Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Supramolecular Gel-Assisted Synthesis of Double Shelled Co@CoO@N-C/C Nanoparticles with Synergistic Electrocatalytic Activity for the Oxygen Reduction Reaction

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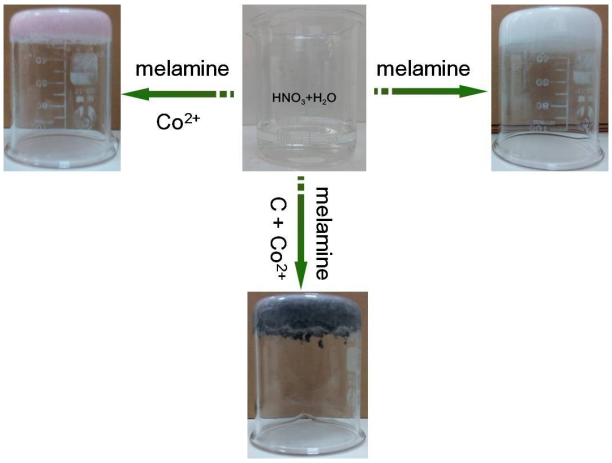

Fig. S1 Images of the supramolecular hydrogel.

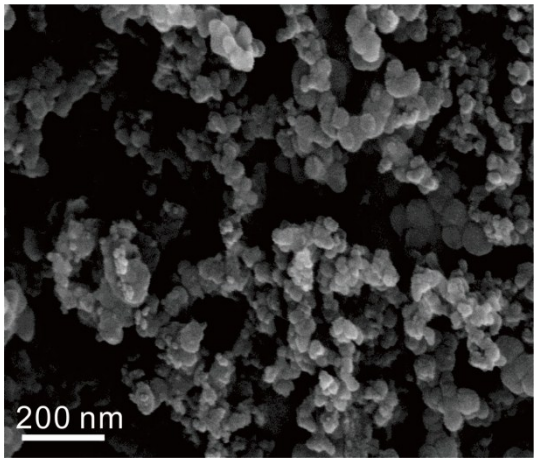

Fig. S2 FE-SEM image of Vulcan XC-72.

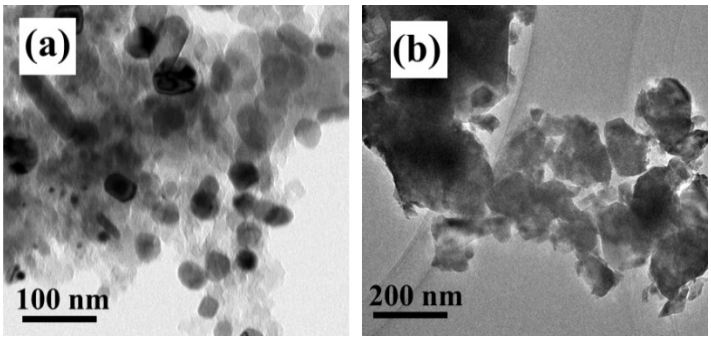

Fig. S3 TEM images of Co/CoO/C and M-Co/Co/CoO.

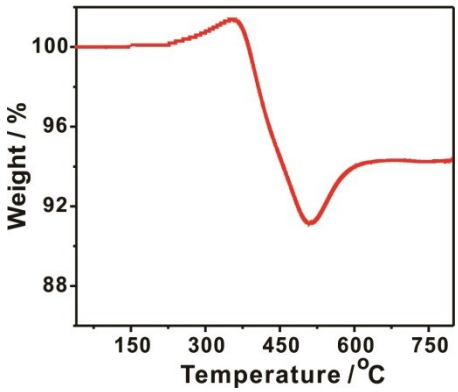

Fig. S4 Thermo gravimetric analysis (TGA) of M-Co/CoO tested in flowing air at temperature ramp of 10 °C min^{-1}.

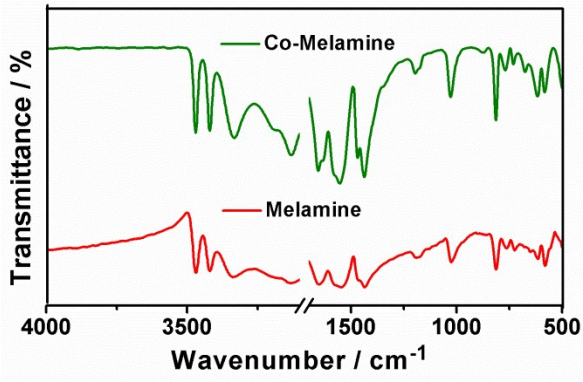

Fig. S5 FT-IR spectra of melamine and Co-Melamine xerogel.

