Mussel-Inspired Nitrogen Doped Graphene Nanosheets Supported Manganese Oxide Nanowires as Highly Efficient Electrocatalysts for Oxygen Reduction Reaction

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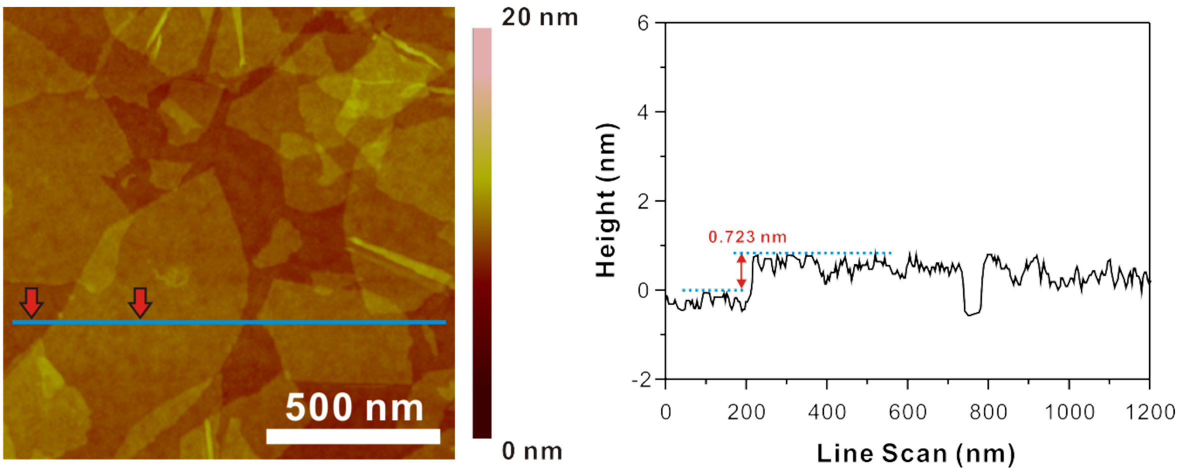

Fig. S1 Height-mode AFM image of the GO nanosheet with a corresponding line scan. The colloidal suspension of GO mainly comprises single-layer graphene nanosheets with a thickness of approximately 0.70 nm.

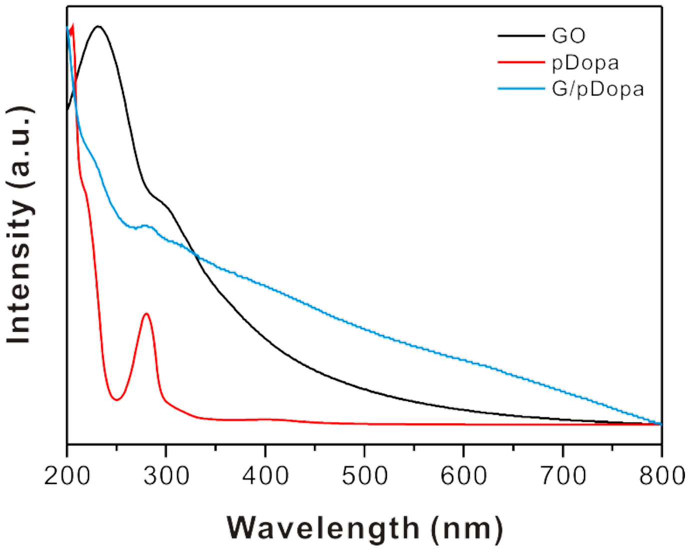

Fig. S2 UV/vis spectra of GO, pDopa and G/pDopa.

Table S1. Relative atomic percentage of various catalysts prepared in this study.

	Relative atomic contents (%)			
	C	O	N	Mn
(1) GO	71.09	28.91		
(2) GO/pDopa	71.93	21.03	7.04	
(3) NG_{600}	83.73	9.31	6.95	
(4) NG_{800}	89.01	5.90	5.09	
(5) NG_{1000}	90.32	5.78	3.90	
(6) $NG/MnO_{x\ (2:1)}$	68.60	20.56	4.54	6.30

Table S2. Deconvoluted high-resolution N 1s XPS configurations of various catalysts prepared in this study.

