Electronic Supplementary Information (ESI)

Star-shaped Pd@Pt core–shell catalysts supported on reduced graphene oxide with superior electrocatalytic performance

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Table S1. EXAFS fitting results of Pt L_3 edge and Pd K edge for the first shell of Pt/RGO, PdPt/RGO, and Pd@Pt/RGO.

Catalyst	Edge	Shell	N[a]	R (Å)[b]	ΔE_0 (eV)[c]	σ^2 (Å^2)[d]	R-factor
Pt foil	Pt L_3	Pt-Pt	12	2.767±0.002	8.1±0.4	0.0048±0.0001	0.0006
Pd foil	Pd K	Pd-Pd	12	2.742±0.002	-2.0±0.6	0.0056±0.0003	0.0018
Pt/RGO	Pt L_3	Pt-Pt	8.2±0.7	2.759±0.004	8.2±1.0	0.0065±0.0004	0.0045
PdPt/RGO	Pt L_3	Pt-Pt	5.4±0.6	2.735±0.005	7.2±0.6	0.0067±0.0007	0.0073
		Pt-Pd	3.9±0.5	2.737±0.005		0.0062±0.0007	
	Pd K	Pd-Pd	5.5±1.3	2.748±0.007	-2.5±1.7	0.0082±0.0013	0.0073
		Pd-Pt	2.0±0.2	2.737±0.005		0.0062±0.0007	
Pd@Pt/RGO	Pt L_3	Pt-Pt	6.6±0.8	2.743±0.008	6.6±1.2	0.0062±0.0007	0.0034
		Pt-Pd	1.0±0.5	2.731±0.016		0.0039±0.0027	
	Pd K	Pd-Pd	9.0±0.8	2.768±0.003	-2.2±0.8	0.0072±0.0004	0.0034
		Pd-Pt	0.5±0.3	2.731±0.016		0.0039±0.0027	

[a] The average coordination number for the coordination shell.

[b] Interatomic distance.

[c] E_0 shift of the path.

[d] Debye-Waller factor.

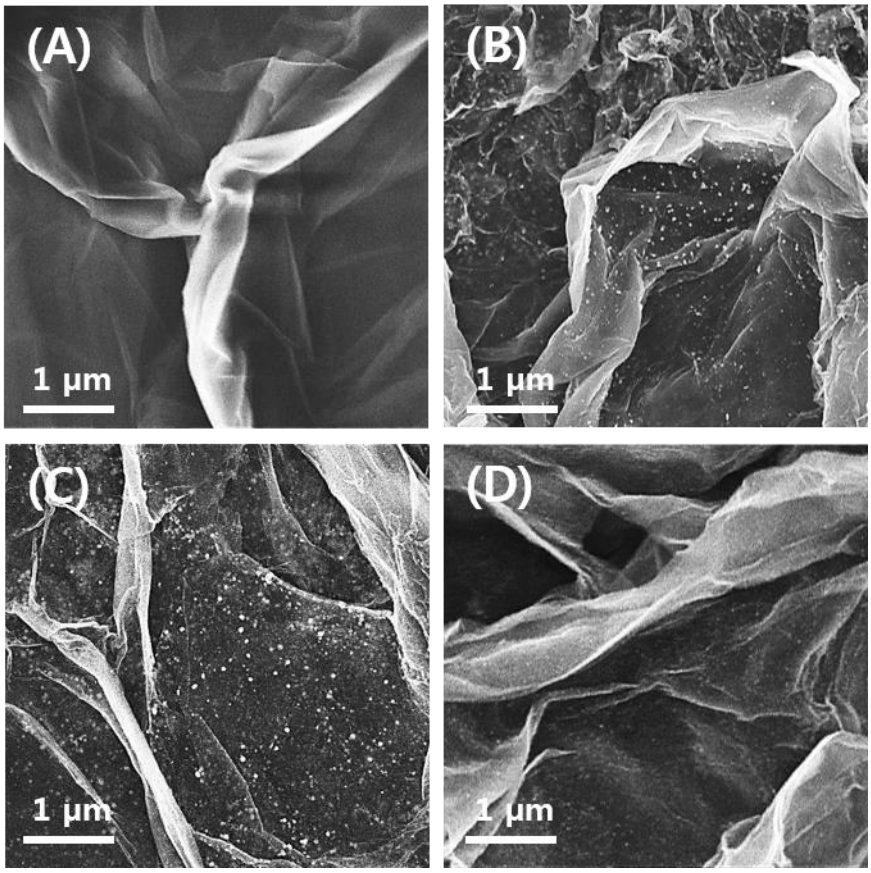

Fig. S1. SEM images of (A) GO, (B) Pd@Pt/RGO, (C) PdPt/RGO, and (D) Pt/RGO.

