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Electronic Supplementary Information

Complete separation of triangular gold nanoplates through selective precipitation under CTAB micelles in aqueous solution

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1. Experimentals

1.1 Chemicals. Hydrogen tetrachloroaurate(III) trihydrate ($HAuCl_4 \cdot 3H_2O$, 99.9%), cetyltrimethylammounium bromide (CTAB, 99%), sodium borohydride ($NaBH_4$, 99%), L-ascorbic acid (99%), trisodium citrate dehydrate (99%), and aminopropyltrimethoxysilane (APTMS, 90%) were purchased from Aldrich and used as received. Deionized water was used throughout during the preparations of aqueous solutions.

1.2 Methods

1.2.1 Preparation of the gold seeds. A 20 mL of aqueous solution containing $2.5x10^{-4}$ M $HAuCl_4$ and $2.5x10^{-4}$ M trisodium citrate was prepared in a conical flask. To this solution, 0.6 mL of ice-cold 0.1 M $NaBH_4$ solution was quickly added with vigorous stirring. The solution became pink in color immediately after the addition of $NaBH_4$ solution, and the solution was sustained for 2 min with vigorous stirring. The seed particles in this solution were used as seeds within two days after preparation. The average particle size measured from the transmission electron micrograph was 2~4 nm.

1.2.2 Growth of gold nanocrystals from the seed solutions. For the growth of triangular nanoplates, 10 mL of growth solution containing $2.5x10^{-4}$ M $HAuCl_4$ and 0.1 M cetyltrimethylammonium bromide (CTAB) was mixed with 0.2 mL of freshly prepared ascorbic acid solution (0.1M) in a clean vial, which resulted in a colorless solution. To this solution was added 20 uL of KI solution (20 mM) and well-mixed (the final concentration of iodide was 40 uM). Finally, 0.025 mL of the seed solution was added and gently mixed. No further stirring or agitation was applied during the crystal growth. The solution color became reddish in color and the typical bands at UV/Vis spectra developed during the growth reached their maxima within ~30 min.

1.2.3 Partial precipitation of triangular (and/or hexagonal) nanoplates. At the first observation, the as-prepared growth solution was kept in the ambient condition for 24 h, and then the solution phase was moved into a new vial while fresh solution of CTAB (0.1M) was poured into the empty bottle that carries partially precipitated gold nanoplates. Simple sonication for 1 min or agitation with a hand was enough to recover the attached nanoplates on the glass wall surface. In order to vary the incubation temperature, the as-prepared growth solution was kept in a water bath with a temperature setting without agitation, which also successfully precipitated the nanoplates. The maximum temperature was only limited to 55 ^{o}C due to water evaporation, since the water bath employed was opened to ambient condition and some black aggregation was observed at higher temperature than ~60 ^{o}C.

1.2.4 Preparation of amine- and carboxylic acid inner-coated glass vials. In order to functionalize the inner surface of glass vial, a few drops of APTMS (less than 20 uL) were dropped in a glass Petri dish (diameter ~10 cm), right above which a glass vial was put on with upside down direction, affording the APTMS vapor could reach the inner side of the vial. The Petri dish with several vials was put into an electronic oven set to a temperature (130 ^{o}C), at which temperature evaporation of the silane compound is accelerated and the hydrolysis process is accomplished to afford amine-terminated vials. For the carboxylated inner surface, to the amine-modified vial was added chloroform solution (~20 mL) containing succinic anhydride (20 mM) and the vial was sealed and kept at ambient condition for 6 h to yield carboxylated inner surface. The resultant vials was thoroughly washed with ethanol and water consecutively and used to contain as-prepared growth solution for the fractional precipitation.

1.2.4 SEM observations over the partially precipitated gold nanoplates. For the SEM observation over the gold nanoplates intact on cover glass, a slice of piranha-cleaned cover glass was dipped into as-grown nanocrystals, and was kept at ambient condition overnight. Without disturbing the solution, the cover glass was just picked up and dried at room temperature at least for 5 h. To enhance the contrast in the SEM image, additional platinum coating was accomplished to the thickness of ~10 nm. SEM images (FEI, Sirion, Netherlands) were obtained by collecting the secondary electrons produced caused by bombarding the sample with an incident electron beam of energy between 1 and 10kV.

1.3 Instrumentation. Absorption spectra of the solutions were taken with a DU800 UV/Vis. spectrophotometer (Beckman Coulter) in a wavelength range from 400 to 1100 nm. Transmission electron microscopy (TEM) images were acquired with a CM20 (Philips) electron microscope at 120 kV using a carbon-coated copper grid. Scanning electron microscopy was obtained with Sirion (FEI, Nethelands).

2. Visual pictures of recovered gold nanoplates. In Figure S1, partially precipitated gold nanoplates was shown that were recovered by pouring a fresh CTAB solution after the supernatants were discarded, and as-prepared solution was also shown for comparison S1(b).

Fig. S1 Optical images of triangular gold nanoplates redissolved in a fresh CTAB solution (0.1M) after being partially precipitated onto the glass wall (left). The as-prepared solution containing isotropic nanoparticles (mostly decahedrons and icosahedrons) and nanoplates is shown in the right for comparison.

3. Efficiency of selective precipitation (Table S1). Production yields of gold nanoplates grown in CTAB solution with iodide ions, and recovery efficiency from the glass wall as a result of the selective precipitation estimated from TEM images.

Table S1.

	Nanoplate (as-grown)	Polygons (as-grown)	Nanoplates (recovered)
Yields (TEM image)	46 ± 5%	54 ± 5%	96 ± 3%