Electronic Supplementary Material (ESI) for RSC Advances.

Carbon dots reduced and stabilized silver nanoclusters: synthesis and formation mechanisms

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S1. Experimental procedures

Synthesis of carbon dots (CDs): CDs were synthesized according to our previous report.[1] In particular, 4 g sucrose and 3 g mercaptosuccinic acid were heated at their melting point for 6 min. After cooling, the supernatant liquid was discarded and the solid product was obtained at the bottom of flask. The precipitates were dispersed with water and then extracted with ether several times in order to remove the remained oleic acid. Finally, the products were freeze-dried and obtained after dialyzed in deionized water using a 1 kDa membrane for 1 day.

Synthesis of silver nanoclusters (AgNCs): Typically, 40 mL ethanol was boiled to 80 °C, the as prepared CDs (100 μL, 50 mg/mL) were added under stirring. Then, silver nitrate (2 mL, 3.42 mg/mL) was added subsequently after ammonia (0.4 mL, 10%) injected. The reaction was processed for 48 h and cooled to room temperature. Then, the mixture was centrifuged and the AgNCs precipitates were washed with ethanol, tetrahydrofuran, dichloromethane three times to remove the remained silver nitrate and CDs. Finally, the AgNCs precipitates were dried in vacuum oven.

UV-vis spectra: UV-vis spectra were measured with a MAPADA double-beam spectrophotometer at room temperature.

Fluorescence spectroscopy: Fluorescence analysis were carried out using a LS-55 fluorophotometer (Perkin-Elmer, USA).

Fourier transform infrared (FTIR) spectra: FTIR spectra were recorded by Thermo (USA) FTIR spectrophotometer. KBr crystals were used as the matrix for sample preparation.

X-ray photoelectron spectroscopy (XPS) analysis: XPS experiments were carried out on KRATOS XSAM800 X-ray photoelectron spectrometer using Mg as the exciting source.

Transmission electron microscopy (TEM) and energy dispersive X-ray spectroscopy (EDX): TEM images and EDX analysis were done on a JEOL JEM-2100 electron microscope operating at 200 kV. A diluted solution was spotted on carbon coated copper grid and then dried in laboratory ambience.

