An Ultrafast-Versatile-Domestic-Microwave-Oven Based Graphene Oxide Reactor for the Synthesis of Highly Efficient Graphene Based Hybrid Electrocatalysts

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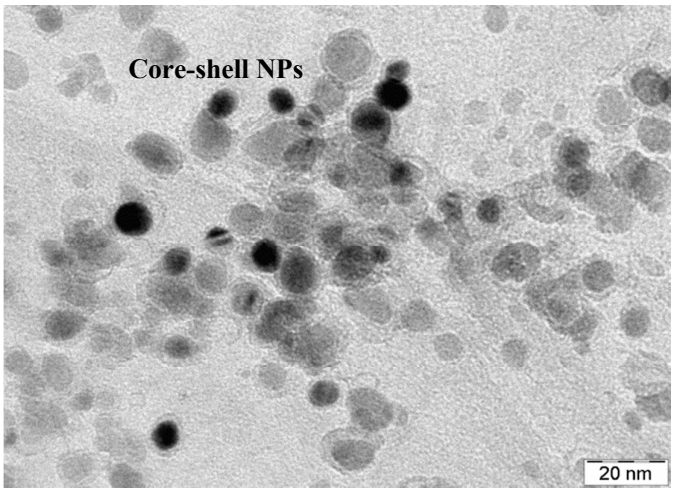


Figure S1. TEM image of Co-Fe_3C-G@rGO.

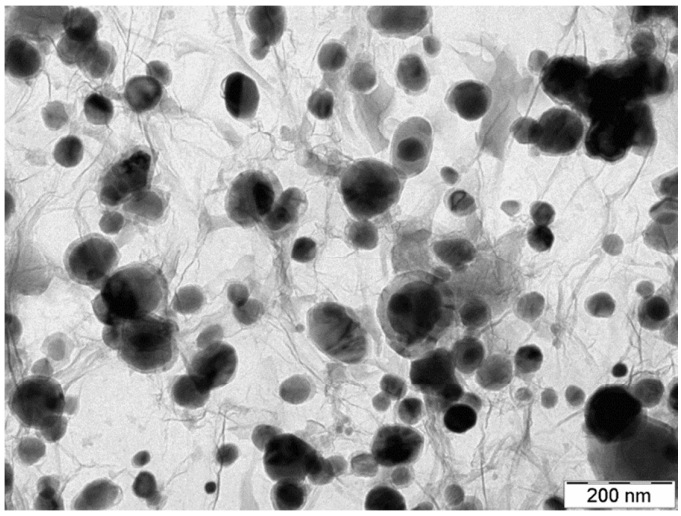


Figure S2**.** TEM image of core-shell Fe-Fe_3C-G@rGO.

