

Electronic Supplementary Information

Sandwich-structured TiO₂-Pt-graphene ternary hybrid electrocatalysts with high efficiency and stability

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Table a			
Element	(keV)	Mass %	At %
C K	0.277	10.68	26.11
O K	0.525	22.58	41.44
Ti K	4.508	48.45	27.70
Pt M	2.048	18.30	2.75
Total		100.00	100.00

Table b			
Element	(keV)	Mass %	At %
C K	0.277	20.33	44.49
O K	0.525	18.06	29.09
Ti K	4.508	44.82	24.29
Pt M	2.048	16.79	2.13
Total		100.00	100.00

Table c			
Element	(keV)	Mass %	At %
C K	0.277	34.88	60.97
O K	0.525	17.99	23.60
Ti K	4.508	31.33	13.73
Pt M	2.048	15.81	1.70
Total		100.00	100.00

Table S1. Quantitative analysis from EDX results of TiO₂-Pt-G₁₀ (a), TiO₂-Pt-G₂₀ (b), and TiO₂-Pt-G₄₀ (c).

Electronic Supplementary Information

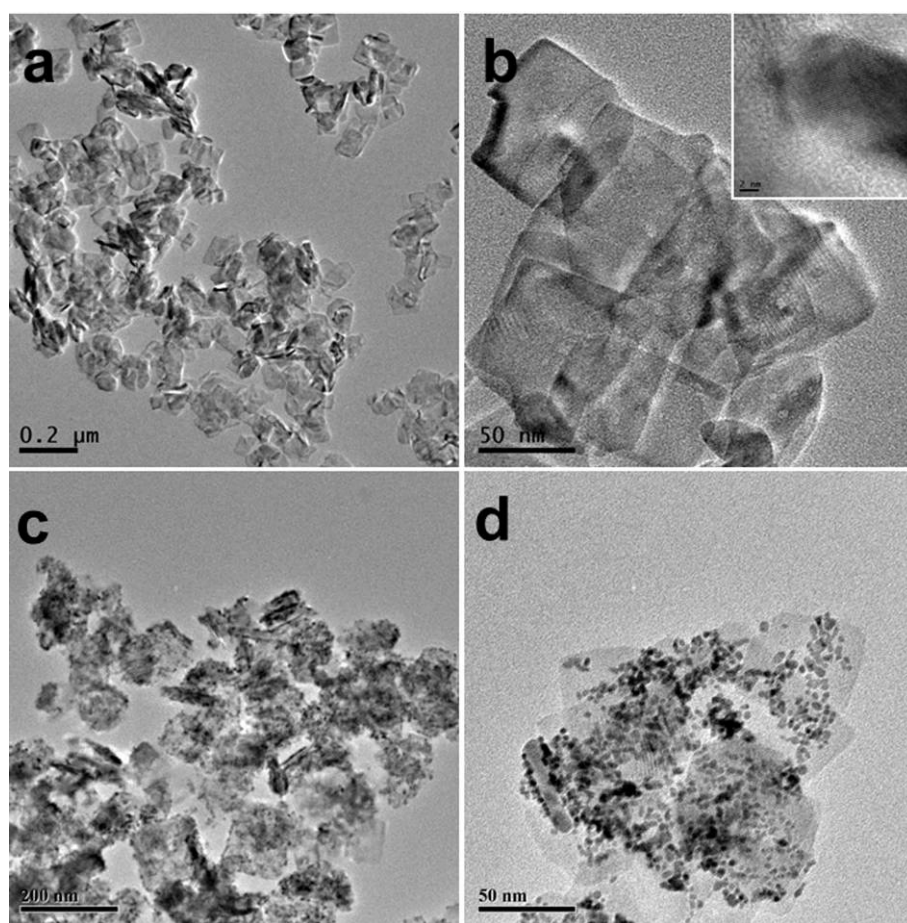


Figure S1. TEM images of TiO₂ NS (a,b), and Pt/TiO₂ NS (c, d).

