Enhanced photovoltaic performance of silver@titania plasmonic photoanode in dye-sensitized solar cells

ABSTRACT

In the present investigation, silver@titania (Ag@TiO2) plasmonic nanocomposite materials with different Ag content were prepared using a simple one-step chemical reduction method and used as a photoanode in high-performance dye-sensitized solar cells. Transmission electron microscopic images revealed the uniform distribution of ultra-small Ag nanoparticles with a particle size range of 2–4 nm on the TiO2 surface. The incorporation of Ag on the TiO2 surface significantly influenced the optical properties in the region of 400–500 nm because of the surface plasmon resonance effect. The dye-sensitized solar cells (DSSCs) assembled with the Ag@TiO2-modified photoanode demonstrated an enhanced solar-to-electrical energy conversion efficiency (4.86%) compared to that of bare TiO2 (2.57%), due to the plasmonic effect of Ag. In addition, the Ag nanoparticles acted as an electron sink, which retarded the charge recombination. The influence of the Ag content on the overall efficiency was also investigated, and the optimum Ag content with TiO2 was found to be 2.5 wt%. The enhanced solar energy conversion efficiency of the Ag@TiO2 nanocomposite makes it a promising alternative to conventional photoanode-based DSSCs.

Keyword: Conversion efficiency; Dye-sensitized solar cells; Nanocomposites; Nanoparticles; Plasmons; Solar cells; Solar energy; Titanium dioxide