Development of plasmonics-based methods for biosensing

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Plasmonics has emerged as an exciting area in the rapidly growing field of nanophotonics combining nanotechnology and photonics, which offers unique opportunities for the advancement in biosensing. Plasmonics uses noble metal nano-structures and is based on their capability of supporting oscillations of free electrons (plasmons), which exist at metal/dielectric interface and can be excited over nanoscale thickness films (Surface Plasmon Polaritons) and separated nanostructures (Localized Plasmons). Plasmonics is now actively employed in biosensing, both in optical transductions and Surface Enhanced Raman Spectroscopy modalities, which are based on monitoring biorecognition events by refractive index and Raman scattering control, respectively.

The presentation will overview already accomplished and currently held projects on the development of plasmonics methods of biosensing. The first project is devoted to the improvement of physical sensitivity of plasmonics biosensors. In particular, we showed that the detection limit of Surface Plasmon Resonance (SPR) biosensors can be drastically improved by employing phase characteristics of light reflected under SPR [1,2]. This approach enables a 100-fold increase of sensor sensitivity compared to conventional SPR. In particular, the imaging modification of phase-sensitive SPR technology, Interferometric SPR imaging, makes possible the real-time detection and imaging of bioobjects, non-resolvable by any other optical method [2-4]. The concept is now extended to new nanoscale architectures. The second project relates to the miniaturization and cost reduction of SPR technology. In particular, we introduced the concept of Photonics Crystal Waveguide-based (PCW) SPR biosensor, which provides the coupling of plasmons from a fundamental single mode of a photonics crystal waveguide and thus enables keep a high sensitivity of SPR technology even in compact sensor designs [5]. Another approach is based on the adaptation of SPR to Si-based technology. Findings in this direction include the first demonstration of SPR sensing effect with a purely Si platform and Si-based multi-layer structures [6]. The concept of Si-based SPR opens opportunities for the development of low-cost micro-SPR biosensors, taking into account an advanced state of development of Si-based microfabrication methods. Finally, the third project addresses the development of new nanoscale architectures of biosensors, making possible the improvement of sensor sensitivity, lateral resolution and high throughput, as well as new functionalities.

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