Electronic Supplementary Information for:

Flexible nitrogen-doped graphene/carbon nanotube/Co_3O_4 paper and its oxygen reduction activity

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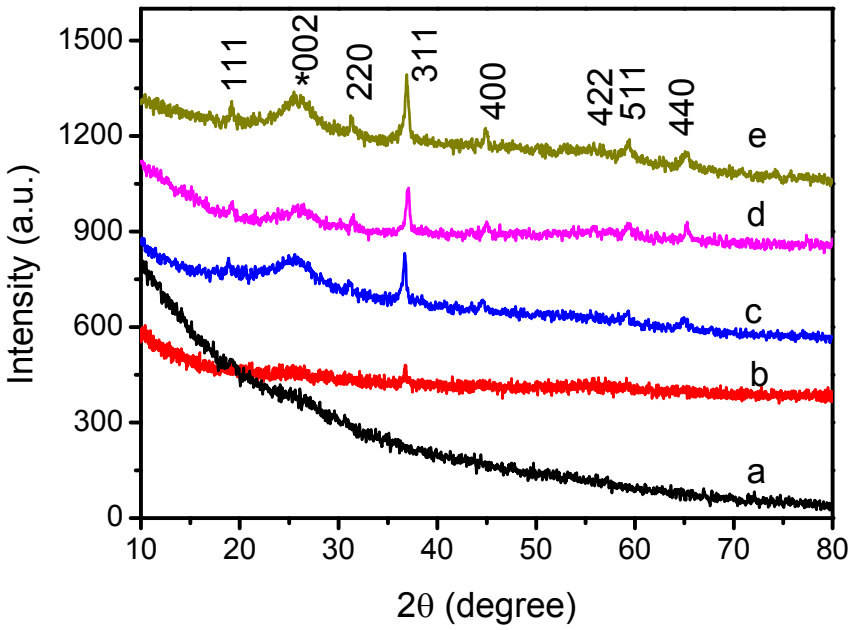

Fig. S1 Time-dependent XRD patterns of initial Co^{2+}-GO/CNT papers with the hydrothermal treatment in ammonia solution at 180 °C: (a) 0; (b) 0.5; (c) 1; (d) 2; (e) 3h.

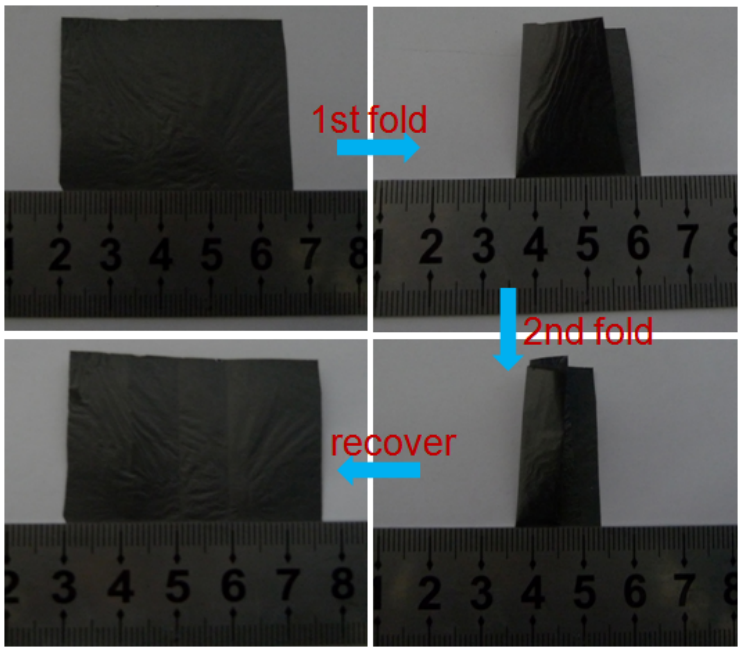

Fig. S2 Photographs showing the flexibility of the NG/CNT/Co_3O_4 paper.

