

Corrosion mechanisms of electrodeposited Zn and Zn-Fe coatings on steel substrate in saline environments

Céline ARRIGHI^{1,2}, Catherine SAVALL¹, Juan CREUS¹, Marie-Georges OLIVIER²

¹LaSIE UMR 7356 CNRS, La Rochelle Université, La Rochelle, France

² Materials Science Department, Faculty of Engineering, University of Mons, Mons, Belgium

Electrodeposited cadmium coatings have been used for many years as a protection against corrosion of steel substrates. The toxicity of cadmium combined with European legislation have led to replace them by other sacrificial coatings, such as zinc coatings for instance. However, many studies have shown that the addition of an element nobler than zinc (Ni, Fe or Co) can reduce the galvanic coupling between the coating and the steel substrate. Consequently, the lifetime of the sacrificial protection is increased. Among zinc alloys, Zn-Ni was one of the most used, due to its efficient corrosion resistance, but the toxicity of nickel salts leads to replace Ni by more eco-friendly elements, such as Fe without degrading anticorrosion properties. Nevertheless, only few information on corrosion mechanisms of electrodeposited Zn-Fe coatings and on the influence of corrosion inhibitors is reported in the literature. This study aims at understanding the influence of iron in corrosion mechanisms of electrodeposited Zn-Fe coatings with and without corrosion inhibitors, in relation with the metallurgical features of the coatings.

Zn-Fe alloys with different iron contents (max 14 wt.%) have been deposited on a low alloy steel substrate by electrodeposition from an additive-free bath composed of zinc oxide, ferrous gluconate and potassium hydroxide [1] using direct and pulsed currents. These coatings have been characterized in terms of composition, morphology and microstructure. Corrosion inhibitors have been used to improve the performance of the coating. Electrochemical tests such as polarization curves and Electrochemical Impedance Spectroscopy (EIS) have been performed in two electrolytes (0.01 and 0.6 M NaCl) to assess corrosion potentials and corrosion rates. Two volumes have been used in order to determine the role of the pH changes, which can influence the efficiency of inhibitors. Moreover, Scanning Vibrating Electrode Technique (SVET) has been used on the sample cross-section to evaluate the sacrificial behaviour of the coatings over time. Corrosion products have been analysed by X-Ray Diffraction (XRD) and metallic species have been dosed in solutions by Atomic Absorption in order to understand corrosion mechanisms and to relate them to the formation of corrosion products.

[1] C. J. Lan, W.Y. Liu, T.S. Chin. Journal of The Electrochemical Society, 154 (1) D30-D33 (2007)