Preparation and Characterization of Cr-free passivation films on zinc coating using Response Surface Methodology and Electrochemical Methods

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Response surface methodology (RSM) was used in this study to determine the optimum operating conditions for the reduction of galvanized sheet corrosion using a Cr-free passivation films. Passivation films layer with strong corrosion resistance was formed on the surface of galvanizing which was impregnated in chromium-free passivating agent. Furthermore, the RSM was used to ascertain the main and interactive effects (deviation between the experimental and theoretical values: 0.12%). The coefficient of determination (R^2) showed that the RSM approach was appropriate for optimization of the Cr-free passivator. Silane coupling agent, ammonium molybdate, nanosilica, and tannic acid played a key role in changing the corrosion area and potential. The results revealed that, compared with Cr^{6+} passivation, Cr-free passivation yielded considerably more homogeneous and smoother surfaces (surface roughness of Cr-free passivation film: $0.54\ \mu\text{m}$). In addition, the properties of the zinc coating after Cr-free passivation were clearly superior to those of the zinc coating subjected to the conventional Cr^{6+} passivation treatment. E_{corr} , current density, and polarization resistance values of this superior coating were $-1073\ \text{mV}$, $0.017\ \text{A cm}^{-2}$, and $989.2\ \Omega$, respectively. This study can serve as an experimental and a theoretical guide for the development of Cr-free passivation films.

Keywords: Cr-free passivation film; galvanized sheet; electrochemical corrosion

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