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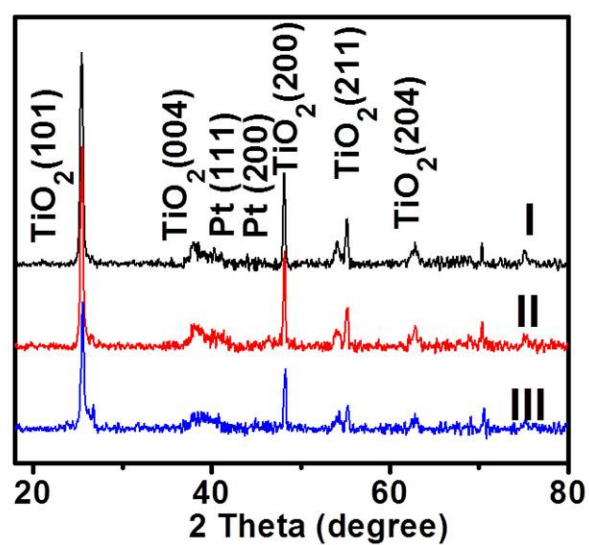


Figure S2. XRD patterns of TiO₂-Pt-G hybrids with different weight ratios of TiO₂ and graphene. Pattern I: TiO₂-Pt-G₁₀; Pattern II: TiO₂-Pt-G₂₀; Pattern III: TiO₂-Pt-G₄₀.

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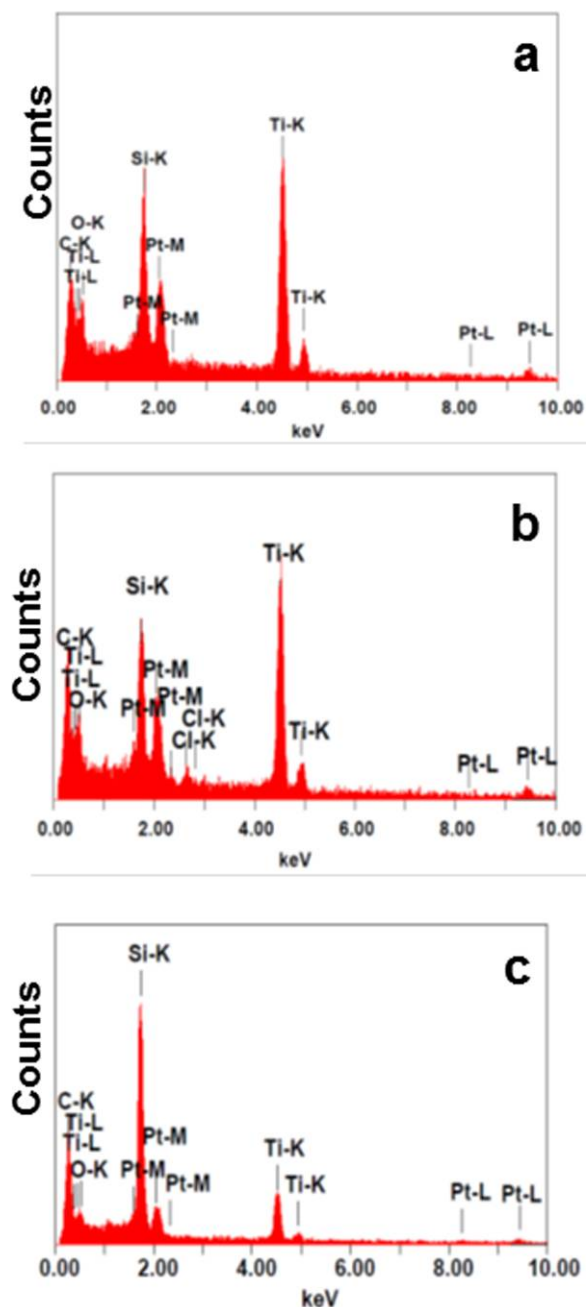


Figure S3. EDX spectra of $\text{TiO}_2\text{-Pt-G}_{10}$ (a), $\text{TiO}_2\text{-Pt-G}_{20}$ (b) and $\text{TiO}_2\text{-Pt-G}_{40}$ (c).

