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EFFECT OF THE MAGNETOSTRICTION INDUCED ON THE CRYSTALLINE STRUCTURE OF NANOPARTICULATE TiO2 PHOTOANODES AND THEIR RELATIONSHIP WITH THE PHOTOVOLTAIC RESPONSE OF BLACK-DYE SENSITIZED SOLAR CELLS

The study of ferromagnetism (FM) in semiconductor oxides having non-cubic crystalline structures (e.g. TiO2) is attractive due to their applications in spintronics. FM can be activated in TiO2 nanomaterials by promoting oxygen vacancies (VO) in paramagnetic defected sites Ti3+VOTi4+. In this context, the VO can induce in Ti3+-doped TiO2 structures remarkable magnetic anisotropy energy (MAE) of 6.51x106 erg/cm3, thus indicating the magnetic saturation (Ms) should be achieved by applying external magnetic fields (MFs) of ⊠425 gauss. Therefore, magnetostriction can be observed in ferromagnetic TiO2 films containing Ti3+VOTi4+ sites as a phenomenon in which their dimensions and shapes are changed when they are magnetized. In this work, black dye-sensitized solar cells (BD-SSC) were prepared using TiO2 nanoparticle films enriched by Ti3+VOTi4+ sites, to gain an understanding of the effects of magnetostriction on the photovoltaic responses of BD-SSC. In this way, photocurrent density-cell potential plots were obtained for the BD-SSC in the absence and presence of MFs having intensities of 125, 250, 500, 1000, and 2000 gauss. MFs lines were parallel applied to the surface of the BD-sensitized TiO2 photoanodes. Our results indicated that the photogenerated electron transport through the dyed TiO2 photoanodes was not limited by electron transfer to I3- anions at the electrolyte in the absence or the presence of MFs, because all the values for the open-circuit potential (-Eoc ⊠ 0.553⊠0.014 V) remain constant. On the contrary, the obtained values for the short-circuit current density Jsc and the global conversion efficiency revealed that both parameters increased as a function of the MFs intensities, thus indicating that the magnetic lines were responsible for decreasing the degree of disorder (0<⊠<1) of the electron-traps at the intra-bandgap state's distribution of the TiO2 film (Jsc is proportional to Q1/⊠ where Q is the number of trapped electrons).

Keywords

ferromagnetic TiO2, magnetostriction, dye-sensitized solar cells.

Reference

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