

Towards ordered porous titania – a comparison with porous alumina

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Electrochemically-prepared ordered porous alumina has become one of the most important nanotemplate materials to date. Therefore, the questions arises whether other valve metals such as Ti, Ta, Nb, V, Hf or W can also be used for fabricating ordered pore arrays. We investigate in detail the electrochemical anodization of titanium in different electrolytes and its potential and temperature dependence (Fig.1). It turns out that due to the semiconducting properties of titania, a mirror image of the behavior of the electrically insulating porous alumina seems to be impossible. So-called porous titania in literature corresponds to the pitting regime of aluminum where pores are created due to dielectric breakdown of titania or alumina, respectively (Fig.2). This is supported by AES depth profiles (Fig.3) indicating no increase of thickness of the porous layer with time. Below the breakdown potential of titania, only thick barrier layers can be obtained. However, by nanoindentation of titanium and successive anodization of titania below the breakdown potential, monodomain porous titanium oxide with a pore depth of 60 nm on a cm^2 -scale can be prepared. (Fig.4) We discuss in detail the growth mechanism of porous structures of titanium and compare it with that of porous alumina [1].

[1] J. Choi, R.B. Wehrspohn, J. Lee, U. Gösele, *Electrochimica Acta* **49**, 2645 (2004)

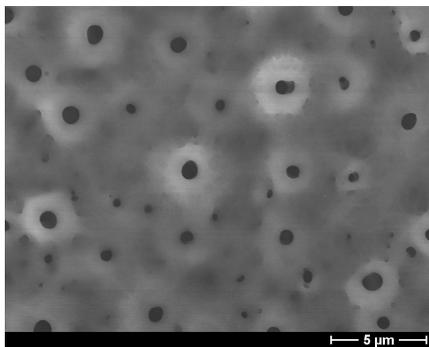


Fig.1: Scanning electron microscopy (SEM) image of titanium anodized in 1 M phosphoric acid at 210 V for 120 min at 5 °C

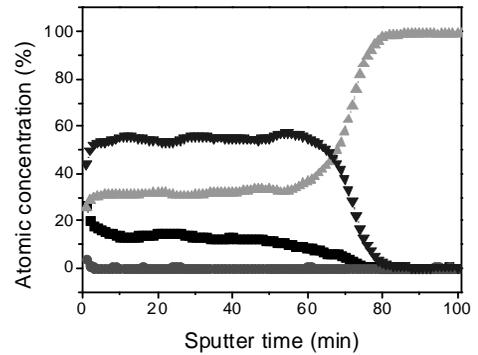
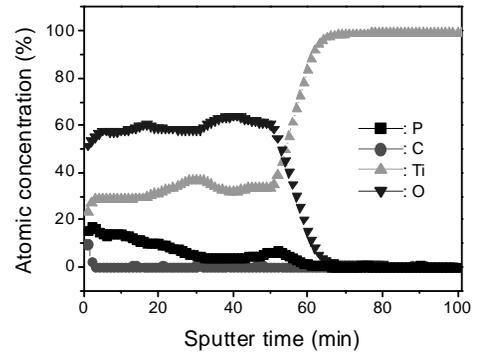


Fig.3: Auger electron spectroscopy (AES) depth profiles for oxide layers grown on titanium under different anodization conditions: (top) 210 V, 120 min, (bottom) 210 V, 1000 min

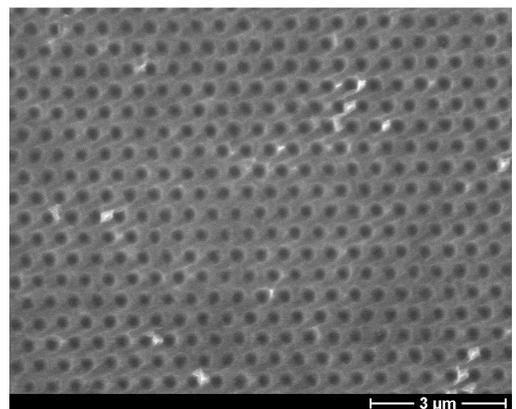


Fig.4: SEM image anodized titanium at 10 V with prepatterns of 500 nm lattice constant

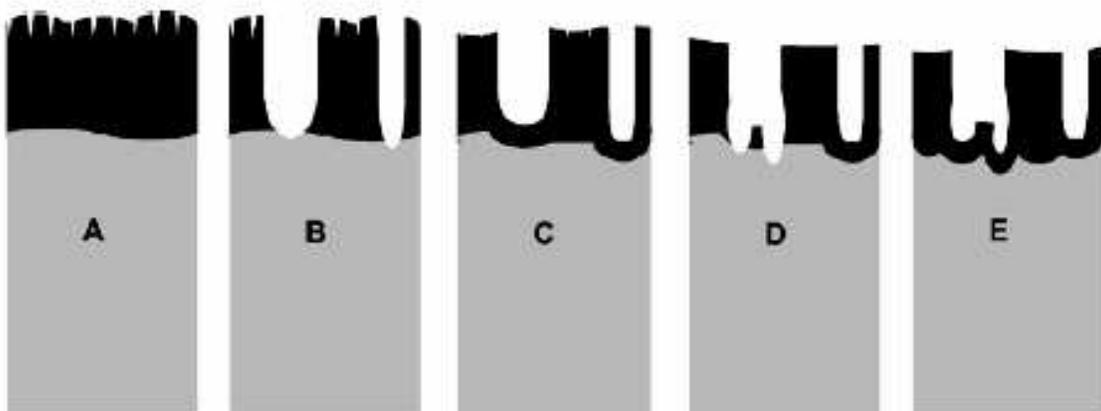


Fig.2: Schematic diagram of porous titanium oxide formation above the breakdown potential: (a) oxide growth to maximal thickness, (b) burst of oxide by the formation of crystallites (pore formation), (c) immediate repassivation of pore tips, (d) burst of repassivated oxide, and (e) dissolution of the formed oxide and second repassivation.