

## ESI for

### **Synthesis of porous Au-NPs/MoS<sub>2</sub> nanocomposites by a redox reaction in water/ethanol mixture solutions**

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**Table S1.** Quantitative analysis of the Mo ions in Au-NPs/MoS<sub>2</sub> nanocomposites with different ratios of Au ions and the MoS<sub>2</sub>.

Sample	Atomic count of Mo <sup>4+</sup> (%)	Atomic count of Mo <sup>6+</sup> (%)	Atomic count of Mo <sup>5+</sup> (%)
Bare MoS <sub>2</sub>	89.71	3.42	4.75
Au-NPs/MoS <sub>2</sub> in 0.5:1 molar ratio	89.53	4.06	6.41
Au-NPs/MoS <sub>2</sub> in 1:1 molar ratio	85.82	6.25	7.93
Au-NPs/MoS <sub>2</sub> in 5:1 molar ratio	79.83	15.33	4.84
Au-NPs/MoS <sub>2</sub> in 10:1 molar ratio	76.67	18.86	4.47

**Table S2.** Quantitative analysis of Mo element in Au-NPs/MoS<sub>2</sub> prepared in different ratio of water and ethanol solutions.

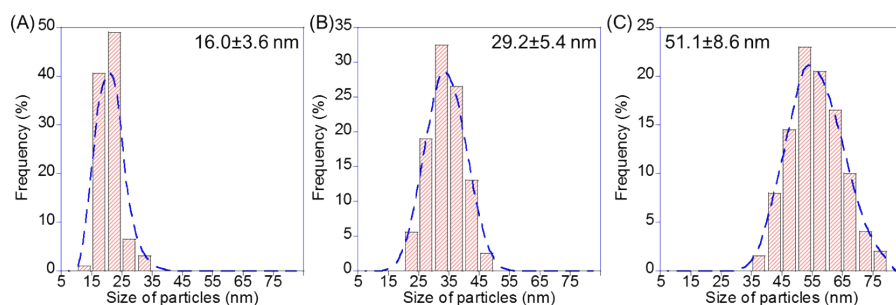
Sample	Atomic count of Mo <sup>4+</sup> (%)	Atomic count of Mo <sup>6+</sup> (%)	Atomic count of Mo <sup>5+</sup> (%)
water	34.97	36.14	28.89
water: ethanol =5:1	65.64	18.15	16.21
water: ethanol =1:1	81.88	9.82	5.3
water: ethanol =1:5	88.99	5.77	5.23
ethanol	89.46	5.45	5.08

**Table S3.** Estimated values of enhancement factor for every substrate with  $10^{-5}$  M R6G (signals intensities were calculated from  $1363\text{ cm}^{-1}$  and  $1650\text{ cm}^{-1}$  peaks in Fig. 8a and Fig.9).

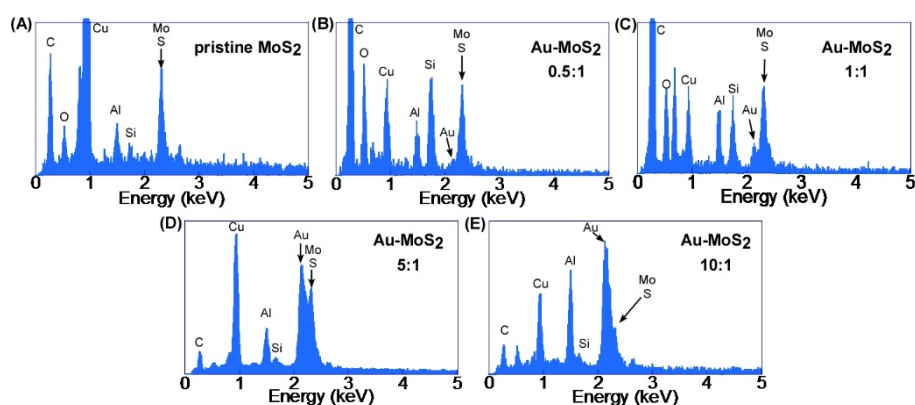
	Bare MoS <sub>2</sub>		Au-NPs/MoS <sub>2</sub> in 0.5:1 ratio		Au-NPs/MoS <sub>2</sub> in 1:1 ratio		Au-NPs/MoS <sub>2</sub> in 5:1 ratio		Au-NPs/MoS <sub>2</sub> in 10:1 ratio		2D -Au-NPs/MoS <sub>2</sub> nanocomposite	
	Peak (cm <sup>-1</sup> )	1363	1645	1363	1645	1363	1645	1363	1645	1363	1645	1363
Intensity (count.)	552	249	1682	661	3910	1764	7344	3127	11822	5037	2076	882
EF ( $\times 10^5$ )	0.92	0.99	2.81	2.62	6.54	6.99	12.3	12.4	19.8	19.9	3.47	3.49
Average EF( $\times 10^5$ )	0.95		2.72		6.77		12.4		19.9		3.48	

**Table S4.** Estimated values of enhancement factor for bare Si substrate and Au-NPs/MoS<sub>2</sub> in 10:1 ratio substrate with different concentration of R6G (signals intensities were calculated from  $1363\text{ cm}^{-1}$  and  $1650\text{ cm}^{-1}$  peaks in Fig. 8b).