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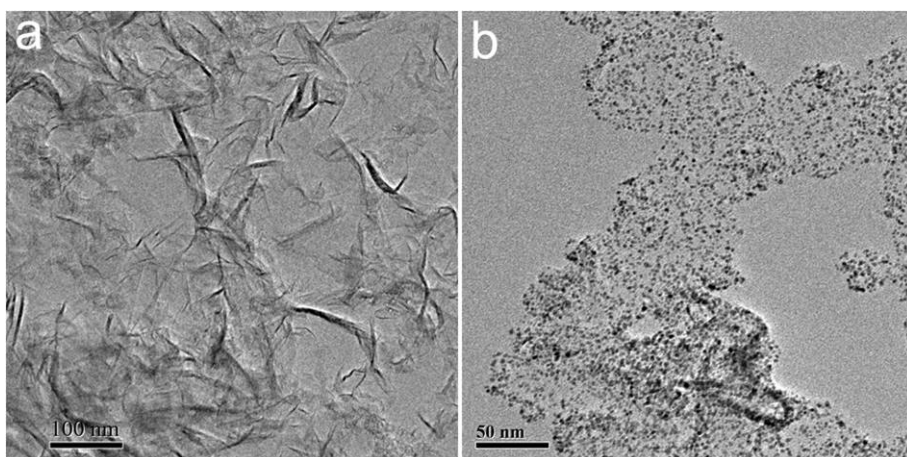


Figure S4. TEM images of graphene (a) and Pt NPs supported on graphene (b).

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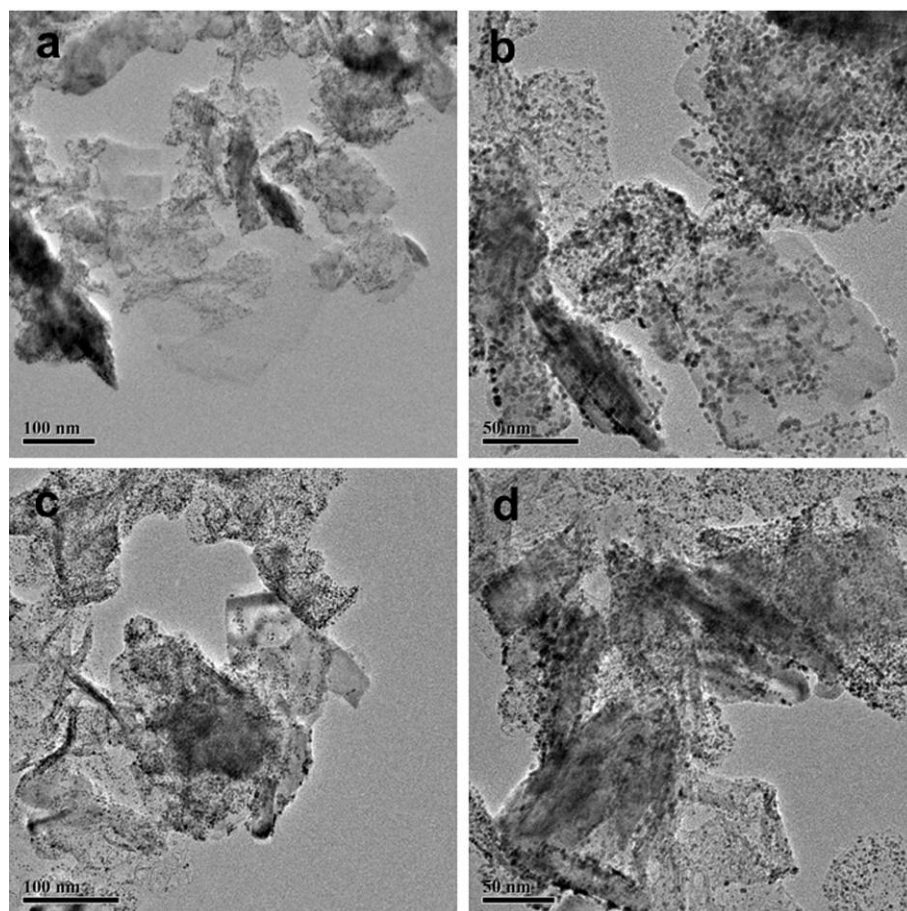


Figure S5. TEM images of TiO₂-Pt-G₂₀ (a, b) and TiO₂-Pt-G₄₀ (c, d).