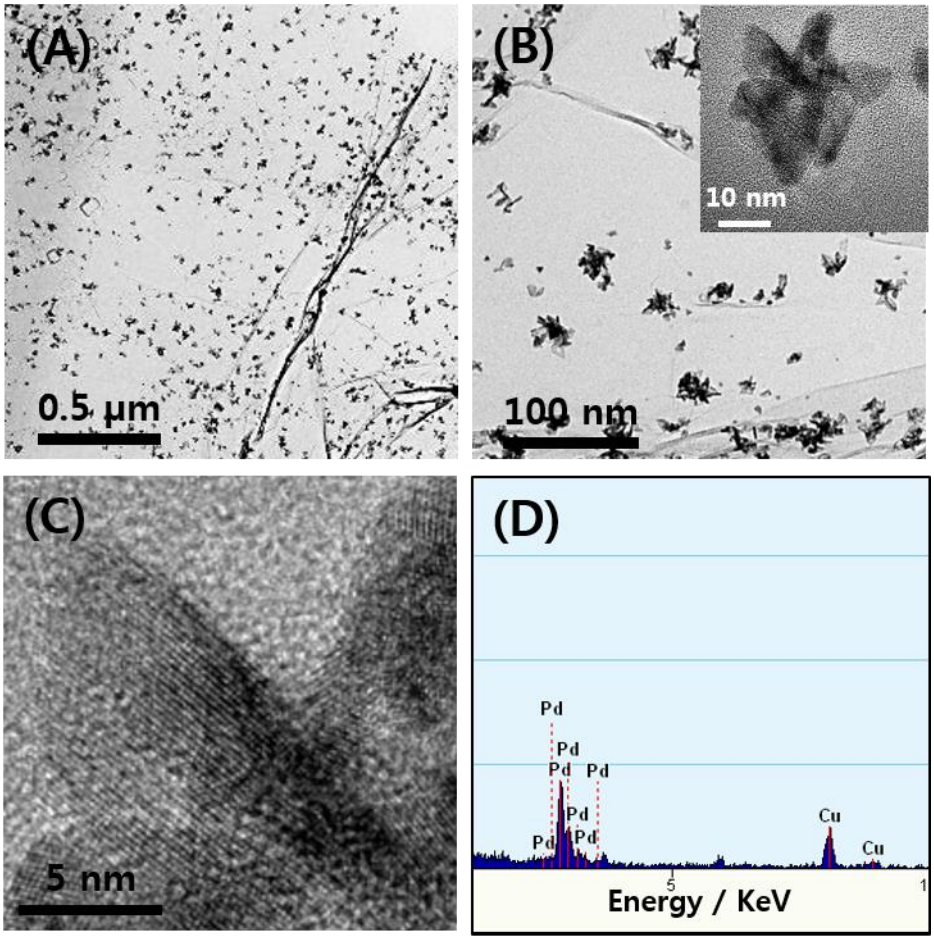

Fig. S2. (A-B) TEM images of Pd/RGO at different magnifications, (C) an HR-TEM image of Pd/RGO, and (D) the EDX spectrum of Pd/RGO. The inset in (B) shows an individual Pd particle on RGO.