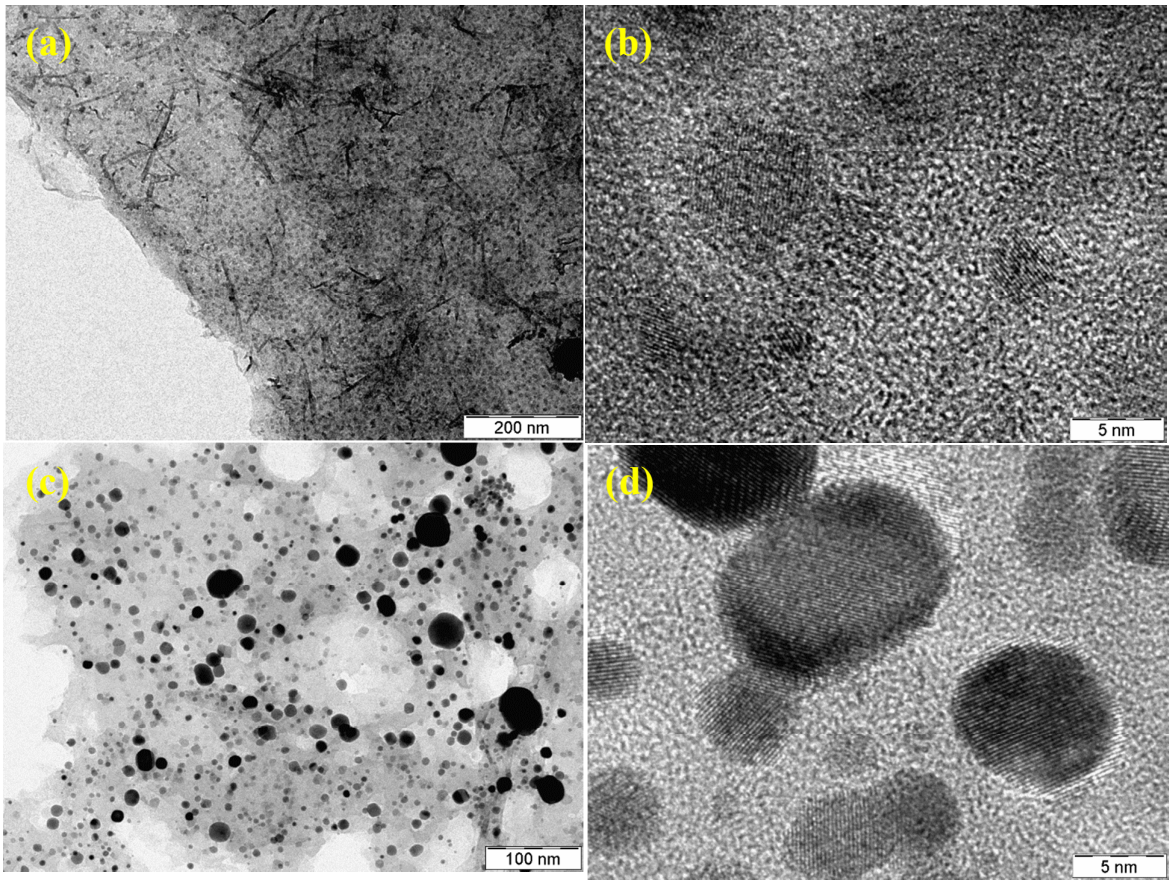


Figure S3. TEM and HTREM images of (a and b) CoO@rGO and (c and d) Pt@rGO**.**

Table S1. % C-C bond in rGO.

	C-C (%)	C-O (%)	C=O (%)
GO	30	50.7	19.3
rGO	88.1	9.1	2.8
Fe3C-G@rGO	86.4	10.6	3
Co-Fe3C-G@rGO	84.2	11.3	4.5
Fe-Fe3C-NG@rGO	85.4	10.3	4.3
CoO@rGO	85.8	9.8	4.4
Pt@rGO	89.2	7.3	3.5

