Applications of Nanoplasmonic Metasurfaces for

Optical Biosensing, Spectroscocopy and Bioimaging

Hatice Altug[1], Saeid Ansaryan[1], Yen-Cheng Liu[1], Deepthy Kavungal[1]

1. Ecole Polytechnique federale de Lausanne, School of Engineering, Bionanophotonic Systems Laboratory, Lausanne, 1015, Switzerland

E-mail: hatice.altug@epfl.ch

35 word abstract: Our group introduces nanophotonic biosensors, bioimaging, and spectroscopy technologies for diagnostic and bioanalytical applications. This talk will present recent progress including nanoplasmonic lab-on-a-chip microarrays for high-throughput and real-time studies of single-cells in new ways.

Nanophotonics excels at confining light into nanoscale optical mode volumes and generating dramatically enhanced light matter interactions. Through the use of custom-made and tailored nanostructured, nanophotonics can manipulate light in ways that are not possible achieve with diffraction limited optics and natural materials. The unique nano-scale effects have been unveiling a plethora of fundamentally new optical phenomena, yet one of the most critical issues ahead for nanophotonics fields is the development of novel devices and applications. It is anticipated that nanophotonics will lead to disruptive technologies in energy harvesting, quantum and integrated photonics, optical computing and also biosensing. To this end, the focus of our research group is on the applications of nanophotonics and nanoplasmonics for biosensing, spectroscopy and bioimaging with the aim to introduce advanced bioanalytical devices that can have impact on areas including basic research in life sciences, disease diagnostics, safety and point-of-care testing [1-6].

We engineer new systems to offer numerous advatantegous including high precision, sensitive, label-free, real-time, multiplexed and low-cost operation, compact device footprint and affordability. We exploit plasmonic and dielectric nanostructures to increase the interaction of light with nanometric sized biomolecules. Depending on the detection principle we design their operation wavelength within a broad spectrum spanning from visible to mid-infrared. We develop nanofabrication methods for low-cost manufacturing of nanophotonic chips [7-8]. We integrate our sensors with microfluidic systems for efficient analyte handing [9-10]. We also use data science tools to achieve high sensor performance. In this talk I will present some of our recent work [9-11].

Our current research effort can be divided into three main directions. One direction is on the development of point-of-care diagnostic tools with the introduction of low-cost, portable, rapid & multiplexed microarray technologies [11]. The second one is on the development of novel Mid-IR spectroscopy techniques where we leverage chemical-specific and conformational sensitive detection [2, 10,13-18]. For the third direction, we develop new bioimaging systems that can enable one-of-a-kind measurements on living cells and also at single cell resolution [19-23]. In this talk, I will present examples from our recent progress with particular emphasis on our nanoplasmonic/photonic lab-on-a-chip systems for high-throughput and real-time studies of live and single cells. For example, our newly introduced nanoplasmonic microarray imaging platforms enables spatial and temporal mapping of extracellular secretion dynamics with high resolution while simultaneously observing cell morphology at single-cell resolution. The detection systems are label-free and capable of long-term monitoring of secreted proteins from hundreds of indiviual cells [22-23].

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