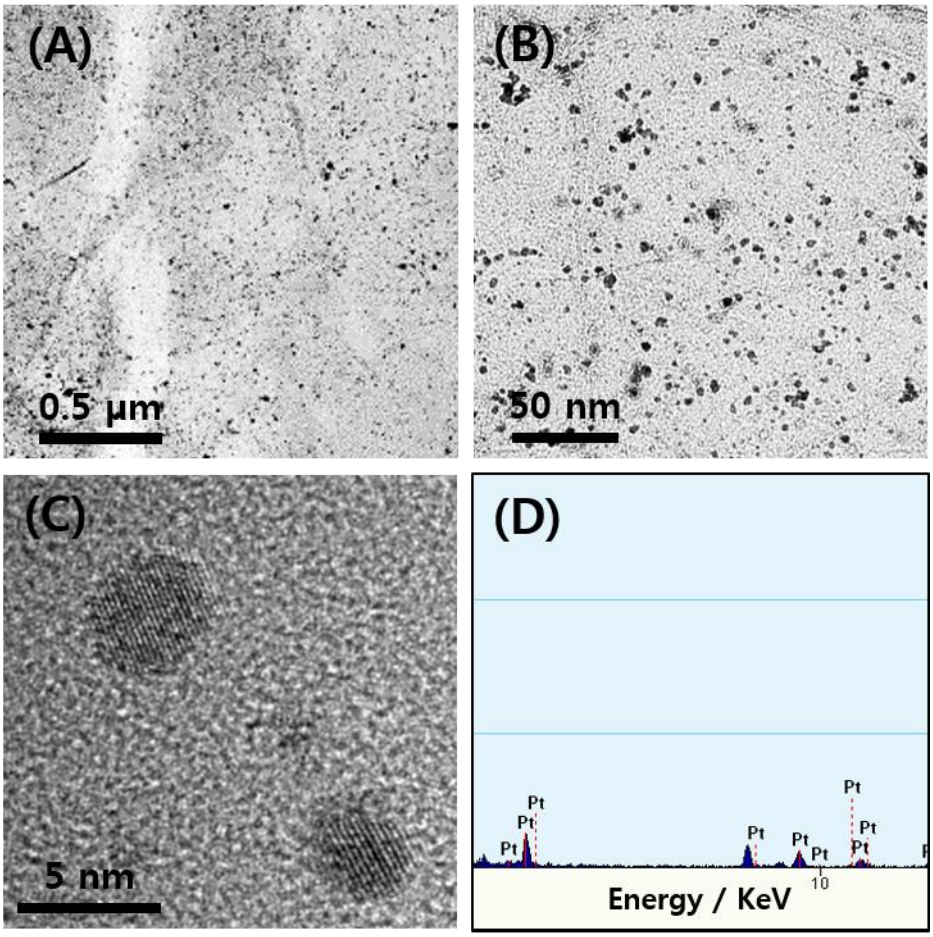

Fig. S3. (A-B) TEM images of Pt/RGO at different magnifications, (C) an HR-TEM image of Pt/RGO, and (D) the EDX spectrum of Pt/RGO.

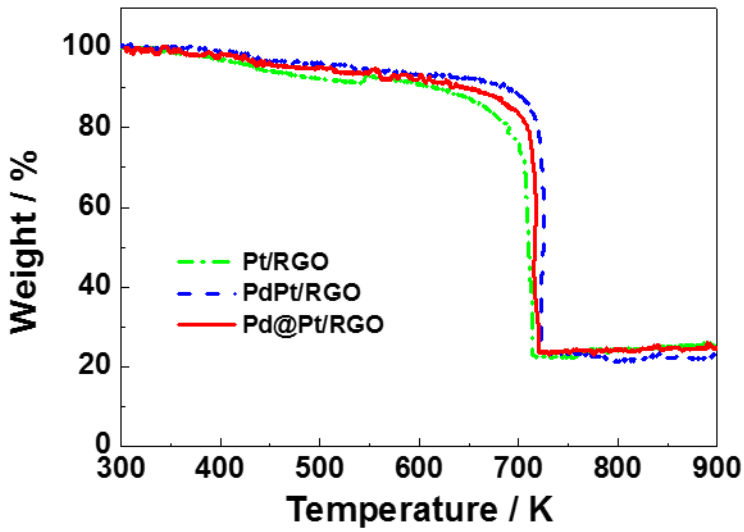

Fig. S4. TGA profiles of Pt/RGO, PdPt/RGO, and Pd@Pt/RGO catalysts from 300 K to 900 K at a temperature ramping rate of 10 K min^{-1}.

