Corrosion protection of AA2024-T3 by "smart" coatings containing cerium nanoreservoirs

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The AA2024-T3 is mainly used in the aerospace industry. The use is limited due to high susceptibility to localized corrosion, related to the strongly heterogeneous microstructure of the alloy.[1] Usually, the metal surfaces are protected against corrosion through multi-layers painting and Cr(VI)-based conversion coatings,[2] but their use is prohibited due to European directives since September 2017.[3]

Hybrid sol-gel coatings can be considered as candidates for replacement of Cr(VI)-based systems. Moreover, such coatings can be doped with different corrosion inhibitors, i.e. cerium salts. One of disadvantage of addition corrosion inhibitors is their fast depletion from the corrosion protection system during immersion in aggressive electrolytes.

The aim of this study was to synthesize an effective corrosion protective coating based on organically modified silane and zirconium alkoxide to be used as barrier protection for AA2024-T3. The coating was also doped with cerium salts bonded on nanoreservoirs to obtain active corrosion inhibition.

Therefore, the work was divided into three parts: a) the corrosion mechanism of cerium salts as corrosion inhibitors on AA2024-T3 was studied; b) the innovative barrier hybrid sol-gel coatings were synthesized from tetraethyl orthosilicate TEOS, 3-(trimethoxysilyl)propyl methacrylate MAPTMS, zirconium(IV) propoxide ZTP and methacrylic acid MAA,[4] c) the protective properties of the hybrid coatings have been upgraded by the addition of cerium bonded on styrene nanoparticles used as nanoreservoirs. This approach was expected to decrease the solubility of cerium during long-term exposure to corrosive environment and contribute to self-healing effect.

The synthesis was studied using spectroscopic methods: in-situ Fourier-transform infrared spectroscopy (FTIR) and multinuclear magnetic resonance spectroscopy (NMR). The corrosion characterization was performed using electrochemical potentiodynamic measurements and electrochemical impedance spectroscopy (EIS). The coating properties were evaluated using surface techniques: X-ray photoelectron spectroscopy (XPS) and glow discharge optical emission spectroscopy (GDOES).

Key words: AA2024-T3, corrosion, hybrid sol-gel, cerium inhibition, self-healing.

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