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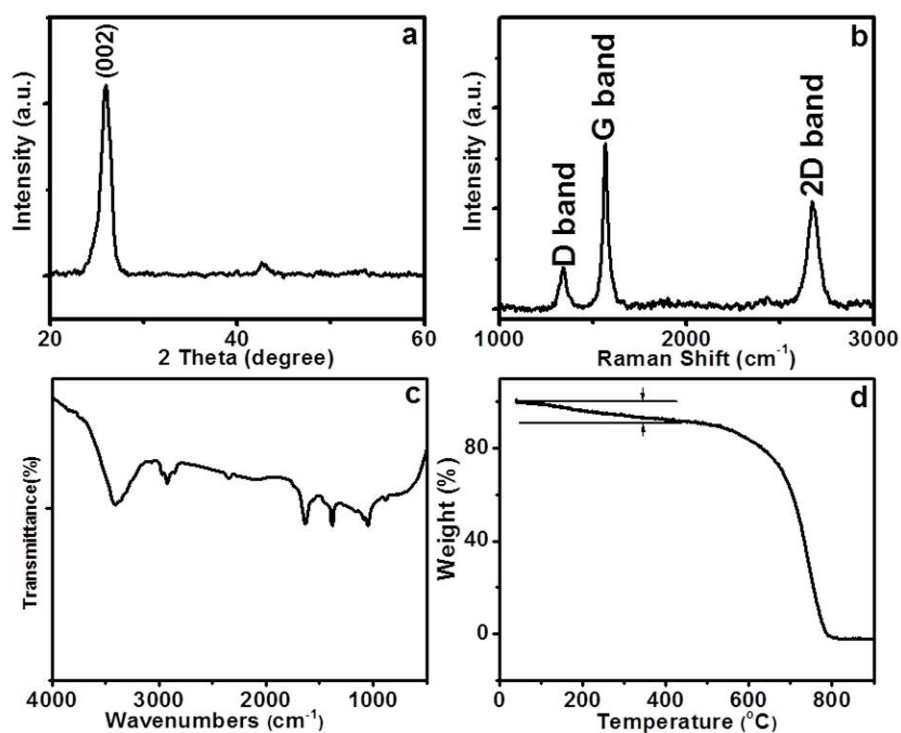


Figure S6. XRD pattern (a), Raman spectra (b), FT-IR (c) and TGA curve (d) of graphene, which confirm the presence of oxygen-containing species and good crystallinity.

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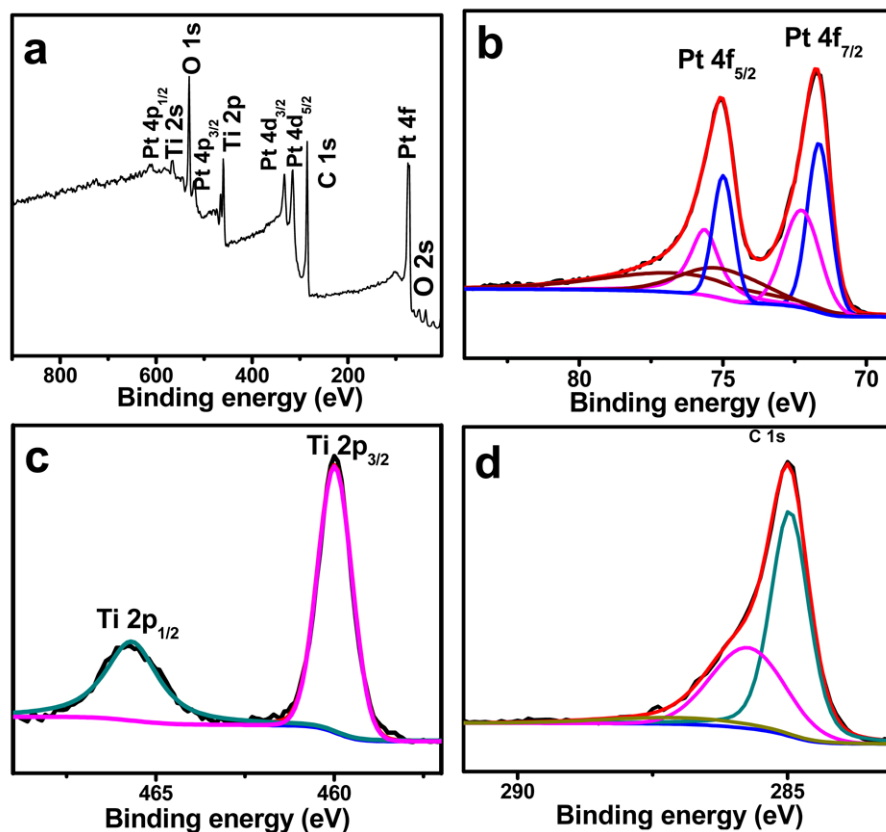


Figure S7. Wide scan XPS spectrum of $\text{TiO}_2\text{-Pt-G}_{20}$ hybrid (a), the corresponding Pt4f core level XPS spectrum (b), fitted XPS Ti1p (c) and C1s spectra (d).