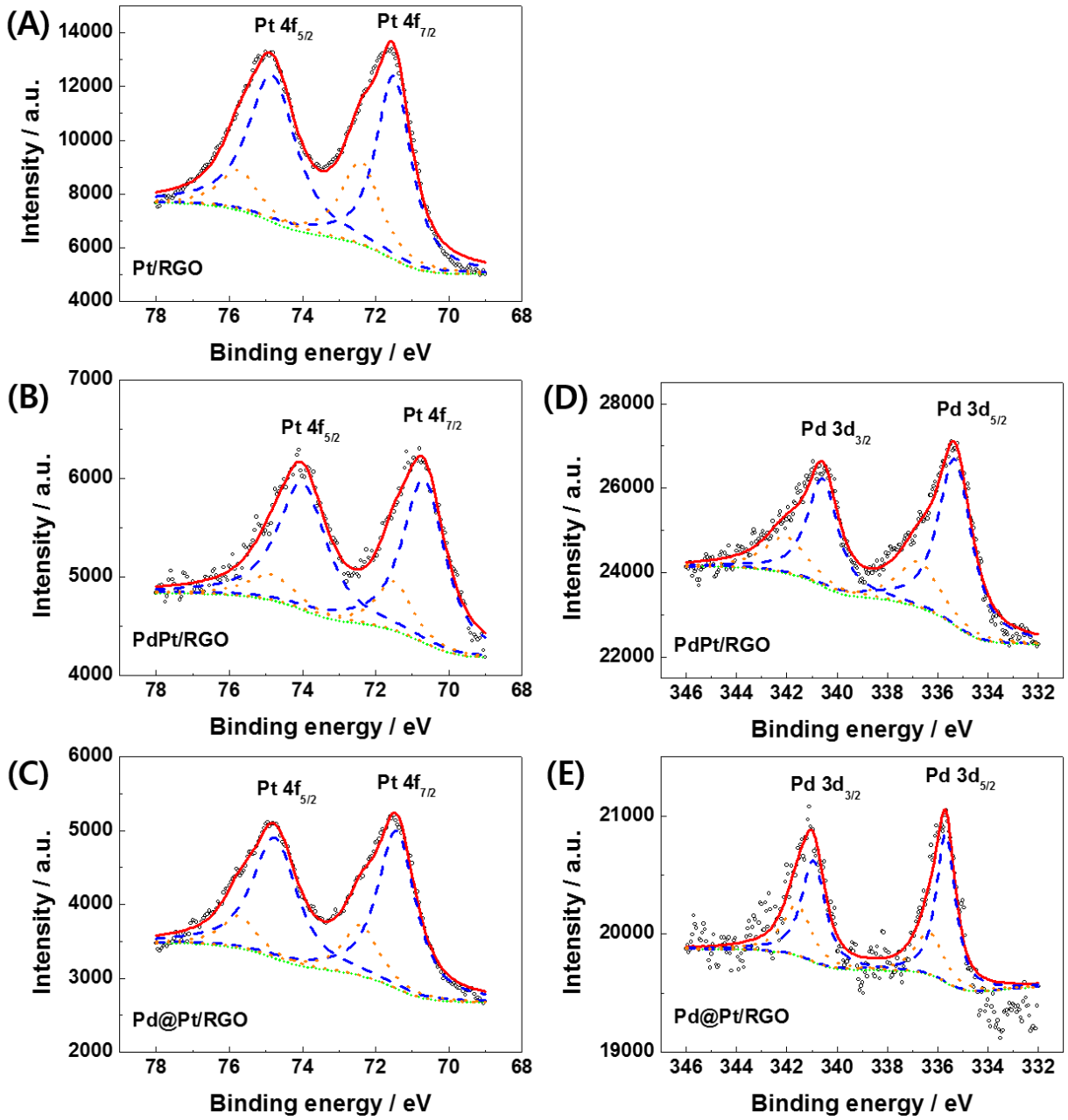

Fig. S5. Curve-fitted XPS spectra of (A-C) Pt 4f and (D, E) Pd 3d for Pt/RGO, PdPt/RGO, and Pd@Pt/RGO.

