

Making Fluorescent Magnetic Nanocrystals by Sequential Additions of Reagents in One-Pot Reactions: A Facile Route to Prepare Multifunctional Nanostructures

*Jinhao Gao, Bei Zhang, Yuan Gao, Yue Pan, Xixiang Zhang, and Bing Xu**

Supporting Information

Synthesis of FePt@CdS core-shell nanocrystals. After using the method reported by Sun et al. to form FePt nanoparticles via the thermolysis of $\text{Fe}(\text{CO})_5$ (0.07 mL) and $\text{Pt}(\text{acac})_2$ (50 mg) in phenyl ether under inert atmosphere, the solution (about 15 mL) was cooled to 200 °C. Without further separation or purification, $\text{Cd}(\text{acac})_2$ (312 mg) and hexadecane-1, 2-diol (500 mg) were added and the mixture was held at 200 °C for 30 min to decompose the $\text{Cd}(\text{acac})_2$ precursor to form FePt@CdO core-shell intermediate nanostructures. The solution was changed from black to dark brown. Sulfur powder (35 mg) was then added, and the reaction mixture was heated up to refluxing (258 °C) for 60 min, which resulted in a black dispersion of FePt@CdS core-shell nanocrystals.

Synthesis of FePt-CdSe nanosponges. After forming FePt nanoparticles by thermal decomposition of $\text{Fe}(\text{CO})_5$ (0.07 mL) and $\text{Pt}(\text{acac})_2$ (50 mg) under inert atmosphere, the solution was cooled to 120 °C. Without any separation or purification, selenium precipitate (85 mg) was added and the temperature was held at 120 °C for 10 min, $\text{Cd}(\text{acac})_2$ (312 mg) was then added, and the temperature was raised to 200 °C at the rate of 10 °C/min and then maintained for 10 min. In the final step, the hot solution (15 mL) was heated quickly to refluxing and left to reflux for 45 min to give a black dispersion of FePt-CdSe nanosponges.

Synthesis of t-Se nanowires using organic solvent. 15 mL of 1, 2-dichlorobenzene solution containing 0.2 g of TOPO was heated up to refluxing. Then selenium powder (80 mg) was added into the hot solution directly. The reaction mixture was cooled down to room temperature rapidly by injecting the hot solution into 40 mL of ethanol after kept refluxing for about 20 min. The yellow flocculent precipitates were formed immediately in ethanol solution. The product was separated by centrifugation and can be re-dispersed in hexane. For the characterization of the intermediate products in route 2 (Scheme 1), the chemical experiment was performed as similar as the synthesis of t-Se nanowires but containing FePt nanoparticles in phenyl ether solution in the first step.

Quantum yield. The quantum yields of the as-prepared FePt@CdX (X = S or Se) core-shell nanocrystals were measured in hexane using 9, 10-dibromoanthracene as the standard (quantum yield = 10%).¹ In detail, 9, 10-dibromoanthracene was dissolved in hexane with its absorbance around 0.12 at the excitation wavelength (normally 365 nm), where the diluted nanocrystals solutions showed the same absorbance. By comparing the integrated areas of emissions from 9, 10-dibromoanthracene and the nanocrystals, the fluorescence quantum yields of the nanocrystals were calculated.²

