

Unveiling the Detailed Turn Off-On Mechanism of Carbon Dots to Different Sized MnO₂ Nanosensor for Selective Detection of Glutathione

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Abstract : Glutathione (GSH) is one of the most important biomolecules having small molecular weight, which helps in various cellular functions like regulation of gene, xenobiotic metabolism, preservation of intracellular redox activities, signal transduction, etc. Therefore, the detection of GSH requires huge attention by using extremely selective and sensitive techniques. Herein, a rapid fluorometric nanosensor is designed by combining carbon dots (Cdots) and MnO₂ nanoparticles of different sizes for the detection of GSH. The bottom-up approach, i.e., microwave method, was used for the preparation of the water soluble and greatly fluorescent Cdots by using ascorbic acid as a precursor. MnO₂ nanospheres of different sizes (large, medium, and small) were prepared by varying the ratio of concentration of methionine and KMnO₄ at room temperature, which was confirmed by HRTEM analysis. The successive addition of MnO₂ nanospheres in Cdots results fluorescence quenching. From the fluorescence intensity data, Stern-Volmer quenching constant values (KS-V) were evaluated. From the fluorescence intensity and lifetime analysis, it was found that the degree of fluorescence quenching of Cdots followed the order: large > medium > small. Moreover, fluorescence recovery studies were also performed in the presence of GSH. Fluorescence restoration studies also show the order of turn on follows the same order, i.e., large > medium > small, which was also confirmed by quantum yield and lifetime studies. The limits of detection (LOD) of GSH in presence of Cdots@different sized MnO₂ nanospheres were also evaluated. It was observed that LOD values were in μM region and lowest in case of large MnO₂ nanospheres. The separation distance (d) between Cdots and the surface of different MnO₂ nanospheres was determined. The d values increase with increase in the size of the MnO₂ nanospheres. In summary, the synthesized Cdots@MnO₂ nanocomposites acted as a rapid, simple, economical as well as environmental-friendly nanosensor for the detection of GSH.

Keywords : carbon dots, fluorescence, glutathione, MnO₂ nanospheres, turn off-on

Conference Title : ICNNS 2021 : International Conference on Nanosensors and Nanosensory Systems

Conference Location : Toronto, Canada

Conference Dates : July 19-20, 2021