# Highly luminescent CdSe/CdS nanoplatelets in water via a new shelling method

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A few monolayer thick colloidal nanoplatelets are a promising class of ultrathin semiconductors owing to their unique optoelectronic properties. Especially, their fast electro-optical response, efficient light absorption, small lasing threshold and large surface area available for electric contact make nanoplatelets a suitable candidate for applications in lasers, photovoltaics, transistors, LEDs and biolabeling.[1]

The stability of these thin nanoplatelets can be increased by wrapping them into a shell or surrounding by a crown of another semiconductor (e.g. CdS, ZnS). In this work, we developed a new reproducible procedure to shell the nanoplatelets in a biphase system by a sequential deposition of cation and anion monolayers (colloidal atomic layer deposition). The advantage of this method consists in the separation of the ionic precursor from the platelets to prevent a separate nucleation of the shell material (Figure 1). In this approach, the shell precursors (salts containing sulfide, cadmium and zinc ions) dissolved in a polar solvent were transferred to the solution of the nanoplatelets in a nonpolar solvent by amine ligands in a sequential manner, where they reacted forming corresponding CdS, ZnS or $Cd_xZn_{x-1}S$ shells. This shell design resulted in a broad tuning of the optical properties of the platelets, in particular, their absorption and emission, while preserving its narrow FWHM up to 19 nm. The quantum yield (QY > 40%) depends on the shell material[3], shell thickness and increases by a prolonged exposure to ambient sunlight.

Furthermore, we used an ethylenediamine-assisted ligand exchange[3] to prepare highly fluorescent water-soluble and colloidally stable core/shell CdSe/Cd(Zn)S nanoplatelets (QY > 30 %).This transfer to aqueous phase is highly advantageous for a broad range of applications of these 2D materials, such as lasing[4], biolabeling, etc.

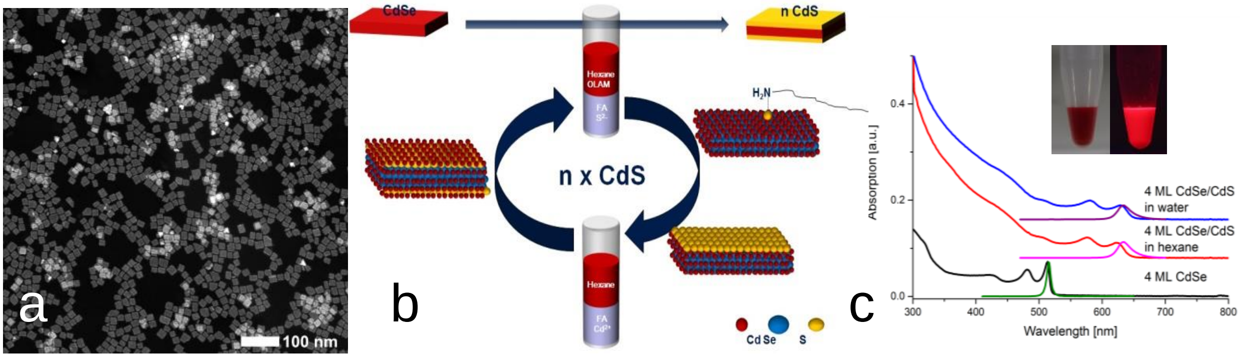


**Fig. 1 (a) HAADF TEM image of core/shell CdSe/CdS nanoplatelets, (b) a scheme displaying the shelling method, (c) absorption and photoluminescence spectra of 4 ML CdSe, CdSe/CdS nanoplatelets in hexane (water) with photographs of the core/shell nanoplatelets in water**.

[1] Ithurria, S.; Tessier, M. D.; Mahler, B.; Lobo, R. P. S. M.; Dubertret, B.; Efros, A. L. *Nat. Mater.* **2011**, *10*, 936–941.
[2] Tessier, M. D.; Mahler, B.; Nadal, B.; Heuclin, H.; Pedetti, S.; Dubertret, B. *Nano Lett.* **2013**, *13*, 3321–3328.
[3] Dai, M. Q.; Yung, L. Y. L. *Chem. Mater.* **2013**, *25*, 2193–2201.
[4] Di Stasio, F.; Grim, J. Q.; Lesnyak, V.; Rastogi, P.; Manna, L.; Moreels, I.; Krahne, R. *Small* **2014**, *11*, 1328–1334.