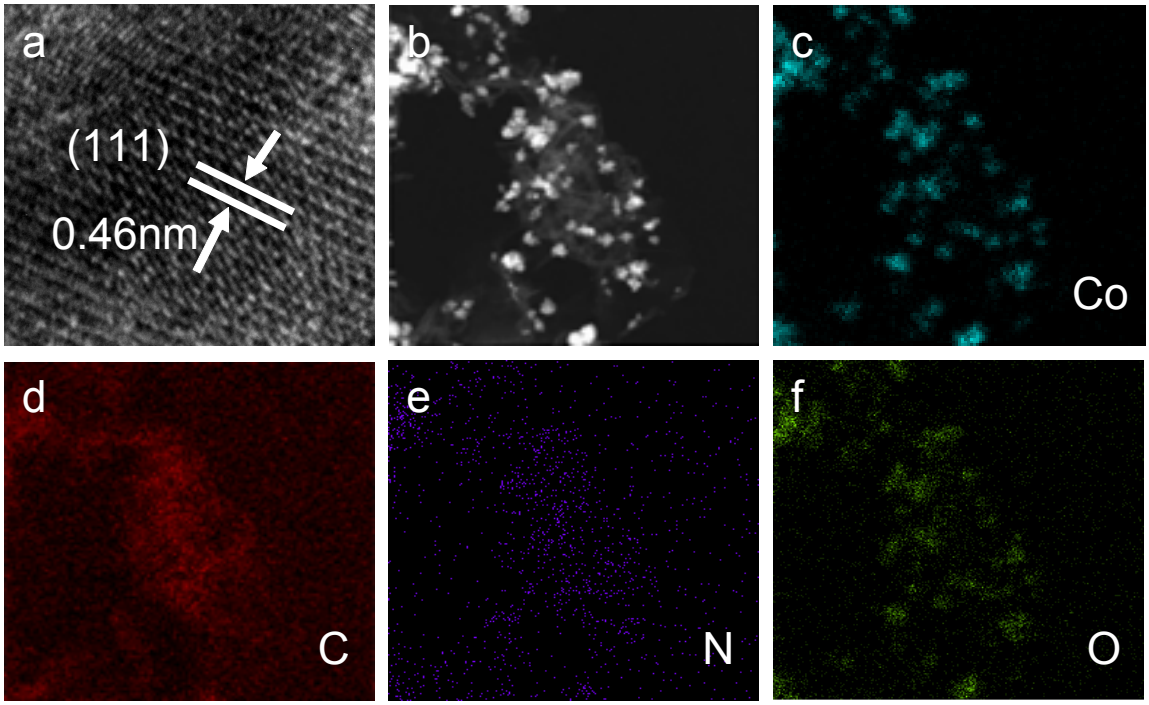

Fig. S3 (a) HRTEM image; (b) STEM image; (c-f) Corresponding elemental mapping images of (c) Co, (d) C, (e) N and (f) O element of NG/CNT/Co_3O_4 paper.

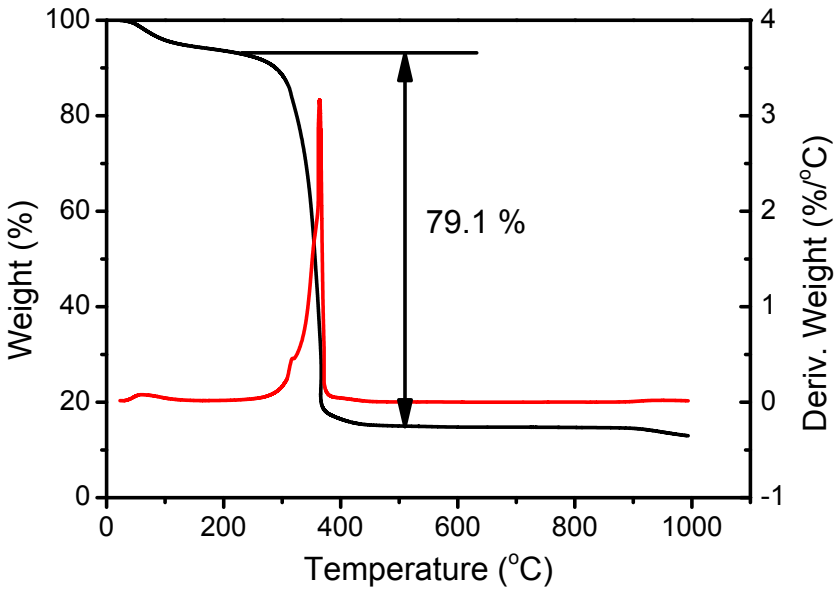

Fig. S4 DSC-TGA curves of NG/CNT/Co_3O_4 paper measured in the air with the heat rate of 10 K min^{-1}.

