Electronic Supplementary Information

Multi-responsive amphiphilic gold nanoparticles (AuNPs) protected by poly (ether amine) (PEA)

Yanna Wen[a], Xuesong Jiang[a]*, Guilin Yin[b], Jie Yin[a] *

a. School of Chemistry & Chemical Technology, State Key Laboratory for Metal Matrix Composite Materials, Shanghai Jiao Tong University, Shanghai 200240, China.

b. National Engineering Research Center for Nanotechnology, Shanghai 200241, China.

Tel.: +86-21-54743268; Fax: +86-21-54747445. E-mail: ponygle@sjtu.edu.cn, jyin@sjtu.edu.cn

Experimental

Measurement

The LCST of gPEA-SH in aqueous solution was measured on Shimadzu UV-2450 spectrophotometer by monitoring the turbidity of the polymer solution as a function of temperature at 500 nm with the heating rate of 1 ^{o}C/min. The temperature at 90% light transmittance of the polymer solution was defined as the LCST. The aqueous solution was prepared from 0.1 M citrate buffered aqueous solution with polymer concentration 1.0 mg/ml.

The UV-vis spectra of solution were measured by Shimadzu UV-2450 spectrophotometer at different exposure time and the solution was diluted 10 times. A spot of AuNPs was centrifuged and dissolved in different polar solvents to measure its solubility. Thermogravimetric analysis (TGA) was conducted in nitrogen (N_2) with a heating rate of 20 ^{o}C/min using a TA Q5000IR thermogravimetric analyzer. For a morphological study, the sample was dropped on carbon-coated copper grids and get rid of solvent for transmission electron microscope (TEM, JEOL2100F) operated at 200 kV.

Dynamic light scattering (DLS) was performed in aqueous solution using a Malvern Zetasizer Nano S apparatus equipped with a 4.0 mW laser operating at λ =633 nm. All samples were measured at a scattering angle of 173^{o}. The variable temperature DLS measurements were also conducted at different temperature from 25 to 50 ^{o}C, and the samples were kept in the sample cell for more than 10 min to achieve stable temperature.

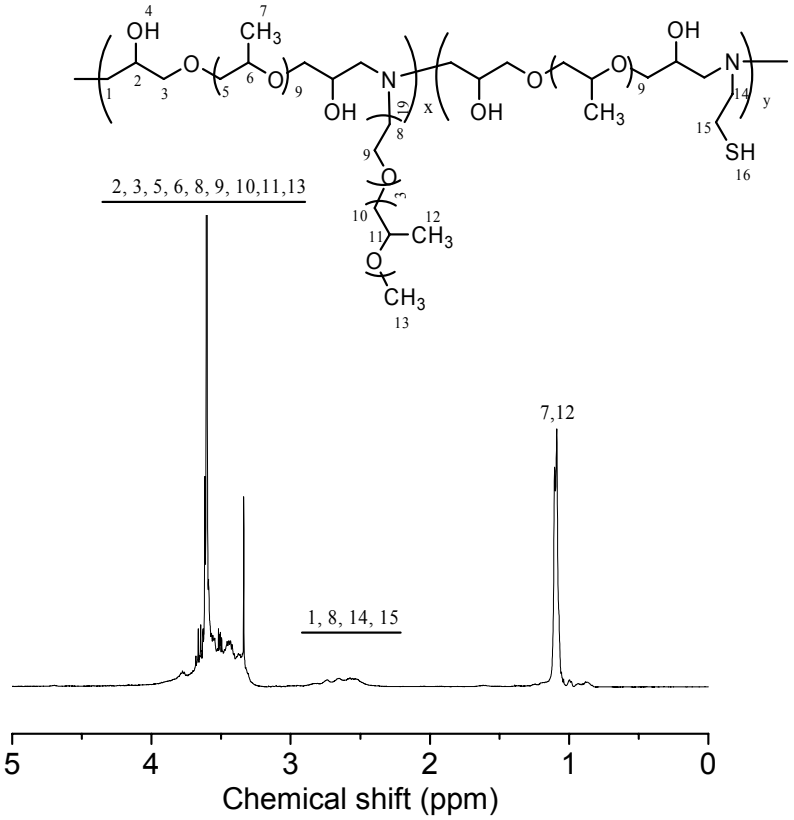
Materials:

Poly (propylene glycol) diglycidyl ether (PPO, M_n=640) and β-mercaptoethylamine (MEA) were purchased from Sigma-Aldrich. Jeff amine L100 (M_n=1000) was purchased from Hunstman Co., Ltd. Chloroauric acid tetrahydrate ($HAuCl_4$) was purchased from sinopharm Chemical Reagent Co., Ltd. All of these materials were used without purification. Polymeric Michle ketone photoinitiator (APMK) was synthesized in our lab according to the literature. Distilled deionized water was used in preparing the gold nanoparticles. Other chemicals are of analytical grade except as noted.

