Abstract

This PhD dissertation focuses on the fabrication and characterization of semitransparent substrates overgrown by titania material. The applicability of the fabricated material as a potential photoanode for efficient light conversion and optoelectrochemical sensing was also investigated. The general approach adopted in this work towards fabricating the semitransparent material consists first of the sputtering of Ti film onto indium tin oxide (ITO) coated glass substrate followed by anodizing of the deposited film. Optimization of the anodization parameters was carried out to obtain highly ordered, semitransparent layers composed of aligned or spaced nanotubes on planar substrates. Next, the tubular morphology was formed on the both sides of planar substrates using an anodization setup equipped with a suitable sample holder allowing each side to be anodized independently. The influence of the distribution of the tubes, i.e. aligned, when outer walls are adjacent to each other, and spaced on some distance, on the photoactivity of the fabricated double-sided materials was studied. Aligned nanotubes were also obtained out of Ti film sputtered onto optical fiber. Anodization was carried out in the system where Ti covered fiber was placed between two platinum meshes. The transparent layer of nanotubes was obtained on the optical fiber owing to the optimization of the distance between the platinum meshes. The presence of tubular layer onto the optical fiber plays important role in determination of the refractive index in liquid medium. It should be underlined that semitransparent materials are less efficient than those fabricated onto Ti foil in terms of light conversion. However, the improvement of the quantum efficiency of the semitransparent tubular layers through their modification can be carried out. To reach this, the incorporation of silver within the nanotubular layers was proposed. This aim was realized by the formation of aligned and spaced nanotubes out of TiAg films with different Ag content (i.e., 1.7, 3.5, and 5 % Ag content, the rest is Ti) deposited onto ITO coated glass substrate. Energy dispersive X-ray analysis revealed for the aligned tubular architecture the preservation of 60 % of the Ag content in the sputtered TiAg layer after the anodization. A three-fold increase in the incident photon-to-current conversion efficiency (IPCE) for the aligned nanotubes out of the TiAg films containing 3.5 % of Ag was obtained with respect to the bare titanium dioxide layer with the same tubular architecture. The quantum efficiency of the tubular layer was also increased through its functionalization with $Ti_3C_2T_x/TiO_2$ heterostructures. The heterostructures were synthesized via laser annealing of $Ti_3C_2T_x$ frozen suspension. The nanotube layer integrated with $Ti_3C_2T_x/TiO_2$ demonstrated about ten time increase in the IPCE compared to the bare substrate. The main outcome of this work is the development of fabrication procedures of semitransparent ordered nanostructures and their functionalization that can contribute to the development of solar powered devices and optoelectrochemical sensors.