Multistate Emissive N-Doped Carbon Dots: The Trade-off between Photoluminescence Properties and Photocatalytic Hydrogen Generation

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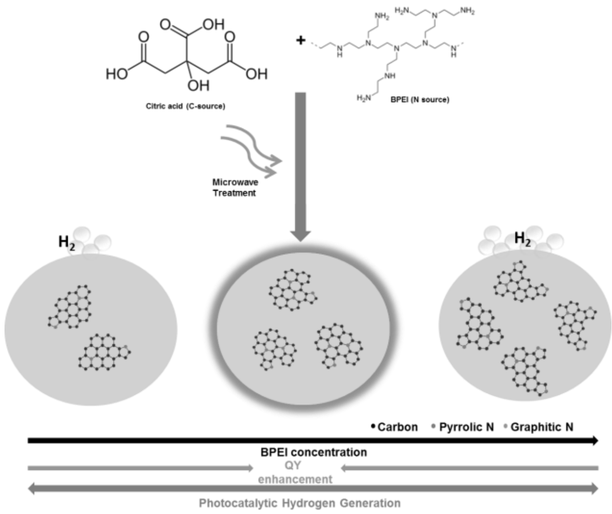
Luminescent carbon dots have garnered the attention of modern research as a new generation of carbon material due to their potential applicability for several photonic, bio-photonic and light-energy conversion devices. However, the fundamental understanding of complicated photophysics, especially the origin of multistate luminescent behavior, is still at an early stage. Considering the current demands, we have synthesized citric acid- derived carbon dots, varying the concentration of a nitrogen-containing precursor, a branched polyetheleneimine (BPEI), in a simple microwave irradiation technique. Upon increasing the BPEI content gradually, the florescence quantum yield (QY) of the carbon dots gradually increases up to a certain extent and after that it starts decreasing. In contrast, solar light-driven photocatalytic hydrogen generation follows the reverse trend of QY. This process does not require any metal co-catalyst, when illuminated with a full spectrum Xenon lamp. Finally, we are able to achieve an optimized carbon dot having the highest photo-catalytic performance (~450 µmole H_2/gram) and consequently lowest PL QY (~<1%).



This indicates a controlled trade-off mechanism between the luminescent properties (based on radiative and/non-radiative recombination) and overall charge separation processes followed by photocatalytic hydrogen generation. In-depth morphological investigation (based on Raman spectroscopy, X-ray photoelectron spectroscopy, electron microscopy etc.) and time resolved optical spectroscopic data has been carried out to illustrate the overall inter-dependency of multi-state emissive properties and photocatalytic activity. In general, these results can be highly beneficial for carbon-based material research and further their applicability for several light-energy conversion devices.

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