INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Synthesis of Carbon Dots and Their Applications in Sensing, Optoelectronics, and Energy Storage Systems

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SHORT ABSTRACT

Carbonaceous nanomaterials are one of the finest nanoparticles discovered to date. The most recent inclusion to the family of carbonaceous materials is carbon dots (CDs). Different unique characteristics of CDs, like fluorescence property, low toxicity, high water solubility, etc., have made them desirable in different areas of applications, such as sensing, optoelectronics, energy storage systems, biomedicines, etc. In this context, the current thesis explores several natural resources employing different synthesis techniques to produce CDs. Further, these CDs have been used in the applications of photoluminescence-based (PL-based) sensing, bioimaging, UV-photodetection, and energy storage systems. Heavy metals (Cr^{6+} and Fe^{3+}) and explosive materials (picric acid; PA) were targeted to test the sensing abilities of the CDs, where potato and cigarette-tobacco have been used as the precursor materials, respectively. Both the synthesized CDs showed quite a good limit of detection (LOD) towards the sensing of heavy metals and explosive materials. These LOD values for the sensing of Cr^{6+} and Fe^{3+} are 0.012 μM and 0.000549 μM, respectively, whereas the LOD for the sensing of PA is 140 nM. The CDs synthesized from cigarette-tobacco were also used in UV-photodetection applications. We have fabricated two devices for this application. One is a photoconductor, and the other is a Schottky diode. CDs were attached with multi-walled carbon nanotube (MWCNT) for the photoconductor, whereas they were attached with ZnO for the Schottky diode. The diode showed a responsivity and the specific detectivity values of 9.57 mA/W and 4.27×10^8 Jones, respectively, at 330 nm wavelength. Further, CDs were used in energy storage applications as well by attaching with single-walled carbon nanotube (SWCNT)/ZnO composite to fabricate an optically responsive hybrid electrode material for supercapacitor. It was observed that the areal capacitance of the supercapacitor got enhanced by ~41.38% at 50 mV/s scan rate under the influence of UV light.