DEVELOPMENT OF AN ANTI-CORROSIVE COATING BASED ON A CERAMIC NANOPIGMENT

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Abstract

Corrosion is the physicochemical interaction between a metal and its environment which results in changes in the properties of the metal and which may often lead to impairment of the function of the metal or the technical system of which these form a part.

Corrosion protection requires the use of corrosion inhibitor coatings that protect the underlying metal. These coatings can be of different nature, from organic or hybrid to totally inorganic. Hybrid systems with a remarkable anti-corrosion and hydrophobic characteristics can be achieved with the introduction of ZnO nanoparticles into an acrylic-silicone polymeric matrix. In other hybrid coatings having corrosion protection, the introduction of inorganic nanoparticles such as SiO_2 or Al_2O_3 also improves the scratch resistance. Inorganic coatings are based on the use of inorganic pigments and present high chemical stability such as resistance to chemical attacks by acids and alkalis, excellent hardness and high temperature stability, which is an advantage compared with organic or hybrid matrices.

In this study, a Fe-Cr ceramic nanopigment was synthesized by sol-gel method and applied over SAE 1015 carbon steel specimens (referenced in accordance with the American Iron and Steel Institute-AISI-) by thermodiffusion.

The characterization of the synthesized pigment was carried out by X-ray diffraction (XRD) (to identify the crystalline phases), scanning electron microscope (SEM) (to investigate the morphology and size of the particles), wavelength-dispersive X-ray fluorescence (WD-XRF) (to determine the chemical composition), and oxygen elemental analysis by thermal decomposition and IR detection (to analyze the oxygen content and calculate the exact stoichiometry of the pigment).

The Fe-Cr pigment was applied over the cited carbon steel above, and the effectiveness of this coating was tested subjecting it to various real corrosive environments: a chloride-rich atmosphere, a marine atmosphere, and an atmosphere exempt of specific contaminants. The test specimens were exposure to these atmospheres for 9 months to study the long-term corrosion resistance to understand the deterioration mechanism.

The inhibition power achieved was determined by XRD, scanning electron microscope with energy dispersive X-ray microanalysis (SEM-EDS), and weight difference. The analyses undertaken permitted the evaluation of the changes generated in the steel and the coated steel, studying the appearance of rust phases, such as α-FeOOH, γ-FeOOH, Fe_3O_4, and other iron hydroxides; and/or disappearance of the original phases and the changes in the morphology of the surface. Finally, the quantification of the corrosion grade was carried out by the determination of the difference of weight.

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