Direct encoding of silica submicrospheres with cadmium telluride nanocrystals

Zhi Yang, Li Li, Zhenhua Sun, Tian Ming, Guisheng Li, Jianfang Wang* and Jimmy C. Yu

Supplementary Information

1. Estimation of the number of CdTe nanocrystals incorporated in each silica sphere

We use the preparation with 0.25 mL TEOS + 0.2 mL NH_4OH + 9 mL H_2O + 20.55 mL ethanol as an example. This preparation gives silica spheres with an average diameter of 184 nm.

The concentration of the CdTe nanocrystal solutions is $\sim 10^{-5}$ M. The volume of the nanocrystal solutions used in our experiments is in the range of 5–20 mL. We assume a value of 10 mL for estimation. The number of CdTe nanocrystals is thus $10 \times 10^{-3} \times 10^{-5} \times 6.02 \times 10^{23} = 6.02 \times 10^{16}$.

The molecular weights of TEOS and SiO_2 are 208.33 and 60.08 g/mol, respectively. TEOS has a density of 0.934 g/mL. The mass of SiO_2 obtained from 0.25 mL TEOS is therefore $0.25 \times 0.934 / 208.33 \times 60.08 = 0.0673$ g. The density of SiO_2 obtained from TEOS without thermal treatment is assumed to be 2.5 g/mL. The mass of each SiO_2 sphere of 184-nm diameter is thus $(4/3) \times \pi \times (184/2 \times 10^{-7})^3 \times 2.5 = 8.15 \times 10^{-15}$ g. Therefore the number of SiO_2 spheres is $0.0673 / (8.15 \times 10^{-15}) = 8.26 \times 10^{12}$.

If we assume that CdTe nanocrystals are uniformly distributed among SiO_2 spheres, then the number of CdTe nanocrystals each silica sphere contains will be $(6.02 \times 10^{16}) / (8.26 \times 10^{12}) = 7.29 \times 10^3 \approx 10^4$.

By taking into account the different volumes of TEOS and different volumes of CdTe nanocrystal solutions used in our experiments, we estimate that the number of CdTe nanocrystals incorporated in each silica sphere is on the order of 10^3–10^5.
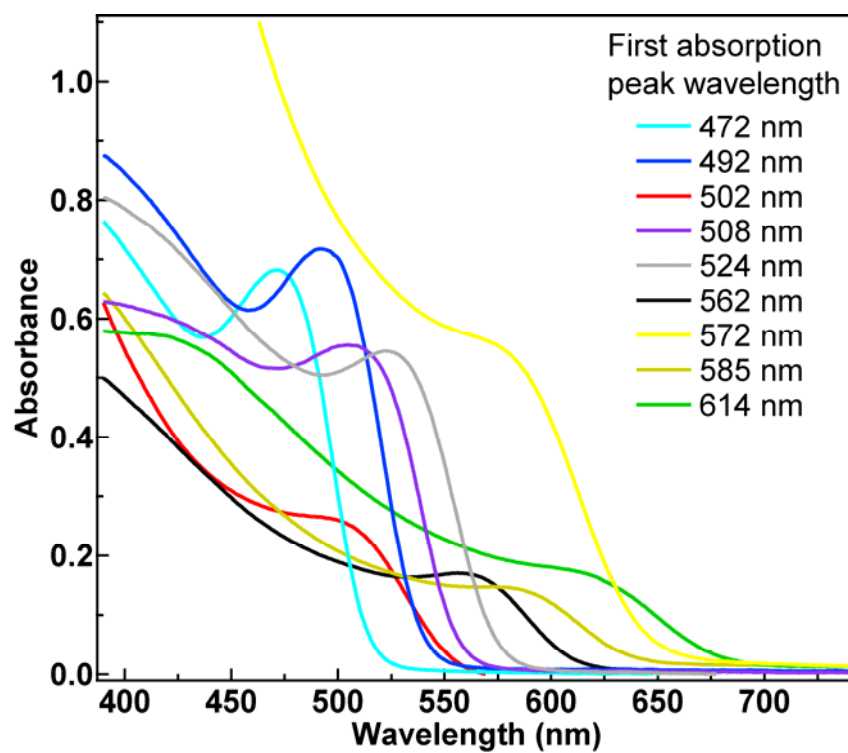
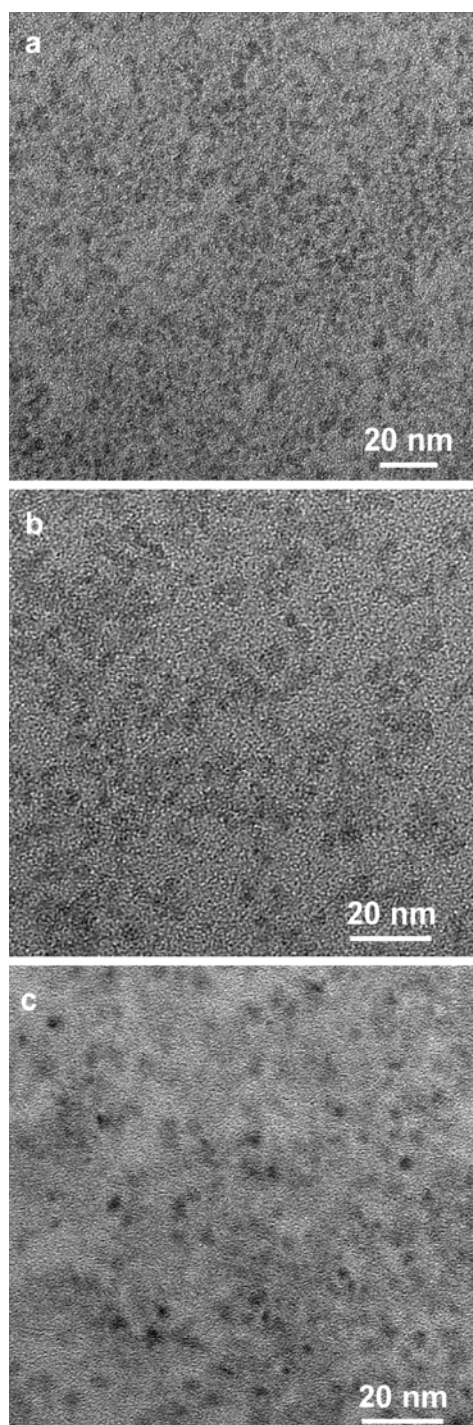**Fig. S1** Absorption spectra of DMF solutions of CdTe nanocrystals.

