

Apparition of burning phenomenon during the self-ordering of anodic nanoporous alumina

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In the last decades nanostructured surfaces have drawn attention for potential applications in several fields as medical, biological, electrical, optical and micromechanical. One of the promising candidates is anodic aluminium oxide (AAO) with self-organized hexagonal arrays of uniform parallel nanopores, formed by electrochemical oxidation of aluminum (i.e. anodizing process) ^[1]. These AAO films have recently been proposed as templates for the growth of nano-materials (nano-dots, nano-wires, nano-tubes, etc.), as micro/nano-structures itself (photonic-crystal, nano-composite structures, membranes for bio-separation, etc.) and as reservoir for solid lubricants to form self-lubricating structures ^[2].

Although aluminum anodic oxidation is a technique used to fabricate highly ordered array structures at a nanometer scale, the conditions under which self-organization occurs are limited and depend on the acid species of the electrolyte. Thus, each electrolyte has an individually specified self-ordering voltage, for example: sulfuric acid at 25 V, oxalic acid at 40 V and phosphoric acid at 195 V, giving 63, 100 and 500 nm pore intervals, respectively ^[3-5]. When the anodic voltage deviates outside the self-organization regime, the order of nanopores becomes poorer. Therefore, voltage is a crucial parameter to control the self-ordering and for this reason anodizing applying a constant voltage is the most standard method to fabricate highly ordered AAO films. It should be noted that the self-ordering voltage induces high current density, conditions close to the apparition of burning ^[6,7] (phenomenon that occurs at extremely high current flow concentrated at the local points of the aluminum surface leading to the local film thickening ^[8,9]). This suggests that the condition inducing film growth under high current density, i.e. the high electric field, is the key factor determining the self-ordering. Consequently, anodizing at constant current is also an interesting procedure because it allows a more uniform oxide growth and a better control of local catastrophic phenomena as burning or cracking.

In the present work, the development of burning during the formation of nanoporous AAO films in a sulphuric acid anodizing process was investigated. The study focused mainly on the AA1050 aluminum anodizing in galvanostatic conditions and the comparison with voltage control conditions. Within this context, the effect of different variables as temperature, electrolyte concentration, current density-voltage, etc. were analyzed. Additionally, the application of a two-step anodizing and the utilization of high purity (99.998%) aluminum as substrate were studied. The characterization of the AAO films consisted in assessing their appearance, thickness, morphology (OM, FE-SEM), composition (EDS, EPMA) and microhardness.

References

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Figures

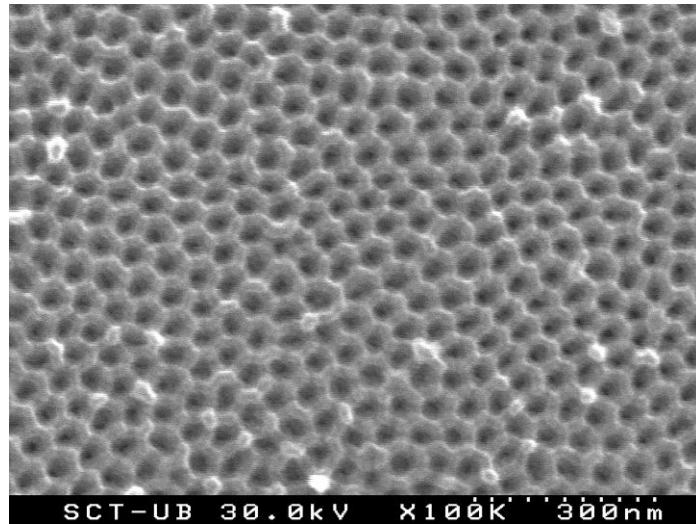


Fig.1. On-bottom FE-SEM image of an AAO film obtained after a two-step anodizing process in sulphuric acid electrolyte.