Electronic Supplementary Material (ESI) for CrystEngComm

Supporting Information

Controlling Crystal Growth Orientation and Crystallinity of Cadmium Sulfide Nanocrystals in Aqueous Phase by Using Cationic Surfactant

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SI 1. Experiment Section

Materials

In this work, cadmium chloride hemipenta hydrate ($CdCl_2.5/2H_2O$, A.C.S Reagent, Aldrich), thioacetamide (TAA, Wakko 98%), polyvinyl pyrrolydone (PVP, M_w = 10,000 g/mol, Aldrich), cetyltrimethylammonium bromide (CTAB, Aldrich 95%), and gelatin (Aldrich) were used without further purification. Deionized water (DI water) was obtained from Milli-Q instrument (0.22 μm, Millipore).

Synthesis of cadmium sulfide

CdS single crystalline nanoparticles were synthesized by mixing thoroughly a solution of 0.01 M $CdCl_2$, 0.01 M TAA and 0.01 M CTAB in 20 ml DI water. Subsequently, the solution was transferred to a 25 ml teflon-lined autoclave then kept in the oven at 200 ^oC for 4 h. After the hydrothermal treatment time, the reaction was cooled naturally to room temperature. Finally, the product was collected by centrifuging and washing several times with ethanol and DI water, respectively.

For the investigating the effect of surfactants, instead of CTAB, 2 g of gelatin and 2 g of PVP were separately mixed with 20 ml aqueous solutions of 0.01 M $CdCl_2$ and 0.01 M TAA, respectively. Hydrothermal treatment was then carried out in the similar procedure above. The effect of reaction temperature and the product formation process as well were also studied by two separately mixed solutions of 0.01 M $CdCl_2$ and 0.01 M TAA in 20 ml DI water. These reaction solutions were then hydrothermally treated for 4 h at 80 ^oC and 200 ^oC, respectively in the same process above.

SI 2. Characterizations

CdS samples were characterized by using X-ray powder diffraction (XRD), transmission electron microscopy (TEM), photoluminescence (PL) spectroscopy and UV-Vis spectroscopy. The XRD patterns of the samples were recorded using the Cu Kα radiation (λ = 1.54056 Å) of a Rigaku X-ray diffractometer operating at 40 kV and 150 mA at a scanning rate of 0.02° per step in the 2θ range of $10° \leq 2\theta \leq 90°$. TEM was performed on JEOL, JEM-2010, and JEOL JEM 2100F transmission electron microscopes operating at 200 kV. A small amount of the powder sample was dispersed into ethanol (99.9%) and a drop of it was placed over a carbon coated microscopic copper grid (300 mesh size). PL spectra were obtained using Hitachi F-7000 fluorescence spectrometer. The UV−vis optical absorbance of the sample was measured using an Agilent 8453

Spectrophotometer. SEM was performed on the field emission scanning electron microscope (FE-SEM) Hitachi S-4300.