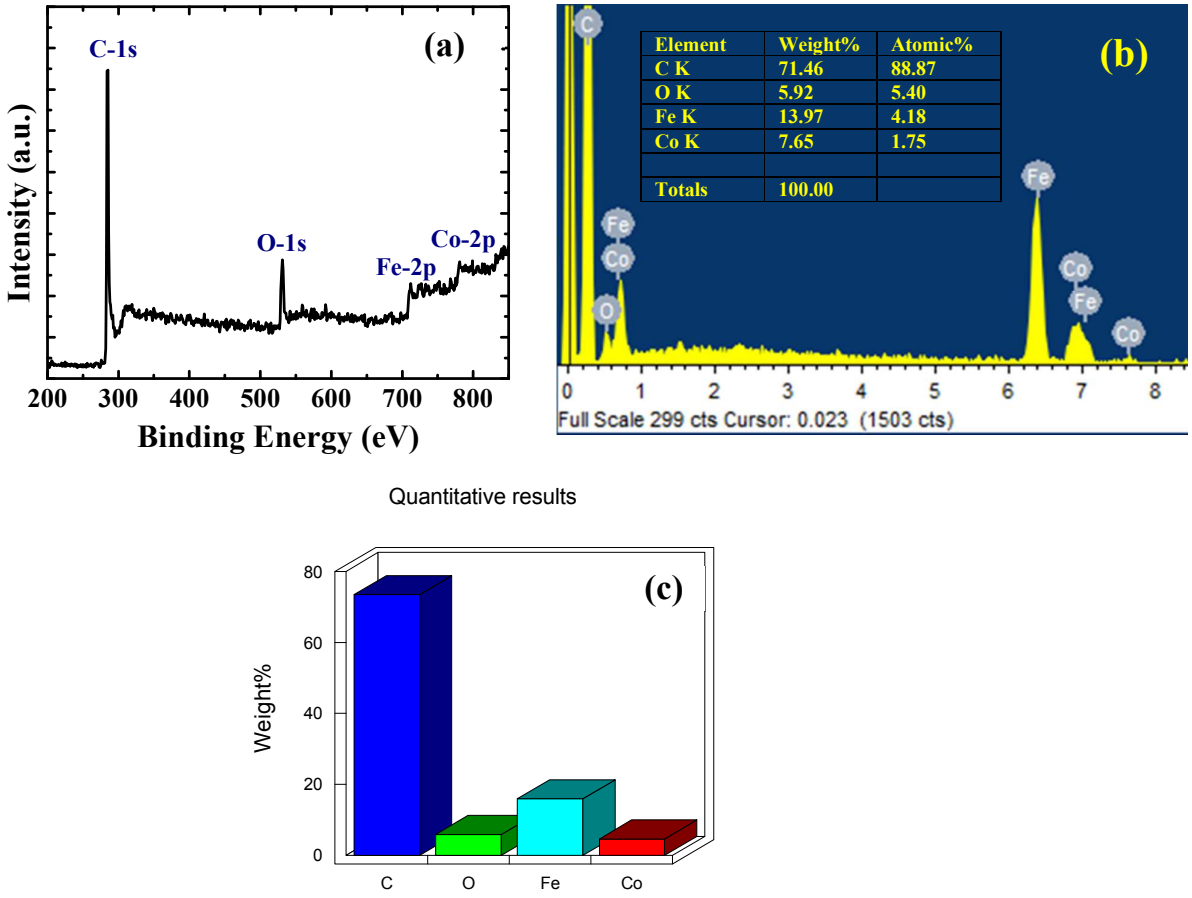


Figure S4. (a-c) Survey XPS spectrum, EDS spectrum and bar graph of the elemental analysis of the Co-Fe_3C-G@rGO. At% of Fe and Co is 4.18 and 1.75, respectively.

