Silver Nanoparticles-Decorated Visible Light Responsive Titania Nano-Rods for Dye Sensitized Solar Cells

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Abstract

Dye-sensitized solar cells (DSSCs) based on nanocrystalline metal oxides are cost-efficient photovoltaic devices and work better even during darker conditions, such as in cloudy weather. Although higher efficiencies have been reported for DSSCs made with TiO_2 nanoparticles and Ru – based dye, their performance is apparently limited by both charge transport and charge separation efficiencies. This may be overcome by using templated porous structures, tetrapods, or vertically aligned nanorods. This work focuses on synthesizing TiO_2 nanorods using hydrothermal method which requires low operating temperature and short growth time. When the particles are made from multi-materials, it does not only improve the property of the main material but also develops their multifunctionality. As such, Ag nanoparticles were synthesized using chemical reduction method and deposited on the synthesized TiO_2 nanorods to enhance the efficiency of DSSCs. The surface morphology of the TiO_2 nanorod samples with and without Ag nanoparticles were compared using SEM images. The effect of silver deposition was investigated by UV-Visible spectroscopy while the particle size of the synthesized Ag nanoparticles was determined by the particle size analyser. Then the liquid state DSSCs were fabricated with N719 dye and photovoltaic performance of the fabricated solar cells were tested under simulated irradiation of 100 $mWcm^{-2}$ with AM 1.5 filter. DSSCs fabricated with Ag nanoparticles deposited TiO_2 nanorod arrays yielded about 60 % higher power conversion efficiency than its control device mainly due to the increment of short circuit current density which is consistent with broad spectrum of the TiO_2 nanorods with Ag.

Keywords: Dye sensitized solar cells, TiO_2 nanorods, hydrothermal method, power conversion efficiency