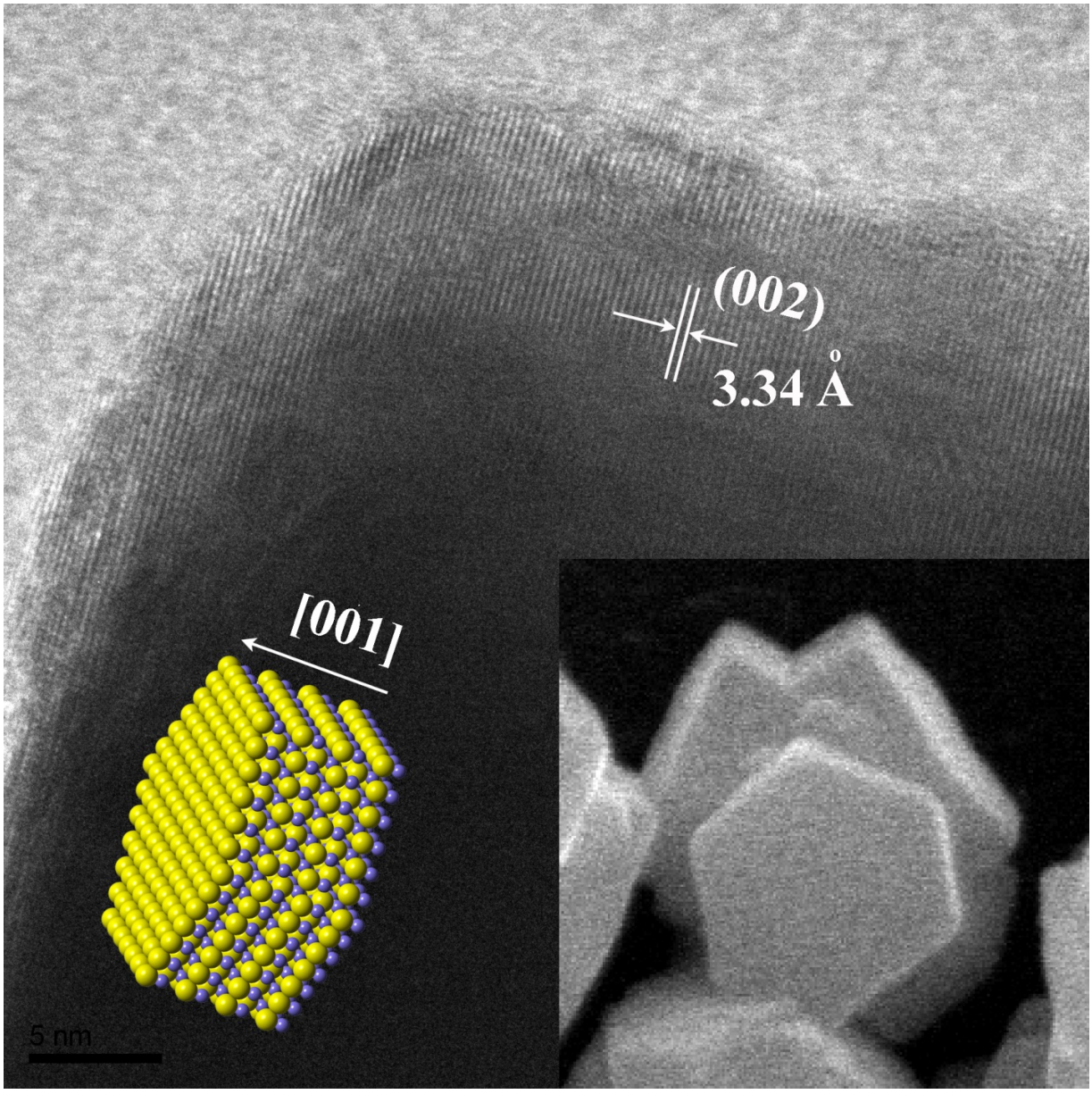


Figure S1. High resolution TEM image of CdS particles prepared at 200 °C without surfactant. Inset: SEM images of this sample.

