Electronic supplementary Information

Peroxidase mimetic activity of fluorescent NS-carbon quantum dots and its application for colorimetric detection of \( \text{H}_2\text{O}_2 \) and glutathione in human blood serum

Vikas Kumar Singh\(^a\), Pradeep Kumar Yadav\(^a\), Subhash Chandra\(^a\), Daraksha Bano\(^a\), Mahe Talat\(^b\) and Syed Hadi Hasan\(^*\)\(^a\)

\(^a\)Nano Material Research Laboratory, Department of Chemistry, Indian Institute of Technology (BHU), Varanasi -221005, U.P., India.

\(^b\)Department of Physics, Institute of Science, Banaras Hindu University, Varanasi-221005, U.P., India

Contents

<table>
<thead>
<tr>
<th>Contents</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ((\text{S}1)) UV-visible absorption spectra of as synthesized NS-CQDs</td>
<td>(\text{S}3)</td>
</tr>
<tr>
<td>2. ((\text{S}2)) Effect of pH on the emission spectra of NS-CQDS with corresponding photograph under UV – light ((\lambda_{\text{ex}} = 365) nm) in the pH range 2 to 12</td>
<td>(\text{S}3)</td>
</tr>
<tr>
<td>3. ((\text{S}3)) Fluorescence spectra of NS-CQDS in different medium (DMEM, FBS, PBS) and its photograph under normal light and UV- light @365 nm</td>
<td>(\text{S}4)</td>
</tr>
<tr>
<td>4. ((\text{S}4)) Effect of ionic strength on emission intensity of NS-CQDS with photograph under UV- light ((\lambda_{\text{ex}} = 365) nm)</td>
<td>(\text{S}5)</td>
</tr>
<tr>
<td>5. ((\text{S}5)) Photostability of as synthesized NS-CQDS after irradiation of UV- light for 80 h</td>
<td>(\text{S}5)</td>
</tr>
<tr>
<td>6. ((\text{S}6)) Zeta potential profile of as synthesized NS-CQDs</td>
<td>(\text{S}6)</td>
</tr>
</tbody>
</table>

\(\text{S}1\)
7. (Table S1) Detail about fluorescence quantum yield measurement ........................................... S6
8. Beer- lambert Law .......................................................................................................................... S7
9. (S7) Optimized parameter for the oxidation of TMB................................................................ S7
10. (S8) photograph of GSH detection by ox-TMB under normal light and UV- light ($\lambda_{ex} = 365$ nm) ..................................................................................................................................... S8
11. (S9) Fluorescence spectra of ox-TMB and ox-TMB + GSH .......................................................... S8
12. (S10) Absorption spectrum of Ox-TMB and emission spectrum of NS-CQDs. Inset shows the photograph of NS-CQDs under UV-light and ox-TMB under normal light ............... S9
13. (S11) Selectivity test for GSH detection by ox-TMB solution ....................................................... S10
Figure S1. UV-visible absorption spectra of as synthesized NS-CQDs

Figure S2. Effect of pH on the emission intensity of NS-CQDS with corresponding photograph under UV – light ($\lambda_{ex} = 365$ nm) in the pH range 2 to 12.
Figure S3. Fluorescence spectra of NS-CQDS in different medium (DMEM, FBS, PBS) and its photograph under normal light and UV-light @365 nm showing high stability and well dispersity.
Figure S4. Effect of ionic strength in term of NaCl concentration on emission intensity of NS-CQDS with corresponding photograph under UV-light ($\lambda_{ex} = 365$ nm)

Figure S5. Photostability of as synthesized NS-CQDS after irradiation of UV-light for 80 h
**Figure S6.** Zeta potential profile of as synthesized NS-CQDs

**Table S1.** Fluorescence quantum yield measurement with Integrated intensity and absorbance of quinine sulphate and NS-CQDs at excitation wavelength 360 nm.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Integrated intensity at 360 nm</th>
<th>Absorbance at 360 nm</th>
<th>Quantum Yield (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quinine Sulphate (Reference)</td>
<td>56191.340</td>
<td>0.047</td>
<td>54</td>
</tr>
<tr>
<td>NS-CQDs</td>
<td>45210.201</td>
<td>0.044</td>
<td>46</td>
</tr>
</tbody>
</table>

Fluorescence Quantum yield was determined by using equation 1

\[
QY = QY_{ref}\frac{\eta^2}{\eta_{ref}^2}\frac{I}{A}\frac{A_{ref}}{I_{ref}}
\]

Where \(QY_{ref}\) is the quantum yield of the reference compound; \(\eta\) is the refractive index \((\frac{\eta^2}{\eta_{ref}^2} = 1)\) of the solvent; \(I\) is the integrated fluorescence intensity; and \(A\) is the absorbance. To minimize reabsorption effects, absorbance in the 1 cm fluorescence cuvette were kept under 0.1.
Beer–Lambert Law

The initial reaction rate was calculated using equation 2

\[ C = \frac{A}{c \cdot b} \quad 2 \]

where, \( c \) is the substrate concentration, \( A \) is the absorbance, \( b \) is the thickness of the solution.

**Figure S7.** Optimized parameter for the oxidation of TMB at different (a) pH (b) Temperature (c) Concentration of \( \text{H}_2\text{O}_2 \) (d) Concentration of TMB and (e) Time respectively.
Figure S8. Photograph showed naked eye colour changed (panel A) and under UV-light @ 365nm (panel B) after addition of different concentration of GSH in the ox-TMB solution.

Figure S9. Fluorescence spectra of ox-TMB (black line) and ox-TMB + GSH (red line) at excitation wavelength 360 nm with turn on signal (inset photograph) showing turn on sensing of GSH.
Figure S10. Absorption spectrum of Ox-TMB and emission spectrum of NS-CQDs. Inset shows the photograph of NS-CQDs under UV-light and ox-TMB under normal light.
Figure S11. Bar diagram represent relative absorption of ox-TMB after addition of 50 µL (C, $10^{-4}$ M) of GSH and 100 µL (C, $10^{-3}$ M) of amino acid and glucose in ox-TMB solution at ambient condition indicating negligible interference and photograph showed corresponding colour change.