Contribution ID: **40** Type: **not specified**

Excellent corrosion resistance of self-healing Al-rich oxide layer on FeCrAl alloy in flowing lead bismuth eutectic

Thursday, 31 October 2024 09:50 (25 minutes)

Liquid lead bismuth eutectic (LBE) is a candidate target material for accelerator driven systems. The chemical compatibility of liquid LBE with structural materials is one of the important issues to be addressed. FeCrAl alloys are candidate structural materials since they can form Al-rich oxide layers on their surface which can function as an anti-corrosion barrier in liquid metals. The purpose of the present study is to clarify the corrosion resistance of FeCrAl alloy APMT (Fe-21Cr-5Al-3Mo) in flowing LBE. The corrosion test facility of OLLOCHI (Oxygen-controlled LBE LOop for Corrosion tests in HIgh-temperature) was operated for the current corrosion study, which was installed at JAEA, J-PARC. The corrosion tests were performed with the APMT rectangular specimens having a size of 14 mm x 10mm x 1mm. They were subjected to the pre-oxidation treatment in an air atmosphere at 1373 K for 10 hours before exposure to flowing LBE. The specimens were installed in the test holder and exposed to flowing LBE at 723 K for 2000 hours. The flow velocity of liquid LBE around the specimens was 1 m/s in average. The specimens were taken out from the specimen holder after the test. The surface of some specimens was artificially damaged. They were then continuously exposed to liquid LBE to clarify the in-situ self-healing behavior of the protective oxide layer. The specimens tested in the flowing LBE were cleaned with a mixed solution of acetic acid, ethanol and 30% H2O2 solution (1:1:1). The corrosion of the specimens was metallurgically analyzed with SEM/EDX, XRD and STEM. The test results indicated that the APMT specimens with the pre-oxidation treatment revealed excellent corrosion resistance due to the presence of the protective oxide layer. The in-situ self-healing of the Al-rich oxide layer which was artificially damaged was also indicated.

Primary author: KITAMURA, Yoshiki (Tokyo Institute of Technology)

Co-authors: Mr -, Humam (Tokyo Institute of Technology); Mr KAWARAI, Atsushi (Tokyo Institute of Technology); Dr SAITO, Shigeru (Japan Atomic Energy Agency, J-PARC); Dr OBAYASHI, Hironari (Japan Atomic Energy Agency, J-PARC); Prof. KONDO, Masatoshi (Tokyo Institute of Technology)

Presenter: KITAMURA, Yoshiki (Tokyo Institute of Technology)

Session Classification: Liquid/solid and particle beam interactions and associated studies: pressure waves, cavitation, erosion, corrosion etc and mitigation techniques

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