C$_x$N$_y$ particles@N-doped porous graphene: a novel cathode catalyst with a remarkable cyclability for Li-O$_2$ batteries

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Fig. S1 (a, b, c ) TEM images of GO, monodispersed PS spheres and rGO/PS composite, (d) SEM image of rGO/PS composite.
Fig. S2 (a, b) SEM images of porous-rGO, (c, d) SEM images of C\textsubscript{x}N\textsubscript{y}@NPG.

Fig. S3 STEM-EDS elemental mapping for C\textsubscript{x}N\textsubscript{y} particle on NPG matrix.
**Fig. S4** The typical EDS spectrum with the characteristic peaks of elements C and N.

**Fig. S5** SEM images of CₓNᵧ@NPG at different pressures. (a-c) 0 kg cm⁻², (d-f) 25 kg cm⁻², (g-i) 50 kg cm⁻², (j-k) 75 kg cm⁻².
Fig. S6 (a) N$_2$ adsorption-desorption isotherms and (b) pore size distribution of C$_x$N$_y$@NPG and porous-rGO.

Fig. S7 Electrochemical window of 1.0 M TEGDME/LiTFSI electrolyte used in Li-O$_2$ batteries at the oxygen atmosphere.

Fig. S8 Subsequent CV curves of C$_x$N$_y$@NPG (a) and porous-rGO cathodes (b) at a scan rate of 0.5 mV s$^{-1}$. 
Fig. S9 SEM images of the oxygen electrode with different magnifications.

Fig. S10 High-resolution SEM images of the C\textsubscript{x}N\textsubscript{y}@NPG electrode after discharge.
Fig. S11 Raman spectra, XRD patterns and XPS of $\text{C}_x\text{N}_y@\text{NPG}$ electrode after 100 cycles at 1000 mA g$^{-1}$ by curtailing capacity to 1000 mA h g$^{-1}$.

Fig. S12 SEM images of the cathode based on $\text{C}_x\text{N}_y@\text{NPG}$ after 100 cycles.
Table 1 The $I_D/I_G$ intensity ratio of Raman spectra of $C_xN_y@NPG$ electrode before cycling and after 100 cycles at 1000 mA g$^{-1}$ by curtailing capacity to 1000 mA h g$^{-1}$.

<table>
<thead>
<tr>
<th>Selected points</th>
<th>$I_D/I_G$</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Fresh electrode</td>
</tr>
<tr>
<td>1</td>
<td>1.15</td>
</tr>
<tr>
<td>2</td>
<td>1.14</td>
</tr>
<tr>
<td>3</td>
<td>1.21</td>
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