Tuning the Optical Properties of Carbon Dots Towards Red Emission

Antonino MADONIA - *CNR-IPCF, Bari, Italy*

Carbon Dots (CDs) are nanosized quasispherical structures composed of Carbon, Nitrogen, Oxygen and Hydrogen. These nanoparticles have earned much interest from the research community thanks to their appealing properties, notably their intense absorbance and bright emission occurring in the visible light domain, their low toxicity and significant biocompatibility, and their remarkable capability to act as electron relays towards close-by species once photoexcited. Such characteristics have paved the way towards the usage of CDs for many different applications, as in the domain of bioimaging, nanomedicine, nanosensing, photocatalysis, and optoelectronics.

Nevertheless, for most of these uses CDs are often required to display tightly controlled optical properties, especially regarding both their photoconversion efficiency and the spectral region in which their emission is displayed. In this regard, the current approaches aiming to harness their properties are still unsatisfactory and mostly based on trial and error strategies, particularly when considering nanoparticles emitting in the red region of the visible light spectrum. Since CDs are in principle ideal candidates for substituting the currently used toxic nanoparticles based on rare elements or heavy metals, it is necessary to find adequate solutions to these problems.

It is in this context that we have explored both synthetic and post-synthetic treatments aimed at tuning the optical properties of CDs, focusing on obtaining red-emitting nanoparticles with high photoluminescence quantum yields. Our strategy is based on solvothermal synthetic approaches unfolding in different solvents, followed by carefully developed purification strategies which allow to isolate the red-emitting product of interest with high reaction yields. The precursors choice enables us to control the obtained fluorophores ultimately responsible for the witnessed optical properties; finally, by making use of a straightforward in-situ passivation strategy we have been able to enhance the emission intensity of our CDs while at the same time preserving the characteristics of their absorption and fluorescence bands.

Our results point towards isolating and controlling the red-emitting centers of CDs, allowing us to better understand the underlying emission mechanisms while at the same time developing active materials for the realization of light emitting devices featuring fluorescence bands peaking above 600nm.