Efficient red fluorescence and high photothermal conversion in the NIR II window from Na-doped carbon dots

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Carbon dots (CDs) are highly desired in biological applications. However, achieving a balance between photoluminescence (PL) efficiency and photothermal conversion efficiency (PTCE) is challenging. Herein, we reported unprecedent combination of efficient red fluorescence and high PTCE in the NIR-II window in a Na-doped CDs system. Upon 808 nm laser irradiation, photo-induced oxidation–reduction reactions happened on the surface of sodium cation-functionalized CDs (Na-CDs), leading to the partial reduction of surface-functionalized Na ions. The photo-reduced Na atoms coordinated with sp2 C domains in the core, resulting in Na-doped CDs (ir-Na-CDs) with an enhanced absorption band in the NIR-II window and a high PTCE of 43% under 1064 nm laser irradiation (1 W cm^{-2}). Composing the ir-Na-CDs with BSA enhanced the PLQY of the red emission to 31% in water without diminishing the PTCE in the NIR-II region. Moreover, ir-Na-CDs@BSA exhibited negligible to low cytotoxicity and demonstrated tumor accumulation capacity after intravenous injection, enabling effective tumor photothermal therapy in the NIR-II region. The developed biocompatible Na-doped CDs are suitable for translation into clinical biomedical applications.

Short Bio:

Songnan Qu achieved his PhD degree in Jilin University. From 2009-2018, he worked in State Key Laboratory of Luminescence and Applications at CIOMP, CAS. In 2019, he moved to University of Macau as a full Professor. His research interests focus on development and applications of luminescent CDs.