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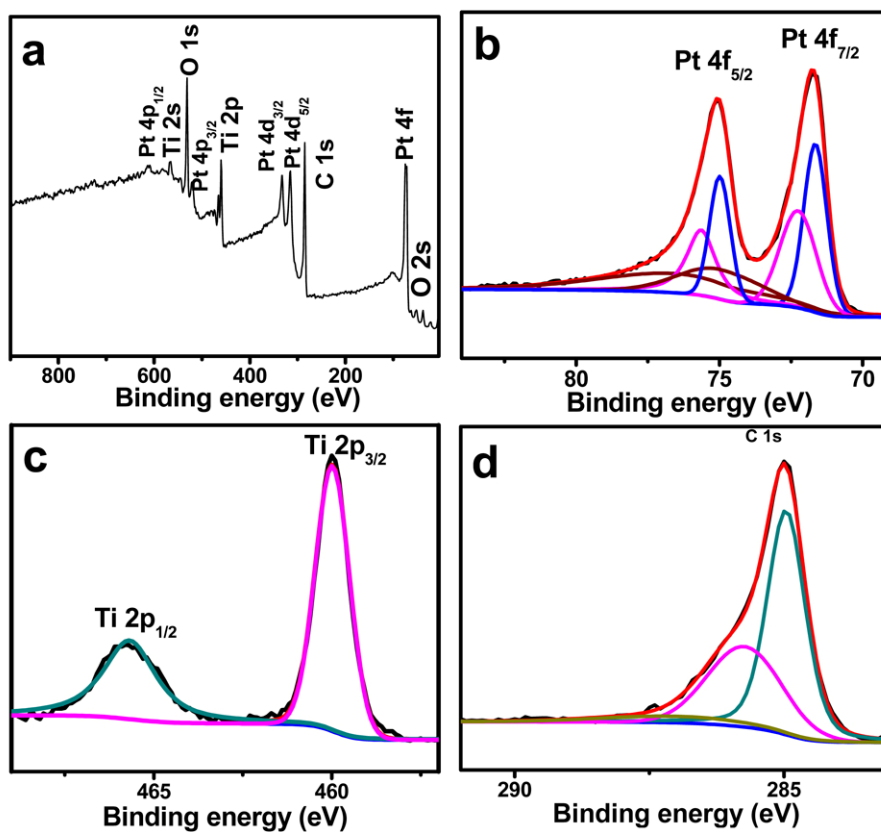


Figure S8. Wide scan XPS spectrum of $\text{TiO}_2\text{-Pt-G}_{40}$ hybrid (a), the corresponding Pt4f core level XPS spectrum (b), fitted XPS Ti1p (c) and C1s spectra (d).

