PhD Thesis Defense JOSE M. GARCIA-GUIRADO 'New Lab-on-a-Chip Strategies for Enantio-Selective and Non-Diffusion-Limited Biosensing'

JOSE M. GARCIA-GUIRADO

October 30, 2018

Tuesday, October 30, 11:00. ICFO Auditorium

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Plasmon Nano-Optics

ICFO-The Institute of Photonic Sciences

The race for fast and small that drives nowadays society has also reached the field of biosensing. Looking for efficient and cost effective biosensors for applications including

screening and treatment monitoring, biomolecular engineering, drug design and food industry; plasmonics and microfluidics technologies have synergistically grown to offer the most attractive solutions. The recent progress in nano-optics has paved the route toward the development of highly sensitive and label-free optical transducers using the localized surface plasmon resonance (LSPR). Additionally, LSPR offer high-end miniaturization and high degree of tunability of both sensors? spatial and spectral responses. These unique properties have recently been interfaced with microfluidics towards lab-on-a-chip (LOC) functional platforms which offer reduced sample volumes and multi-tasking operations on a single chip.

Combining nano-optics, microfluidics and biochemical sensing makes this PhD project highly multidisciplinary. This blend aims at pushing the limits of LSPR sensing by addressing two significant problems in the biosensing community.
On one hand, we went through chiral plasmonic sensing. Chiral molecules exhibit signatures in the ultraviolet frequency region. They are typically characterized by circular dichroism (CD), which suffers of low sensitivity and the need of big sample volumes and concentrations. Plasmonic nanostructures have the potential to enhance the sensitivity of chiral detection and translate the molecular signatures to the visible spectral range. However, to date, it remains unclear which properties plasmonic sensors should exhibit to maximize this effect and apply it to reliable enantiomer discrimination. As a consequence, a collection of results of difficult interpretation and cross comparison can be found in the literature. Here, we bring further insight into this complex problem and present a chiral plasmonic sensor composed of a racemic mixture of gammadions that enables us to directly differentiate enantiomers. We also present a plasmo-fluidic sensing platform, which allows the systematic study of chiral biomolecules by enabling multiple sensing assays on a single chip.

On the other hand, we addressed one of the major challenges of plasmonic sensing in microfluidics environments; the transport of the analyte to the sensor surface, which due to the laminar flow that rules in micro-channels, is limited by Brownian diffusion. Hence, dictates the total duration of the sensing assay. Here, we use the electrothermoplasmonic (ETP) effect to overcome this limit through opto-electrical fluid convective flow generation. To this end, we designed a LSPR sensing chip that integrates ETP operation into state-of-the-art microfluidics. Our results demonstrate that ETP-LSPR has improved performances over standard LSPR.

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