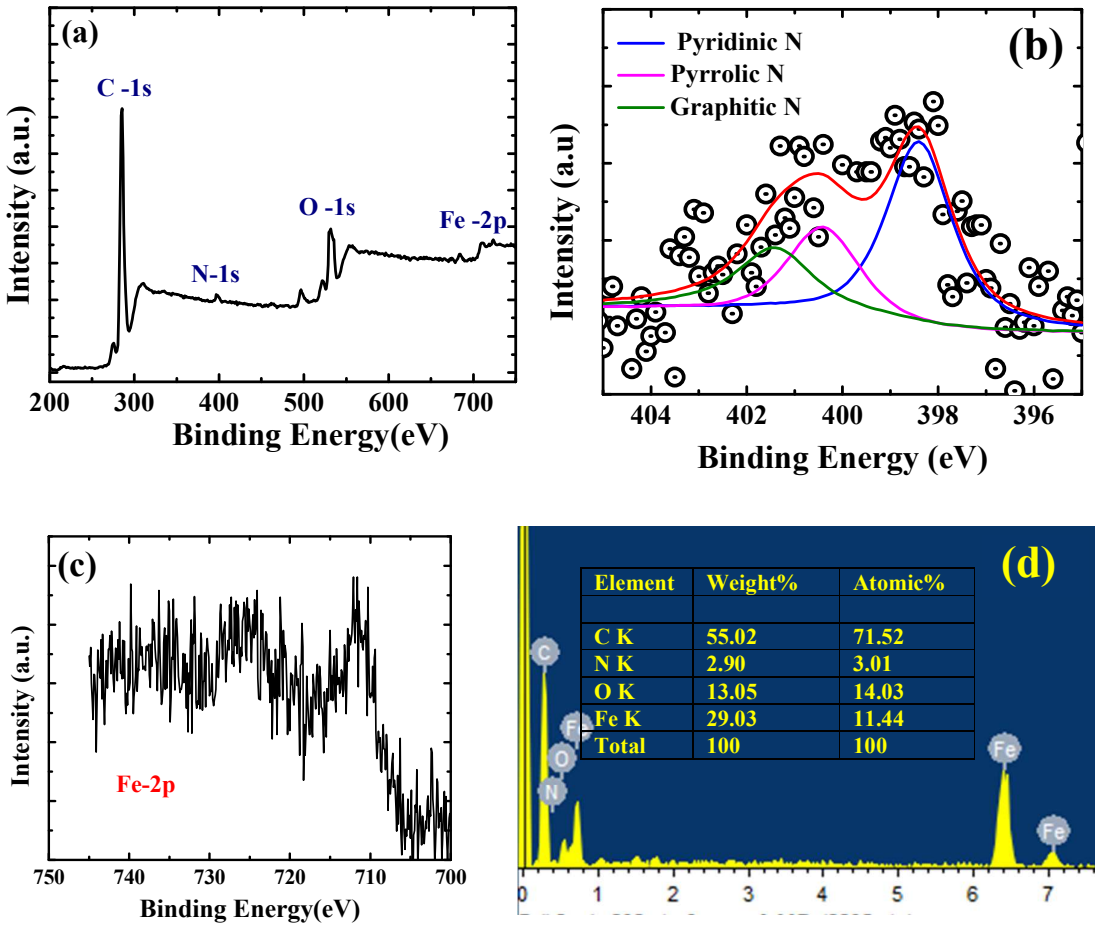
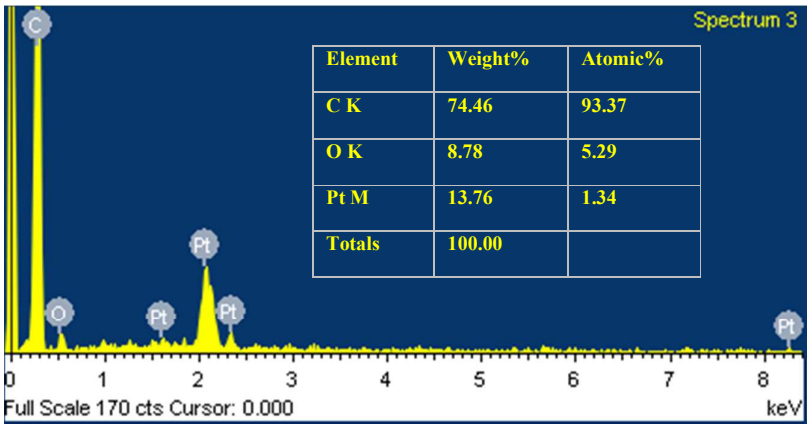


Figure S5. (a) XPS survey spectrum of Fe-Fe_3C-NG@rGO. (b and c) XPS spectra of N 1s and Fe 2p. (d) EDS spectrum of the corresponding hybrid nanostructure, respectively. At% of Fe is 11.44.



Element	Weight%	Atomic%
C K	74.46	93.37
O K	8.78	5.29
Pt M	13.76	1.34
Totals	100.00	

Figure S6. EDS spectrum of Pt@rGO hybrid nanostructures.