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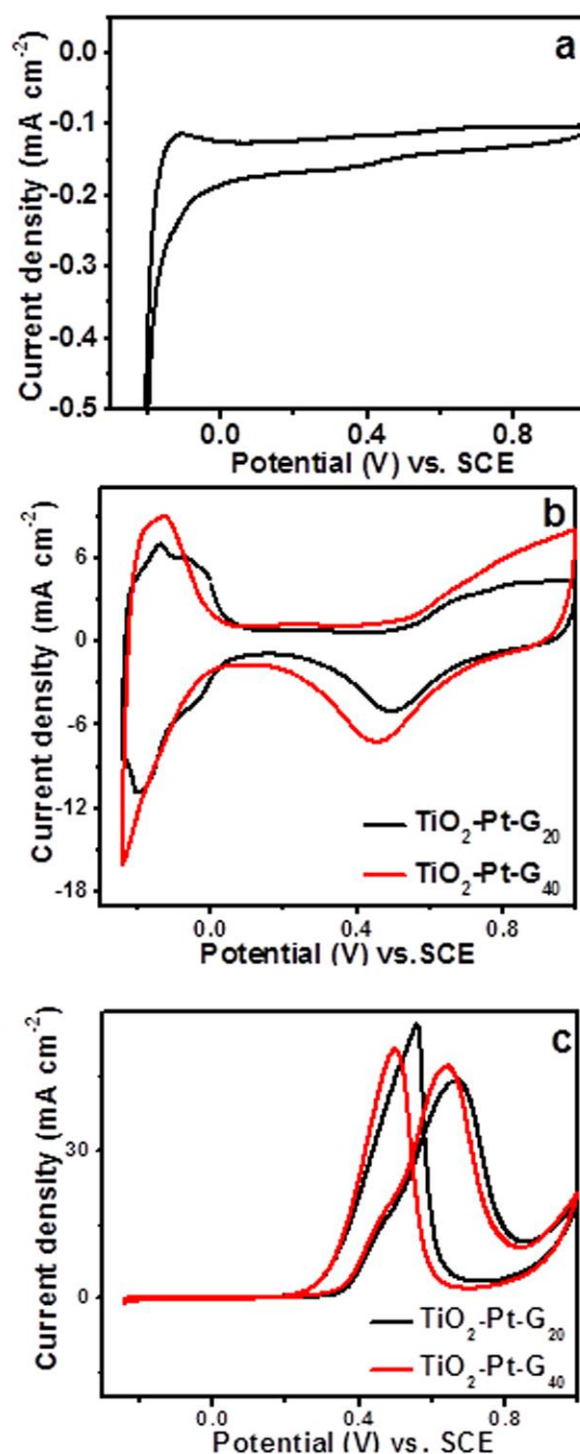


Figure S9. Cyclic voltammograms (CVs) of the Pt/TiO₂ NSs (a) and TiO₂-Pt-G hybrids in a 0.5 M H₂SO₄ solution with the sweep rate of 50 mV s⁻¹ (b). CVs of methanol oxidation on TiO₂-Pt-G hybrids in a 0.5 M H₂SO₄ + 1M CH₃OH solution. The Pt loading on the electrode is 0.2 mg cm⁻² and the sweep rate is 5 mV s⁻¹ (c).

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catalyst	Carbon content	ECSA ($\text{m}^2 \text{g}^{-1}$)	Current density (mA cm^{-2})	I_f/I_g
Pt/CB	80	43.4	22.6	0.95
Pt/Graphene	80	54.6	38.3	0.7
TiO ₂ -Pt-G ₁₀	12	62.8	42.3	1.24
TiO ₂ -Pt-G ₂₀	23	65.6	45.2	0.82
TiO ₂ -Pt-G ₄₀	41	70.2	47.8	0.97

Table S2. A summary of the important information of the electrocatalysts. ECSA is defined by electrochemical surface area which is calculated from Figure 6a and S7b. Current density is selected from Figure 6b and S7c.

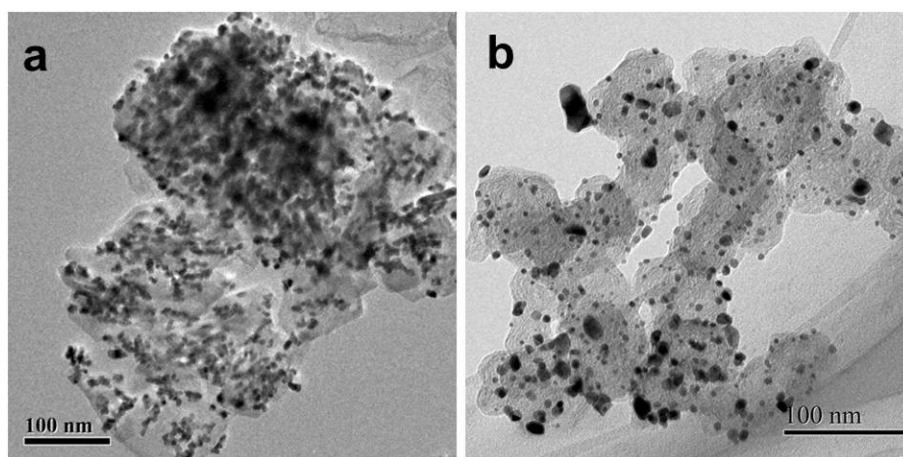


Figure S10. TEM images of TiO₂-Pt-G₁₀ (a) and Pt/CB (b) after 6000 ADT cycles in a 0.5 M H₂SO₄ solution with a sweep rate of 50 mV s⁻¹.