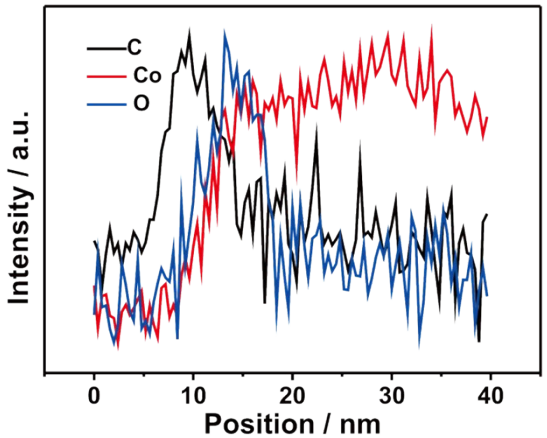

Fig. S6 Line profile spectra of Co@CoO@N-C/C nanoparticle.

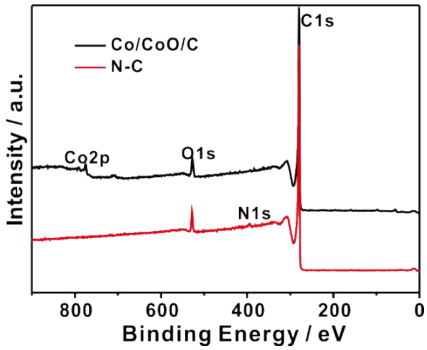

Fig. S7 Survey XPS spectra of N-C and Co/CoO/C.

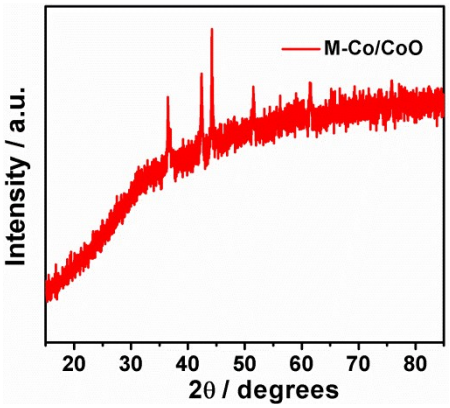

Fig. S8 XRD pattern of M-Co/CoO.

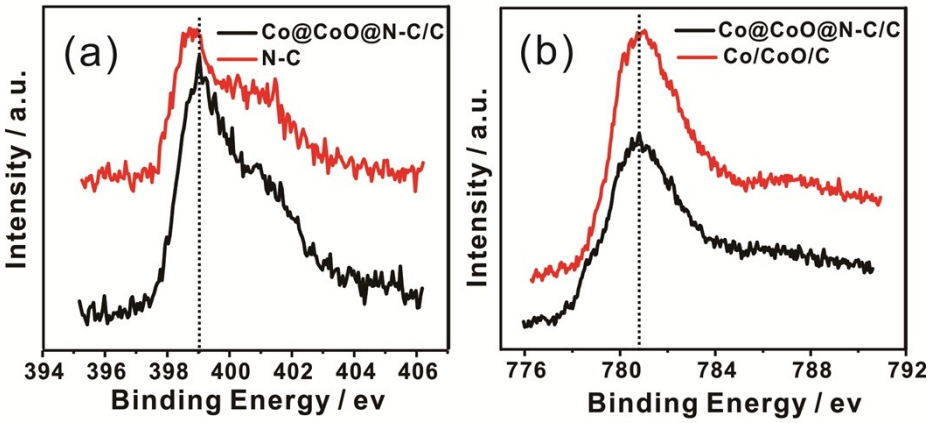

Fig. S9 (a) N 1s spectra of N-C and Co@CoO@N-C/C. (b) Co 2p spectrum of Co/CoO/C and Co@CoO@N-C/C.

