

Electronic Supplementary information

Investigation on Photo-Induced Charge Separation on CdS/CdTe Nanopencils

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Measurement

Characterization: TEM observations were recorded using a JEM1011 (JEOL) instrument, operated at 100 kV. STEM observations were recorded using a HD-2300C (Hitachi High-Technologies) instrument, equipped with a cold field emission gun and spherical aberration corrector (CEOS), and operated at 200 kV. HAADF images were simultaneously acquired by DigiScan (Gatan). XRD patterns were recorded on a PANalytical X'Pert Pro MPD diffractometer, with CuK α radiation ($\lambda = 1.542 \text{ \AA}$) at 45 kV and 40 mA. Ultraviolet-visible-near infrared (UV-vis-NIR) absorption spectra were recorded using a U-4100 spectrophotometer (Hitachi). XRF elemental analyses were recorded using an Element Analyzer JSX-3202C (JEOL).

TA Measurements: The femtosecond TA spectroscopy setup was based on a regenerative amplifier Yb:KGW laser system (pulse width: 200 fs, repetition rate: 50 kHz). TA spectra were recorded using white-light probe pulses (470–1000 nm) generated by the illumination of a sapphire crystal, with 1030-nm femtosecond pulses from the regenerative amplifier. The remaining power of the regenerative amplifier was used for the excitation of an optical parametric amplifier, to generate the 651-nm pump

pulse. To suppress many body effects such as Auger recombination, the pump pulse intensity was adjusted, so that signal intensities were proportional to pump intensities. HNPs dispersed in CHCl₃ in a 1-mm path length quartz cell were used in all experiments. Measurements were performed at RT.

The rise time of CdS bleaching signals in the HNPs was evaluated by fitting the time evolution absorbance at 510 nm to:

$$\Delta\alpha(t) = A \left[\exp\left(-\frac{t}{\tau_d}\right) - \exp\left(-\frac{t}{\tau_r}\right) \right]$$

where τ_d and τ_r are the decay and rise times of the CdS bleaching signal, respectively, and A is the amplitude. Considering the instrument response function, TA decay curves were fitted to the function convoluted with a Gaussian function. Fitting results are shown in Table S1.

Table S1. Parameters obtained by fitting the time-evolution changes in absorbance at 720 and 510 nm, after excitation of CdTe.

CdS (510 nm)	τ_r
Heterodimer	0.44 ps (Ref. 1)
#1	0.492 ± 0.039 ps
#2	0.466 ± 0.012 ps
#3	0.433 ± 0.011 ps

Synthesis of CdS nanopencils and CdS/CdTe HNPs

Synthesis of CdS nanopencils : CdCl₂ (0.25 mmol), S (0.25 mmol), oleylamine (2.5 mmol), and oleic acid (2.5 mmol) were added to di-*n*-octylether (10 mL) in a 50-mL three-neck flask. The solution was stirred at 260 °C under a N₂ atmosphere. The spherical CdS NCs formed in situ were transformed into CdS nanopencils, through Ostwald ripening at 260 °C. Only CdS NCs were formed when this solution was heated at 220 °C. This indicates that a stepwise transformation from spherical NCs to nanopencils proceeds with increasing temperature. The solution was cooled to RT, and the products were

precipitated with ethanol and then centrifuged. The supernatant was discarded and the precipitate was dispersed in hexane. A TEM image of the CdS nanopencils is shown in Figure S1.

Synthesis of CdS/CdTe HNPs : CdS nanopencils (0.02 mmol) in oleylamine (4 mL) in a 50-mL three-neck flask were heated at 260 °C under a N₂ atmosphere. Te powder (0.1 mmol) in tri-*n*-octylphosphine (0.4 mL) was heated at 250 °C for ~3 h, and then injected into the hot CdS nanopencil solution. The solution was cooled to RT, precipitated with ethanol and then centrifuged. The supernatant was discarded and the precipitate was dispersed in chloroform.

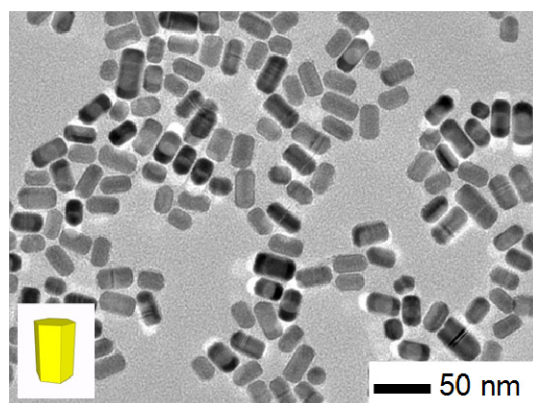


Figure S1. TEM image of CdS nanopencils formed in the one-step synthesis.

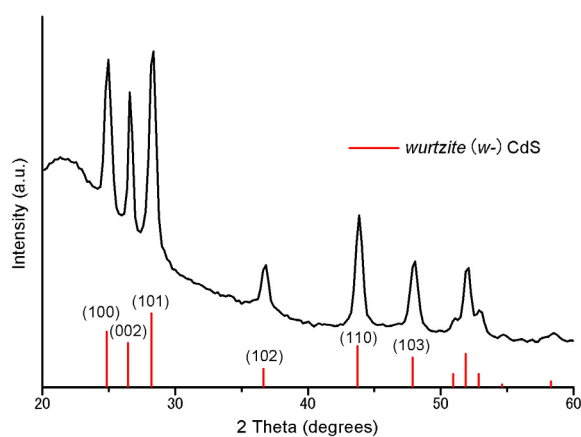


Figure S2. XRD pattern of CdS nanopencils.