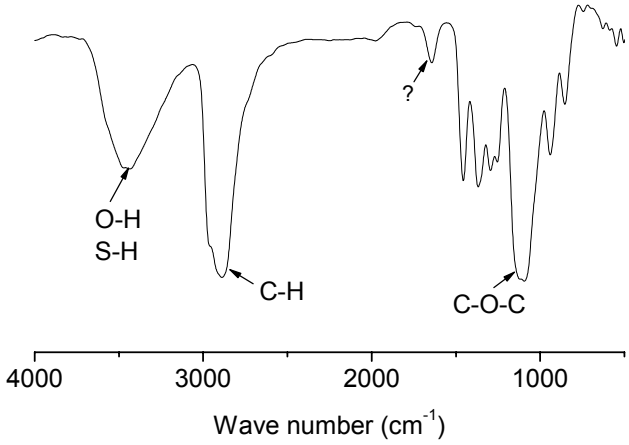
Synthesis and characterization of gPEA-SH

1.28 g (2 mmol) PPO640, 1.0 g (1 mmol) Jeff amine L100, 0.077g (1 mmol) β-mercaptoethylamine (MEA) and 10 ml ethanol were added into two-necked flask. The mixture was heated to 80 ^{o}C for 24 h under nitrogen. After cooling to room temperature, the mixture was poured into 10 fold anhydrous ether and filtered, dried in vacuum at 40 ^{o}C to get gPEA-SH.

FTIR: 3434 cm^{-1} (OH), 2891 cm^{-1} (CH), 1096 cm^{-1} (C-O-C). GPC: $M_n=1.6\times10^4$, $M_w=8.1\times10^4$, $M_w/M_n=5.1$.



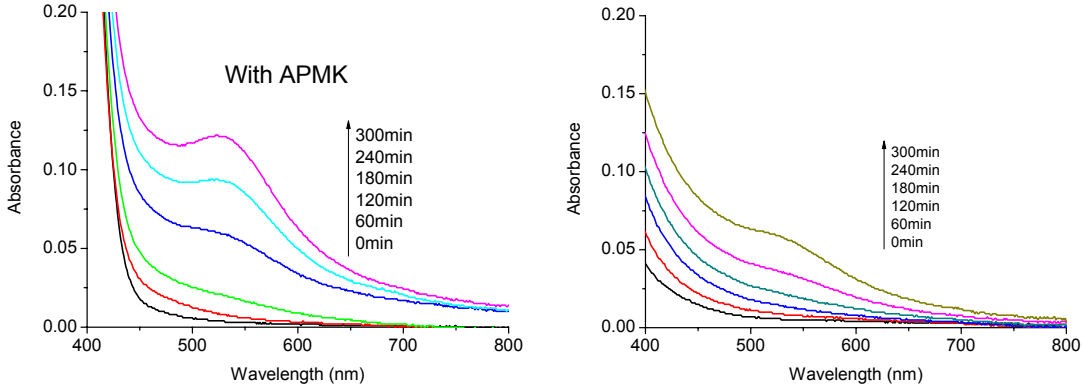
S1. ^{1}H NMR of gPEA-SH using $CDCl_3$ as solvent



S2. FTIR spectrum of gPEA-SH

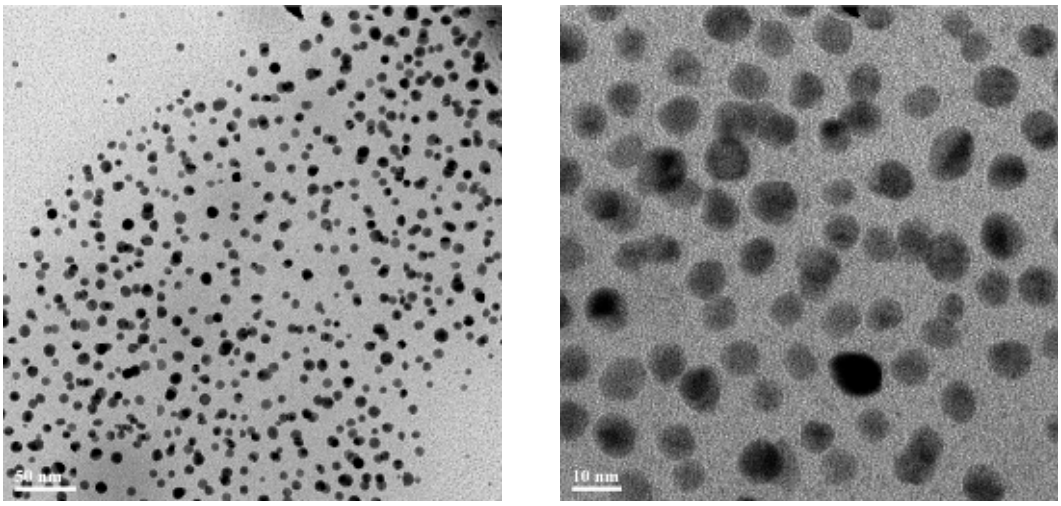
Synthesis and characterization of gold nanoparticles

