

Water soluble CdTe quantum dots for highly luminescent patterns obtained by laser writing

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Light-emitting Nanoparticles for LED/OLED displays

In this work, and in the wider framework of the NANOSCRILA project, granted by Regione Lazio, the development of nanoparticles for innovative LED/OLEDs displays manufacturing is performed by novel synthetic strategies involving the laser technology as a manufacturing tool.

Motivation

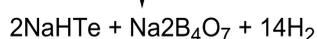
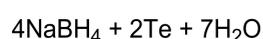
Laser patterning of cadmium based Quantum Dots is an alternative method of QDs patterning over a surface. This process is studied to develop the patterning of luminescent materials for pixel formation or color conversion layer suitable for display manufacturing. Here are explored the conditions to quench the luminescent CdTe QDs prepared in water



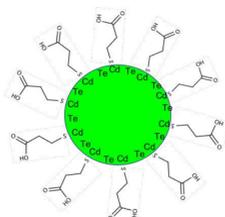
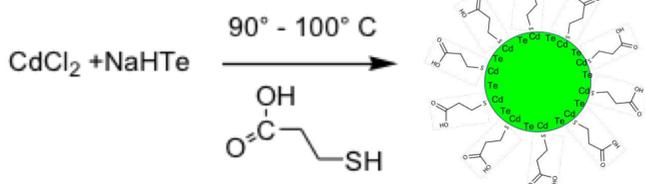
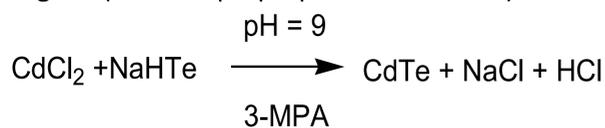
CdTe based QDs synthesised in water

The synthesis of the CdTe QDs in water follows a known chemical path that starts from cadmium and tellurium precursors that react at relatively low temperature (90 – 120 °C) in the presence of a ligand.

- The Te precursor is obtained from the reduction of Te powder with sodium borohydride.



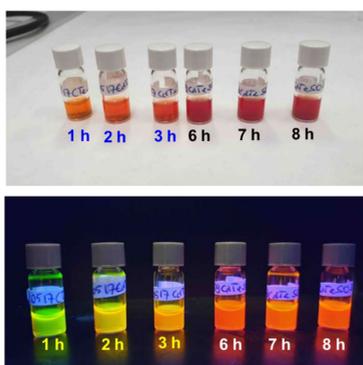
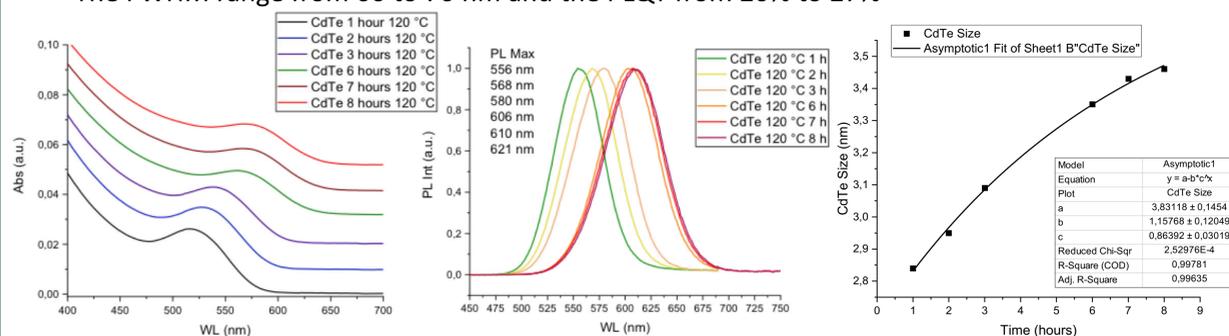
- The Te precursor is then introduced in water in presence of Cd reduced ions in presence of a ligand (3- mercaptopropionic acid - MPA)



Optical characterisation of the CdTe based QDs

The thermal treatment in solution generates the light-emitting CdTe QDs. They are characterized by UV-Vis and PL spectroscopy.