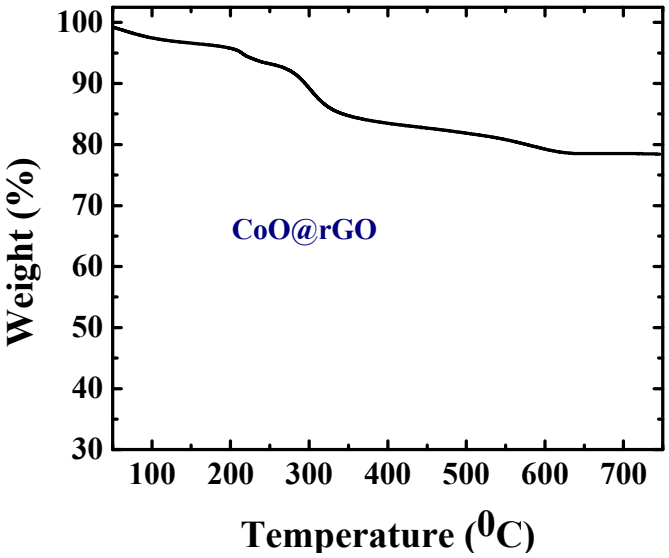


Figure S7. Thermogravimetric analysis (TGA) curve of the CoO@rGO performed in Ar atmosphere in 10 ^{0}C/minute ramping rate.

Table S2. Comparison of the OER catalytic activity and onset potentials of recent developed Co based different catalysts.

Catalyst (loading)	Onset potential η (mV)	Over potential at a current density of 10 mA/ cm^{-2} (mV)	Medium	Ref.
Commercial RuO_2 (0.214 mg/cm^2)	190 mV	388 mV	1 M KOH	This work
Co-Fe_3C-G@rGO (0.214 mg/cm^2)	220 mV	340 mV	1 M KOH	This work
CoO@rGO (0.214 mg/cm^2)	160 mV	300 mV	1 M KOH	This work
Multiwalled carbon nanotubes/Au/Co_3O_4 (0.360 mg/cm^2)		350 mV	1 M KOH	*J. Power Sources*, 2015, **300**, 285-293
CoO_x@CN (0.42 mg/cm^2)		410 mV	1 M KOH	*J. Am. Chem. Soc., 2015, 137, 2688–2694.*
Co_3O_4/multiwalled carbon nanotubes (0.57 mg/cm^2)		390 mV	0.1 M KOH	*J. Mater. Chem. A, 2013, **1**, 12053-12059*
Co_3O_4/N-doped porous carbon (0.360 mg/cm^2)		390 mV	0.1 M KOH	*Nano Energy, 2015, **12**, 1-8*
Co_9S_8/N,S-GO (0.25 mg/cm^2)		400 mV	0.1 M KOH	*ACS Catal. 2015, 5, 3625−3637*
Fe/Fe_3C@ N-graphitic layer (0.710 mg/cm^2)		580 mV	0.1 M KOH	*Green Chem., 2016, 18, 427–432*
Co_9S_8@NC (0.214 mg/cm^2)		370 mV	0.1 M KOH	*Dalton Trans., 2016, 45, 6352–6356*
Nitrogen-doped CG-CoO		340 mV	1 M KOH	*Energy Environ. Sci., 2014, 7, 609–616*
Graphene-Co_3O_4 (640 mg/cm^2)		313 mV	1 M KOH	*Scientific Reports, 2015, 5, 7629*
$CoSe_2$ nanobelt on N doped graphene (0.2 mg/cm^2)		366 mV	0.1 M KOH	*ACS Nano 8, 3970–3978 (2014)*

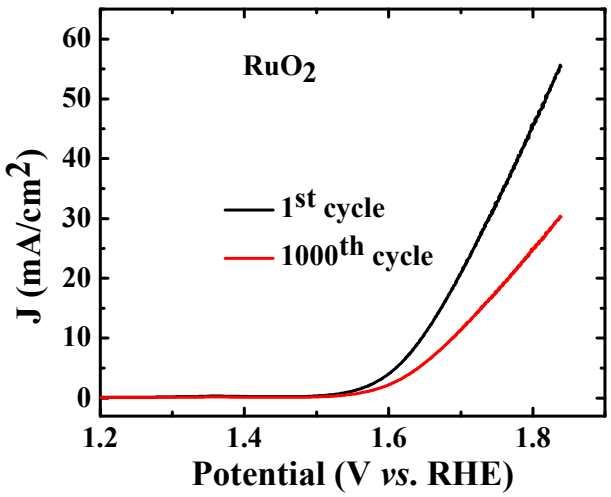


Figure S8. OER LSV plot for stability test up-to 1000nd cycle in 1M KOH solution of RuO_2 with the scan rate 100 mV/s with the rotation speed 1200 rpm.

