Phosphate functionalized activated carbon as an efficient metal-free electrocatalyst for oxygen reduction reaction

Supporting Information

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Fig. S1 (a) SEM and (e) TEM images of AC, (b) SEM and (f) TEM images of PAC, (c) SEM and (g) TEM images of PAC-1 and (d) SEM and (h) TEM images of PAC-2.

Fig. S2 EDS element mapping images of (a) C, (b) O and (c) P elements of PAC-3.
Fig. S3 High-resolution P 2p spectra of (a) PAC, (b) PAC-1 and (c) PAC-2.

Fig. S4 Raman spectra of (a) AC, (b) PAC, (c) PAC-1 and (d) PAC-2.

Fig. S5 LSV curves of AC in O₂-saturated 0.1 M KOH solution at various rotation speeds with 10 mV·s⁻¹. (b) Koutecky-Levich plots of AC at different electrode potentials.
Fig. S6 LSV curves of PAC in O\textsubscript{2}-saturated 0.1 M KOH solution at various rotation speeds with 10 mV·s\textsuperscript{-1}. (b) Koutecky-Levich plots of PAC at different electrode potentials.

Fig. S7 LSV curves of PAC-1 in O\textsubscript{2}-saturated 0.1 M KOH solution at various rotation speeds with 10 mV·s\textsuperscript{-1}. (b) Koutecky-Levich plots of PAC-1 at different electrode potentials.

Fig. S8 LSV curves of PAC-2 in O\textsubscript{2}-saturated 0.1 M KOH solution at various rotation speeds with 10 mV·s\textsuperscript{-1}. (b) Koutecky-Levich plots of PAC-2 at different electrode potentials.
Fig. S9 RRDE curves of (a) AC, (b) PAC, (c) PAC-1 and (d) PAC-2 in O₂-saturated 0.1 M KOH solutions at 10 mV·s⁻¹ and 1600 rpm rotation speed.

Fig. S10 LSV curves of different AC samples treated with acid (AC-1), base (AC-2), acid and base (AC-3) in O₂-saturated 0.1 M KOH solutions with 10 mV s⁻¹ and 1600 rpm rotation speed.

Table S1. The specific surface area and average pore size of different AC samples treated with acid (AC-1), base (AC-2), acid and base (AC-3).

<table>
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<tr>
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<th>AC-1</th>
<th>AC-2</th>
<th>AC-3</th>
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<tbody>
<tr>
<td>Specific surface area (m² g⁻¹)</td>
<td>662.3</td>
<td>712.9</td>
<td>856.5</td>
</tr>
<tr>
<td>Average pore size (nm)</td>
<td>4.5</td>
<td>4.4</td>
<td>4.2</td>
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**Fig. S11** LSV curves of the PAC-3, PAC-3(700) and PAC-3(800) samples in O$_2$-saturated 0.1 M KOH solutions with 10 mV s$^{-1}$ and 1600 rpm rotation speed.