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Supporting Information

Uniform Au@Pt core-shell nanodendrites supported on molybdenum disulfide nanosheet for methanol oxidation reaction

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Preparation of MoS_2 nanosheets

Using the intercalation-exfoliation method developed by Joensen with some modifications. Under Ar atmosphere, 0.3 g MoS_2 was intercalated with 10 mL *n*-butyllithium solution at room temperature for 2 days. The unreacted *n*-butyllithium solution was removed and the residual solvent was removed by Ar gas flow. Oxygen-free water was added to exfoliate the Li intercalated MoS_2, and then the suspension was sonicated for 1h to assist the exfoliation process. Finally, the aqueous dispersion of MoS_2 nanosheets was centrifuged at least twice to remove the LiOH and other soluble impurities.

Preparation of dendritic Pt/MoS_2

In a typical synthesis of Pt nanodendrites decorated MoS_2 nanocomposite (Pt/MoS_2), 4 mL (0.025 mg/mL) of MoS_2 nanosheets aqueous dispersion was mixed with 100 μL 50 mM sodium carboxymethylcellulose (CMC) under vigorous stirring for 2 min. Then, 100 μL 100 mM L-ascorbic acid (AA) was added with vigorous stirring. After 5 s, 100 μL 5 mM aqueous H_2PtCl_6 was added and heated on a hotplate at approximately 100°C for 6 min to grow dendritic Part nanocrystals. The product was collected by centrifugation at 5 000 rpm for 10 min and residual CMC was removed by three consecutive washing/centrifugation cycles with acetone and water. The TEM image showed dendritic Pt had been successfully decorated on the surface of MoS_2 nanosheet with average diameter of 50 nm (Figure S1).

Preparation of the Au@Pt/MoS_2/GCE

A glassy carbon electrode of 3 mm in diameter was mechanically polished with 0.3 and 0.05 mm alumina slurry and then sequentially sonicated in water, ethanol and water for several minutes. The cleaned GCE was dried under nitrogen stream. The as-prepared Au@Pt/MoS_2-2 nanocomposite was dispersed in Milli-Q water to form a stable suspension. Then, 5 μL of the suspension was dropped onto the cleaned GCE and dried under ambient condition. The final modified electrode was defined as Au@Pt/MoS_2-2/GCE. For comparison, Pt/C, Pt/MoS_2, Au@Pt/MoS_2-1 was prepared by using a similar procedure. Based on the inductively coupled plasma mass spectroscopy (ICP-MS) measurements, the loading amounts of Pt for the Pt/MoS_2, Au@Pt/MoS_2-1 and Au@Pt/MoS_2-2 were 0.168, 0.176, 0.234 ng, respectively. For cyclic voltammetry (CV) and chronoamperometric (CA) measurements, the electrolyte solutions were purged with high-purity N_2 gas before use for 30 min. Methanol electro-oxidation measurements were performed in a solution of 0.5 M NaOH that contained 1 M methanol at 100 mV/s.

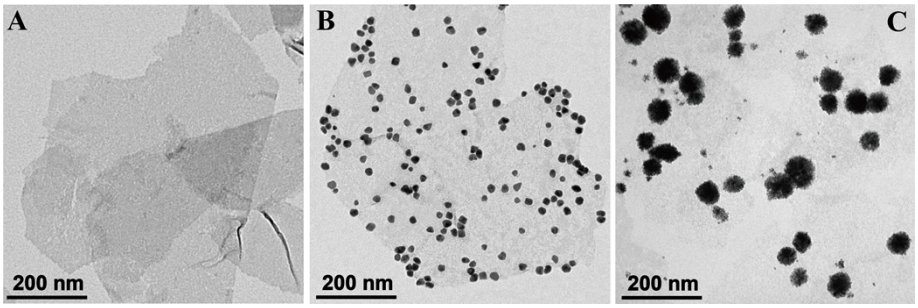

Fig. S1. TEM images of (A) MoS_2, (B) Au/MoS_2 and (C) Pt/MoS_2.