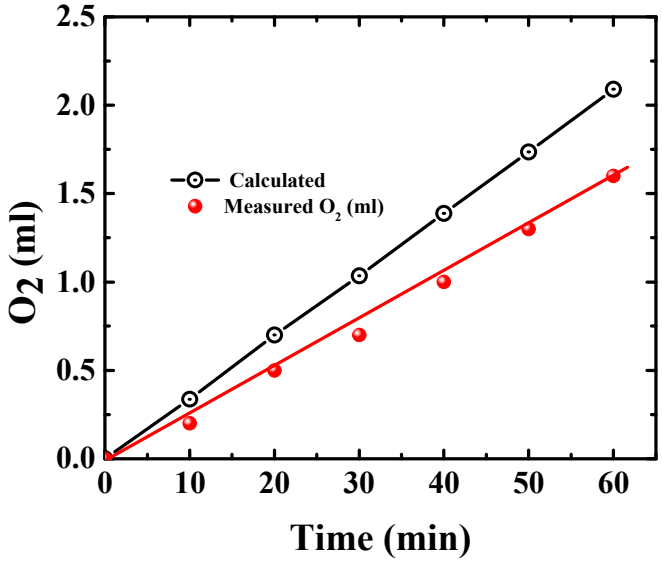


Figure S9. Volume of O_2 gas measured with time during galvanostatic electrolysis (Constant 300 mV overpotential and the catalyst loading on the electrode surface is ~ 1 mg/cm^2). The calculated values are based on Faraday's law.

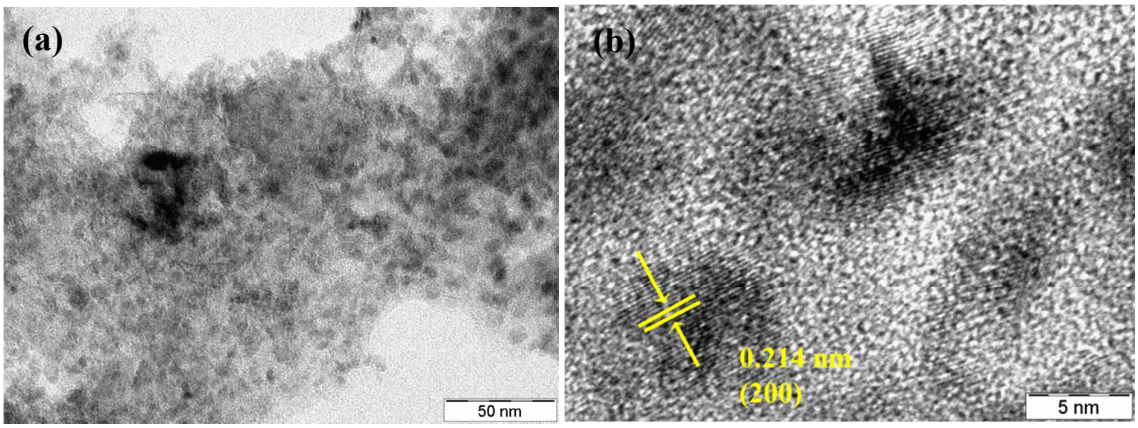


Figure S10. (a and b) TEM and HRTEM images of the CoO@rGO hybrid nanostructures after the OER performance up-to 2500th LSV.