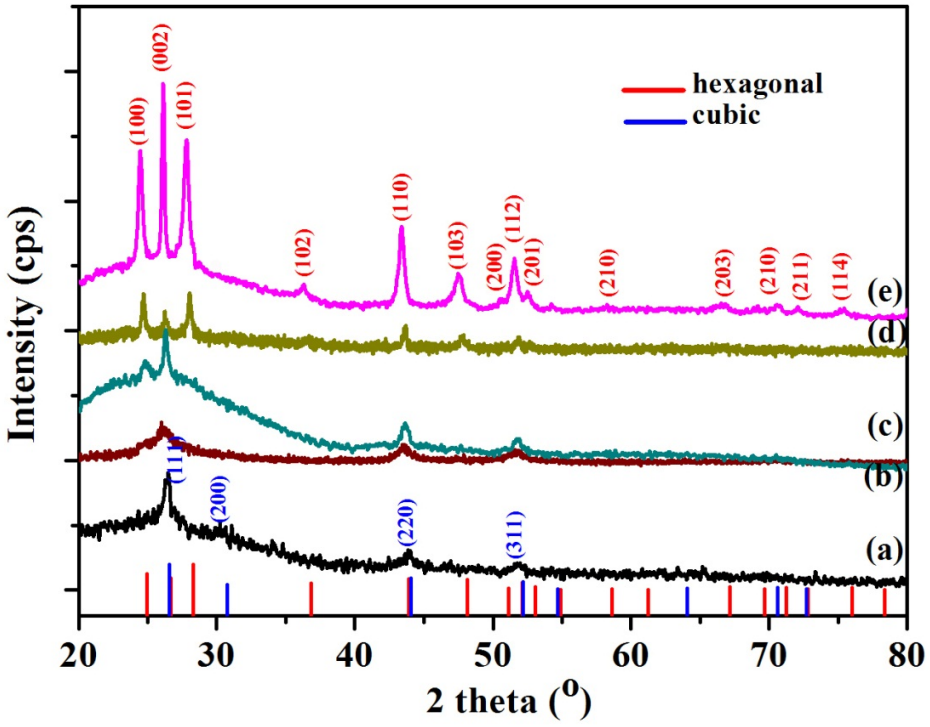


Figure S2. XRD patterns of CdS samples prepared without surfactant at (a) 80 ^{o}C, (b) with gelatin at 200 ^{o}C, (c) with PVP at 200 ^{o}C, (d) with CTAB at 200 ^{o}C and (e) without surfactant at 200 ^{o}C.

