Electronic Supplementary Information

Template-free solvothermal preparation of ternary hollow balloons as RuO$_2$-like efficient electrocatalysts for oxygen evolution reaction with superior stability

He Wang$^1$, Jianhua Tang$^1$, Yinle Li$^1$, Hang Chu$^1$, Yuancai Ge$^1$, Robert Baines$^2$, Pei Dong$^2$, Pulickel M. Ajayan$^2$, Jianfeng Shen$^{1*}$, Mingxin Ye$^{1*}$

$^1$ Institute of Special Materials and Technology, Fudan University, 200433, Shanghai, China. E-mail: mxye@fudan.edu.cn

$^2$ Department of Materials Science and NanoEngineering, Rice University, 6100 Main Street, Houston, TX 77005, USA.

*Corresponding author. Email: jfshen@fudan.edu.cn; mxye@fudan.edu.cn

Figure S1. Nyquist plots of 1h-FNSH, 4h-FNSH, 8h-FNSH and 16h-FNSH electrodes recorded at an applied potential of 0.5 V with a frequency range of 100 kHz to 100 mHz in 1 M KOH
Figure S2. XPS survey spectra (a) of FNSH and the XPS spectra of Fe 2p (b), Ni 2p (c), and S 2p (d) for FNSH.

Table S1. Quantification results of EDX of FNSH

<table>
<thead>
<tr>
<th>Sample</th>
<th>Concentration (at. %)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Fe</td>
</tr>
<tr>
<td>FNSH</td>
<td>15.11</td>
</tr>
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</table>
Table S2. ICP-OES result of FNSH

<table>
<thead>
<tr>
<th>Sample</th>
<th>Concentration (μM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fe</td>
</tr>
<tr>
<td>FNSH</td>
<td>20.525</td>
</tr>
</tbody>
</table>

Figure S4. DLS result of 8h-FNSH.

Figure S5. XRD patterns of FNS obtained with reaction time 1 h, 4 h and 8 h.
**Figure S6.** SEM and the corresponding TEM images (inset in the SEM images) of FNS obtained with different reaction times (a) 12 h, (b) 16 h, (c) 32 h, (d) 48 h; varying ratios of water-glycol (e) 1:0, (f) 2:1, (g) 1:2, (h) 0:1; different reaction temperatures (i) 180 °C, (j) 200 °C; multiple amounts of L-cysteine (k) 0.04 mol/L, (l) 0.16 mol/L; Scale bars shown in all of the SEM and TEM images correspond to 2.0 um. XRD patterns of different FNS samples (m)
Figure S7. XRD pattern of FNSH/GA.

Figure S8. SEM images of FNSH/GA.
**Figure S9.** Raman spectrum of FNSH/GA.

**Figure S10.** XRD patterns of Ni$_{0.96}$S and Fe$_3$S$_4$. 
Figure S11. SEM images of Ni$_{0.96}$S (a), Ni$_{0.96}$S/GA (b), Fe$_3$S$_4$ (c) and Fe$_3$S$_4$/GA (d).

Figure S12. polarization curves of FNSH/GA, Fe$_3$S$_4$/GA, NiS/GA at 5 mV s$^{-1}$
Figure S13. CV for FeNi$_2$S$_4$ under different reaction time, including (a) 1 h, (b) 4 h, (c) 8 h, (d) 16 h, with a scan rate of 0.05, 0.1, 0.15, 0.2, 0.25 and 0.3 V s$^{-1}$ in 1.0 M KOH at the potential from 0 to 0.5 V.

Figure S14. Durability tests for 8 h FNSH/GA at 10 mA cm$^{-2}$. 
Figure S15. N\textsubscript{2} adsorption-desorption isotherms of different products under different reaction time, including 1 h, 2 h, 4 h, 8 h and 16 h.

Figure S16. SEM images of CuCo\textsubscript{2}S\textsubscript{4} (a) and CoNi\textsubscript{2}S\textsubscript{4} (b)

References: