Article

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Anal. Chem., **Just Accepted Manuscript** • DOI: 10.1021/acs.analchem.6b01941 • Publication Date (Web): 27 Jun 2016

Carbon-dot and Quantum-dot-coated Dual-emission Core-Satellite Silica Nanoparticles for Ratiometric Intracellular Cu^{2+} Imaging

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ABSTRACT:

Copper (Cu^{2+}) is physiologically essential, but excessive Cu^{2+} may cause potential risk to plants and animals due to the bio-accumulative properties. Hence, sensitive recognition is crucial to avoid over-intake of Cu^{2+}, and visual recognition is more favored for practical application. In this work, a dual-emission ratiometric fluorescent nanoprobe was developed possessing the required intensity ratio, which can facilitate the sensitive identification of Cu^{2+} by naked eyes. The probe hybridizes two fluorescence nanodots [quantum dots (QDs) and carbon dots (CDs)]. Although both of them can be viable fluorescence probes for metal ion detection, but rarely research has coupled this two different kinds of fluorescence material in one nanosensor to fabricate a selectively ratiometric fluorescence probe for intracellular imaging. The red emitting CdTe/CdS QDs were capped around the silica microsphere to serve as the response signal label, and the blue-emitting CDs, which is insensitive to the analyte, were covalently attached to the QDs surface to act as the reference signal. This core-satellite hybrid sphere not only improves the stability and brightness of QDs significantly, but also decreases the cytotoxicity towards HeLa cells tremendously. Moreover, the Cu^{2+} could quench the QDs emission effectively, but have no ability for reduction the CDs emission. Accordingly, a simple, efficient and precise method for tracing Cu^{2+} was proposed. The increase of Cu^{2+} concentration in the series of $0\text{-}3\times10^{-6}$ M was in accordance with linearly decrease of the F_{650}/F_{425} ratio. As for practical application, this nanosensor was utilized to the ratiometric fluorescence imaging of copper ions in HeLa cells.