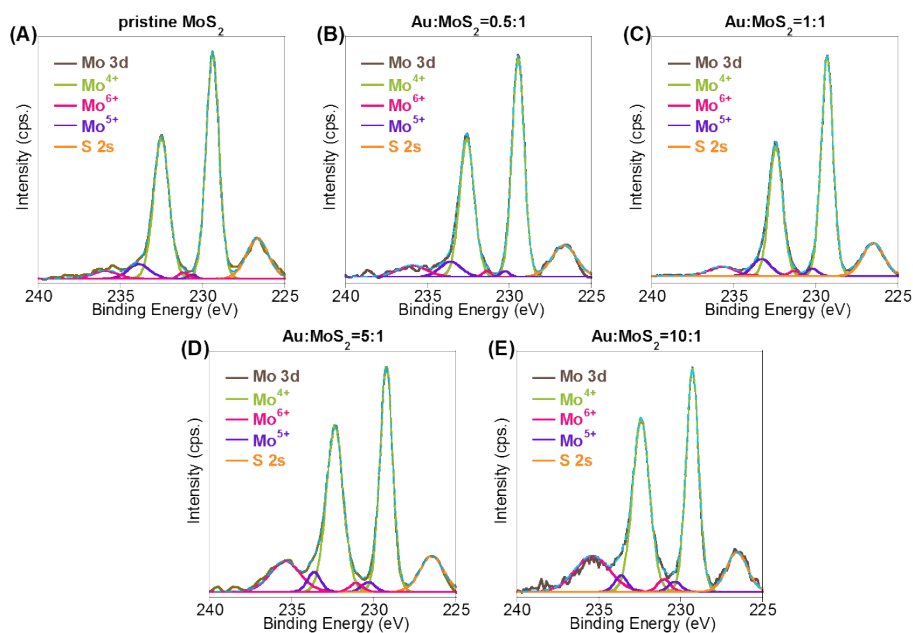
	10 <sup>-1</sup> M on Si substrate		10 <sup>-4</sup> M on Au- NPs/MoS <sub>2</sub>		10 <sup>-5</sup> M on Au- NPs/MoS <sub>2</sub>		10 <sup>-6</sup> M on Au- NPs/MoS <sub>2</sub>		10 <sup>-7</sup> M on Au- NPs/MoS <sub>2</sub>	
	Peak (cm <sup>-1</sup> )	1363	1645	1363	1645	1363	1645	1363	1645	1363
Intensity (count.)	367	155	21761	9820	11822	5037	3902	1661	453	185
EF ( $\times 10^5$ )	-		3.64	3.89	19.8	19.8	65.3	65.7	73.7	73.3
Average EF( $\times 10^5$ )	-		3.76		19.8		65.4		73.4	



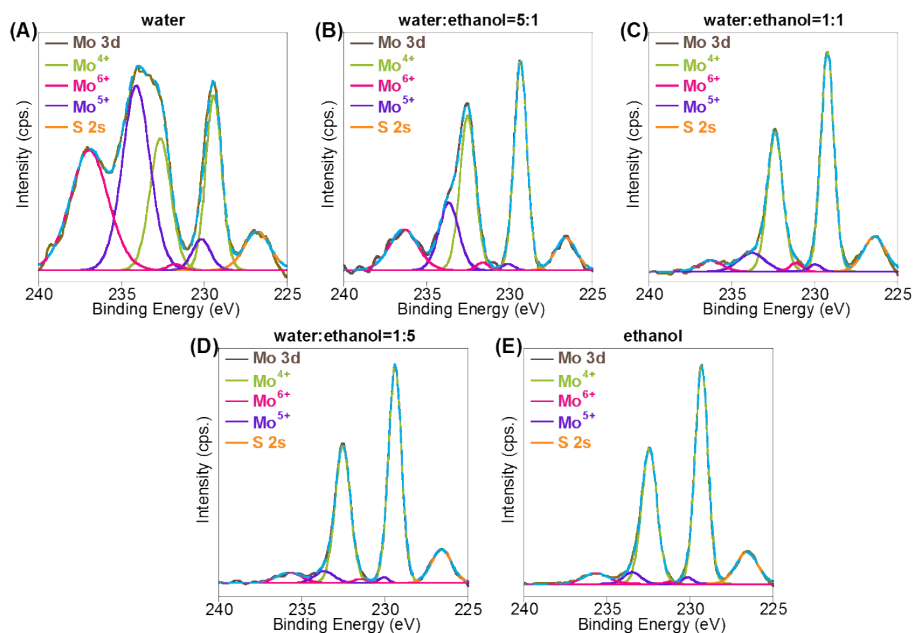
**Fig. S1.** Size distribution of Au-NPs in different Au-NPs/MoS<sub>2</sub> nanocomposites (A) Au-NPs/MoS<sub>2</sub> in 1:1 molar ratio; (B) Au-NPs/MoS<sub>2</sub> in 5:1 molar ratio, (C) Au-NPs/MoS<sub>2</sub> in 10:1 molar ratio. These distribution diagrams was prepared using the STEM images by counting each 200 particles.