A certain amount of gPEA-SH, $HAuCl_4$ and APMK were dissolved in distilled deionized water. The mixture was irradiated by UV light with a 365 nm cut-off filter, whose intensity is 2 mW/cm^2. With the increasing of exposure time, the solution changed from yellow to wine red, indicating the formation of AuNPs.

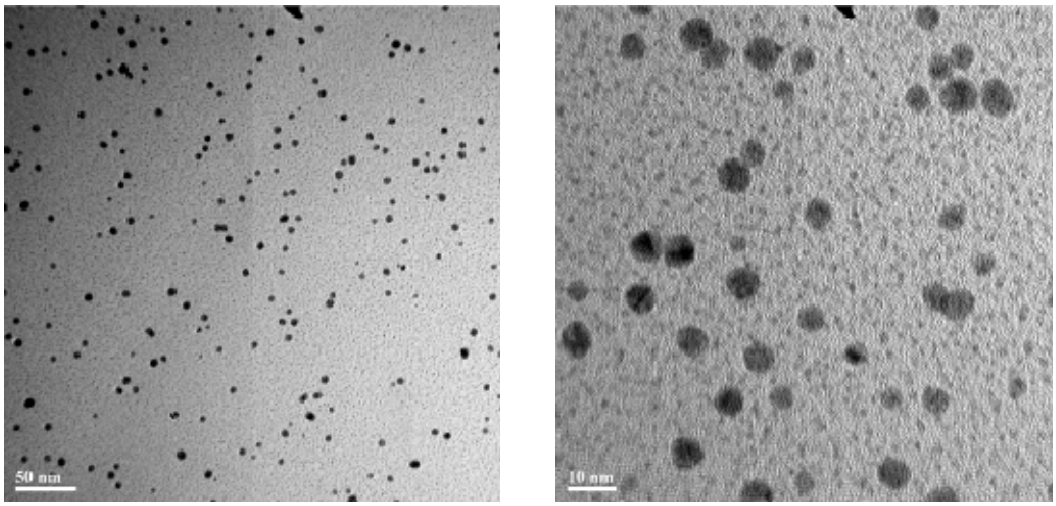


(a) (b)

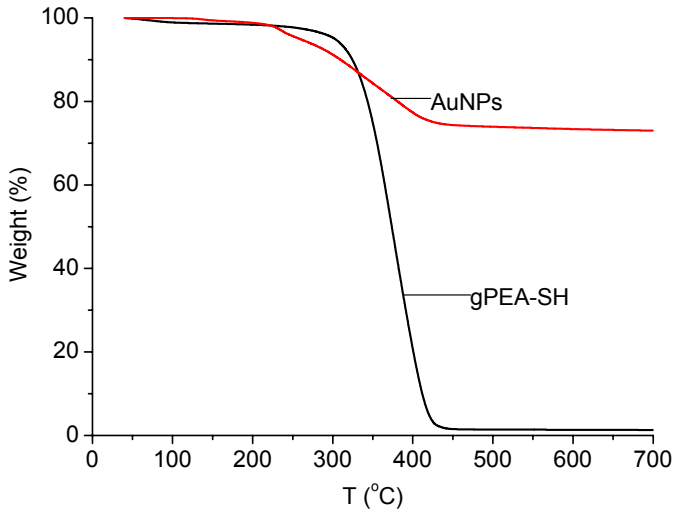
S3. UV-vis absorbance spectra of gold nanoparticles prepared (a) with APMK and (b) without APMK at different irradiation time.