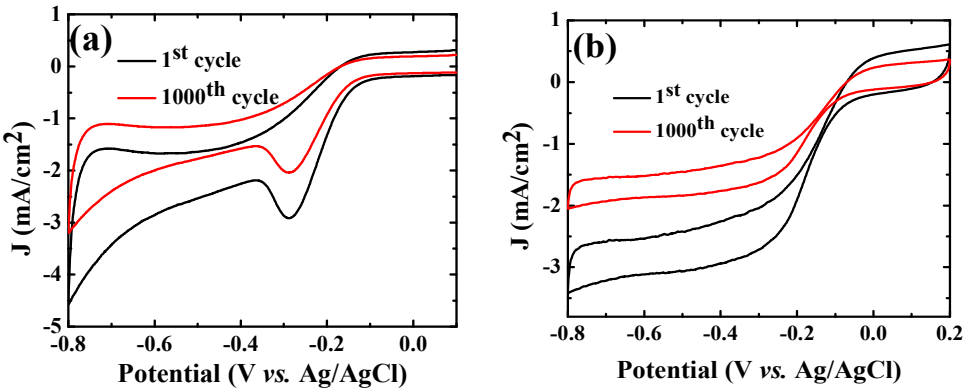


Figure S11. (a and b) ORR CV plot for stability test up-to 1000nd cycle in 0.1M KOH solution for hybrid and Pt/C, respectively.

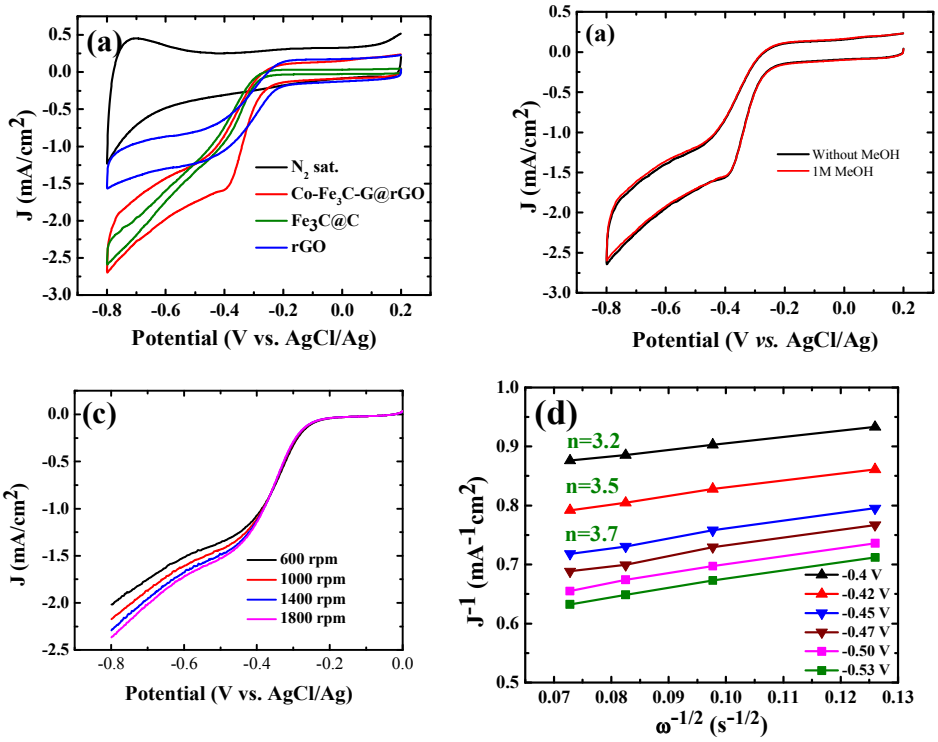


Figure S12. CV of different rGO based hybrids in N_2- and O_2-saturated solution with 0.1 M KOH at a scan rate of 50 mV/s with 600 rpm, (b) methanol tolerance activity of the Co-Fe_3C-G@rGO hybrid. (c) ORR polarization curves different rotation rate at 10 mV/s in 0.1 m KOH solution. (d) K-L plot of inverse current density (J^{-1}) versus $\omega^{-1/2}$ at different potentials of Co-Fe_3C-G@rGO hybrid nanostructures.

