9th International Workshop on Electrodeposited Nanostructures

Broad Self-Ordering Regime in Hard-Anodized Nanoporous Alumina

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Nanoporous Anodic Aluminum Oxide (AAO) membranes exhibiting narrow pore size distribution and self-ordered hexagonal pores arrangement have triggered the interest of the scientific community during the last decades for the fabrication of functional nanostructured materials in a broad field of applications, due to the low cost and high throughput of the anodization technique. Recent studies highlight that Hard Anodization (HA) processes, carried out under stable high-field anodization conditions, can substantially broaden the self-ordering window achieved through Mild Anodization (MA) methods [1]. There is still a lack of scientific knowledge about the intrinsic nature of HA processes and its differences with MA, as well as the range of lattice constants that can be achieved by this novel fabrication method. Furthermore, the self-ordering conditions are usually determined by trial and error, which is time-consuming and provides limited results. In the present work, we have performed a systematical study about the HA self-ordering regime in oxalic acid electrolytes for a wide range of conditions. The use of linear sweep voltammetry in a broad voltage range from 40 V up to 250 V has been useful to understand the main features of the anodic oxidation of Al in oxalic acid electrolytes with varying their concentration. The HA processes presented here, along with a careful analysis of the voltammetric curves, provide a systematic method to establish the optimum self-ordering regime for any electrolyte, thus allowing for a continuous tuning of the geometrical characteristics of HA-AAO membranes in a broad lattice parameter range from 250 up to 460 nm.

References:

[1] W. Lee, R. Ji, U. Gösele, K. Nielsch, "Fast fabrication of long-range ordered porous alumina membranes by hard anodization", Nature Materials **5**, 741-747 (2006).