

Supporting information:

Synthesis of InAs core nanocrystals: we discuss a typical preparation: 3 g of TOP was heated in a three-neck flask on a Schlenk line under Ar atmosphere to a temperature of 300 °C with vigorous stirring. 1 ml of stock solution (see below), was rapidly injected and the solution was cooled to 260 °C for further growth. The growth was monitored by taking the absorption spectra of aliquots extracted from the reaction solution. Additional injections were used to grow larger diameter cores. Upon reaching the desired size, the reaction was allowed to cool down to room temperature and was brought into the glove box. 100 ml of Anhydrous toluene was added to the reaction solution. The nanocrystals were precipitated by adding anhydrous methanol. The size distribution of a typical reaction is on the order of $\pm 15\%$. This was improved using size selective precipitation using toluene and methanol as the solvent and non-solvent respectively.

Stock solution of InAs Core:

Under Ar atmosphere, 9 g of InCl_3 (40.7 mmol) was dissolved in 30ml of TOP at 260 °C with stirring. Then the solution was cooled, and taken into the glove box. The stock solution was prepared by mixing a desired amount of $(\text{TMS})_3\text{As}$ and InCl_3 TOP solution with the Arsenic to Indium molar ratios at 1 to 2 or 1 to 1.5.

B) Shell growth:

The amounts of shell material precursors needed to a shell with desired thickness were determined by a calculation assuming a spherical core and shell structure. The average radii of InAs cores were estimated from HRTEM images. The lattice parameters of core and shells in this calculation were taken from their bulk materials respectively.

I. GaAs shell growth: TOP capped InAs cores ($\sim 0.4 \mu\text{mol}$) were dissolved in 5 g of TOP in a three-necked flask. Under Ar flow on a Schlenk line, the nanocrystal solution was heated to 260°C , and the precursor solution of GaAs shell (see below) was introduced into the hot solution by drop-wise addition. After addition was complete, keep the temperature of reaction mixture at 260°C for about two hours. Then, the reaction mixture was cooled to room temperature. InAs/GaAs core/shell nanocrystals passivated by TOP were obtained by precipitation using a mixture of methanol and toluene. The growth of core/shells was monitored by UV-VIS spectroscopy of aliquots taken from the reaction flask.

GaAs shell precursor solution: 300 mg of GaCl_3 (1.7 mmol) was dissolved in 10 ml of TOP by stirring in glove box. Then the stock solution was prepared by mixing $(\text{TMS})_3\text{As}$ and GaCl_3 TOP solution with the Arsenic to Indium molar ratios at 1 to 4.

II. InP shell growth: TOP capped InAs cores ($\sim 0.4 \mu\text{mol}$) were dissolved in 5 g of TOP in a three-necked flask. Under Ar flow on a Schlenk line, the nanocrystal solution was heated to 260°C , and a desired amount of InP shell precursor solution (see below) was added dropwise into the hot InAs nanocrystals solution. After addition was complete, keep the temperature of reaction mixture at 260°C for 5~10 mins for thin shell growth, and about half an hour for thicker shell growth. Then, the reaction mixture was cooled to room temperature. InAs/InP core/shell nanocrystals capped by TOP were obtained by precipitation using a mixture of methanol and toluene. The growth of core/shells was monitored by UV-VIS spectroscopy and fluorescence spectroscopy of aliquots taken from the reaction flask.

InP shell precursor solution: concentrated InCl_3 TOP solution (1.36 M) for InAs core growth was diluted by 10 time with TOP. Then this diluted InCl_3 TOP solution was mixed with $\text{TMS})_3\text{P}$ at P to In molar ratios at 1 to 1.2~1.5.

III. CdSe shell growth: TOP capped InAs cores ($\sim 0.4 \mu\text{mol}$) were dissolved in 5 g of TOP in a three-necked flask. Under Ar flow on a Schlenk line, the nanocrystal solution was heated to 260°C , and the CdSe shell precursor solution (see below) was added dropwise into the hot InAs nanocrystals solution. After addition was complete, keep the temperature of reaction mixture at 260°C for ~ 5 mins for thin shell growth, and about half an hour for thicker shell growth. Then, the reaction mixture was cooled to room temperature. InAs/CdSe core/shell nanocrystals capped by TOP were obtained by precipitation using a mixture of methanol and toluene. The growth of core/shells was monitored by UV-VIS spectroscopy and fluorescence spectroscopy of aliquots taken from the reaction flask.

