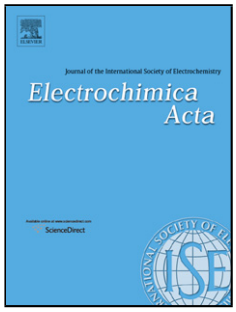

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Enhancing the electron transfer and band potential tuning with long–term stability of ZnO based dye–sensitized solar cells by gallium and tellurium as dual–doping

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ABSTRACT

A series of ZnO nanoparticles with Ga and Te dual–doping were successfully synthesized by using a facile sol–gel route, and their performance as the photoanode material in DSSCs was employed for the first time. The effects of simultaneously Ga–Te dopants into ZnO host ($Ga_xTe_{1-x}ZnO$ where the values of x ranging from 0 to 1 mol % with increments of 0.25 mol %) on the structural, optical, morphological, and compositional properties of the resulting samples were characterized via XRD, Raman, UV–vis–NIR spectrometer, PL, BET, AFM, FE–SEM, EDX, and XPS measurements. The incorporation of Ga–Te enlarges the surface area of the photoanodes, leading to higher dye–loading capability. Moreover, the PL intensity of pure ZnO drastically decreases by Ga–Te doping, which demonstrates the reduction of oxygen vacancies, indicating the slow recombination of photoinduced charge carriers. Owing to the doping effect of Ga–Te, the energy conversion efficiencies of the DSSCs based on these photoanodes lie in the range of 4.79–7.08%, which is higher than that of pure ZnO (3.53%). This improvement of efficiency can be mainly ascribed to the combined effects of faster electron transport rate, retarded charge recombination, enhanced dye adsorption capability, longer electron lifetime as well as shifted negatively of condution band edge in dual–doped ZnO films. Furthermore, it is noteworthy that after 1200 h, the degraded $Ga_{0.25}Te_{0.75}ZnO$ device still shows 86% of their initial efficiency. This study provides a strategy for constructing self–powered systems using a device such as $Ga_xTe_{1-x}ZnO$ based DSSC described here for the first time.

Keywords: Dye–sensitized solar cells, Ga–Te dual–doped ZnO photoanode, Electron transfer, Long–term stability, Band potential tuning, Lifetime.

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