Supplementary information

Seedless synthesis and SERS characterization of multi-branched gold nanoflowers using water soluble polymers

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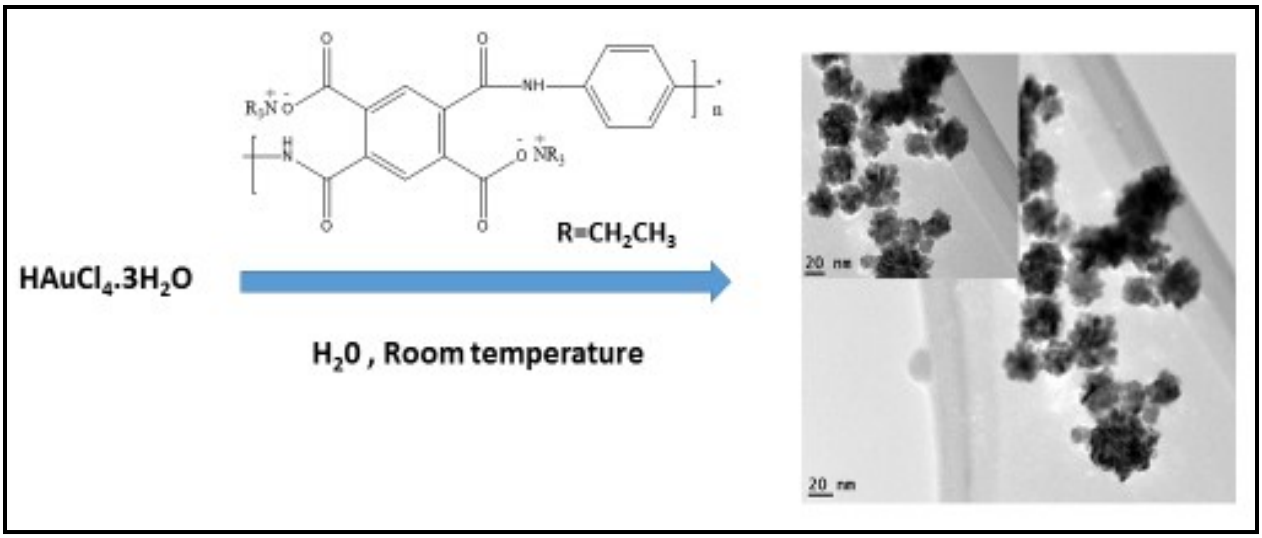