	G/pDopa	
N species	Peak position / eV	% N
Pyridinic-N (N-5)	398.23	4.31
Pyrrolic-N (N-6)	399.95	75.23
Graphitic-N (N-Q)	401.45	20.46

	NG_{600}	
N species	Peak position / eV	% N
Pyridinic-N (N-5)	398.11	34.37
Pyrrolic-N (N-6)	399.92	42.36
Graphitic-N (N-Q)	401.31	23.27

	NG_{800}	
N species	Peak position / eV	% N
Pyridinic-N (N-5)	398.10	27.50
Pyrrolic-N (N-6)	400.25	35.21
Graphitic-N (N-Q)	401.21	37.29

	NG_{1000}	
N species	Peak position / eV	% N
Pyridinic-N (N-5)	398.10	30.27
Pyrrolic-N (N-6)	400.33	32.95
Graphitic-N (N-Q)	401.32	36.77

	NG/MnOx	
N species	Peak position / eV	% N
Pyridinic-N (N-5)	398.13	28.12
Pyrrolic-N (N-6)	400.28	47.39
Graphitic-N (N-Q)	401.39	24.49

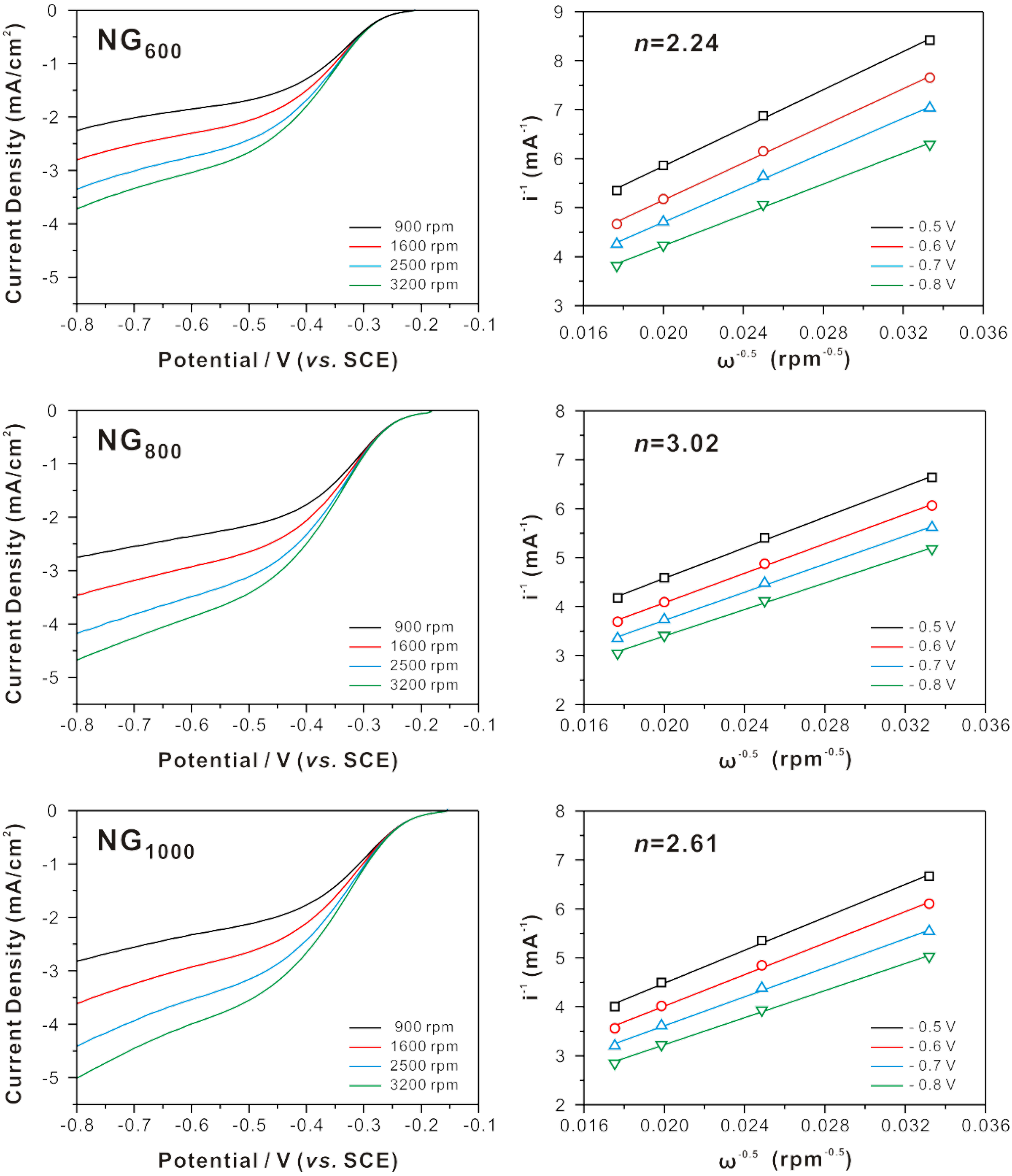

Fig. S3 Linear sweep voltammogram of NG catalysts prepared from different pyrolysis temperature from 600 to 1000 ^{o}C with the corresponding K-L plot and electron transfer number.

