Supporting Information

A Universal and Facile Approach to Suppress Dendrite Formation for Zn and Li Metal Anode

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Scheme. S1 Schematic illustration of material fabrication processes.

Fig. S1 Voltage profiles of galvanostatic Zn plating/stripping for different separator, (a) GF/GO0.2 separator and (b) GF/GO0.5 separator.
Fig. S2 Surface images of pristine Zn foil.

Fig. S3 SEM images of the Zn dendrites in GF separator at 2 mA cm⁻².

Fig. S4 (a) The oxidation profiles of the zinc-titanium half-batteries (left) with the GF separator and (right) the GF/GO1 separator between 0 and 0.3 V (vs Zn/Zn²⁺); (b) EIS plots of zinc-titanium half-batteries using the GF/GO1 and GF separator.
**Fig. S5** Voltage profiles of the initial Zn plating on Ti foil in zinc-titanium half-batteries with the GF separator and the GF/GO1 separator at 5 mA cm\(^{-2}\).

**Fig. S6** SEM images of GF/GO1 separator (a) (b); GF (c) and GO (d).
Fig. S7 Wettability test of GF (a) and GF/GO1 (b) separator.
**Table. S1** Porosity and electrolyte uptake of GF and GF/GO separator.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Porosity (%)</th>
<th>Electrolyte uptake (%)</th>
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<tr>
<td>GF separator</td>
<td>1232</td>
<td>13214</td>
</tr>
<tr>
<td>GF/GO1 separator</td>
<td>1473</td>
<td>15891</td>
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**Fig. S8** (a) The Nyquist plots of the GF and GF/GO1 separator at room temperature; (b) The ionic conductivity of GF and GF/GO1 separator.

**Fig. S9** XRD patterns of prepared MnO$_2$ cathode material before and after ball milling.
Fig. S10 SEM images of MnO$_2$ before (a-b) and after (c-d) ball milling.

Fig. S11 SEM images of MnO$_2$ (a) and (b) after coating.
Fig. S12 (a) Rate performances and (b) the electrochemical impedance spectra of Zn/MnO$_2$ cells using different separators.
Table. S2 The $R_s$, $R_{sf}$ and $R_{ct}$ of the Zn-symmetric batteries and Zn//MnO$_2$ batteries with different separator.

<table>
<thead>
<tr>
<th>Battery Type</th>
<th>$R_s$ ($\Omega$)</th>
<th>$R_{sf}$ ($\Omega$)</th>
<th>$R_{ct}$ ($\Omega$)</th>
</tr>
</thead>
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<tr>
<td>Zn-symmetric batteries</td>
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<td></td>
<td></td>
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<tr>
<td>GF separator</td>
<td>6.084</td>
<td>83.158</td>
<td>2733</td>
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<tr>
<td>GF/GO1 separator</td>
<td>4.513</td>
<td>21.918</td>
<td>657.3</td>
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<tr>
<td>Zn//MnO$_2$ batteries</td>
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<tr>
<td>GF separator</td>
<td>5.812</td>
<td>11.821</td>
<td>565.2</td>
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<td>GF/GO1 separator</td>
<td>3.419</td>
<td>7.133</td>
<td>305.9</td>
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</table>

Fig. S13 Electrochemical impedance spectra of (a) Zn-symmetric batteries with GF/GO1 separator and (b) GF separator after cycling; Electrochemical impedance spectra of (c) Zn/MnO$_2$ full batteries GF/GO1 separator and (d) GF separator after cycling.
Fig. S14 (a) Cycling performance of the Zn/MnO₂ full batteries using different separators at a current density of 0.5 A g⁻¹ and (b) the capacity retention rate of other zinc ion batteries using different cathode materials after cycles.
Fig. S15 $i(v)/v^{1/2} - v^{1/2}$ plot in different voltage of GF/GO1 separator Zn/MnO$_2$ cell in (a) charge and (b) discharge.
Fig. S16: (a) CV curves of GF separator Zn/MnO$_2$ cell at different scan rate; (b) b values of GF separator MnO$_2$/Zn cell at different peaks, calculated based on multi-rate CV results; (c) Capacitive charge storage contribution at the scan rate of 1.0 mV s$^{-1}$. 
Fig. S17 (a) Voltage profiles of different Li-symmetric cells with GF/GO1 separator and GF separator during Li plating/stripping using step-up current densities; (b) Voltage profiles in first ten cycles.