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N, S-Carbon Quantum Dots Derived From Plastic Waste: Turn-Off Fluorescence Recognition of Heavy Metal Ions and a Turn-On for Histamine

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Extended Abstract

The accumulation of huge quantities of plastic waste is a serious environmental issue due to its non-degradable/environmental hazard nature in the absence of inadequate technology for disposal. Polyethylene terephthalate (PET) is one of the most common, abundant industrial and municipal waste [1], due to its low production costs and the great applications for this material, which has made it easier for people in their daily lives. The cost-effective impact on ecological system made the recycling of plastic waste as one of the captivating topics in scientific world [2].The use of Carbon Dots (CDs) derivate from plastic waste is used for the detection of different species. The CDs are a novel class of fluorescent nanomaterials, with properties such as photoluminescence, high solubility, low toxicity, and favorable biocompatibility [3]. They are spherically symmetrical, with a size less than 10 nm, and a structure that can vary between amorphous and crystalline.

The present work highlights the sustainable approach of transforming plastic waste into fluorescent carbon dots (FCDs) through carbonization and hydrothermal methods. The obtained FCDs, which were characterized appropriately by different analytical techniques such as XRD, FT-IR, TGA, SEM, and TEM, were used to recognize heavy metal ions, observing a discriminable fluorescence behavior for Fe (III), Cu (II), or Hg (II) ions. The fluorescence emission was turned-off for the interaction of FCDs with the above cations, i.e., the intensity of fluorescence was quenched if the concentration of the metal ions was increased, consisting of the interference analysis and Jobs plots. The detection limit was found to be 0.35 μM for Cu (II), 1.38 μM for Hg (II), and 0.51 μM Fe (III).

The FCDs were further functionalized by *L*-cysteine and *o*-phenylenediamine to enrich with nitrogen and sulfur atoms to result in N, S-FCDs, which were then employed successfully for sensing of biologically essential histamine. The detection limit for the histamine was 0.04 μM for Cu (II), 0.11 μM for Hg (II), and 3.21 μM Fe (III). The most selective metal ion is the Cu (II), the stoichiometry for the interaction between the ion and the histamine is 1:2, this mean that Cu (II) has the formation of a bidentate complex (chelate) [4] and it have been widely used in clinical diagnostics, several foods, and specially in environmental applications. After analyzing the results, it was observed that the fluorescence intensity was enhanced as a “turned on switch” for histamine, showing that the plastic waste-based FCDs and N, S-FCDs can be applied clinically to detect toxic metals and as well as bio-molecules, respectively.

References

(1) El Essawy, N. A.; Ali, S. M.; Farag, H. A.; Konsowa, A. H.; Elnouby, M.; Hamad, H. A. J. E.; safety, e. Green synthesis of graphene from recycled PET bottle wastes for use in the adsorption of dyes in aqueous solution. **2017,** *145*, 57.

(2) Hu, Y.; Gao, Z.; Yang, J.; Chen, H.; Han, L. J. J. o. c.; science, i. Environmentally benign conversion of waste polyethylene terephthalate to fluorescent carbon dots for “on-off-on” sensing of ferric and pyrophosphate ions. **2019,** *538*, 481.

(3) de Oliveira, B. P.; da Silva Abreu, F. O. M. J. M. L. Carbon quantum dots synthesis from waste and by-products: Perspectives and challenges. **2021,** *282*, 128764.

(4) Fukuda, Y.; Sone, K. J. B. o. t. C. S. o. J. Studies on Mixed Chelates. I. Mixed Copper (II) Chelates with N, N, N′, N′-Tetramethylenediamine and a Bidentate Ligand. **1972,** *45* (2), 465.