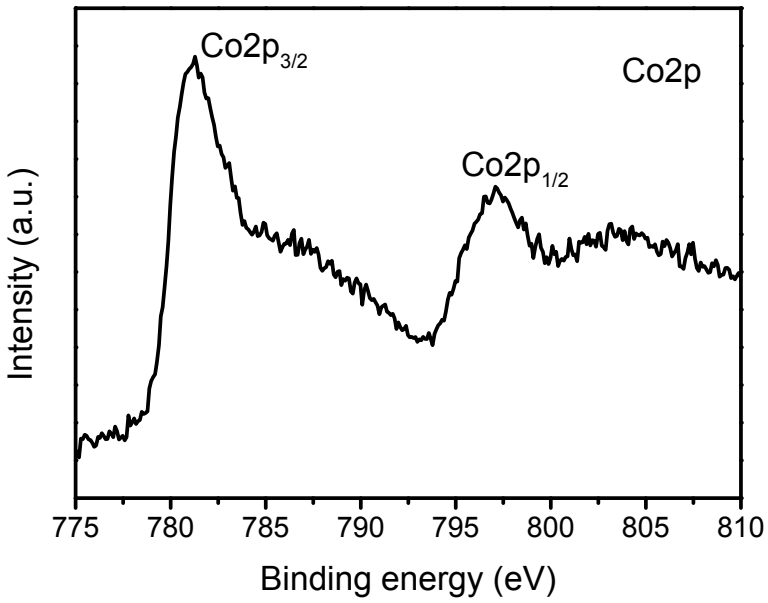

Fig. S5 Co2p core-leveled XPS spectrum of NG/CNT/Co_3O_4 paper.

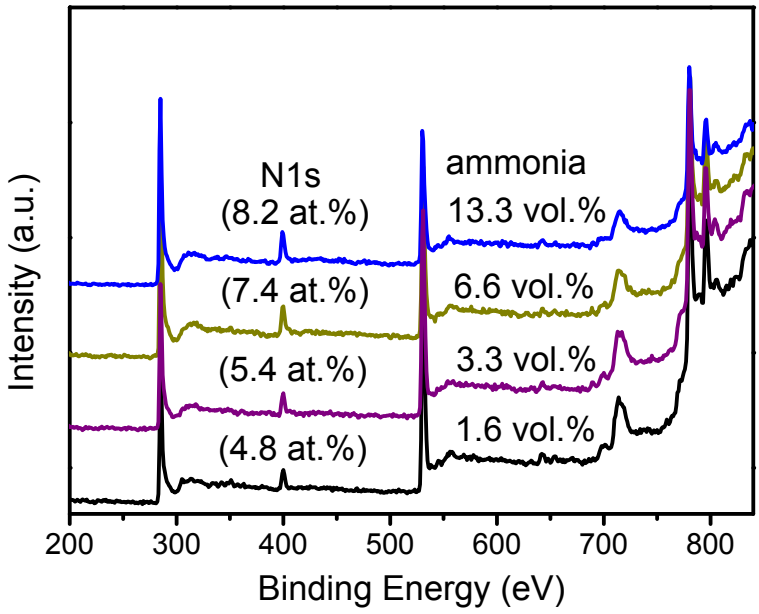

Fig. S6 XPS spectra of NG/CNT/Co_3O_4 papers prepared with the hydrothermal treatments in ammonia solutions with different concentrations (from 1.6 vol. % to 13.3 vol. %).

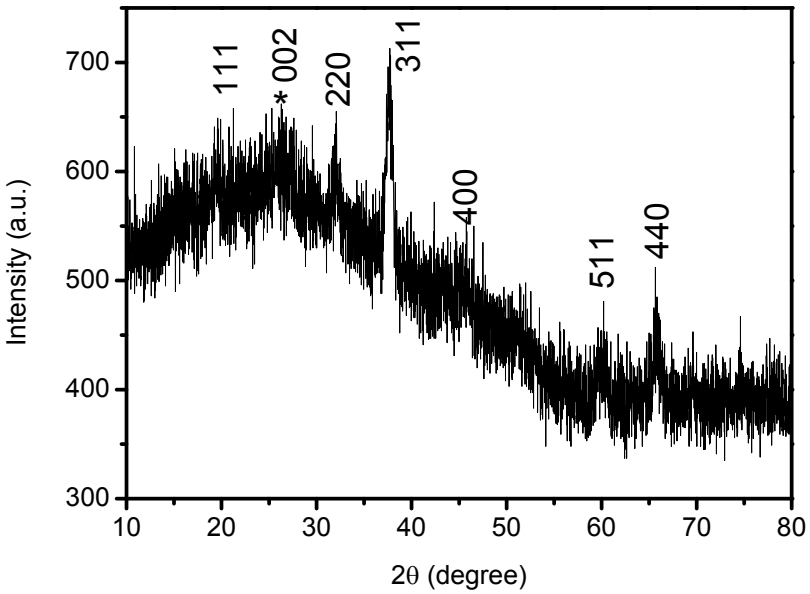

Fig. S7 XRD pattern of physically mixed NG/CNT/Co_3O_4 paper.

