Electronic Supplementary Information

Ultra-small B$_2$O$_3$ nanocrystals grown in-situ on highly porous carbon microtubes for Lithium-Iodine and Lithium-Sulfur battery

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Fig. S1. The view of Li$_2$S$_8$ and LiI$_3$ adsorbed on graphene carbon materials and the calculated adsorption energy.

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<tr>
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<th>Li$_2$S$_8$</th>
<th>LiI$_3$</th>
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<tbody>
<tr>
<td>B$_2$O$_3$</td>
<td>-1.54 eV</td>
<td>-1.70 eV</td>
</tr>
<tr>
<td>Graphene</td>
<td>-0.84 eV</td>
<td>-0.79 eV</td>
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Fig. S2. XRD patterns of the prepared B$_2$O$_3$/carbon microtubes composite and pure carbon microtubes.
**Fig. S3** Raman spectra of the prepared B$_2$O$_3$/carbon microtubes composite and pure carbon microtubes.

**Fig. S4** N$_2$ adsorption-desorption isotherms (a) and corresponding pore size distribution calculated from desorption branch by the BJH method (b) of the as-prepared B$_2$O$_3$/carbon microtubes composite.
**Fig. S5** XPS survey scan (a) and high resolution scan of B 1s of B$_2$O$_3$/carbon microtubes composite.

**Fig. S6** TGA curves of prepared B$_2$O$_3$/carbon microtubes composite and pure carbon microtubes.
Fig. S7. Cycle performance of iodine cathodes in different electrolytes at the rate of 20 C.

Fig. S8. The Nyquist plots of the Li-I$_2$ batteries in different electrolytes after 300 cycles at the rate of 20 C.
**Fig. S9.** Cycle performance of iodine cathode without interlayer at the rate of 20C.

**Fig S10.** The discharge-charge curves of I$_2$/B$_2$O$_3$ modified carbon microtubes composite at the rate of 20 C.
Fig. S11. Cycle performance of sulfur cathode at various rates with pure carbon microtubes interlayer (1st-15th: 0.5C; 16th-30th: 1C; 31st-45th: 2C; 46th-60th: 4C; 60th-80th: 2C).

Fig. S12 XRD pattern (a) and SEM image (b) of the B$_2$O$_3$/carbon microtubes composite after washing B$_2$O$_3$. 
Fig. S13 SEM images of the compressing pieces of interlayer. (a) B$_2$O$_3$/carbon microtubes composite; (b) carbon microtubes.