Fig. S2 TEM images of CdTe nanocrystals. (a) CdTe nanocrystals with an emission peak wavelength of 527 nm. (b) CdTe nanocrystals with an emission peak wavelength of 565 nm. (c) CdTe nanocrystals with an emission peak wavelength of 622 nm.
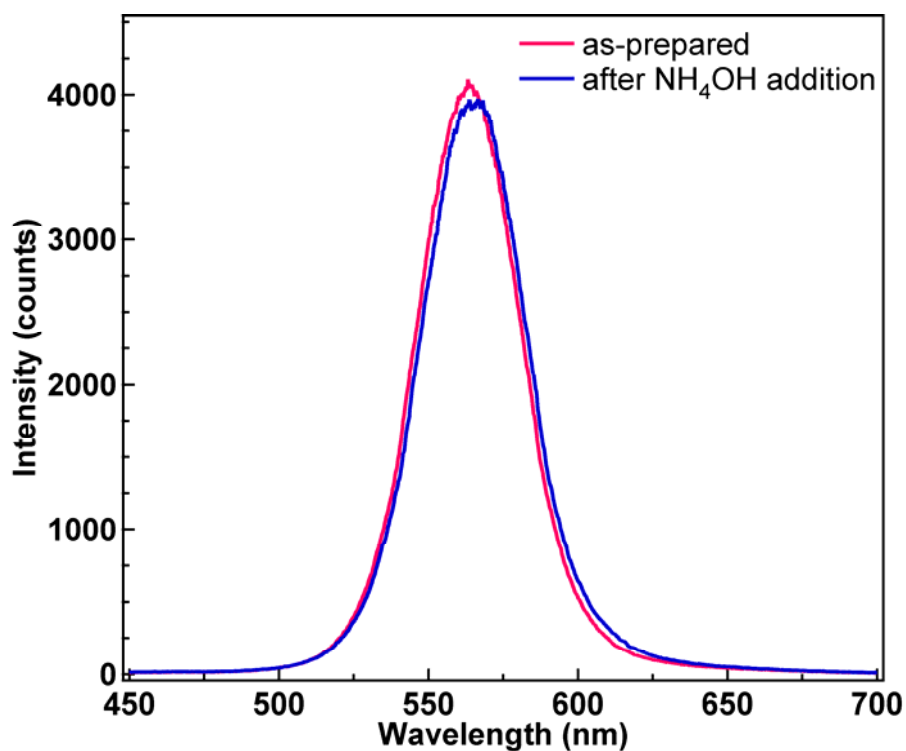
Fig. S3 Emission spectra of as-prepared CdTe nanocrystals in DMF and after being dispersed in a mixture of NH_4OH, water, and ethanol. The dispersion of CdTe nanocrystals in the mixture followed the procedure for the encapsulation of CdTe nanocrystals in SiO_2 spheres, except that TEOS was not added.
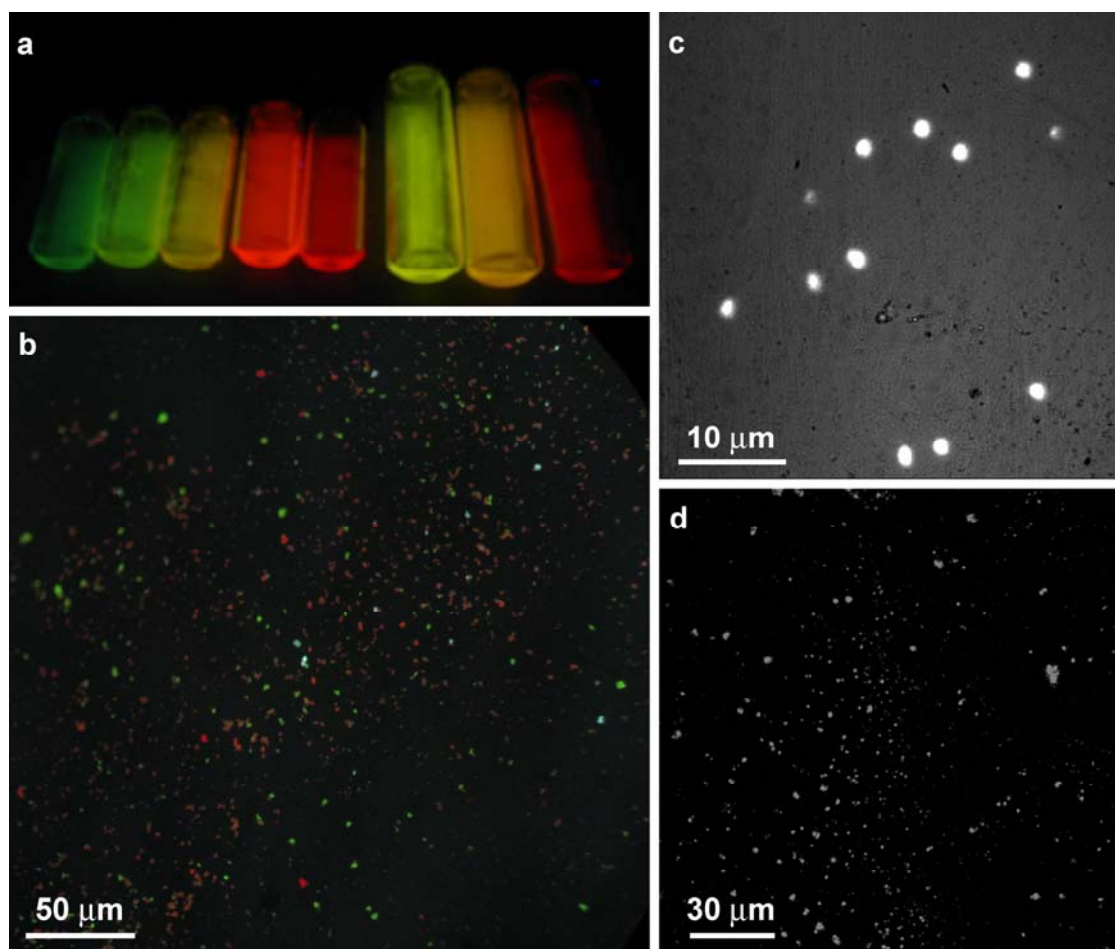
Fig. S4 (a) Digital photo of ethanol dispersions of SiO_2 spheres containing differently colored CdTe nanocrystals under UV light illumination at 365 nm. (b) Digital photo of a mixture of three SiO_2 sphere samples deposited on a glass slide. The three SiO_2 sphere samples contain green, orange, and