One dimensional anodic nanostructures for energy applications

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The self-organized 1D TiO_2 nanotubular layers have attracted considerable scientific and technological interest over the past two decades, all motivated by a great performance in the range of applications including photo-catalysis, solar cells, hydrogen generation and biomedical uses.[1,2] The synthesis of these nanotubular layers has been carried out by a conventional electrochemical anodization of Ti sheet. Except the 1D character, these nanotubes possess unique features such as tunable dimensionality, structural flexibility, unidirectional electron transport through nanotube walls, chemical and mechanical stability and biocompatibility.

One of the major application targets of TiO_2 nanotubes has been their utilization as scaffolds or templates for deposition of secondary materials towards new applications. For instance, tailoring the TiO_2 anode chromophore interface can increase the efficiency of the cells, such as DSSC[3] and perovskite-based solar cells[4]. The enhancement can be achieved by increasing the interfacial surface area between the chromophore and the TiO_2 oxide in order to facilitate charge separation. Unlike randomly ordered mesoporous TiO_2 support, ordered nanostructures, such as self-organized TiO_2 nanotubes with high aspect ratio, offer the advantage of directed charge transport and controlled phase separation between donor and acceptor materials and thus they seem to be one of the most promising nanoscale solar hybrid technologies.[5]

Numerous techniques were utilized for this purpose, such as for example wet chemical and electrochemical routes or physical deposition techniques.[6] However, recently it has been shown that the utilization of Atomic Layer Deposition (ALD) can extend the functional range of TiO_2 nanotubes by homogenous coatings or decoration of tube interiors by a secondary materials.[6-14] ALD is the only technique of choice to coat in particular high-aspect ratio nanotube layers. Overall, the deposited coatings influence strongly photo-electrochemical properties of nanotube layers.

The presentation will be focused in detail on TiO_2 nanotube layers of various aspect ratios coated by CdS and other chalcogenides using ALD. Experimental details and some very recent photo-electrochemical and structural characterization of a new type of heterostructured photo-chemical cells[11,13,14] will be presented and discussed.

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