

Light-emitting Nanoparticle Materials: CdS based Quantum Dots by Direct Laser Patterning and Si Nanocrystals by Laser Pyrolysis

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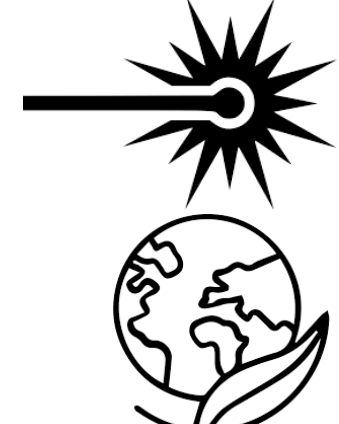
Light-emitting Nanoparticle Materials

In this work, carried out in the wider framework of NANOSCRILA project, granted by Regione Lazio, the development of active materials for innovative LEDs is performed by novel synthetic strategies involving nanomaterials and a new methodology that employs laser light.

The laser light is used for the formation of luminescent cadmium-based nanoparticles and for the modification of silicon-based nanocrystals to enhance their luminescence.



Motivation

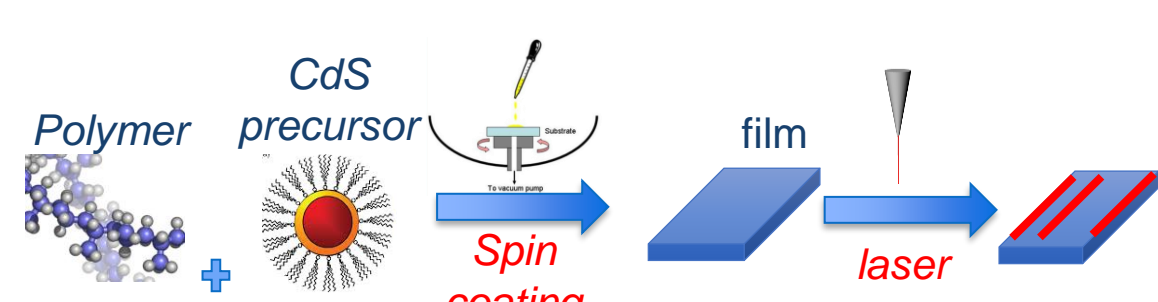


Laser patterning of cadmium based Quantum Dots (CdS QDs) is a simplification of industrial processes in the development of active materials for innovative LEDs devices at high resolution.

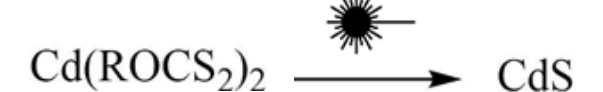
Silicon nanocrystals represents a possible eco-friendly alternative towards the generation of luminescent nanomaterials.

CdS based QDs by Direct Laser Patterning

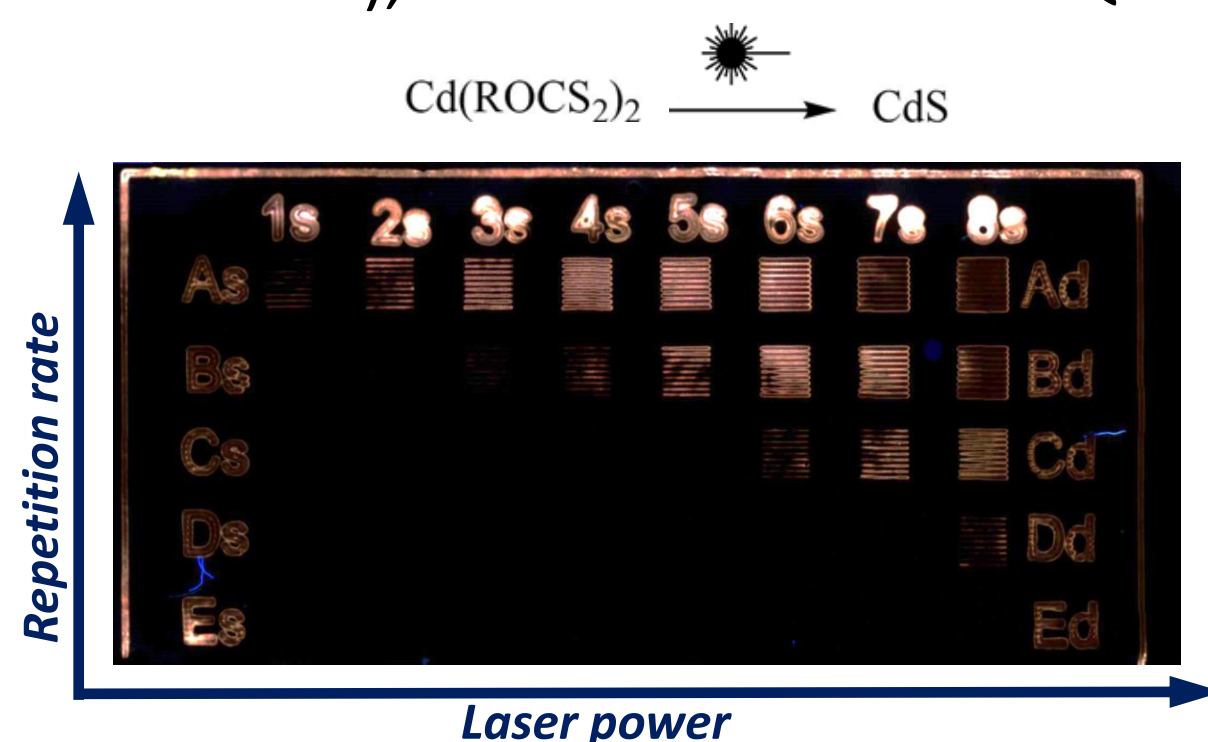
The synthesis of QDs from single source precursors allows to obtain hybrid nanocomposite materials through the generation of QDs directly in polymer matrices.



