FORMATION OF TIO2-BASED COLUMNLIKE NANOSTRUCTURED ANODIC FILMS ON PURE AND DOPED TITANIUM LAYERS

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Abstract

Nanostructured titanium oxide films are widely used for various applications, for instance solar energy conversion, where an increment in the surface-to-volume ratio and band-gap tuning may drastically improve the film performance. In our work to date, we have investigated the anodic process of porous-alumina-assisted formation of titanium oxide nanocolumn arrays from pure and doped titanium layers. We observe a substantial increase of chemical stability in the case of a doped titanium, which is caused by suppressing the field crystallization of titanium oxide and its mixing with alumina during the anodic process.

Experimental samples were thin aluminium layers superimposed on either a pure Ti or a doped Ti layer sputtered onto SiO2/Si substrates. Pieces of both samples were anodized in an organic-acid-based electrolyte at 40 V and reanodized to potentials up to 150 V in order to grow titania nanocolumns in the alumina pores. The alumina matrix was then removed by selective etching in a CrO3/H3PO4-based solution.

SEM and XPS analyses revealed that TiO2 nanocolumns grown on the pure Ti underlayer at higher potentials were unstable in the etching solution and soon dissolved away from the sample surface. In the case of the doped titanium, the anodizing/reanodizing process resulted in the formation of titanium oxide nanocolumns that were chemically stable during the substantially prolonged time spans in the etching solution.

These results enable preparation of long-aspect-ratio titanium-oxide nanocolumns slightly doped with different impurities, which may exhibit improved functional properties compared with the pure titanium oxide nanostructures.

Keywords: Titanium oxide, doping, nanocolumns, anodizing, porous alumina, thin films

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