S2. Supplementary figures

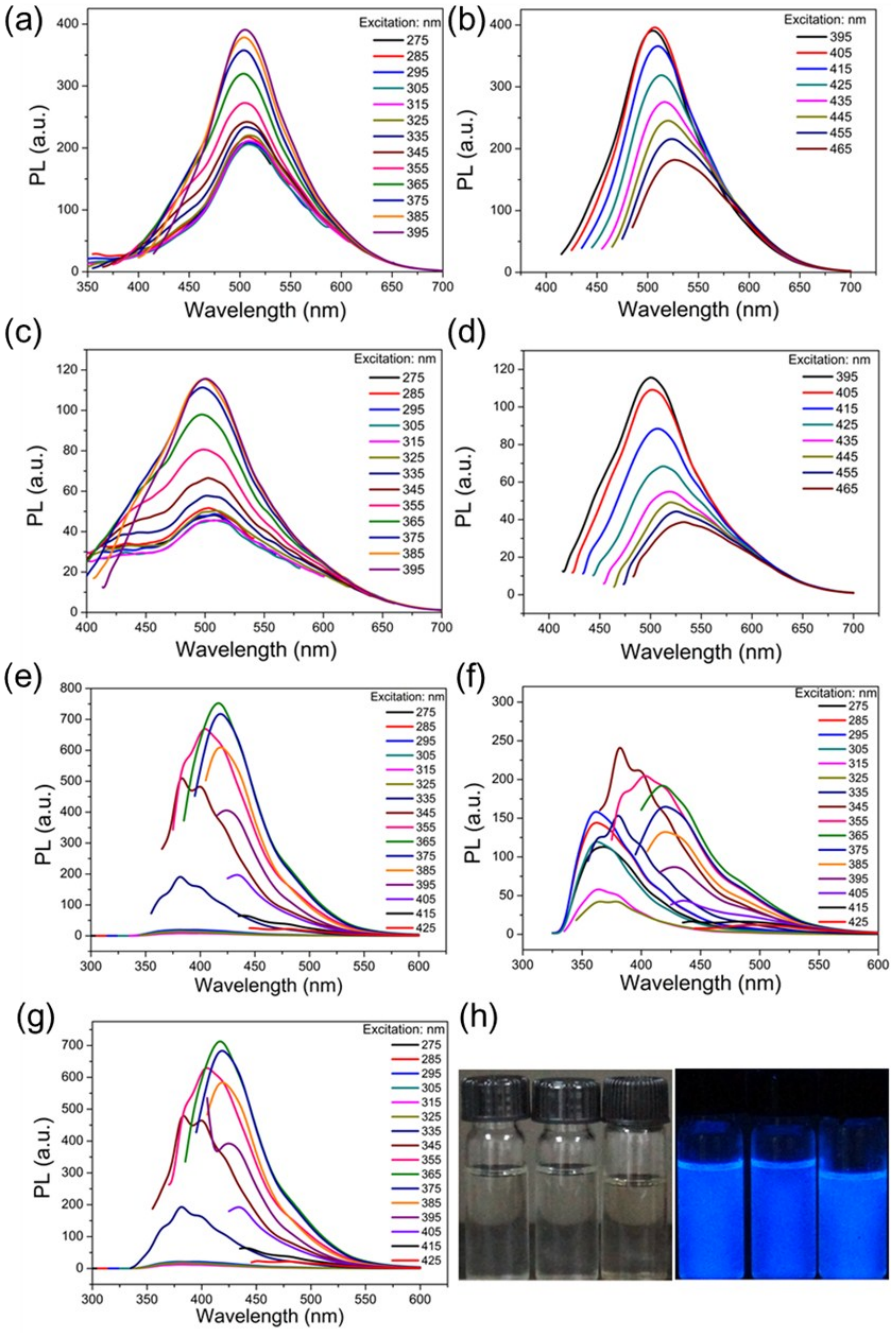

Figure S1. PL spectra and photographs of the control experiments. (a) and (b) PL spectra of C-dots in ethanol at room temperature. (c) and (d) PL spectra of C-dots in ethanol with ammonia at room temperature. (e), (f), (g) PL spectra of C-dots boiled for 48 h in ethanol, ethanol with ammonia, ethanol with sodium hydroxide, respectively. (h) Photographs of liquid for (e), (f), (g) in daylight and under exposure

at 365 nm UV light.

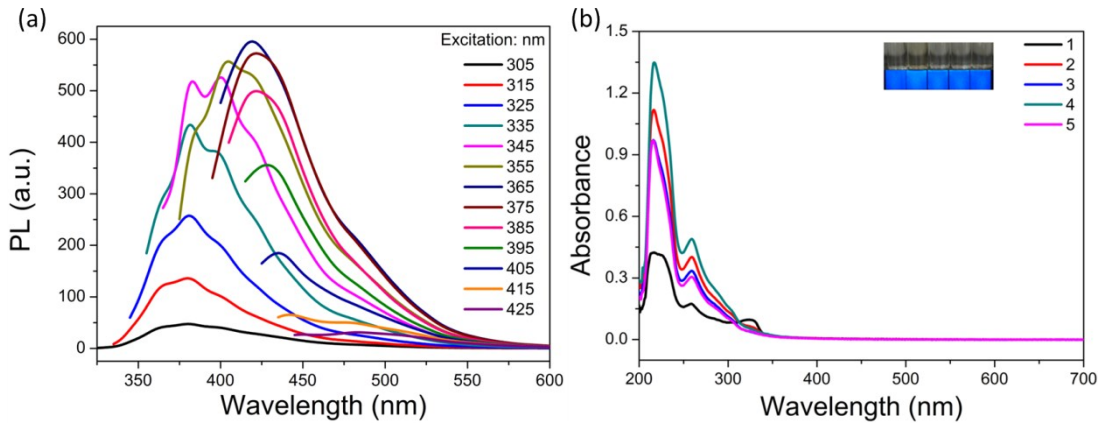

Figure S2. (a) PL spectra of supernatant liquid of AgNCs synthesis by using 400 μL 10% ammonia in 40 mL ethanol. (b) UV-vis spectra of supernatant liquid of AgNCs synthesis. (1, C-dots boiled in ethanol. 2, 3, 4, 5, supernatant liquid of AgNCs synthesis using 400 μL 5, 10, 15, 20% ammonia in 40 mL ethanol.) The inserts from left to right are the corresponding photographs of liquid for 1-5 in daylight and under exposure at 365 nm UV light.