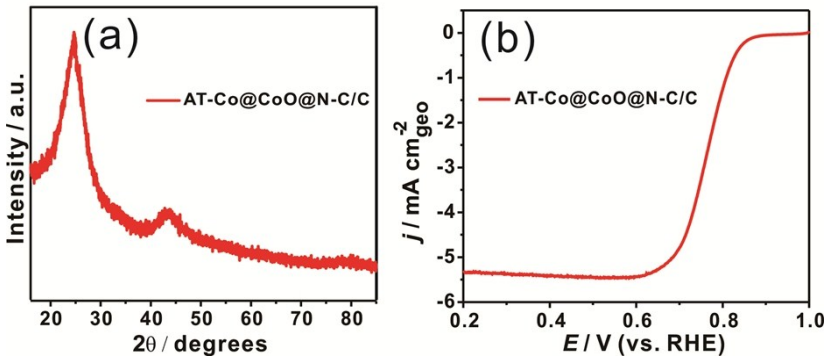

Fig. S10 (a), (b) XRD patterns and ORR polarization curve of AT-Co@CoO@N-C/C.

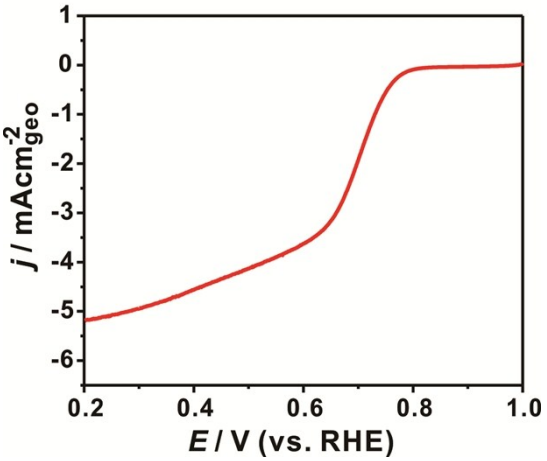

Fig. S11 ORR polarization curve of Vulcan XC-72.

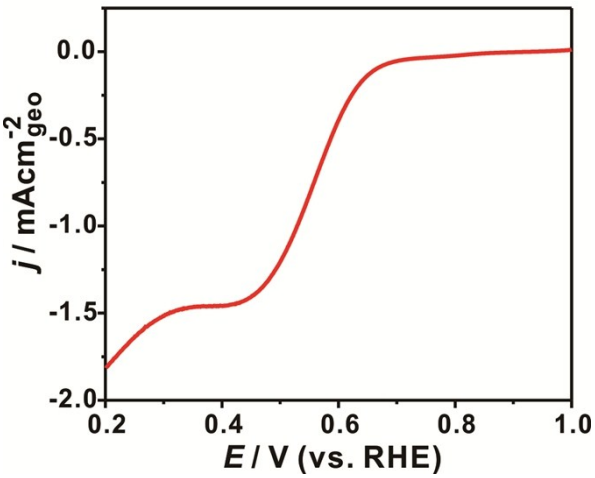

Fig. S12 ORR polarization curve of M-Co/CoO.

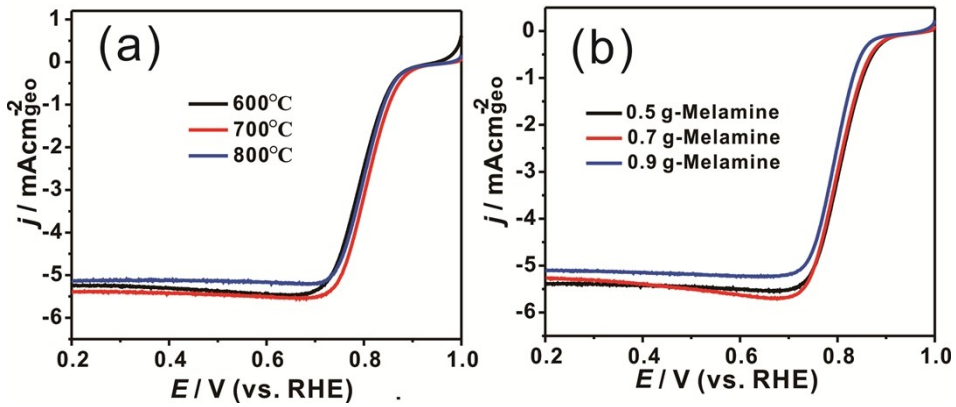

Fig. S13 (a) ORR polarization curves of Co@CoO@N-C/C after heat-treated at different temperature. (b) ORR polarization curves of different mass of melamine in N-C.