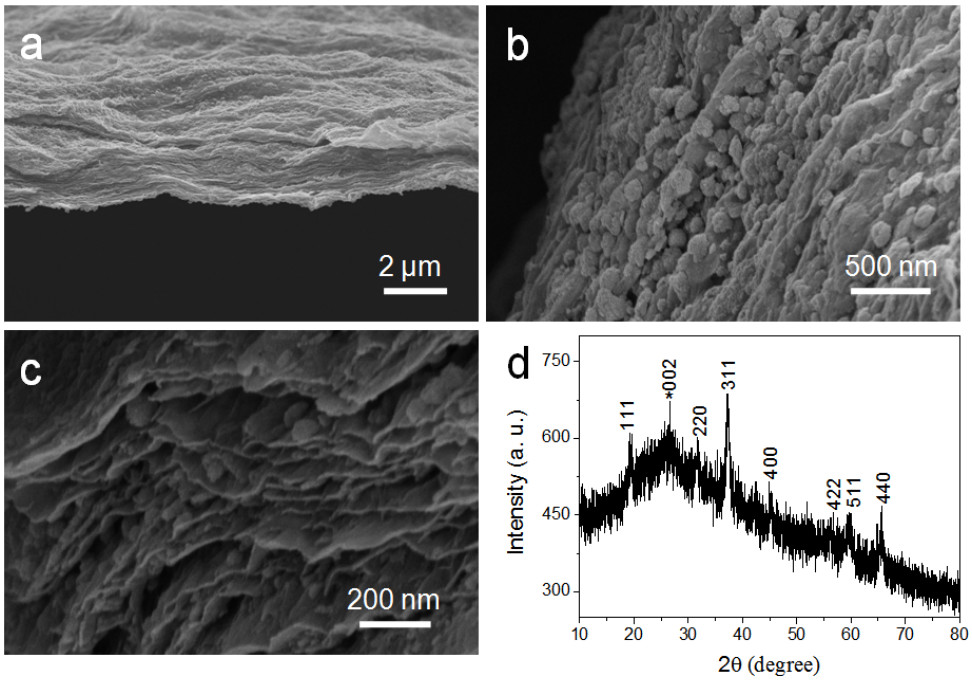

Fig. S8 (a) SEM image of the cross-section of NG/Co_3O_4 paper; (b) SEM image of the surface of NG/Co_3O_4 paper; (c) High-magnified SEM image of the cross-section NG/Co_3O_4 paper; (d) XRD pattern of NG/Co_3O_4 paper.