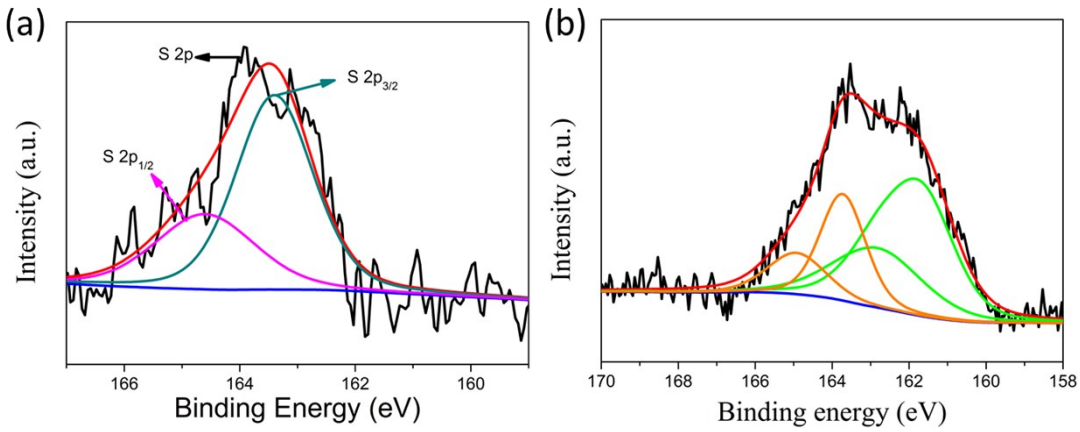

Figure S3. The high resolution XPS spectrum of S 2p peak for CDs (a) and AgNCs (b).The S $2p_{3/2}$–S $2p_{1/2}$ peaks were fitted using one S 2p doublet with a 2:1 area ratio and a splitting of 1.2 eV.[2] The green and orange peaks were attributed to S-Ag and S-C bond, respectively. χ^2 for the fit shown in (b) was 0.28.