Laser patterning of a polymer, filled with a suitable precursor (Cd xanthate), leads to luminescent QDs.

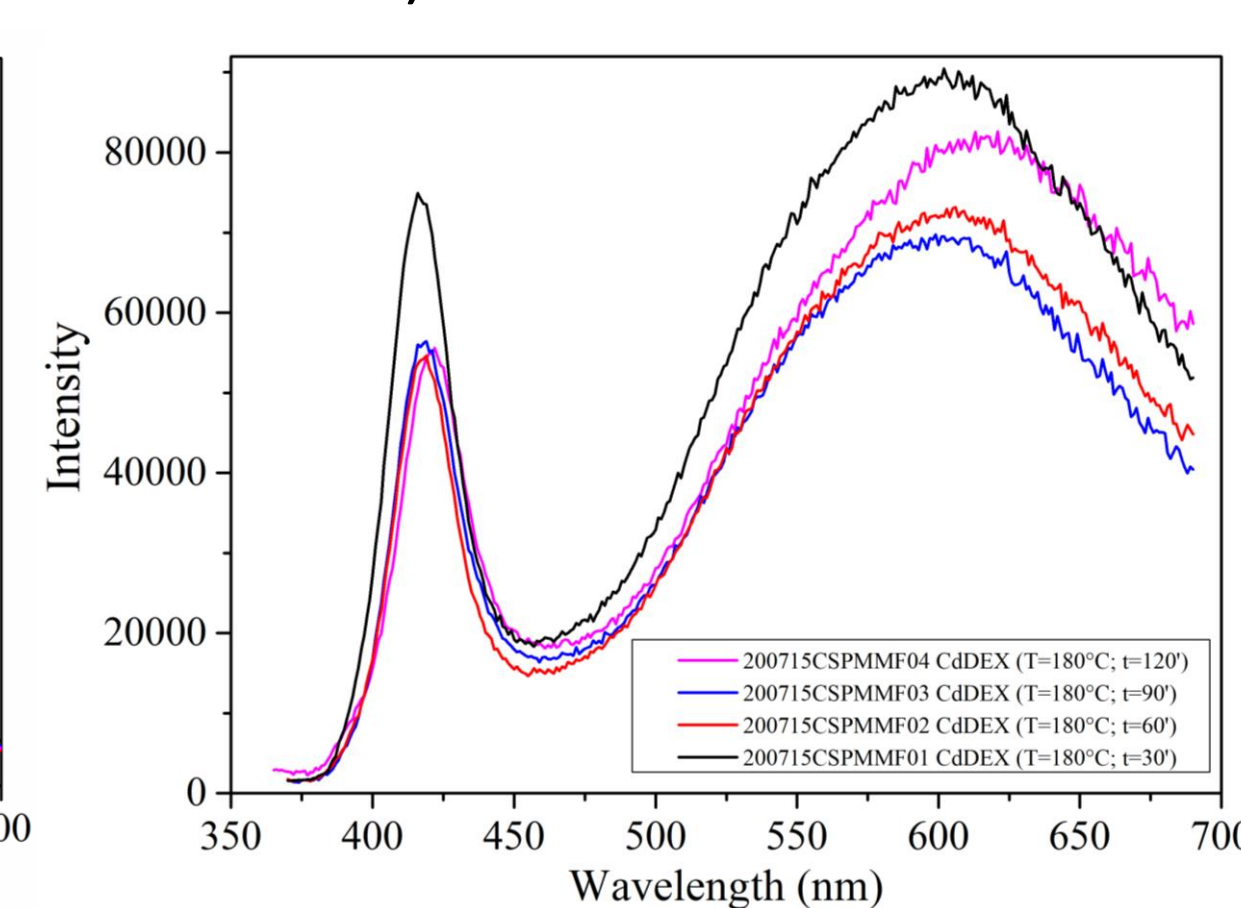
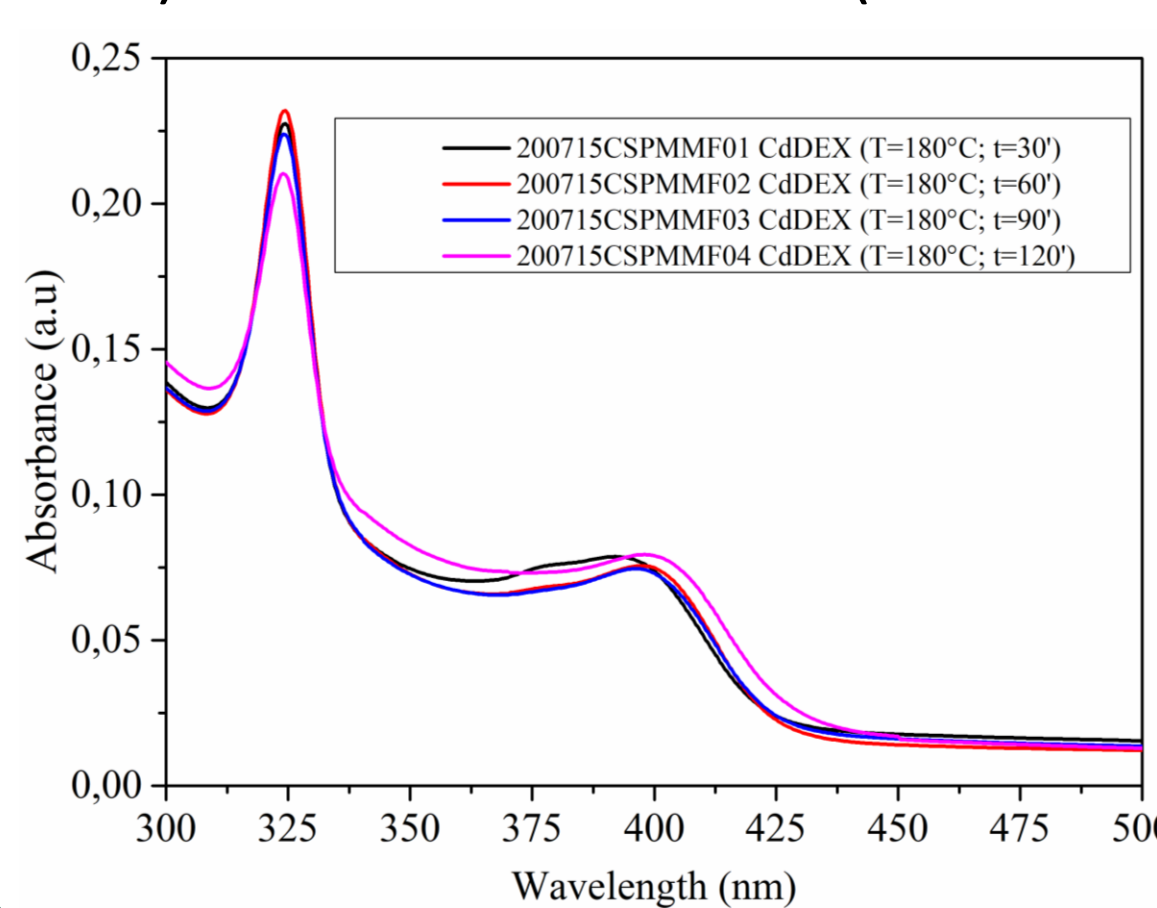


The polymer with CdS precursor, treated by laser @ 355 nm, results in fluorescent CdS QDs only for specific repetition rate and laser power, as showed by fluorescent microscope image.