Figure S1: Synthesis of AuNFs with PPDDs

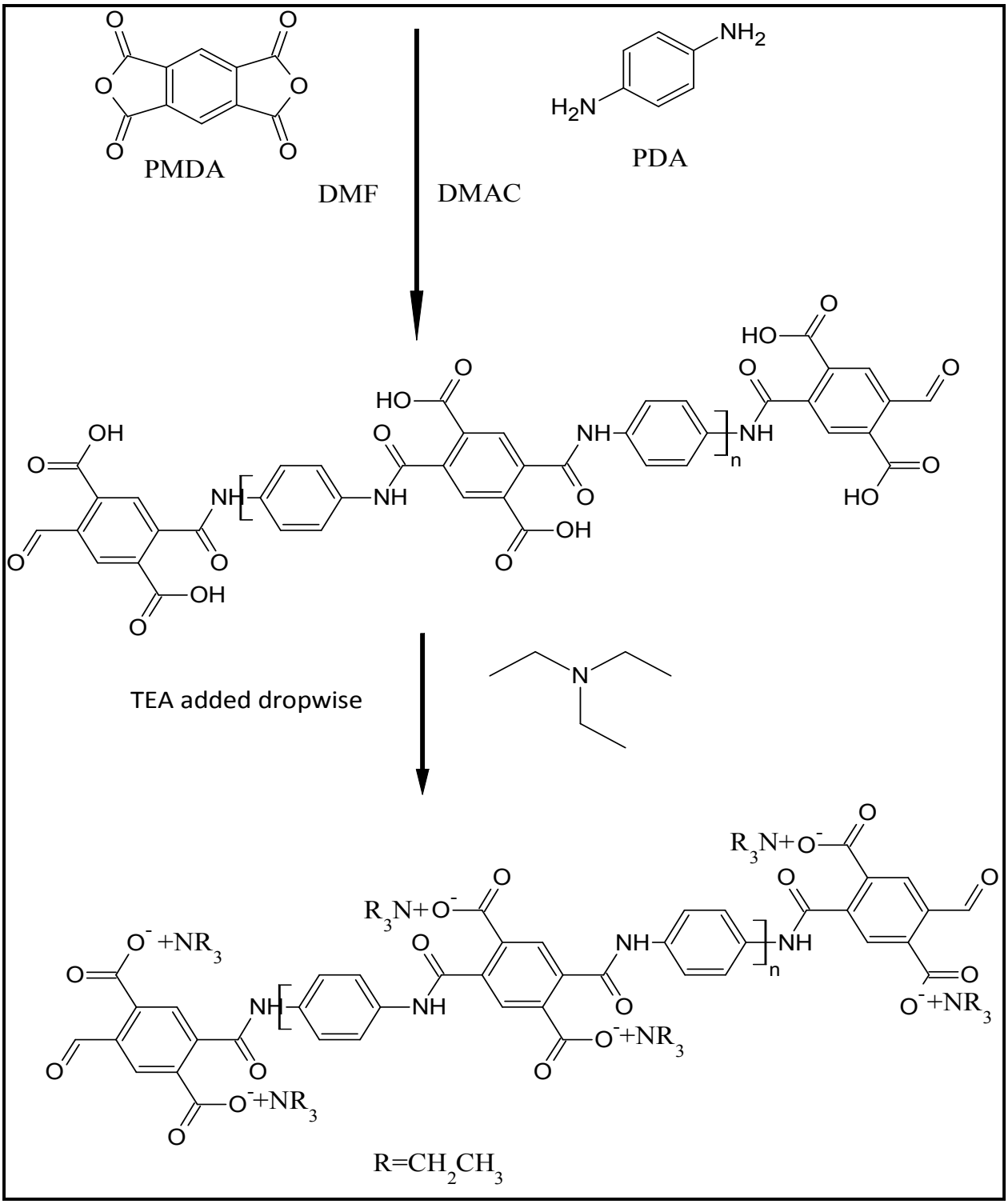


Figure S2: Summary of the synthesis of PPDD and PPDDs

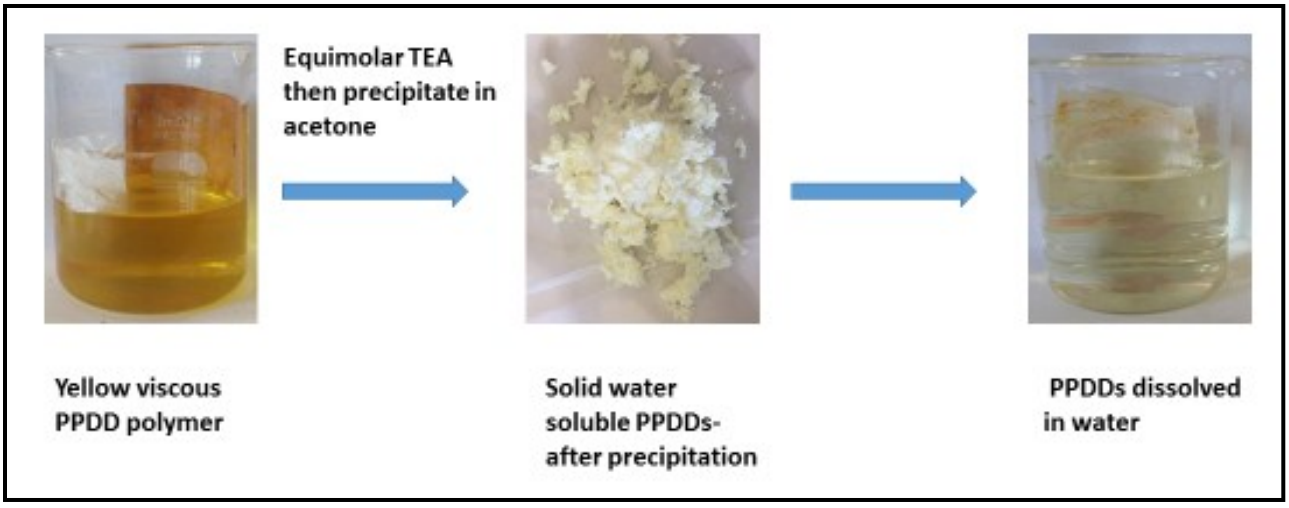


