Supporting information for

L-Ergothioneine Promotes the Formation of Long Gold Nanowires and Their 2D Assembly

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Content List

Part 1. The fabrication of gold nanowires in the presence of various gold seeds.

I. Synthesis of gold seeds

Synthesis of $NaBH_4$-seeds

30 μL $HAuCl_4$ (82.5 mM) was added to 7.5 mL of aqueous CTAB (100 mM) solution, the clear solution changed to orange-yellow color, followed by the injection of 200 μL $NaBH_4$ (40 mM) aqueous solution in an ice bath, the solution immediately changed to brown color, and then mixed the solution rapidly for 2 min by shaking. Finally, the seed solution was kept in a water bath at 30°C for 3h to decompose excess $NaBH_4$.

Synthesis of CA-seeds

24 μL $HAuCl_4$ (82.5 mM) was added to 7.5 mL trisodium citrate (0.27 mM) aqueous solution, followed by the injection of 200 μL $NaBH_4$ (100 mM) solution in an ice bath, and then mixed the solution rapidly for 2 min by shaking. Finally, the seed solution was kept in a water bath at 30°C for 3h to decompose excess $NaBH_4$.

II. Synthesis of gold nanowires in the presence of gold seeds

To observe the influence of gold seeds, typically, gold seeds (25 μL, either $NaBH_4$-seeds or CA-seeds) generated by $NaBH_4$ were added into the $HAuCl_4$/CTAB/EGT aqueous solutions and the mixture was incubated for 10 minutes. Finally, AA was added. The following procedure were kept the same as those fabrications without gold seeds.

Part 2. Figures

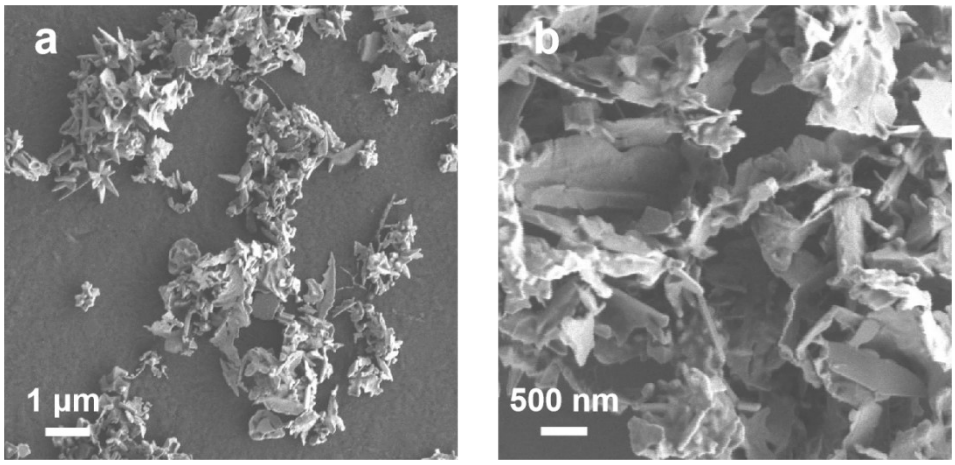


Figure S1. SEM images showing that mussy gold nanostructures generated in CTAB/$HAuCl_4$/AA procedure. (a) The concentrations for CTAB, $HAuCl_4$ and AA were 5, 0.4, and 2 mM, respectively. (b) The concentrations of CTAB, $HAuCl_4$ and AA were 30, 0.4, and 8 mM, respectively.

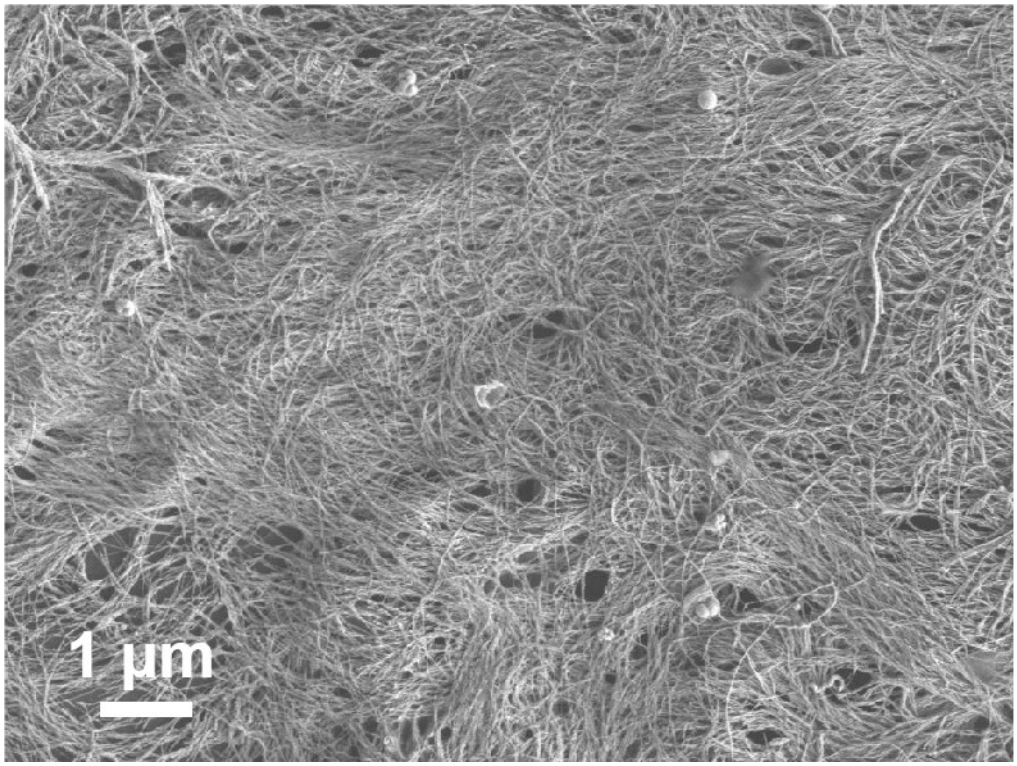


Figure S2. SEM image of obtained long gold nanowires after adding EGT in the CTAB/$HAuCl_4$/AA system. The concentrations of EGT, $HAuCl_4$, CTAB and AA were

0.1, 0.4, 8, and 2 mM, respectively.