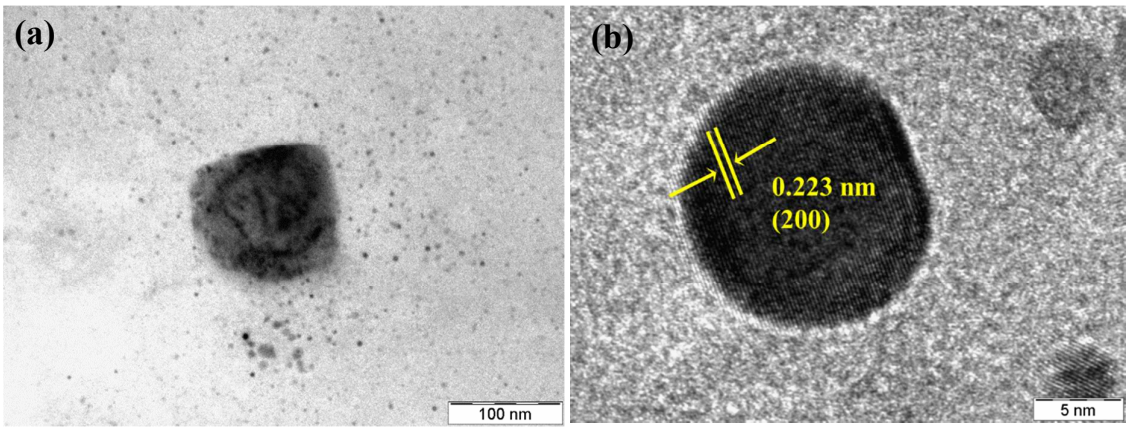


Figure S13. (a and b) TEM and HRTEM images of the Pt@rGO hybrid nanostructures after 500th consecutive CV of MeOH oxidation.

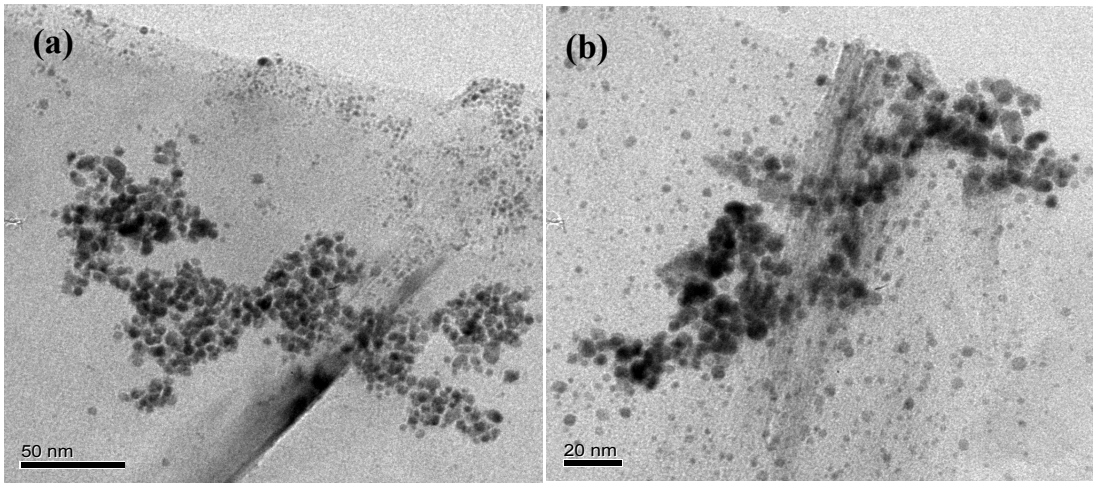


Figure S14. (a and b) TEM images of Pt@rGO synthesized from the mixture of GO and $Pt(acac)_2$.