OLED and OPD-based Mini-Spectrometer Integrated on a Single-Mode Waveguide: Towards Monolithically Integrated Optical Biosensors

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Session : Flexible displays & lighting
Contribution: Oral (but I can do a poster if this work do not suit for an oral presentation)

Abstract:

Organic semiconductor technology offers new and attractive routes for monolithic integration based on the fact that the required materials can be deposited additively in only those areas where their specific functionality is required, e.g. using print processes such as gravure or ink-jet printing. In this contribution we explore this asset for the realization of monolithically integrated optical biosensors consisting of an OLED source, a waveguide, a transducer - e.g. based on surface plasmon resonance (SPR) - and organic photodetectors (OPDs). Two different schemes have been tested to couple the light into a single-mode waveguide:

1. We report on the successful coupling of light from an (ink-jet printed) OLED into a planar, single-mode waveguide. The coupling mechanism relies on direct excitation of the waveguide mode by the evanescent field of the co-planar OLED [2]. Contrary to other published schemes to incorporate an OLED as light source into photonic systems [3], the approach presented here is suitable for coupling into low-order mode waveguides.
2. The OLED pump a photo luminescent material which couple the light into the single mode waveguide.

Light coupled into the waveguide is finally detected by an organic mini spectrometer consisting of an etched grating and an array of OPDs. Current wavelength resolution is about 30nm. A new OPD array with a resolution below 5nm is currently being tested.

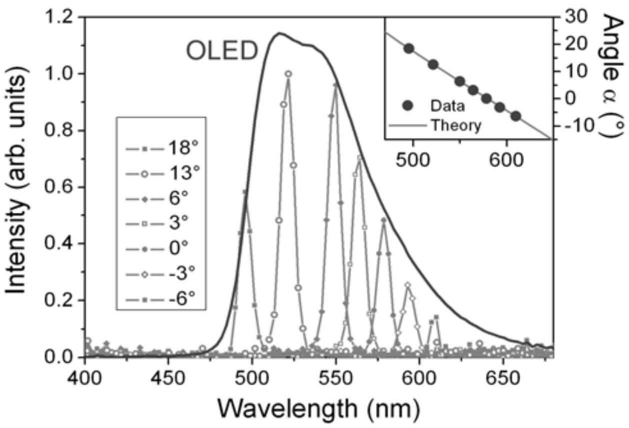

Figure 1: Spectrum of the OLED (thick full line) that couples light into the 150 nm thick Ta_2O_5 waveguide at one end of the sample chip together with spectra of the light coupled out by a grating of 312 nm period at the other end of the chip (thin lines with symbols). The peak wavelength of the out-coupled light varies with the out-coupling angle α, in good accordance with the theoretical prediction for the waveguide and grating used.

[1] Part of the work reported here was carried out within the framework of the EU-project SEMOFS (IST-FP6-016768).

[2] Patent pending
[3] Y. Ohmori et al., "Realization of polymeric optical integrated devices utilizing organic light-emitting diodes and photodetectors fabricated on a polymeric waveguide", IEEE J. Sel. Top. Quant. 10 (2004), pp. 70; Y.-Y. Lin et al., "Integration of polymer light-emitting diode and polymer waveguide on Si substrate", Appl. Phys. Lett. 89 (2006), pp. 063501