Title:

Synthesis of duplex coatings: PEO layers sealed by an optimized/modified hybrid sol-gel for the improvement of corrosion properties of AA2024

Summary

The aviation industry has made significant efforts over the past few decades to reduce aircraft weight and fuel consumption. This is often achieved through lowering operational and maintenance costs, increasing passenger capacity, and improving the frequency and efficiency of maintenance checks. One of the most effective strategies for weight reduction is using materials with lower density, with aluminum being a key material due to its lightweight properties, ductility, corrosion resistance, and cost-effectiveness.

The 2024 aluminum alloy, particularly from the Al-Cu series, is widely used in aircraft for its balance of strength, damage tolerance, and fatigue resistance. Copper as an alloying element enhances the mechanical properties of aluminum alloys but poses corrosion challenges. Various surface modification techniques have been explored to improve corrosion resistance, with Plasma Electrolytic Oxidation (PEO) emerging as a promising eco-friendly solution. PEO produces hard, dense ceramic coatings that offer superior wear resistance and thermal stability.

During the PEO process, micro-arcs create a ceramic coating with both internal and porous sublayers, the latter posing long-term corrosion resistance challenges. Filling these pores with a sol-gel coating can enhance the performance of PEO layers. Sol-gel coatings are environmentally safe, cost-effective, and offer adjustable properties based on application needs. They form a reliable protective layer through chemical adsorption and mechanical interlocking with the PEO layer.

This thesis, part of the SEALCERA project funded by the *Fédération Wallonie Bruxelles*, focuses on enhancing the corrosion resistance of AA2024 aluminum alloy through a PEO/sol-gel duplex coating system. The research aims to synthesize this coating system to improve corrosion properties by effectively sealing the porous PEO layer with sol-gel, thereby optimizing the coating performance.

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