Towards ordered porous titania structures.

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Self-ordered porous alumina structures have gained considerable interest in the last years due to their use as templates for nanowire growth as well as their application as photonic crystals [1]

Here, we compare the growth mechanism of porous alumina with those of porous titania. Porous titania has potential applications in the areas of bioimplants as well as photonic bandgap material due to its very high refractive index. However, there is no report on thick ordered porous titania structures, yet.

Figure 1 shows a linear sweep voltammetry of aluminum and titanium in phosphoric acid. Whereas aluminum oxide has a breakdown potential of about 200V, the breakdown voltage of titanium oxide is significantly lower and depends strongly on the electrolyte. The reason is that alumina has a bandgap of 7-9.5 eV whereas titania has a much lower bandgap (3.2-3.8 eV). Therefore, porous titanium oxide was typically obtained in literature above the breakdown potential of titania [2-3]. In this growth regime, the thickness is limited purely by the applied potential and ordering is impossible.

Titanium was nanoindented similar to aluminum by imprint lithography [4] and first electrochemically anodized above the breakdown potential of titania U= 210 V. Even though there are pores, the ordering is not maintained and the thickness of the layer is in the order of several µm (Fig.2). Then, we anodized titanium below the breakdown potential of titania like it is the case for porous alumina (U = 10V). It was possible to maintain the ordering of the nanoindented structure. However, the thickness of the ordered layer is currently limited to 60 nm. We speculate that this originates mainly from the solubility of titania and the deviation from the 10% porosity rule [5].

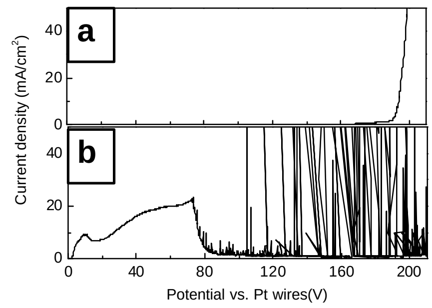

Fig. 1. A linear sweep voltammogram of aluminum (a) and titanium (b) in 40 wt% phosphoric acid.

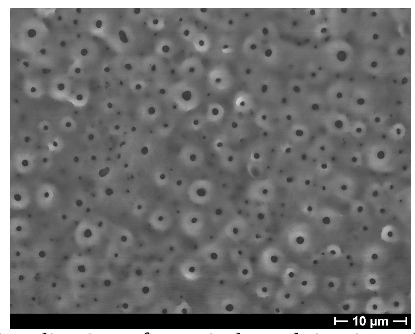

Fig.2. Anodization of nanoindented titanium above the breakdown potential in phosphoric acid.

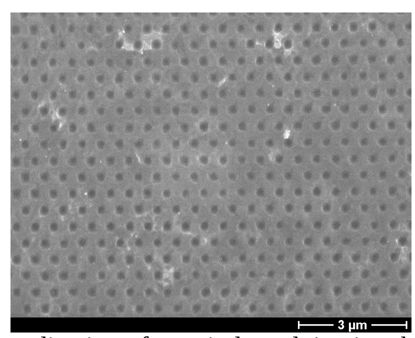

Fig.3. Anodization of nanoindented titanium below the breakdown potential in ethanolic HF.

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