Supporting information

An electrochemical ratiometric biosensor for the detection of
dopamine based on MXene-Au nanocomposite

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1. Experimental sections

Regents and instruments

5 mg·mL\(^{-1}\) multilayer Ti\(_3\)C\(_2\)T\(_x\) MXene solution was purchased from Beike 2D Materials Co. Ltd (Suzhou, China). Methylene blue, HAuCl\(_4\)·3H\(_2\)O, and dopamine were bought from Aladdin Reagent (Shanghai) Co. Ltd. K\(_3\)[Fe(CN)]\(_6\), Na\(_2\)HPO\(_4\), NaH\(_2\)PO\(_4\), and KCl were purchased from Shanghai Macklin Biochemical Co., Ltd. The above reagents were analytically pure and used without further treatment. Milli-Q water purification system was employed to produce the ultrapure water (18.2 MΩ·cm) used in this work.

Transmission electron microscopy (TEM) images were observed on a JEM-2100 instrument. X-ray diffraction (XRD) measurements were conducted on a Rigaku Smartlab diffractometer with Cu K\(_\alpha\) radiation. All the electrochemical measurements were performed on a CHI660E electrochemical station (Shanghai CH Instruments Co. Ltd) with three-electrode system: modified glassy carbon electrode as working electrode, platinum wire as counter electrode and Ag/AgCl (3 M KCl) as reference electrode.

Synthesis of MXene-Au nanocomposite

MXene-Au was prepared based on the reported reference [24] with minor modification. First, 0.2 mL MXene solution (5 mg·mL\(^{-1}\)) was dropped into 4.8 mL water and sonicated for 30 min. Next, 1.0 mL HAuCl\(_4\) (20 mM) was dropped into the above solution. After reacting for 5 min under continuously stirring, the mixture was centrifugated and washed three times with water. Finally, MXene-Au nanocomposite was obtained by drying the precipitate at 60°C for 12 h in vacuum.

Synthesis of MB-MXene-Au nanocomposite

1.0 mg MXene-Au nanocomposite was added into 1.0 mL 25 μM methylene blue (MB) solution and sonicated for 1 h. The superfluous MB was removed by centrifugation and washing.

Fabrication of MB-MXene-Au/GCE

First, glassy carbon electrode (GCE) was polished with Al\(_2\)O\(_3\) suspension on polishing cloth. After being washed with water and ethanol, the performance of GCE
was tested by scanning the cycle voltammetry of $[\text{Fe(CN)}_6]^{3-/4-}$ in 0.10 M KCl solution. Then the electrode was rinsed well with water and dried with nitrogen. Next, 6 μL 1 mg·mL$^{-1}$ MB-MXene-Au solution was dropped on the electrode surface and dried naturally. Finally, 6 μL 0.025% Nafion was added on MB-MXene-Au/GCE to immobilize MB-MXene-Au on the electrode firmly.

**Electrochemical measurements**

Nafion/MB-MXene-Au/GCE was immersed into 5 mL pH 6.0 PBS containing different concentration of dopamine for electrochemical detection.

Differential pulse voltammetry (DPV) was measured with the parameters: +0.5 ~ -0.5V scan range, 4 mV potential increment, 50 mV pulse width, 50 mV amplitude, and 0.5 s pulse period. The electrochemical impedance spectroscopy (EIS) was carried out in 0.1 M KCl solution containing 20 mM $[\text{Fe(CN)}_6]^{3-/4-}$ with a frequency range from 0.1 Hz to 100 kHz. The amplitude of the applied sine wave potential was 5 mV and the formal potential of the system was set at +0.22 V.

**2. Figures**

![Zeta potential of MXene-Au and MB-MXene-Au](image.png)

Figure S1. Zeta potential of MXene-Au and MB-MXene-Au
Figure S2. Stability study of the ratiometric biosensor. (A) and (B) are the local enlargement of DPV for MB and DA, respectively.

Figure S3. Effect of HAuCl₄ concentration on the performance of the ratiometric biosensor.
### 3. Tables

Table S1. Comparison of DA detection based on various modified nanomaterials

<table>
<thead>
<tr>
<th>Modified material</th>
<th>Detection technique</th>
<th>Linear range</th>
<th>Detection limit</th>
<th>Reference</th>
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<td>100-1000 μM</td>
<td>0.24 μM</td>
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<tr>
<td>Ionic liquid/Ti$_3$C$_2$Cl$_2$</td>
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<tr>
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<tr>
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<td>S-doped graphene</td>
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<tr>
<td>N-doped reduced GO</td>
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<td><strong>This work</strong></td>
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</tbody>
</table>

Note:

$^a$ERHG: electrochemically reduced holey graphene;  
$^b$MB: methylene blue;  
$^c$BP: 4-(pyren-4-yl)-N-(4-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)butanamide;  
$^d$pXA: polyxanthurenic acid;  
$^e$MIPs: molecularly imprinted polymers (MIPs);  
$^f$pThi: polythionine.

**References:**


10 L. Zhang, C. Li, Y. Yang, J. Han, W. Huang, J. Zhou, and Y. Zhang, *Talanta.*, 2022, **247**, 123614.


