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Study on Electromigration Effect in High-temperature Liquid Metal Pool

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Liquid lead (Pb) is candidate coolant of accelerator driven systems, fast reactors and fusion reactors. However, the chemical compatibility of liquid Pb with structural materials is one of the important issues. The flow of electrons and ions in the liquid metal components may result in electrical current flow. The electrical current flow in a liquid metal pool can promote a mass transport phenomenon through electromigration. The electromigration can accelerate the corrosion of structural materials. The purpose of this study is to clarify the effect of electromigration on the material compatibility in liquid Pb pool. Two specimens of 304 stainless steel were installed on the electron receiving side and the electron influx side of the crucible filled with liquid Pb. The electromigration test was conducted under the electrical current flow of 10 A at the temperature of 773 K. The results of SEM/EDX analysis performed on the tested specimens indicated that two different mass transport phenomena took place in each specimen. Dimple-like patterns and cavities were formed on the surface of the electron-receiving side, and they indicated that dissolution corrosion was promoted. The metallic impurities were precipitated on the specimen surface on the electron influx side. The precipitation was identified as CrNiAs crystals through XRD and EDX analysis. The collision of the Pb atoms on the specimen surface of the electron-receiving side promoted the dissolution corrosion according to the electromigration. The dissolved elements and impurities escaped from the electron-receiving side onto the electron influx side according to the electromigration of Pb atoms. The dissolved elements and impurities precipitated on the specimen surface of the electron influx side according to the oversaturation condition which was induced by the electromigration.

Primary author: -, Humam (Tokyo Institute of Technology)

Co-authors: Mr HATAKEYAMA, Susumu (Tokyo Institute of Technology); Prof. KONDO, Masatoshi (Tokyo Institute of Technology)

Presenter: -, Humam (Tokyo Institute of Technology)

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