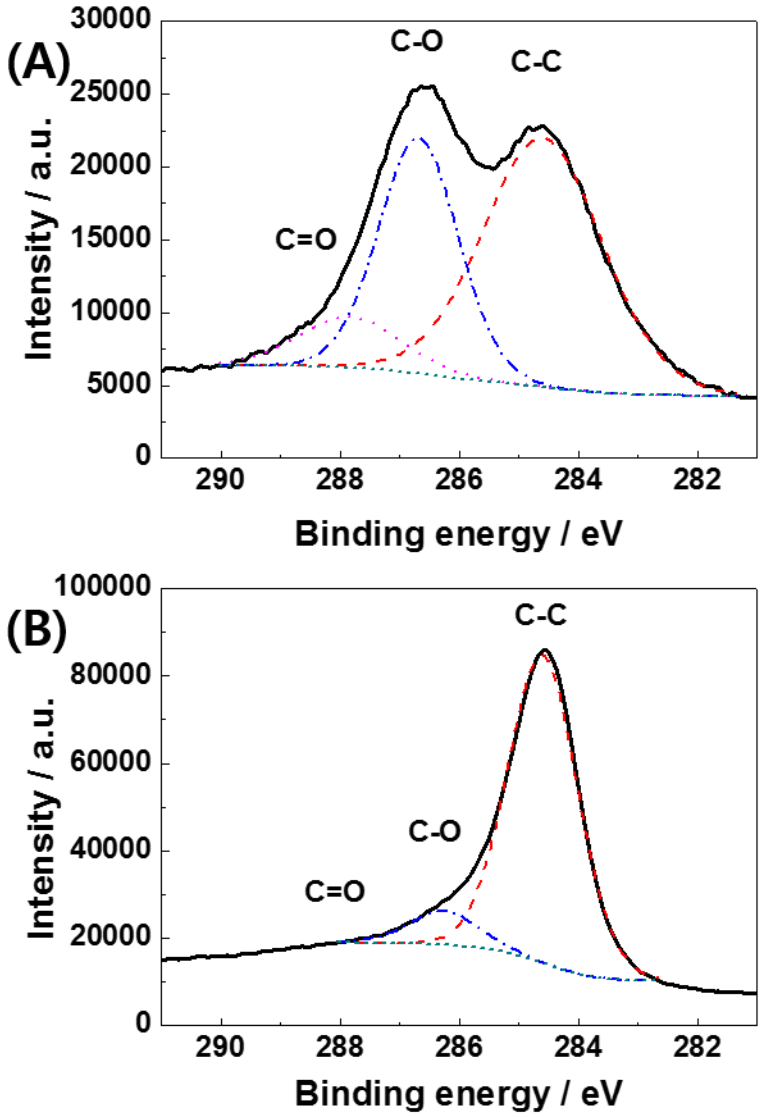

Fig. S6. Deconvoluted C1s XPS spectra for (A) GO and (B) Pd@Pt/RGO.

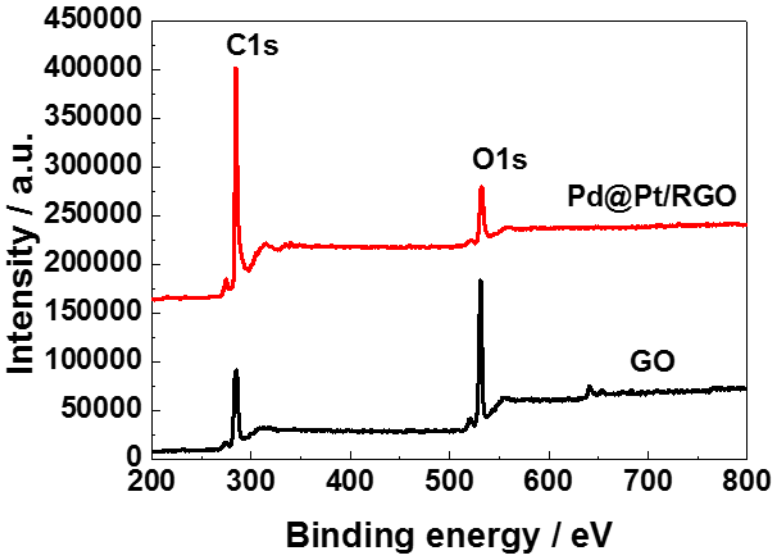

Fig. S7. XPS survey spectra of GO and Pd@Pt/RGO.