CdSe shell precursor solution: 80 mg of Selenium (1 mmol) was dissolved in 7 ml TOP in glove box. Then add $\text{Cd}(\text{CH}_3)_2$ to this TOPSe solution with Se to Cd molar ratios at 1 to 1.2.

IV. ZnSe shell growth:

Roughly $0.4 \mu\text{mol}$ of TOP capped InAs nanocrystals was dissolved in a mixture of TOP and TOPO (2 g of TOP and 2 g of TOPO) at 60°C under Ar. Then, the nanocrystals solution was heated to 260°C . An amount of stock solution of ZnSe shell for half monolayer growth (by calculation) was added dropwise into the hot nanocrystals solution. After 10 min, another proportion of stock solution for half monolayer shell growth was added and wait for another 10 min. Repeat this

procedure until the demanded shell thickness reached. Then, the reaction mixture was cooled to room temperature. InAs/ZnSe core/shell nanocrystals capped by TOP/TOPO were obtained by precipitation using a mixture of methanol and toluene. The growth of core/shells was monitored by UV-VIS spectroscopy and fluorescence spectroscopy of aliquots taken from the reaction flask.

ZnSe shell precursor solution: ZnSe shell stock solution was prepared by mixing a TOPSe solution (1 mmol) and 2 M of $\text{Zn}(\text{CH}_3)_2$ toluene solution with equimolar amounts.

V. ZnS shell growth:

About 0.4 μmol of InAs nanocrystals passivated by TOP was dissolved in a mixture of TOP and TOPO (2 g of TOP and 2 g of TOPO) at 60 °C under Ar. Then, the nanocrystals solution was heated to 260 °C. A desired amount of stock solution of ZnS shell for half monolayer growth (by calculation) was added dropwise into the hot nanocrystals solution. After 10 mins, another proportion of stock solution for half monolayer shell growth was added, and wait for another 10 min. Repeat this procedure until the demanded shell thickness reached. Then, the reaction mixture was cooled to room temperature. InAs/ZnS core/shell nanocrystals passivated by TOP/TOPO were obtained by precipitation using a mixture of methanol and toluene. The growth of core/shells was monitored by UV-VIS spectroscopy and fluorescence spectroscopy of aliquots taken from the reaction flask.

ZnS Shell precursor solution: ZnS Shell stock solution was obtain by mixing $(\text{TMS})_2\text{S}$ TOP solution (1 mmol) and 2 M of $\text{Zn}(\text{CH}_3)_2$ toluene solution with molar ration: 1 to 1.

Table 1 Dependent of quantum yield of shell thickness for different preparation

coreshell	r_{core}	S.T. / Q.Y.		S.T. / Q.Y.		S.T. / Q.Y.		S.T. / Q.Y.		comment
InAs/CdSe	1.2	0	1.2	~0.6	13	~1.2	21	~1.8	18	Fig.3a
InAs/ZnSe	1.2	0	1.2	~0.6	9.0	~1.5	18	~2.5	14	Fig. 3c
InAs/ZnS	1.2	0	1.2	~0.7	4.0	~1.3	8.0	~1.6	7.0	Fig. 3e
InAs/CdSe	1.7	0	1.1	~0.6	10	~1.2	20	~2.0	14	SIfig. 1
InAs/ZnSe	1.7	0	1.1	~0.5	8.5	~1.2	16	~2.1	13	SIfig. 2
InAs/ZnS	1.7	0	1.1	~0.6	5	~1.3	7.1	~2.2	6.3	Fig. 3f
InAs/CdSe	2.5	0	0.9	~0.7	11	~1.2	17	~1.6	14	Fig. 3b
InAs/ZnSe	2.8	0	0.9	~0.7	13	~1.3	20	~2.2	15	Fig. 3d

r_{core} : core radius in nm, S.T. shell thickness in monolayers, Q.Y. quantum yield, SIfig.1 and SIfig.2: the figures in supporting information.