S4. TEM image of AuNPs prepared by 1 mM $HAuCl_4$, 1.5 mM gPEA-SH and 0.5 mM APMK in aqueous solution (pH8.0) under UV irradiation with the intensity of 2 mW/cm^2 for 300 min at room temperature



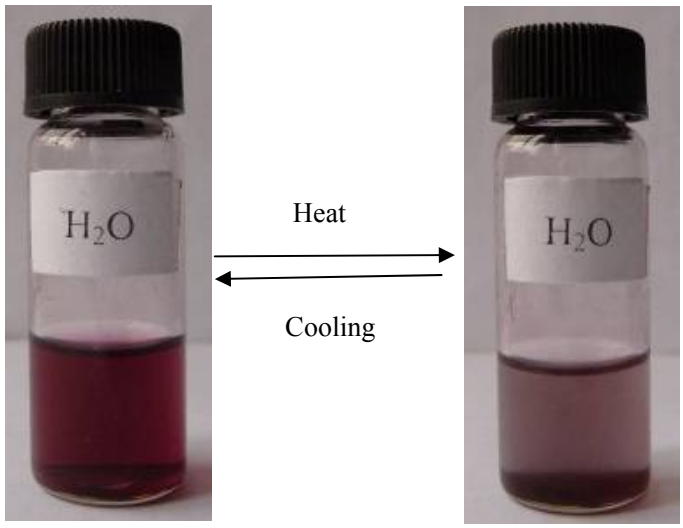
S5. TEM image of AuNPs prepared by 1 mM $HAuCl_4$ and 1.5 mM gPEA-SH in aqueous solution (pH8.0) under UV irradiation with the intensity of 2 mW/cm^2 for 300 min at room temperature



S6. TGA of gPEA-SH and AuNPs prepared by 1 mM $AuCl_3$, 0.5mM APMK and 1.5 mM gPEA-SH in aqueous solution (PH8.0) at different irradiation time.

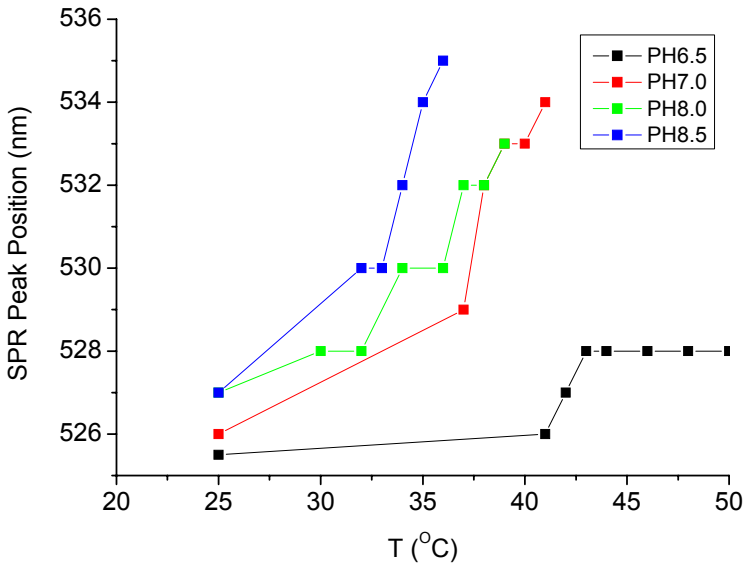
Solubility of the obtained AuNPs

S7. Photo pictures of AuNPs in different polarity solvents at room temperature.

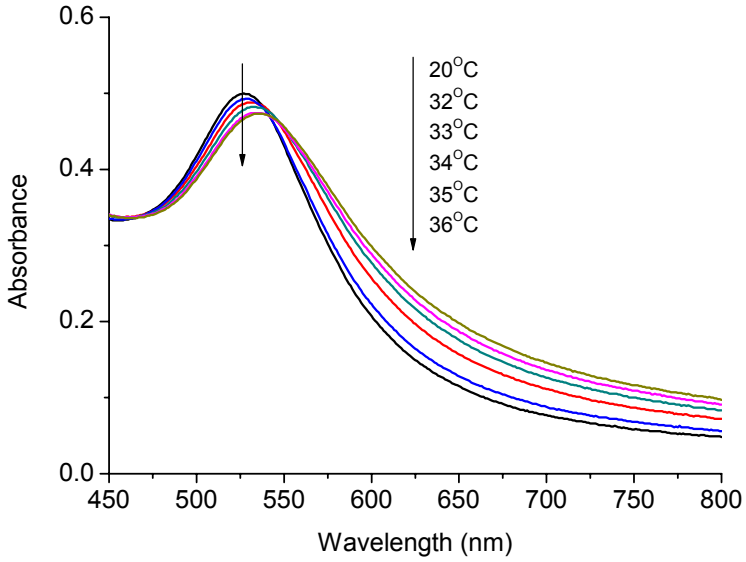


S8. AuNPs in aqueous solution at 20 ^{o}C (left) and 40 ^{o}C (right).

Effect of pH and temperature on AuNPS



S9. The SPR of AuNPs at different temperature in different PH solution



S10. UV-vis absorbance spectra of AuNPs in aqueous solution (pH8.5) at different temperature