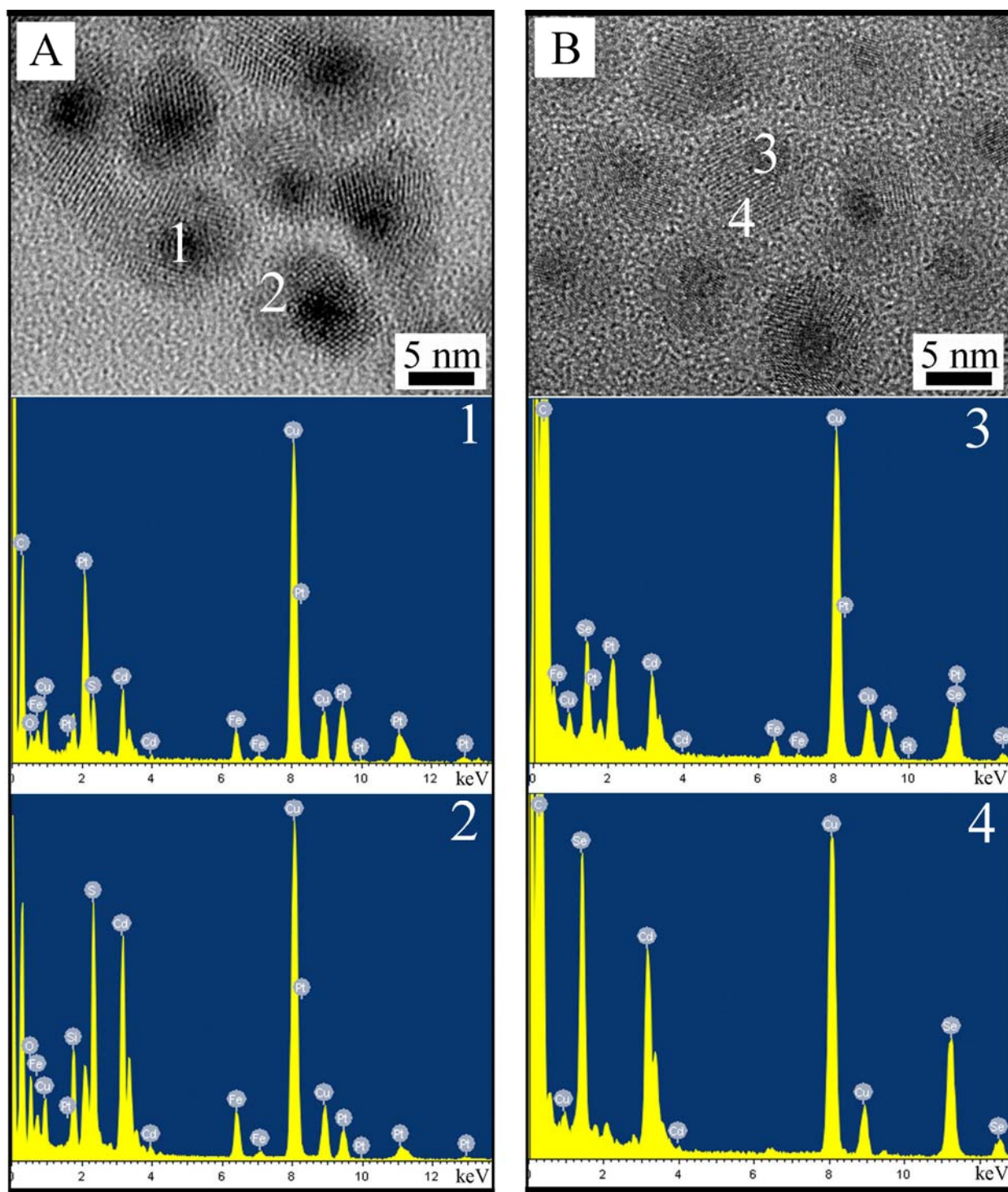


Figure S1. (A) EDX spectra of FePt@CdS core-shell nanocrystals, showing that the core consisted primarily of Fe and Pt and the shell of Cd and S, corresponding to regions 1 and 2, respectively. (B) EDX spectra of FePt@CdSe core-shell nanocrystals, showing that the cores consisted primarily of Fe and Pt and the shells of Cd and Se, corresponding to regions 3 and 4, respectively.