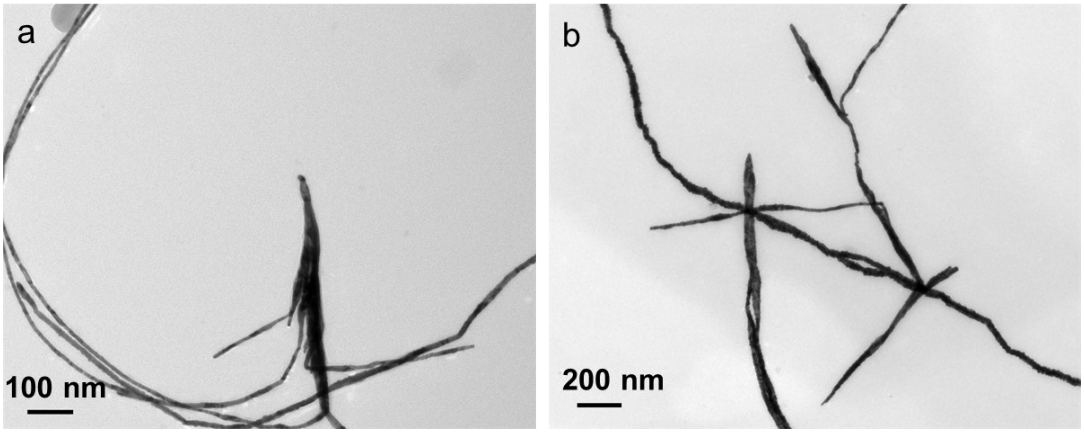


Figure S3. TEM images of gold nanowires.

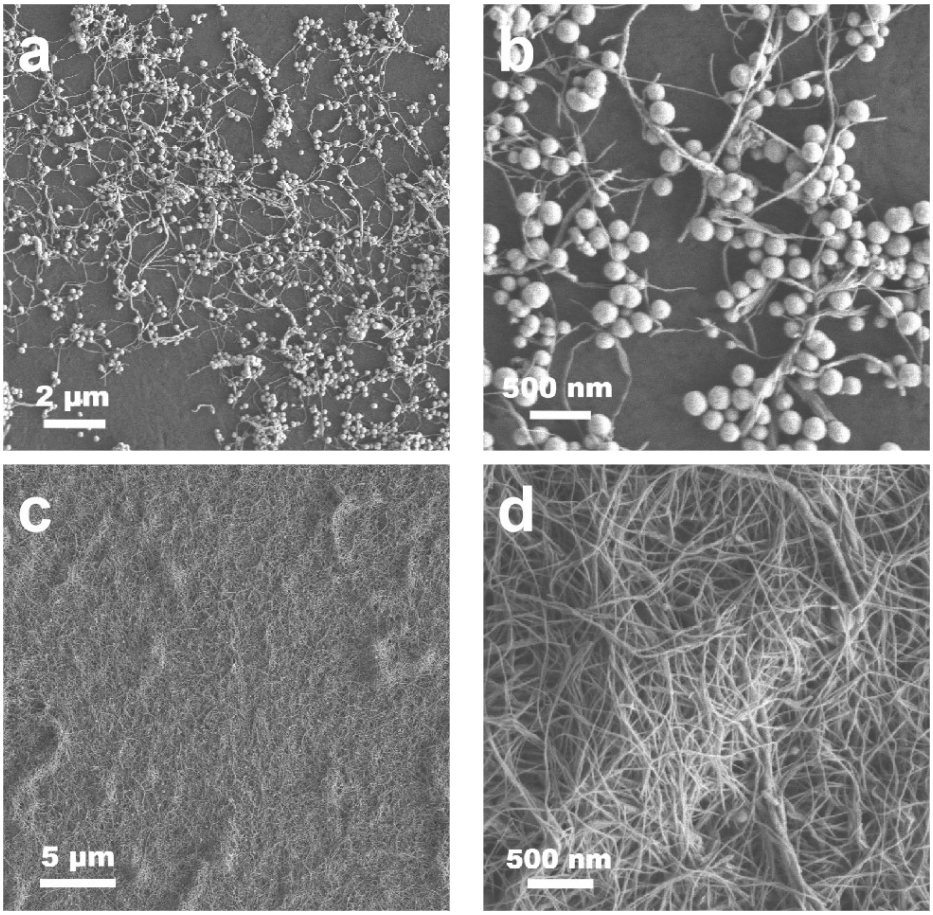


Figure S4. The comparison of the products obtained in glass vials (a-b) and PP vials (c-d). The concentrations of CTAB, $HAuCl_4$, EGT and AA were 8, 0.4, 0.1, 8 mM, respectively.