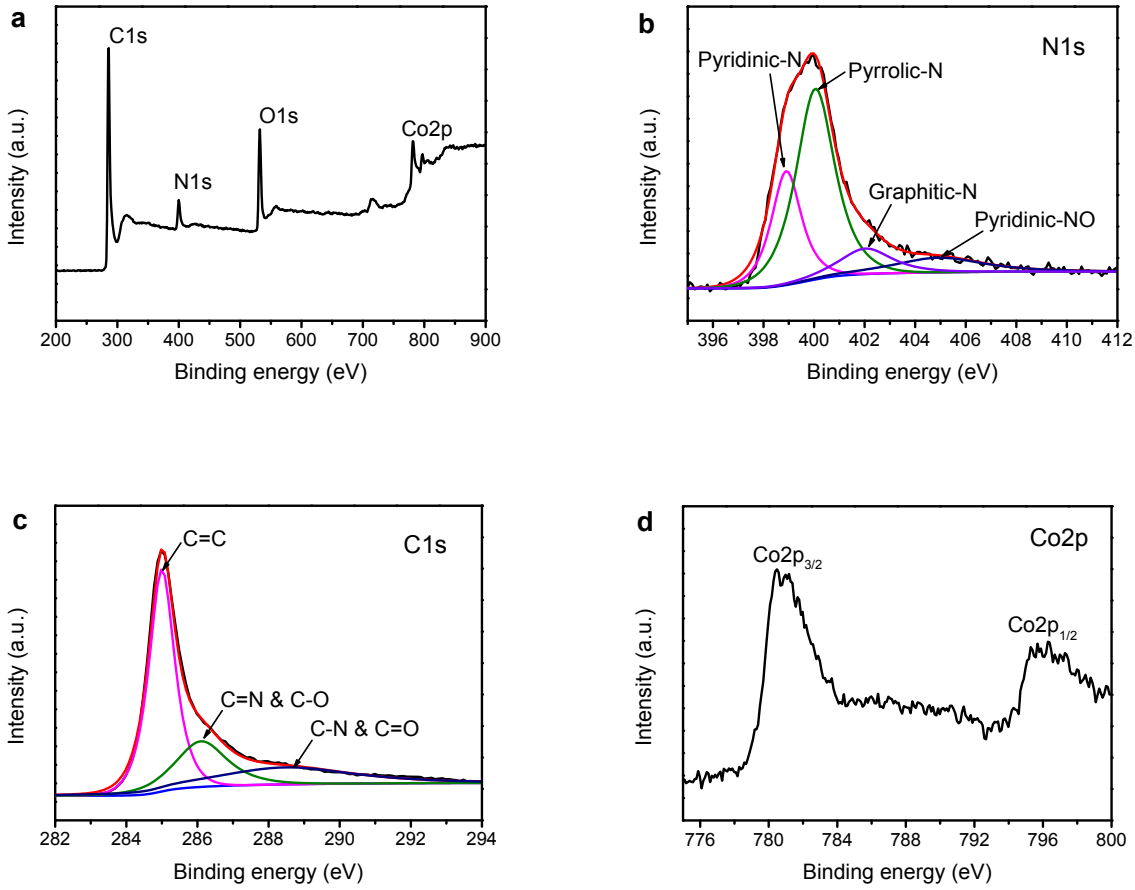

Fig. S9 XPS spectra of NG/Co_3O_4 paper. (a) survey XPS spectrum; (b) N1s core-leveled XPS spectra; (c) C1s core-leveled XPS spectra; (d) Co2p core-leveled XPS spectrum.

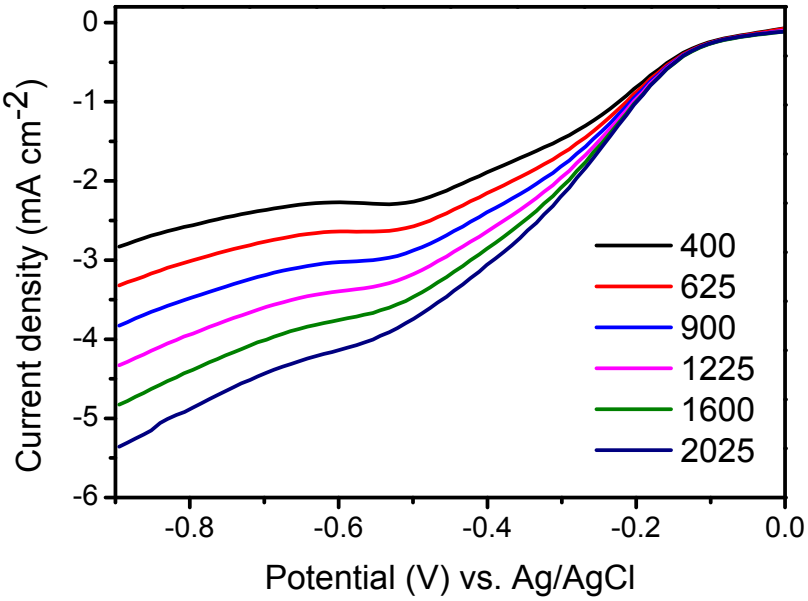

Fig. S10 RDE voltammograms of NG/CNT/Co_3O_4 paper in O_2-saturated 0.1 M KOH at different rotation speeds with sweep rate of 10 mV s^{-1}.

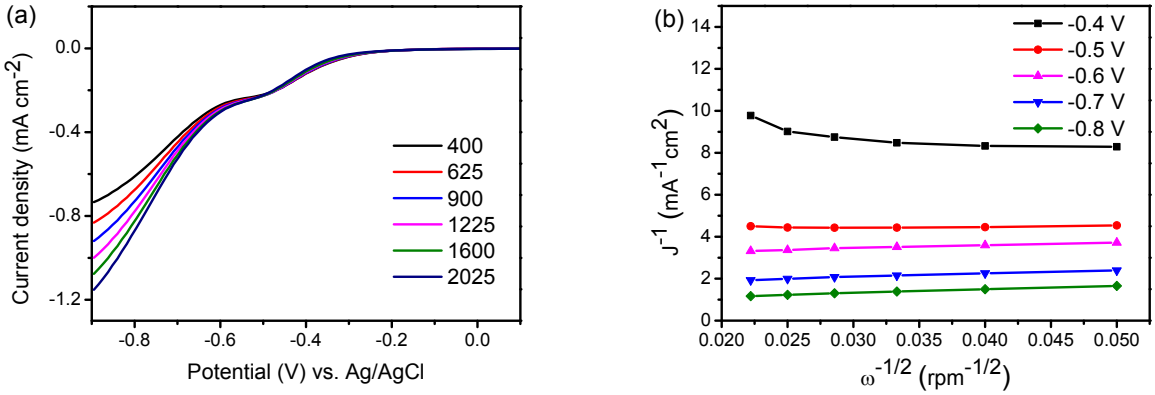

Fig. S11 (a) RDE voltammograms of initial Co^{2+}-GO/CNT paper in O_2-saturated 0.1 M KOH at different rotation speeds (sweep rate: 10 mV s^{-1}); (b) Corresponding K-L plots (J^{-1} versus $\omega^{-1/2}$) at different potentials.

