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Solvatochromism in Highly Luminescent Environmental Friendly Carbon Quantum Dots for Sensing Applications: Conversion of Bio-waste into Bio-asset

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Abstract:

Recently synthesis and fluorescence based sensing by using carbon quantum dots (CQDs) have become a widely spoken topic of research due to the several advantageous properties of CQDs in compared to semiconductor quantum dots. In this work, we have reported the rarely reported solvatochromism along-with a high photoluminescence (PL) quantum yield (PLQY) of 22%. Samples have been synthesized by using a simple process of hydrothermal carbonization of a naturally occurring bio-waste i.e. *Aegle marmelos* leaves powder. The linear absorption and PL emission characteristics of CQDs have been studied in different solvent environments to explore the origin of the observed excitation dependent PL emissions characteristics of the sample. The interesting solvatochromic PL (SPL) behaviour of CQDs are observed at an excitation wavelength of 325 nm by dispersing them in different polar protic and aprotic solvents, which suggest their possible applications as a replacement of solvatochromic dye molecules for sensing applications. Different polarity functions and molecular-microscopic solvent polarity parameter (E_T^N) are used to calculate the change in dipole moment ($\Delta\delta$) of the solute-solvent system and the origin of SPL in CQDs has been explained. The SPL behaviour of CQDs has been utilized for fluorescence sensing of organic liquids (Ethanol and Tetrahydrofuran) in water. Whereas, the photo-induced electron transfer mediated quenching in PL of aqueous dispersion of CQDs has led to development of "turn off" fluorescence Fe^{3+} ion sensor with a detection limit of 0.12 μM. Therefore, this work may open a new avenue of conversion of a bio-waste into a fluorescent bio-asset.

Keywords: Carbon quantum dots; Optical absorption spectroscopy; Photoluminescence; Solvatochromism; Metal ion sensing