Examination of the Corrosion Behavior and Corrosion Mechanism of Copper Alloy in Simulated Geological Saline Solution

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Abstract

With the developing technology for the disposal of High Level Nuclear Wastes (HLNWs), copper alloy has been selected as the canister material. However, the regarding corrosion issue of copper canister in crystalline rock repository remains unclear, so that a significant question arises as to the suitability of copper alloy toward the intended purpose. Whether Oxygen-free, Phosphorous-doped copper (OFP-Cu) is passive in sulfide-containing geochemical brine and what corrosion mechanism it obeys need to be ascertained. By means of DC polarization and electrochemical impedance spectroscopic (EIS) techniques, the corrosion behavior and corrosion mechanism of oxygen free phosphorus copper in simulated geological brine for HLNWs was investigated. The Point Defect Model was successfully developed to study the passivation of copper alloy. Copper cation vacancy is identified as the preponderant point defect within the passive layer by Point Defect Model coupled EIS optimization (PEO) and Mott-Schottky analysis. Corrosion kinetic parameters for the generation/annihilation of ionic defects were accounted by PEO. Sulfate is found to induce the passivity breakdown by promoting the ejection of copper cation vacancies, resulting in a larger passive dissolution current density and a decrease thickness of barrier layer.

Keywords Copper alloy; EIS; Passivity; Electrochemistry; Corrosion Mechanism

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