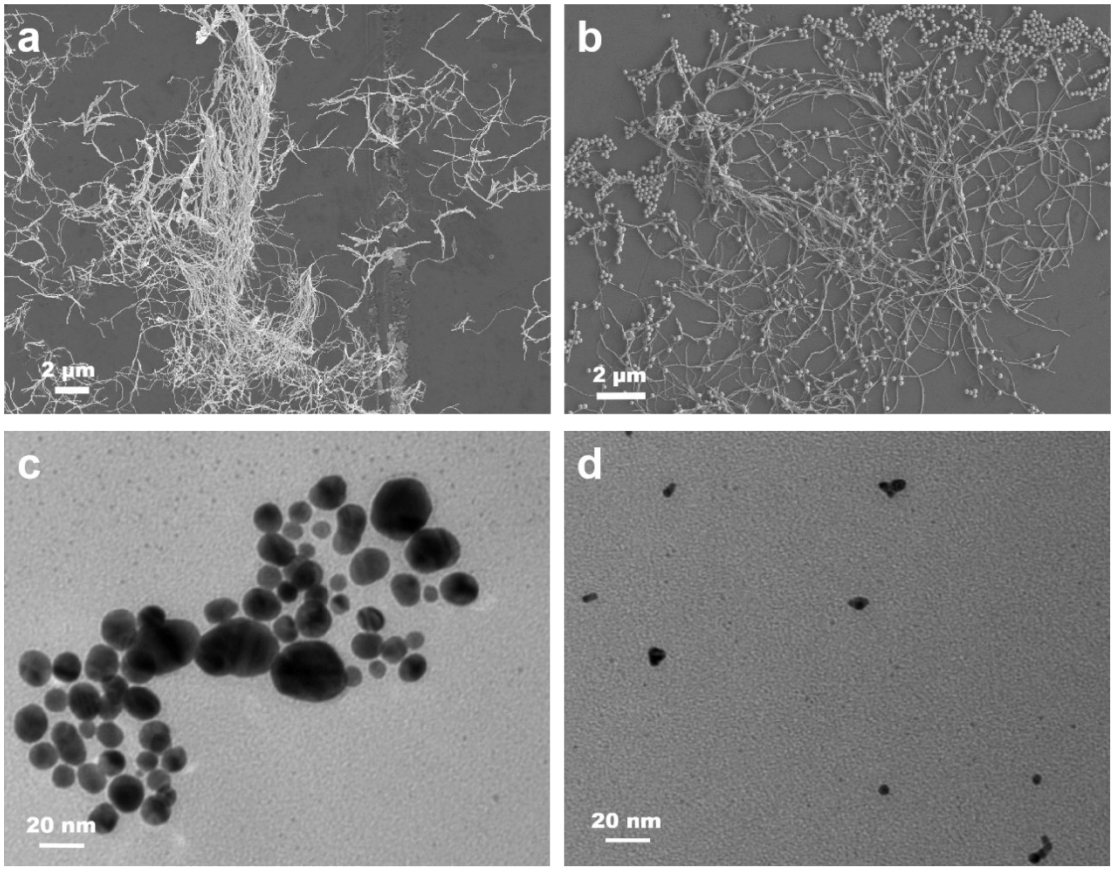


Figure S5. SEM images of gold nanowires generated with $NaBH_4$-seeds (a) and CA-seeds (b). TEM images of $NaBH_4$-seeds (c) and CA-seeds (d). Although the size of these seeds was in a range from several nanometers to 20 nm, the diameter of corresponding gold nanowires was still in a narrow distribution. The concentration of CTAB, $HAuCl_4$, EGT and AA in (a-b) were 16, 0.4, 0.06, 8 mM respectively. The adding amount of seeds were 25 μL.

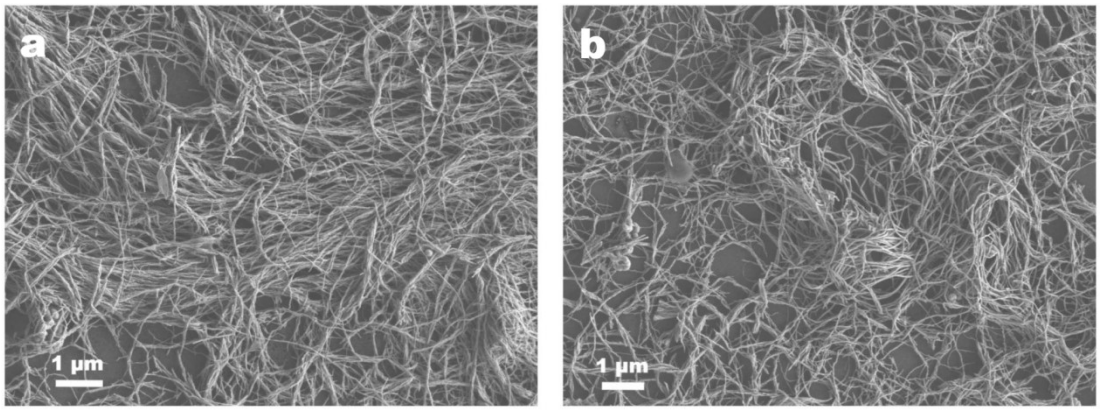


Figure S6. SEM images of gold nanowires generated in the molar ratio of $HAuCl_4$:AA at 1:1.25 (a) and 1:2.5 (b). The concentrations of CTAB, $HAuCl_4$, EGT and AA were (a) 8, 0.4, 0.1, 0.5 mM and (b) 8, 0.4, 0.1, 1 mM, respectively.

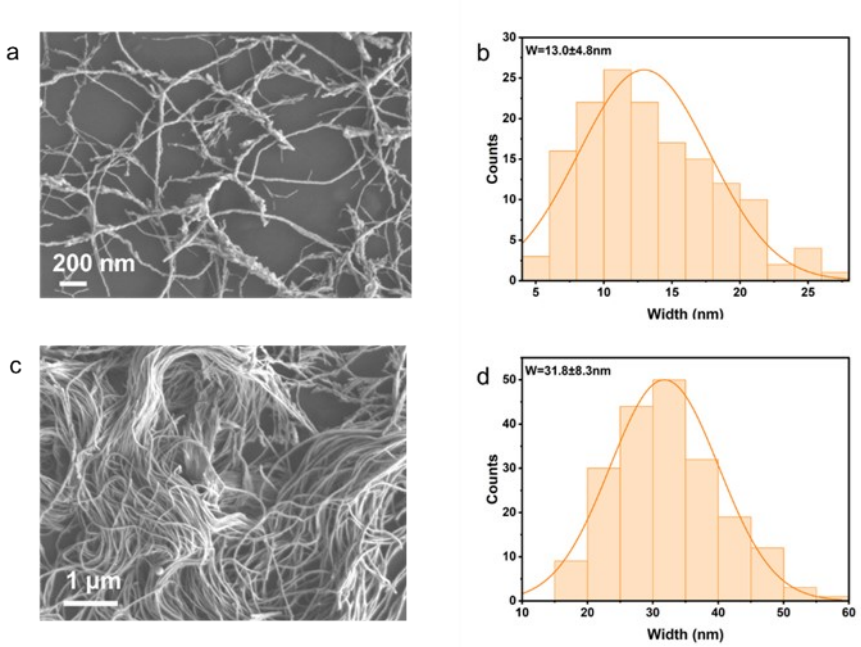


Figure S7. (a, c) SEM image of gold nanowires in two different CTAB concentrations. The preparation conditions were as following: CTAB 16 mM (a) or 8 mM (c), $HAuCl_4$ 0.4 mM, EGT 0.2 mM, and AA 8 mM. (b, d) The histogram of diameter distribution of gold nanowires in (a) or (c).

The diameter distribution of these isolated nanowires in (a) is around 13 nm, but there were many aggregated nanowires which cannot be counted, and they showed branched

feature, thus this sample was not listed as a high-quality gold nanowire.

