

Electronic Supplementary Material (ESI) for RSC Advances
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Supporting information for

Salt- and pH-resistant gold nanoparticles decorated with mixed-charge zwitterionic ligands, and their pH-induced concentration behavior

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Experimental Section

Materials and instruments

2-(dimethylamino)ethanethiol hydrochloride (purity > 95%) and sodium borohydride (DAET) (purity > 96%) were purchased from Sigma-Aldrich. 3-mercaptopropylsulfonic acid sodium (MPS) (purity > 98%) was purchased from Adams-Bata. Chloroauric acid tetrahydrate, trisodium citrate dihydrate, hydrochloric acid, sodium hydroxide, and sodium chloride were obtained from domestic suppliers and were of analytical reagent grade. All of the materials were used as supplied.

UV-vis spectra were recorded on a UV-1800 spectrophotometer (Shimadzu, Japan). Transmission electron microscopy (TEM) characterizations were performed on JEM-2100F and JEM-1230 transmission microscopes (JEOL, Japan).

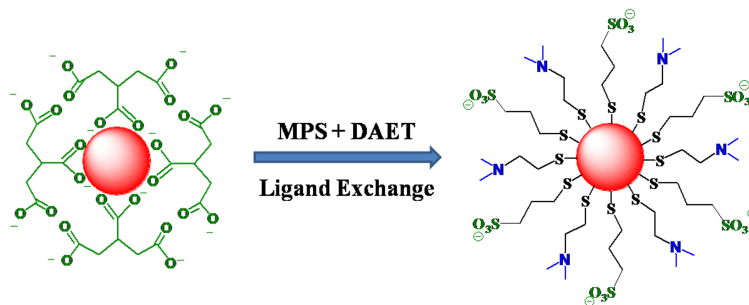
Preparation of 4 nm Au NPs

18.5 mL of H₂O, 0.5 mL of 1.0×10^{-2} M HAuCl₄, and 0.5 mL of 0.01 M sodium citrate were mixed and stirred in an ice-bath-cooled three-necked flask for 5 min. Then, 0.5 mL of 0.1 M NaBH₄ was added to the solution. The color of the solution changed from light yellow to orange, indicating the formation of the 4 nm Au NPs, as confirmed using TEM.

Decorating the 4 nm Au NPs with 1:1 mixed MPS + DAET, MPS, and DAET

48 or 96 μ L of a 1:1 molar ratio 5×10^{-3} M mixed MPS/DAET solution was added to 24 mL of citrate-capped 4 nm Au NPs. The 4 nm Au colloids were then continuously stirred for 12 h at room temperature, to allow sufficient ligand exchange of the citrate ions with the MPS/DAET. Decorating the 4 nm NPs with MPS was performed using a method similar to that used for the decoration of the 4 nm NPs with mixed MPS + DAET. It was noted that the addition of the DAET ligand alone easily caused the aggregation of the 4 nm Au colloids; therefore, no further studies related to single-component DAET decoration were performed. The final surface configuration of the 1:1 mixed MPS/DAET on the surface of the Au NPs is shown in Scheme S1.

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Scheme S1 Schematic surface configuration of 1:1 mixed MPS/DAET-decorated Au NP.

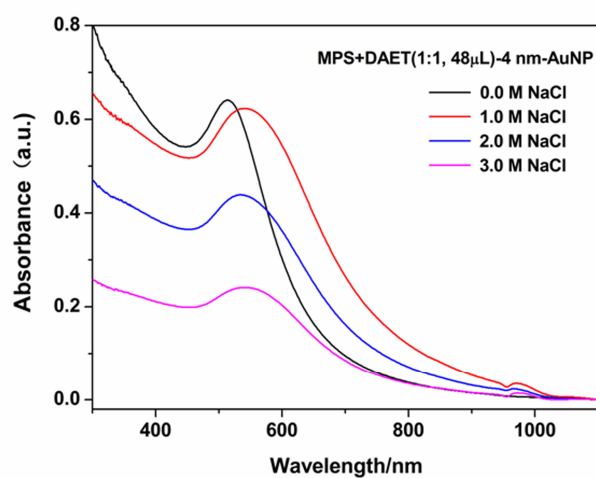


Fig. S1 UV-vis spectra for the 4 nm Au colloids in NaCl solutions with various concentrations, upon the addition of one-monolayer amount of 1:1 mixed MPS/DAET.

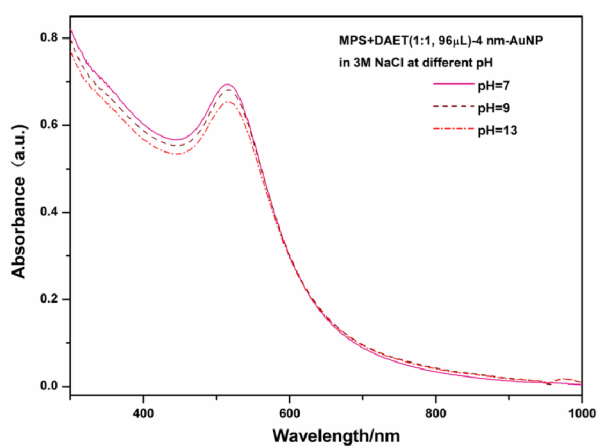


Fig. S2 UV-vis spectra for the 1:1 mixed MPS/DAET-decorated 4 nm Au NPs in 3 M NaCl solutions, at pH values of 7, 9 and 13.

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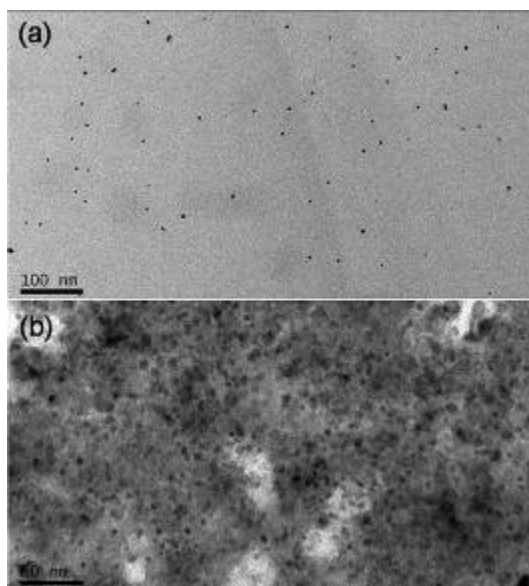


Fig. S3 TEM images of the 1:1 mixed MPS/DAET-decorated 4 nm Au NPs prepared from dispersions at (a) pH = 7, and (b) pH = 5.