Controlling the photoactivity of nanopatterned titanium oxide

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Titanium oxide is a wide-bandgap semiconductor with high electron mobility, which makes it an excellent material for solar cells and photocatalytic reactions. The overall efficiency is a key parameter in this type of application, and one of the most effective ways of its increase is to maximize the working surface area of the active material, which can be done by nanopatterning. One of the most effective, scalable, and straightforward methods to synthesize nanopatterned titanium oxide is an electrochemical oxidation process called anodization. However, the order of the nanostructures obtained by this method is limited by the grain boundaries, which in turn affects the total surface area of the active material. To overcome this drawback, we used a combination of nanosphere lithography and anodization. The proposed approach allowed to obtain of TiO2 nanotubes with long-range hexagonal ordering at large areas, as shown in Fig. 1.

The photoactivity of the TiO2 nanotubes was studied by fluorescence spectroscopy in the UV-Vis range as a function of the patterning period and annealing temperature. The crystal structure of the nanotubes was characterized by X-Ray diffraction and Raman spectroscopy and compared to the material obtained by classical anodization. The fluorescence spectroscopy measurements revealed that the parameters of the patterning process have a strong influence on the photooxidation effect. These results indicate that the combination of pre-patterning and anodization provides an excellent tool for controlling their photoactivity.

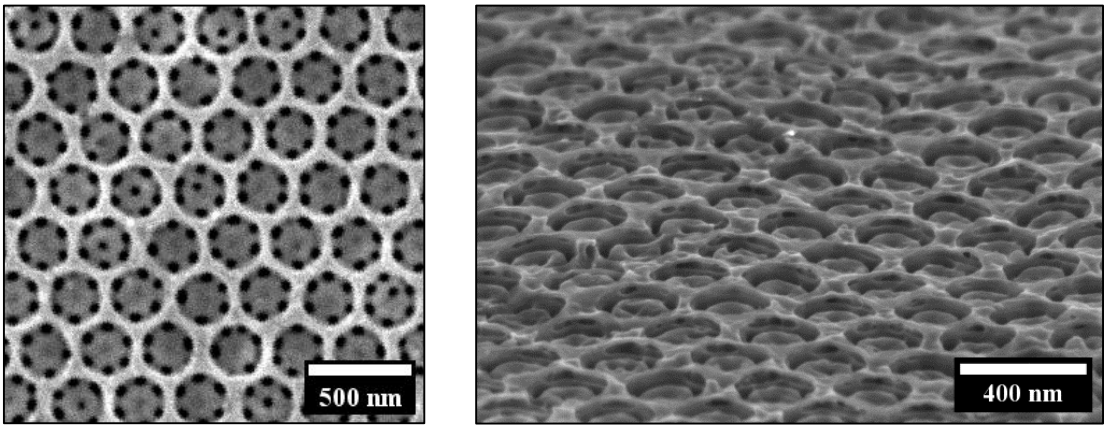

Fig. 1. The top view (left) and side view (right) show the surface morphology of anodized titanium oxide pre-patterned by nanosphere lithography.