CdS based QDs by thermal annealing

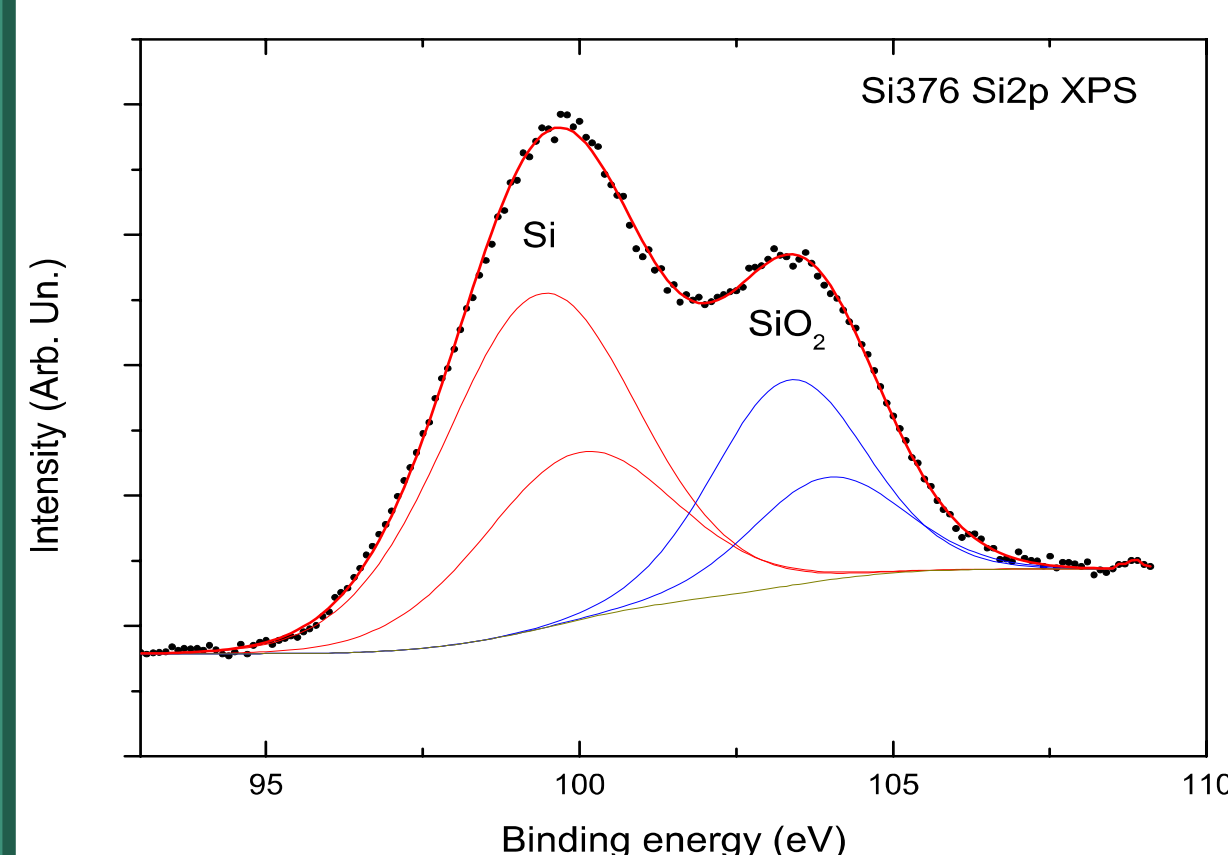
Thermal treatments also generate light-emitting QDs. Over annealing time the absorption peak at 320 nm of the precursor is reduced, while the typical CdS shoulder (at 400 nm) appears. The prolonged heat treatments amplify the luminescence phenomena, totally absent in the as prepared material. The PL spectra show the presence of two peaks at about 420 nm and 600 nm suggesting the presence of the band edge emission (sharp band at 420 nm) and defects emission (broad band at 600 nm).



Si Nanocrystals by Laser Pyrolysis

Synthesis of Silicon nanocrystals is carried out by CO₂ laser pyrolysis of silane. A chemical investigation is performed for the sample Si 376 by using the XPS technique. The Si 2p lineshape shows two peaks due to Si and Si oxide.

