SnO$_2$–TiO$_2$ Hybrid Nanofibers for Efficient Dye-Sensitized Solar Cells

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ABSTRACT
Pristine SnO$_2$ nanostructures typically result in low open circuit voltage ($V_{OC}$) <500 mV due to the lower Fermi energy ($E_F$) when employed as a photoanode materials in dye sensitized solar cells (DSSCs). On the other hand, the most successful photoanode material, i.e., TiO$_2$ nanoparticle although provides a high $V_{OC}$ $> 800$ mV result in poor charge collection owing to their inferior electron mobility ($\mu_n$). Herein, we employ nanofiber–nanoparticle composite of SnO$_2$–TiO$_2$ which showed similar $V_{OC}$ and short circuit current density ($J_{SC}$) to a reference TiO$_2$ based DSSCs. The nanocomposite developed here involves multi-porous SnO$_2$ nanofibers characterized by a lower $E_F$; however, with higher $\mu_n$ and TiO$_2$ nanoparticles of higher $E_F$ and lower $\mu_n$. The TiO$_2$ particles in the pores of SnO$_2$ nanofibers were developed by TiCl$_4$ treatment, whose concentration is optimized for the saturated $J_{SC}$ and $V_{OC}$. The best performing DSSCs fabricated using the composite electrodes deliver power conversion efficiency (PCE) of $\approx 7.9\%$ ($V_{OC}$ $\approx 717$ mV; $J_{SC}$ $\approx 21$ mA cm$^{-2}$), which is significantly higher than pure SnO$_2$ photoanode with PCE $\approx 3.0\%$ ($J_{SC}$ $\approx 14.0$ mA cm$^{-2}$ and $V_{OC}$ $\approx 481$ mV) at similar experimental conditions.

KEYWORDS: Photovoltaic; SnO$_2$ nanofibers; TiO$_2$–SnO$_2$ composite; Interfacial charge recombination; Electron life time

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