"Polymer based nanophotonics devices fabricated by nanoimprint lithography"

The outline of the talk is:

- Introduction to Nanoimprint Lithography (NIL): fundamental process challenges
- Modelling of the NIL process
- Fabrication and characterization of polymer light extraction devices
- Fabrication of bimetallic interdigitated electrode structures for photovoltaic applications
- A new 3D nanofabrication technique is introduced

Abstract:

This talk deals with an emerging nanopatterning technique, Nanoimprint Lithography. Nanoimprint lithography is a top-down patterning technique combining nanometer scale resolution and high throughput. Nanoimprint lithography relies on the deformation of a polymer material from a rigid stamp, which incorporates nano/micro features or structures.

Two polymer photonic devices have been fabricated and characterized showing the feasibility of NIL as a low cost and high throughput lithography technique for various applications. A two-dimensional photonic crystal Si stamp has been fabricated and used to imprint in an active material, which incorporates core shell (CdSe)/ZnS nanocrystals. We demonstrate that is it possible to control the extracted light using such a device as the surrounding environment. A 2.2 enhancement of light collection is realized when using the photonic crystal as a surrounding material, whereas an 27- fold enhancement light collection, compared to an imprinted unpatterned sample, is achieved via coupling the leaky modes of the photonic crystal to surface plasmons. Using the same principle, a polymer photonic crystal band edge laser is demonstrated. The laser emission wavelength can be tuned by controlling the lattice constant of the PhCs, covering the wavelength band over 30 nm at around 550 nm.

The short diffusion length of photogenerated electron-hole pairs limits the efficiency of photovoltaic devices. In order to overcome some problems of the top-bottom contact of photovoltaic devices, bi-metallic interdigitated electrodes (IDE) have been successfully fabricated. The main advantage of this geometry is that to have a thick polymer layer and a short distance between the contacts. This approach will allow to absorb an important part of the incident light and to collect the charge carriers efficiently. We electroplate Au interdigitated electrodes with Pt to improve the efficiency of the exciton-splitting process and the charge collection in organic solar cells.

A novel nanoimprint based technique is also presented. This technique namely, "reverse contact ultraviolet nanoimprint lithography", enables us to pattern features over pre-patterned surfaces forming a three layer woodpile-like structure. The main advantage of this technique is the ability to imprint suspended structures without having to etch the residual layer. In particular this novel technique demonstrates the ability to fabricate

three-dimensional structures that could be used for both, photonic and biological applications.