Effect of morphology on electron drift mobility in porous TiO_2

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Abstract

Porous titanium dioxide is an attractive material for solar cell application on account of its stability, electron transport properties, and the possibilities for controlling surface morphology as well as for its ease of fabrication and low cost. Nanostructured TiO_2 has been intensively studied for applications to dye sensitised solar cells. The performance of the titanium dioxide based solar cells is influenced, among other factors, by the electron mobility of the porous titanium dioxide. Different fabrication processes for porous titanium films result in different film morphology, which in turn affects the electron transport. We have employed three different techniques namely, electrostatic spray assisted vapour deposition (ESAVD), D.C. reactive sputtering, and doctor blading of sol-gel dispersions to deposit thin TiO_2 films onto indium tin oxide (ITO) coated glass substrates. All these films exhibited only the anatase phase as confirmed by X-ray diffraction analysis. Using the time-of-fight technique, the electron drift mobility in the porous TiO_2 films was measured. The results show that in the low field region (< 55,000 V cm^{-1}) the mobility, in all the films, were in the range of 10^{-7} to 10^{-6} cm^2 Vs $^{-1}$. The drift mobility in the films prepared by reactive sputtering was consistently higher than in the films prepared by the two other techniques. Sputter deposited films had lower porosity (~ 10% and 36% for normal-, and oblique (60°)-angle deposited films) compared to ~ 50% for films deposited by the two other techniques. The relationship between the drift mobility and film morphology is discussed with the aid of scanning electron microscopy studies.