ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΥΛΙΚΩΝ

ΠΑΡΟΥΣΙΑΣΗ ΜΕΤΑΠΤΥΧΙΑΚΟΥ ΔΙΠΛΩΜΑΤΟΣ ΕΙΔΙΚΕΥΣΗΣ

Τίτλος

"3D Active Photonic Nanostructures".

Καμπουράκη Ασημίνα -Ελένη

Μεταπτυχιακή Φοιτήτρια

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Abstract

We present our most recent results on the fabrication of 3D high-resolution photonic nanostructures containing Cadmium Sulfide (CdS) quantum dots (QDs), exhibiting higher order diffraction patterns and stop-gaps at visible wavelengths. These structures are fabricated using direct laser writing (DLW) and novel, organic-inorganic hybrid materials.

DLW by multi-photon polymerization is a nonlinear optical technique which allows the fabrication of 3D structures with a resolution beyond the diffraction limit. The polymerization process is initiated when the beam of an ultra-fast laser is focused into the volume of a transparent, photosensitive material. Multi-photon absorption takes place within the focal volume, where polymerization occurs. By moving the focused laser beam in a three-dimensional manner within the material, 3D structures can be fabricated.

The materials used in this work are photostructurable organic inorganic hybrid

materials, prepared using the sol-gel process. This versatile technique has been exploited for the incorporation of inorganic networks into polymer matrices, using as monomers molecules that carry an inorganic part (which serves as the precursor to the inorganic network) and a polymerizable organic group (which acts as the precursor to the organic polymer). In the present work, we have included in the composite a quencher, allowing the fabrication of features well below the diffraction limit, and quantum dot precursors, enabling the *in situ* synthesis of CdS QDs.

We first prepared a composite material based on a polymerizable silicon precursor, and a cadmium-containing organic salt. Next, the inorganic siloxane network was formed by the sol-gel process, whereas, the photosensitivity that this material demonstrates, allowed its 3D laser structuring. Microstructures with spatial resolution below 100 nm and minimal shrinkage distortion were fabricated. Then, the microstructures were reacted with Na_2S, leading to the *in situ* synthesis of CdS quantum dots within the volume of the 3D structures. The X-Ray diffraction pattern of a CdS containing films showed three broad peaks attributed to the crystalline cubic structure of the nanoparticles. The UV-VIS absorption spectra showed a series of overlapping peaks, which are characteristic of poly-disperse CdS quantum dots formed within the material. Fluorescence spectroscopy was used to measure the emission attributed to the CdS nanoparticles which was found in the visible region of the spectrum. Excellent quality photonic crystal woodpile structures with period as low as 500 nm were fabricated. For the first time in such structures, we show the existence of third order nonlinear effects as well as diffraction patterns and higher order stop-gaps at visible wavelengths.