Uniform Pd-Pt alloy nanoparticales supported on graphite nanoplatelets with high electrocatalytic activity toward methanol oxidation

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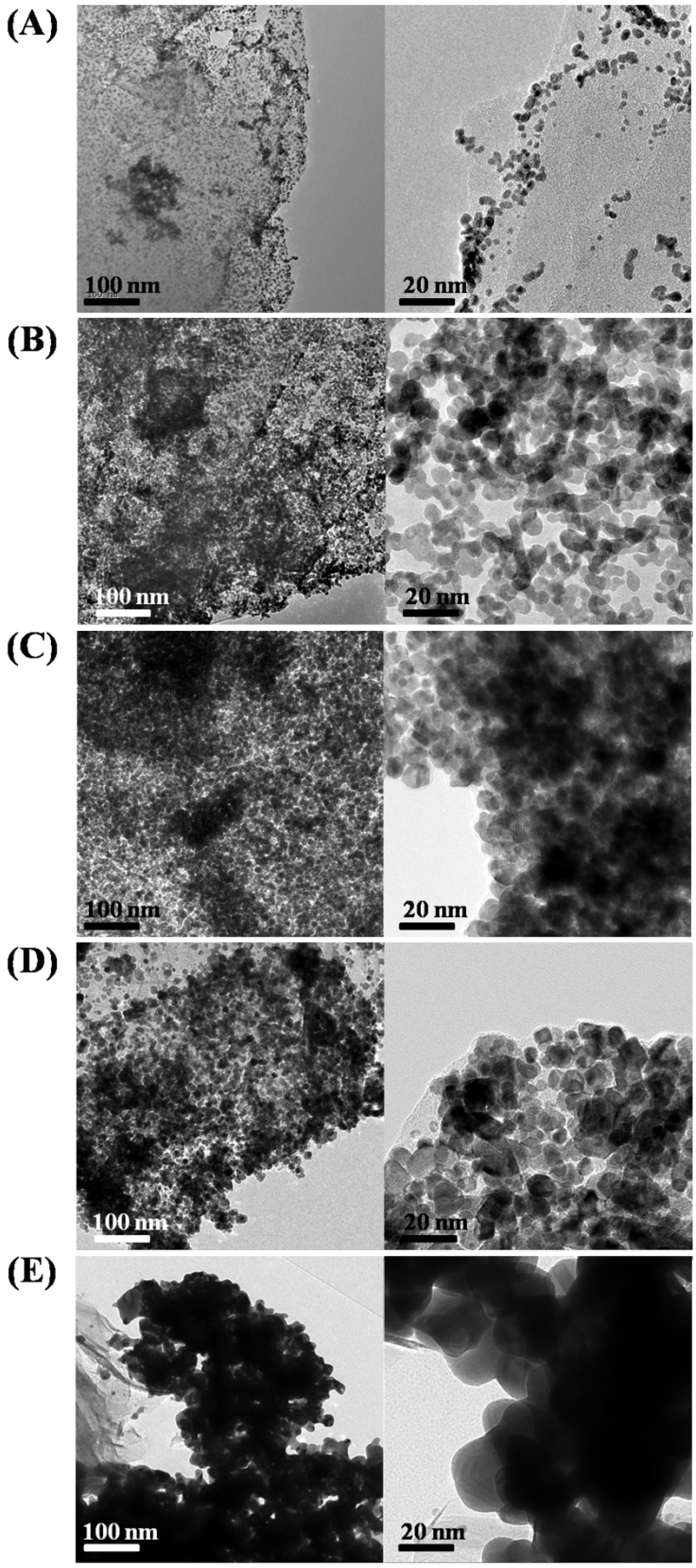

Figure S1 TEM images of Pt (A), Pd_1Pt_3 (B), Pd_1Pt_1 (C), Pd_3Pt_1 (D) and Pd (E) on bare GNPs, respectively.

