Pore-size effect in optimizing the photovoltaic performance of dye-sensitized solar cells (DSSCs) composed of mesoporous TiO_2 photoelectrodes

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The mesoporous anatase TiO_2 particles are synthesized using a soft template (1) of tri-block copolymer and a hard template (2) of mesoporous ZnO/$Zn(OH)_2$-composite. Both materials produce a high BET surface area of more than 200 m^2/g, favorable to a high dye uptake. However, their different pore sizes of 6.8 nm (1) and 3.0 nm (2) lead to different photovoltaic performances of DSSCs. While the TiO_2 photoelectrode having larger pores gives a photo-conversion efficiency (η) of 6.71 %, the TiO_2 photoelectrode having small pores provides only half the performance (3.05%). For reference, the photo-conversion efficiency is 5.62 % when using P25 TiO_2 nanopowders. Mesoporous TiO_2 with proper pore size (e.g. 6.8 nm) seems to make the most of its high surface area, thereby allowing a high uptake of dye to enhance the current density. On the other hand, the low efficiency of mesoporous TiO_2 with too small pores (e.g. 3 nm) is probably attributed to the low uptake of dye due to the hindered diffusion and adsorption of dye molecule through the pore.