Well-Organized TiO_2 Films Controlled by Interactions for Dye-Sensitized Solar Cells

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Hierarchically-Ordered TiO2 (hier-TiO2) films were prepared with wall sizes that were controlled by altering the water ratio, which determined the interfacial energy the solvent and the PVC-g-POEM/preformed-TiO2 (pre-TiO2) hybrids. The wall size of the hier-TiO2 films increased with increasing amounts of water due to the volume expansion of the POEM/pre-TiO2 hybrids. Systematic control of wall and pore size is achieved and enables the bifunctionality of excellent light scattering properties and easy electron transport through the film. To analyze these properties, reflectance spectroscopy, incident photon-to-electron conversion efficiency and electrochemical impedance spectroscopy analyses were used. The efficiency of the hier4-TiO2 cell was the highest and reached 7.7% at the 100 mWcm-2, which is much higher than those of less-organized TiO2 cells (4.0%) prepared using the commercially available paste (Dyesol, 18NR-T). The higher efficiency is due to the enhancement of all photovoltaic properties, such as Jsc, Voc, and FF, which is resulted from the well-organized structure with hierarchical pores, high porosity, and excellent light scattering ability.