Figure S3: Digital images of the appearance of PPDD polymer, PPDDs in solid form and PPDDs after dissolution in water.

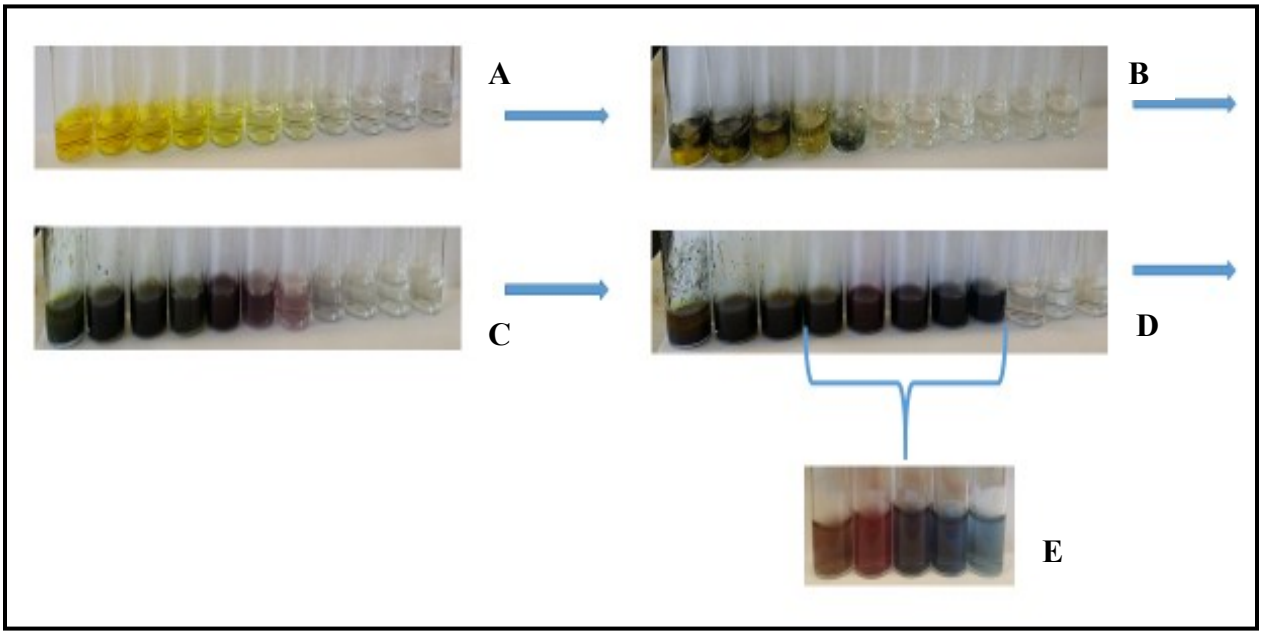
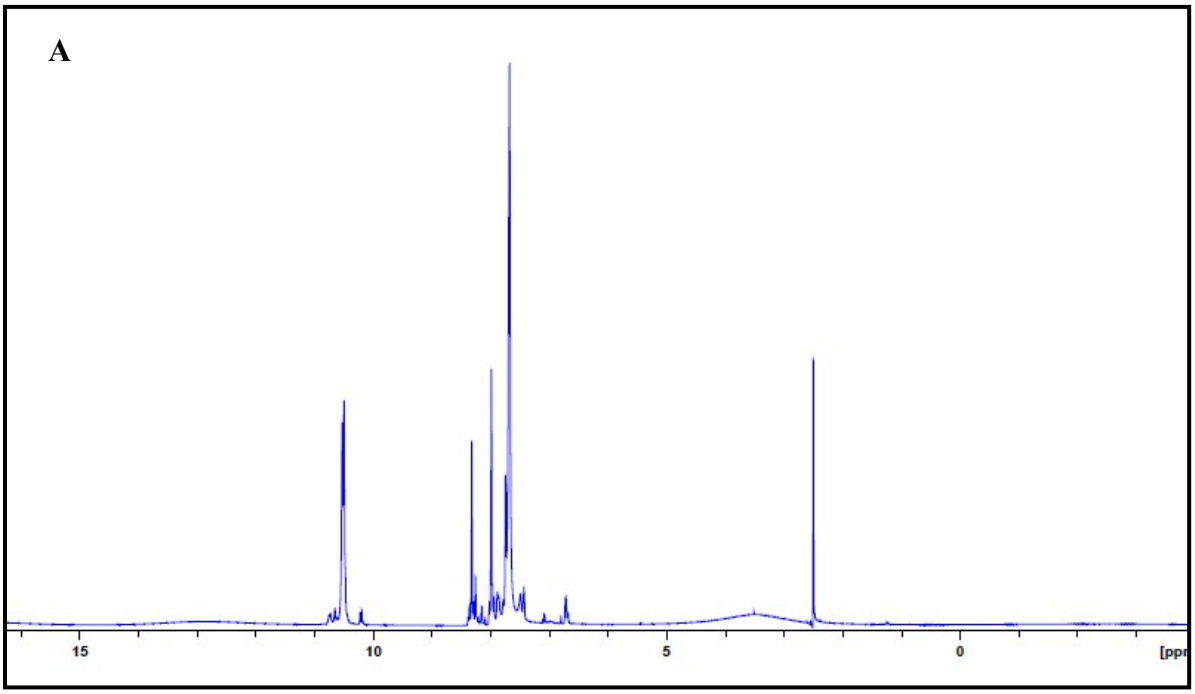


