materials

MDPI

Supplementary Materials

Intense Near-Infrared Light-Emitting $NaYF_4$:Nd,Yb-Based Nanophosphors for Luminescent Solar Concentrators

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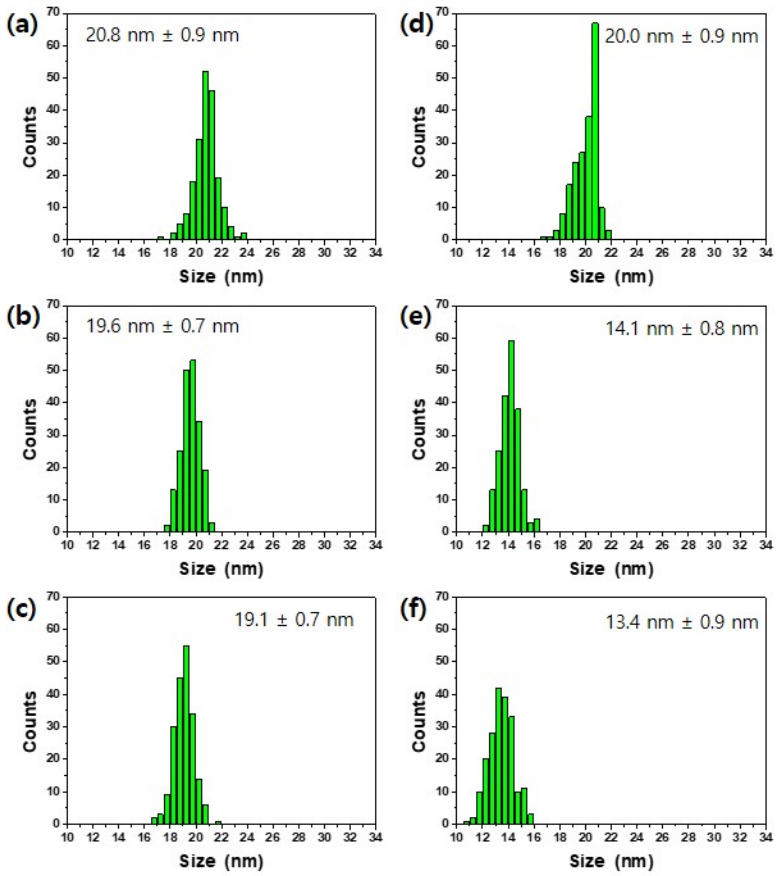

Figure S1. Size distributions of $NaYF_4$:Nd(x%),Yb(10%) core DSNPs with various Nd^{3+} concentrations [x = (a) 10%, (b) 20%, (c) 25%, (d) 30%, (e) 40%, and (f) 50%].

