Electrophoretic impregnation of porous anodic aluminum oxide film by silica nanoparticles

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HIGHLIGHTS

- Pores of an anodic film were completely filled by electrophoretic impregnation.
- Electric field and dispersion conductivity control the impregnation depth.
- Progressive filling from the bottom of pores to the top.

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ABSTRACT

In this paper, it is proposed to study the deposition of nanoparticles by electrophoretic deposition (EPD) inside a porous anodic aluminum oxide film. Despite the presence of a highly resistive barrier layer at the metal-anodic film interface, porous anodic films on AA 1050A were successfully filled by 16-nm, surface modified silica particles. During this study it was shown that both the colloidal suspension conductivity and the applied electric field drive the penetration into the porous film. FEG-SEM observations showed that large (130-nm diameter), linear pores of 10 μm in length can be completely filled in 1 min. These results attest that porous anodic films can be efficiently filled with nanoparticles by EPD despite the presence of the barrier layer.

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1. Introduction

Nanomaterials in the form of nanoparticles, nanowires and nanotubes are the main components in the burgeoning field of nanotechnology. Due to their physical and chemical properties, these nanomaterials have the potential for use in applications such as memory devices [1], chemical sensors [2], medical science [3] and energy storage [4]. One promising technique to assemble these nanoelements over macroscopic length scales is the electrophoretic deposition (EPD) [5]. EPD is a well-established, versatile, low-cost method to deposit ceramic and metal films on a conducting substrate. This process deposits directly the end product avoiding chemical reactions at the surface of the substrate. However, the use of EPD in water is very restricted due to the electrolysis of water which occurs for low voltages and causes the evolution of hydrogen and oxygen gases at the electrodes which could affect the quality of the deposits formed [6].

Another advantage is that EPD can be used as well on flat surface as on complex surface. For example, Bazin et al. deposited silica nanoparticles by EPD on nanostructured copper electrodes to form