Fluorescent Carbon Dots for Sensing of Metal Ions and Proteins

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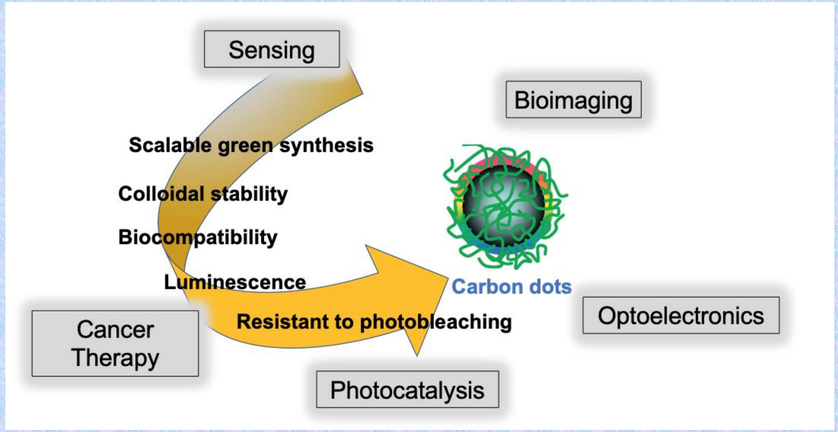
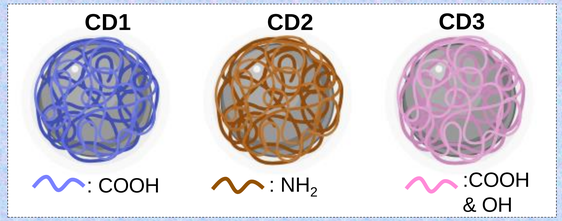
Introduction



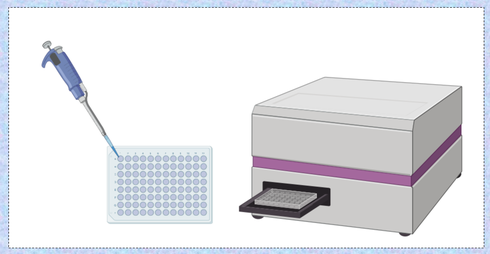
- **Carbon dots (CDs)** are emerging class of nanomaterials, defined by their characteristic sizes of < 10nm. CDs possess a carbon core that is functionalized by various groups at it's surface.
- CDs have unique fluorescent properties which have been exploited to utilize them in bioimaging, sensing, optoelectronics, etc.
- Our project specifically focused on synthesizing 3 CDs with different surface chemistry and their usage in sensing of metal ions and proteins
- This novel application of carbon dots allows for a more accurate and efficient way to detect various metal ions and proteins in a biologically relevant scenario.

Our method:

- **Synthesis of different CDs:** Hydrothermal synthesis route was used to prepared CD1-CD3 at a temperature of 180°C for 6h. Following this probe sonication and filtration was performed. CD1 had abundant carboxylic (COOH) groups, CD2 had abundant amine (NH_2) groups and CD3 had abundant hydroxyl (OH) and carboxylic groups (COOH).



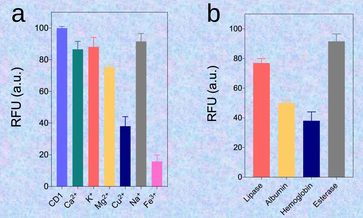
- **Measurement of Fluorescence Readings when CDs added to Metal Ions or Protein Solutions:** Biological relevant metal ions and proteins solutions were prepared separately and then added in a 96 well plate, to which different CD solutions were also added. In both cases pipettes were used. The fluorescence readings were collected using a plate reader at 360nm excitation, 460nm emission with gain of 50 for 1h.



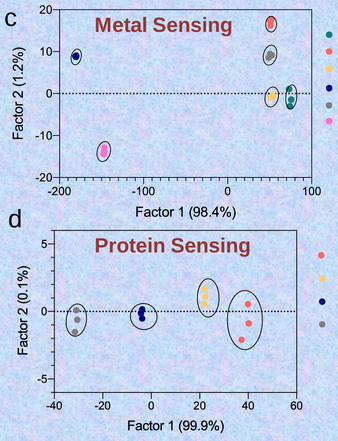
Metal Ions: Fe^{3+}, Cu^{2+}, Ca^{2+}, K^{+}, Mg^{2+}, Na^{+}
Proteins: Lipase, Hemoglobin, Albumin, Esterase

Results & Discussion

- **Plotting of fluorescence data collected from plate reader:** After collecting the data from the plate reader, we plotted the data by keeping the value of CDs alone as 100, and plotting the remaining values for samples in which metal ion solutions or protein solutions were added, with respect to it. A representative case is shown below in (a) and (b) for CD1.



- **Using Machine Learning (ML) Algorithms to separate Metal Ions & Protein Solutions:** Finally, we attempted to use a ML tool called as Linear discriminant analysis (LDA) to separate our different biological metal ions & protein solutions. We observe from (c) and (d) that our array of CDs (CD1-CD3) when combined together was able to separate out different metal ions and proteins solutions with 100% accuracy.



Hence, our array of CDs could be used to sense biologically relevant metal ions & proteins at the same time.

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