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# Nanowire Deposition in Thick Porous Anodic Alumina Membranes on Silicon

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Porous anodic alumina (PAA) membranes, which consist of an array of parallel channels of prescribed diameter and length in an amorphous alumina matrix, have been demonstrated as templates for the synthesis of nanowires, often via electrochemical deposition. While this is a cheap and versatile method for the preparation of nanowire arrays, several disadvantages of the process have made the technology unattractive for scale up. PAA membranes are usually micron-thick free-standing films, which cannot tolerate even moderate mechanical stresses and crack easily. If supported on an aluminum substrate, a barrier layer separates the channels from the aluminum, making the electrodeposition of nanowires difficult. Furthermore, porous alumina is stable only over a narrow pH range, making it incompatible with many processes, such as lithography, which is necessary in order to fill the pores of the template with more than one material.

We have fabricated PAA membranes supported on silicon wafers. Various coatings were first applied on the silicon wafers, in order to modify the mechanical and electrochemical properties of the PAA-wafer interface. The template fabrication process consists of the thermal evaporation of aluminum (usually several microns thick), the electrochemical polish of the aluminum, and the anodization of the aluminum. Depending on the composition of the coating layers, the current will either fall off or increase sharply at the end of the anodization. The coating layer also determines the morphology of the barrier layer. Using a 250-nm titanium coating, an inverted thin barrier layer was obtained. This barrier layer was selectively removed from the structure, without damaging the channels, by increasing the pH at the wafer-PAA interface via an electrochemical reaction at the titanium surface. The thru-channels are then conveniently used for the synthesis of nanowires.

This process has been used to fabricate membranes and nanowire arrays on large substrate areas. The rigidity of the substrate allows for easy manipulation of the structure. Patterning is done on the substrate prior to the formation of the PAA membrane. In addition, free-standing films with highly planar surfaces can be obtained by their spontaneous separation from properly chosen substrates.

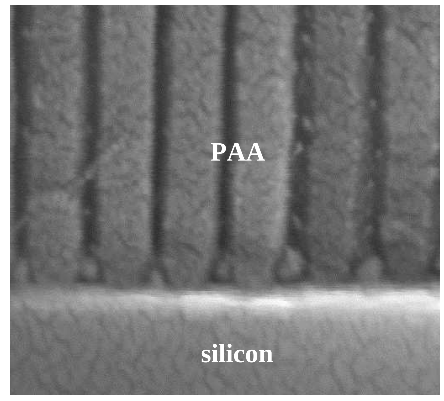


Fig. 1: SEM image of the interface between the PAA membrane and a silicon wafer.

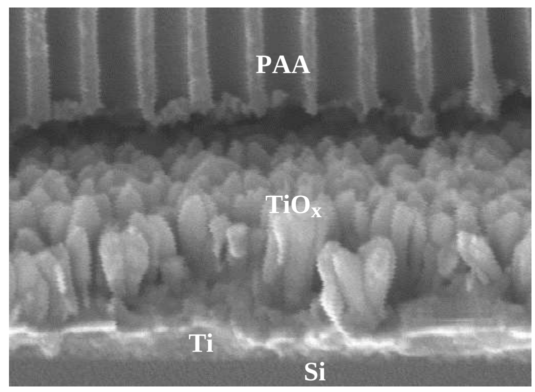


Fig. 2: SEM image of the interface between the PAA membrane and a titanium coated silicon wafer, after barrier layer removal.

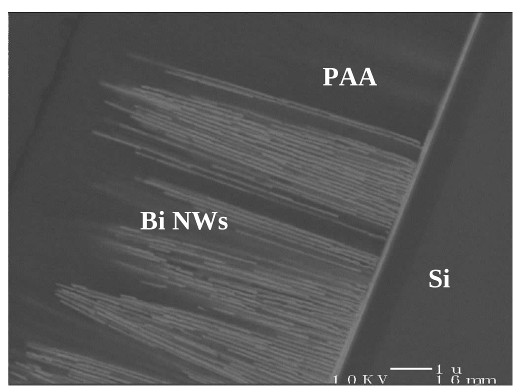


Fig. 3: SEM image of an array of bismuth nanowires grown on a Pt/Ti coated silicon wafer.