NANOSTRUCTURED COATINGS FOR METALLIC CONSTRUCTION MATERIALS PROTECTION

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ABSTRACT

Nanostructured coatings exhibit a high potential for corrosion protection of metallic materials, namely, the hybrid sol-gel coatings due to the synergic effect on the mechanical and chemical properties achieved by interconnecting organic and inorganic components. In this study, a nanostructured hybrid sol-gel coating with optimized anticorrosive properties was developed for protection of an aluminium alloy frequently used in the construction field. Its performance was assessed in different corrosive conditions, showing an effective ability to protect the alloy either individually or integrated an anticorrosive coating system usually applied in architecture, replacing the toxic Cr(VI) based pre-treatments.

KEYWORDS: Nanostructured hybrid coatings, sol-gel, aluminium alloy, corrosion, construction materials.

1 INTRODUCTION

Aluminium alloys are used for a host of applications in building and construction. A thin oxide layer that natural forms on the aluminium surface exposed to oxygen confer good corrosion resistance to atmospheric exposure to these alloys, however, insufficient for the polluted or the marine environments. Therefore, architectural aluminium components are usually coated not only to achieve a required aesthetical aspect, but also to protect them against corrosion, increasing durability and reducing maintenance needs. This anticorrosive protection is often performed by organic coatings which require alloy surface pre-treatment to promote adherence. This used to be afforded by chromate conversion treatments, forbidden since 2007 due to Cr(VI) toxicity. The actual pre-treatments do not fulfil all the chromate functions, hence seeking for “green” alternatives is still needed.

The hybrid sol-gel silane based coatings have shown to be an effective anticorrosive protection of aluminium in chloride media. This type of

coatings are able to covalently bond to oxide covered metallic substrates and may be functionalized to be compatible with organic coatings, promoting their adhesion to the metallic substrate, what makes them also an environmental friendly alternative to Cr(VI) pre-treatments.

2 EXPERIMENTAL

In this work, epoxysilane-based hybrid coatings incorporating in situ synthesized zirconia nanoparticles were obtained by the sol-gel process and applied to EN AW-6063 alloy by dip-coating.

First, the anticorrosive properties of these coatings were improved by changing several sol-gel process parameters like organic/inorganic and hydrolysis water ratios, curing process, and by introduction of a cerium based corrosion inhibitor. The anticorrosive properties were assessed by Electrochemical Impedance Spectroscopy (EIS). The hybrid coatings were also characterized by SEM-EDS, AFM, FTIR and by thermal analysis, in order to relate morphology and chemical structure with corrosion behaviour.

Following this, aluminium specimens with the optimized hybrid sol-gel coatings were exposed to saline solutions with pH~3,6,10, were also coated with an architectural organic coating by lacquering and subjected to accelerated corrosion tests, salt spray (EN ISO 9227) and filiform corrosion (EN ISO 4623-2), along with only sol-gel coated ones, to evaluate their corrosion performance. The lacquered pre-treated specimens were also subjected to cross-cutting, cupping and bending tests to evaluated the adhesive performance of the hybrid sol-gel pre-treatment. These performance tests were carried out and the respective results were evaluated following requirements applied to architectural coatings.

3 RESULTS AND CONCLUSIONS

The results obtained in the performance tests revealed that the hybrid films were able to provide corrosion protection to the aluminium alloy substrate in chloride media, more efficiently in neutral media and, owing to the inhibitor, also in alkaline media. The lacquered pre-treated specimens exhibited very good corrosion behaviour in the neutral salt spray test, but yielded inferior performances in the filiform test that may be attributed to adherence problems. The hybrid coating in fact promotes adhesion between the aluminium substrate and the architectural organic coating. However, it was found that the exposure to wet environments led to a decrease in the adhesive properties that may cause problems to their anticorrosive efficacy in service.