

## Supplemental Information

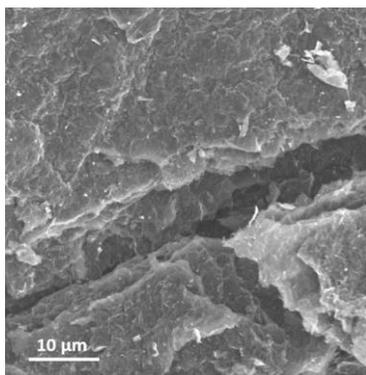
### The catalytic effect of graphene structure on Pt/graphene catalysts

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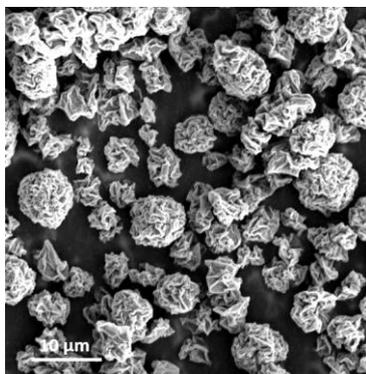
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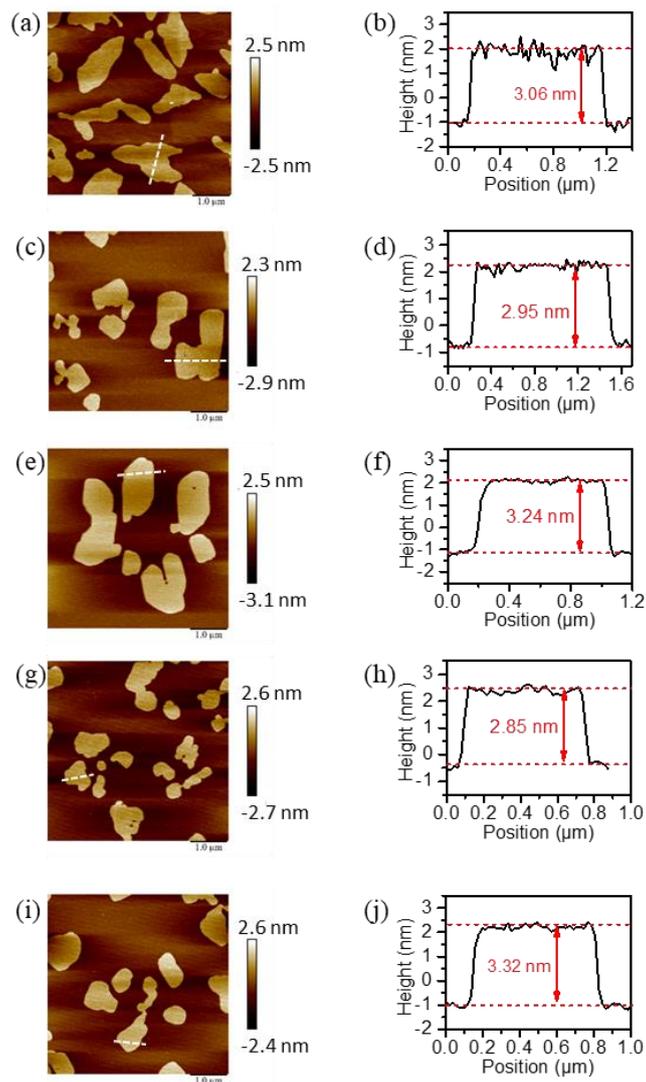
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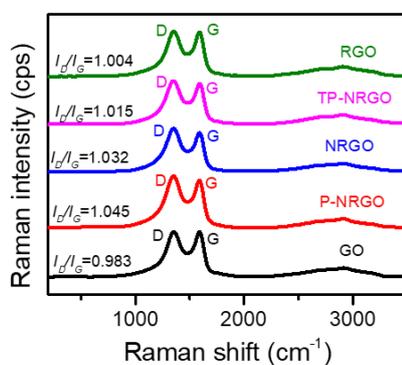
**Fig. S1** SEM image of NGO.