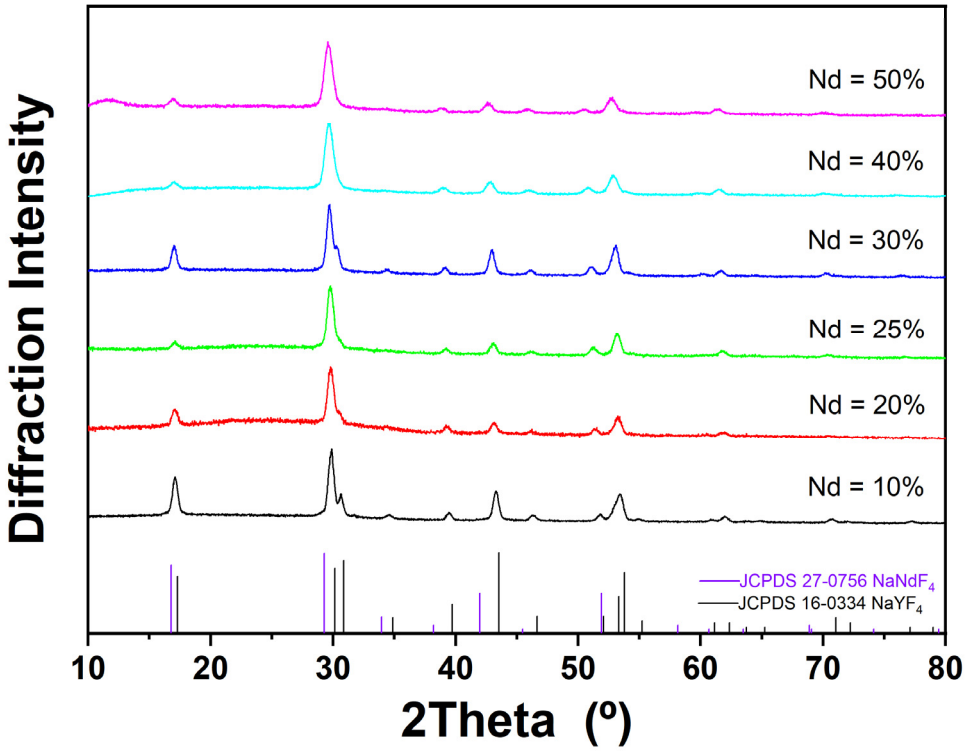

Figure S2. XRD patterns of $NaYF_4$:Nd(x%),Yb(10%) core DSNPs with various Nd^{3+} concentrations [x = 10, 20, 25, 30, 40, and 50%].