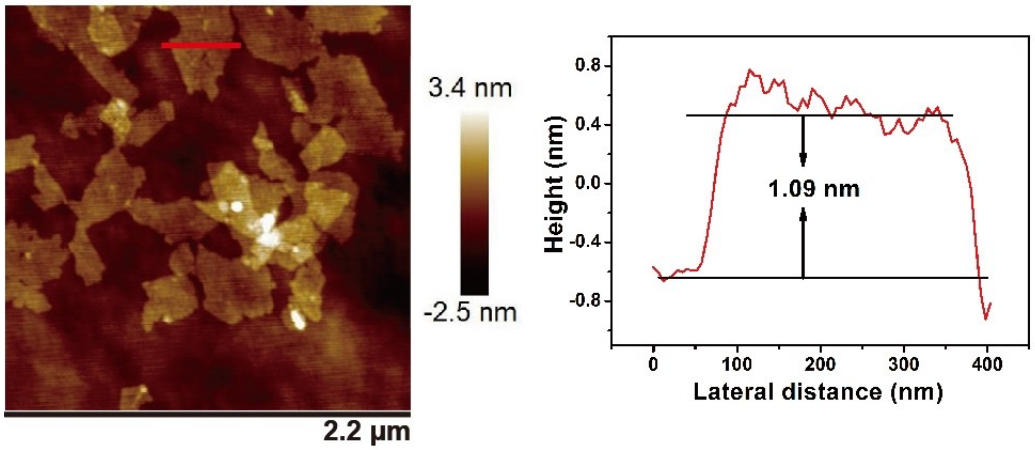

Fig. S2. AFM image of MoS_2 nanosheets.

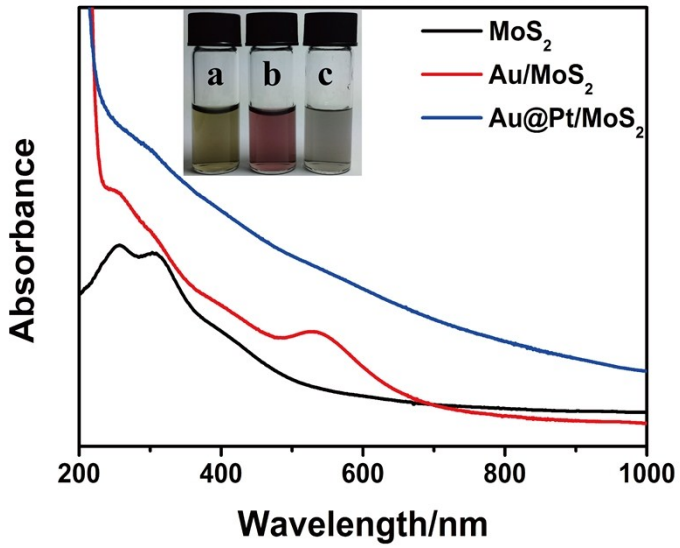

Fig. S3. UV−vis spectra of MoS_2 (black line), Au/MoS_2 (red line) and $Au@Pt/MoS_2$ (blue line). Inset: the photo of the colors of (a) MoS_2, (b) Au/MoS_2 and (c) $Au@Pt/MoS_2$.

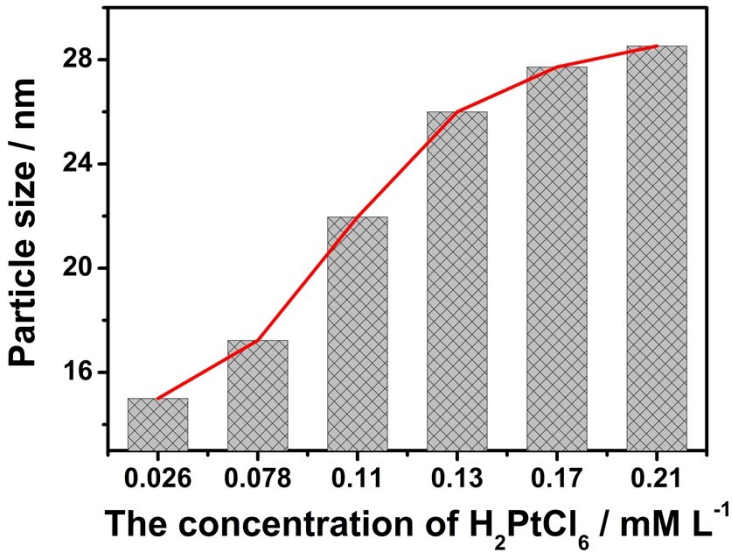

Fig. S4. The corresponding particle size distribution of Au@Pt synthesized at under different concentrations of H_2PtCl_6 (0.026 mM, 0.078 mM, 0.11 mM, 0.13 mM, 0.17 mM and 0.21 mM).

