

Abstract

Present thesis addresses that apart from being a good optical material, carbon dots (Cdots) can be highly crystalline in nature, turning them into a quality nano material for energy storage and conversion. The aim of this thesis is to pursue detailed investigations on the structural characteristics of Cdots. In this thesis we try to pinpoint on probing the hetero atom doping, which influenced the photophysical property of Cdots through surface modifications and heteroatom induced structural arrangement. In spite of being an emerging class of “nano light” the origin of optical properties of Cdots is still not well explained. That is the motivation of this thesis to investigate detailed photophysical properties of Cdots and implementation of the same for sensing application. Besides, exact geometry inside Cdot nano structure is not known. Structural randomness restricts utilization of this state-of-the-art environment friendly and easy-to-synthesize nano material in the field of organic electronics, photovoltaics, energy storage and conversion. Present thesis also imparts light on preparing highly crystalline Cdots. Origin of the observed structural characteristics were investigated in details and were finally utilized for efficient energy conversion and energy storage applications.

The present thesis is comprised of six chapters as described below.

Chapter 1 consists of the introduction part and literature review of carbon dots, properties and applications.

Chapter 2 describes dopant induced improved photoluminescence phenomenon of amorphous Cdots. Taking advantage of the enhanced photoluminescence efficiency of Cdots due to doping, a dual light emitting nano composite system was fabricated for ratiometric intracellular pH sensing.

Chapter 3 consists discovery of conducting nature in Cdots. The conducting property was investigated based on *I-V* characteristic studies of Cdot films. A Cdot based semi-crystalline polymeric nano composite system with polypyrrole (PPy) was synthesized

where Cdots were found to enhance the conducting nature of the composite system. Finally, the improved conducting nature of the composite system was successfully utilized for sensing nitro explosive compounds based on *I-V* characteristic studies.

Chapter 4 demonstrates synthesis of dopant induced non-graphitic crystalline nature in Cdots. Generation of excellent crystallinity was found to be advantageous for efficient photothermal conversion and phonon transportation. Finally, this phenomenon in Cdot system was successfully implied for solar light assisted sea water desalination.

Chapter 5 describes facile synthesis of highly crystalline Cdot assembly. Assisted by excellent crystallinity, the as-prepared assembled Cdot system was found to boost the electrochemical performance and charge storage ability in electrodes, which was finally implied to fabricated Cdot based supercapacitors.

Chapter 6 includes conclusion and future prospects.