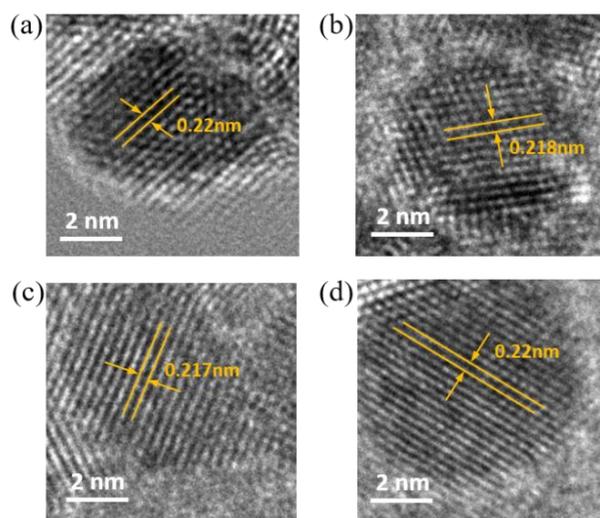
**Fig. S2** SEM image of GO.



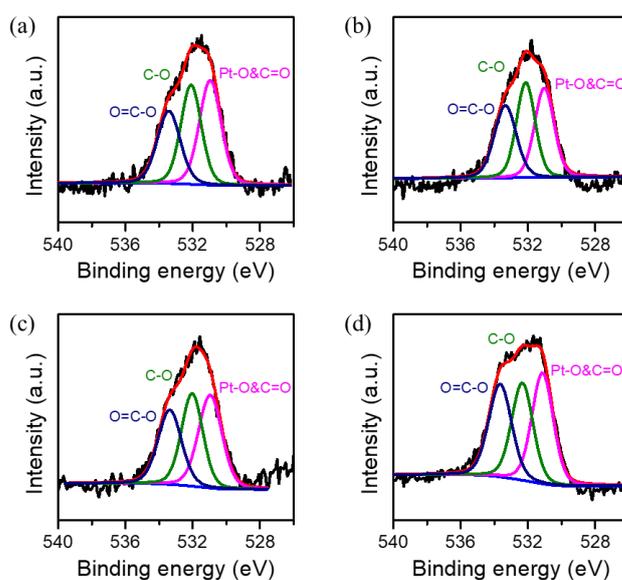
**Fig. S3** AFM images and height profiles of (a, b) GO, (c, d) P-NRGO, (e, f) NRGO, (g, h) TP-NRGO and (i, j) RGO.



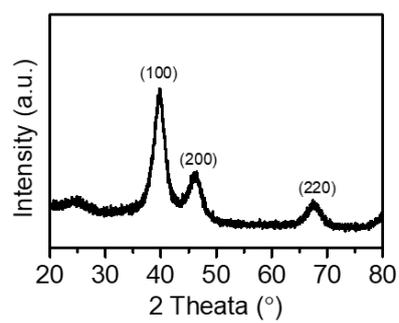
**Fig. S4** Raman spectra of GO, P-NRGO, NRGO, TP-NRGO and RGO.



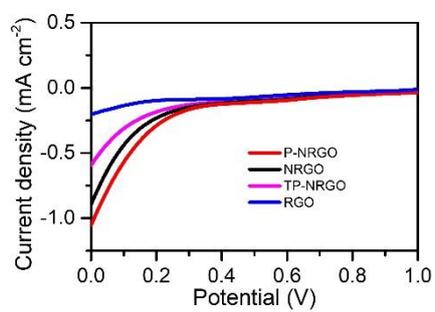
**Fig. S5** High resolution TEM images showing the lattice and d-spacing value of (a) Pt/P-NRGO, (b) Pt/NRGO, (c) Pt/TP-NRGO and (d) Pt/RGO.