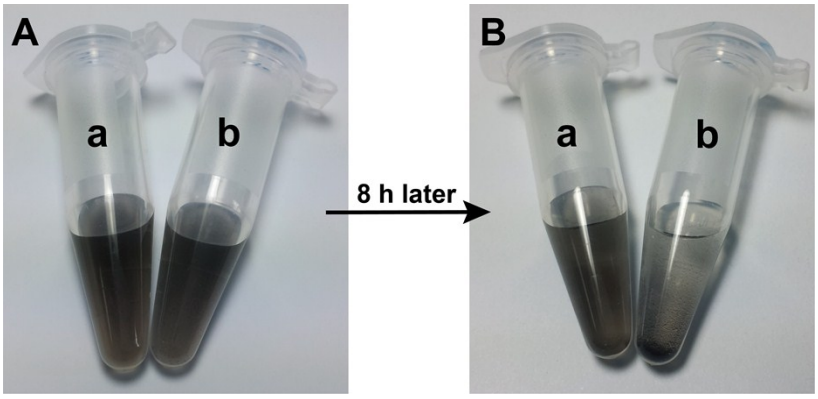

Fig. S5. The photo of Au@Pt/MoS_2 synthesized at different temperature (a)100°C and (b)160°C, (A) freshly prepared nanocomposite and (B) after 8 h storage.

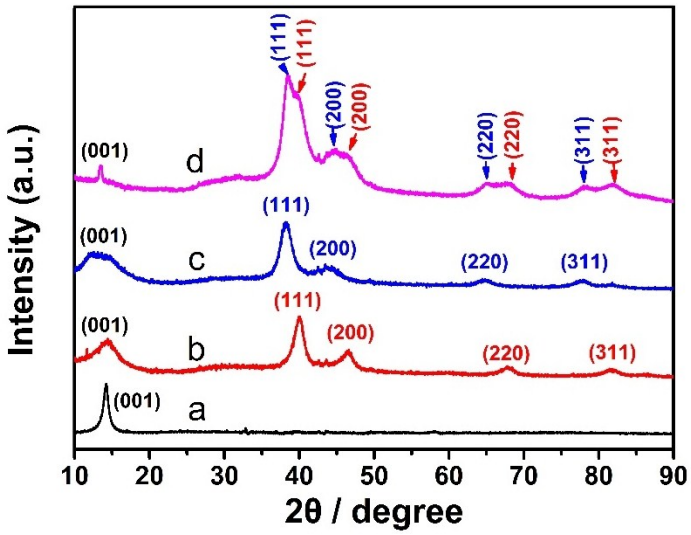

Fig. S6. XRD patterns of (a) MoS_2, (b) Au/MoS_2, (c) Pt/MoS_2 and (d) Au@Pt/MoS_2. The intensity and position for MoS_2, Au and Pt references were taken from the JCPDS database (MoS_2: card no. 87-2416, Au: card no. 04-0784, Pt: card no. 04-0802). Observed peaks can be indexed to the (111), (200), (220) and (311) reflections of face centered cubic (fcc) structure of Au and Pt, showing the pure crystalline nature of the prepared particles.