Figure S4: Schematic showing the synthesis of AuNFs using water soluble PPDDs-**A**: Serial diluted solutions of $HAuCl_4.3H_2O$, **B**: $HAuCl_4.3H_2O$ solutions mixed with 2ml of water soluble PPDDs, **C**: Nanoparticle (NP) formation after ~2 minutes **D**-NP formation after ~6 minutes, **E**: Final NP solutions

Figure S5: NMR Characterization of PPDDs

^{1}H NMR PPDD polymer



^{1}H NMR PPDDs-water soluble trimethylamine salt

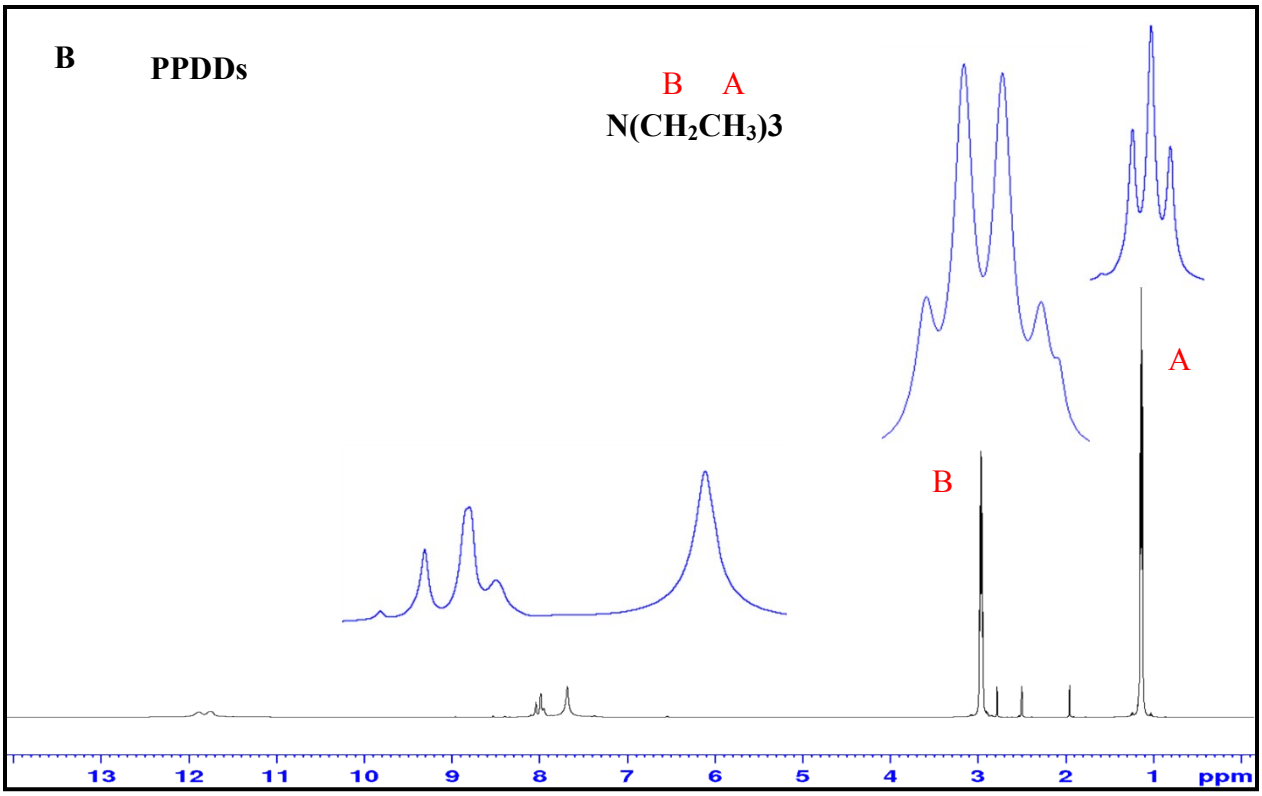
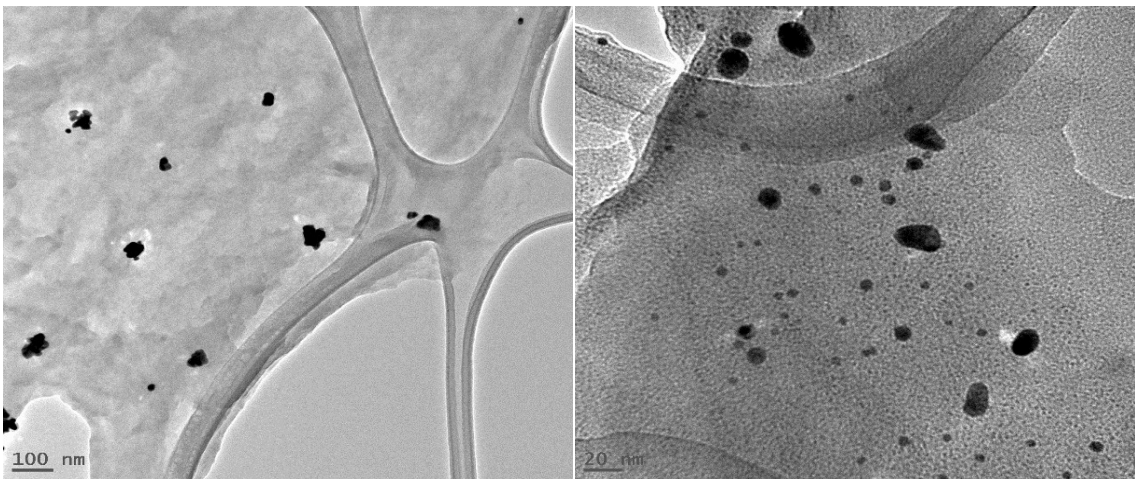
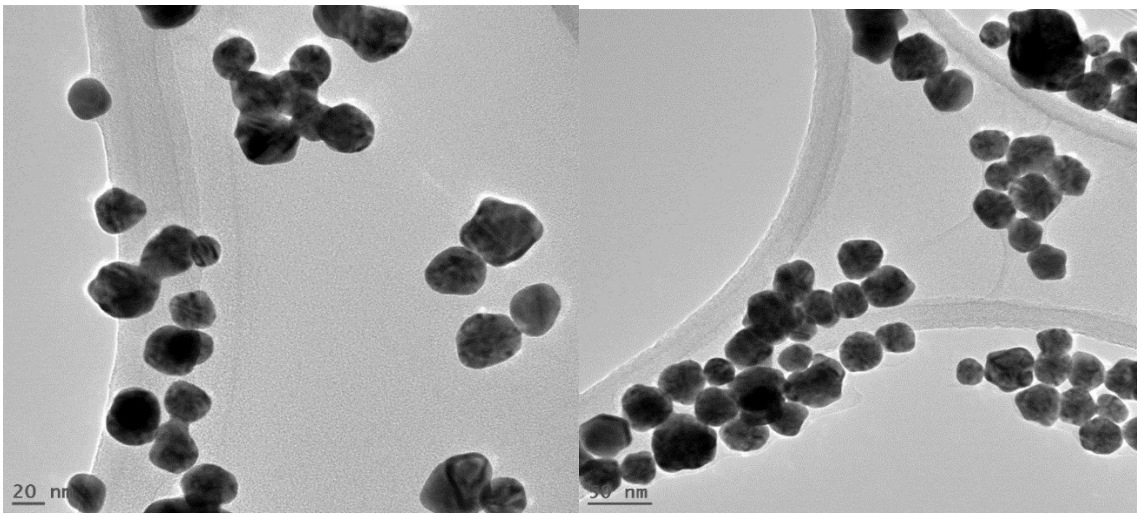