red CdTe nanocrystals, respectively. A digital camera was attached to the eyepiece of an upright Olympus BX60 optical microscope for recording digital photos. A HeCd laser at 325 nm was used for photoluminescence excitation. The laser light was introduced sideways to the bottom side of the glass slide. A long-pass filter with a cut-on wavelength of 400 nm was employed to block the excitation laser light. (c) Photoluminescence image of SiO_2 spheres containing green CdTe nanocrystals. The image was taken with a charge-coupled device camera that was attached to the optical microscope. (d) CLSM image of SiO_2 spheres containing red CdTe nanocrystals.
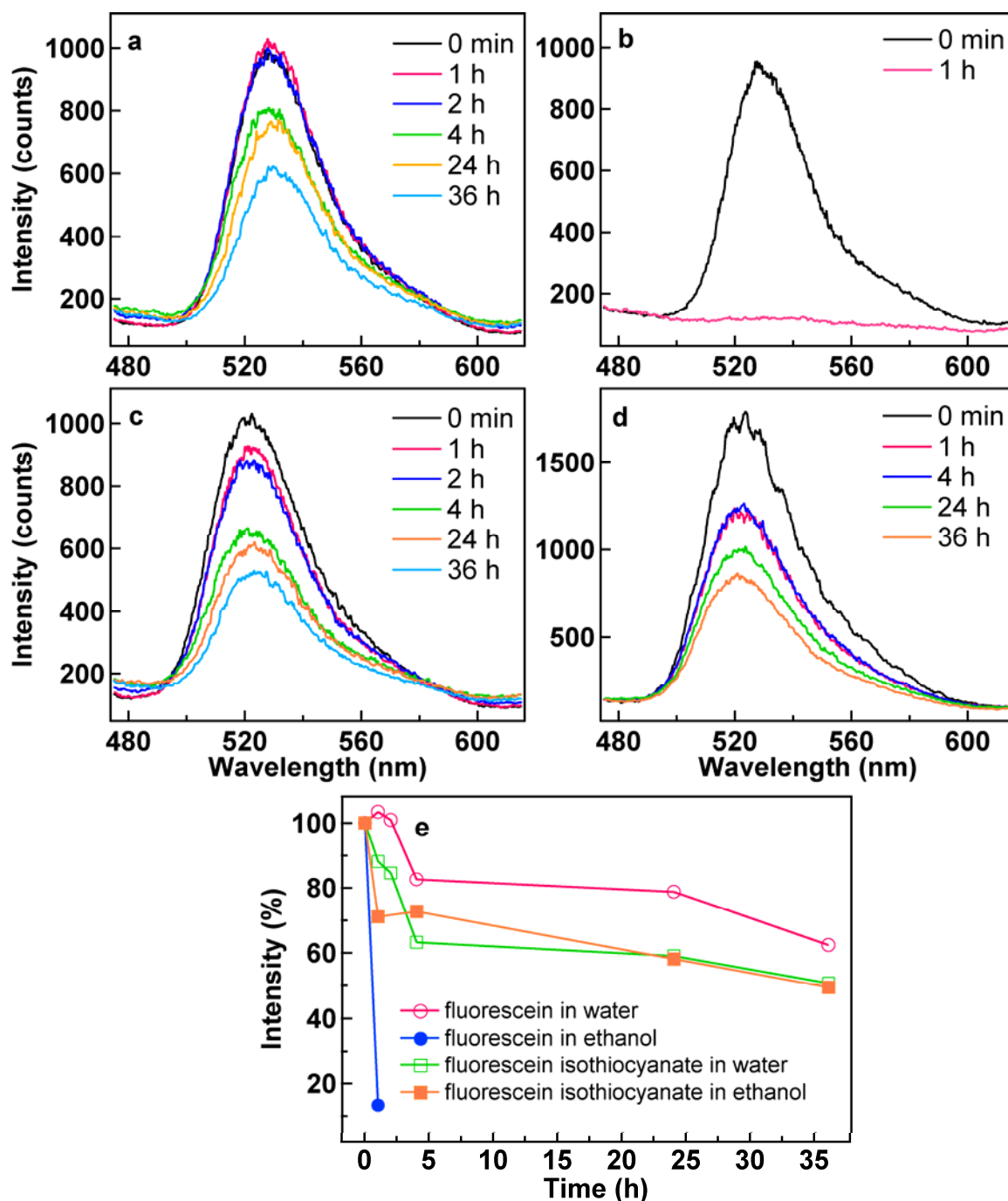
Fig. S5 Leaching of fluorescein molecules that are incorporated in the mesostructured silica shell. No CdTe nanocrystals were embedded in the solid core. The samples were dispersed in water or ethanol. Right before each fluorescence spectral measurement, the samples were precipitated by centrifugation. The supernatant was discarded, and the solvent at the same volume was added. (a) Core−shell spheres dispersed in water and containing fluorescein in the shell. (b) Core−shell spheres dispersed in ethanol and containing fluorescein in the shell. (c) Core−shell spheres dispersed in water and containing fluorescein isothiocyanate that was derivatized with 3-aminopropyltriethoxysilane. (d) Core−shell spheres dispersed in ethanol and containing fluorescein isothiocyanate that was derivatized with 3-aminopropyltriethoxysilane. (e) Fluorescence intensity changes as a function of time. The derivation of fluorescein isothiocyanate with 3-aminopropyltriethoxysilane was carried out by dissolving 7 mg of

fluorescein isothiocyanate and 10 mg of 3-aminopropyltriethoxysilane in 20.4 g of ethanol and then stirring for 3 h.