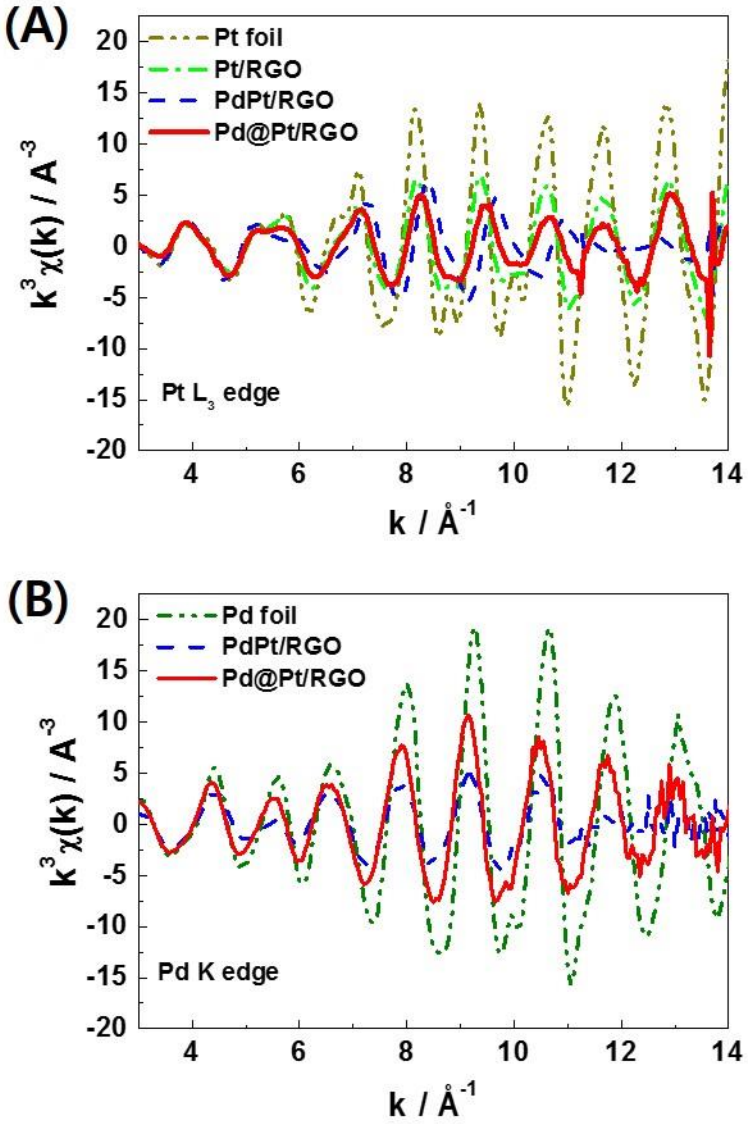

Fig. S8. K^3-weighted EXAFS spectra of (A) Pt L_3-edge and (B) Pd K-edge for Pt/RGO, Pd/RGO, PdPt/RGO, and Pd@Pt/RGO with their corresponding metal foils.

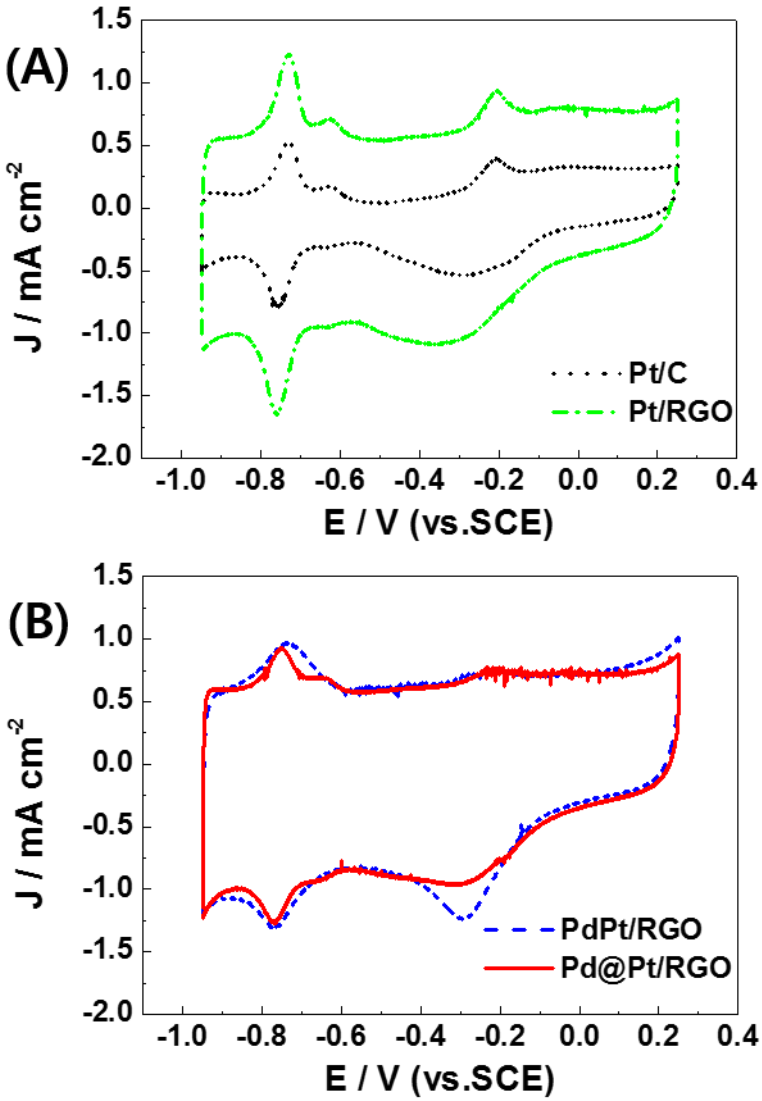

Fig. S9. CVs of the (A) monometallic Pt/C and Pt/RGO and (B) bimetallic PdPt/RGO and Pd@Pt/RGO in N_2-saturated 0.5 M NaOH solution; the scan rate was 50 mV s^{-1}.

