

Microstructural Characterization and Process Control of the Blackening Phenomenon in Zinc-Aluminum-Magnesium Coatings

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Abstract This study investigates the blackening phenomenon that occurs in zinc-aluminum-magnesium (Zn-Al-Mg) alloy coatings with fingerprint-resistant films during service, focusing on microstructural characterization of corrosion products and the analysis of their formation mechanisms. The research identifies the primary cause of blackening as the corrosion of the distinct alloy phases, including zinc-rich and aluminum-rich phases. Detailed observations indicate that the degree of discoloration is closely linked to the extent and distribution of corrosion. Specifically, when corrosion is limited to the zinc-rich phase, the resulting color difference is relatively minor, with a value less than 5 on the color scale. However, when both the aluminum-rich and zinc-rich phases are affected, the color difference exceeds 10, indicating a more severe visual impact.

Furthermore, this study finds that incomplete curing of the fingerprint-resistant film is not the main contributor to blackening. Instead, inadequate baking temperatures or excessive coating thickness can impair the film's barrier properties, leading to increased water absorption and accelerated corrosion. The water quenching process also contributes to minor surface corrosion, further aggravating the blackening effect.

By comprehensively analyzing these factors, this research clarifies the complex relationship between blackening and corrosion in Zn-Al-Mg alloy coatings. The findings provide crucial insights into optimizing coating processes, including adjustments in film application and thermal treatments, which are essential for enhancing the durability, aesthetic appeal, and protective performance of Zn-Al-Mg alloy coatings in practical

applications. These insights offer both theoretical and practical significance for the coating industry.

Keywords Blackening Phenomenon, ZnAlMg, Corrosion Mechanism, Fingerprint-Resistant Film

Reference

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