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Bright-green-emissive nitrogen-doped carbon dots as a nanoprobe for bifunctional sensing, its logic gate operation and cellular imaging

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Abstract

A fluorescent nanoprobe based on nitrogen-doped carbon dots (N-CDs) with green fluorescent emission have been fabricated through a facile one-step hydrothermal treatment using catechol and triethylene tetramine as precursors. The obtained N-CDs with excellent luminescent properties and superior biocompatibility have been applied for the development of a bifunctional sensor for the detection of Fe^{3+} and ascorbic acid (AA). Fe^{3+} that are tightly chelating the surface of N-CDs can induce fluorescence (FL) quenching of N-CDs through photo-induced electron transfer (PET). Meanwhile, the addition of AA serves to shelter the CDs effectively from being quenched by Fe^{3+} due to AA, as an antioxidant, enable easy-conversion of Fe^{3+} to reduced states (i.e. Fe^{3+} and Fe^{2+}). The N-CDs are used as a facile and label-free "on-off-on" fluorescent nanoprobe for the determination of Fe^{3+} and AA with detection limits of 58.82 nM and 0.236 μM with the corresponding linear ranges of 25-200 μM and 25-300 μM, respectively. According to this phenomenon, an "AND" logic gate based on the novel N-CDs has been constructed. As-prepared N-CDs with negligible toxicity and perfect biocompatibility were expanded for cellular imaging and sensing Fe^{3+} and AA in living cell, which enlarges the application range of the N-CDs. Most importantly, the as-constructed fluorescent sensing system was successfully applied to detection of Fe^{3+} in tap water and the analyses of AA in fresh fruits with satisfactory results.

Graphical abstract:

Scheme 1 Illustration of the synthetic procedure and cellular imaging for N-CDs and the N-CDs-based bifunctional fluorescence nanoprobe for of Fe^{3+} and AA.

Keywords: nitrogen-doped carbon dots; bifunctional sensing; logic gate; cellular imaging

1. Introduction