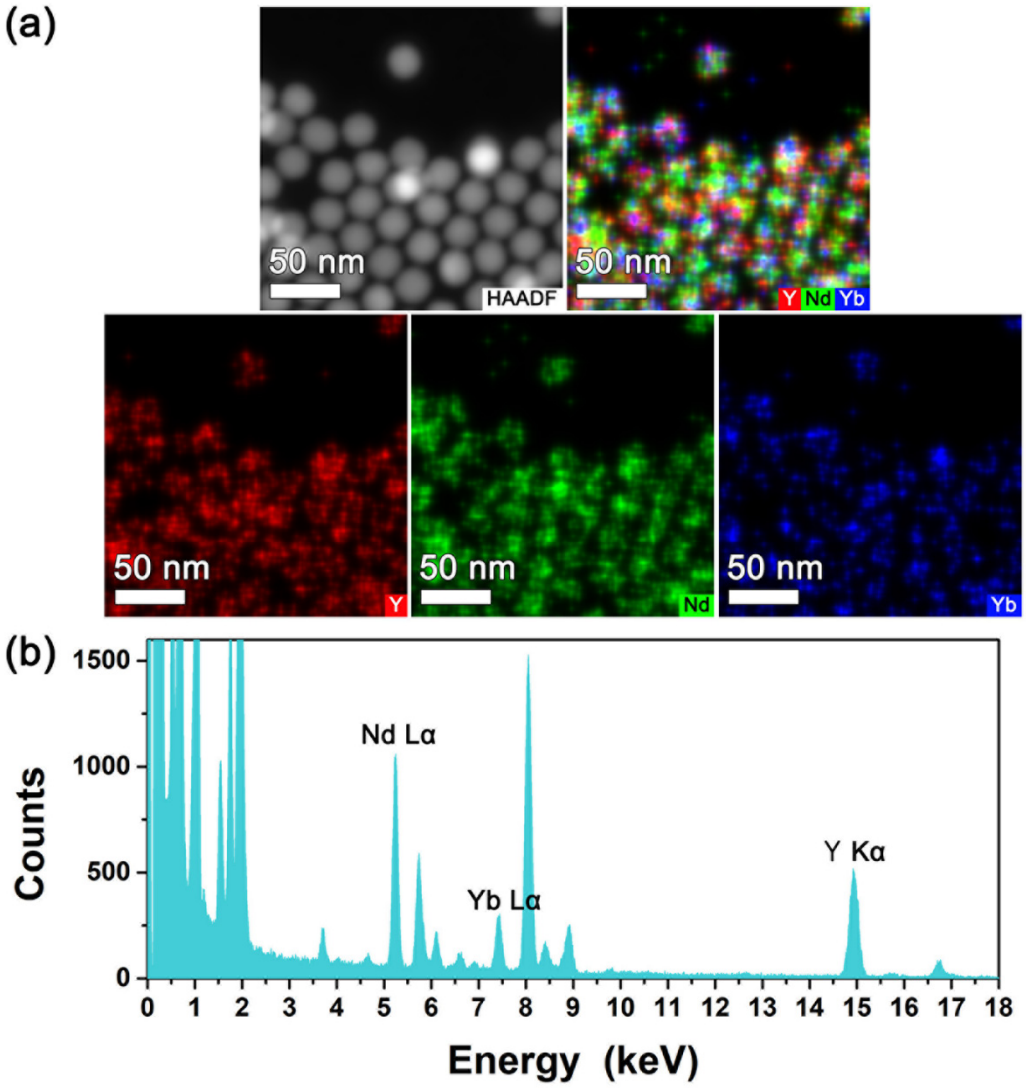

Figure S3. (a) HAADF-STEM image and EDS map images (merged image, Y Kα, Nd Lα, and Yb Lα map images) of $NaYF_4$:Nd(30%),Yb(10%) core DSNPs. (b) EDS spectrum of $NaYF_4$:Nd(30%),Yb(10%) core DSNPs.

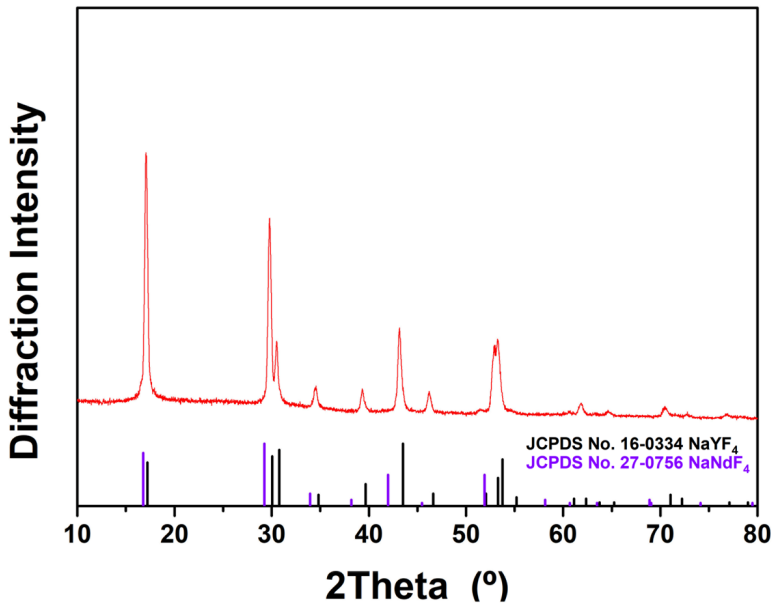

Figure S4. XRD pattern of $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%)/$NaYF_4$ C/S/S DSNPs.

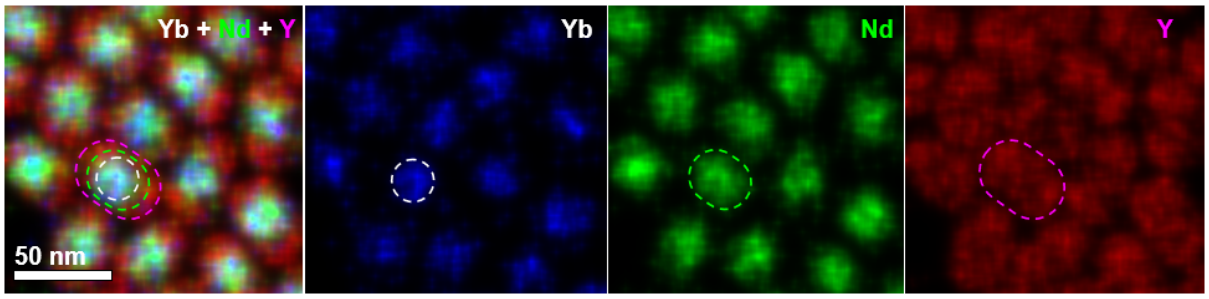

Figure S5. EDS map images showing the distribution of Yb (blue color), Nd (green color), and Y (red color) of the $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%)/$NaYF_4$ C/S/S DSNPs. The composite EDS map image clearly demonstrates that the synthesized DSNPs have core/shell/shell structure.

