# Radiative and non-radiative decay pathways in carbon nanodots toward bioimaging and photodynamic therapy

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The origin and classification of energy states, as well as the electronic transitions and energy transfers associated with them, have been recognized as critical factors for understanding the optical properties of carbon nanodots (CNDs). Herein, we report the synthesis of crystalline CNDs in an optimized process that allows low-temperature carbonization using ethanolamine as the major precursor and citric acid as an additive. The results suggest that the energy states in our CNDs can be classified into four different types based on their chemical origin: carbogenic core states, surface defective states, molecular emissive states, and non-radiative trap states. Each energy state is associated with the occurrence of different types of emissions in the visible to near-infrared (NIR) range and the generation of reactive oxygen species (ROS). The potential pathways of radiative/non-radiative transitions in CNDs have been systematically studied using visible-to-NIR emission spectroscopy and fluorescence decay measurements. Furthermore, the bright photoluminescence and ROS generation of these CNDs render them suitable for in vitro imaging and photodynamic therapy applications.