Journal of Nanomedicine & Biotherapeutic Discovery

Extended Abstract

Carbon Dots in Nanomedicine Roger M Leblanc, University of Miami, USA

Roger M Leblanc

Abstract

Carbon Dots (CDs) with size but 10 nm have recently triggered great attention within the research of materials science and engineering thanks to their unique properties. They need been widely explored for applications for printing, bio imaging, drug delivery, thermoelectric materials, photo catalysis and biomedical engineering. These CDs were prepared from both top-down and bottom-up strategies and rigorously characterized by spectroscopy (UV-vis, fluorescence, FTIR and XPS), microscopy (AFM and TEM) and other (e.g., spectrum analysis, zeta potential, etc.) commonly used techniques.

A significant medical challenge one faces to treat Central system nervous (CNS) related diseases is to cross the barrier. Recently, the in vivo experimental observations suggested that many CDs could enter the CNS of zebrafish and rats with different mechanisms. Due to the abundant presence of carboxylic acids on the surface, CDs are easily conjugated with transferrin and anticancer drugs Doxorubicin. The system was proved to be an efficient drug delivery system for the delivery of doxorubicin into cancerous cells. The study has shown that CDs with low quantum yield dark bind to calcified bone structures of live zebrafish larvae with high affinity and selectively.

Binding resulted in an exceedingly strong enhancement of photoluminescence that wasn't observed in other tissues, including non-calcified endochondral elements. Retention of CDs by bones was very stable, long lasting and with no detectable toxicity. Further, it's shown that this high affinity and specificity binding property towards bone is exclusive to the CDs developed within the lab, selective CDs in literature didn't show any interaction with the bone. These observations support a unique and revolutionary use of CDs as highly specific drug delivery carrier.

Thermoelectricity refers to phenomena by which thermal energy is converted directly into electricity with none moving parts or working fluids. Significant efforts are dedicated to developing materials that might improve the conversion efficiency. Recently discovered that the addition of CDs could improve the conversion efficiency of thermoelectric materials by the maximum amount as 70%, which is unprecedented.

Carbon dots (CDs) have received significant attention worldwide from the start of this century, and recently, it's bloomed in every branch of applied sciences. Due to their outstanding physical and chemical properties along with biocompatibilities, CDs find a large spectrum of applications in drug delivery, explosive detection, chemical sensing, food safety, bio imaging, energy conversion, photo catalysis, etc. This brief review is concentrated on the synthesis of CDs and their applications. The photo physical properties of CDs are discussed herewith.

Recently, due to low toxicity and superior fluorescence and optical properties, carbon (C) dots have received considerable attention from scientists and technocrats. C-dots are not only used for electronics and optoelectronics but are also utilized for bio imaging, therapeutics and diagnosis, sensing, regenerative medicines, and nanomedicines. Because of their various

Roger M Leblanc
University of Miami, USA,E-mail: emailrml@miami.edu

interesting properties and wide applications, C-dots are extensively studied. This short review describes the different synthetic methodologies, properties, and specifically, nanomedicinal applications of C-dots such as biological imaging, cancer drug delivery, regenerative medicines, and bio sensing.

Carbon dots (CDs), as a new type of carbon-based nanomaterial, have attracted broad research interest for years, because of their diverse physicochemical properties and favourable attributes like good biocompatibility, unique optical properties, low cost, Eco friendliness, abundant functional groups (e.g., amino, hydroxyl, carboxyl), high stability, and electron mobility. In this Outlook, we comprehensively summarize the classification of CDs based on the analysis of their formation mechanism, micro-/nanostructure and property features, and describe their synthetic methods and optical properties including strong absorption, photoluminescence, and phosphorescence. Furthermore, the recent significant advances in diverse applications, including optical (sensor, ant counterfeiting), energy (light-emitting diodes, catalysis, photovoltaics, supercapacitors), and promising biomedicine, are systematically highlighted. Finally, we envisage the key issues to be challenged, future research directions, and perspectives to show a full picture of CDs-based materials.

Carbon dots (CDs) are photo luminescent nanomaterials with wide-ranging applications. Despite their photo activity, it remains unknown whether CDs degrade under illumination and whether such photo degradation poses any cytotoxic effects. Here, we show laboratory-synthesized CDs irradiated with light degrade into molecules that are toxic to both normal (HEK-293) and cancerous (HeLa and HepG2) human cells. Eight days of irradiation photolysis 28.6-59.8% of the CDs to <3 kilo Dalton molecules, 1431 of which are detected by high-throughput, non-target high-performance liquid chromatography-quadrupole time-of-flight mass spectrometry. Molecular network and community analysis further reveal 499 cytotoxicity-related molecules, 212 of which contain polyethylene glycol, glucose, or benzene-related structures. Photo-induced production of hydroxyl and alkyl radicals play important roles in CD degradation as affected by temperature, pH, light intensity and wavelength. Commercial CDs show similar photodegraded products and cytotoxicity profiles, demonstrating that photo degradation-induced cytotoxicity is likely common to CDs regardless of their chemical composition. Our results highlight the importance of light in cytocompatibility studies of CDs.

This work is partly presented International Conference on Nanomedicine, Nanomaterials and Nanotechnology in Healthcare May 27-28, 2019.