Low-Energy High-Current Electron Beam Surface Pretreatment to Improve the Anodizability of Al-Si Foundry Alloys

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Aluminum-silicon (Al-Si) alloys are widely used across engineering sectors such as aerospace, automotive, marine, and construction due to their low density, high strength-to-weight ratio, excellent thermal and electrical conductivity, good castability, and recyclability. To improve corrosion resistance and hardness, anodic oxidation is commonly employed. However, the anodizability of Al-Si alloys is negatively influenced by the presence of silicon particles (eutectic structure and primary Si).

This study explores the use of Low-Energy High-Current Electron Beam (LEHCEB) irradiation as a surface pretreatment to enhance the anodizability of Al-Si alloys. The rapid melting and solidification induced by LEHCEB promotes silicon redistribution and refinement, leading to a more uniform microstructure. The effects of varying energy densities (2-5 J/cm²) and number of pulses (4-32) were investigated. Subsequent anodic oxidation was carried out in sulfuric acid (H_2SO_4) at 0°C for durations of 15, 30, and 45 minutes. Figure 1 shows the SEM morphology and EDX silicon elemental map of anodic oxide formed on a pristine (a, c) and LEHCEB pretreated (b, d) hypoeutectic Al-Si alloy.

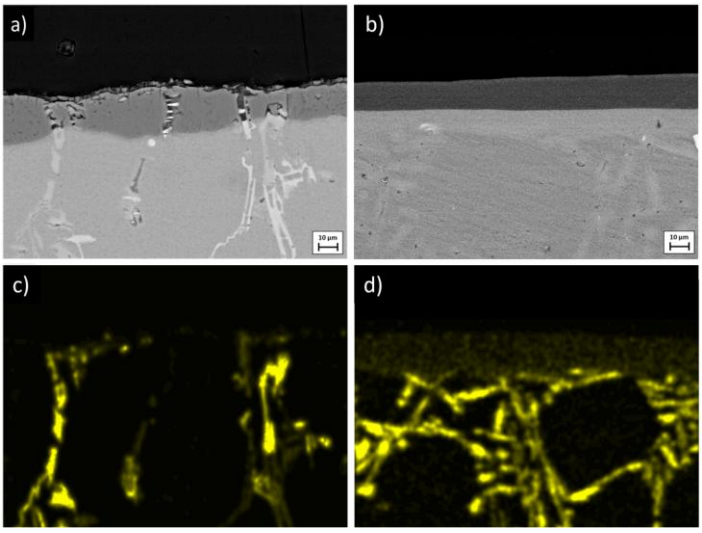

Figure 1. SEM cross section morphology and EDX silicon elemental map of anodic oxide formed on a pristine (a, c) and LEHCEB pre-treated (b, d) hypoeutectic Al-Si alloy.