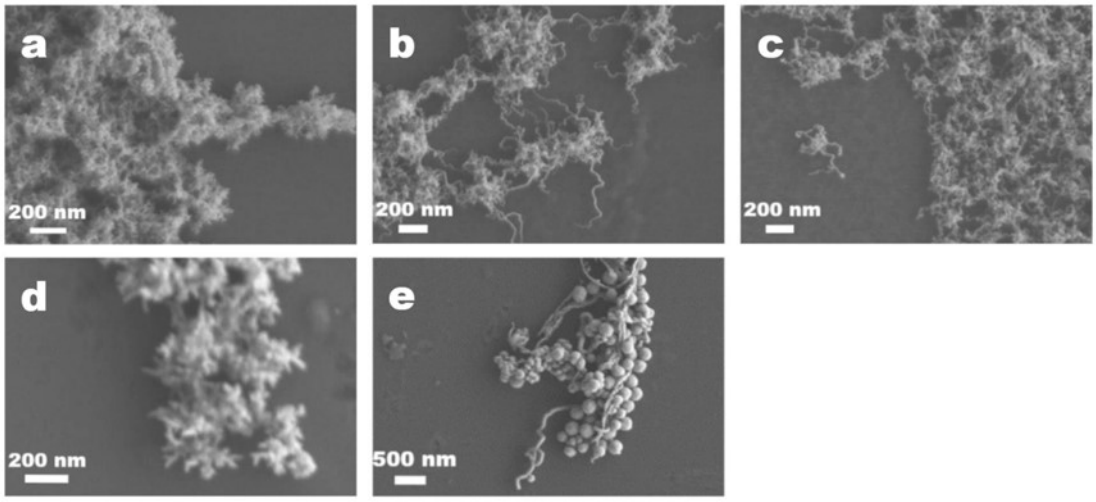


Figure S8. SEM images of gold nanostructures obtained in the lower concentration range of CTAB, 0.5–2 mM. (a) EGT 0.01 mM, CTAB 0.5 mM, (b) EGT 0.05 mM, CTAB 0.5 mM, (c) EGT 0.2 mM, CTAB 0.5 mM, (d) EGT 0.01 mM, CTAB 1 mM, (e) EGT 0.01 mM, CTAB 2 mM. The obtained nanostructures in above conditions are highly branched and twisted, or accompanied by gold nanoparticles.

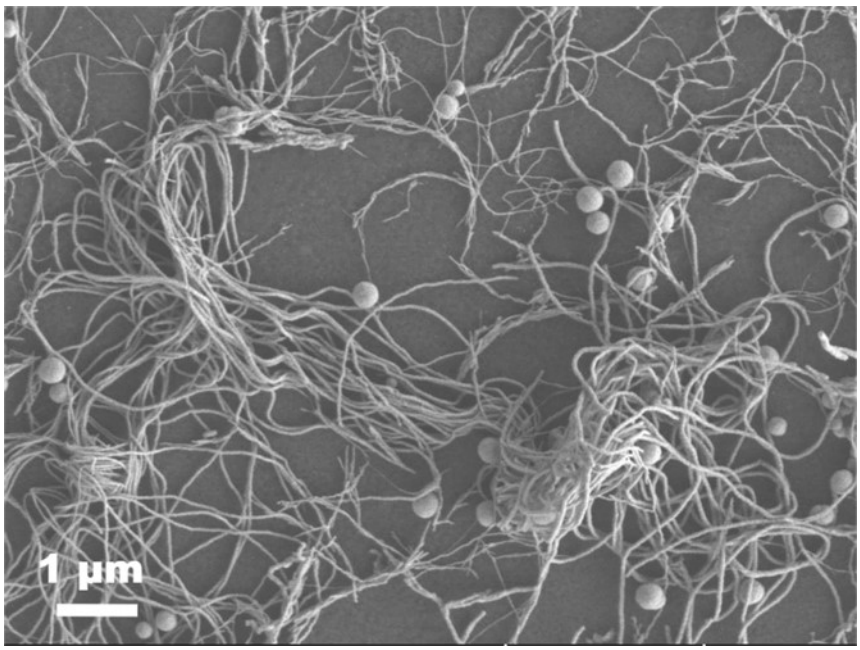


Figure S9. Longer gold nanowires with spheres generated in the condition of 0.01 mM EGT and 8 mM of CTAB.

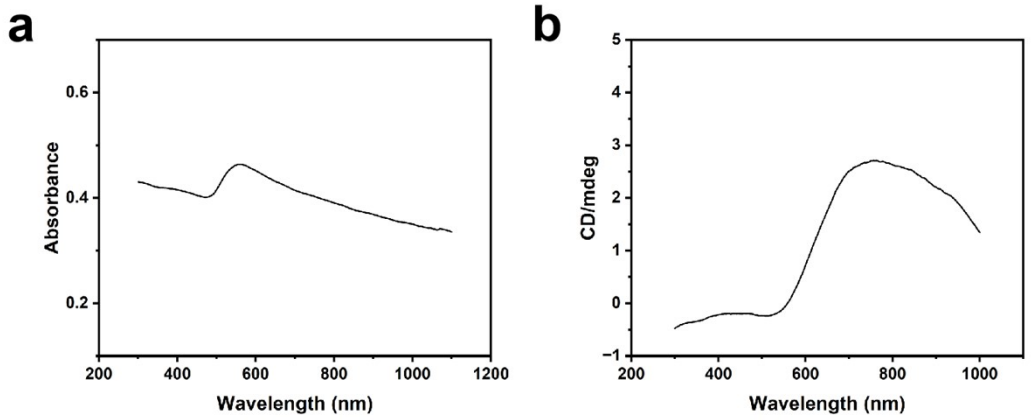


Figure S10. Extinction spectrum (a) and CD spectrum (b) of gold nanowires generated in the condition of 0.1 mM EGT and 16 mM of CTAB.

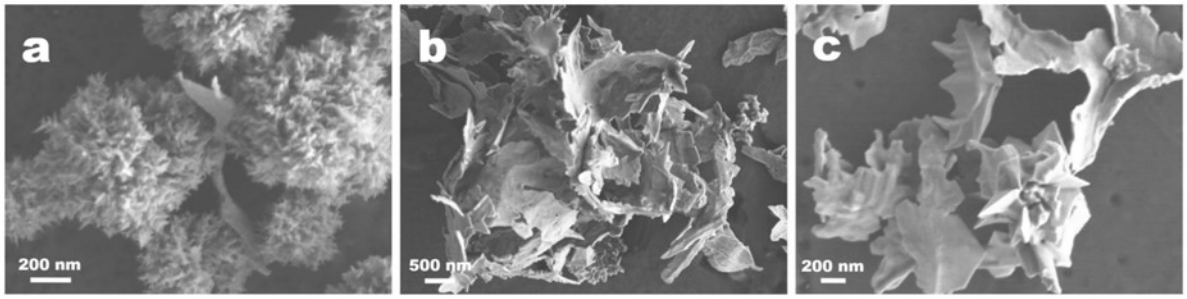


Figure S11. SEM images of the products by adding 0.1 mM $_{L}$-cysteine (a), $_{L}$-histidine (b), and betaine (c), to replace EGT. The concentration of CTAB was 16 mM.