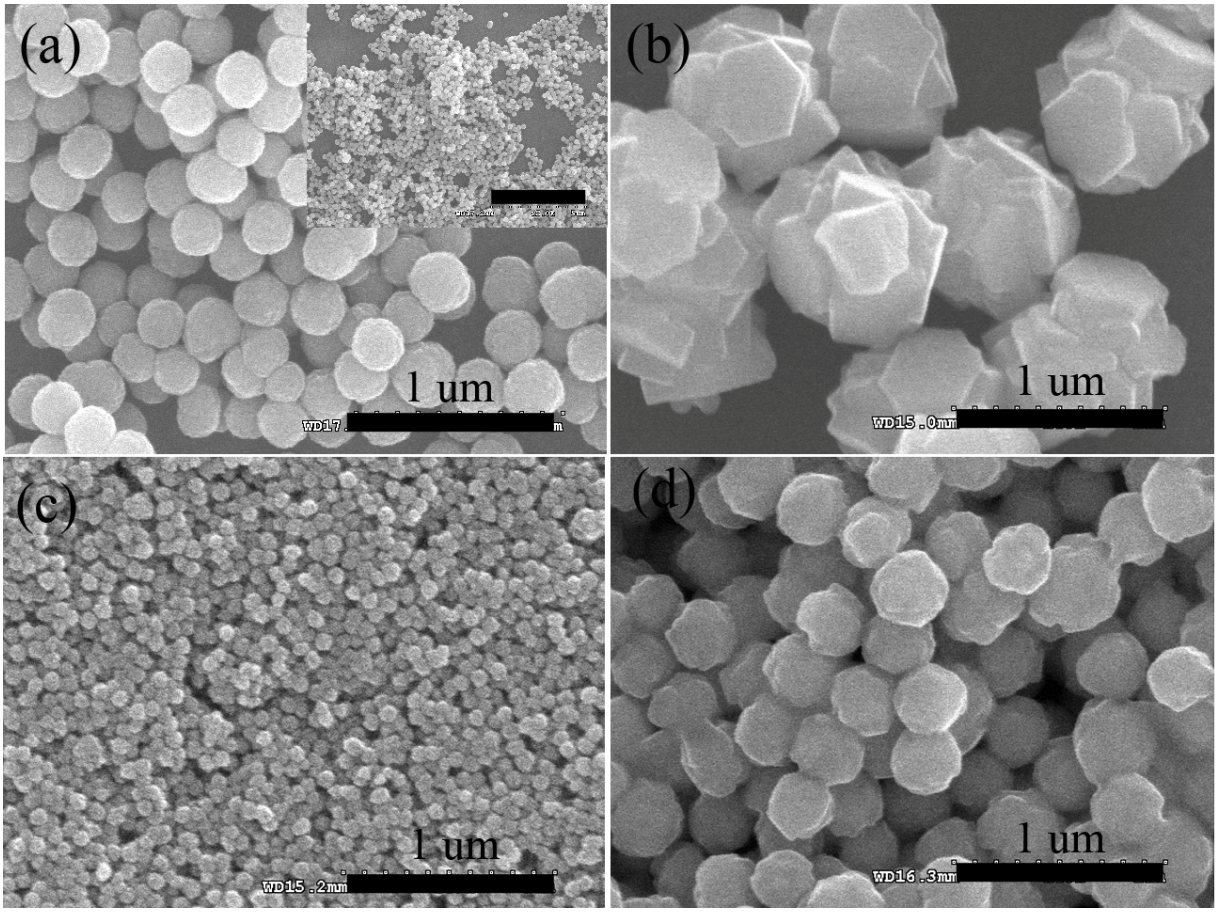


Figure S3. SEM images of CdS samples prepared without surfactants at (a) 80 ^{o}C, (b) 200 ^{o}C, (c) with gelatin at 200 ^{o}C and (d) with PVP at 200 ^{o}C. Inset: large area view of sample in Figure 1a (scale bar: 5 μm).

