OR2105

Coupling of Atmospheric Plasma Jet and Plasma Electrolytic Oxydation as potential alternative for the classical anodization of 3000 aluminum alloys

Jérémy Mertens[1], Siavash Asadollahi[2], Jacopo Profili[2], Luc Stafford[2], François Reniers[1]

[1]Université Libre de Bruxelles, Bruxelles, Belgium [2]Université de Montréal, Montréal, Canada

jermerte@ulb.ac.be

During the past few decades, anodization of aluminum alloys is facing new challenges due to the increasingly strict environmental standards all around the globe. Therefore, a significant demand exists for more environmentally friendly alternatives to Cr(VI) baths or similar classical anodization methods. In this study, a novel alternative process for the anodization of the aluminum 3000 series is proposed. This original procedure couples two plasma-based techniques for modifying the chemical and physical properties of the aluminum substrate.
First, aluminum substrates are exposed to an extensive treatment under an atmospheric pressure plasma jet (APPJ), working through a rotating arc inside the jet body. SEM, stylus profilometry and X-Ray microtomography measurements clearly indicate an increase in the surface roughness with the treatment duration. This is due to the etching of the substrate as suggested by optical emission spectroscopy (OES) but also due to the partial melting and crystallographic rearrangement of the alloy structure during the process observed through X-ray diffraction measurements, favorizing 200 and 111 Miller plans. APPJ-treated samples are then used in a plasma electrolytic oxidation (PEO) for varying durations. This leads to the formation of a γ-Al_2O_3 layer with thicknesses dependent on the treatment duration. Stylus profilometry and SEM show a strong variation in the roughness depending on the initial substrate and the PEO treatment duration. XPS and XRD measurements show that the APPJ treatment allows a strong decrease of silicate salt grafting, which is initially present in the solution, reducing the growth of an amorphous SiO_2 phase into the plasma anodized layer. The effect of the coupling of the two plasma techniques on the electrochemical behavior of the substrates is then evaluated by potentiodynamic curves and electrochemical impedance spectroscopy.

Keywords
Anodization
APPJ
PEO