Eco-friendly hybrid sol-gel coatings for replacement of Cr-based treatments in medium strength aluminium alloys for space application

Cecilia Agustín Sáenz, Patricia Santa Coloma Mozo, Eider Martín Ugarte, Francisco Fernández Carretero, Marta Brizuela Parra

Tecnalia Research & Innovation, Parque Científico y Tecnológico de Gipuzkoa. Mikeletegi Pasealekua, San Sebastian (Spain)

ABSTRACT

In this work, eco-friendly alternative pre-treatment for aluminium alloys to replace Cr-based conversion layers is proposed through new hybrid organic-inorganic sol-gel coatings. The sol-gel matrix was produced from inorganic precursors (Si and Zr alkoxides), a hybrid precursor organically functionalized with epoxy group and organic monomers with the aim of increase the cross-linking network and arrive to optimum organic/inorganic ratio. The influence of the addition of bi-functional organic monomer was studied during the several stages of sol-gel method.

The new hybrid coatings were applied on 6000 series alloys like 6061, 6063 and 6082 for space application, particularly for several parts of a deployable thermal radiator for satellites. Several commercially available solutions were also applied and tested in parallel, based on several technologies such as chemical conversion coatings containing Cr III, Ti or Zr compounds. Furthermore, Cr VI chemical conversion (Alodine 1200S) coating was studied as baseline.

Some of these alloys are used for low-stressed structure in light aerospace industry showing excellent corrosion resistance to atmospheric conditions. However, since they have been traditionally protected by Cr-based compounds, the corrosion resistance provided by new hybrid coating and commercial solutions was assessed by aging tests following specifications of space industry. Furthermore, for this application low contact electrical resistance is required, what has become the main challenge. Trade-off between corrosion protection and low contact electrical resistance properties have lead the design of hybrid coating. Several strategies have been followed like adding conductive polymers and Ag nanowires, as well as coating thickness adjustment.

Sol-gel approach has offered the possibility to tailor organic/inorganic phases permitting to develop a new composition coating with promising properties that has shown high versatility and adaptation to aluminium alloys and applications. Results have showed comparable or better performance depending on the test over commercially available with the advantage that it is an eco-friendly approach.