Electrochemical Corrosion and Mathematical Model of Cold Spray Copper Composite Coating - Part II: Limiting Current Region

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In this paper, Cu – Cu₂O composite coating was prepared by cold spray technique and the corrosion behavior of the coating in 3.5% NaCl solution was studied using rotating ring-disk electrode. Experiments were designed to investigate the influences of rotation rate, chloride ion concentration, solution temperature and Cu₂O content on the polarization behavior of the coating. The results shown that under strong convection and high temperature conditions, the cumulative effect of insoluble corrosion product CuCl weakened, corrosion current increased, and current peak disappeared gradually due to enhanced diffusion. Limiting current \( i_L \) and rotation rate \( \omega \) were in a log-linear relationship. When the chloride ion concentration in the solution increased, large amounts of chlorine ions were complexed with insoluble CuCl to generate soluble CuCl\(^{-}\). So limiting current increased, potential range of limiting current narrowed, and current peak disappeared gradually. Limiting current was also in a log-linear relationship with the Cl\(^{-}\) concentration. As cathode, Cu₂O particles in the coating promoted the corrosion of copper and the release of dissolved copper, which improved the antifouling efficacy of the coating. Limiting current was controlled by diffusion of CuCl\(^{-}\), and limiting current generating mechanism was essentially the diffusion-controlled film dissolution mechanism. The mathematical model for limiting current region was built based on the reaction course proposed herein and agreed well with the experimental results, which proved the correctness of the reaction course hypothesis and the mathematical model.

Keywords: Cold spray, Electrochemical polarization, Antifouling, Corrosion, Mathematical model

FULL TEXT