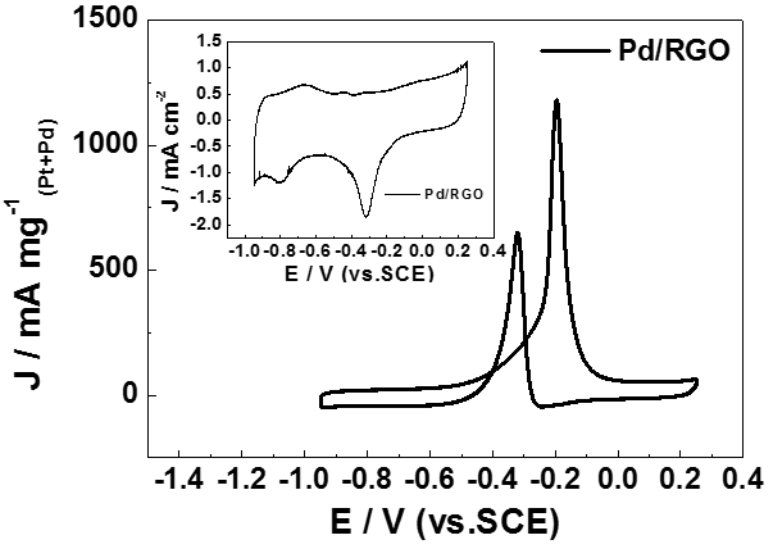

Fig. S10. CV of Pd/RGO in N_2-saturated 0.5 M NaOH + 0.5 M methanol obtained at a scan rate of 50 mV s^{-1}. Inset shows the CV of Pd/RGO in N_2-saturated 0.5 M NaOH.

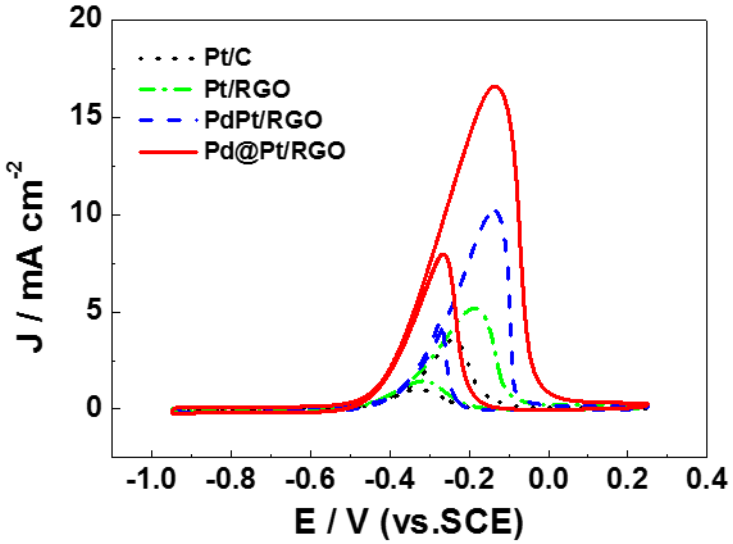

Fig. S11. ECSA-normalized CV curves of Pt/C, Pt/RGO, PdPt/RGO, and Pd@Pt/RGO in N_2-saturated 0.5 M NaOH + 0.5 M methanol obtained at a scan rate of 50 mV s^{-1}.

