

Environmentally Friendly Surface Treatment for New Generation Aluminium-Lithium Aerospace Alloys

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Increasing payload and fuel efficiency are drivers for the aerospace industry to strive to improve lightweight materials for application in aircraft structures. Lithium-containing aluminum alloys are attractive due to their low density and high stiffness compared with conventional aluminum alloys. For service performance, an adequate, economic, and environmentally-friendly corrosion protection scheme is necessary. Traditionally, the anticorrosion performance of aerospace aluminum alloys has been achieved through chromic acid anodizing (CAA), followed by painting. However, the increasing environmental concerns and strict legislation on the use of chromic acid require the development of low-cost and environmentally-friendly anodizing electrolytes.

In this work, the anodizing behavior of a commercial Al-Li-Cu alloy in an environmentally-friendly electrolyte, namely tartaric-sulfuric acid (TSA), has been investigated. Attention is focused on optimizing the process parameters to tailor the morphology, composition and structure of the resultant porous anodic films to achieve desirable performance.

A relatively fine porous anodic film, with well-defined cells, was observed at relatively low voltages, with copper-rich nanoparticles occluded in the film material (Figure 1). Pores of increased dimensions, with lateral porosity, were observed at increased voltages (Figure 2). The oxidation of copper is responsible for the additional lateral porosity in the anodic film. It is also revealed that copper in the alloy matrix can be occluded in the anodic film material as copper-rich nanoparticles (Figure 3) or it can be oxidized and incorporated into the film material as copper ions, depending on the anodizing voltage. Further, lattice images of copper-rich nanoparticles indicate that they have structures consistent with either the Θ , Θ' or Θ'' phases, regardless of their locations in the anodic films.

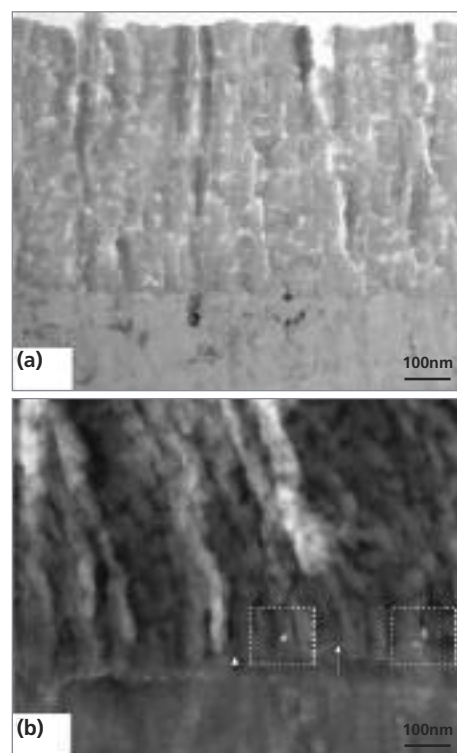


Fig. 2 Transmission electron micrographs of an ultramicrotomed section of AA 2099-T8 aluminum alloy after anodizing at a constant voltage of 14 V: (a) bright field image; (b) HAADF image.

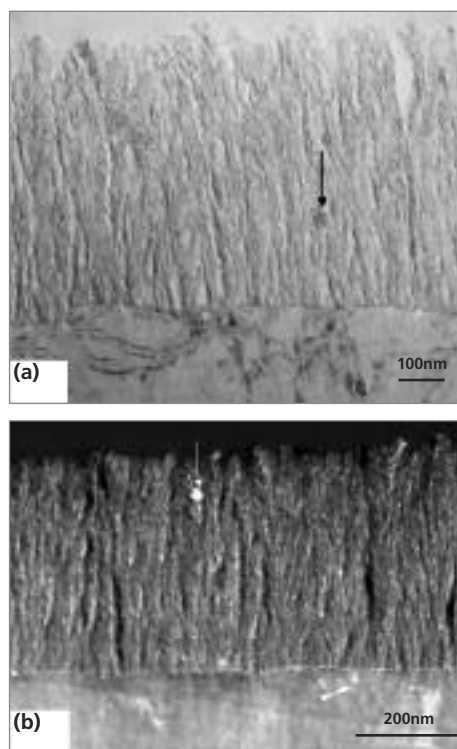


Fig. 1 Transmission electron micrographs of an ultramicrotomed cross section of AA 2099-T8 aluminum alloy after anodizing from the OCP to 3 V (SCE) at a sweep rate of 0.03 V/min: (a) bright field image; (b) HAADF image.

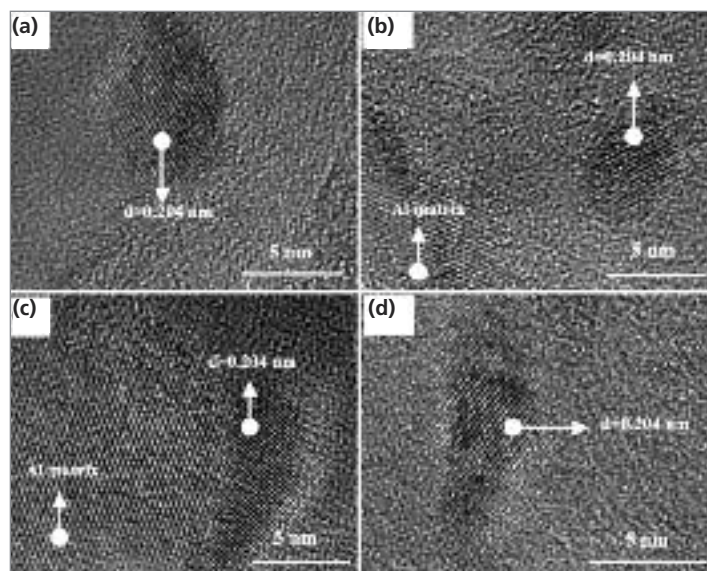


Fig.3 Lattice images of copper-rich nanoparticles: (a-d) in different regions of the anodic film.

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