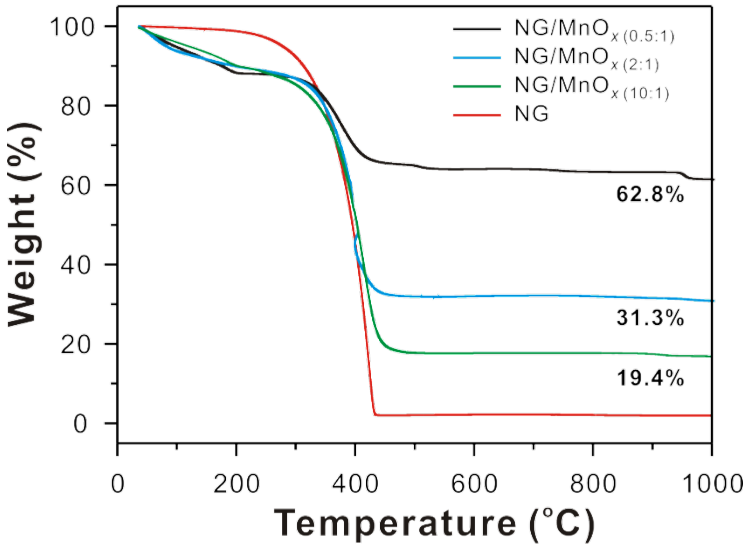

Fig. S4 Thermogravimetric analysis (TGA) for NG/MnO_x hybrid catalysts. The samples were subjected to heating at a rate of 10 °C·min^{-1} under air atmosphere.

