Electronic Supplementary Information for

Tannic acid decorated AuPd lavender-like nanochains for enhanced oxygen reduction electrocatalysis

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Characterizations

ZEISS Gemini 500 scanning electron microscope (SEM) was used to characterize the morphology. FEI Talos-S transmission electron microscopy (TEM) was employed to investigate the structure and composition of catalysts. X-ray diffraction (XRD) pattern was conducted on a PANalytical X’Pert Powder with Cu Kα radiation X-ray source (λ = 0.154056 nm). X-ray photoelectron spectra (XPS) spectrum was carried out by ESCALAB MK II spectrometer (VG Scientific, UK) with Al Kα X-ray excitation. The Fourier transform infrared (FT-IR) spectra were measured using a Thermo Fisher Scientific Nicolet iS50 spectrometer.

Synthesis of Au NWs

The Au NWs were prepared according to previous work.\(^1\) 4.5 mL of 1-naphthol ethanol solution (0.5 M) were added to 4.5 mL of HAuCl\(_4\) aqueous solution (0.05 M). Then, the mixed solution was placed in a 60 °C water bath and the reaction was allowed to proceed for 1 min. Au NWs can be collected by centrifugation and washing with ethanol for several times. The product was dispersed in 1 mL H\(_2\)O for further use.

Electrochemical calculation

The electron transfer number \((n)\) is calculated by the Koutecky-Levich equation as follow:

\[
\frac{1}{j} = \frac{1}{j_k} + \frac{1}{j_d}
\]

\[
j_d = 0.2nFD^{2/3}v^{-1/6}\omega^{1/2}C_{O2}
\]

Where, \(j, j_k,\) and \(j_d\) are the measured, kinetic, and diffusion currents, respectively. \(F\) is the Faraday's constant (96485 C mol\(^{-1}\)). \(D\) is the diffusion coefficient of O\(_2\) (1.93 \times 10^{-5} \text{ cm}^2 \text{s}^{-1}), \) \(v\) is the kinetic viscosity (1.13 \times 10^{-2} \text{ cm}^2 \text{s}^{-1}), \(\omega\) is the rotation speed of electrode (rpm), and \(C_{O2}\) is the bulk concentration of O\(_2\) dissolved in 0.1 M KOH solution (1.2 \times 10^{-3} \text{ mol L}^{-1}).
The electrochemical active surface area (ECSA) is calculated using the following equation:

\[
\text{ECSA} = \frac{Q}{m} \times 420
\]

Where \( m \) is the Pd loading on the electrode surface, 420 \( \mu \text{C cm}^{-2} \) is the reduction charge of a Pd oxide monolayer on the Pd surface, and \( Q \) is acquired by integrating the reduction charge of the Pd oxide layer.
**Fig. S1** (a) SEM and (b) TEM images of Au NWs.

**Fig. S2** (a) SEM and (b) TEM images of AuPd LCs.
Fig. S3 XRD patterns of (a) AuPd LCs and (b) AuPd@TA LCs.

Fig. S4 XPS spectra of (a) AuPd LCs and (b) AuPd@TA LCs.
Fig. S5 XPS spectra of (a) Au 4f and (b) Pd 3d for the AuPd LCs.

Fig. S6 FT-IR spectra of AuPd@TA LCs and TA.
**Fig. S7** CV curves of AuPd@TA LCs, AuPd LCs and Pt/C in a N$_2$-saturated 0.1 M HClO$_4$ solution at a scan rate of 50 mV s$^{-1}$.

**Fig. S8** (a) ORR polarization curves with different rotation rates, and (b) the electron transfer numbers at different potentials of the AuPd@TA LCs.
Fig. S9 (a) ORR polarization curves with different rotation rates, and (b) the electron transfer numbers at different potentials of the AuPd LCs.

Fig. S10 (a) ORR polarization curves with different rotation rates, and (b) the electron transfer numbers at different potentials of the Pt/C.
Fig. S11 TEM image of the AuPd@TA LCs after testing in a 0.1 M KOH solution.

Fig. S12 TEM image of the AuPd@TA LCs after testing in a 0.1 M HClO₄ solution.
Table S1 The comparisons of the ORR performance of the AuPd@TA LCs with the recently reported Pd-based catalysts.

<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Electrolyte</th>
<th>Specific activities (mA cm(^{-2}))</th>
<th>Mass activities (A mg(^{-1})metal)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>AuPd@TA LCs</td>
<td>0.1 M KOH</td>
<td>1.87</td>
<td>0.90</td>
<td>This work</td>
</tr>
<tr>
<td>O-PdFe/C</td>
<td>0.1 M KOH</td>
<td>0.87</td>
<td>0.18</td>
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<tr>
<td>Pd(_2)FeCo/C</td>
<td>0.1 M KOH</td>
<td>0.59</td>
<td>0.21</td>
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<td>Pd(_4)Au HC/C</td>
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<td>0.137</td>
<td>0.287</td>
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<td>Pd–B/C</td>
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<td>0.960</td>
<td>/</td>
<td>5</td>
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<tr>
<td>np-PdNi</td>
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<tr>
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<td>/</td>
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References