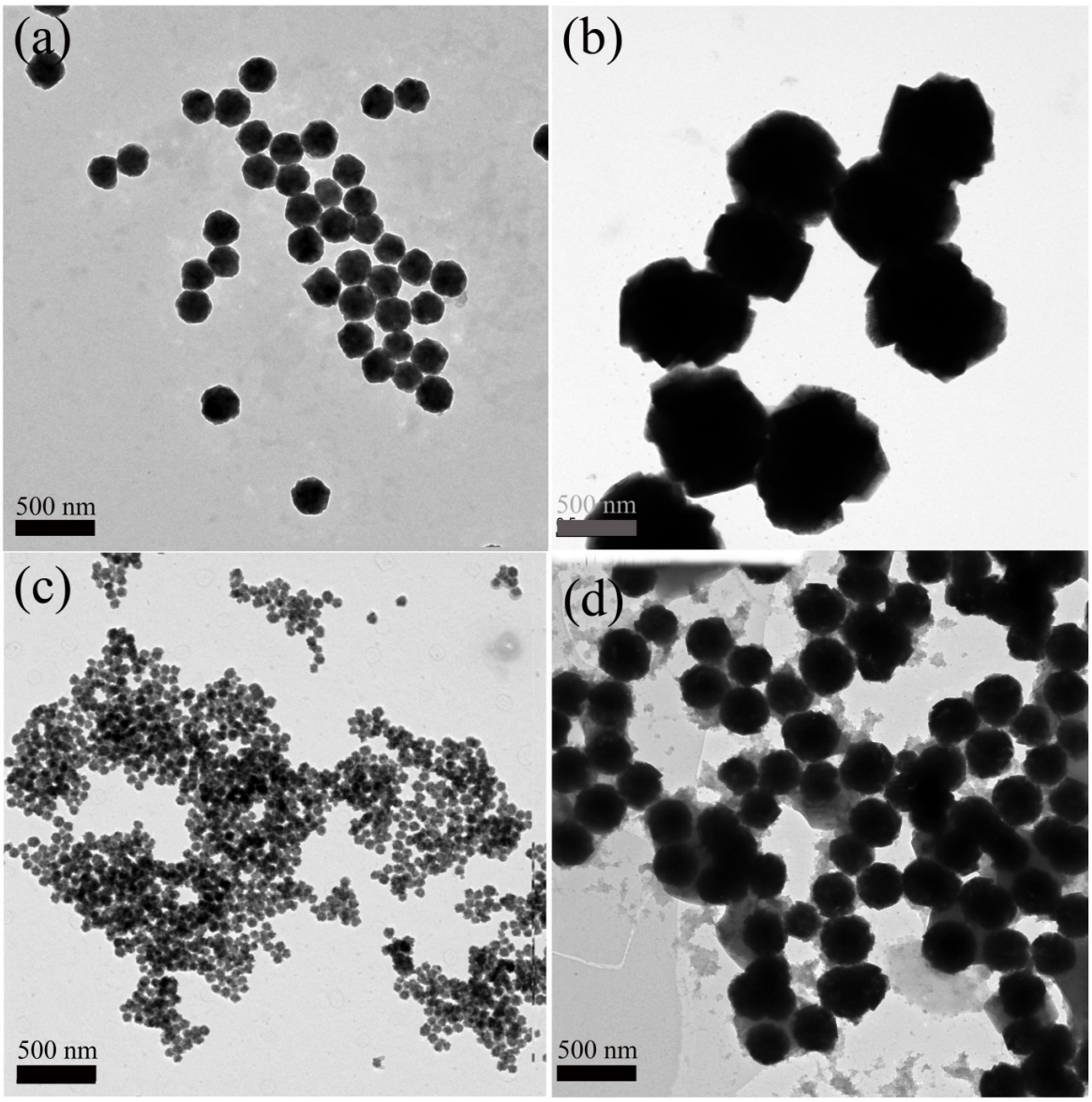


Figure S4. TEM images of CdS samples prepared without surfactants at (a) 80 ^{o}C, (b) 200 ^{o}C, (c) with gelatin at 200 ^{o}C and (d) with PVP at 200 ^{o}C.

