Cut-edge corrosion study on Al-rich metallic coated steel

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Aluminium additions to metallic coatings on steel substrates have been accepted as a successful solution versus the standard zinc based coatings. The development of these products responds to the market’s demand of more versatile products, which faces the leaching effect of zinc and the rising cost of obtaining this element, among the main advantages. However, these materials show a special sensitivity to corrosion, mainly localized in the exposed cross section, being this identified as cut-edge corrosion.

The aim of this work is to improve the knowledge of the corrosion mechanism that takes place in the cut-edge of existing Al-rich metallic coated steel with an additional organic coating. In this frame, a limited set of samples with different contents on aluminum in the metallic coating (from 0.5 to 99.5 % wt.) was considered. As organic coating, an epoxy-based paint layer with a well-known formulation was applied to the specimens.

The first works go through the characterization of materials before corrosion. An overview is given about the different phases and composition present in the different metallic coatings and the barrier and electrical properties studied by Odd Random Phase Electrochemical Impedance Spectroscopy (ORP-EIS) and other global electrochemical techniques.

In a second stage, the cut-edge corrosion study is described from an industrial point of view, with observations mainly based on the results of accelerated corrosion tests and a number of different systems. Due to the vast amount of variables implied and the difficulties to treat them, the study turns to “basic research” consisting mainly in a selection of well-known samples and suitable electrochemical and surface analysis techniques. As corrosive agent, continuous immersion in NaCl 0.05M is chosen.

The local character of this kind of corrosion process, evidenced in previous works and in the studied literature, lead to the use of local electrochemical techniques. Scanning Vibrating Electrode Technique coupled with Selective Ion Electrode technique (SVET-SIET) and Scanning Kelvin Probe Force Microscopy (SKP/FM) were used for in-situ studies of the existing reactions upon immersion. These techniques could elucidate important aspects concerning the local current density and potential distribution and its link with the local pH and distributions of Na⁺ and Cl⁻. The analysis of the corrosion products ex-situ and at different times of immersion was carried out by Raman and Fourier Transform Infrared Spectroscopy in order to have a knowledge about the molecules present at different stages of immersion and their elemental composition and morphology was analyzed by Field Emission Electron Microscopy (FE-SEM) coupled with Energy Dispersive X-ray Spectroscopy (EDX).

As conclusion, Aluminum additions were proved to decrease the corrosion performance of the cut-edge under immersion in NaCl and a corrosion mechanism is proposed for the studied specimens.