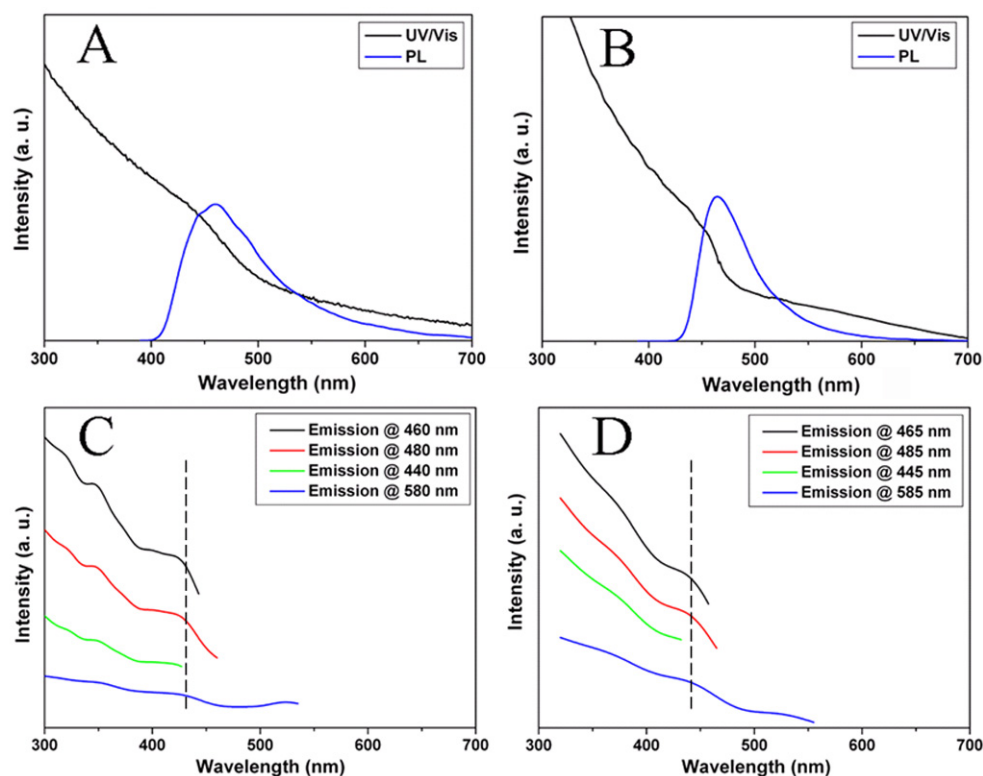


Figure S2. UV/Vis and fluorescence spectra of (A) FePt@CdS core-shell nanocrystals and (B) FePt@CdSe core-shell nanocrystals. Photoluminescence excitation (PLE) spectra of (C) FePt@CdS core-shell nanocrystals and (D) FePt@CdSe core-shell nanocrystals under the different emission wavelengths.

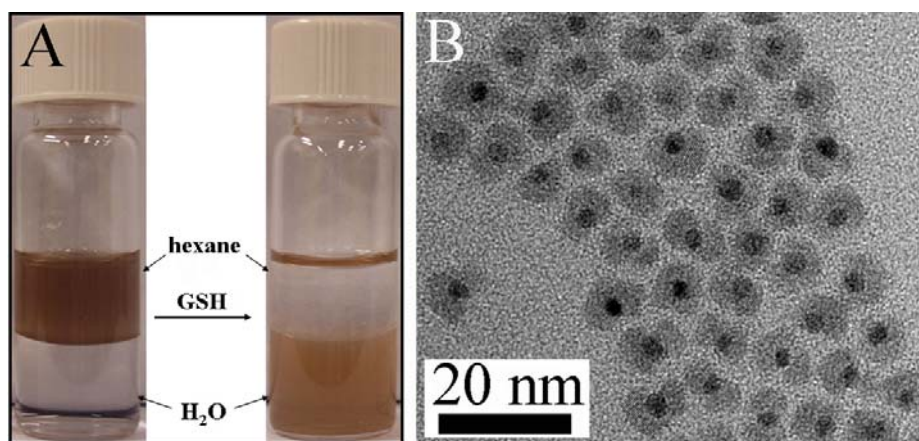


Figure S3. (A) Optical images of FePt@CdSe core-shell nanoparticles transferred from hexane layer to water layer after surface modification by glutathione (GSH) molecules. (B) A TEM image of FePt@CdSe core-shell nanoparticles after surface modification.

