

Investigation of photoluminescent semiconductor quantum dots synthesized by direct laser patterning

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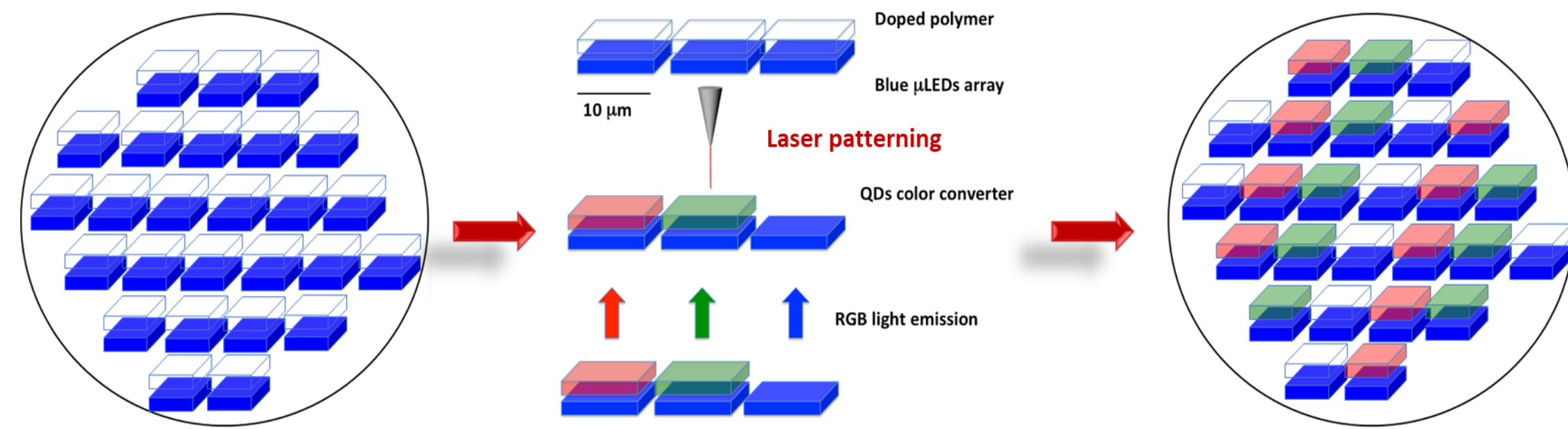
Micro QDs as Light Emitted Diode

This work represents the study and research carried out in a wider context, the project MiLEDI granted by the European Union Horizon 2020 research and innovation programme and Photonics 21. MiLEDI project merges nanotechnology and photonics as building blocks that arranged in a proper way give rise to a robust technology, useful for industrial production of RGB micro-LEDs/OLEDs. Photonics and nanomaterials and their application on device manufacturing are the key issues of the project to realize an innovative micro-display that can be applied in all fields involving display manufacturing, from new generation televisions to augmented reality devices.