Figure S6: Additional TEM images

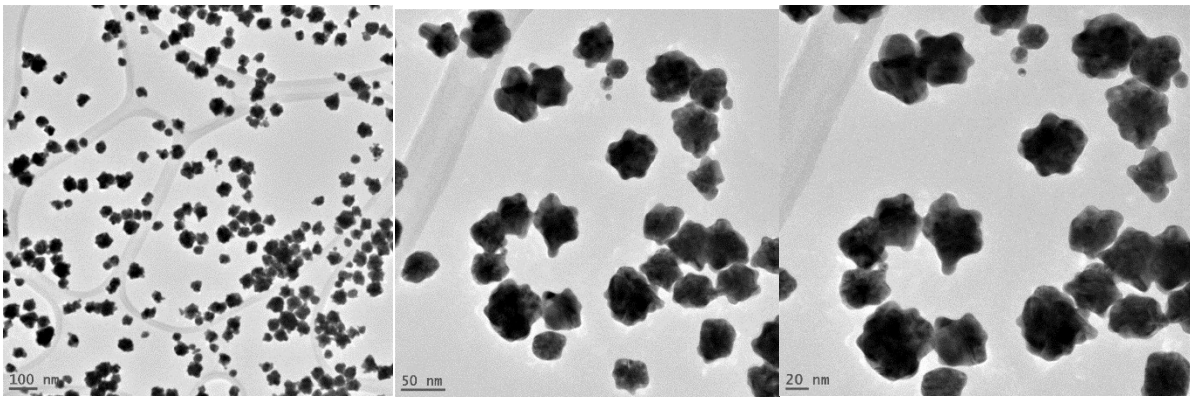
6.25mM



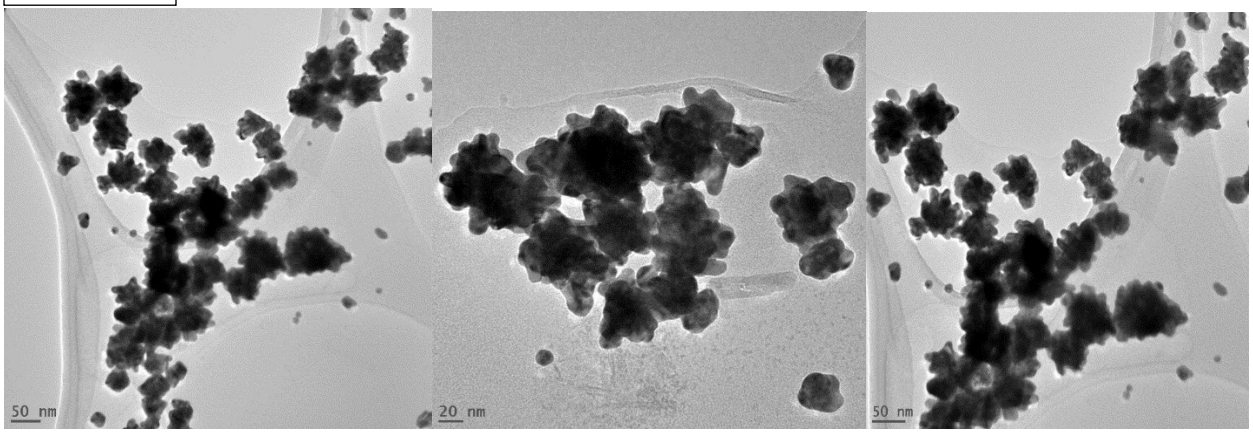
3.13mM

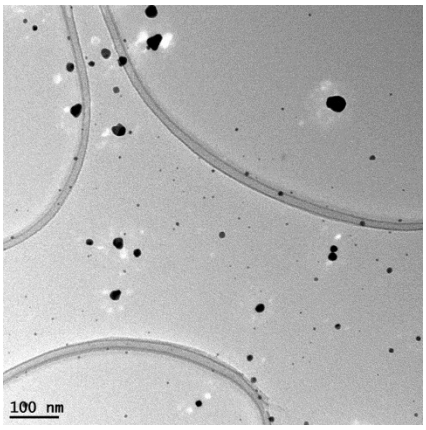


1.563mM



0.781mM





0.391mM

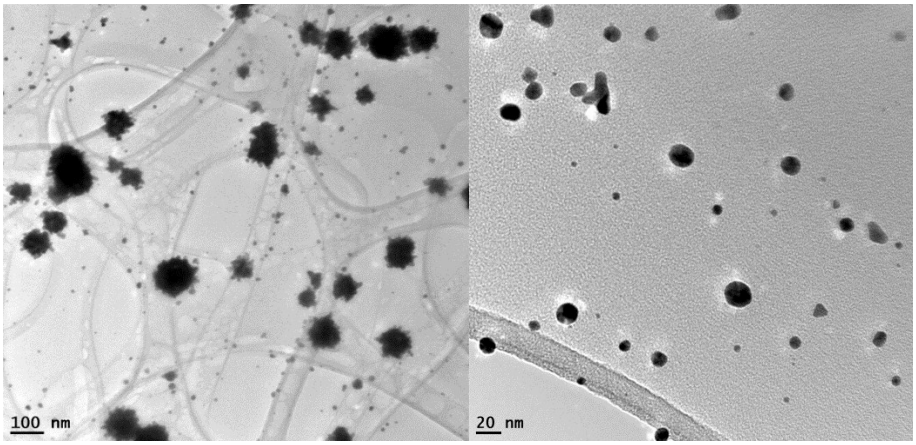