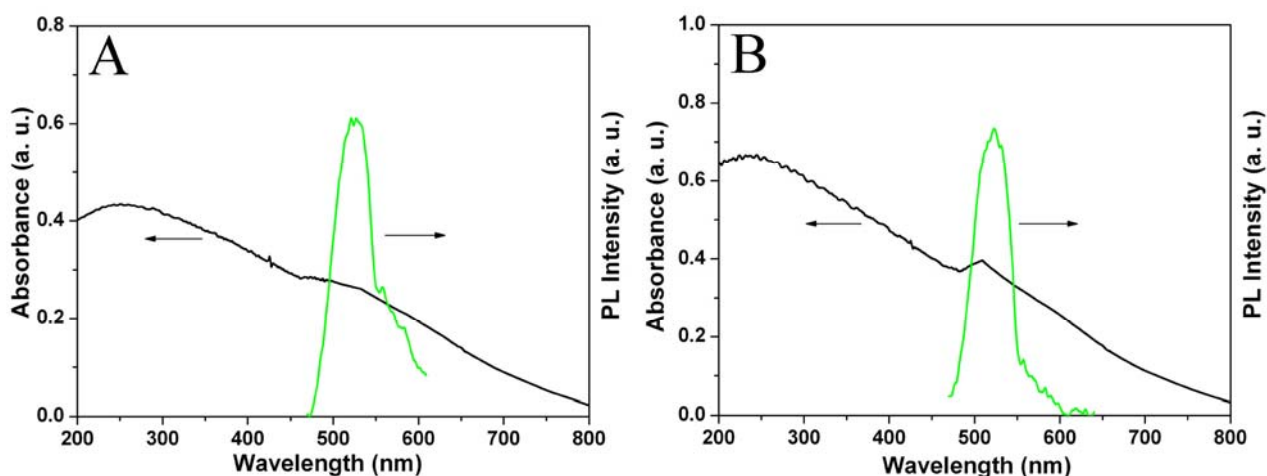


Figure S4. UV/Vis and fluorescence spectra ($\lambda_{\text{ex}} = 450 \text{ nm}$) of (A) FePt-CdS nanosponges and (B) FePt-CdSe nanosponges in solid state samples. UV/Vis absorption peaks of these two nanosponges are $\sim 510 \text{ nm}$. The fluorescence emission peaks of these two nanosponge samples are $\sim 530 \text{ nm}$.

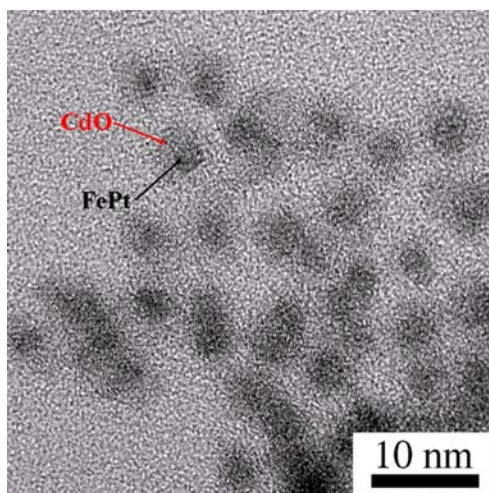


Figure S5. A TEM image of FePt@CdO core-shell intermediate nanostructures.

