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Fundamental Mechanisms Responsible of the Fluorescence Capability of CQDs

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ABSTRACT

The fundamental mechanisms responsible of the fluorescence capability of CQDs are very debated. Some authors have provided evidence of size-dependent fluorescence properties, suggesting that the emission arises from electronic transitions with the core of the dots, influenced by quantum confinement effects, whereas other works have rather attributed the fluorescence to recombination of surface-trapped charges or proposed a form of coupling between core and surface electronic states. The excitation-dependent fluorescence of CQDs, leading to their characteristic emission tunability, has been mostly linked to the inhomogeneous distribution of their emission characteristics, due to polydispersity, although some works have explained it as a violation of Kasha's rule arising from an unusually slow solvent relaxation. Carbon dots (CDs) have recently triggered great attention in the research of material science and biomedical engineering due to their unique properties. They have been widely explored for applications in printing, photocatalysis, bioimaging, sensing, drug delivery, and nanomedicine. In this presentation, I will firstly introduce preparations of diverse CDs. Particularly, extensive structural characterizations have been performed to build comprehensive structural models for 3 distinct CD species derived from both top-down and bottom-up approaches. Then, I will mainly focus on various applications of the CDs developed in our lab: (1), glucose-based CDs could cross the blood-brain barrier (BBB) due to the presence of glucose transporter proteins on the BBB; (2), carbon nitride dots conjugated with anti-cancer therapeutic drugs and a targeting molecule were capable of effective treatment against diffuse large B-cell lymphoma both in vitro and in vivo; (3), metformin derived CDs showed a unique nucleus targeting property; (4), CDs have constantly shown the capability to inhibit the formation of amyloid precursor protein (APP), beta-amyloid (Aβ) and Aβ fibrils. CDs are promising nanomedicine and drug nanocarriers to treat Alzheimer's disease; (5), photocatalytic degradation of diverse water pollution models revealed a remarkably enhanced photocatalytic activity of gel-like compared with most known CD species and comparability to graphitic carbon nitride (g-C3N4). In addition, the degradation rate constant was further improved by 1.4 times by embedding g-C3N4 in G-CDs; (6), a pilot study showed a versatile nanocarrier could be assembled via the direct conjugation between distinct CDs to fulfill multitasks.

Biography

Dr. Roger M. Leblanc received his B. S. in chemistry in 1964 from Université Laval, Canada, and Ph. D. in physical chemistry in1968 from the same university. He was appointed as professor in 1994 and chair of Department of Chemistry at University of Miami from 1994 to 2002 and again from 2013 to present. He was also one of the three editors of Colloids and Surfaces B: Biointerfaces from 1998 to 2013. He has published 540 scientific articles in peer-reviewed journals. As a professor, he has supervised more than 100 M.S. and Ph.D. students.