One-step synthesis of room-temperature-phosphorescent carbon
dots and their application as security ink

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\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{Lifetime.png}
\caption{The lifetime of NCDs solution.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{Fluorescence.png}
\caption{The fluorescence quantum yield of NCDs solution.}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=0.4\textwidth]{Lifetime Powder.png}
\caption{The lifetime of NCDs powder.}
\end{figure}
**Figure S4** The fluorescence quantum yield of NCDs powder.

**Figure S5** Phosphorescence intensities of the NCDs powder during continuous excitation with a UV beam ($\lambda_{\text{ex}} = 365$ nm). Irradiation time: 0 to 60 min.

**Figure S6** (a) Phosphorescence spectra of NCDs powder at different temperatures from 20 to 70 °C ($\lambda_{\text{ex}} = 365$ nm). (b) their variation of intensity versus temperature.
Figure S7 Phosphorescence emission spectra of NCDs powder in air and N\(_2\) (\(\lambda_{\text{ex}} = 365\) nm).

Figure S8 (a) The TEM image of NCDs-1. (b) The size distribution of NCDs-1 (columns) and distribution curve (solid line). The Figure S9 indicate that the as-prepared NCDs-1 has well dispersed and their average size is 5 nm.

Figure S9 The FTIR spectra of NCDs-1. The peaks centered around 3433 cm\(^{-1}\) and around 3190 cm\(^{-1}\) are the absorption of –OH stretching vibration and –NH\(_2\) stretching vibration, respectively. The methylene (–CH\(_2\)–) asymmetric and symmetric stretching frequencies locate at 2976 and 2920 cm\(^{-1}\) in the FTIR spectrum, respectively. The absorption peak at 1664 cm\(^{-1}\) correspond to C=O stretch of the amide bond and carboxyl. The peaks observed at 1630, 1578 and 1394 cm\(^{-1}\) are assigned to the bending vibration of N–H, the stretching vibration of C=N and C–N bending modes, respectively. The peak at 1053 cm\(^{-1}\) corresponds to the symmetric stretching vibrations of C–O–C.
Figure S10 (a) High-resolution O 1s XPS spectra of NCDs-1. The figure S11 shown the High-resolution O 1s XPS spectra of NCDs-1, The wide O 1s core level peak exhibits two main peaks, they located at 531.7 and 533.1 eV to the C=O and C–O bonds.

Figure S11 The UV-Vis absorbance (red line), PL excitation (PLE: $\lambda_{ex} = 416$ nm) and emission (PL: $\lambda_{em} = 484$ nm) spectra of NCDs-1 solution (inset: NCDs-1 solution under daylight and UV lamp (365 nm))

Figure S12 Excitation–emission color map of NCDs-1 solution.
Figure S13 The lifetime of NCDs-1 solution.

Figure S14 The fluorescence quantum yield of NCDs-1 solution.

Figure S15 (a) The TEM image of CDs. (b) The size distribution of CDs (columns) and distribution curve (solid line). The experiment data indicate that the as-prepared CDs has well dispersed and their average size is 5 nm.
Figure S16 The FTIR spectra of CDs. The peaks centered around 3447 cm\(^{-1}\) is the absorption of –OH stretching vibration. The C=O stretching vibration and C=C locate at 1714 and 1637 cm\(^{-1}\) in the FTIR spectrum, respectively. The absorption peak at 1409 cm\(^{-1}\) correspond to deformation vibration of C–H. The peak observed at 1203 cm\(^{-1}\) is assigned to the stretching vibration of C–O.

Figure S17 The UV-Vis absorbance (red line), PL excitation (PLE: \(\lambda_{\text{ex}} = 380\) nm) and emission (PL: \(\lambda_{\text{em}} = 460\) nm) spectra of CDs solution (inset: CDs solution under daylight and UV lamp (365 nm)).

Figure S18 Excitation–emission color map of CDs solution.
**Figure S19** The lifetime of CDs solution.

**Figure S20** The fluorescence quantum yield of CDs solution.

**Figure S21** FTIR spectra of the free acrylamide.