SUPPORTING INFORMATION

Broadband light confinement using hierarchically-structured TiO_2 multi-layer for dye-sensitized solar cells

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Light confinement effect and dye-loading capacity of type I, II, and III films

Absorbance spectra were measured to investigate the light confinement of each layer comprising the hierarchically-structured multi-layer (HSM). For this, we prepared 7-μm-thick sensitized films made of type I, II, and III particles by using screen-printing method and subsequent sintering at 500 °C for 30 min. Then, they were immersed into 0.3mM N719 dye solution for 12hrs at room temperature. For the evaluation of dye-loading capacity, dye molecules were detached from the sensitized films by using 0.1M NaOH solution (water/ethanol, 50/50, v/v). The calculated amount of dye molecules were in good agreement with the corresponding BET surface area of each sample (Table 1).

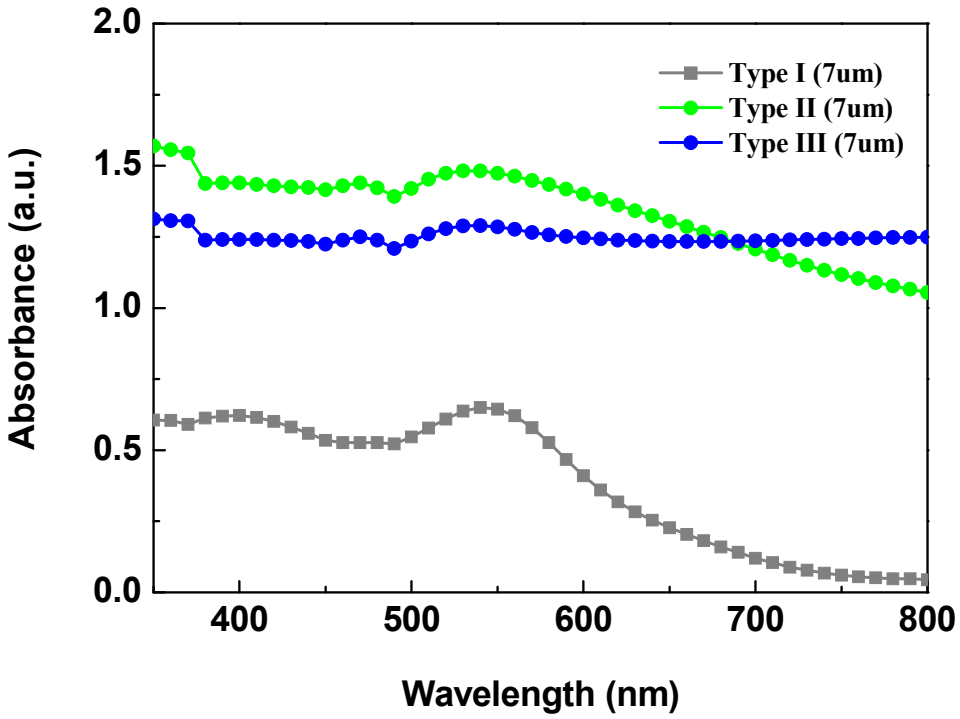

Figure S1. Absorbance spectra of the 7-μm-thick photoelctrodes made of type I, II, and III particles after sensitization with N719.

Table S1. Dye-loading capacity of the 7-μm-thick photoelctrodes made of type I, II, and III particles.

Sample	Type I	Type II	Type III
Adsorbed dye (10^{-7} mol·cm^{-2})	0.820	0.872	0.913

It was observed that type I showed the lowest absorbance values in a given spectral range, which is mainly due to the weak light scattering efficiency of the nanocrystalline TiO_2. On the other hand, type II and III films performed much higher absorbance values over a wide range of wavelength. This result stems from two factors: enhanced light confinement and dye-uptake. Since type II and III have a higher degree of hierarchical order, their secondary nanostructures function as light scatterers in the visible range. Moreover, these two films are

able to adsorb more dye molecules than type I. However, slightly different trends can be seen between type II and III films. As shown in Fig. 5, type III performed the highest reflectance among the three types of films, which may cause a certain amount of optical loss owing to the reflected photons from the film surface. In type II, number of uncaptured photons can be minimized by virtue of reduced reflectance and transmittance. As a result, type II exhibited slightly higher optical absorption over type III over a broad spectral range.