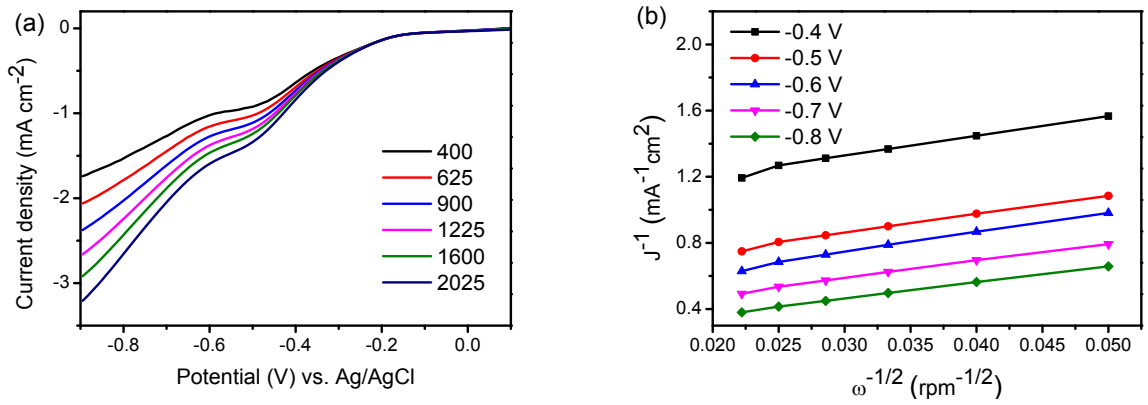

Fig. S12 (a) RDE voltammograms of NG paper in O_2-saturated 0.1 M KOH at different rotation speeds (sweep rate: 10 mV s^{-1}); (b) Corresponding K-L plots (J^{-1} versus $\omega^{-1/2}$) at different potentials.

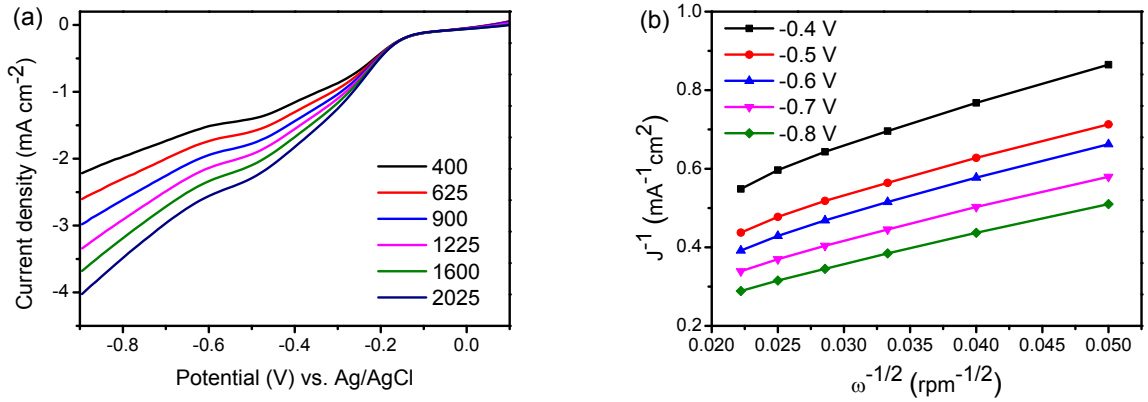

Fig. S13 (a) RDE voltammograms of NG/CNT paper in O_2-saturated 0.1 M KOH at different rotation speeds (sweep rate: 10 mV s^{-1}); (b) Corresponding K-L plots (J^{-1} versus $\omega^{-1/2}$) at different potentials.

