Supporting Information

Nitrogen-doped carbon nanoparticles modulated turn-on fluorescence probes for histidine detection and its imaging in living cells

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Fig. S1 (A) TEM image and (B) FT-IR spectra of the N-CNPs.

Fig. S2 (A) Survey XPS and (B) N1s spectra of the N-CNPs.

Fig. S3 Time-resolved fluorescence decay of N-CNPs. The black line was the instrument response function. $\tau = \tau_1 + \tau_2 = 7.50 \times 22\% + 18.00 \times 78\% = 15.69\, \text{ns}$. 
**In vitro cytotoxicity characterization.** Cells were cultured and maintained in DMEM medium (GIBCO, Gaithersburg, MD, USA) supplemented with 10 % fetal bovine serum (FBS), 100 U mL\(^{-1}\) penicillin, 100 μg mL\(^{-1}\) streptomycin, 2 mM L-glutamine and 1 mM pyruvate acid at 37 °C in a humidified 5% CO\(_2\) atmosphere. MTT [3-(4, 5-dimethyl-2-thiazolyl)-2, 5-diphenytetrazolium bromide] assay was performed to evaluate the cytotoxic activities of N-CNPs to the cultured cells. Hela cells seeded in 96-well plates were exposed to 100 μL of different concentrations (500 μg mL\(^{-1}\), 250 μg mL\(^{-1}\), 125 μg mL\(^{-1}\), 62.5 μg mL\(^{-1}\), 32 μg mL\(^{-1}\), 16 μg mL\(^{-1}\), 8 μg mL\(^{-1}\), 4 μg mL\(^{-1}\) and 2 μg mL\(^{-1}\)) of N-CNPs and N-CNPs/Cu\(^{2+}\) in triplicate. After 24 h of incubation, 10 μl of MTT (5 mg mL\(^{-1}\)) were added to each well and the plate was incubated for another 4 h. The MTT solution was then removed and 100 μl of dimethyl sulfoxide (DMSO) was added to dissolve the formazan. The optical density was measured at 570 nm using 96-well plate reader (Spectra Max M5 Microplate reader, Molecular Devices, USA). Cell viability was expressed as the percentage of survival cells compared to the cells in untreated control wells.
**Fig. S5** Time-dependent fluorescence intensity of N-CNPs with the addition of Cu (II) ions at room temperature.

**Fig. S6** The influence of different metal ions on the fluorescence of CNPs. $F_0$ is the fluorescence intensity of CNPs and $F$ is the fluorescence intensity of a mixture of metal ions and CNPs.
**Fig. S7** Time-dependent fluorescence intensity of N-CNPs/Cu (II) ions with the addition histidine.

![Graph](image)

**Fig. S7** Time-dependent fluorescence intensity of N-CNPs/Cu (II) ions with the addition histidine.

![Graph](image)

**Fig. S8** (A) UV-vis spectra of histidine (black), Cu (II) ions (red), and the Cu (II) ions histidine complex (blue) in aqueous solution. (B) UV-vis spectra of N-CNPs (black), N-CNPs-Cu (red), N-CNPs- Cu-histidine complex (blue).
**Fig. S9** Fluorescence responses of N-CNPs/Cu (II) ions in the absence (blue bar) and presence (yellow bar) of histidine at different pH values.

**Fig. S10** Fluorescence response of N-CNPs solution before (black) and after (blue) the addition of 30 μM histidine. The red line is the fluorescence spectra of histidine solution.
**Fig. S11** Time-dependent fluorescence intensity of N-CNPs/Cu (II) ions with the addition of cysteine at different time.

**Table S1** Comparison of the linear range and detect limit for histidine using different methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Linear range (µM)</th>
<th>Detection limit (µM)</th>
<th>Refs</th>
</tr>
</thead>
<tbody>
<tr>
<td>HPLC</td>
<td>3.7 - 1000</td>
<td>1.1</td>
<td>1</td>
</tr>
<tr>
<td>Electrochemical</td>
<td>10 - 100000</td>
<td>5.0</td>
<td>2</td>
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<tr>
<td>Capillary electrophoresis</td>
<td>1.0 - 150</td>
<td>0.14</td>
<td>3</td>
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<tr>
<td>Fluorescence based on Ag NCs/Cu (II) ions</td>
<td>0-100</td>
<td>1.4</td>
<td>4</td>
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<tr>
<td>Fluorescence based on CdTe/Ni (II) ions</td>
<td>1-30</td>
<td>0.2</td>
<td>5</td>
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<tr>
<td>Phosphorescence based on Mn: ZnS QDs/Co (II) ions</td>
<td>1.25-30</td>
<td>0.74</td>
<td>6</td>
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<tr>
<td>Fluorescence based on N-CNPs/ Cu (II) ions</td>
<td>0.5-60</td>
<td>0.1</td>
<td>This work</td>
</tr>
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