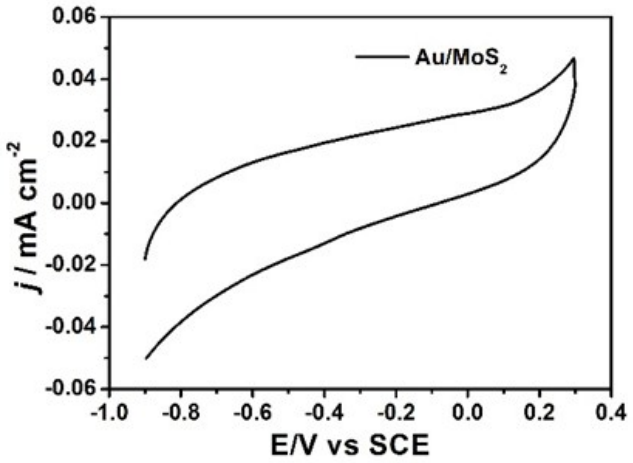

Fig. S7. Cyclic voltammograms of Au/MoS_2 in 0.5 M NaOH + 1 M CH_3OH at room temperature with 100 mV s^{-1}.

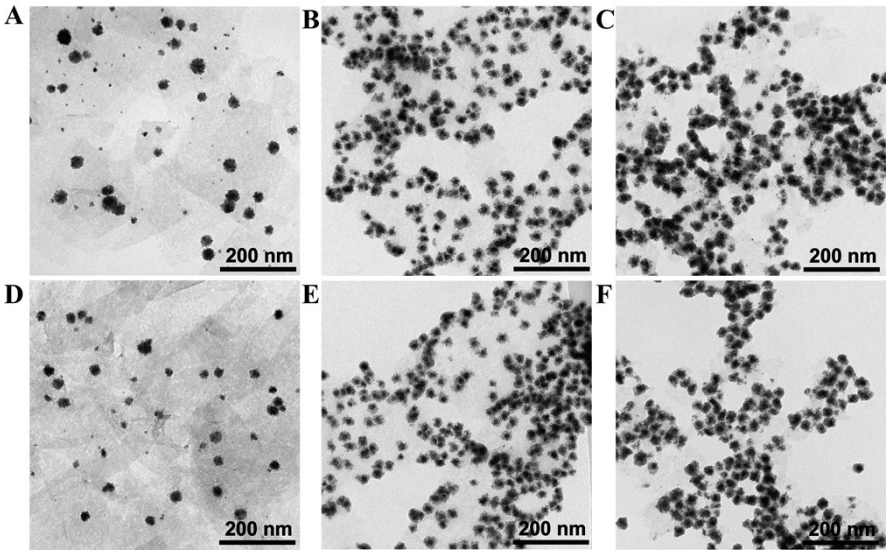

Fig. S8. TEM images of Pt/MoS_2, $Au@Pt/MoS_2$-1 and $Au@Pt/MoS_2$-2 before and after electrocatalytic process.

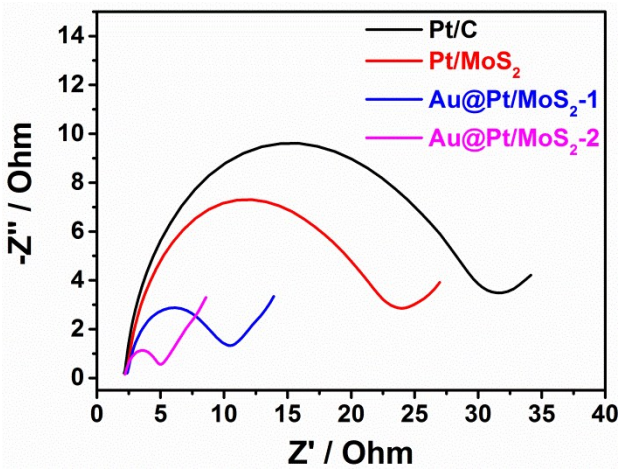

Fig. S9. Electrochemical impedance spectroscopy of different electrodes modified with Pt/C, Pt/MoS_2, $Au@Pt/MoS_2$-1 and $Au@Pt/MoS_2$-2 for methanol electro-oxidation in a solution containing 1. 0 M methanol and 0.5 M NaOH.

Table S1. A summary of the results from inductively coupled plasma mass spectroscopy (ICP-MS).

	Pt / mg L^{-1}	**mass fraction / Pt**	**the loading amounts of Pt/μg**
Pt/MoS_2	33.6	0.00336%	0.168
$Au@Pt/MoS_2$-1	35.2	0.00352%	0.176
$Au@Pt/MoS_2$-2	46.8	0.00468%	0.234