CdSe/ZnS core-shell fluorescent quantum dots stabilized in water with a Gemini amphiphilic pseudopeptidic compound

Jenifer Rubio, Francisco Galindo, Mª Ángeles Izquierdo, Mª Isabel Burguete and Santiago V. Luis

Departamento de Química Inorgánica y Orgánica, Universitat Jaume I
Avda. Sos Baynat, s/n 12071, Castellón de la Plana, Spain., E-mail: jrubio@qio.uji.es

In the last decades, semiconductor nanocrystals (quantum dots, QDs) are being widely studied due to its unique electronic and photophysical properties.[1] Specially, they have been used as fluorescent probe. They show several advantages over organic dye, like narrow emission bands, size-dependent tunability and stability to photobleaching.

The synthesis of QDs is normally carried out in non polar organic solvents and the stabilization of the resulting nanoparticles is done by means of coordinating hydrophobic ligands. Accordingly, one of the main challenges for the application of semiconductor nanocrystals in the biological realm as fluorescent bioprobes is the synthesis of water-soluble derivatives. Ligand exchange and encapsulation are among the most interesting strategies to bring about this objective.[2] The first method involves replacement the hydrophobic ligands by hydrophilic ones (normally thiols), however this approach has two main drawbacks: the thiolated ligands are prone to oxidation and the emission quantum yield can drop dramatically.[3] The second strategy is based on the encapsulation of the hydrophobic QDs with a protective shell of a certain hydrophilic material. This method, although is less popular, has the advantages of greater stability to oxidation and minimal influence on the fluorescence properties of the nanocrystals. Silica and hydrophilic polymers can be considered as the most investigated wrapping materials for this purpose. The formation of the water compatible nanoparticle is dictated by the one well-established mechanism, the *interdigitation* of chains between the inner hydrophobic ligand and the outer hydrophilic polymer.[4] Curiously, the utilization of low molecular weight molecules for this purpose is still a challenge.

Following our work in the field of supramolecular nanostructures based on gemini amphiphilic pseudopeptidic compounds (thereafter named GAPs),[5] we envisioned the synthesis of compounds capable to transfer hydrophobic CdSe/ZnS QDs to pure water. To this aim, we designed a new GAP containing a central ammonium in the bridge, which has been used successfully to the aforementioned goal. The fluorescence emission stability, the long fluorescence lifetime in water and especially the resistance to dynamic quenching by chloride ions, were the most remarkable features of this new type of nanomaterials.

References

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