

Supporting information(S1)

Molybdenum Disulfide Quantum Dots as Dual-Function Catalysts and Coreactants for Enhanced Ru(bpy)₃²⁺ Electrochemiluminescence

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Determination of the ECL efficiency

The ECL efficiency represents the ratio of photons emitted to the number of electrons excited. Its absolute efficiency is denoted as

$$\Phi_{\text{ECL}} = \frac{\int_0^{t'} \text{ECL} dt}{\int_0^{t'} i dt}$$

(1)

Where “ECL” and “i” refer to ECL photon count and Faradaic electrochemical current value, respectively.

Taking Ru(bpy)₃²⁺/TPrA system as a reference, the relative efficiency is expressed as

$$\frac{\Phi_{\text{st}}}{\Phi_{\text{x}}} = \frac{\left(\frac{\int_0^{t'} \text{ECL} dt}{\int_0^{t'} i dt} \right)_{\text{st}}}{\left(\frac{\int_0^{t'} \text{ECL} dt}{\int_0^{t'} i dt} \right)_{\text{x}}} = \frac{\left(\frac{\int_0^{t'} \text{ECL} dt}{Q} \right)_{\text{st}}}{\left(\frac{\int_0^{t'} \text{ECL} dt}{Q} \right)_{\text{x}}}$$

(2)

Whereas “st” and “x” represent Ru(bpy)₃²⁺/TPrA reference and Ru(bpy)₃²⁺/MoS₂ QDs, respectively.

Since the conversion coefficient between the light intensity and photon number remains consistent across instruments, Eq. 2 can be transformed into

$$\Phi_{\text{st}} = \Phi_{\text{x}} \times \frac{\text{ECL}_{\text{st}} \times Q_{\text{x}}}{Q_{\text{st}} \times \text{ECL}_{\text{x}}}$$

(3)

Assuming the ECL efficiency of $\text{Ru}(\text{bpy})_3^{2+}/\text{TPrA}$ system is 100%, the relative ECL efficiency of $\text{Ru}(\text{bpy})_3^{2+}/\text{MoS}_2$ QDs system is tested to be

$$\Phi_{\text{st}} = \frac{\text{ECL}_{\text{st}} \times Q_x}{Q_{\text{st}} \times \text{ECL}_x} \times 100\%$$

(4)

Analysis of the V-I curve and ECL spectra of the ECL reaction, as depicted in Fig. S6, a yielded the ECL and Q values for $\text{Ru}(\text{bpy})_3^{2+}/\text{TPrA}$ and $\text{Ru}(\text{bpy})_3^{2+}/\text{MoS}_2$ QDs systems, respectively. By substituting these values into Eq. 4, the relative ECL efficiency of the $\text{Ru}(\text{bpy})_3^{2+}/\text{MoS}_2$ QDs system was calculated as 89.4%.

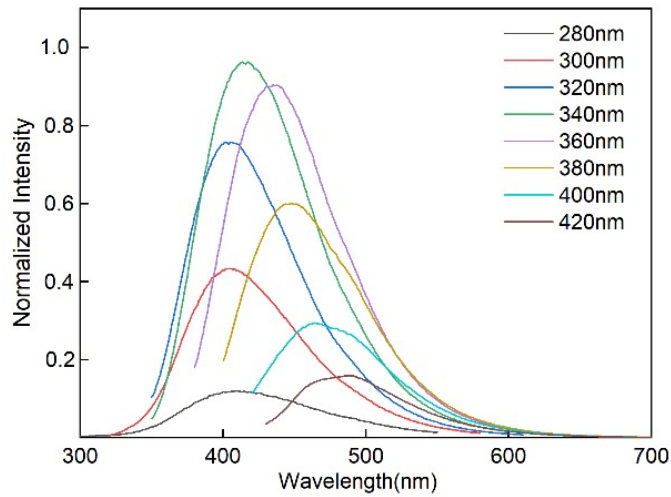


Fig. S1 Fluorescence spectra of MoS_2 QDs at different excitation wavelengths.