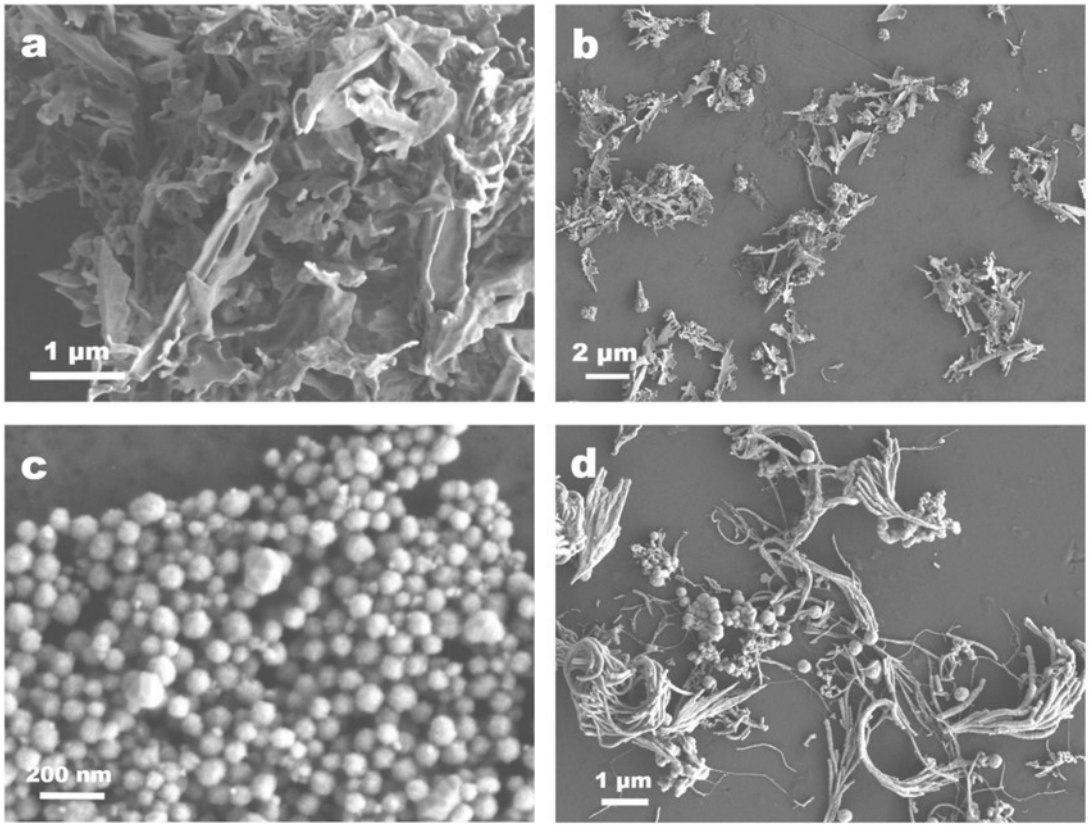


Figure S12. SEM images of gold nanoparticles obtained in different concentration of 2-MAD, 50 (a), 100 (b), 200 (c), 400 μM (d), respectively, with 8 mM CTAB.

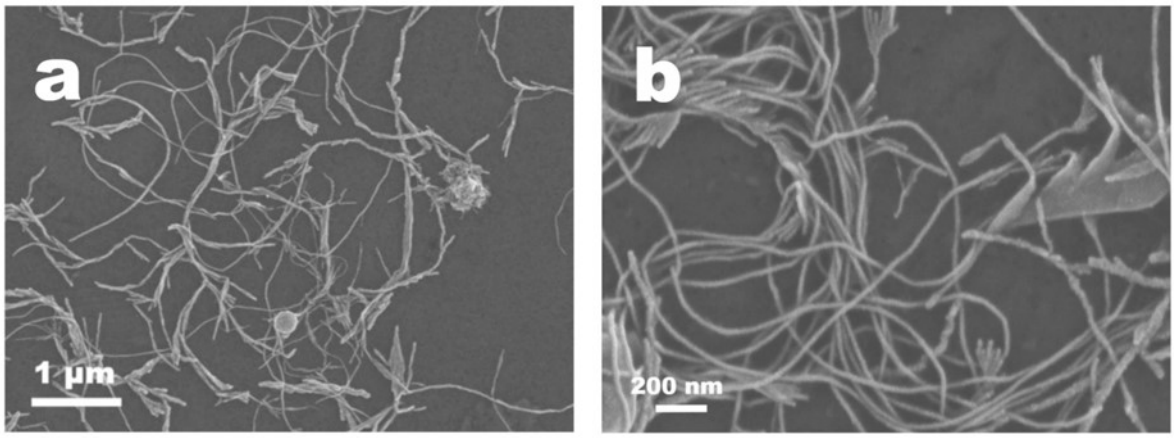


Figure S13. SEM images of gold nanowires obtained in the presence of 16 mM CTAC (a-b) with 0.1 mM EGT.