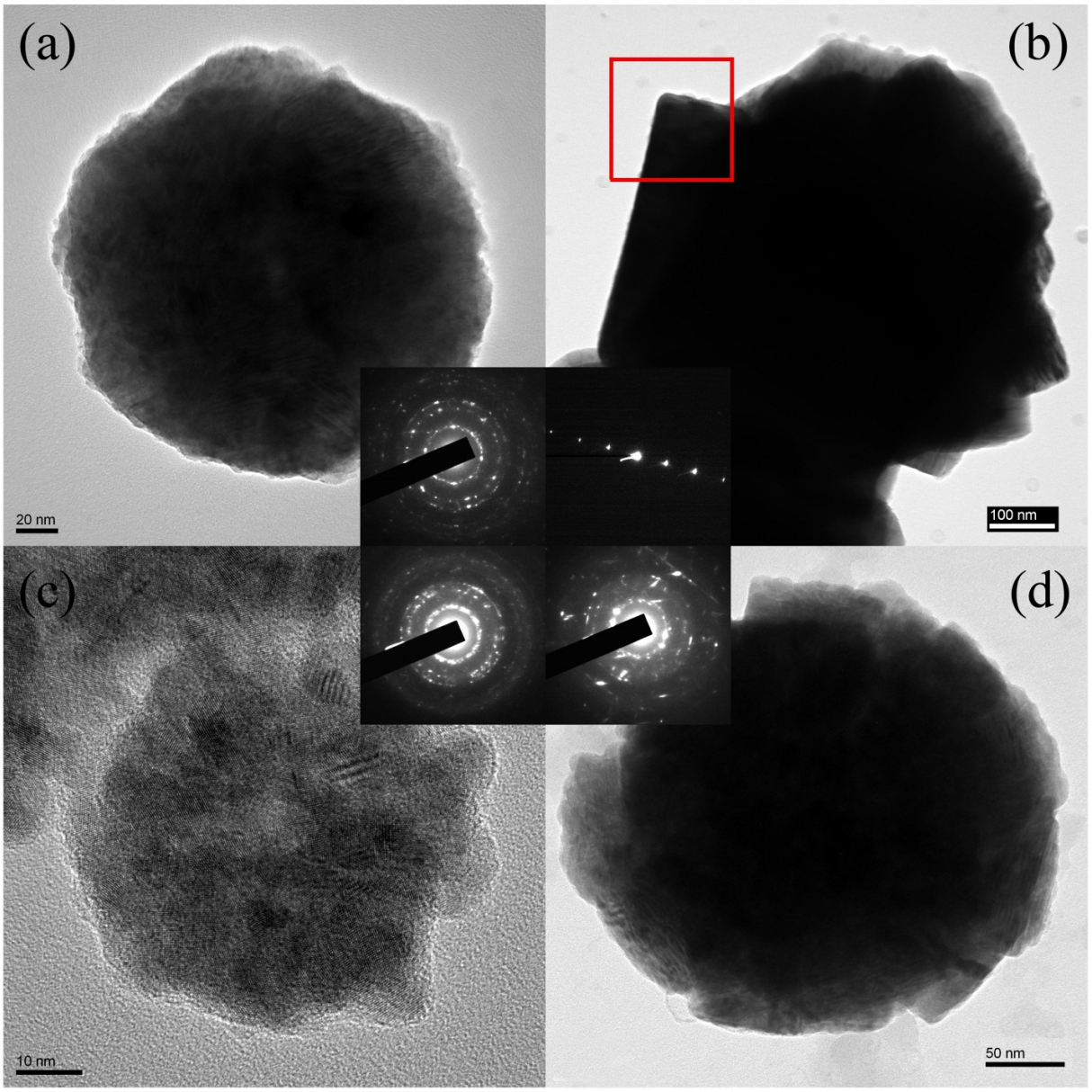


Figure S5. TEM images with SAED images (inset) of CdS samples prepared without surfactants at (a) 80 ^{o}C, (b) 200 ^{o}C, (c) with gelatin at 200^{o}C and (d) witzh PVP at 200 ^{o}C. Red circles indicate small primary crystals.