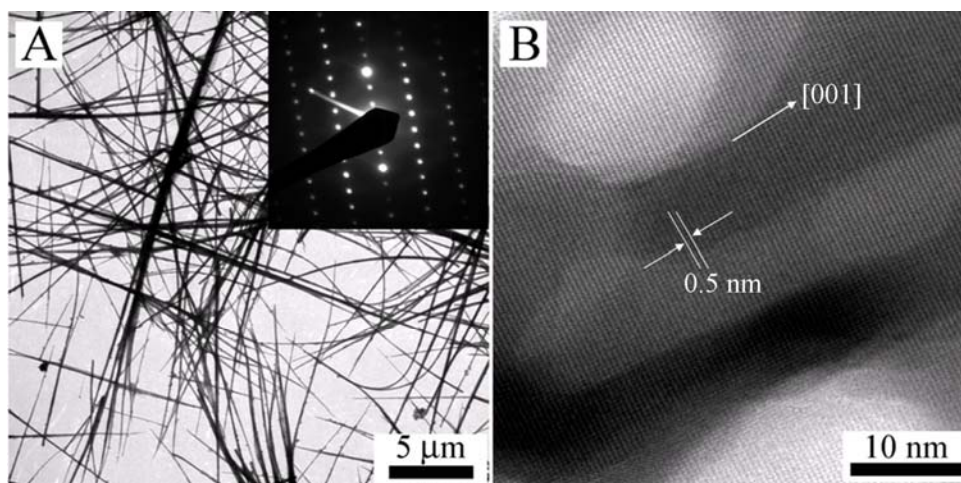


Figure S6. (A) A TEM image of trigonal Se nanowires obtained from hot 1, 2- dichlorobenzene solution containing TOPO (Inset: The electron diffraction pattern obtained from the middle portion

of an individual nanowire); (B) A HRTEM image of t-Se nanowires with the fringe spacing of ~ 0.5 nm in the (001) lattice planes.

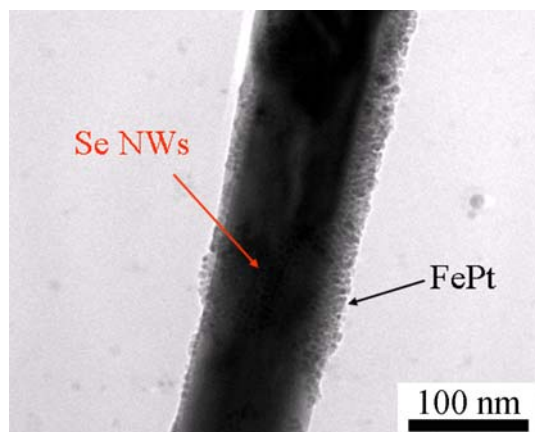


Figure S7. A TEM image of the intermediate product in route 2 (Scheme 1): Se nanowires connecting FePt nanoparticles. The diameter size of Se nanowires is very big likely due to the quench process when the formation of intermediate product.

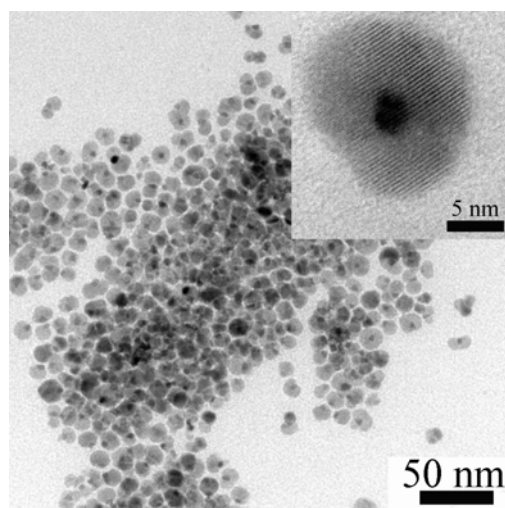


Figure S8. A TEM image of FePt@CdTe core-shell nanoparticles (Inset: HRTEM image).

- (1) Demas, J. N.; Crosby, G. A. *J. Phys. Chem.* **1971**, *75*, 991-1024; Nijegorodov, N.; Mabbs, R. *Spectrochimica Acta Part a-Molecular and Biomolecular Spectroscopy* **2001**, *57*, 1449-1462; Pavlovich, V. S.; Pershukovich, P. P. *Opt. Spectrosc.* **2000**, *88*, 197-200.
- (2) Bao, H. B.; Gong, Y. J.; Li, Z.; Gao, M. Y. *Chem. Mater.* **2004**, *16*, 3853-3859.