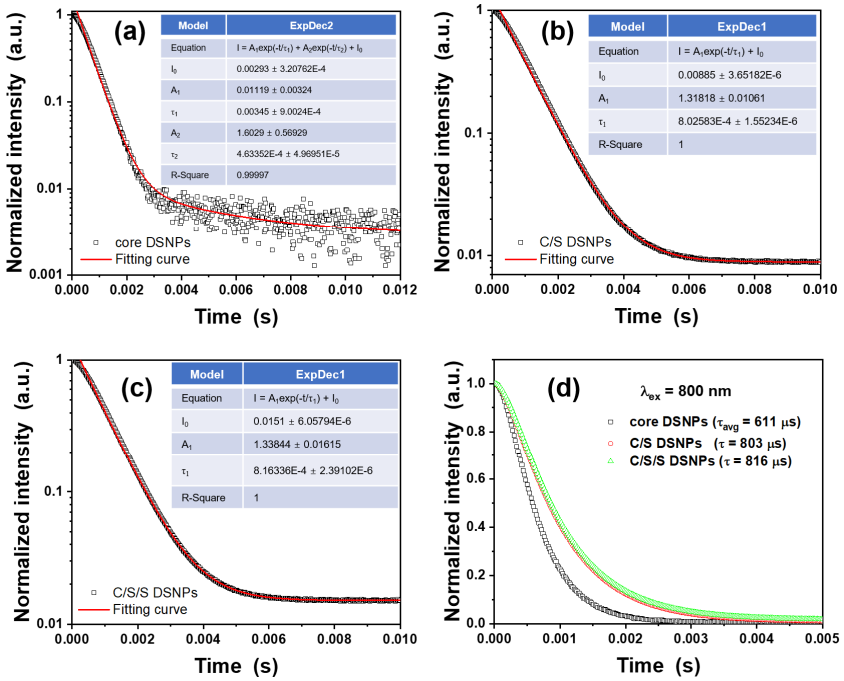

Figure S6. Time-resolved PL profiles with fitted curves of (a) $NaYF_4$:Nd(30%),Yb(10%) core DSNPs, (b) $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%) C/S DSNPs, and (c) $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%)/$NaYF_4$ C/S/S DSNPs under 800 nm excitation. (d) Time-resolved PL profiles of $NaYF_4$:Nd(30%),Yb(10%) core DSNPs (black square), $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%) C/S DSNPs, (red circle), and $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%)/$NaYF_4$ C/S/S DSNPs (green triangle). In the case of the core DSNPs, the average PL lifetime can be obtained by using a following Equation (S1) [S1],

$$\tau_{avg} = \frac{A_1\tau_1^2+A_2\tau_2^2}{A_1\tau_1+A_2\tau_2} \text{ ---------- (S1)}$$

For the core DSNPs, the average PL lifetime (τ_{avg}) was calculated to be 611 μs.