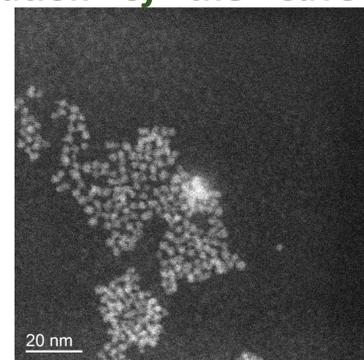
- The QDs size range from 2.8 to 3.5 nm
- The PL emission changes from 556 nm (green) to 621 nm (red)
- The FWHM range from 60 to 70 nm and the PLQY from 20% to 27%



Structural characterisation of the CdTe QDs (TEM)

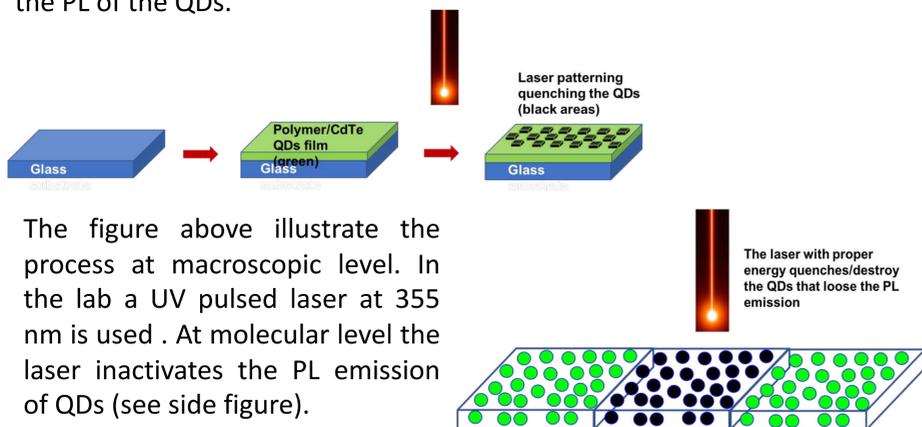
The HAADF-STEM images show that particles are crystalline with size ranging from 2 to 5 nm.

The sample is grown at 100 ° for 2 hours and the size derived from UV-Vis spectrum is 2.67 nm.



Film deposition and reverse laser patterning

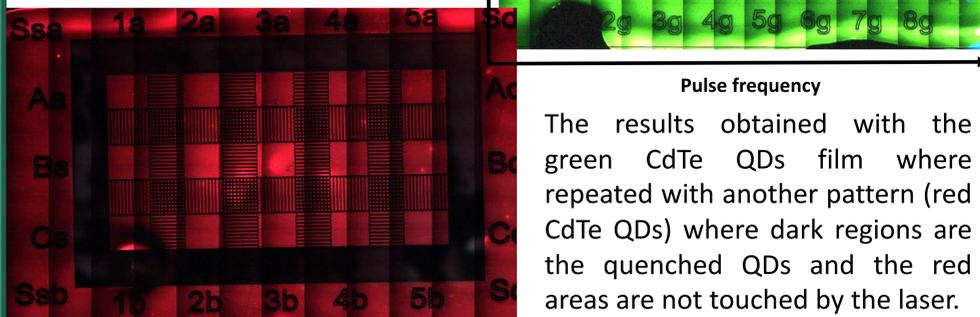
The laser patterning in Nanoscrila has been used both for the direct synthesis of the CdS QDs, but can also be used for the technique of the reverse laser patterning. In this working scheme, a film of light emitting QDs is deposited over a substrate and then the laser is used to inactivate the PL of the QDs.



Cd Nanocrystals inactivation

To inactivate the PVA/CdTe QDs film the UV laser was set at different laser power and pulse frequency to find the optimal laser conditions for QDs inactivation.

A film loaded with green QDs is deposited over a quartz glass. The concentration of the used QDs depend upon the PLQY of the batch used.



The results obtained with the green CdTe QDs film where repeated with another pattern (red CdTe QDs) where dark regions are the quenched QDs and the red areas are not touched by the laser.

Conclusions

- To improve the photoluminescent quantum yield and to decrease the environmental impact of the cadmium based QDs, the CdTe QDs were synthesized in water. The synthesis produced CdTe QDs with a PLQY ranging from 5 % to 27 % depending upon the reaction conditions.
- The reverse laser patterning is demonstrated with a UV pulsed laser at 355 nm by using a specific combination of laser power/pulse repetition rate.

Acknowledgements

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