(001)-oriented anatase TiO_2 nanosheets as a photoanode material for dye-sensitized solar cell

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Dye-sensitized solar cell (DSC) is one of the most promising photovoltaic technologies for production of renewable, clean, and affordable energy [1]. Since its invention by Graetzel et al. in 1985 [Ref. 2] it has been permanent subject of interest of research teams all over the world. One of the key issues in optimization of the Graetzel cells consists in the morphological engineering of the TiO_2 photoanode. High surface area and crystallinity predetermine nanocrystalline TiO_2 to work effectively as photoanode in DSC [3]. Among others, an increase of the open-circuit voltage (U_{OC}) of DSC via tuning of the photoanode material is a pathway towards an improvement of the device performance. (001)-oriented anatase exhibits enhanced Li insertion activity [4] as compared to (101)-oriented one due to synergic contributions of faster interfacial charge transfer and facile Li transport within a more open structure of the anatase lattice. Since material and structural requirements for both Li insertion electrode and DSC photoanode are similar and charge transport in the anatase skeleton controls the overall efficiency of both processes, the performance of “reactive” (001)-oriented anatase photoanode in DSC was examined [5]. Although the (001) face adsorbed a smaller amount of the used dye sensitizer (C101), it provided a larger open-circuit voltage of the solar cell. The negative shift of flatband potential is suggested to be responsible for the observed enhancement of U_{OC}.

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References

[1] K. Kalyanasundaram, Ed., Dye-Sensitized Solar Cells, CRC Press Taylor & Francis, Boca Raton 2010, pp. 45-81

[2] J.Desilvestro, M.Grätzel, L.Kavan, J.Moser and J.Augustynski, J.Am.Chem.Soc., **107** (1985), 2988

[3] Kavan L (2012) Chem Rec 12:131–142

[4] Bousa M, Laskova B, Zukalova M, Prochazka J., Chou A., Kavan L., J. Electrochem. Soc., **157** (2010)(10), A1108-A1112

[5] Laskova B., Zukalova M., Kavan L., et al., J Solid State Electrochem.,**16** (2012):2993–3001