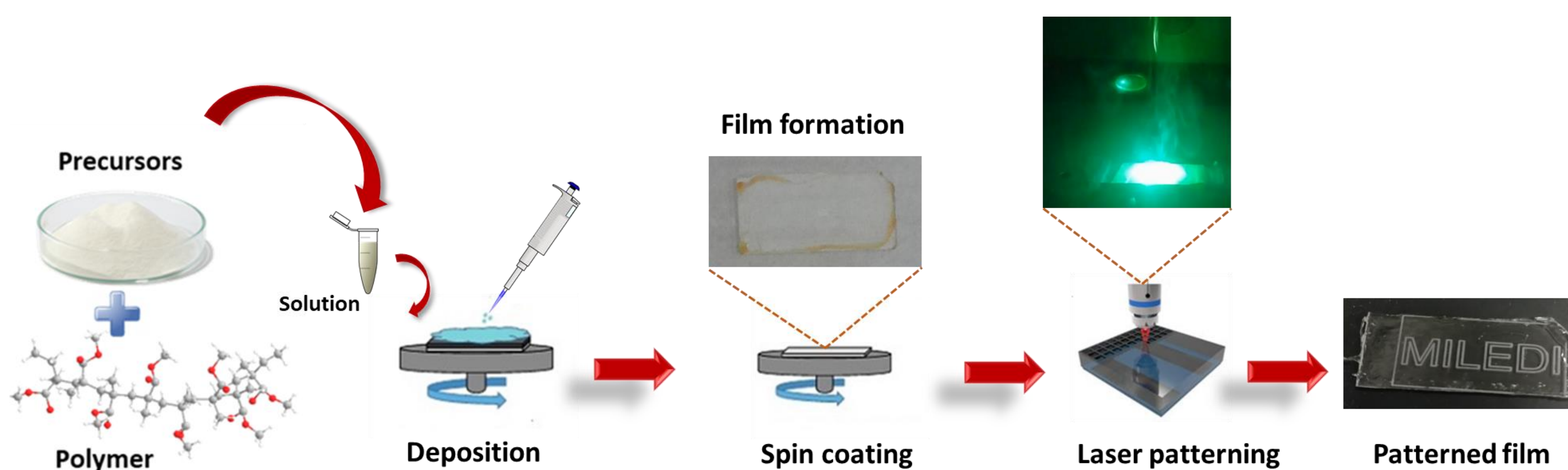


Aim of the work

The work focuses on the realization of new photoluminescent materials, inorganic semiconductor nanocrystals, namely quantum dots (QDs), starting from properly metallo-organic precursors directly within a polymeric matrix by direct laser patterning (DLP) processes. Photoluminescent semiconductor nanocrystals, QDs, have received considerable interest both from the point of view of the study of the materials and in terms of industrial needs, especially in photonic applications. The main industrial advantage of DLP over the existing technologies is the simplification of the writing process, which takes place in a single step. Moreover, the proper combination between the modulation of the laser beam parameters and the chemical formulation of the mixture adopted to produce QDs allows to synthesize nanocrystals with tunable emission properties, making the DLP methodology particularly suitable in a wide range of industrial fields.



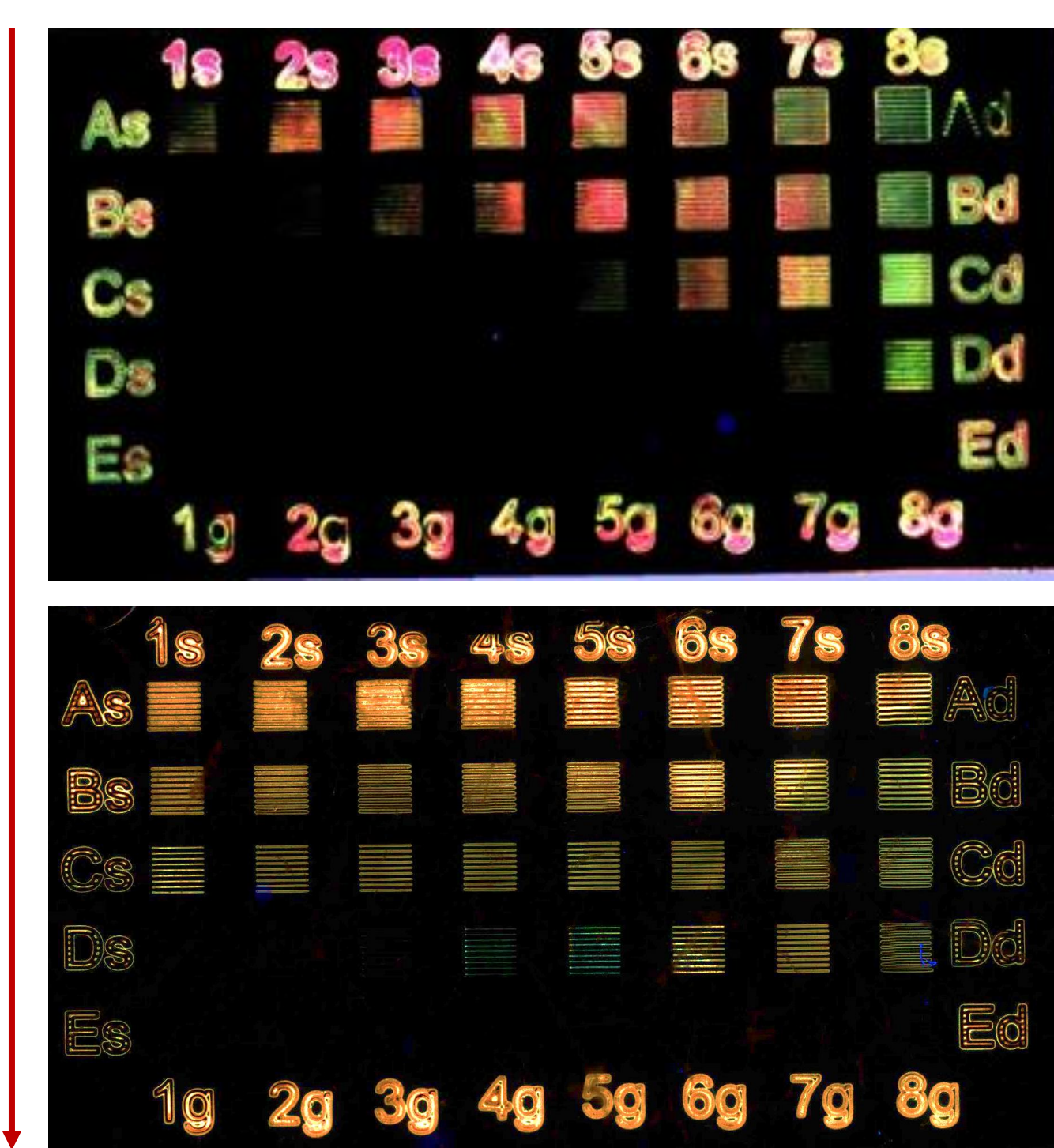
CdSe and CdTe based QDs by Direct Laser Patterning