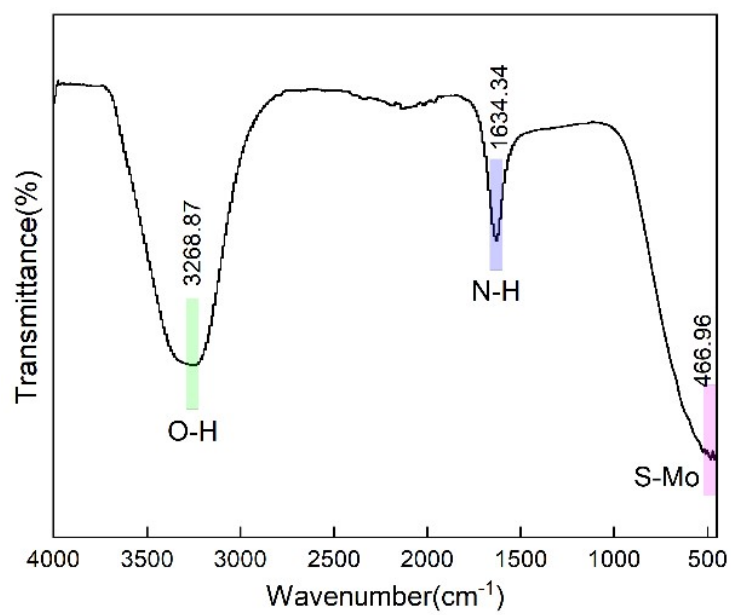


Fig. S2 FTIR spectrum of MoS₂ QDs

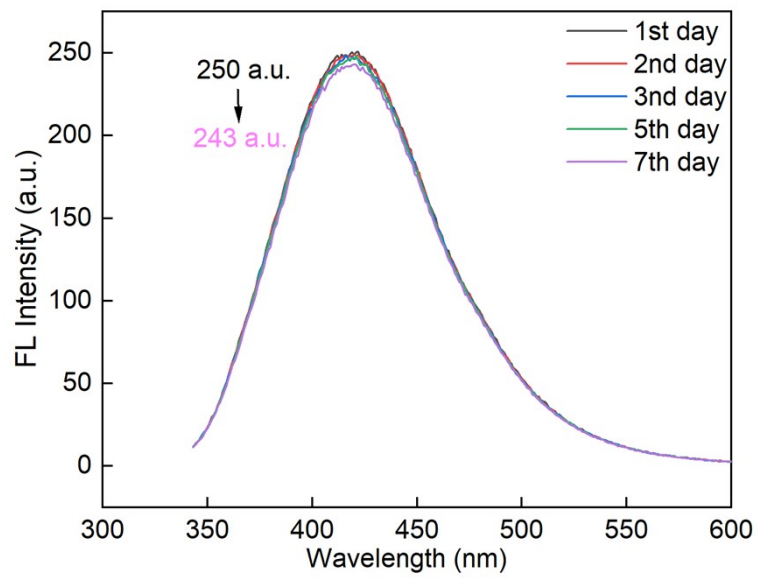


Fig S3. Fluorescence emission spectra on days 1, 2, 3, 5, 7.

