Fabrication of 3D photoluminescent nanostructures containing quantum dots by 2-photon polymerization

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Luminescent semiconductor quantum dots (QDs) have drawn tremendous attention due to their unique optical properties in the recent decade not only for the diagnostic and sensory but also in photonic applications [1-5]. In that context, the spatially controlled deposition and patterning of QD is an essential step for exploiting their unique properties. In this work, we demonstrate the capability to fabricate three-dimensional (3D) fluorescent structures with 80 nm resolution utilizing direct laser writing (DLW) based on two-photon polymerization (TPP), which is a promising way to produce 3D and 2D nanoscale structures for multifold applications[6-9]. Blue, Green or Red emitting quantum dots (QDs) were grafted into trifunctional acrylic monomers and then used as negative photoresist for 2 photon polymerization [10, 11] (cf. Fig.1).

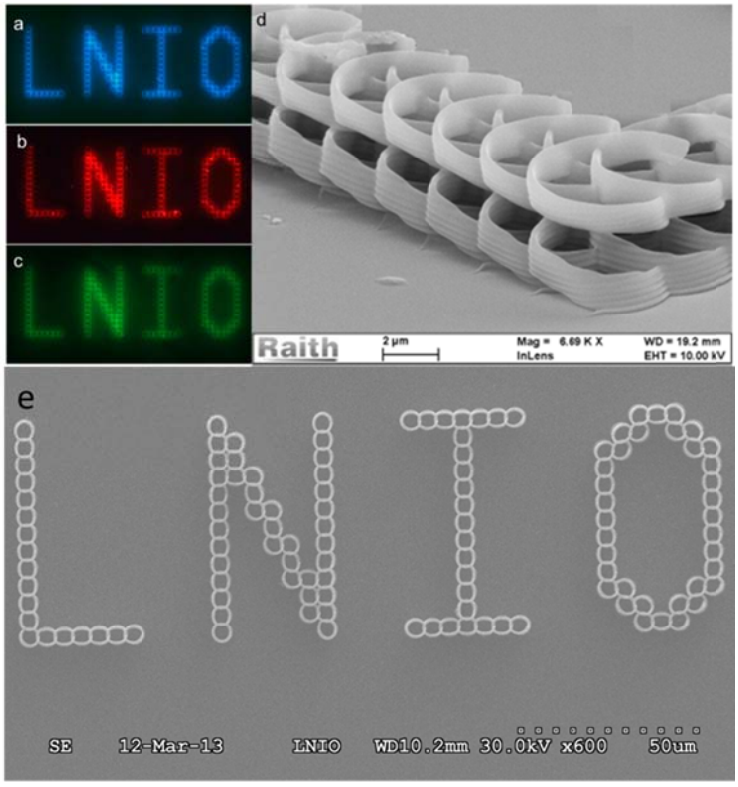

Figure 1 (a,b, and c) Fluorescence images of the QDs-containing 3D microstructures showing emission of blue (a), red (b) and green (c) light. (d and e) SEM images of 3D polymer microstructures fabricated by TPP-based DLW using the QDs-containing polymerizable solutions.

The fluorescent images and emission spectra show local emission from the polymer structures. The influence of the QDs, laser power and writing scan speed on the resolution of the as-prepared structures is also investigated. It is demonstrated that, the presence of QDs increases the lateral resolution where the feature size of polymer lines can reach 70 nm. This behavior can be attributed to the interaction between QDs and the photoinitiator during writing thus leading to the decreased number of radicals produced by this later. This assumption was confirmed by FITR, UV spectroscopy and photoluminescence measurements from the structures. In this sense, the local integration of QDs nanoemitters on plasmonic nanowires and waveguide is promising perspective to use the QDs-grafted polymers.

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