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Supplementary information

Ultrasonochemically-induced MnCo$_2$O$_4$ nanospheres synergized with graphene sheet as a non-precious bi-functional cathode catalyst for rechargeable zinc-air battery

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Fig. S1  XRD pattern of hydroxide formation phase.
Fig. S2 (a) Nitrogen adsorption - desorption isotherm and (b) the pore size distribution of MCO-GS.
Fig. S3 (a-b) Electrocatalytic ORR and OER activities of MCO-GS, MCO and Pt-C catalysts in a O$_2$-saturated 0.1 M KOH electrolyte.
Fig. S4 (a-c) FESEM images of cycled electrode.
Fig. S (a) Ex-situ XPS spectra of cycled MCO-GS electrode of Zn 2p region.
### Table S1. Comparison of the bi-functional activity of Sonchemically induced MnCo$_2$O$_4$ catalyst with reported catalysts.

<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Method of synthesis</th>
<th>Onset ORR potential (V) at I =3 mA cm$^{-2}$</th>
<th>Onset OER potential at (V) at I=10 mA cm$^{-2}$</th>
<th>Bi-functional activity (OER - ORR) E(V)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual phase-MnCo$_2$O$_4$/Nitrogen doped -rGO</td>
<td>Hydrothermal method</td>
<td>~0.81</td>
<td>~1.73</td>
<td>0.92</td>
<td>ACS Appl. Mater. Interfaces 2014, 6, 12684</td>
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<tr>
<td>MnCo$_2$O$_4$@ppy</td>
<td>Co-precipitation method</td>
<td>~0.71</td>
<td>~1.73</td>
<td>1.02</td>
<td>Electrochim. Acta 2015, 180, 788</td>
</tr>
<tr>
<td>MnCo$_2$O$_4$</td>
<td>ultrasonic humidifier for aerosol-route (480 °C)</td>
<td>0.8</td>
<td>1.63</td>
<td>0.83</td>
<td>Angew.Chem. Int. Ed. 2017, 56, 14977-14981</td>
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<tr>
<td>MnCo$_2$O$_4$</td>
<td>Annealing</td>
<td>0.63</td>
<td>1.74</td>
<td>1.13</td>
<td>ChemSusChem, 2015, 8, 164</td>
</tr>
<tr>
<td>Co$_3$O$_4$/MnCo$_2$O$_4$</td>
<td>Thermal heating method</td>
<td>0.68</td>
<td>1.77</td>
<td>1.09</td>
<td>Nanoscale 2013, 5, 5312</td>
</tr>
<tr>
<td>CoMn$_2$O$_4$-Nitrogen doped graphene sheet</td>
<td>Hydrothermal method</td>
<td>0.90</td>
<td>1.66</td>
<td>0.76</td>
<td>Electrochemistry Communications, 41 (2014) 59–63</td>
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<tr>
<td>NiCo$_2$O$_4$–nitrogen doped graphene oxide</td>
<td>Solvothermal</td>
<td>0.75</td>
<td>1.63</td>
<td>0.88</td>
<td>Chem. Commun., 2017,53, 7836-7839</td>
</tr>
<tr>
<td>MnCo$_2$O$_4$-Graphene sheet</td>
<td>Sonochemical method</td>
<td>0.85</td>
<td>1.61</td>
<td>0.76</td>
<td>Our Work</td>
</tr>
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