SUMMARY

Aluminium and its alloys are important technological materials, especially in applications which require light and high strength materials. Various surface treatments on aluminium and its alloys AA2024-T3 and AA7075-T6 were studied in order to increase the corrosion resistance of these materials in NaCl solution and in Harrison's solution. The addition of corrosion inhibitors to the solutions and the formation of conversion coatings sol-gel coating were studied. The composition and morphology of the coatings was investigated using infrared spectroscopy, nuclear magnetic resonance spectroscopy, Raman and UV/Vis spectroscopies and microscopy.

The resistance of aluminium and its alloys to corrosion was improved by the addition of corrosion inhibitors cerium(III) acetate or cerium(III) chloride to the corrosive medium. This type of protection is suitable for closed systems. An alternative, for other applications, is the use of cerium conversion coatings. Effective protection was obtained with cerium(III) chloride and with cerium(III) nitrate. Hydrogen peroxide was used as an oxidant. The use of corrosion inhibitors and cerium conversion coatings results in corrosion protection to a limited duration or extent. To achieve more effective and longer lasting protection, hybrid sol-gel coatings were synthesized.

Synthesis of sol-gel coatings started with the use of 3-methacryloxy-propyltrimethoxysilane (MAPTMS) and tetraethylorthosilicate (TEOS). Different molar ratios of MAPTMS to TEOS were used with a 5-fold excess of water. The synthesis proceeded at 60 °C and was catalysed by hydrochloric acid. The degree of inhibition by these coatings on aluminium was more than 99.3 %. The disadvantages of such coatings are the high temperature of synthesis, the necessary dilution of the sol with ethanol and the necessary drying at 150 °C.

To overcome these disadvantages the synthesis was optimized at room temperature. The synthesized coatings protect aluminium well, but were not effective for the alloy AA7075-T6. Further doping with nanoparticles of cerium/zirconium oxide did not improve the anti-corrosion properties. Sols were therefore synthesized using smaller amounts of water and hydrochloric acid to eliminate dilution with ethanol. Coatings were dried at 180 °C. AA7075-T6 was not protected effectively, so the properties of sol were improved by the addition of zirconium sol, synthesized separately from zirconium tetrapropoxide (ZTP) and methacrylic acid (MAA). The alloy was now protected effectively. The properties of the coatings were markedly improved by aging the sol for 48 h and drying under daylight at 100 °C. The influence of ratios of (MAPTMS + TEOS) to MAA was also studied at constant ratio (MAPTMS + TEOS)/ZTP. This coating, with high MAA content, could be dried at room temperature. Resistance to corrosion improved by doping the sol with cerium salts. The addition of $Ce(NO_3)_3$ in particular improved the coating properties, affecting the coating network. Such coating may be capable of self-healing thus providing an active long-term protection.

Synthesized sol-gel coatings enable effective corrosion protection of aluminium and its alloys.

Keywords: aluminium and aluminium alloys, corrosion, cerium salts, hybrid sol-gel