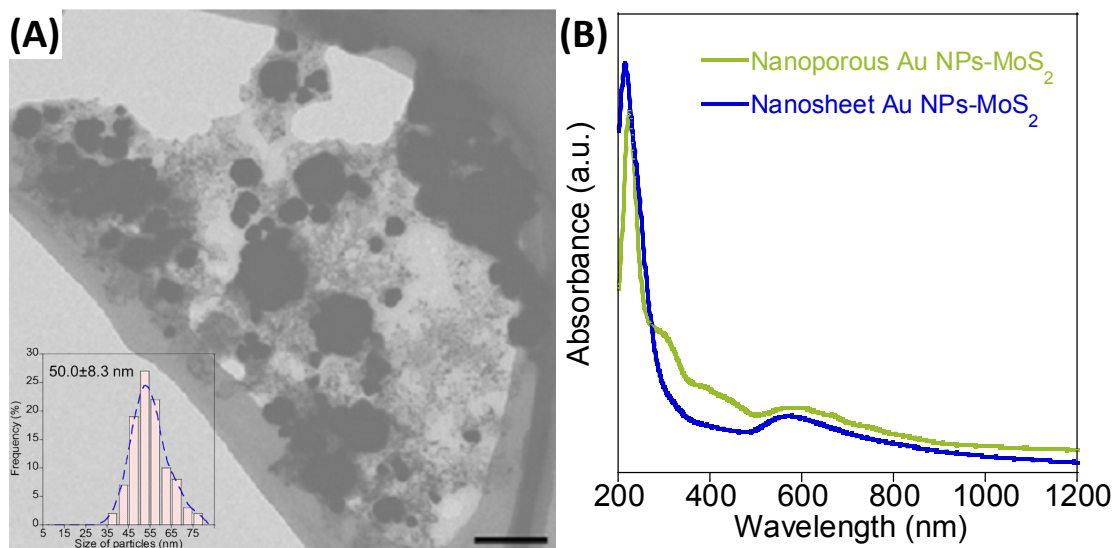
**Fig. S2.** EDXs results of different Au-NPs/MoS<sub>2</sub> nanocomposites with different molar ratios of the Au ions and MoS<sub>2</sub>. (A) pristine MoS<sub>2</sub>; (B) Au-NPs/MoS<sub>2</sub> in 0.5:1 molar ratio; (C) Au-NPs/MoS<sub>2</sub> in 1:1 molar ratio; (D) Au-NPs/MoS<sub>2</sub> in 5:1 molar ratio and (E) Au-NPs/MoS<sub>2</sub> in 10:1 molar ratio.



**Fig. S3.** XPS spectra of the Mo3d for (A) bare MoS<sub>2</sub> and Au-NP/MoS<sub>2</sub> nanocomposites with ratios of the Au ions and MoS<sub>2</sub> of (B) 0.5:1, (C) 1:1, (D) 5:1 and (E) 10:1.



**Fig. S4.** XPS spectra of the Mo 3d for (A) bare MoS<sub>2</sub> and Au-NPs/MoS<sub>2</sub> nanocomposites with ratios of the Au ion and MoS<sub>2</sub> of (B) 0.5:1, (C) 1:1, (D) 5:1 and (E) 10:1.



**Fig. S5.** (A) STEM image of 2D-Au-NPs/MoS<sub>2</sub> nanocomposite. The scale bar is 100 nm. The inset is size distribution of the Au-NPs of the samples. (B) UV spectra of the 2D-Au-NPs/MoS<sub>2</sub> nanocomposite and 3D porous Au-NPs/MoS<sub>2</sub> nanocomposite.