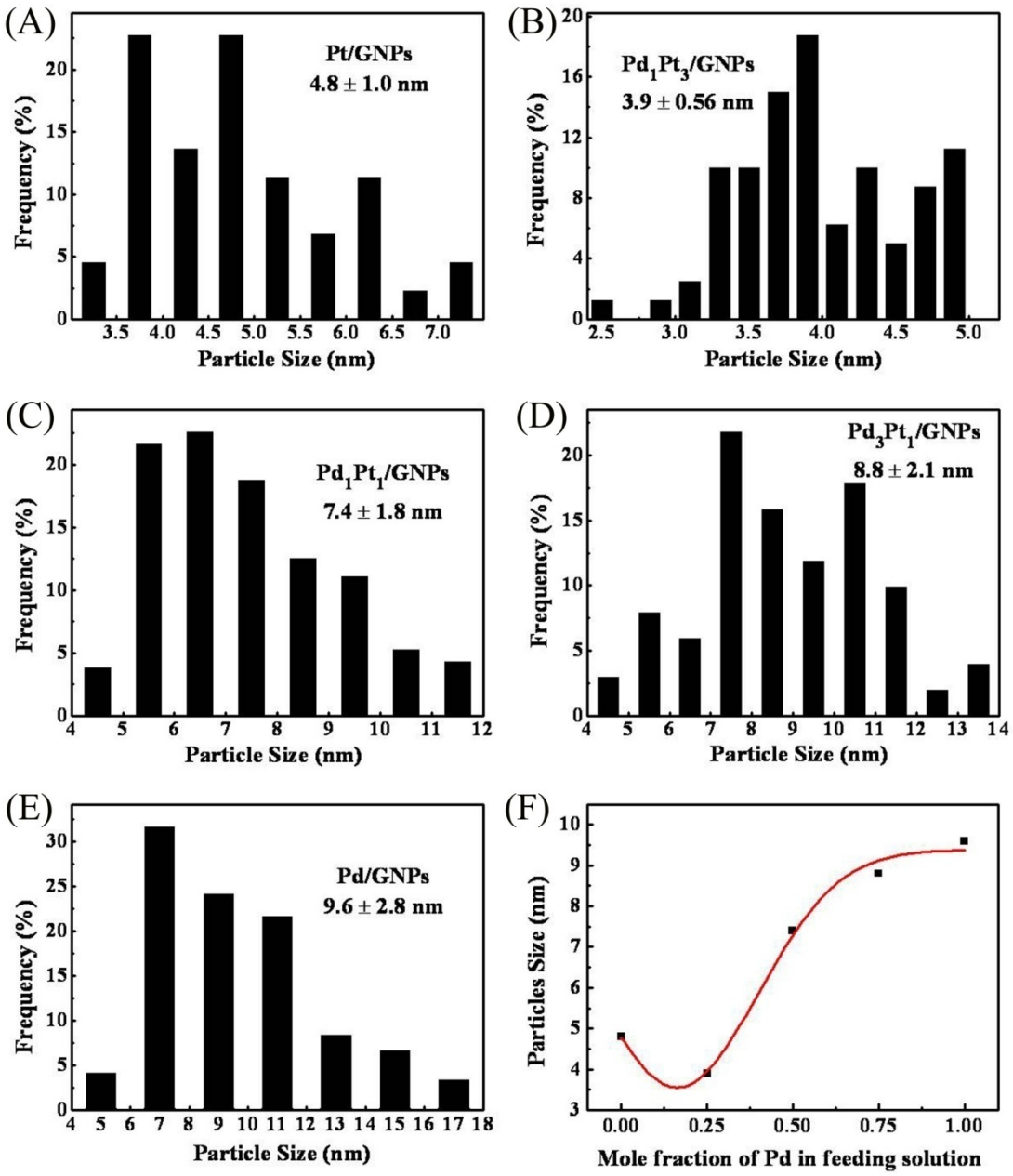

Figure S2 Sizes distributions of the nanoparticles in (A) Pt/GNPs, (B) Pd_1Pt_3/GNPs, (C) Pd_1Pt_1/GNPs, (D) Pd_3Pt_1/GNPs, (E) Pd/GNPs and (F) particle sizes of the Pd, Pt, and Pd-Pt bimetallic NPs with different mole fraction of Pd in feeding solution.

From Figure S2, it can be seen that the average size of the metal nanoparticles in Pt/GNPs, Pd_1Pt_3/GNPs, Pd_1Pt_1/GNPs, Pd_3Pt_1/GNPs and Pd/GNPs catalysts as estimated from the histograms is 4.8 ± 1.0 nm, 3.9 ± 0.56 nm, 7.4 ± 1.8 nm, 8.8 ± 2.1 nm and 9.6 ± 2.8 nm, respectively. More than 150 nanoparticles were counted in obtaining the results, as commonly practiced by others [1].