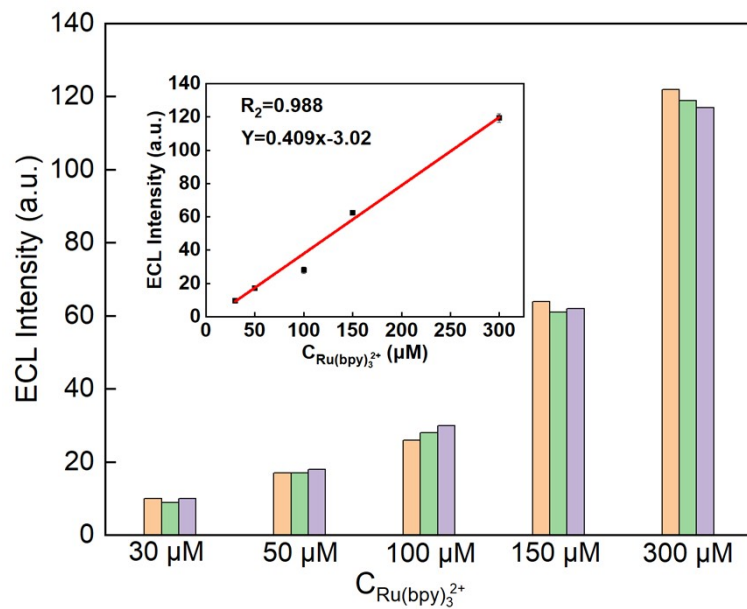


Fig. S4 The ECL intensity of different concentrations of Ru(bpy)₃²⁺. The inset in the figure shows the fitted curve of Ru(bpy)₃²⁺ concentration and ECL intensity (n = 3).

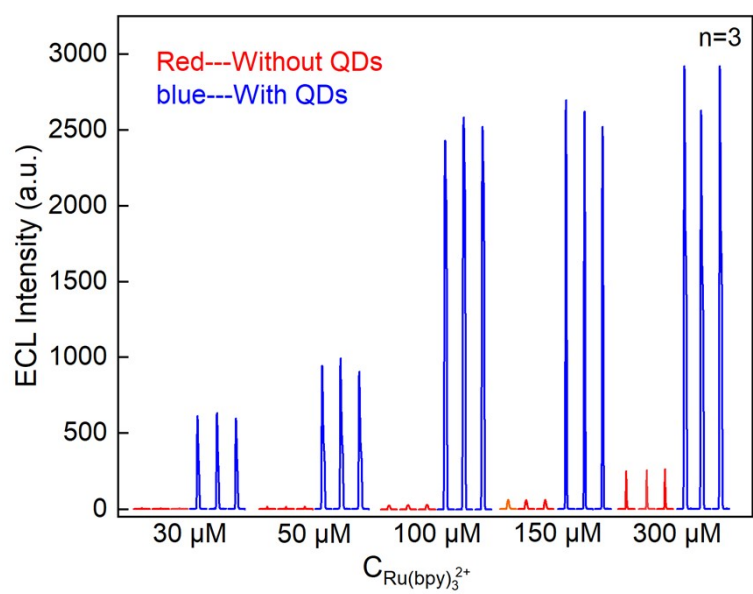


Fig S5. ECL intensity curves of solutions with different concentrations of Ru(bpy)₃²⁺ with or without MoS₂ QDs (The concentration of MoS₂ QDs is 30μg/mL). (n=3)

