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Photoanode with hybrid TiO₂ nanoparticles/hierarchically structured TiO₂ microspheres for efficient dye-sensitized solar cells

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Among various components of a dye-sensitized solar cell (DSSC), the photoanode plays an important role in the overall power conversion efficiency as both dye adsorption and electron transport take place in the photoanode. A typical photoanode of DSSC is fabricated with nanoparticles of a semiconductor metal oxide such as TiO₂ having diameters in the range 10 - 20 nm. Therefore, overall light scattering in the device is poor due to inefficiency of scattering by these nanoparticles. In order to enhance the light absorption within the photoanode by scattering effect, we have successfully fabricated hybrid TiO₂ nanoparticles (NP) /hierarchically structured TiO₂ microspheres (MS) photoanode to achieve higher efficiency through improved light harvesting. This was achieved by incorporating hierarchically structured TiO₂ microspheres into the P25 TiO₂ nanoparticle layer. The highest power conversion efficiency of 7.17 % was achieved for the cell with 10 wt % MS incorporated photoanode which is superior to that of the pristine P25 NP-photoanode based cell with efficiency 6.34 %. The diffuse reflectance measurements and current density-voltage measurements revealed that the improved efficiency is mainly attributed to the increase in photocurrent generation due to the enhancement in light absorption by improved scattering effect.

Keywords: dye-sensitized solar cells, photoanode, hierarchical structure, TiO₂ microspheres and light scattering

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