C90 - Optimized TiO2 blocking layers for dye-sensitized solar cells (DSSC)

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In recent years much attention has been paid to dye-sensitized solar cells[1] due to their low cost and wide applicability. The modest efficiencies achieved by these devices are caused by several phenomena including electronic losses due to parasitic electronic reactions (back transfer reaction)[2]. Each of the single element of the cell has therefore to be carefully engineered in order to increase the overall performances of the device. One of the most common ways to reduce the electronic losses is to introduce a compact layer of conductive material (blocking layer) between the transparent conductive substrate and the sensitized semiconductor film[3].

Aim of this work was to asses the correlation between the most common deposition processes and the spectrophotometric, morphological and electrochemical properties of the blocking layers produced. The blocking layer of TiO_2 was prepared on FTO glass using two of the most common colloidal deposition processes: dip and spin coating. The results obtained with the conventional dip coating[4] (immersion of a conductive substrate FTO in an aqueous solution of $TiCl_4$ 50 mM at 70 °C for 30 minutes) were compared with the ones coming from spin coating of two different solutions (aqueous and alcoholic). The two solutions were characterized in terms of viscosity, surface tension and contact angle. On the basis of these analysis, the spin coating parameters (speed of rotation and the duration of the deposition) were optimized in order to obtain a uniform single layer observed through optical and scanning electron microscopy.The samples prepared either by dip and spin coating were heat-treated at 450 °C for 30 minutes. The presence of TiO_2 in the anatase crystalline phase required for the blocking layer was assessed through XRD analysis. The influence of more cycle of deposition (2,4,6) was also evaluated.

The TiO_2 films obtained were characterized by spectrophotometric (UV-vis), morphological (SEM and AFM) and electrochemical analysis (voltammetry sweep linear and cyclic, electrochemical impedance spectroscopy EIS). These analysis allows to identify the best process and deposition parameters necessary to obtain an efficient blocking layer.

The ethanol system allowed the production of the most thick (120 nm), homogeneous, continuous and dense film among the all conditions and the two processes tested. Moreover, the EIS analysis shown that the TiO_2 blocking layer made by alcoholic solution promotes a decrease of the dark current and therefore an improvement of the cell efficiency as expected.

References

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