Improved photovoltaic effects of photonic crystal based photoelectodes in dye-sensitized solar cell

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We synthesized TiO_2 nanoparticles and polystyrene(PS) particles via sol-gel process and emulsion polymerization, respectively. We fabricated a photonic crystal film by slide coating methodfor dye-sensitized solar cell(DSSCs). A slide coating is a relatively simple and fast method to fabricate a photonic crystal film and the position of photonic bandgap can be controlled by the size of PS particles. As a photonic crystal film prepared by slide coating has two layers of a scattering layer and a photonic crystal layer, the scattering effect and the photonic amplification are expected at the same time in DSSCs. A TiO_2 photonic crystal film was applied as a photoelectrode in DSSCs, and a single cell showed a relatively high photon-to-current conversion efficiency up to 5%. To know the photonic amplification, we matched the position of photonic bandgap of dyes with the maximum absorption wavelength of dye molecules. The amount of dye molecules adsorbed in a photoelectrode was about half of that in because a photonic crystal structure has a smaller surface area. We expect an improvement of phonon-to-current conversion efficiency when the surface area is increased in TiO_2 photonic crystal film. So, we carried out an infiltration of TiO_2 nanoparticles with electrophoretic deposition(EPD). The pores of scattering layer were filled with TiO_2 particles by EPD method and we investigated the effect of photonic crystal clearly. Then, the conversion efficiency of photonic crystal_based solar cell was improved up to 6.47%.