Figure S6-Trend of Nanoflower size versus gold precursor concentration

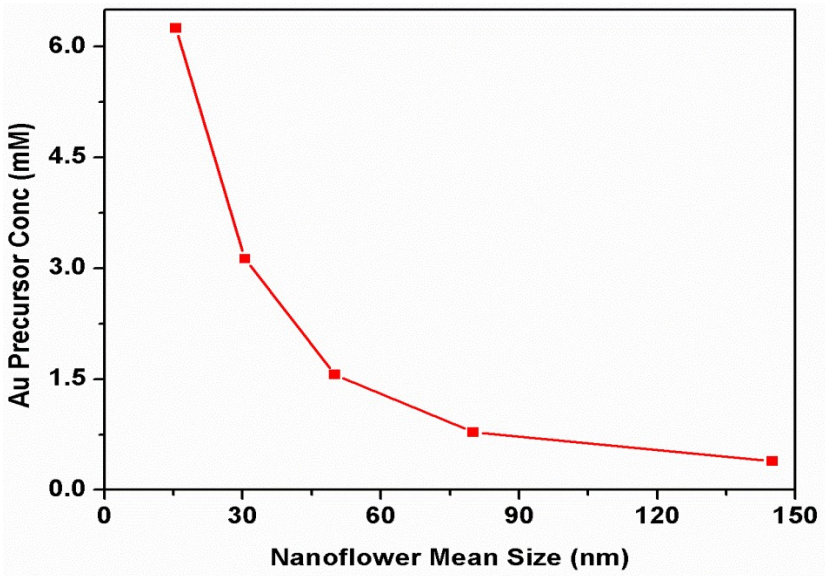
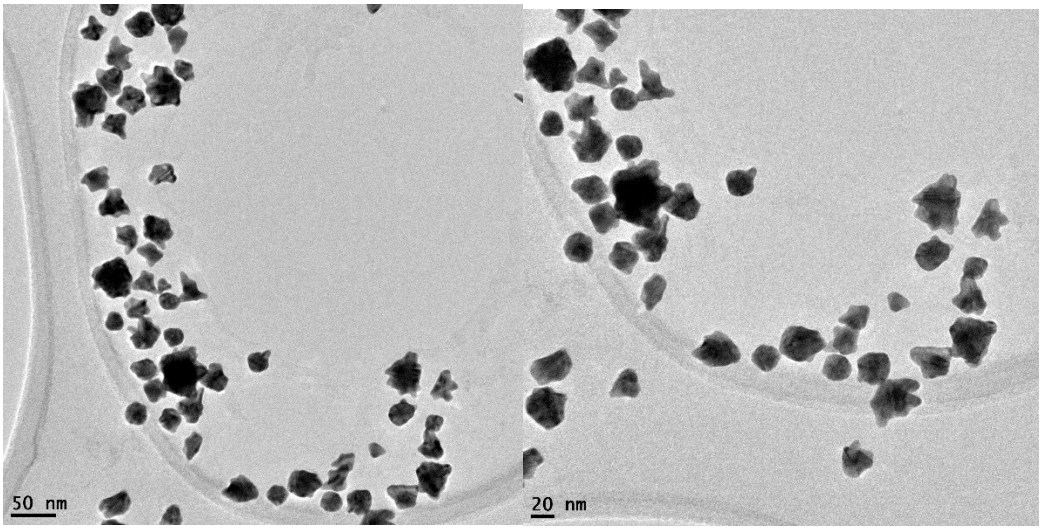
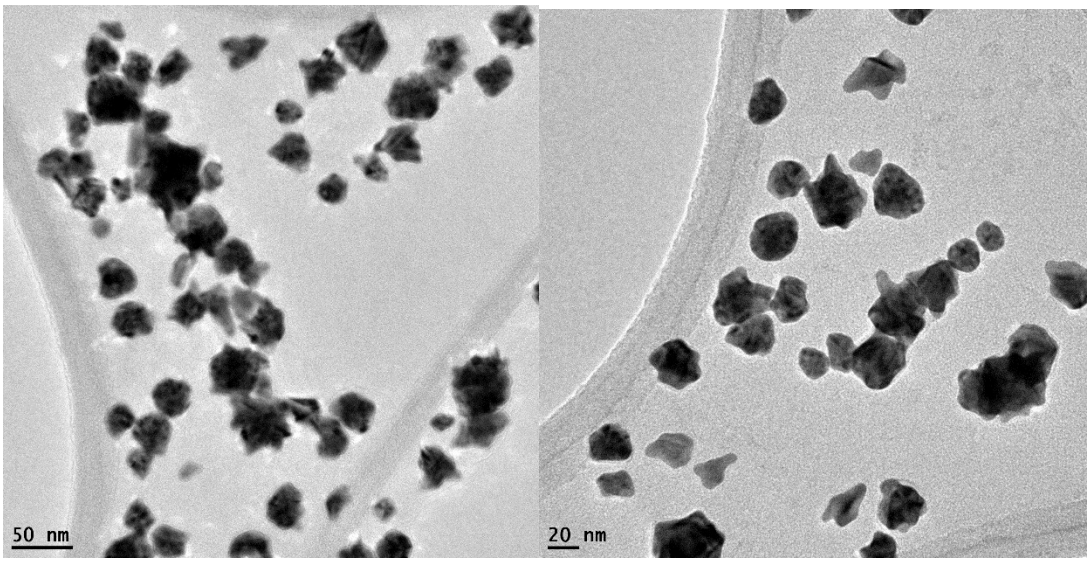


Figure S7: **Effect of PPDDs concentration on the size and morphology of AuNFs.**

