Optimization of titanium dioxide decorated by graphene quantum dot as a light scattering layer for enhanced dye-sensitized solar cell performance

ABSTRACT

Titanium dioxide (TiO2) as a photoanode in dye-sensitized solar cells (DSSCs) has some drawbacks that reduce its photovoltaic performances i.e. low dye loading capacity and low light-harvesting efficiency. Therefore, TiO2 decorated by graphene quantum dot (GQD) as a light scatterer has been successfully fabricated via electrodeposition and drop-casting. The response surface methodology/central composite design was successfully utilized to optimize the preparation of photoanode with TiO2-GQD as a light scattering layer (LSL). A reduced quadratic model was successfully designed to predict the power conversion efficiency (PCE) accurately up to 97% with a 3% residual standard error. The TiO2-GQD LSL depicted a cluster of spherical nanoparticles on top of the photoanode that not only enhanced the light scattering effect but also improved the light-harvesting range from visible light to ultraviolet and near-infrared range. The resultant TiO2 nanoparticles with TiO2-GQD LSL showed vast enhancement of PCE up to 66% from 3.06% to 5.01% due to a good synergistic effect.