INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Synthesis, Photo-Physical Properties, and Applications of Nitrogen-doped Carbon Dot

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SHORT ABSTRACT

The thesis addressed various strategies to regulate the photo-physical property and applicability of carbon dots (CDs) by heteroatom (especially Nitrogen(N)) incorporation approach. This thesis pursues a detailed analysis of the structural and optical properties of newly developed N-doped CDs (NCDs). Till now, the source of emission property of CDs is not explained properly, which is the main inspiration of the thesis to explore each detailed photo-physical characteristic of synthesized NCDs and executed the same in the sensing and biological platform. The systematic development of carbon-based quantum dots (carbon and graphene quantum dots) as potential luminescent materials is discussed along with their synthesis procedures, photoluminescent properties, and vast application. The specific detection of Pb^{2+} and ClO^{-} by using surface-functionalized graphene quantum dot (F-GQD) is successfully achieved. The surface modification of graphene quantum dot (GQD) was done by a simple coupling reaction between 2,6-diaminopyridine moiety, and GQD which is further applied to imaging and recognition of ClO^{-} in living cells and Pb^{2+}detection occurred by aggregation induced emission enhancement manner whereas the ClO^{-} detection consists of energy migration through H-bonding network between amino group of F-GQD and ClO^{-}. Again, the hydrothermal synthesis was considered for synthesis of highly blue emissive NCDs (quantum yield 22.7 % in an aqueous medium) from 3,6-diaminoacridine hydrochloride and L-aspartic acid for the detection of two analytes i.e., vitamin-B12 and bilirubin. Here also, the mechanism of detection of two analytes are totally opposite in nature. For vitamin-B12, inner filter effect plays the key role for emission suppression, whereas, H-bonding induced energy transfer was operated for detection of bilirubin. Moreover, the NCD was further applied in living cell imaging and successfully recognize vitamin-B12 in HeLa cells. We cover a brief detection strategy to recognize 4-nitroaniline (4-NA) by two different emissive NCD-1 (blue) and NCD-2 (green). Here, the sensing mechanism highly depends on the emission wavelength and solvent system. Moreover, a novel NCD was reported which contains unique optical properties i.e., three different color emissions (blue, green, and red) under different excitation windows and their application of Fe^{3+} and ascorbic acid detection as well as logic gate preparation. Once more, we synthesized a dual-emissive N-doped carbon dot (NCD) for very specific ratiometric detection of pH and Fe^{3+} with a distinct ratiometric property. Furthermore, this NCD act as pretty good anti-cancerous agent, and it was recognized intracellular pH as well as

exogenous Fe^{3+} in the breast cancer cell line (MCF-7). A solution-phase white light also constructed by considering the emission property of NCD. In the last, we encompass the whole summary of the existing thesis and future scenarios of this thesis.