Every peak has two components, Si2p3/2 and Si2p1/2 with difference energy = 0.6 eV.

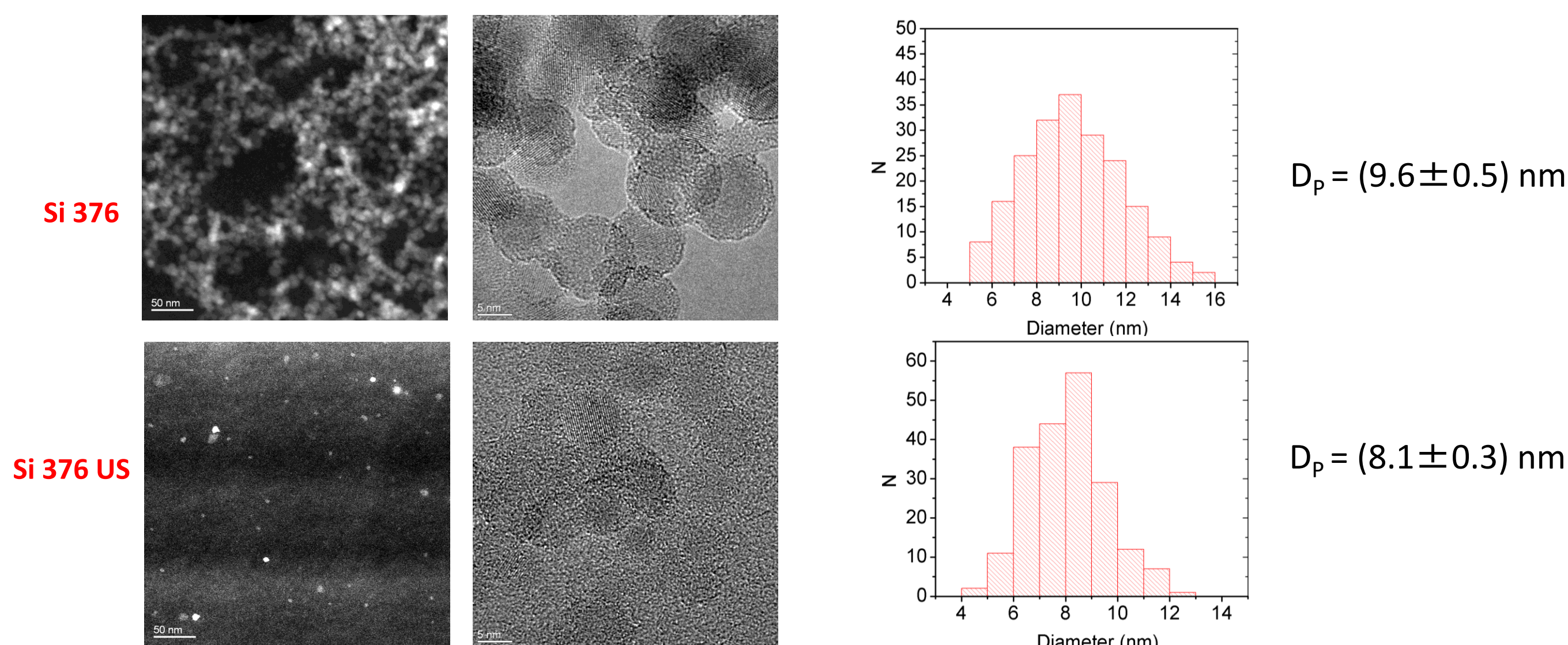


$\Delta(\text{BE}) = 3.9 \text{ eV}$, suggesting the presence of SiO₂.

From intensities analysis, we evaluate SiO₂ thickness about 0.97 nm ± 0.05 nm.

Si Nanocrystals characterization

The microstructure and the crystal size distribution are examined by Transmission Electron Microscopy (TEM). Both Scanning TEM pictures, recorded in dark field, and High Resolution TEM evidence crystalline particles. Si 376 as synthesized and Si 376 after further ultra sonication (Si 376 US) are evaluated.



Conclusions

- The laser treatment of polymer embedded with CdS precursor resulted in generation of luminescent CdS QDs only for specific repetition rates and power. This method can be used to draw patterns for optoelectronic devices.
- Silicon nanocrystals were synthesized by CO₂ laser pyrolysis of silane and characterized by XPS and TEM to evaluate particles chemical composition, dimension and size distribution.

Acknowledgements

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