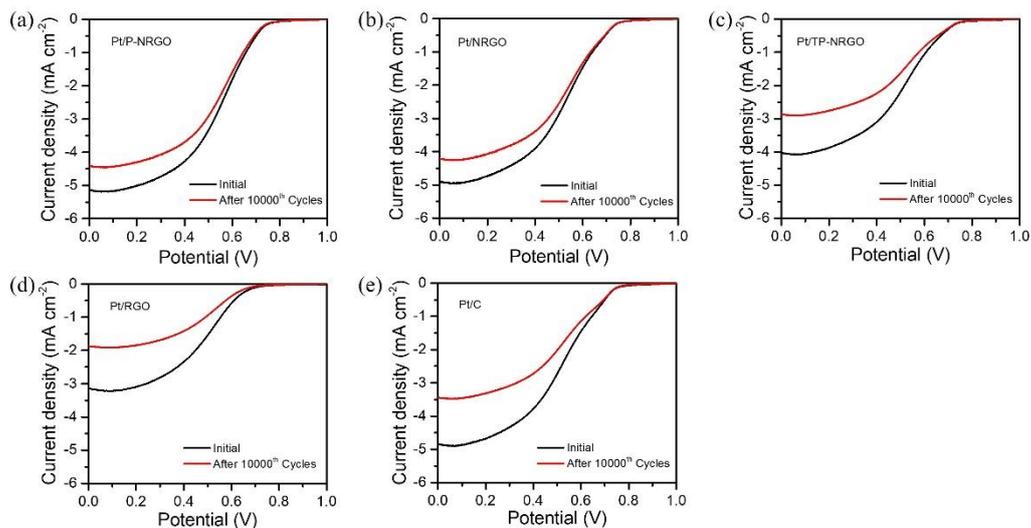
**Fig. S6** High-resolution O 1s XPS spectra of (a) Pt/P-NRGO, (b) Pt/NRGO, (c) Pt/TP-NRGO and (d) Pt/RGO. The binding energy at 531.1 eV can be attributed to Pt-O & C=O, and the peak of C=O covers the peak of Pt-O bond.



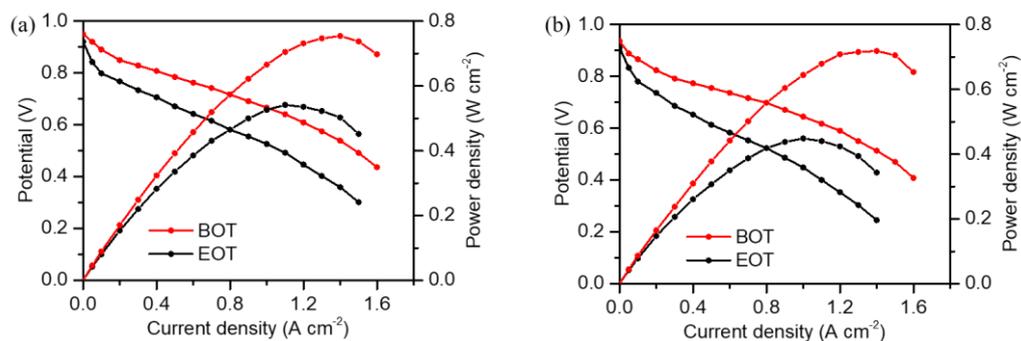
**Fig. S7.** XRD pattern of commercial Pt/C catalyst.



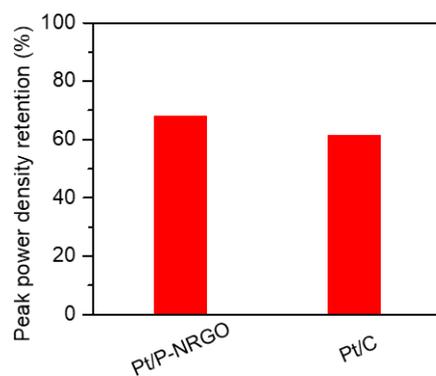
**Fig. S8** ORR polarization curves of P-NRGO, NRGO, TP-NRGO and RGO supports. ORR polarization curves were conducted in O<sub>2</sub>-saturated 0.5 M H<sub>2</sub>SO<sub>4</sub> electrolyte at a scan rate of 10 mV s<sup>-1</sup> and a rotation of 1600 rpm.



