

## Electrochemiluminescence of water-dispersed nitrogen and sulfur doped carbon dots synthesized from amino acids

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The stocked NS-CDs solution was kept in a 10 mm quartz cuvette and irradiated with a 365nm UV lamp in a dark room for 90 minutes, and the changes in fluorescence intensity were recorded by an FL-2700 fluorescence spectrophotometer (Hitachi, Japan). The excitation and emission slit widths were both kept at 5.0 nm, the PMT Voltage was set at 700 V, with the response time 0.4s. The results were displayed in Fig.S1. It can be seen that, under the UV irradiation, the fluorescence intensities of the NS-CDs were almost unchanged, showing the stable optical properties of the prepared NS-CDs.

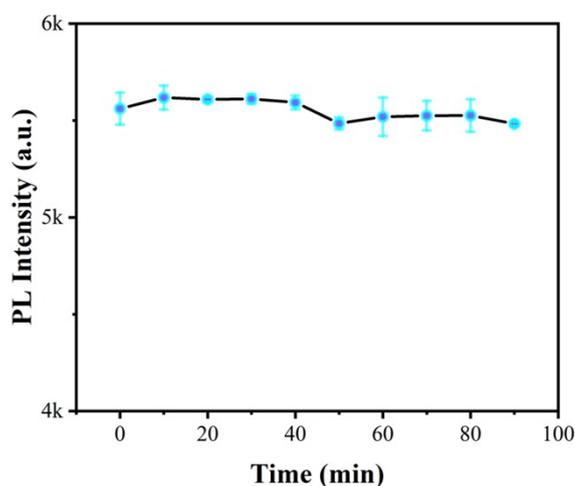


Fig. S1 The changes of photoluminescence intensities of NS-CD dispersion under UV light

In order to ensure the redox potentials of the annihilation pathway, the differential pulse voltammetry (DPV) scan of the annihilation pathway was carried out. As shown in Fig.S2, two oxidation peaks and a reduction peak were observed. The amplitude was set as 0.05 V, the pulse width was 0.05 sec, and pulse period was 0.5 sec. The sensitivity of  $1e^{-4}$  A/V was chosen

for the scanning.

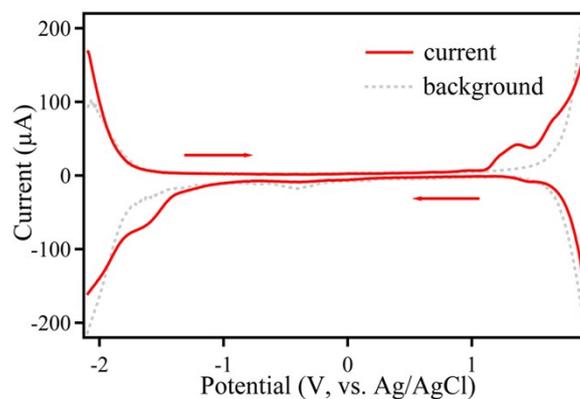


Fig. S2 The DPV scan of the annihilation pathway. The arrows display the initial scan direction

Coreactant  $K_2S_2O_8$  was explored to the three-electrode system with NS-CDs solution in the tube, to study the coreactant ECL behavior of the NS-CDs. The NS-CDs solution and 40mM  $K_2S_2O_8$  were introduced to the three-electrode system. Under the scan rate of 0.01V/s and the sensitivity of 0.001 A/V, weak photocurrent was generated in the vicinity of the working electrode, as shown in Fig. S3. It indicates that radical species may be formed to generated photocurrent, but the ECL efficiency should be very low. The possible explanation for this phenomenon should be that, it is hard for NS-CDs dispersed in the solution to get electrons from working electrode, thus the  $NS-CDs^{\cdot-}$ , radical NS-CDs, cannot be generated easily and oxidized by  $K_2S_2O_8$  afterwards, thus less excited state of NS-CDs was produced, and weaker photocurrent was generated.

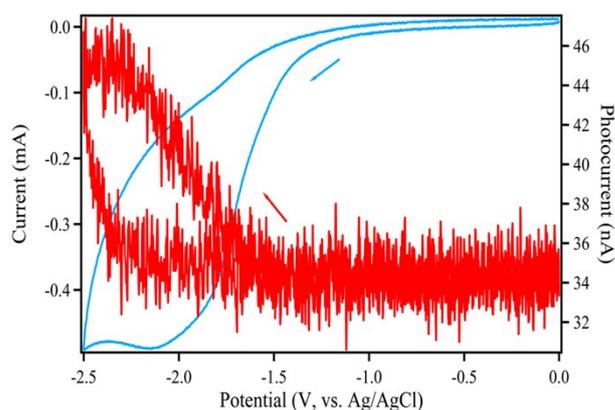


Fig. S3 The coreactant ECL behavior of NS-CDs solution with  $K_2S_2O_8$ . The arrows display the initial scan direction. The current curve was in blue and photocurrent curve in red.

The working electrode was modified by 2.64 and 5.76  $\mu\text{g}$  of NS-CDs. The coreactant ECL behaviors of the system with the addition of 35 and 55 mM of  $K_2S_2O_8$  were studied, respectively. The voltammetric ECL was shown in Fig. S4.

Fig. S4A shows the results for the system that, 2.64  $\mu\text{g}$  of NS-CDs was used for modification of GCE, with 35 mM of  $K_2S_2O_8$  added. Fig. S4B shows the results for the system that, 5.76  $\mu\text{g}$  of NS-CDs was used for GCE modification, with 55 mM of  $K_2S_2O_8$  added. The scan rate was set at 0.1 V/s and the sensitivity was  $5e^{-4}$  A/V for each scanning.

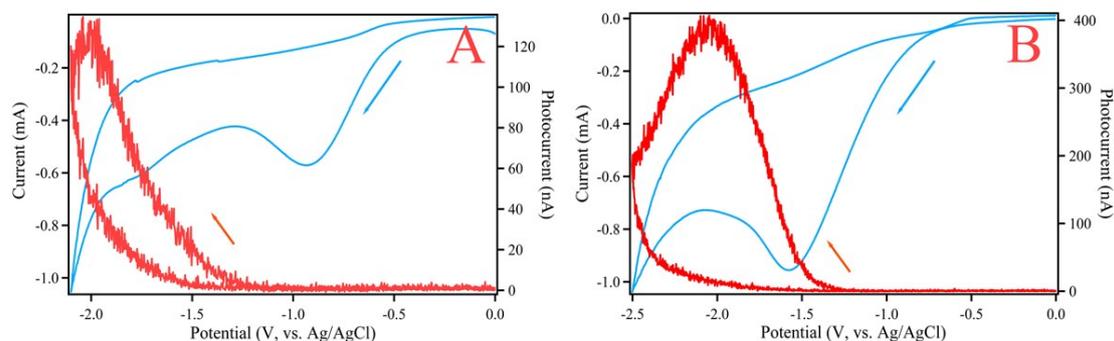


Fig. S4 The coreactant ECL behavior of NS-CDs/  $K_2S_2O_8$ . The working electrode was modified by (A) 2.64  $\mu\text{g}$  and 5.76  $\mu\text{g}$  of NS-CDs, with the coreactant 35 and 55mM  $K_2S_2O_8$ , separately. The current curves were in blue and photocurrent curves in red. The arrows display the initial scan direction.