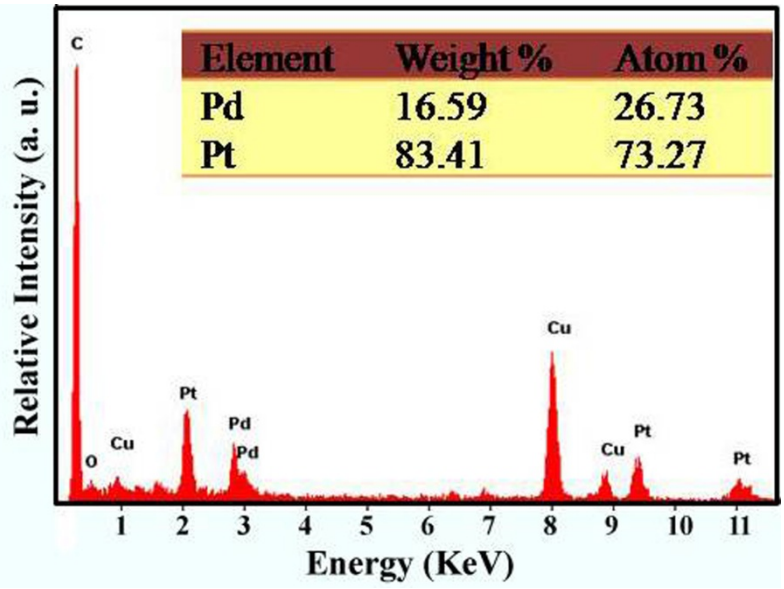

Figure S3 EDX spectrum of Pd_1Pt_3/GNPs and the inset table shows element contents based on EDX measurement.

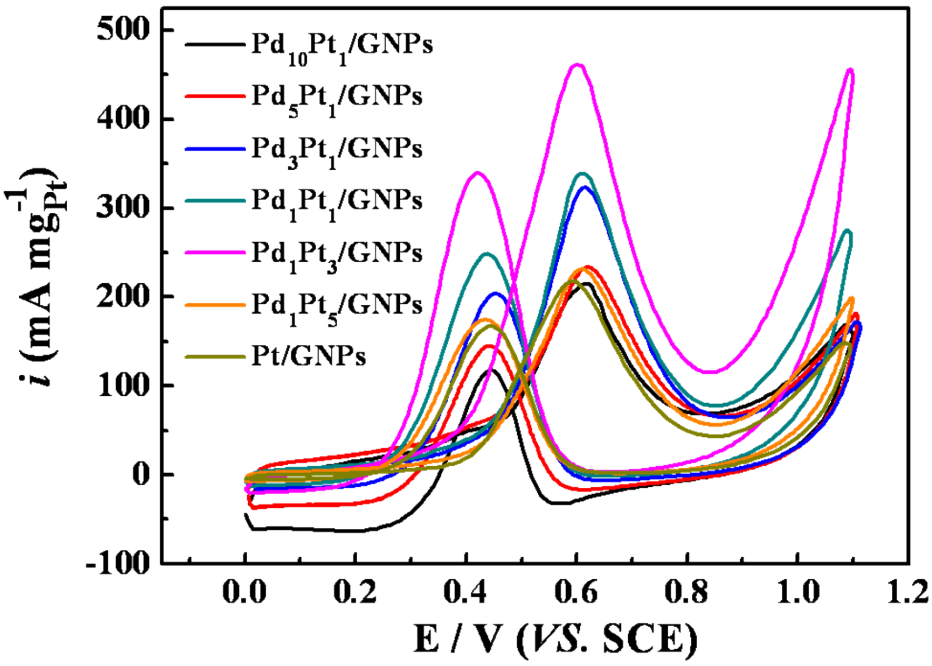

Figure S4 (A) Cyclic voltammograms (CVs) of Pt/GNPs, Pd_1Pt_5/GNPs, Pd_1Pt_3/GNPs, Pd_1Pt_1/GNPs, Pd_3Pt_1/GNPs, Pd_5Pt_1/GNPs, and $Pd_{10}Pt_1$/GNPs catalysts in 0.5 M H_2SO_4 + 1.0 M methanol at a scan rate of 20 mV s^{-1}.

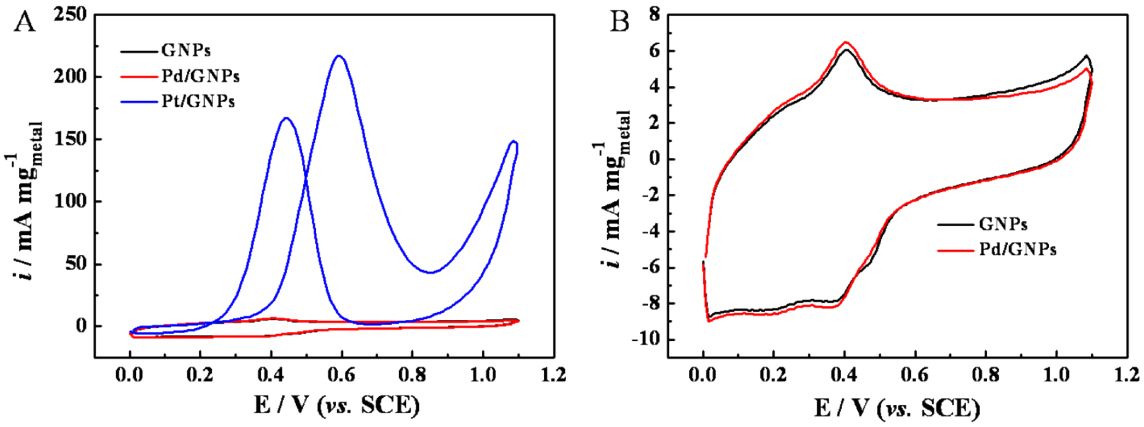

Figure S5 (A) CVs of GNPs, Pt/GNPs and Pd/GNPs catalysts in 0.5 M H_2SO_4 + 1.0 M methanol at a scan rate of 20 mV s^{-1}; (B) The same CVs of GNPs and Pd/GNPs as in (A), but shown with enlarged vertical axis.