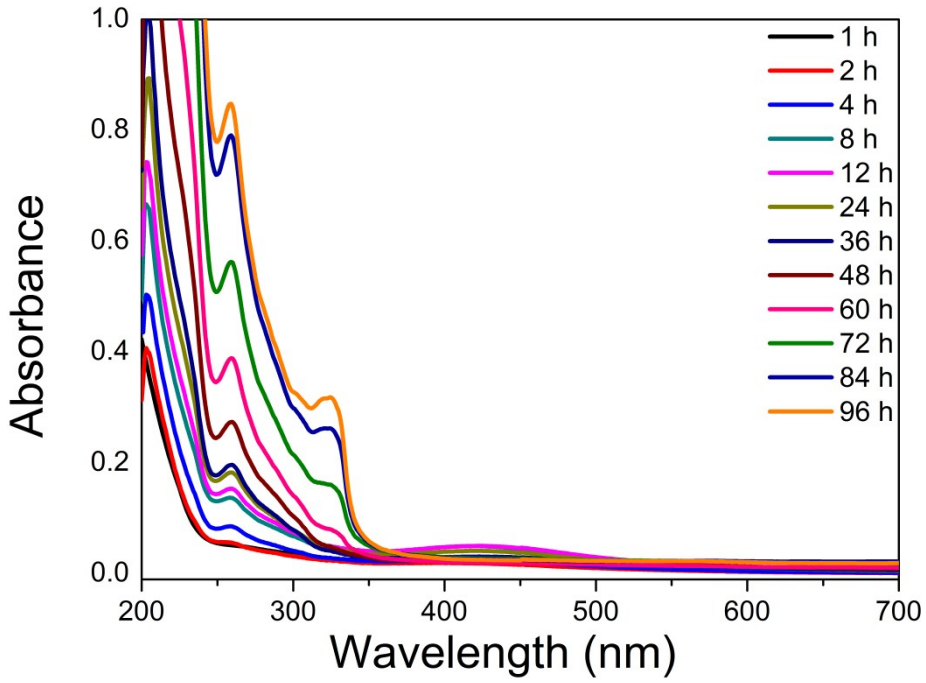

Figure S4. Time resolution of UV-vis spectra for AgNCs synthesis.

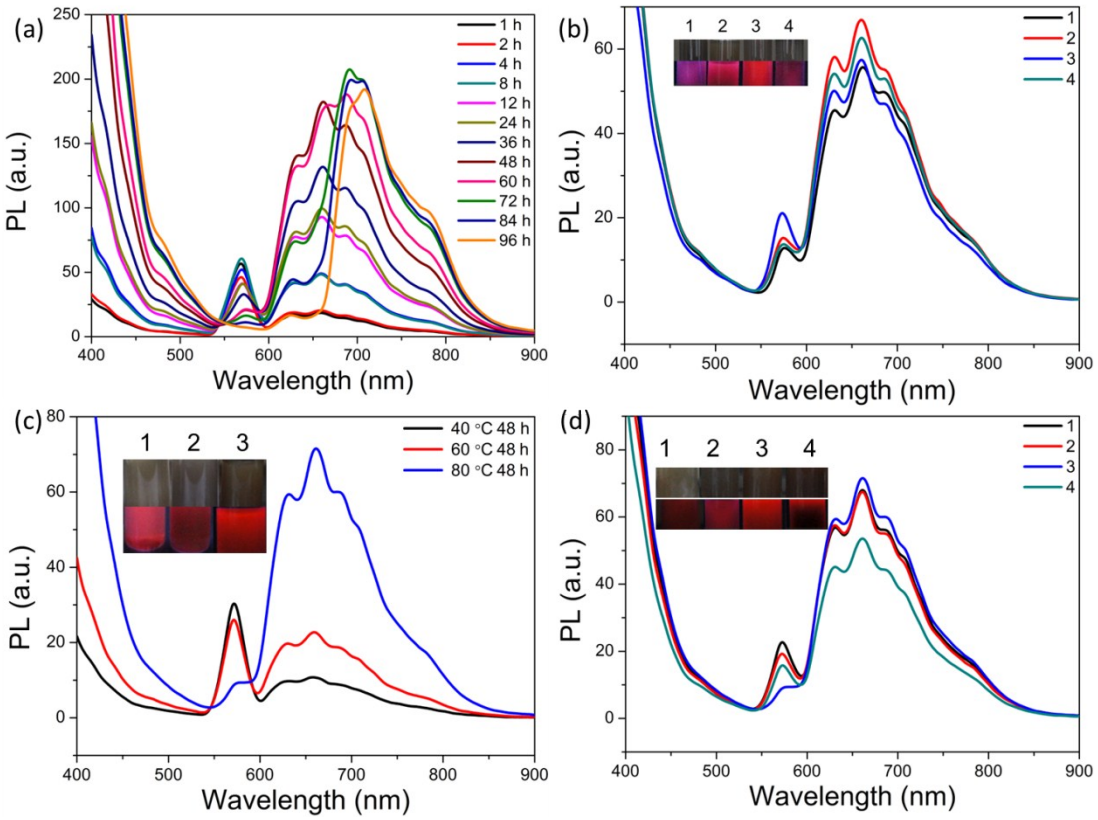

Figure S5. (a) Time resolution of PL spectra for AgNCs synthesis. (b) PL property of AgNCs by varying the concentration of ammonia (1-4: 400 μL 5%, 10%, 15%, 20% ammonia in 40 mL ethanol). (c) PL spectra for AgNCs with different synthesis temperature. (d) PL spectra of the as prepared AgNCs with different concentration ratio between C-dots and silver ion (1-4: 0.625, 1.25, 2.5, 5 mg CDs with 2 mL 3.42 mg/mL silver nitrate and 400 μL 10% ammonia in 40 mL ethanol at 80 °C for 48 h). The inserts are the corresponding photographs of the products for in daylight and under exposure at 365 nm UV light.

