Electronic Supplementary Information (ESI)

Synthesis and photovoltaic property of fine and uniform Zn$_2$SnO$_4$ nanoparticles

Dong Wook Kim,$^{ab}$ Seong Sik Shin,$^b$ In Sun Cho,$^c$* Sangwook Lee,$^{ab}$ Dong Hoe Kim,$^b$ Chan Woo Lee,$^b$ Hyun Suk Jung$^d$ and Kug Sun Hong$^{*ab}$

$^a$Research Institute of Advanced Materials (RIAM), Seoul National University, Seoul 151-744, Korea, $^b$Department of Materials Science and Engineering, Seoul National University, Seoul 151-744, Korea, $^c$Department of Mechanical Engineering, Stanford University, Stanford, California 94305, USA, $^d$School of Advanced Materials Science and Engineering, Sung Kyun Kwan University, Suwon 440-746, Korea

Fig. S1 Low magnified TEM image of Zn$_2$SnO$_4$ nanoparticles (NPs) that was synthesized by a hydrothermal reaction with ammonium carbonate (AC) addition as much as the AC/Zn mole ratio of 0.5 at 180 °C for 12 h.
**Fig. S2** Optical absorption spectrum of Zn$_2$SnO$_4$ NPs; inset, corresponding band gap determination.
Fig. S3 XRD pattern and SEM image Zn$_2$SnO$_4$ powder synthesized by a hydrothermal reaction without AC addition at 200 °C for 12 h.
Fig. S4 XRD patterns of the powders prepared by reaction time-controlled experiments. All the diffraction peaks of powder obtained at a reaction time of 12 h are indexed to a cubic Zn$_2$SnO$_4$ (JCPDS No. 24-1470).
**Fig. S5** J-V characteristics of the DSSCs employing Zn$_2$SnO$_4$ NP films as a function of film thickness.
Fig. S6 Comparative studies of photovoltaic properties with DSSCs employing the ultra-fine Zn$_2$SnO$_4$ NPs and the commercial TiO$_2$ NPs (P25). (a) Photocurrent density-voltage ($J-V$) characteristics of DSSCs, (b) optical absorption spectra of the desorbed dye molecules from the Zn$_2$SnO$_4$ and TiO$_2$ photoelectrodes, and (c) Electron diffusion coefficients ($D_n$) and (d) lifetimes ($\tau_n$) as a function of short circuit current ($J_{SC}$) that is obtained by the stepped light-induced transient measurements of photocurrent and photovoltage (SLIM-PCV)$^1$. 

56