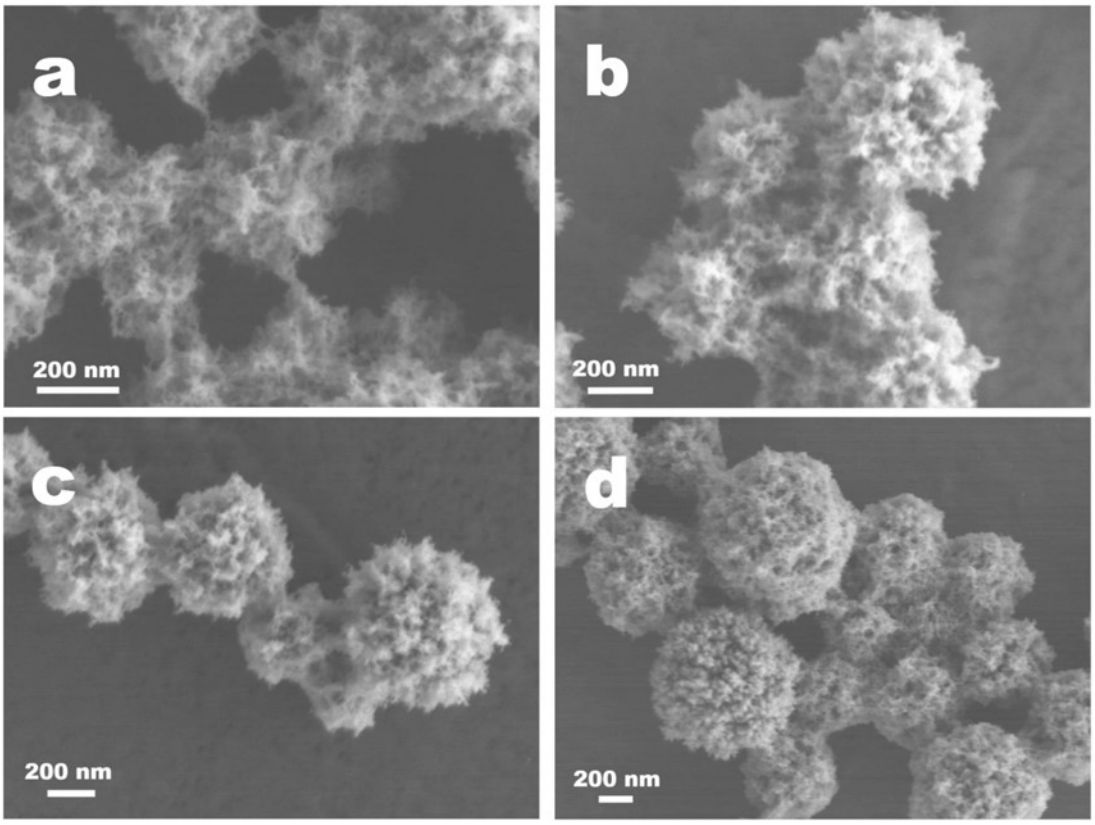


Figure S14. (a-d) SEM images of gold nanoparticles obtained in different concentration of CPC, 2 (a), 4 (b), 8 (c), 16 mM (d), respectively, with 0.1 mM EGT, 0.4 mM $HAuCl_4$ and 8 mM AA.

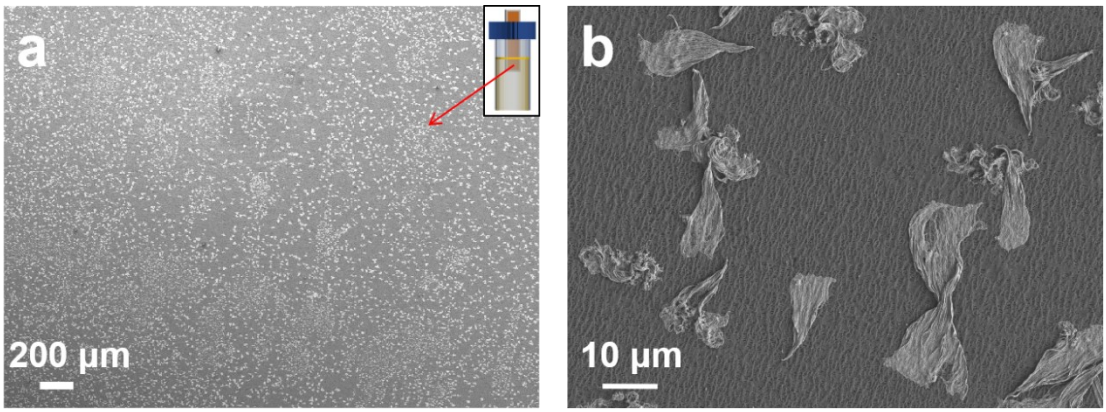


Figure S15. SEM images of gold nanowires aggregated on the PP membrane, which was inserted into the reaction solution partly in a glass vial. (a) Gold nanowires were formed on the part of PP membrane immersed in solution. (b) Gold nanowires aggregated to weaves on PP membrane.

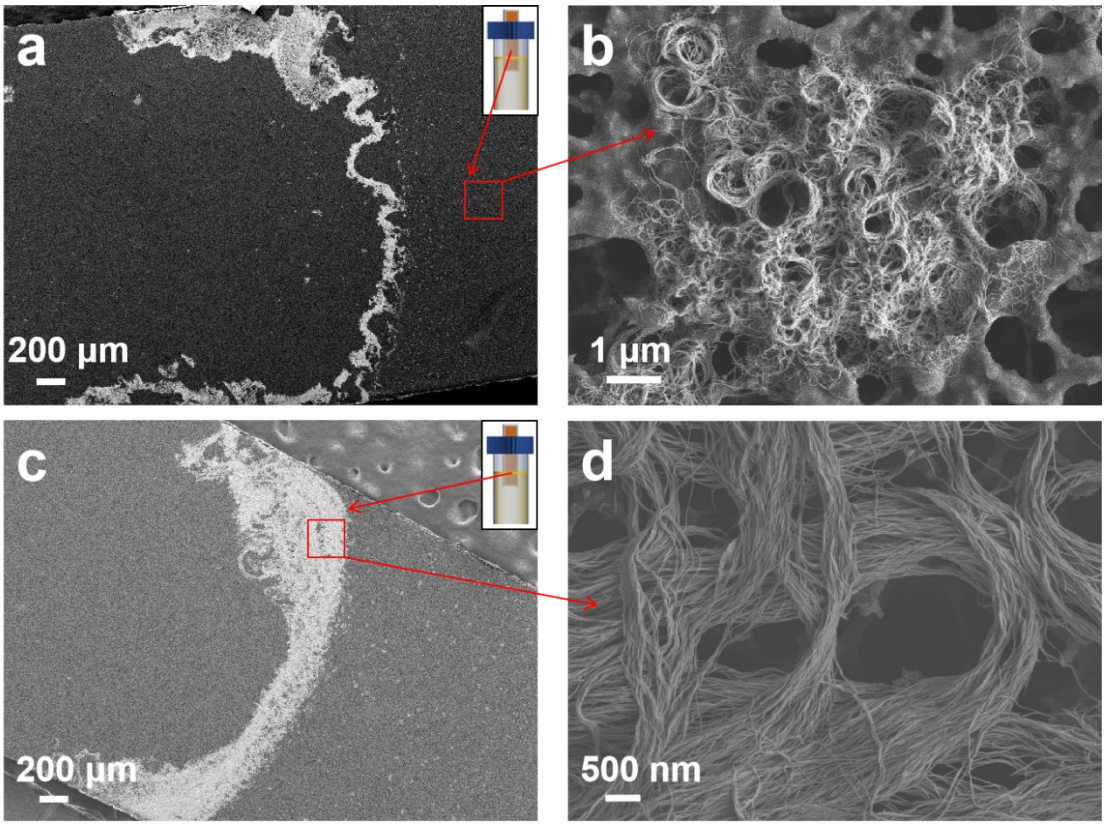


Figure S16. SEM images of gold nanowires aggregated on MCE membranes, which were inserted into reaction solutions partly in the glass vial. (a, b) Gold nanowires can be observed above the contact level of the reaction solutions. (c, d) Most of gold nanowires are aggregated around the contact line of MCE membrane and reaction solution.

