Enhancement of surface area in electrodeposited nanowires through porous anodic alumina tuning

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Developments in nanotechnology made the fabrication of nanostructures possible by disposing a wide variety of techniques and methods that allows a very precise control over the morphology of such structures at the nanoscale. In the past years, high aspect ratio nanoparticles, such as nanowires (NWs), have become increasingly important in a wide range of applications, from electronic devices, solar energy and even biomedical applications, for their unique physical and chemical properties. In some particular applications, like solar photoelectrochemical devices or drug delivery systems, the material surface area is a crucial parameter to increase performance [1].

Many different approaches can be considered to fabricate NW arrays. Nanoporous alumina templates (NATs) are extensively used due to their unique structural properties. This technique is very versatile since the pore size, density and height can be easy and readily controlled by the electrolyte type, anodizing temperature, voltage and time. Recently, the possibility to tune pore diameter during the anodization process presented the possibility to further increase the surface area of these materials [2,3]. Electrodeposition is a well controllable method to fabricate metallic or semiconducting NWs where the alumina pores are uniformly filled. Particularly, pulsed electrodeposition (PED) is a simple, inexpensive and industrially applicable method for the deposition of high aspect ratio nanostructures [4].

In this work we present a systematic study on the fabrication of diameter modulated Fe NWs. The anodization potential was varied during NATs formation obtaining a diameter range from 50 nm to 100 nm [5]. Aiming the maximum fill ratio of the alumina templates with different aspect ratios, the deposition pulse, temperature and electrolyte were optimized. We were then able to achieve the fabrication of highly ordered Fe NWs with diameters modulated with different patterns which are promising nanostructures for photoanodes after thermal conversion into hematite. The surface area of these nanostructures was increased by a factor of 2.5.

References:

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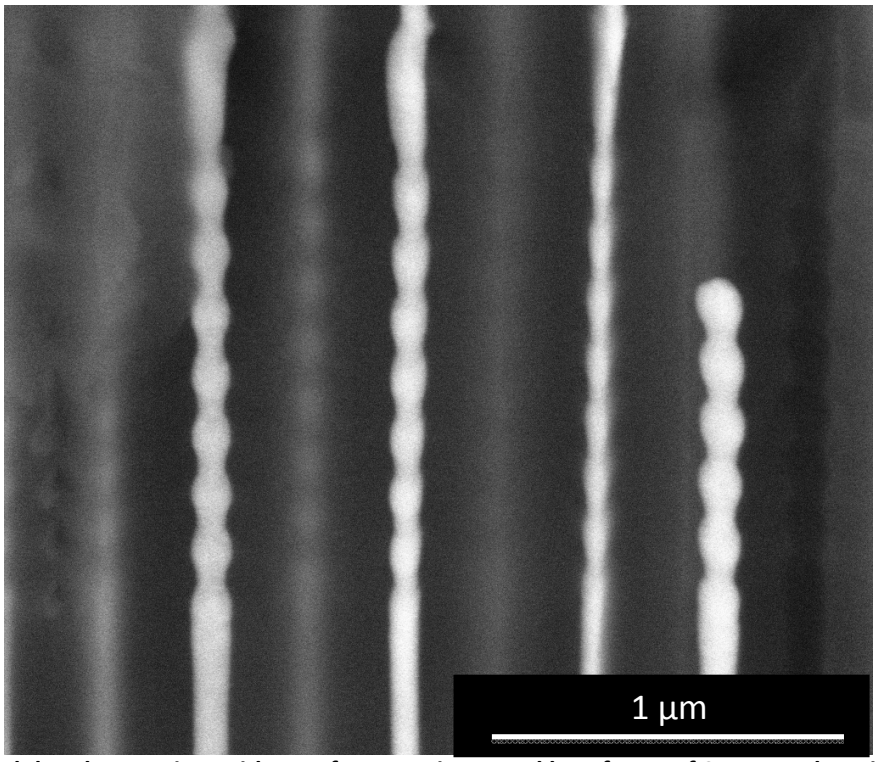

Figure 1 - Modulated nanowires with a surface area increased by a factor of 2.7, over the mild oxalic acid anodization [3].