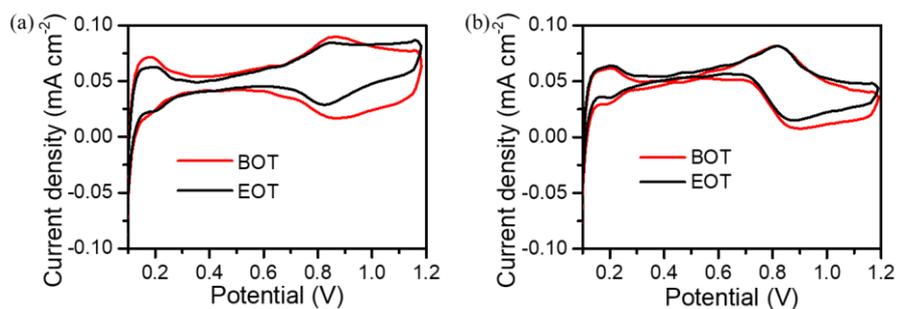
**Fig. S9** ORR polarization curves of (a) Pt/P-NRGO, (b) Pt/NRGO, (c) Pt/TP-NRGO, (d) Pt/RGO and (e) Pt/C catalysts before and after 10000<sup>th</sup> cycles of CV in O<sub>2</sub>-saturated 0.5 M H<sub>2</sub>SO<sub>4</sub> electrolyte.



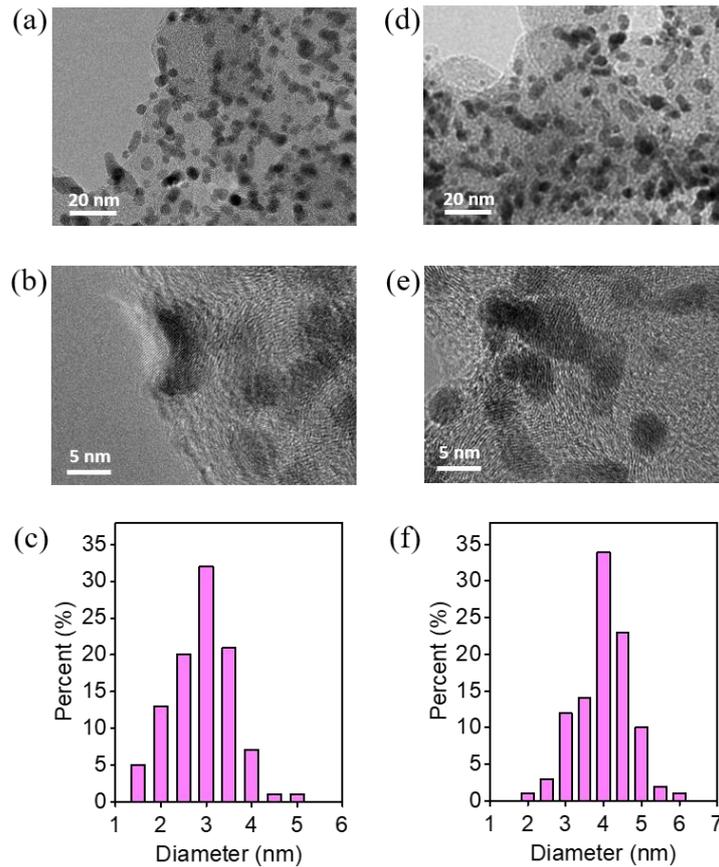
**Fig. S10** (a) Polarization and power density plots of MEA assembled with Pt/P-NRGO at BOT and EOT. (b) Polarization and power density plots of MEA assembled with commercial Pt/C at BOT and EOT.