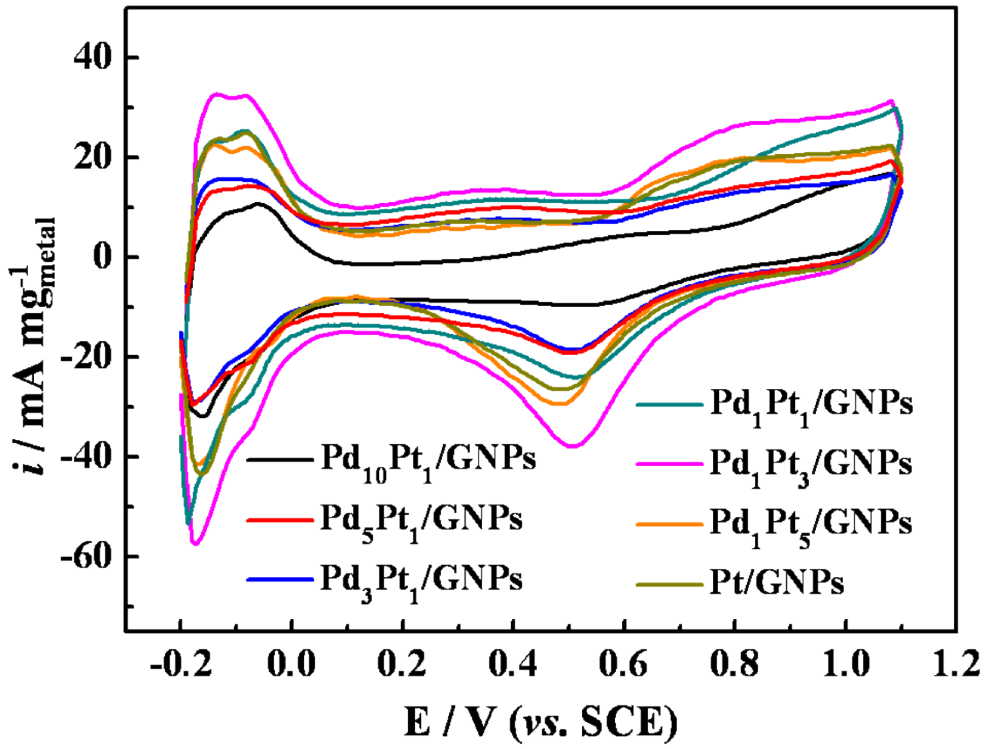

Figure S6 Cyclic voltammograms (CVs) curves of catalysts of different Pd to Pt ratios in 0.5 M H_2SO_4 solution at a scan rate of 50 mV s^{-1}.

Table S1 Summary of the composition and loading date for the catalysts on the basis of ICP-OES analysis.

Catalysts	Metal Ratio (Pd/Pt)	Metal Loading (%)		
		Pd	Pt	Total Metal
Pd/GNPs	1 : 0	17.81		17.81
$Pd_{10}Pt_1$/GNPs	10 : 1.31	14.22	3.43	17.65
Pd_5Pt_1/GNPs	5 : 1.22	12.64	5.68	18.32
Pd_3Pt_1/GNPs	3 : 1.13	11.12	7.7	18.82
Pd_1Pt_1/GNPs	1 : 0.95	6.80	11.89	18.69
Pd_1Pt_3/GNPs	1 : 2.92	3.04	16.32	19.36
Pd_1Pt_5/GNPs	1 :4.89	1.91	17.2	19.11
Pt/GNPs	0 : 1		19.02	19.02

Table S2 Electrochemical parameters obtained from Figure 6.

$PdCl_4^{2-}/PtCl_6^{2-}$ (mol/mol)	Peak (f)		Peak (b)
	$i_{f,\,peak}$		$i_{b,\,peak}$
	(mA mg^{-1}_{metal})	(mA mg^{-1}_{Pt})	(mA mg^{-1}_{metal})
0:1	216.99	216.99	167.39
1:5	206.63	231.07	155.91
1:3	385.22	460.24	283.83
1:1	218.19	339.75	159.41
3:1	122.81	323.09	77.45
5:1	62.84	233.64	39.05
10:1	34.64	215.63	18.92

References

[1] L. Zhao, X. Ji, X. Sun, J. Li, W. Yang, X. Peng, *J. Phy. Chem. C*, 113 (2009) 16645-16651.