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NANO / Nanomaterials and nanostructured thin films

Local plasma-chemical etching of the silicon substrate surface by using of anodic alumina template

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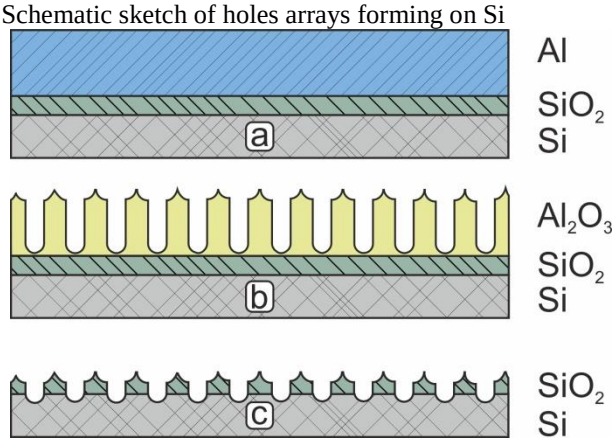
Abstract content

The research idea consists in forming thin functional layer on Si substrate with regularly arranged nanostructures to create on their basis efficient photovoltaic and sensor devices. The approach is to use regular nanoporous anodic alumina (AA) matrix as template to create holes arrays on Si surface, which are filled with metal oxides or sulfides by ionic layering, sol-gel method or chemical vapor deposition. In this study, the results of research on the technological processes of system nano-holes creating on the Si substrate via the porous AA matrixes are presented for the subsequent filling with the functional nanostructures. The technological sequence of samples preparation is shown in Figure 1. At first, the highly ordered AA layer with open nanopores (without so called oxide barrier layer) was formed directly on Si surface by the two-stage electrochemical anodization of Al. This condition is necessary to ensure qualitative and reproducible etching of Si surface through AA mask. Finally, a process of plasma-chemical etching (PCE) of the Si substrate surface through the modified AA porous mask has been developed. We used deep reactive ion etching (DRIE) in Ar plasma to remove the disordered AA surface layer and to reduce the oxide thickness and residues of the barrier oxide layer. CHF3 was chosen as the active gas for PCE. Optimal technological PCE modes and conditions were selected that ensure uniform selective etching of Si with satisfactory anisotropy without destroying of AA mask. Figure 2 shows SEM image of Si surface after PCE through AA mask in gas mixture Ar(100 sccm)/CHF3(5 sccm) for 20 min. at coil and platen power of 400 and 100 W, respectively. The dimensions of the holes in Si were 80 nm, with depth of 100 nm. The thickness of the mask was 250 nm, with pore diameters of about 60 nm.

References

Schematic sketch of holes arrays forming on Si



SEM image of Si wafer after PCE through AA mask