ALUMINA MEMBRANES AS ETCHING MASK

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Porous alumina membranes recently have attracted much attention as it is a very appropriate material to realize ordered nanostructure arrays [1], [2]. A lot of work has been done on the study of these membranes and it has been shown that the pore diameter, pore density and the thickness of the membranes can easily be controlled[3].
One promising way of using alumina membranes for the fabrication of devices would be to transfer the ordered pore structure to layers of different materials [4]. The most obvious way to realize such transfer is to use the alumina membranes as etching mask and to etch thereby the same porous structure inside an underlying layer. However, prior to this, the barrier layer at the bottom of the pores has to be removed. The alumina barrier layer is inevitable during the creation of the porous structure. Its thickness is close to the pore diameter and proportional to the voltage applied during anodic oxidation process.

In our work, we have demonstrated such transfer to different type of layers. We first perform a double anodic oxidation process of an Al layer at the top of a multilayer structure. Once the ordered porous structure is obtained we applied different methods to remove the barrier layer at the bottom of the pores and finally we performed the etching of the underlying layers.

The etching by high-energy ICP has been first studied in order to remove the barrier layer and to etch inside the subsequent Al layer. By using a gas mixture of Cl_2 and Ar and a high platen power, perfectly straight pores have been transferred into an Al layer showing exactly the same order like the alumina membranes (Fig.1).

Secondly, we have shown the transfer inside an n-poly-Si layer and subsequently inside a SiO_2 layer. For this, high energy etching is not appropriate as it destroys easily the n-poly-Si and SiO_2. Thus, we first removed the barrier layer by a highly controlled anodic oxidation process of the alumina (Fig.2). Then, RIE etching has been performed to etch the n-poly-Si and SiO_2 layers by using a low chamber pressure and high acceleration energy. This combination allows to realize an an-isotropic etching which leads to the same pore structures in the etched layers (Fig.3).

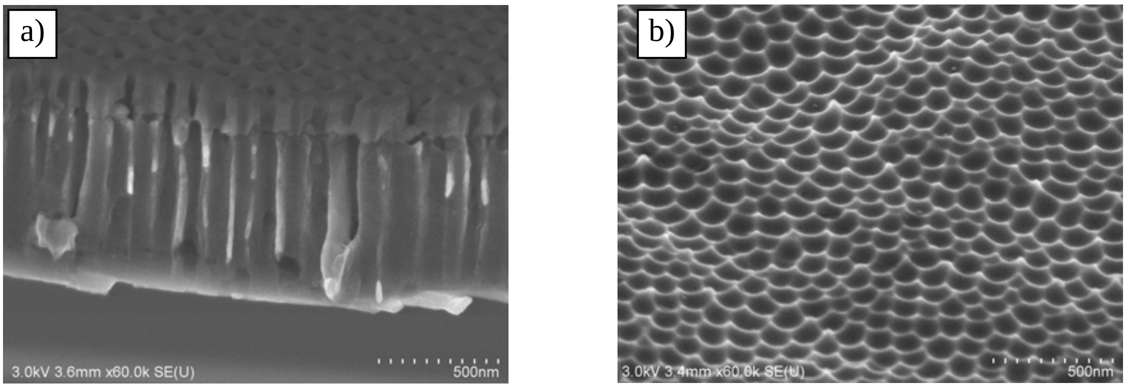

Fig.1: Porous alumina as etching mask for Al, SEM images. a) side view of the etched pore structure in an Al layer with alumina membrane on top; b) top view of the pores inside the same Al layer after removing of the alumina membrane.

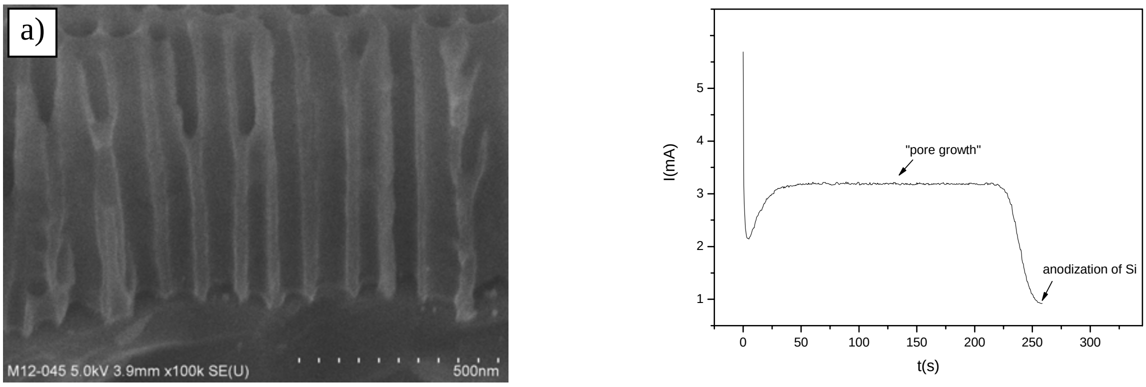

Fig.2: Realization of opened bottom pores on top of a n-poly-Si layer by highly controlled anodization. a) SEM image of the alumina membranes with open pores on n-poly-Si layer; b) current characteristics during anodic oxidation.

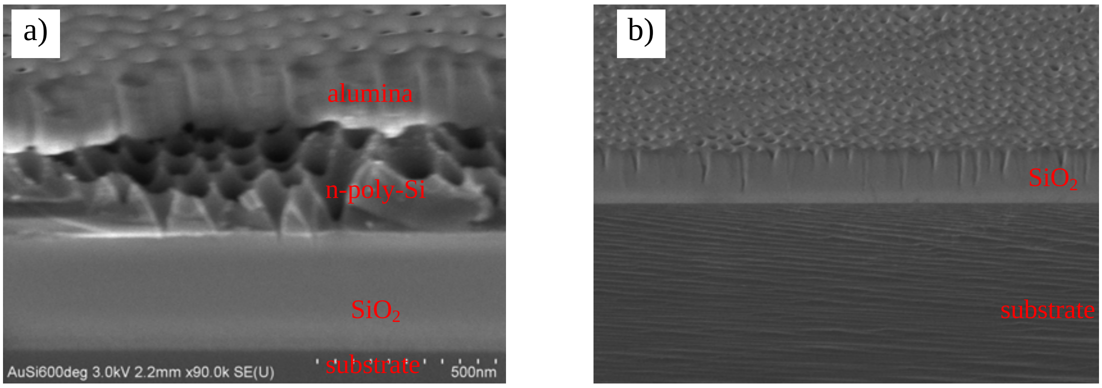

Fig.3: Porous alumina as etching mask for the n-poly-Si and SiO_2 layers, SEM images. a) RIE etching at 30 W and 3 mTorr for 20 min; b) RIE etching at 50 W and 3 mTorr for 50 min followed by removal of the alumina membrane and n-poly-Si to show the transfer of the ordered structure (same sample as in a)).

References:

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