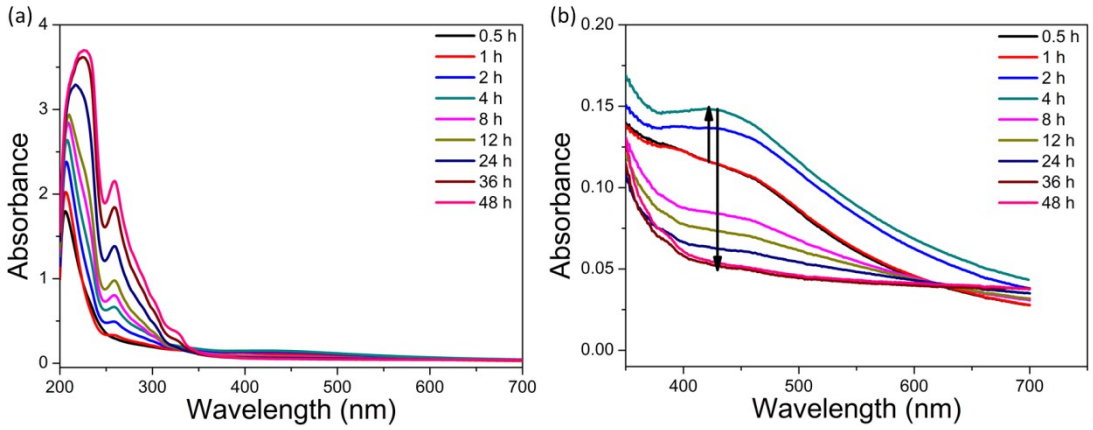

Figure S6. (a) and (b) Time resolution of UV-vis spectra for AgNCs synthesis in isopropanol.

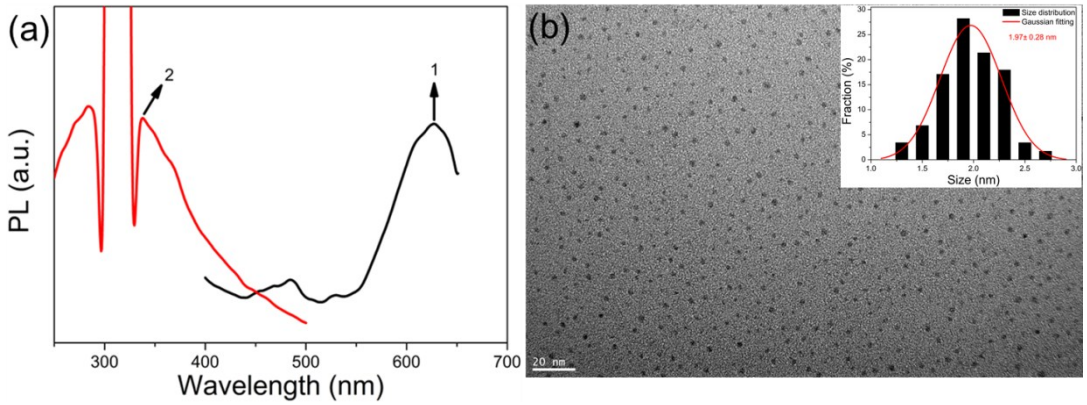

Figure S7. (a) 1, Emission spectra; 2, Excitation spectra of AgNCs synthesized in isopropanol. (b) TEM image of AgNCs synthesized in isopropanol. The inset is the size distribution of the as prepared AgNCs.

References:

1. Jin, J.-C.; Xu, Z.-Q.; Dong, P.; Lai, L.; Lan, J.-Y.; Jiang, F.-L.; Liu, Y. *Carbon* **2015,** 94, 129-141.

2. Arena, G.; Contino, A.; D'Agata, R.; Sgarlata, C.; Spoto, G. *New Journal of Chemistry* **2005,** 29, 1393-1395.