Electron transfer between carbon dots and polyoxometalates: new promising hybrid materials for photocatalytic applications

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Polyoxometalates (POMs) constitute an original family of nanoscaled metal-oxygen polyanionic clusters constituted of highly oxidized metals. They offer serious opportunities and promise great improvements in the domain of photocatalysis and photo-electrocatalysis because they are able to reversibly accept a large number of electrons. They have particularly shown catalytic properties for water-splitting and pollutants degradation. Indeed, their physical and chemical properties, including their redox properties, can be easily tuned by adjusting their chemical composition and their structure, which in term of material processing is a real chance to design the best material for the best application. Focusing on photocatalysis, POMs suffer from a serious drawback for an eventual technological transfer and an industrial routine use because they are limited to the UV-range absorption. In order to overcome this issue, a strategy consists in the use of photosensitizers which absorb in the visible domain and which act as electron relays for the POMs. Several photosensitizers (organic dye, metal complexes, quantum dots...) have been already associated with POMs to extend their absorption range to the visible. Nevertheless, such sensitizers suffer from either a bad stability during light irradiation or a high toxicity due to the presence of metals.

A new family of carbon material, called "carbon dots" (C-dots), is emerging few years ago. They correspond to carbon nanoparticles, both amorphous and nanocrystals with graphene-core, having promising combination of useful properties. Indeed, recent researches suggest that C-dots combine bright fluorescence capabilities such as ZnS or CdS quantum dots, absorption in the visible domain, conductivity properties, easy functionalization, and bio- and eco-compatibility. Thus, C-dots appear as extremely promising for uncountable applications: new photonic materials, catalysis, sensing, bioimaging, light sources...

In this context, C-dots can be used as photosensitizers for POMs. We have already obtained several C-dots-POMs hybrids, in particular based on electrostatic interactions or covalent bonds. These hybrids have been fully characterized. Then, time-resolved optical measurements have allowed to evidence for the first time electron transfer between exciting C-dots and POMs, suggesting that these hybrid materials can have promising applications in photocatalysis.