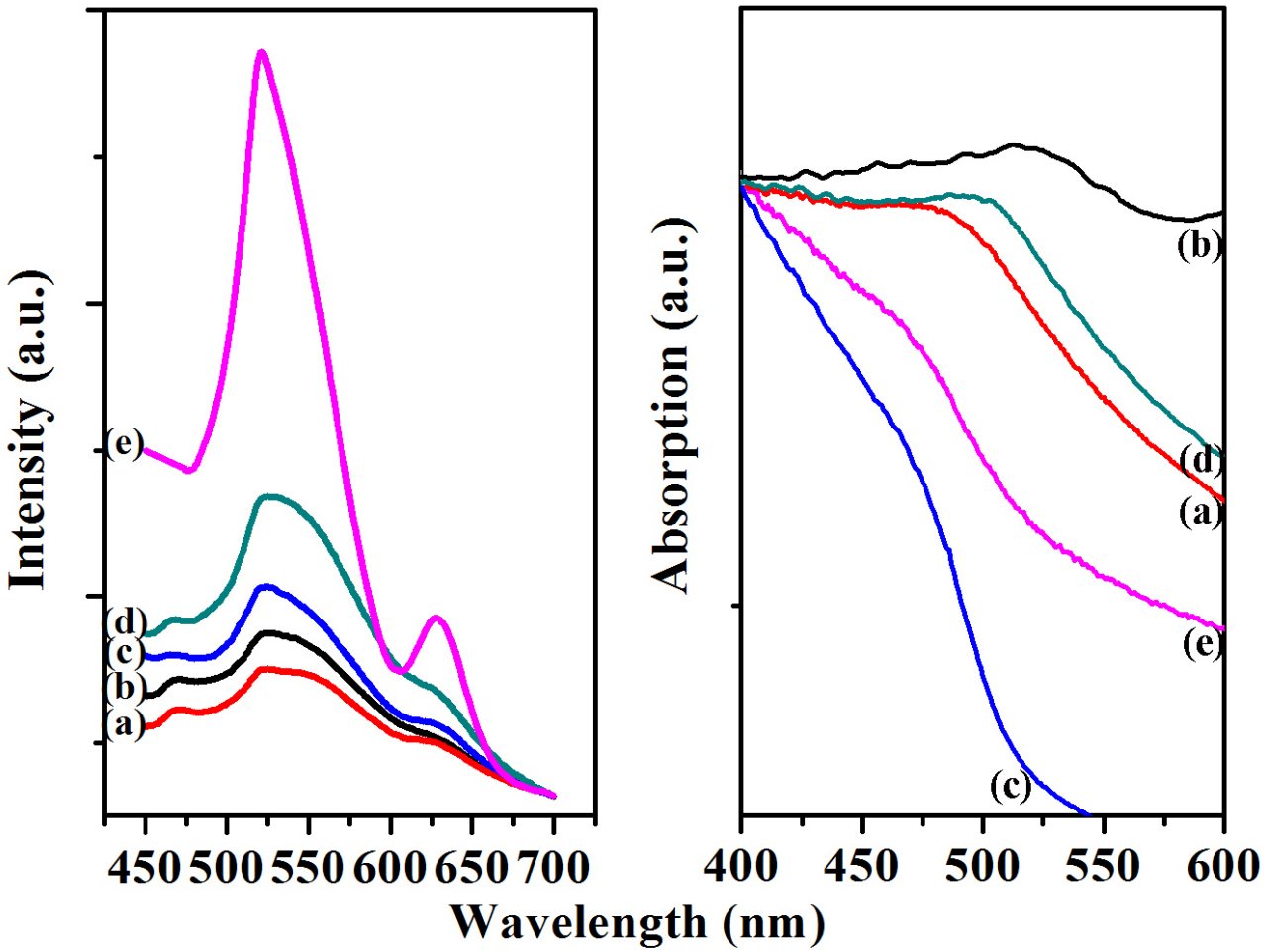
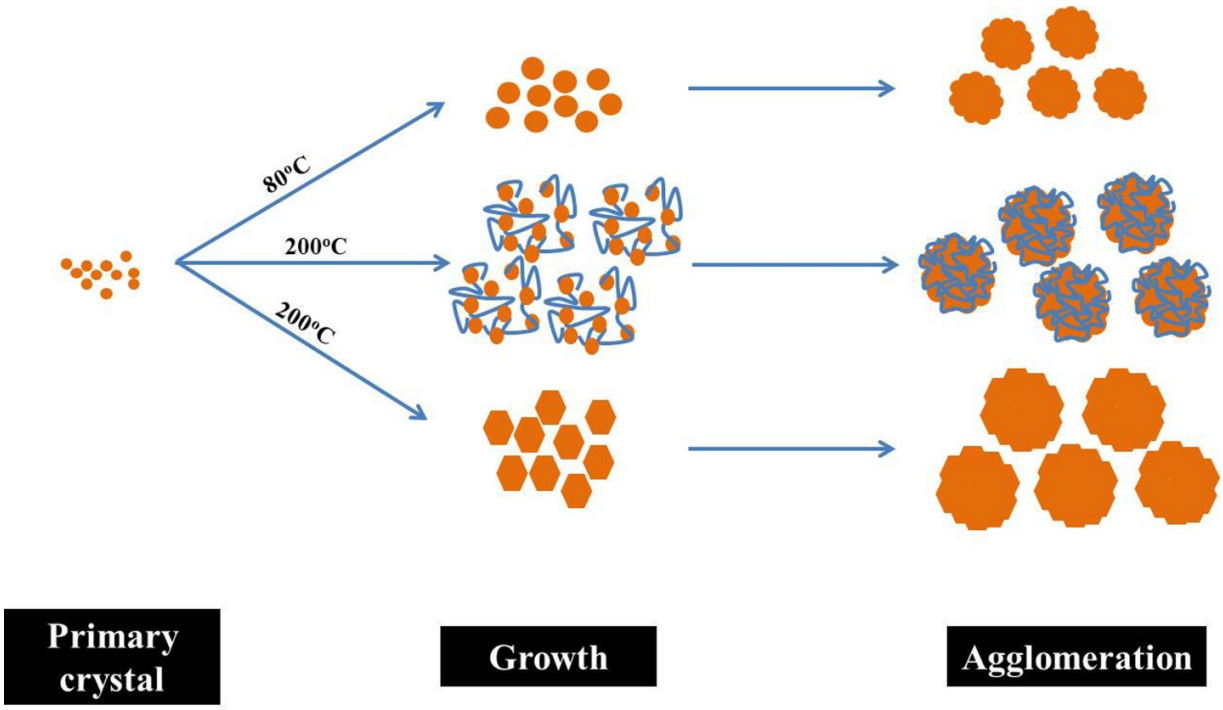
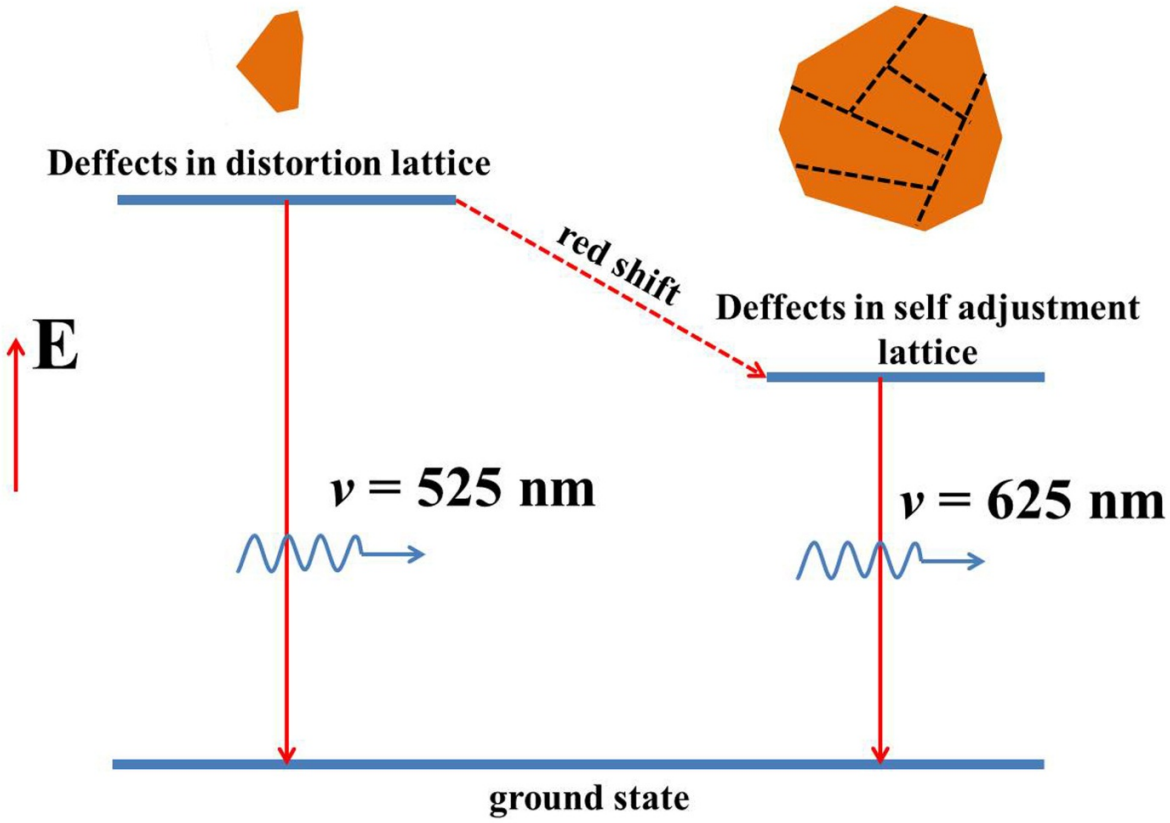


Figure S6. Photoluminescence (left) and UV- Vis spectra (right) of CdS samples prepared (a) without surfactant at 80 ^{o}C, (b) without surfactant at 200 ^{o}C, (c) with gelatin at 200 ^{o}C, (d) with PVP at 200 ^{o}C, and (e) with CTAB at 200 ^{o}C. Excitation wavelength: 400 nm.



Scheme S1. Schematic drawing on the growth of CdS clusters.



Scheme S2. Illustration for the red shift of PL spectra during the crystal growth.