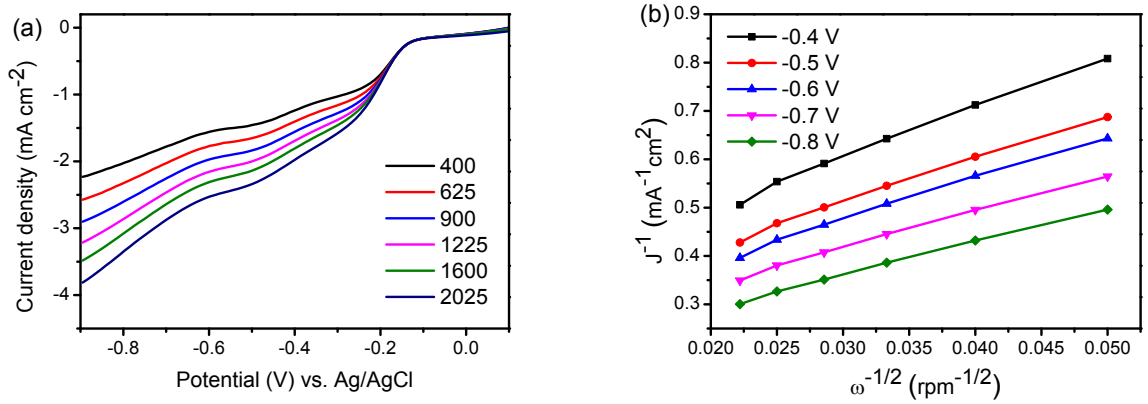

Fig. S14 (a) RDE voltammograms of NG/Co_3O_4 paper in O_2-saturated 0.1 M KOH at different rotation speeds (sweep rate: 10 mV s^{-1}); (b) Corresponding K-L plots (J^{-1} versus $\omega^{-1/2}$) at different potentials.

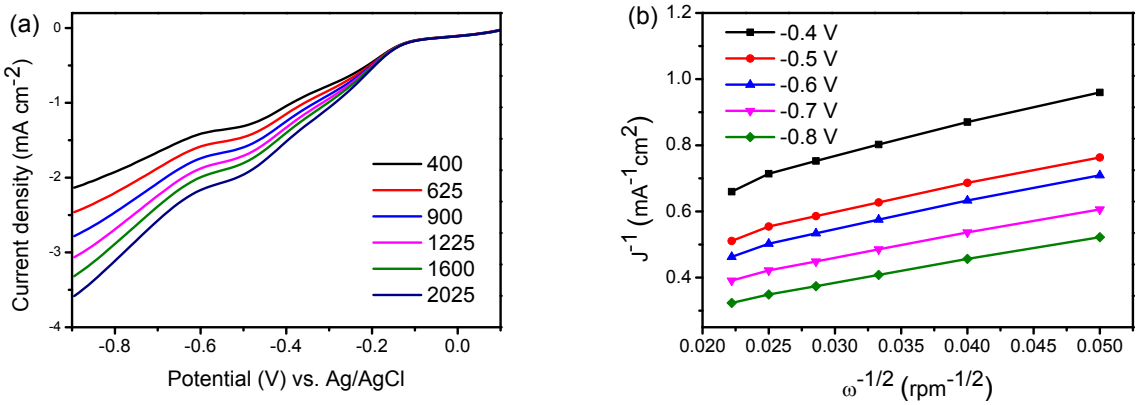

Fig. S15 (a) RDE voltammograms of physically-mixed NG/CNT/Co_3O_4 paper in O_2-saturated 0.1 M KOH at different rotation speeds (sweep rate: 10 mV s^{-1}); (b) Corresponding K-L plots (J^{-1} versus $\omega^{-1/2}$) at different potentials.