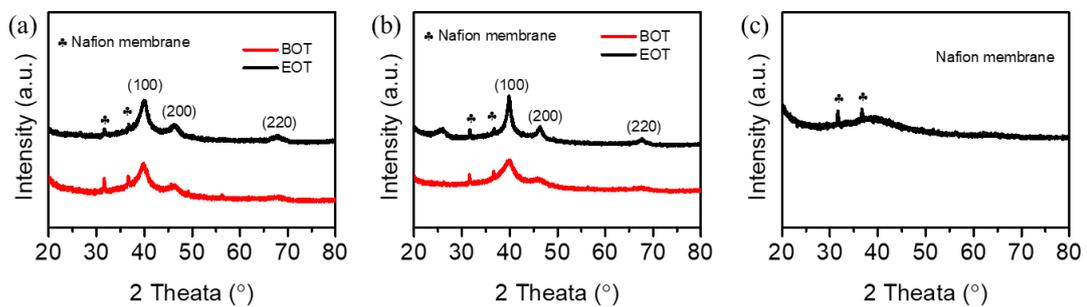
**Fig. S11** Peak power density retention for Pt/P-NRGO and commercial Pt/C from BOT to EOT.



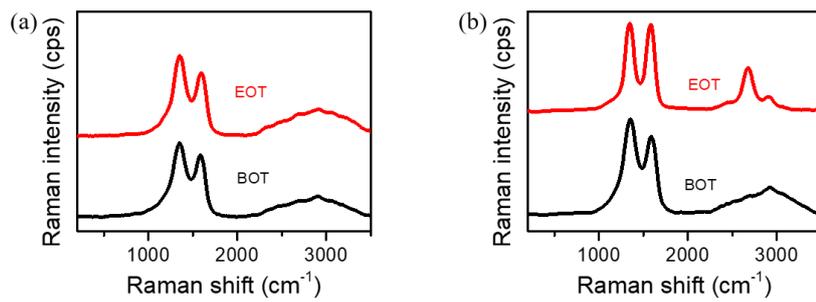
**Fig. S12** (a) CV curves of MEA assembled with Pt/P-NRGO at BOT and EOT. (b) CV curves of MEA assembled with commercial Pt/C at BOT and EOT.



**Fig. S13** (a, b) TEM images with different magnifications for Pt/C at BOT. (d, e) TEM images with different magnifications for commercial Pt/C at EOT. Pt particle size distribution of commercial Pt/C at (c) BOT and (f) EOT.



**Fig. S14** (a) XRD patterns of Pt/P-NRGO at BOT and EOT. (b) XRD patterns of commercial Pt/C at BOT and EOT. (c) XRD pattern of Nafion membrane. The XRD analyses for catalysts were tested using catalyst coated membrane (CCM).



**Fig. S15** Raman spectra of Pt/P-NRGO at BOT and EOT. (b) Raman spectra of commercial Pt/C at BOT and EOT.

**Table S1** The percentage of different types of N in the P-NRGO, NRGO and TP-NRGO materials obtained from the XPS analysis.

	Pyridinic N (%)	Pyrrolic N (%)	Graphitic N (%)	Oxidized N (%)
P-NRGO	32.78	32.13	21.98	13.11
NRGO	35.35	34.15	21.33	9.17
TP-NRGO	39.17	27.77	19.04	14.02

**Table S2** The percentage of different types of N in the Pt/P-NRGO, Pt/NRGO and Pt/TP-NRGO catalysts obtained from the XPS analysis.

	Pyridinic N (%)	Pyrrolic N (%)	Graphitic N (%)	Oxidized N (%)
Pt/P-NRGO	40.33	31.80	21.72	6.15
Pt/NRGO	36.36	31.08	21.05	11.51
Pt/TP-NRGO	40.92	26.70	19.49	12.89

**Table S3** Electrochemical active surface area (ECSA), mass activity (MA), and specific activity (SA) comparison of catalysts based on a three-electrode system test results.

	ECSA (m <sup>2</sup> /g)	MA (A/mg)	SA (mA/cm <sup>2</sup> )
Pt/P-NRGO	97.4	0.53	0.54
Pt/NRGO	84.7	0.45	0.53
Pt/TP-NRGO	87.1	0.35	0.40
Pt/RGO	40.6	0.17	0.41
Pt/C	84.2	0.43	0.51