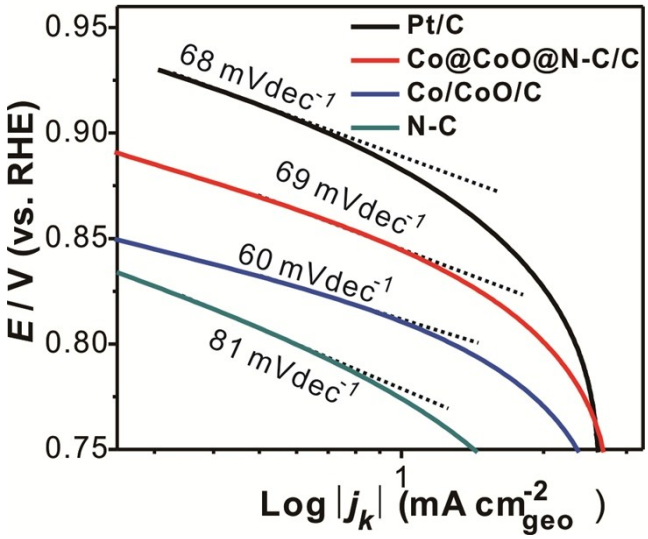

Fig. S14 Tafel plots of Pt/C, N-C, Co/CoO/C and Co@CoO@N-C/C in O_2-saturated 0.1 M KOH electrolyte.

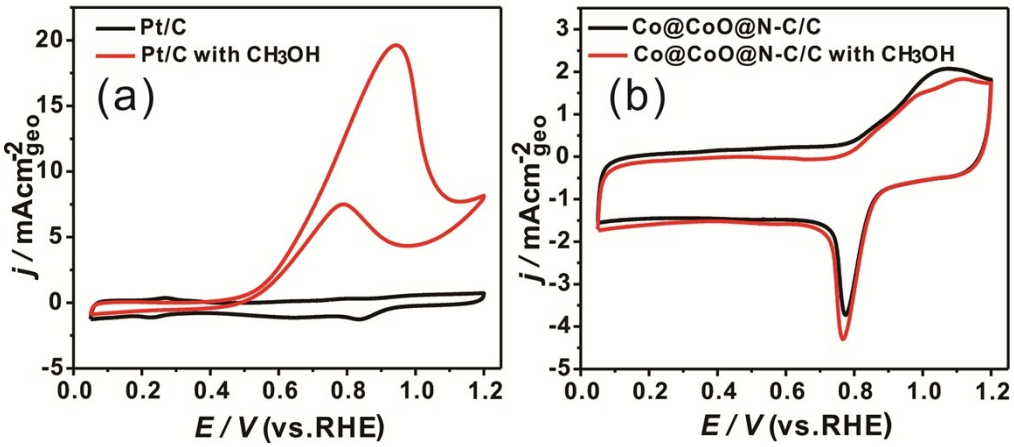

Fig. S15 CV curves of Pt/C (a) and Co@CoO@N-C/C (b) in O_2 saturated 0.1 M KOH electrolyte with or without 1 M methanol at a scan rate of 50 mVs^{-1}.

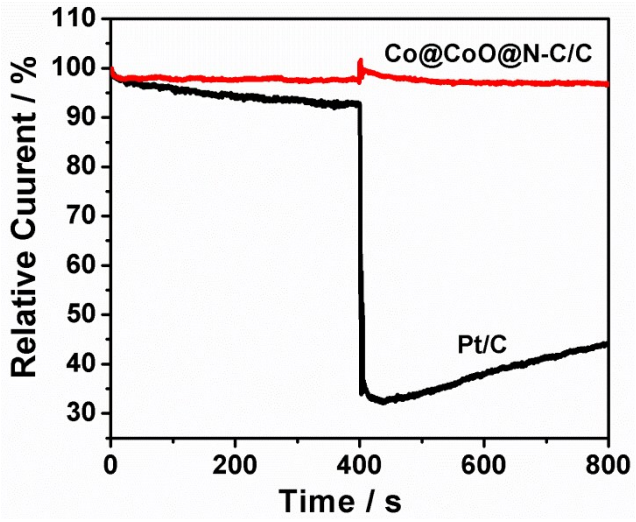

Fig. S16 i-t chronoamperometric response of Pt/C and Co@CoO@N-C/C in 0.1 M KOH solution with introduction of 1 M methanol after about 400 s.

