Preparation of a Cr coating on low-carbon steel by electrodeposition in a NaCl-KCl-NaF-Cr₂O₃ molten salt

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The thermodynamic calculation results of electrochemical reduction in a NaCl–KCl–NaF–Cr₂O₃ molten salt system indicates that it is feasible to prepare a Cr coating on low carbon steel by electrochemical deposition. The electrochemical reaction mechanism and electrocrystallization process of chromium investigated at 1073 K by an electrochemical workstation, indicate that the electrochemical reduction of Cr(III) to Cr takes two steps, $\text{Cr}^{3+} + \text{e} \rightarrow \text{Cr}^{2+}$, and $\text{Cr}^{2+} + 2\text{e} \rightarrow \text{Cr}$. The electrochemical processes of Cr(III) and Cr(II) are quasi-reversible reactions, and the electrocrystallization process of Cr is an instantaneous hemispheroid three-dimensional nucleation process. A Cr coating with thickness of 250 μm was successfully deposited on a low carbon steel substrate. The atomic growth process, composition and morphology of the coating were investigated by SEM, EDS and XRD. The results of the AC impedance method show that the corrosion resistance of the Cr-coated low-carbon steel is much higher than that of low-carbon steel.

Keywords: Thermodynamic calculation; Coating; Electrochemical deposition; Characterization

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