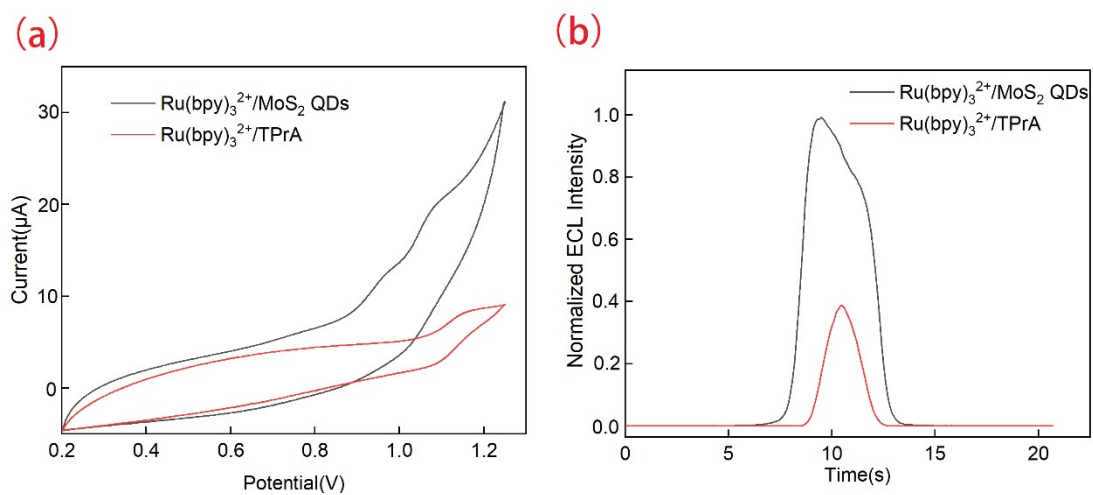


Fig. S6 CV curves and ECL intensity-time curves of the $\text{Ru}(\text{bpy})_3^{2+}/\text{TPrA}$ and $\text{Ru}(\text{bpy})_3^{2+}/\text{MoS}_2$ QDs systems. Electrochemical test conditions: MoS_2 QDs 20 $\mu\text{g}/\text{mL}$, TPrA 5mM, $\text{Ru}(\text{bpy})_3^{2+}$ 100 μM , 0.1M PBS, bare electrode.

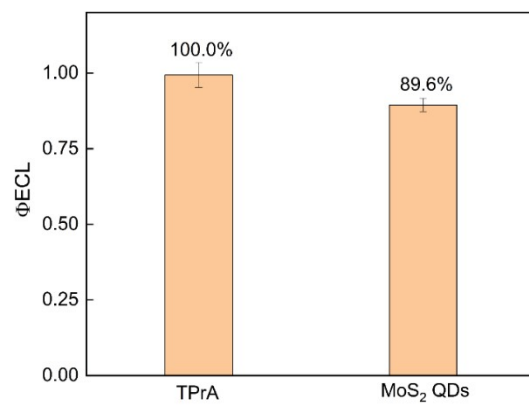


Fig. S7 ECL efficiencies of Ru(bpy)₃²⁺/TPrA and Ru(bpy)₃²⁺/MoS₂ QDs. (n=3)