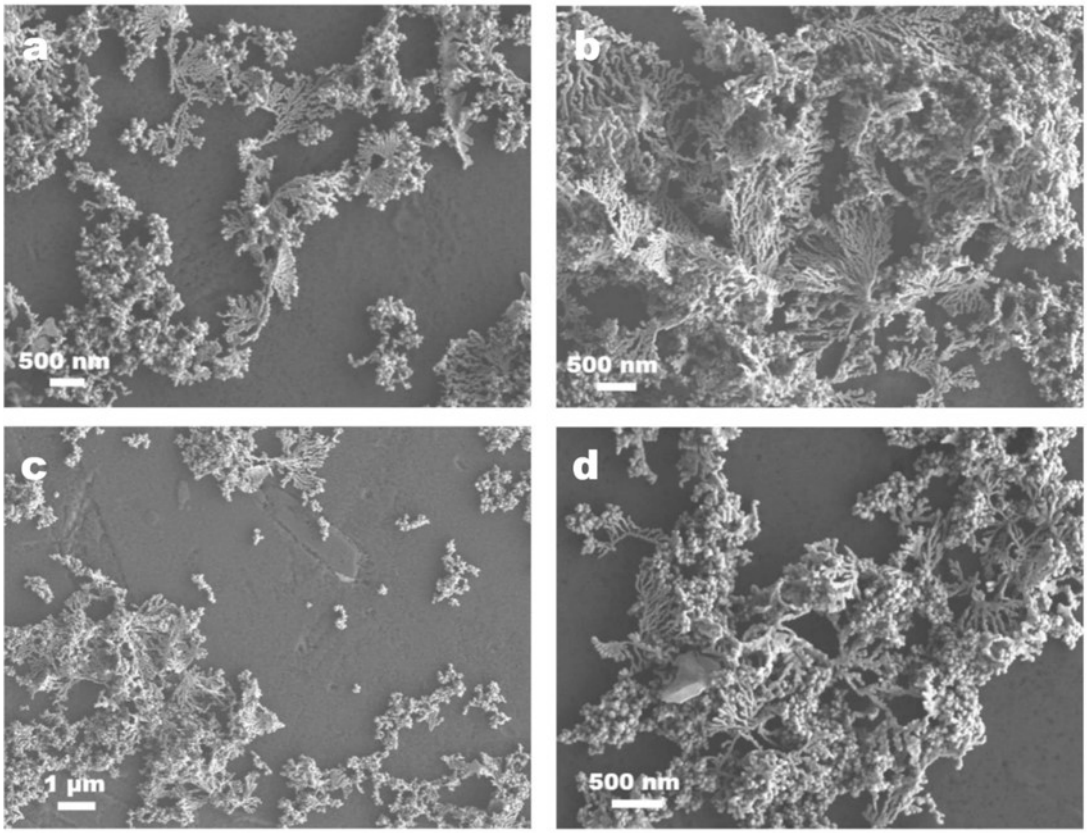


Figure S17. SEM images of branched leaf-shaped gold nanostructures generated under varied concentrations of KI, 7.5 (a), 10 (b), 15 (c), and 25 μM (d), respectively, in the presence of 0.5 mM CTAB and 0.1 mM EGT. The branched leaf-shaped gold nanostructures were obtained under a low concentration of CTAB (0.5 mM) when the concentration of KI (5 μL, 5 mM), EGT was 0.1 mM, AA 8 mM.

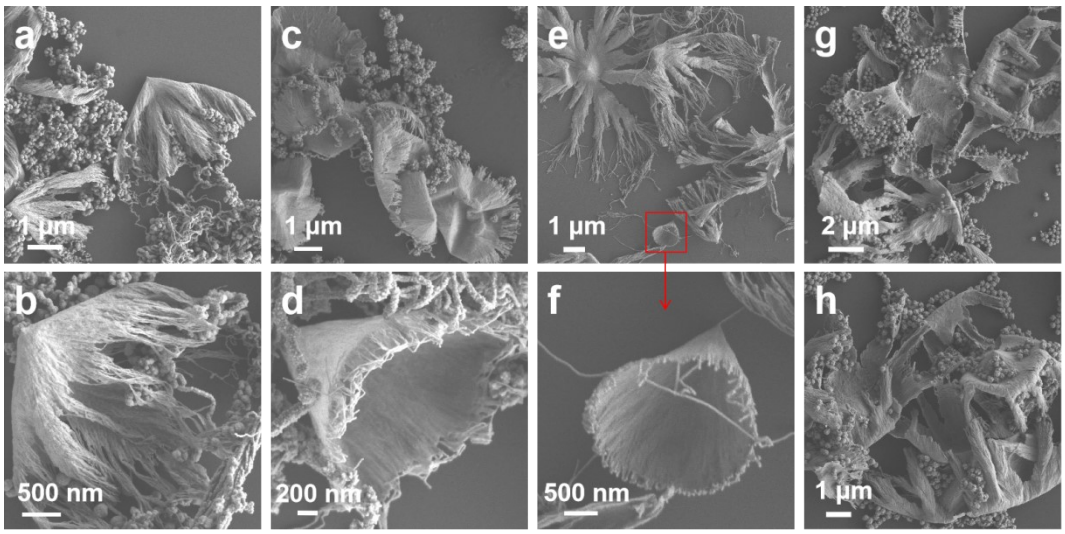


Figure S18. SEM images of assembled gold structures obtained at conditions with C_{KI} (μM): C_{CTAB} (mM) (a-b) 2:2, (c-d) 3:3, (e-f) 3:4, and (g-h) 4:4, respectively.