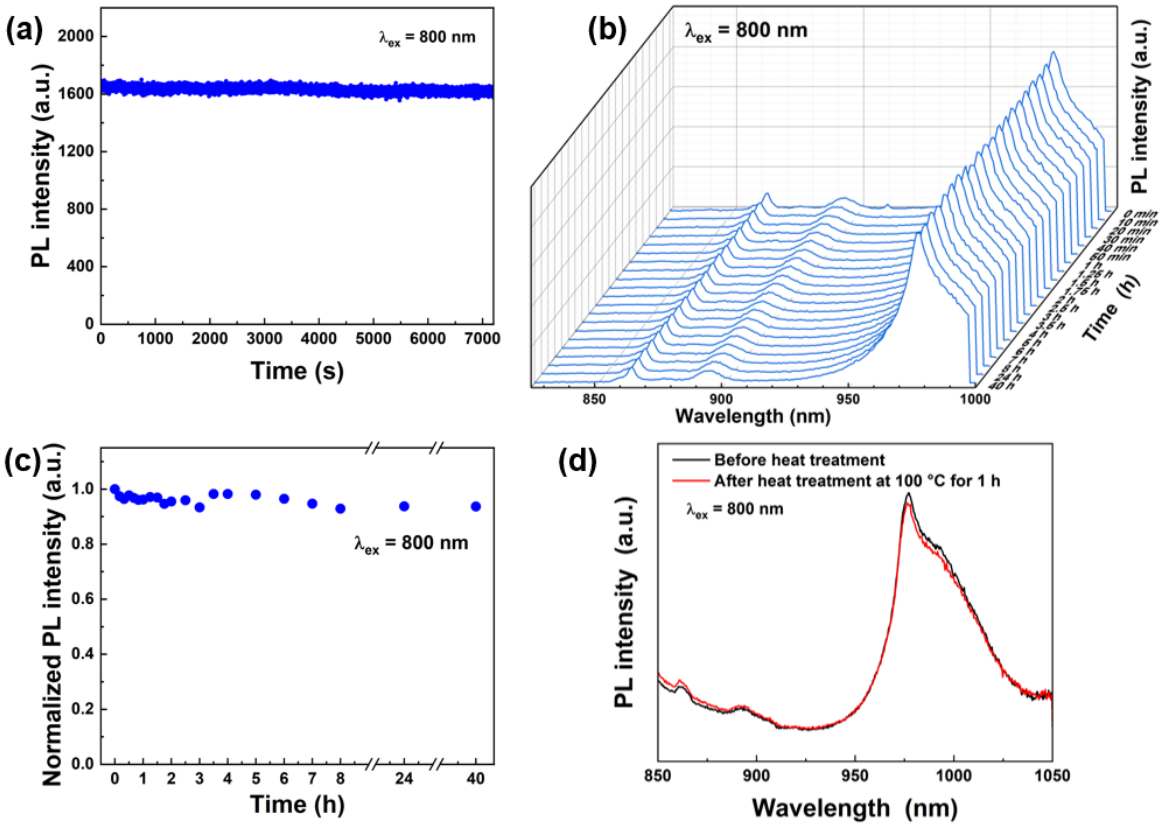

Figure S7. (a) PL intensities of the $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%)/$NaYF_4$ C/S/S DSNPs monitored at 978 nm under continuous irradiation with an 800 nm NIR laser (27.2 $W \cdot cm^{-2}$). (b) PL spectra and (c) normalized PL intensities of the $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%)/$NaYF_4$ C/S/S DSNPs under irradiation with a 365 nm UV lamp (6 W). (d) PL spectra of the $NaYF_4$:Nd(30%),Yb(10%)/$NaYF_4$:Nd(10%)/$NaYF_4$ C/S/S DSNPs before and after heat treatment at 100 °C for 1 h.

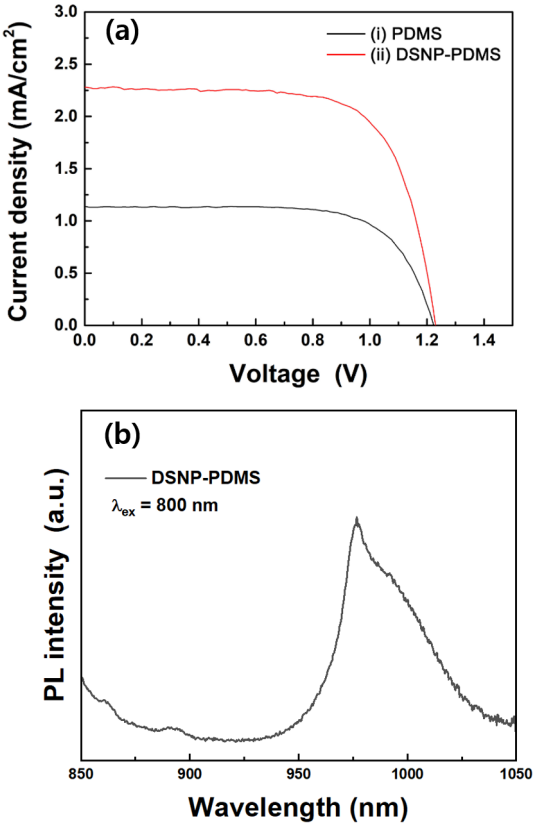

Figure S8. (a) Current density versus voltage curves of (i) bare PDMS- and (ii) C/S/S DSNP-PDMS composite-coupled silicon solar cells. (b) PL spectrum of the C/S/S DSNP-PDMS composite under excitation with 800 nm NIR light (1 mW).

Reference

[S1] Kıbrıslı, O.; Vahedigharehchopogh, N.; Ersundu, A. E.; Çelikbilek Ersundu, M. Instantaneous Color Tuning of Upconversion Emission in a Novel Lanthanide-Doped Monolithic Glass via Excitation Modulation. *J. Phys. Chem. C* **2020,** *124*, 10687-10695.