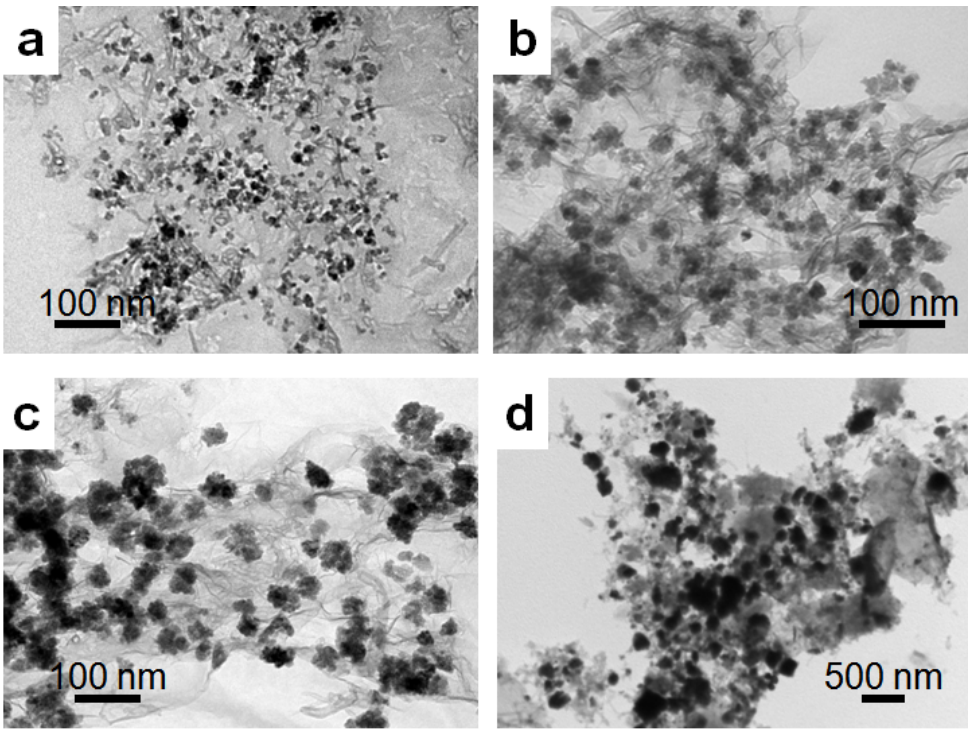

Fig. S16 SEM images of the NG/CNT/Co_3O_4 papers synthesized with different contents of $Co(NO_3)_2$. (a) 0.1 mmol; (b) 0.2 mmol; (c) 0.3 mmol and (d) 0.4 mmol.

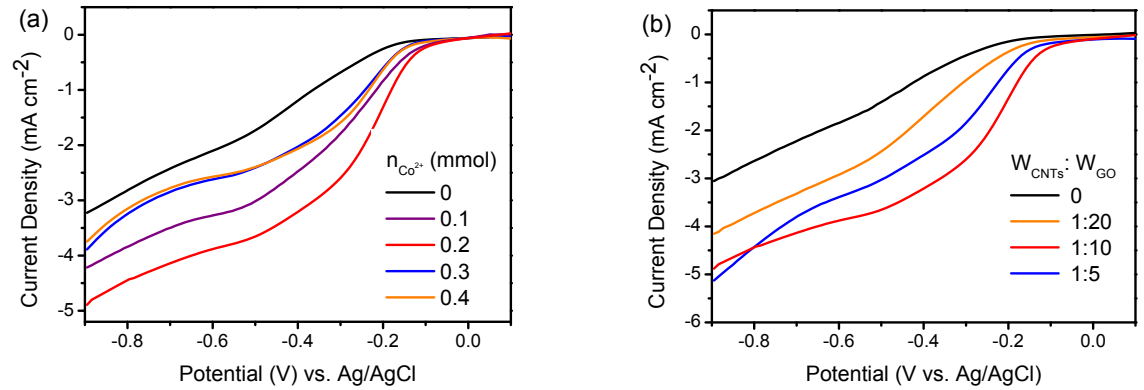

Fig. S17 RDE voltammograms for the NG/CNT/Co_3O_4 papers synthesized with (a) different contents of $Co(NO_3)_2$ with the constant weight ratio of CNT and GO of 1:10 and (b) different weight ratios of CNTs and GO in O_2-saturated 0.1 M KOH solution at rotation speed of 1600 rpm and sweep rate of 10 mV s^{-1}.

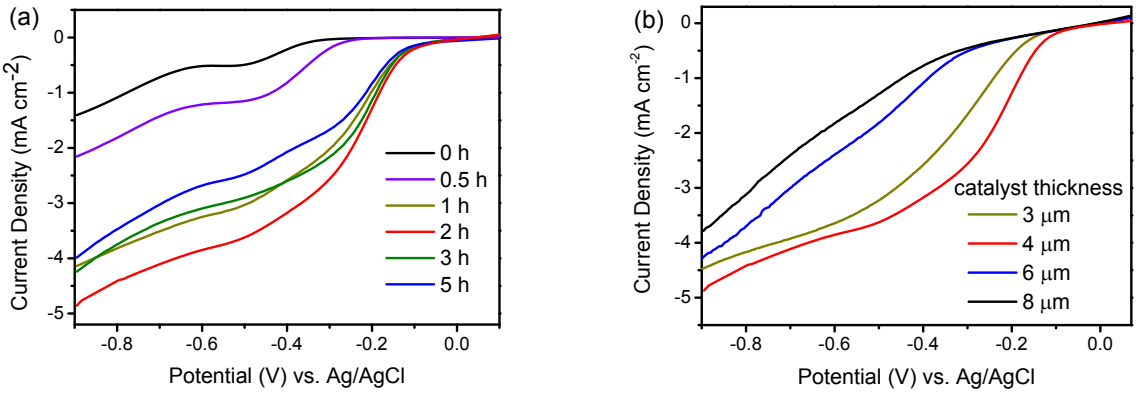

Fig. S18 RDE voltammograms for the NG/CNT/Co_3O_4 papers synthesized with (a) different hydrothermal time and (b) different thicknesses by changing the volumes of the mixtures at the optimized relative contents of CNT, GO and cobalt nitrate.