Aligned Semiconductor Oxide Nanostructures for Dye sensitized solar cells

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The application of aligned oxide nanostructures it is thought to improve electron injection in Dye sensitized solar cells (DSCs). In this work we present the application of different aligned semiconductor oxides, like TiO_2 and ZnO, in DSC. The efficiency of vertically-aligned ZnO nanorods is still lower than applying hierarchical ZnO nanoplates, nanosheets, disk-like nanostructures or aggregates that can achieve about 5-6% efficiency in DSC [1]. In an effort to understand the factors that limit power conversion efficiency, we report in this work a slight modification of the hydrothermal synthesis technique for the obtention of vertically-aligned ZnO nanorods. Our initial results show that, for the same NR growth time, shorter NR length but higher power conversion efficiencies are obtained with the modified method. For example, for a 5 µm ZnO NR thickness, 1% efficiency is obtained. Applying the modified method, 1.24% efficiency can be achieved for a ZnO NR electrode of only 1 µm thick. The latter is attributed to the different dye loading capacity of the ZnO NRs. Our work also encompasses the synthesis of transparent thin film electrodes made of vertically aligned nanocolumns of TiO_2 with well-controlled oblique angles grown by physical vapor deposition at glancing incidence (PVD-GLAD). For an electrode thickness of 500 nm, we report a 40% variation on solar cell efficiency (from 0.6% to 1.04%) when the deposition angle was modified between 60º and 85º. Transparent thicker films with higher surface area deposited at the optimal angle of 70º were grown with a zigzag morphology which confers high mechanical strength to the thin films. Using this topology, the application of an electrode thickness of 3 µm in a DSC resulted in a power conversion efficiency of 2.78% maintaining electrode transparency [2].

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References

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