Bright and Stable CdSe/CdS@SiO_2 Nanoparticles Suitable for Long Term Cell Labeling

Tangi Aubert,[1,†] Daniel Wassmuth,[1,†] Stefaan Soenen,[2,†] Kevin Braeckmans,[2,†] Zeger Hens[1,†]

[1] Physics and Chemistry of Nanostructures, Ghent University, Belgium

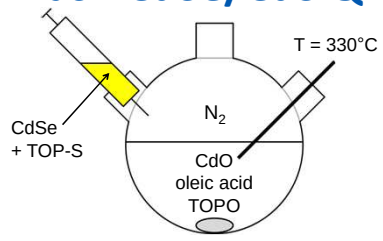
[2] General Biochemistry and Physical Pharmacy Lab, Ghent University, Belgium

[†] Center for Nano- and Biophotonics, Ghent University, Belgium

Introduction

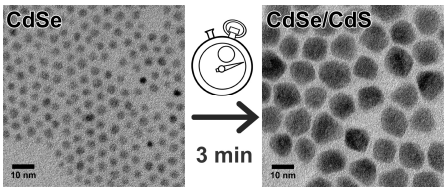
Functional silica nanoparticles (NPs) offer numerous potential applications in the fields of biotechnology and nanomedicine. In particular luminescent QD@SiO_2 nanoparticles constitute very promising nanoprobes for cell labeling and bioimaging techniques. In this contribution we report on our recent progress in the development of such functional nanomaterial, from its synthesis to its application in cell labeling. This includes first a new very efficient method for the synthesis of 'flash' CdSe/CdS core-shell QDs featuring high photoluminescence quantum yields and very low blinking rates.[1] Next, these QDs are encapsulated in silica nanoparticles through a water-in-oil microemulsion process with a high control on the morphology of the resulting CdSe/CdS@SiO_2 nanoparticles.[2] The high quality of our CdSe/CdS QDs allows us to fully retain their quantum yield even after several months of storage in water.[2] Thanks to these properties, the great potential of these nanoparticles for long term cell labeling is demonstrated.[2]

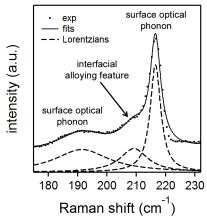
Flash CdSe/CdS QDs[1]



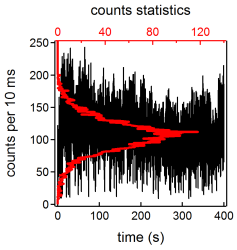
adapted from synthesis of CdSe/CdS dot-in-rods using carboxilic acid instead of phosphonic acids[1]

- very fast synthesis → thick CdS shells
- high chemical yields
- high photoluminescence quantum yields





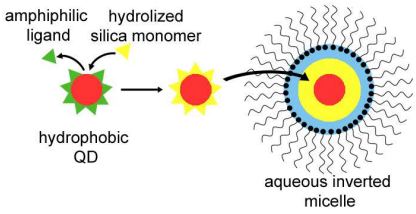
Raman spectroscopy → interfacial alloying

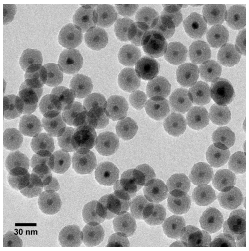


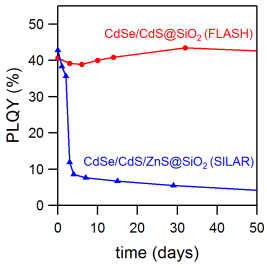
No blinking!

Silica encapsulation[2]

water-in-oil microemulsion





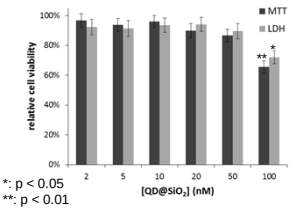


Contrary to conventional core-shell QDs (SILAR), quantum yield remains unchanged even after several months of storage in water

Highly stable in water!

Toxicity study[2]

cytotoxicity on HUVECs (24 hrs exposure)

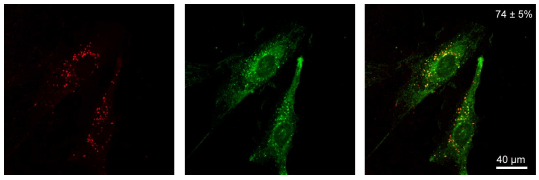


First significant effect at 100 nM → CdSe/CdS@SiO_2 are 20 times less toxic than bare QDs

Cell labeling[2]

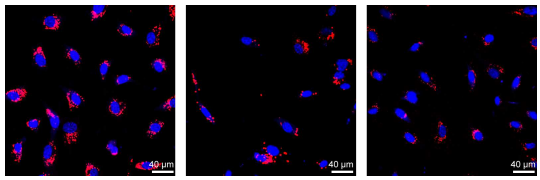
HUVECs, [NPs] = 50 nM, 24 hrs exposure

red channel (NPs) | green channel (dye) | merged (NPs + dye)



→ rapid endosomal uptake of high levels of NPs

0 cell division | 3 cell divisions | 7 cell divisions



→ up to 9 cell division can be observed

Suitable for long term cell labeling!

Conclusions

- **Flash CdSe/CdS QDs:** very fast synthesis, high photoluminescence quantum yields, high chemical yield, size tunable, no blinking
- **CdSe/CdS@SiO_2 nanoparticles:** good control on the morphology, high stability of the photoluminescence quantum yield in water
- **Cell labeling:** reduced toxicity of the CdSe/CdS@SiO_2 nanoparticles, rapid uptake of high level of nanoparticles, suitable for long term cell labeling

References

(1) M. Cirillo, T. Aubert, Z. Hens et al., *Chem. Mater.* **2014**, 26, 1154-1160

(2) T. Aubert, K. Braeckmans, Z. Hens et al., *submitted*

Acknowledgement

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