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A novel, PbS:Hg quantum dot-sensitized, highly efficient solar cell structure with triple layered TiO2 photoanode

lM.A.K.L.DissanayakeabT.JaseetharanabG.K.R.SenadeeraacC.A.Thotawatthageab

Abstract

Hg-doped PbS quantum dot-sensitized solar cells (QDSSCs) were fabricated using successive ionic layer adsorption and reaction method with TiO2 single layer, double layer and triple layer photoanode nanostructures. The triple layer TiO2 photoanode was fabricated by using a TiO2 nanofibre (NF) layer sandwiched between two TiO2 nanoparticle (NP) layers in order to enhance light harvesting through effective light scattering process. The performance of this photoanode has been further enhanced by the surface charge control process and mild annealing treatment. TiO2 triple layer nanostructure based QDSSC showed a significantly higher energy conversion efficiency of 4.72% under the simulated light of 100 mW cm−2 with AM 1.5 filter. The efficiency of the best solar cell made with a single layer of TiO2 nanoparticles under the same conditions was 2.94%. The enhanced solar cell efficiency has been attributed to improved light harvesting by multiple light scattering in the tri-layer TiO2 photoanode structure combined with efficient electron transport with less recombination as evidenced from electrochemical impedance spectroscopic measurements.

Keywords

Quantum dot-sensitized solar cellsTiO2 tri-layer photonanodeElectrochemical impedance spectroscopyMultiple exciton generationQuantum confinement effect