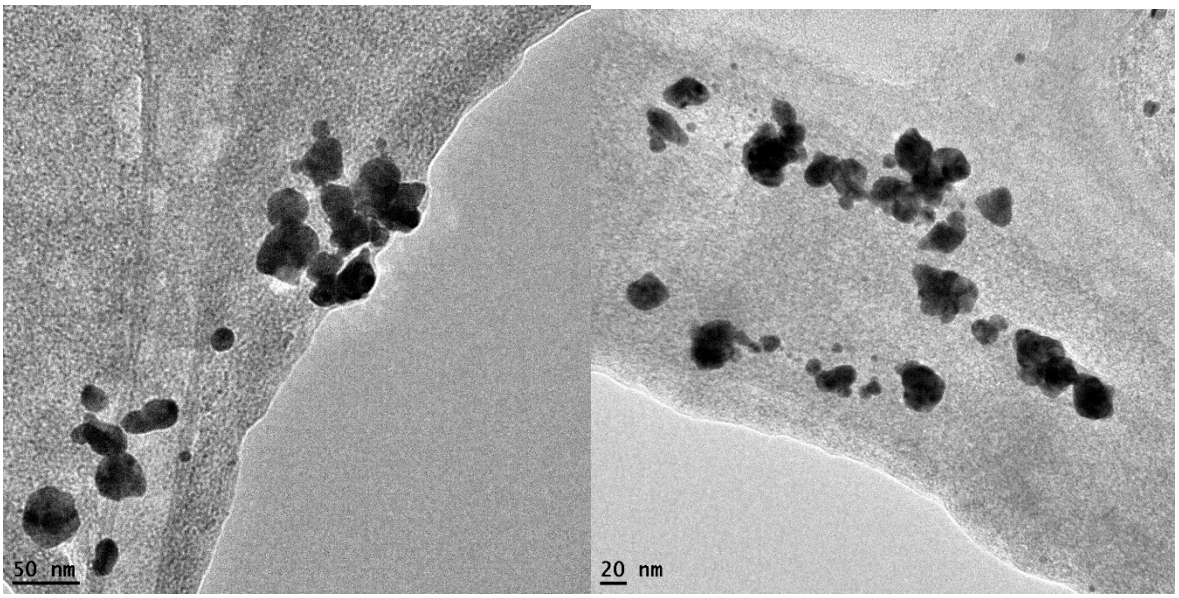
S7-A: In 0.4w/v PPDDs



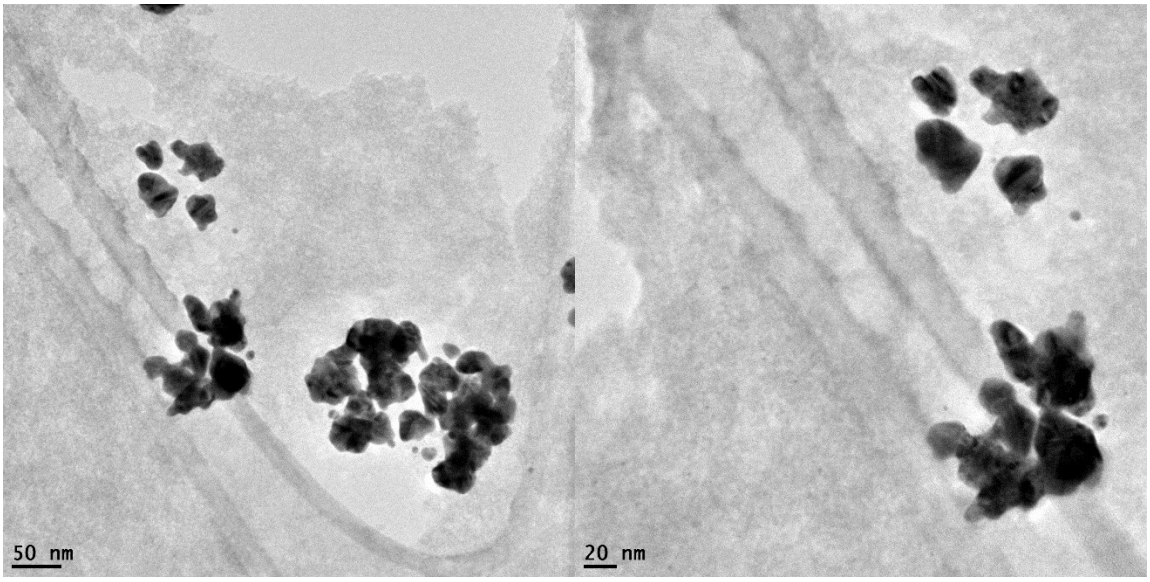
S7-B: In 0.2w/v PPDDs



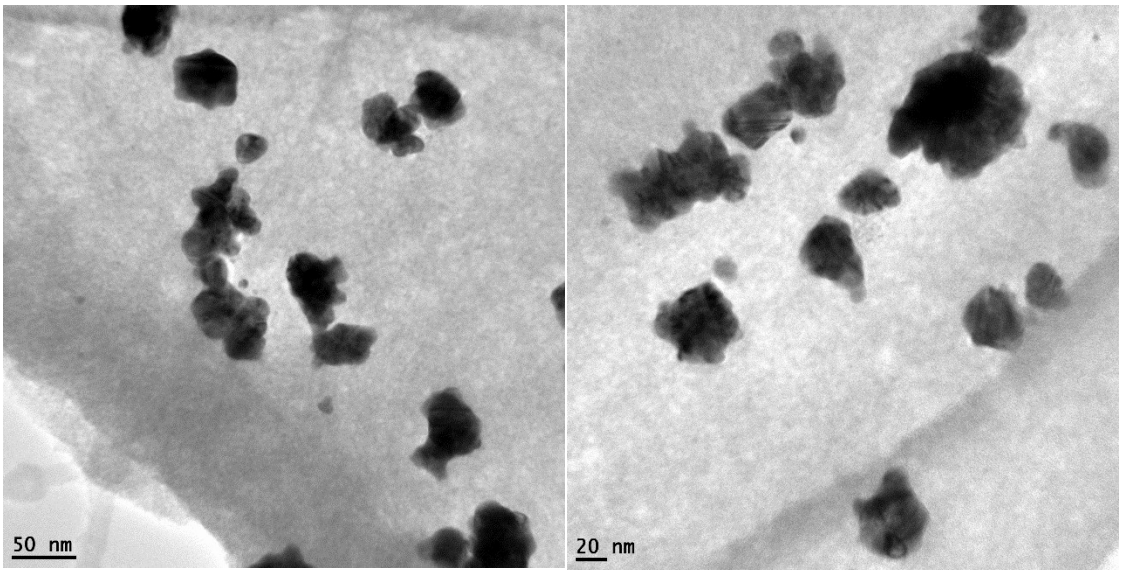
S7-C: In 0.1w/v PPDDs



S7-D: In 0.05w/v PPDDs



S7-E: In 0.025 w/v PPDDs



S7-F: In 0.0125w/v PPDDs

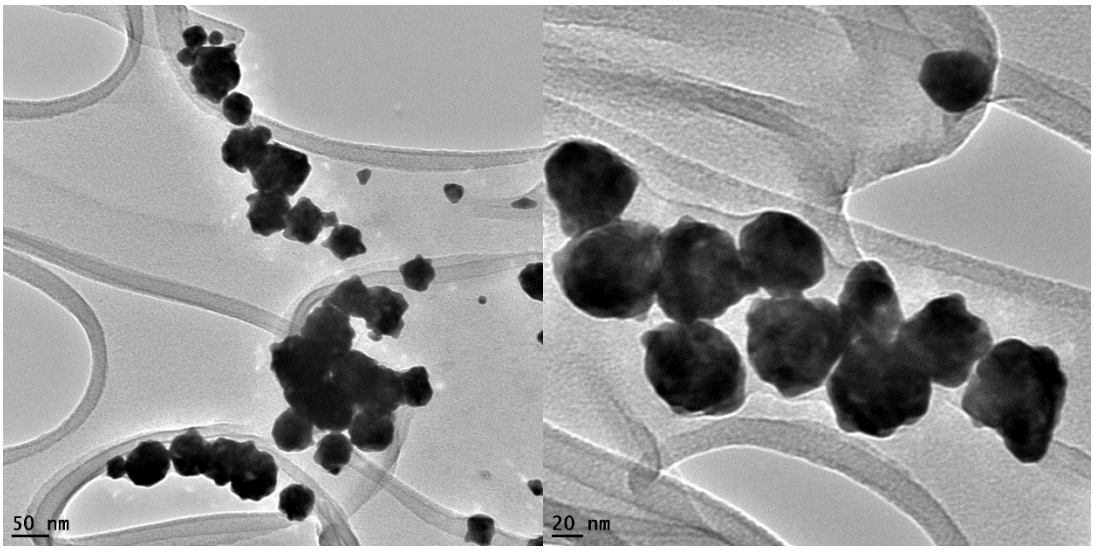
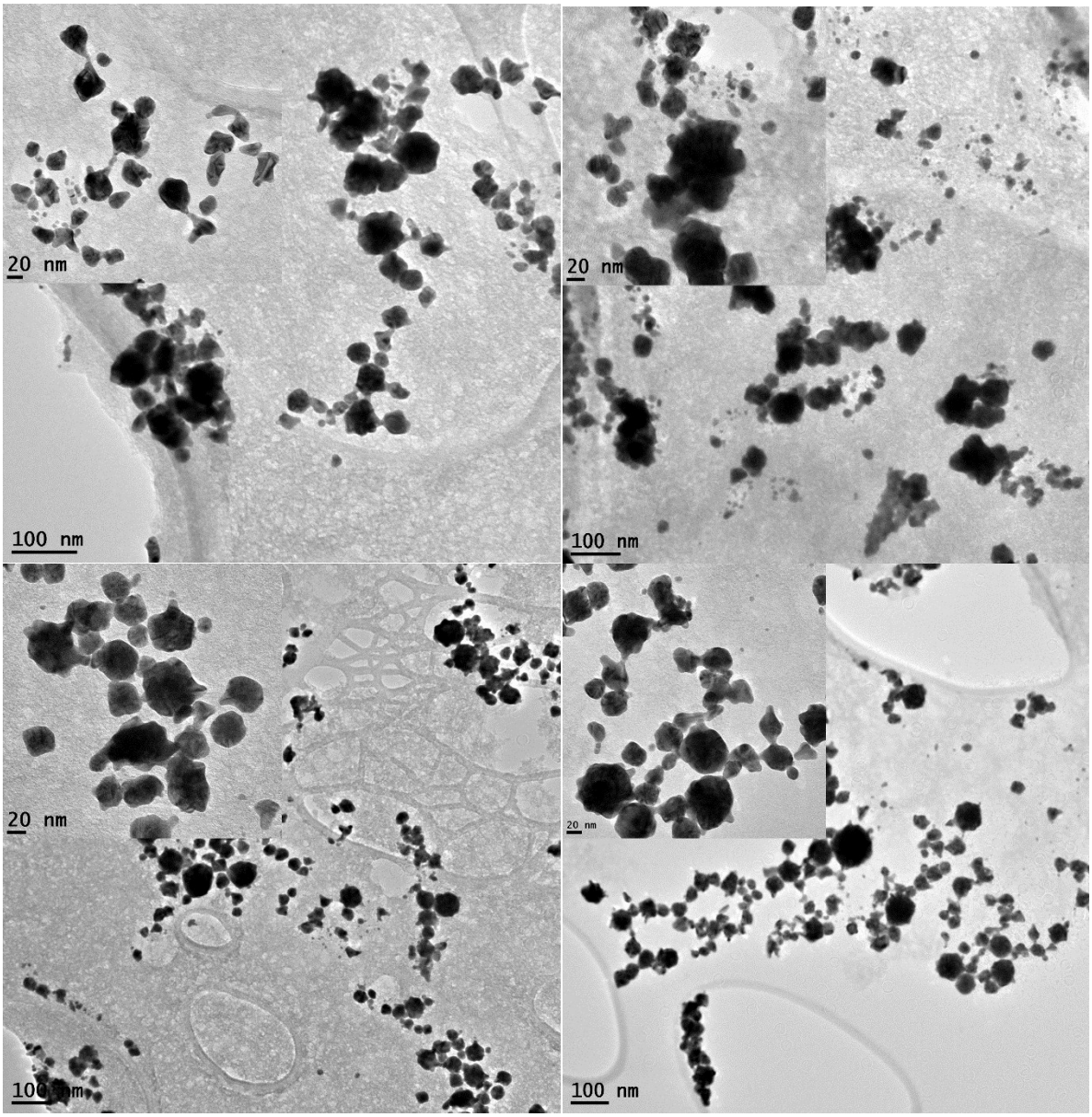


Figure S8: Effect of Temperature on nanoflower morphology-50 Celcius



Section S9: Enhancement Factor Calculations

4-MBA standard in EtOH: I=29284.375 at 884.375 cm-1

4-MBA: **2mM**, 1.2044E+24 4-MBA/mL

The enhancement factor is estimated on the basis of the relationship:

$$EF = \frac{I_{Sample}}{I_{RL}} \times \left[\frac{(RL/cm^3)}{(NPs/cm^3) \times (RL/NP) \times \theta} \right]$$

Unless you finish the equation, you should use the ratio of intensity to estimate EF

where, I sample is the Raman intensity of the assembly solution, $^{I_{RL}}$ is the Raman intensity of the standard Raman Label (RL) solution, $^{RL/cm^3}$ is the number of RL molecules dissolved per mL (1.02×1020, 0.17 mM), $^{NPs/cm^3}$ is the number of gold nanoparticles per mL, RL/NP is the number of RL molecules in 1 monolayer (39-nm: 1.6×104, 62-nm: 3.9×104), and is surface coverage of RL on the nanoparticles.

The ratios of intensity are referred to as Analytical Enhancement Factor –AEF.

AEF was calculated by means of the following expression[71, 72]:

$$AEF = \frac{I_{Sample}}{I_{RL}} ;$$

	884.375 cm^{-1}	**1092 cm^{-1}**	**1480 cm^{-1}**
AuNF Sample	**I_sample/I-4MBA**	**(I_Sample/I_4-MBA)**	
6.25mM	0.31309373	3.7709E+23	0.1496241
3.13 mM	0.33178679	3.99604E+23	0.1716060
1.563 mM	0.5552643	6.6876E+23	0.3100822
0.781 mM	0.38514569	4.63869E+23	0.1768886
0.391mM	0.7840419	9.443E+23	0.14518971