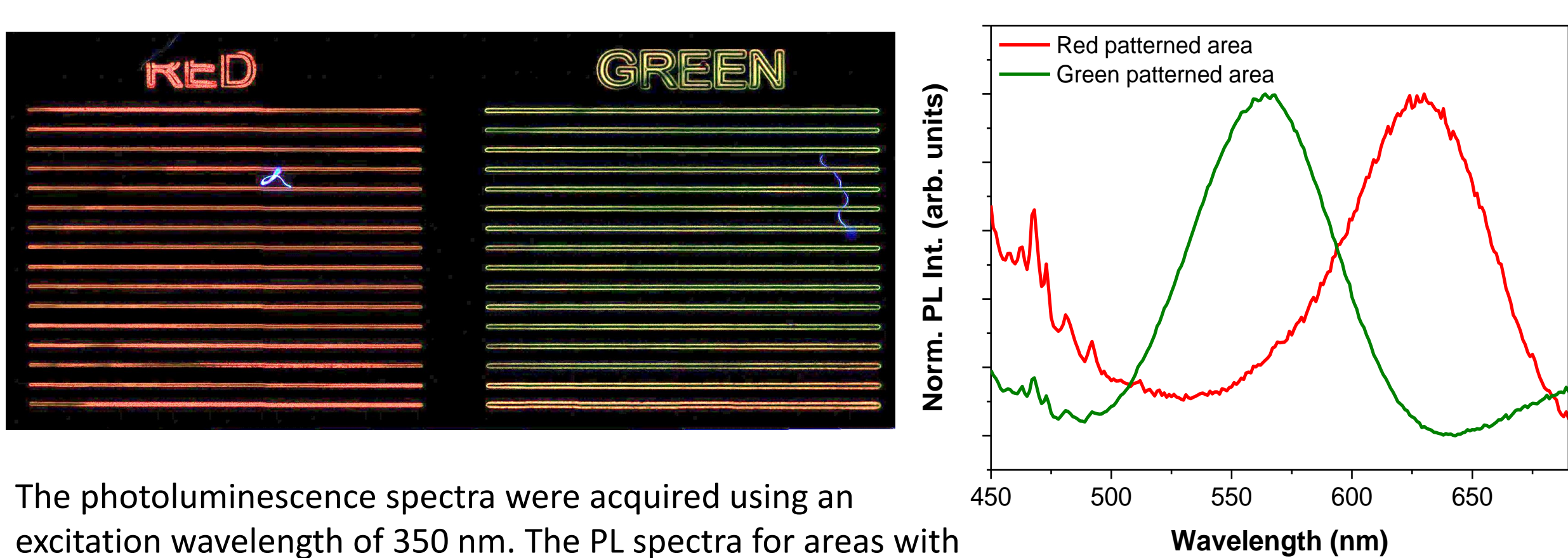
The synthesis of QDs from single or double source precursors allows to obtain nanocomposite materials through the generation of QDs directly in polymer matrices. The polymer with CdTe or CdSe precursors, treated by laser @ 355 nm, results in photoluminescent CdTe or CdSe QDs, varying properly the chemical formulation of film solutions and the laser parameters (frequency, power, speed of writing and passes), as showed by fluorescent microscope images. We have therefore shown a green and red emission for CdTe films and a green and orange emission for CdSe films, obtaining for CdTe photopatterned QDs brighter areas than CdSe ones.