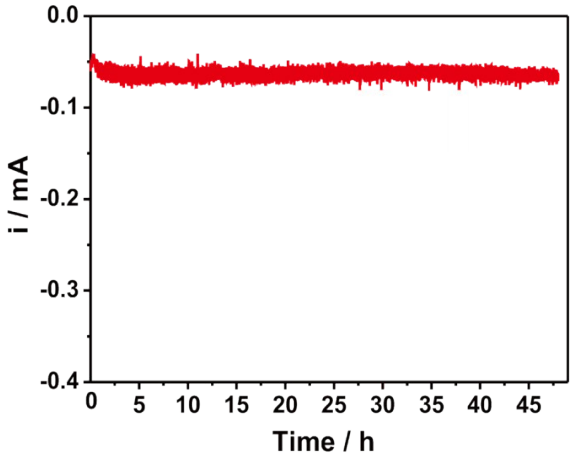

Fig. S17 Long-term durability measurement of Co@CoO@N-C/C at a poential of 0.7 V in O_2-saturated 0.1 M KOH solution.

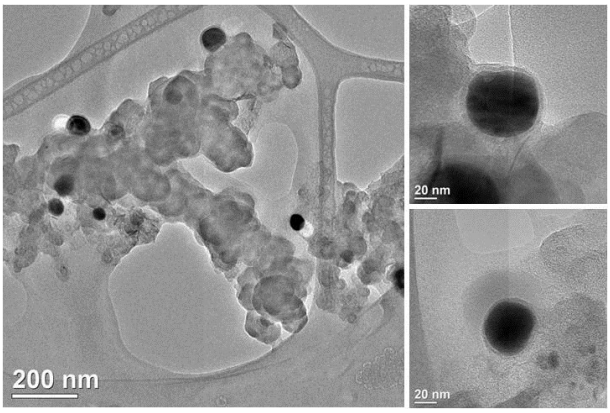

Fig. S18 TEM images of Co@CoO@N-C/C after long-term durability measurement.

Table S1 Comparison of the ORR performance of some cobalt based catalysts reported in literature.

Catalysts	ORR activity (V vs. RHE)[a]			Ref.
	ORR peak[b]	Onset potential	Half-wave potential[c]	
Co@CoO@N-C/C	**0.79**	**0.95**	**0.81**	**This work**
N-CG-CoO#1 M KOH	**0.76**	**0.90**	**0.79**	**[1]**
CoO/C	**-**	**0.83**	**0.77**	**[2]**
NCO-A_1	**0.7**#5 mv s^{-1}	**0.93**	**0.78**	**[3]**
CoO_X/BP-N	**-**	**0.86**#10 mv s^{-1}	**0.79**	**[4]**
Co/N-C	**0.73**	**0.83**#10 mv s^{-1}	**0.74**	**[5]**
C@Co-P/C	**-**	**0.87**	**0.80**	**[6]**
Co@Co_3O_4@C	**0.79**	**0.93**#10 mv s^{-1}	**0.81**	**[7]**
Co/CoO/$CoFe_2O_4$/G	**0.7**	**0.77**#10 mv s^{-1}	**0.69**	**[8]**
Co_2FeO_4/MWCNT	**0.7**	**0.91**	**0.73**	**[9]**
Co_3O_4@N–C	**0.80**	**0.95**	**0.7**	**[10]**
Co/Co_3O_4/C-N	**-**	**0.95**#20 mv s^{-1}	**0.74**	**[11]**
NG/CNT/Co_3O_4	**-**	**0.9**#10 mv s^{-1}	**0.71**	**[12]**
Co-N-CAs	**0.79**	**0.84**#10 mv s^{-1}	**0.78**	**[13]**
Co-N-rGO	**0.79**	**0.91**#10 mv s^{-1}	**0.77**	**[14]**
Co_3O_4/N-MG	**0.82**	**0.93**	**0.81**	**[15]**

[a] Conversions of Hg/HgO electrode, Ag/AgCl electrode, and SCE into RHE scale were achieved by adopting the calibration results.

[b] ORR peak was obtained from cyclic voltammetry measured in O_2-saturated 0.1 M KOH aqueous solution with a sweep rate of 50 mV s^{-1} unless otherwise noted.

[c] Onset potential and Half-wave potential were obtained from linear sweep voltammetry performed on RDE in O_2-saturated 0.1 M KOH solution with a rotation rate of 1600 rpm.

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