Facile synthesis of cationic gold nanoparticles with controlled size and surface plasmon resonance

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Supporting Information

Experimental section

Chemicals

Ascorbic acid was purchased from Alfa Aesar (MA, USA). Hydrogen tetrachloroaurate(III) hydrate was purchased from Stream Chemical (MA, USA). Sodium citrate dehydrate was purchased from Sigma Aldrich (MO, USA). Sodium borohydride was purchased from Across (NJ, USA). The synthesis of alkanethiol ligand presenting triethylene glycol and tertiary ammonium head group (TTMA ligand) followed the previously reported literature.[1]

Synthesis of 5 nm-sized gold nanoparticles (AuNPs) as seeds

A total of 20 mL solution of 250 μM $HAuCl_4$ and 250 μM sodium citrate was prepared in a conical tube. A total of 0.6 mL of 100 mM $NaBH_4$ (ice-cooled) was added to the solution at once with gentle shaking. The suspension was aged for 2 h and used for the seed-mediated growth.

Size-controllable synthesis of cationic AuNPs

250 μL of 10 mM aqueous TTMA ligand solution and 500 μL of 10 mM $HAuCl_4$ were sequentially added to 4 mL of water. 1 mL of 10 mM ascorbic acid was added to the solution at once with gentle shaking. Finally, 100 μL of differently concentrated 5 nm-size AuNPs (600, 60, 30, 10, 5 and 1 nM) was added to the solution and incubated for 3 h. The synthesized cationic AuNPs were centrifuged and washed with water three times.

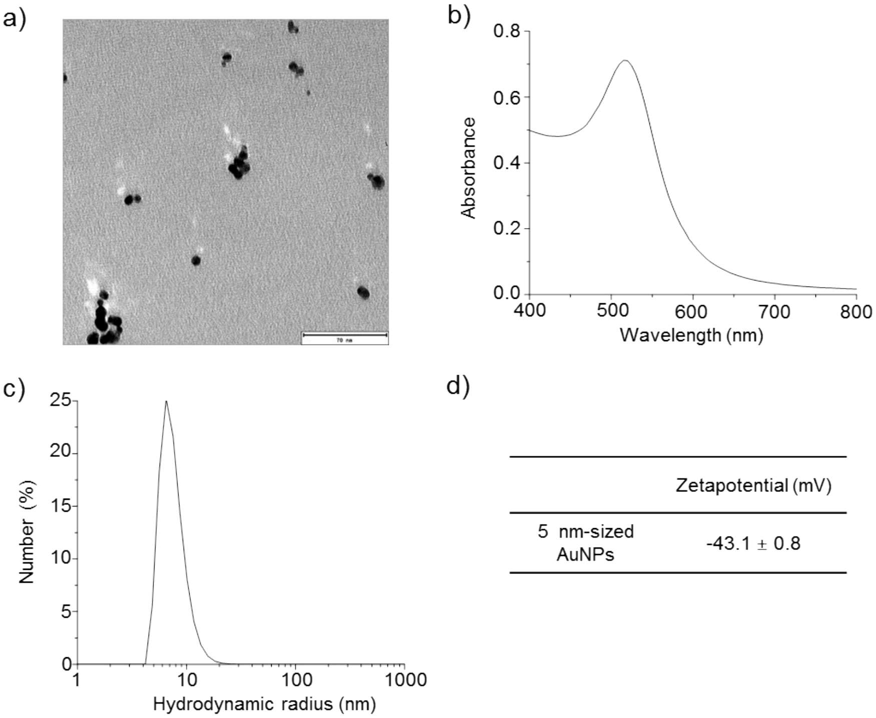
Colloidal stability test of 5 nm-sized and 20 nm-sized cationic AuNPs in PBS

100 µL of 300 nM 5 nm-sized AuNPs and 300 pM was added to 900 µL of phosphate buffered saline (PBS), respectively. The AuNPs in PBS were analyzed by UV-vis spectroscopy at each time point (5, 10, 30, 60, 120, 180 and 240 min).

Characterization

All of the synthesized AuNPs were observed under TEM (Tecnai G2, FEI, USA) at 120 kV. UV spectra of the AuNPs were recorded by using a SpectraMax M5 (Molecular Devices, USA). Dynamic Light Scattering analysis was conducted by using a Nano ZS (Malvern, UK). Laser desorption/ionization mass spectrometry (LDI-MS) was performed at positive mode on a Autoflex III time-of-flight mass spectrometer (Bruker, Germany). All mass spectra were acquired in reflection mode. Operating conditions were as follows: ion source 1= 19.00 kV, ion source 2= 16.60 kV, lens voltage= 8.44 kV, reflector voltage= 20.00 kV, and reflector voltage 2= 9.69 kV.