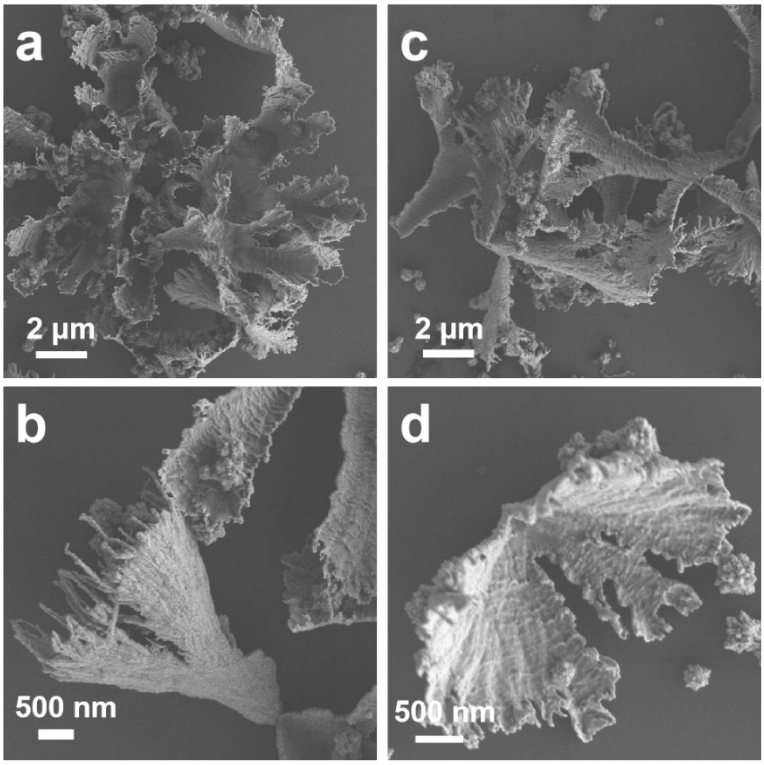


Figure S19. SEM images of the products obtained at conditions with C_{KI} (μM): C_{CTAB} (mM) (a-b) 5:5 and (c-d) 6:6, respectively.

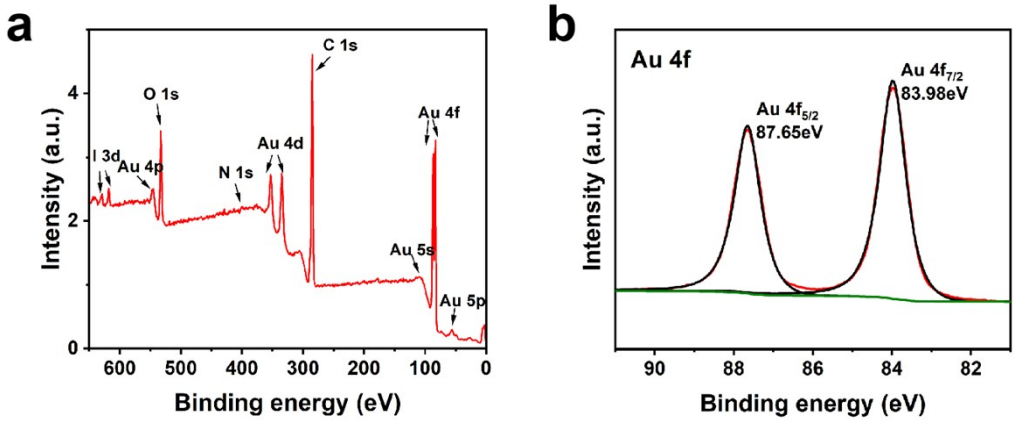


Figure S20. XPS characterization of these assembled 2D leaf-like gold nanostructures, confirming that they are Au (0).

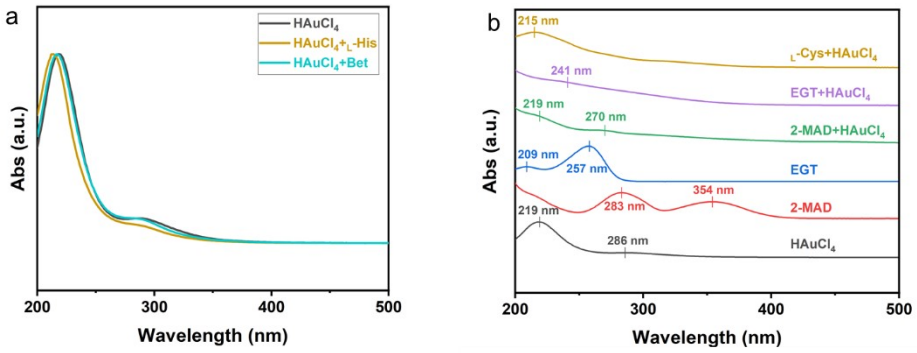
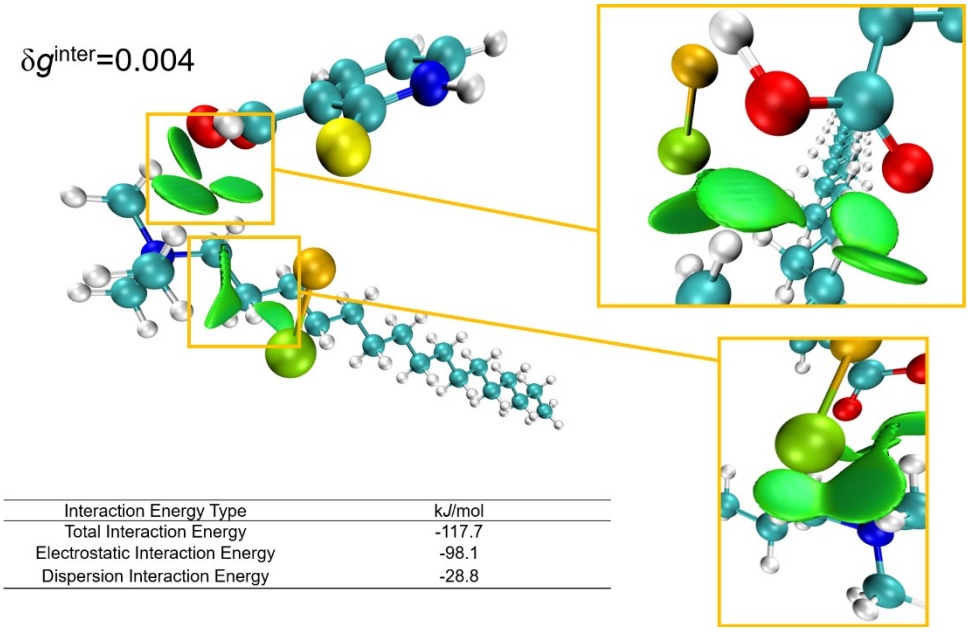


Figure S21. UV-Vis spectra of $HAuCl_4$ (0.1 mM) before and after adding histidine/betaine (a) or $_L$-Cys/EGT/2-MAD (b). The concentration of $_L$-histidine($_L$-His), betaine (Bet), $_L$-Cys, EGT and 2-MAD was 0.1 mM.



Interaction Energy Type	kJ/mol
Total Interaction Energy	-117.7
Electrostatic Interaction Energy	-98.1
Dispersion Interaction Energy	-28.8

Figure S22. The non-covalent interaction between CTAB and $[MAD\text{-}Au(I)Cl]^-$ calculated by DFT. This analysis is done with Multiwfn Version 3.8. The red, yellow, green-blue, indigo, gold, green and gray balls represent O, S, C, N, Au, Cl, and H atoms, respectively. The blue colored areas represent prominent attractive weak interaction while the green colored areas represent weaker Van der Waals reaction.