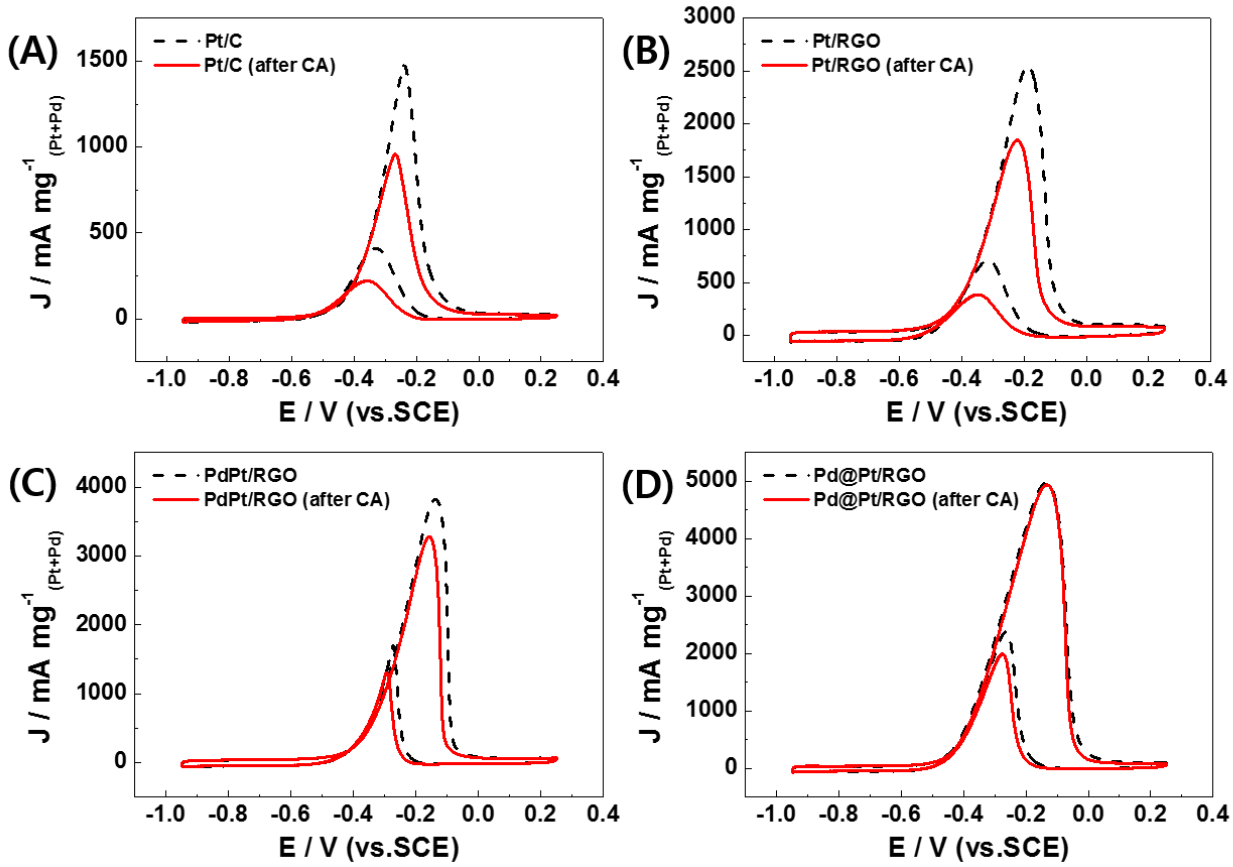

Fig. S12. CVs of (A) Pt/C, (B) Pt/RGO, (C) PdPt/RGO, and (D) Pd@Pt/RGO before and after CA tests in 0.5 M NaOH + 0.5 M methanol.

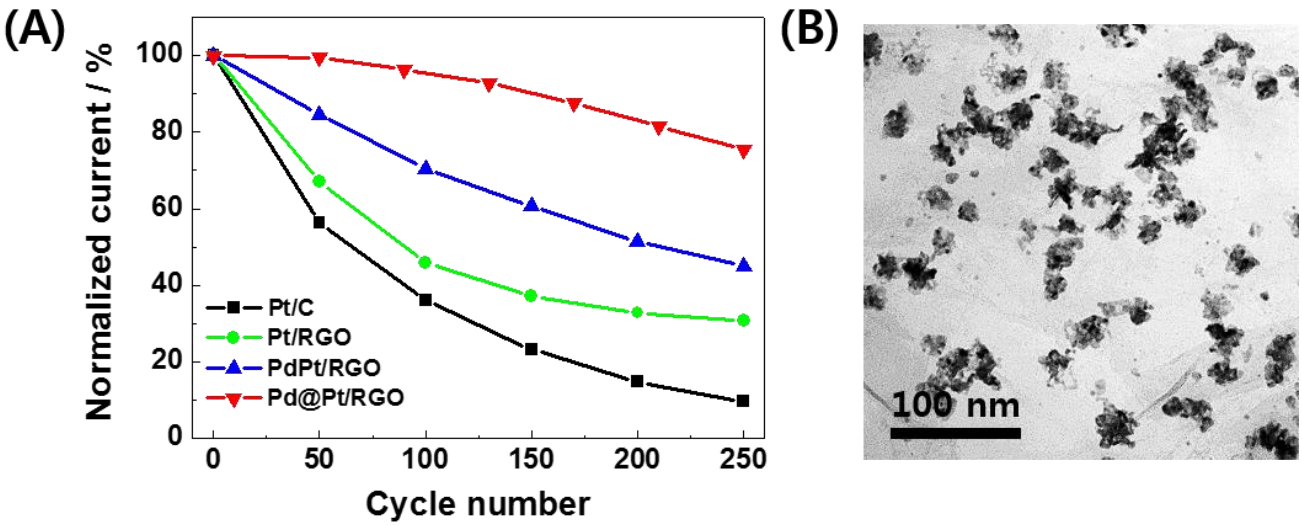

Fig. S13. (A) Normalized cycling stabilities of Pt/C, Pt/RGO, PdPt/RGO, and Pd@Pt/RGO in 0.5 M NaOH + 0.5 M methanol at a scan rate of 50 mV s^{-1}. (B) TEM image of the Pd@Pt/RGO after cycling stability test.