradiation can become a powerful tool for industry to test newer chemistries and fabrication parameters at significantly lower cost and with an accelerated schedule.

Neutron Irradiation will include a core set of samples for C26M, some PM-HIP APMT samples, and some model alloys and will be performed in facilities IMCL, and HFEF. PIE will only be conducted on C26M with work being done on PM-HIP APMT and the model alloys to be covered by future collaborations, NSUF work scopes, or programmatic funding.

Fabrication will occur at North Holmes Laboratory (NHL), assembly will occur at Test Train Assembly Facility (TTAF) and INL Research Facility (IRC), irradiation will occur in ATR. Materials that are radioactive such as Zirc-4, aluminum, FeCrAl alloys from irradiation from ATR will be shipped and properly disassembled at HFEF.

The proposed operations schedule is:

Year 1:

- Proton irradiation completed; samples shipped to IMCL.

- Engineering analysis of neutron irradiation capsule. Fabrication of irradiation specimens.

Year 2:

- Characterization of proton irradiated specimens.

- Insertion of neutron irradiation capsules

Year 3:

- Analysis of proton irradiated samples, at least one manuscript submitted for publication.

- 0.5 dpa samples removed from ATR

Year 4:

- 2.0 dpa samples removed from ATR

- Initial hardness testing/mechanical testing on 0.5 dpa samples

- Begin microstructural characterization of 0.5 dpa samples IMCL.

Year 5:

- 0.5 dpa characterization completed at IMCL.

- Start mechanical testing/2.0 dpa samples

- Start microstructural characterization of 2.0 dpa samples IMCL.

Year 6:

- Analysis of 0.5 dpa samples completed, at least 1 manuscript submitted for publication.

- 2.0 dpa characterization completed at IMCL.

Year 7:

- Analysis of 2.0 dpa samples completed, at least 1 manuscript submitted for publication.

SECTION C. Environmental Aspects or Potential Sources of Impact:

Air Emissions

Air emissions would include minor amounts of radionuclides and toxic air pollutants. The irradiation in the ATR is not a modification in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H. ATR radionuclide emissions are sampled and reported in accordance with Laboratory Wide Procedure (LWP)-8000 and 40 CFR 61 Subpart H. All experiments will be evaluated by ATR Environmental Support and Services staff, prior to insertion in the ATR. All radionuclide release data (isotope specific in curies) directly associated with this experiment will be calculated and provided to ATR Programs Environmental Support organization.

The proposed action has the potential to generate radiological and chemical emissions from irradiation at MFC (HFEF and IMCL). Air emissions are anticipated to be minor, and concentrations would not exceed the current monitored air emissions from these facilities. An Air Permit Applicability Determination (APAD) would not be required.

The irradiated specimens will be delivered to the MFC HFEF for disassembly and then undergo routine PIE at IMCL. All radionuclide release data at HFEF and IMCL will be recorded as part of their continuous stack monitors. These activities are considered routine and not a modification in accordance with Idaho Administrative Procedures Act (IDAPA) 58.01.01.201 and 40 Code of Federal Regulation (CFR) 61 Subpart H.

Discharging to Surface-, Storm-, or Ground Water

N/A

Disturbing Cultural or Biological Resources

N/A

Generating and Managing Waste

Waste that will be generated consists of Zirc-4, aluminum, FeCrAl alloys. After materials are irradiated at ATR, the material will be radioactive, and shipped to HFEF for disassembly. No hazardous or radioactive material will be utilized in the fabrication of components prior to irradiation. The amount of waste generated will be less than 0.5 cubic meter.

Releasing Contaminants

When chemicals are used during the project there is the potential for spills that could impact the environment (air, water, soil).

Using, Reusing, and Conserving Natural Resources

All materials will be reused and recycled where economically practicable. All applicable waste will be diverted from disposal in the landfill where conditions allow.

SECTION D. Determine Recommended Level of Environmental Review, Identify Reference(s), and State Justification: Identify the applicable categorical exclusion from 10 Code of Federal Regulation (CFR) 1021, Appendix B, give the appropriate justification, and the approval date.

For Categorical Exclusions (CXs), the proposed action must not: (1) threaten a violation of applicable statutory, regulatory, or permit requirements for environmental, safety, and health, or similar requirements of Department of Energy (DOE) or Executive Orders; (2) require siting and construction or major expansion of waste storage, disposal, recovery, or treatment or facilities; (3) disturb hazardous substances, pollutants, contaminants, or Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-excluded petroleum and natural gas products that pre-exist in the environment such that there would be uncontrolled or unpermitted releases; (4) have the potential to cause significant impacts on environmentally sensitive resources (see 10 CFR 1021). In addition, no extraordinary circumstances related to the proposal exist that would affect the significance of the action. In addition, the action is not “connected” to other action actions (40 CFR 1508.25(a)(1) and is not related to other actions with individually insignificant but cumulatively significant impacts (40 CFR 1608.27(b)(7)).

References: 10 CFR 1021, Appendix B to subpart D, items B3.6, "Small-scale research and development, laboratory operations, and pilot projects."

Justification: B3.6 Small-scale research and development, laboratory operations, and pilot projects. Siting, construction, modification, operation, and decommissioning of facilities for small-scale research and development projects; conventional laboratory operations (such as preparation of chemical standards and sample analysis); and small-scale pilot projects (generally less than 2 years) frequently conducted to verify a concept before demonstration actions, provided that construction or modification would be within or contiguous to a previously disturbed or developed area (where active utilities and currently used roads are readily accessible). Not included in this category are demonstration actions, meaning actions that are undertaken at a scale to show whether a technology would be viable on a larger scale and suitable for commercial deployment.'

Is the project funded by the American Recovery and Reinvestment Act of 2009 (Recovery Act) ☐ Yes ☒ No

Approved by Jason L. Anderson, DOE-ID NEPA Compliance Officer on: 12/13/2021