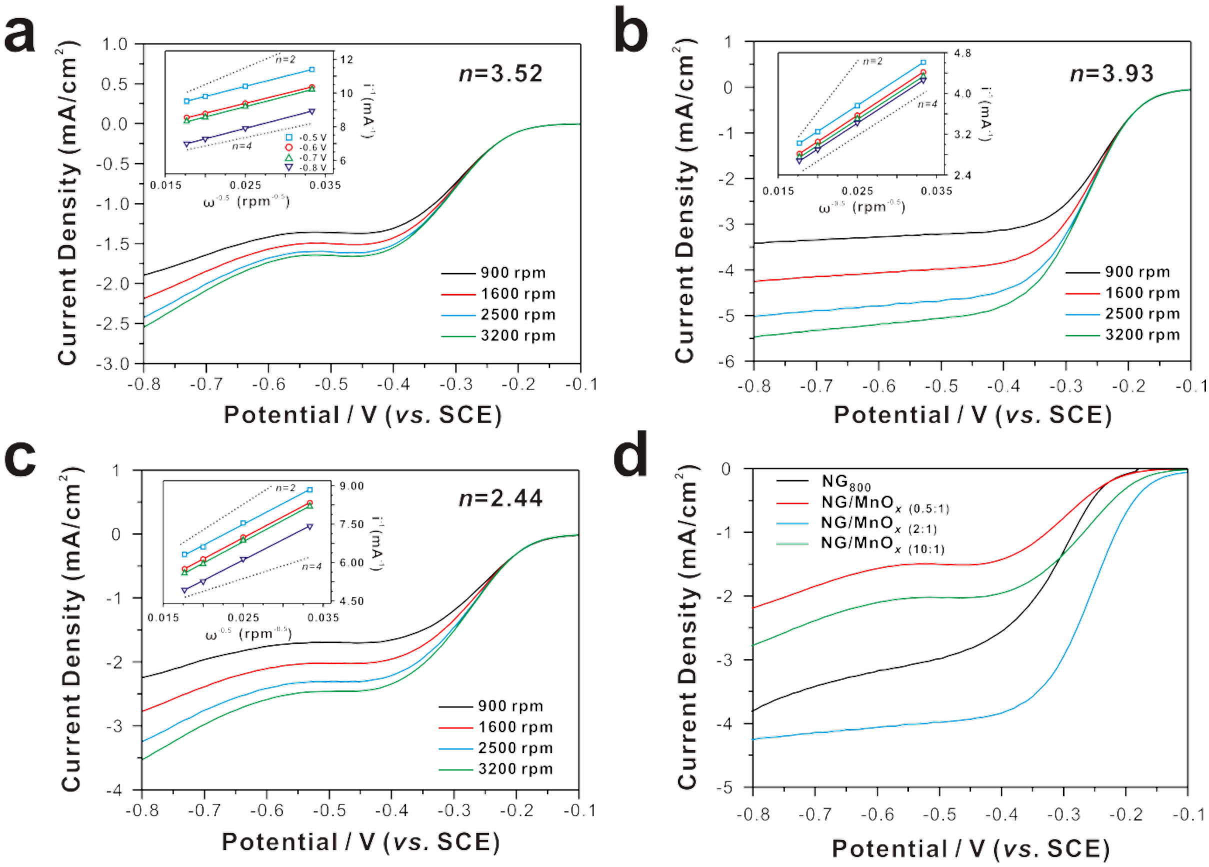

Fig. S5 (a-c) Linear sweep voltammogram and (d) polarization curves of NG/MnO_x hybrids with varied GO contents from 0.5 to 10 with respect to MnO_x precursor. (a) NG/$MnO_{x\,(0.5:1)}$. (b) NG/$MnO_{x\,(2:1)}$ and (c) NG/$MnO_{x\,(10:1)}$. It was measured at O_2-saturated 0.10 M KOH aqueous solution with wide range of rotating rates from 900 to 3200 rpm. The inset images show the corresponding K–L plots. Theoretical slopes for n = 2 and 4 are also constructed for comparison.

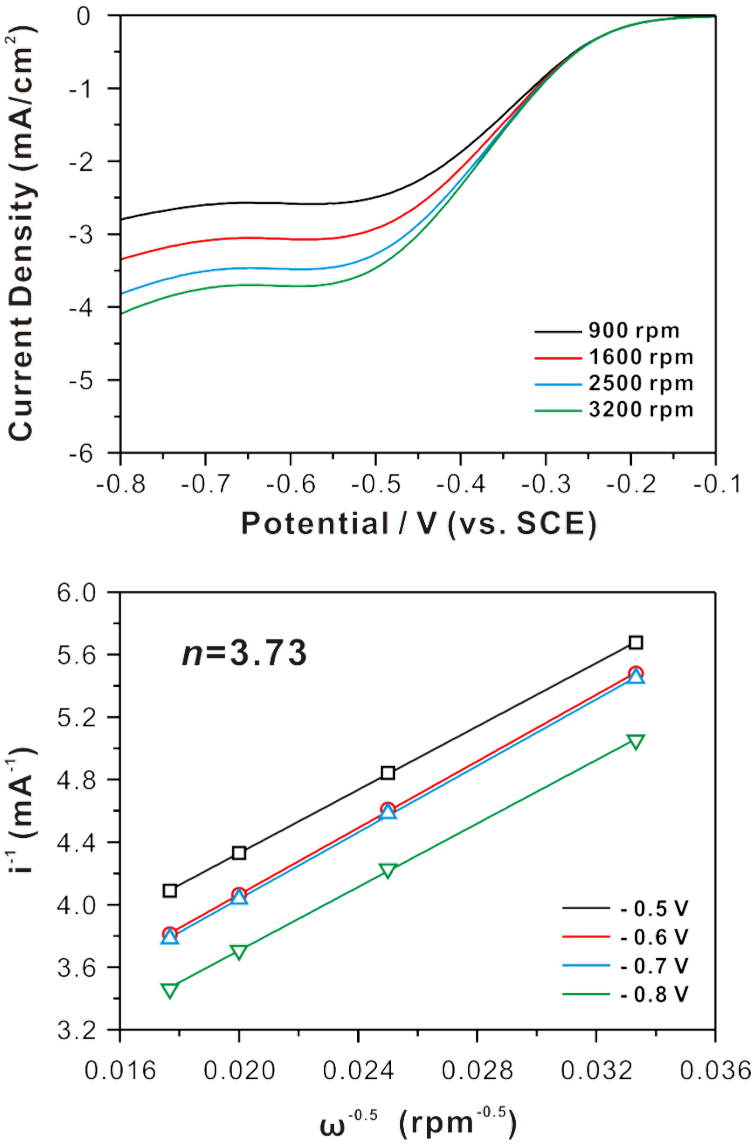

Fig. S6. Linear sweep voltammogram of TRGO/MnO_x $_{(2:1)}$ catalyst with the corresponding K-L plot and electron transfer number. TRGO/MnO_x $_{(2:1)}$ catalyst was synthesized following the method described for NG/ MnO_x $_{(2:1)}$ except using $TRGO_{800}$.