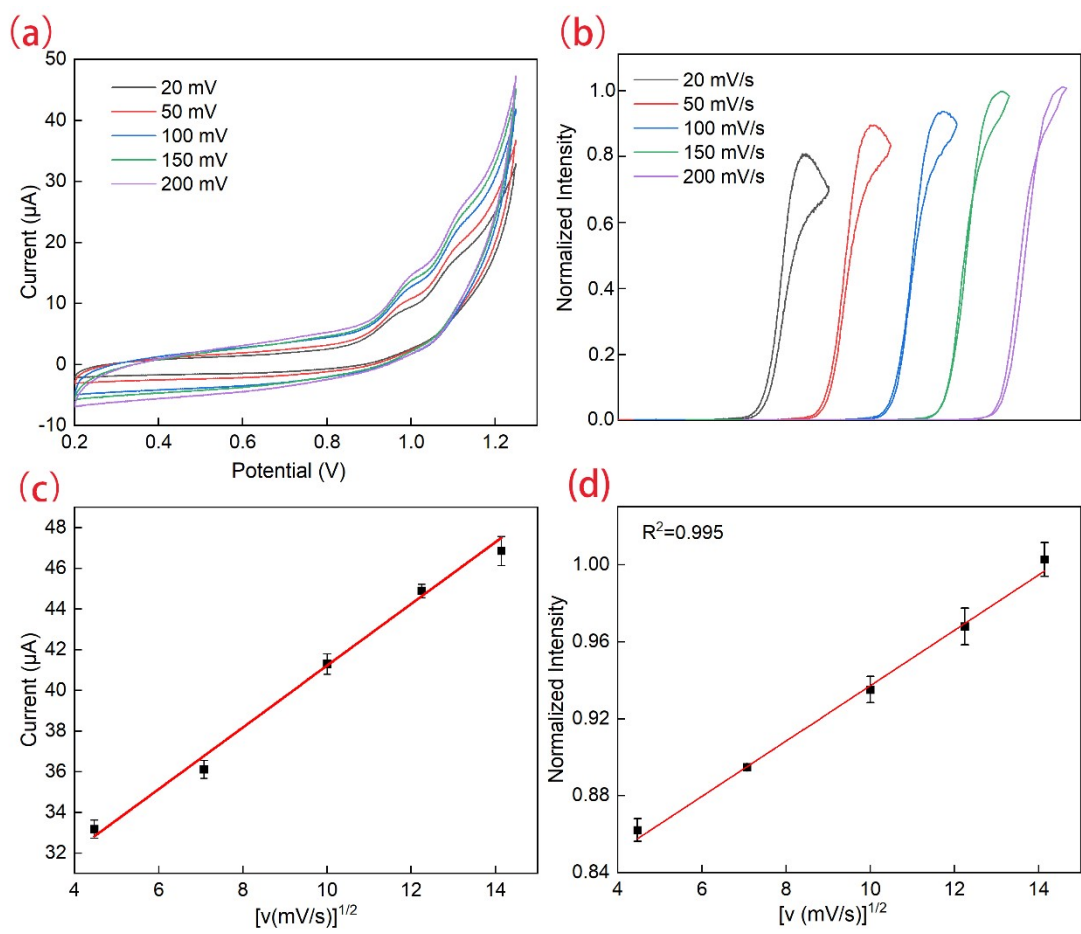


Fig S8 (a) CV curves and (b) ECL potential curves for 100 μM Ru(bpy)₃²⁺ in a 0.1 M PBS solution (pH 10.0) containing 30 μg/mL MoS₂ QDs at various scan rates, and the relationships between (c) the oxidation peak current and (d) the ECL intensity versus $v^{1/2}$. (n=3)

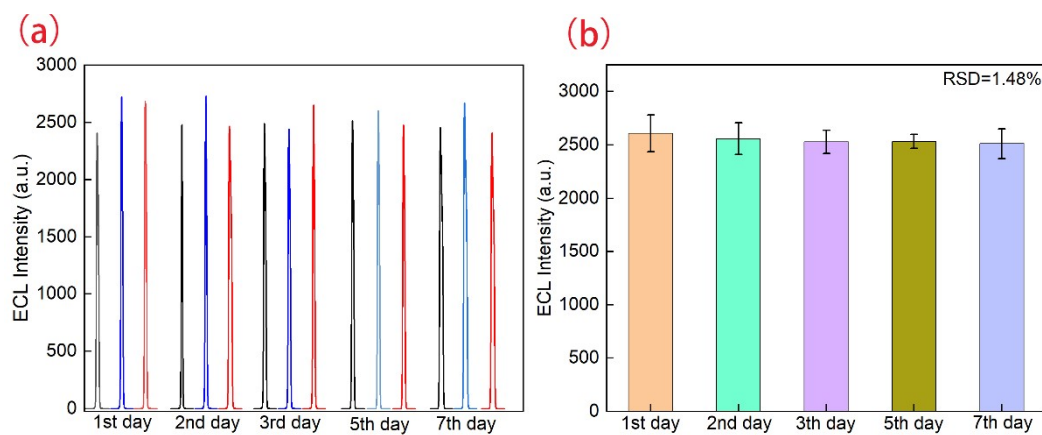


Fig S9. (a) ECL response curves of the $\text{Ru}(\text{bpy})_3^{2+}/\text{MoS}_2$ QDs system on days 1, 2, 3, 5, 7 ($n=3$); (b) ECL intensity error bars on days 1, 2, 3, 5, 7, RSD=1.48%; Electrochemical test conditions: MoS_2 QDs $30 \mu\text{g/mL}$, $\text{Ru}(\text{bpy})_3^{2+}$ $100 \mu\text{M}$, PBS 0.1 M , GCE.