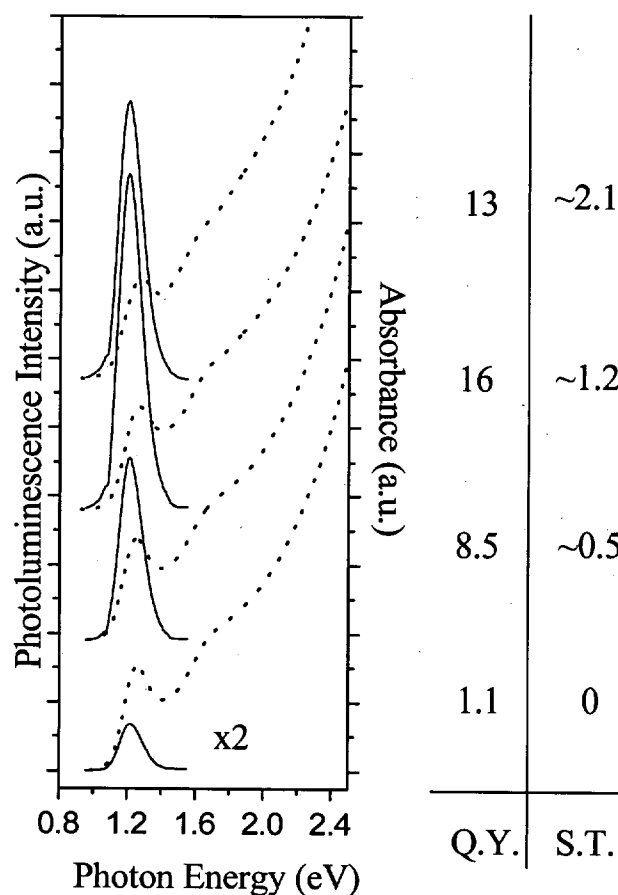


Fig.1 Absorption (dotted lines) and fluorescence (solid lines) spectra of InAs/CdSe core/shell nanocrystals. The core radius is 17 Å. The shell thickness (S.T.), and the fluorescence quantum yield (Q.Y.), are indicated on the right side.

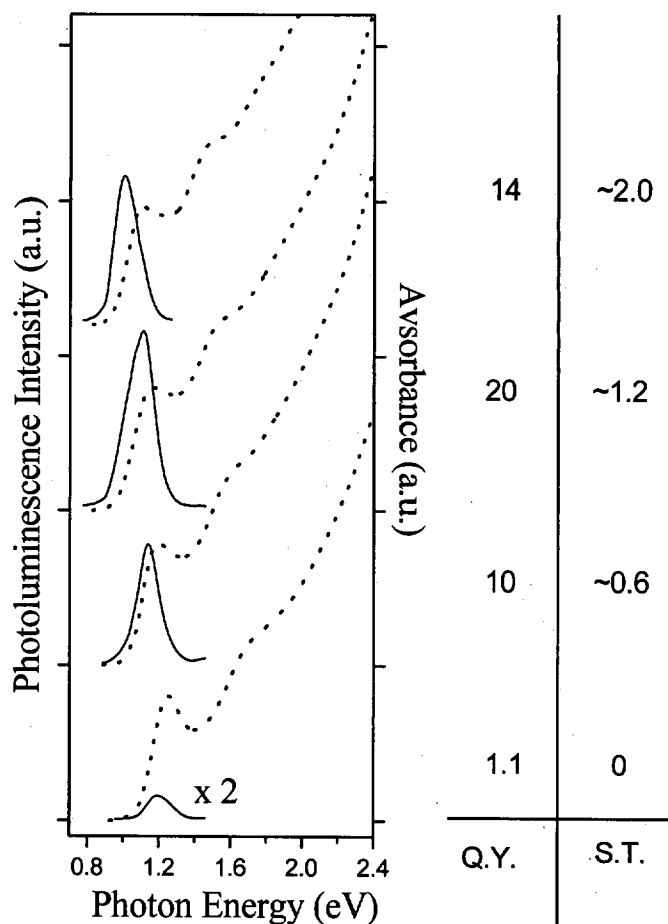


Fig.2 Absorption (dotted lines) and fluorescence (solid lines) spectra of InAs/ZnSe core/shell nanocrystals. The core radius is 17 Å. The shell thickness (S.T.), and the fluorescence quantum yield (Q.Y.), are indicated on the right side.