Electrochemical study of oxide scales on pure iron in liquid lead-bismuth eutectic

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Abstract Lead Bismuth Eutectic (LBE) has been proposed as a candidate coolant for the Gen-IV fast reactor as well as both coolants and neutron spallation target in the Accelerator Driven System (ADS), due to its favorable physical and chemical properties. However, LBE at high temperatures is highly corrosive environment. The corrosion of structural materials in LBE is a great challenge for the application of LBE. An effective method to mitigate corrosion of materials in LBE is to form protective oxide scales. The effect of oxygen concentration, flow velocity, and temperature on the inhibition efficiency and structure of oxide scales of the candidate materials in liquid LBE have been of the subject of considerable attention. However, information on the effect of oxide scale structure on the impedance behavior in the liquid LBE is limited.

In this work, the impedance behavior of pre-oxidized pure iron in liquid lead-bismuth eutectic (LBE) was studied using electrochemical impedance spectroscopy. The resistance of the oxide scale on the iron oxidized in air at different temperatures and for different durations were compared. The results real that the impedance magnitude of the oxide film increases with increasing the oxidation temperature. The impedance magnitude of the samples oxide at 200 ℃ and 400 ℃ were negligible, indicating the oxide film formed at low temperature was too thin to prevent LBE penetrate into the oxide scale. When the temperature higher than 600 ℃, a compact "*p-type*" Wüstite oxide scale could be formed on the samples and effectively protects the iron from corrosion in liquid LBE, and that the resistance of the oxide film increases with increasing the temperature, due to the formation of a thicker scale. At the same temperature, prolonging of the oxidation time in air can reduce the defect concentration in the oxide film and improve the resistance of the oxide scale to corrosion in liquid LBE. Based on the result, it recommends that the low-temperature and long-time pre-oxidation is an effectively method for achieving better corrosion resistance of materials upon subsequent exposure to liquid LBE.

Keywords Lead-bismuth eutectic; Corrosion; Oxide film

Reference

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