Quantum dots connected to silver nanoparticles: towards affordable redox photocatalysts working with visible light

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PhD may follow: Yes

Summary :

In this project we propose to investigate a new class of photocatalysts based on colloidal quantum dots that are expected to be i/ affordable, ii/ working with visible light and iii/ able to photocatalyze redox reactions in smooth conditions, as shown by a recent study in our laboratory. The originality of the systems developed in this project will be the controlled size connection's of quantum dots with silver nanoparticles by a click chemistry approach (Huisgen cycloaddition of azides and alkynes). Such assemblies quantum dots/ silver nanoparticles will promote the electron/hole separation by electron transfer from the quantum dots to the silver nanoparticles and should enable us to improve the efficiency of the photocatalytic systems previously reported by our team.

Full description :

Several studies in the literature demonstrated that when CdSe or CdS quantum dots are used as redox photocatalysts, the transfer of photoinduced charge carriers from the core of the quantum dots to electron acceptors or electron donors in the surrounding solution is limited by unwanted electron/hole charge recombination.

A promising strategy to promote the charges separation and avoid charges recombination is to connect the quantum dot with a molecule or another nanoparticle that is a very good hole or electron acceptor. So the separated charges live longer and react more efficiently with the substrates in the surrounding solution.

In this internship we propose to connect CdSe quantum dots with silver nanoparticles, which are known to be efficient electron acceptors. The controlled size connection will make profit of the ligands shells of both types of nanoparticles and of the very versatile technique of â€œHuisgen azides-alkynes cycloaddition called Click chemistryâ€•. Ligands bearing appropriate moieties (azide or alkyne) will by grafted on the surface of quantum dots and silver nanoparticles [3], and then â€œclikedâ€• together in order to connect the two types of nanoparticles together.

The efficiency of these new photocatalytic systems will be tested quantitatively for the photooxidation of 8oxo-deoxyguanosine (a very common DNA lesion) in the presence of nitroaromatic electron acceptors, which was already described as occurring but rather slowly, when quantum dots are used as photocatalysts in the absence of silver nanoparticles [1].

This internship will provide the trainee with some skills in nanoparticles functionalization, click chemistry, photochemistry and photophysics of nanoparticles and in various techniques for monitoring reactions such as HPLC, mass spectroscopy and magnetic resonance.

Requested skills :

Background in photochemistry/photophysics and in synthesis or functionnalization of nanoparticles would be helpful.