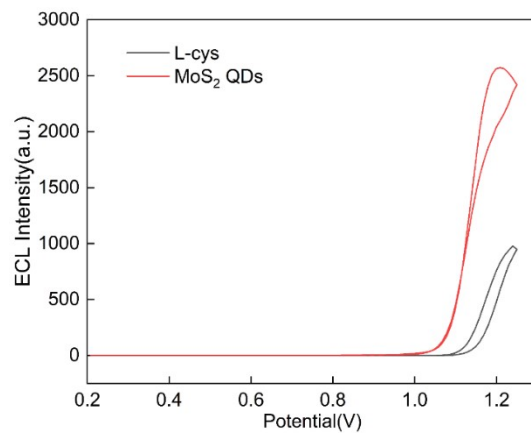


Fig. S10 Enhancement effect of L-cysteine and MoS₂ QDs on Ru(bpy)₃²⁺

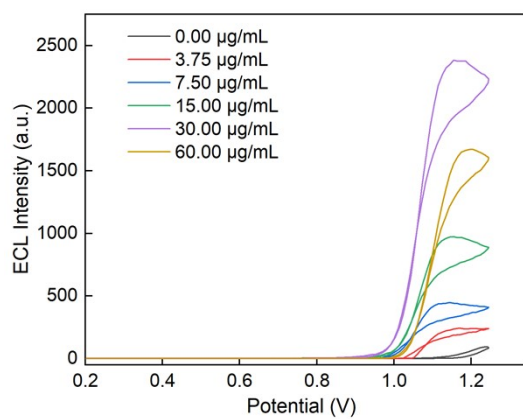


Fig. S11 The influence of the addition amount of MoS₂ QDs on the MoS₂ QDS/Ru(bpy)₃²⁺ system; The concentration of Ru(bpy)₃²⁺ is 100 µM.

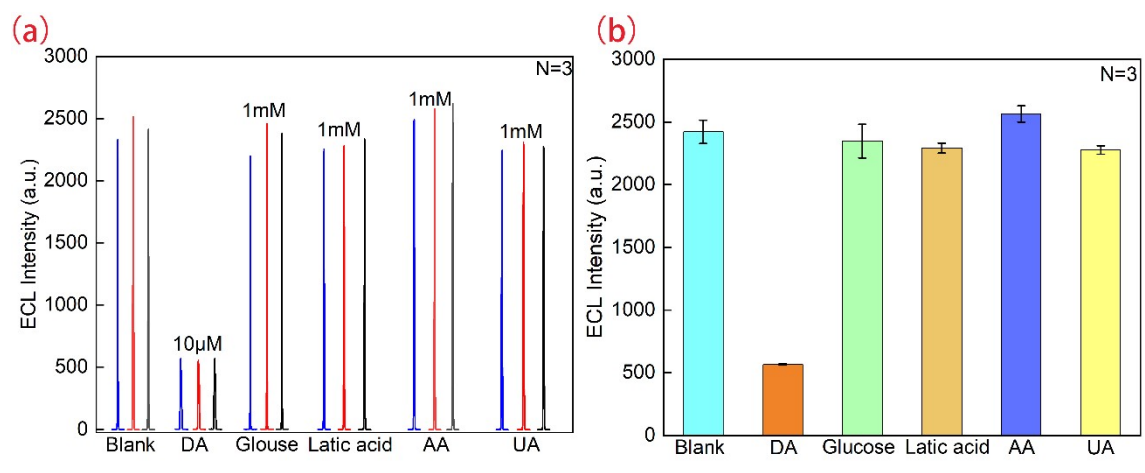


Fig. S12 (a) ECL intensity changes upon addition of different substances (DA, glucose, lactic acid, AA, UA); (b) Corresponding bar graph showing ECL intensity variations (n=3)