Figures



	Zetapotential (mV)
5 nm-sized AuNPs	-43.1 ± 0.8

Fig. S1 a) TEM image, b) UV-vis spectrum, c) DLS profile and d) zeta potential value of 5 nm-sized AuNPs used as a seed in this work.

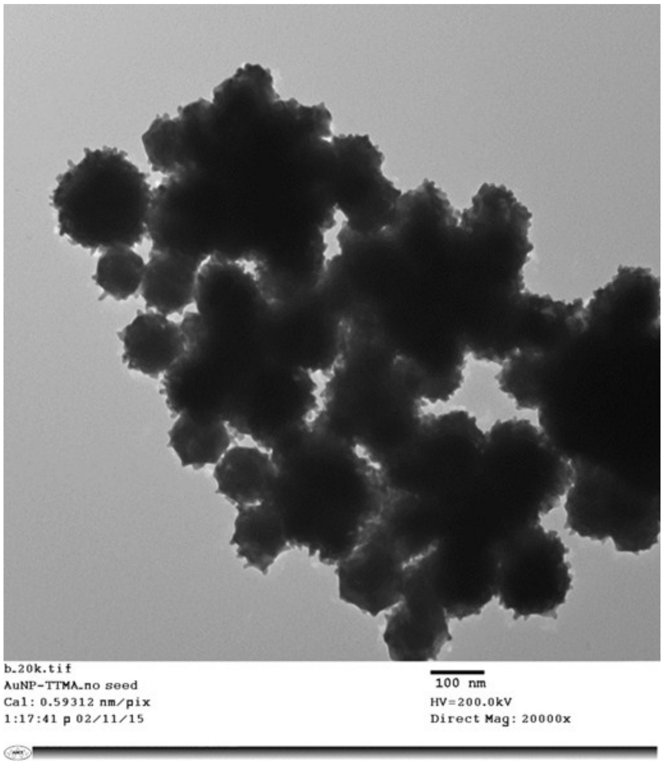


Fig. S2 TEM image of cationic AuNPs that were synthesized by the present method *without* seeds.

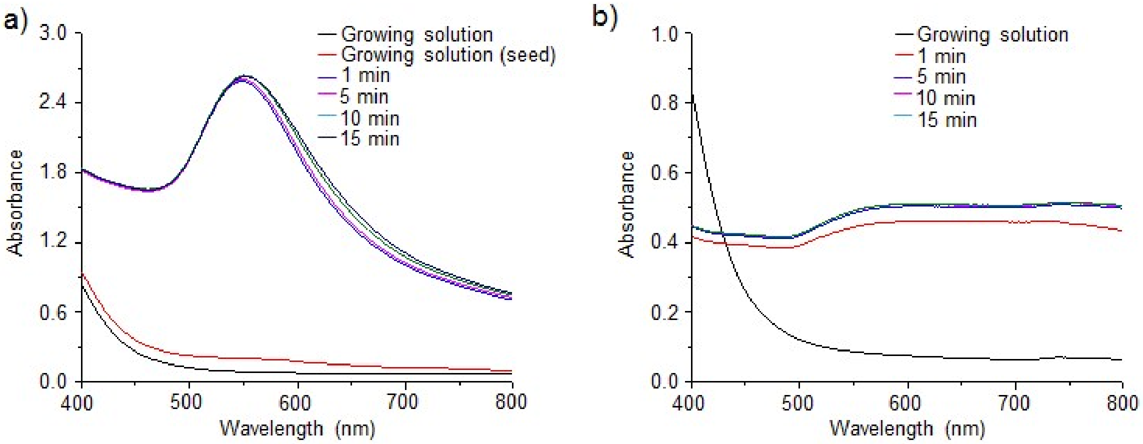


Fig. S3 UV-vis spectra of AuNPs during growth reaction with (a) and without seed (3 pmol) (b).

References

1. X. C. Yang, B. Samanta, S. S. Agasti, Y. Jeong, Z. J. Zhu, S. Rana, O. R. Miranda, V. M. Rotello, *Angew. Chem. Int. Ed.* 2011, **123**, 497.