Laser frequency (from 100 to 20 kHz)

Laser power (from 100% to 20%)

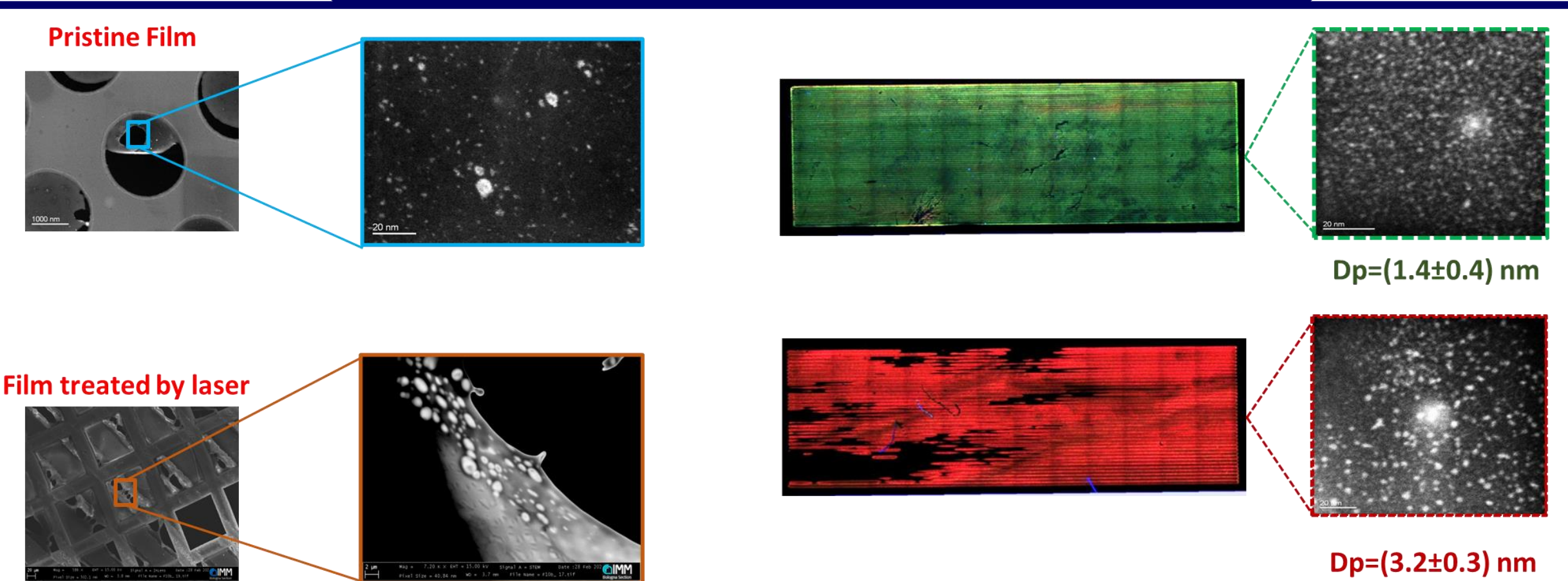


Optical characterization



The photoluminescence spectra were acquired using an excitation wavelength of 350 nm. The PL spectra for areas with green and red coloration, show the maximum at 565 and 610 nm and a FWHM of ~ 70 nm. The position of the PL peaks confirms the analysis carried out with the fluorescence microscope, highlighting the possibility to obtain NPe with defined colorations from films produced with the same chemical composition.

TEM Analysis



The morphological characterization was carried out through TEM analysis to verify the presence of CdTe nanoparticles. Pristine film showed the presence of bigger particles related to Cd and Te precursors and the absence of crystalline particles. Contrary, film treated by laser showed the formation of aggregates in the areas written by the laser with different size, smaller size for green QDs and bigger for red QDs as expected.

Acknowledgements

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