Integrated Nanophotonics for Life Science and Biomedical Applications

Emerging healthcare needs, including global healthcare, personalized medicine, and point-of-care applications are demanding breakthrough advancements in diagnostic and bioanalytical tools. Towards this goal, our lab is developing next-generation nanophotonic lab-on-a-chip systems offering high performance in accuracy, response time, integration, throughput, and affordability while reducing complexity, cost and device footprint [1-5]. We build optical biosensors, spectroscopy, bioimaging and microarray technologies to sensitively detect and analyze biological samples, including disease biomarkers, misfolded protein aggregates, nucleic acids, drugs, and living cells. To achieve our objectives we uniquely combine nanophotonics with advanced nanofabrication, microfluidics, surface chemistry, and data science techniques. In particular, we engineer optical metasurfaces exploiting plasmonics and dielectric resonators to fundamentally increase interaction of light with nanometric sized biomolecules and depending on the detection principle their operation wavelength is controlled within a broad spectrum ranging from visible [6-9] to mid-infrared [10-13]. We utilize low-cost and wafer-scale nanofabrication methods for manufacturing of nanophotonic metasurfaces [6, 11]. We integrate metasurfaces with microfluidic systems for efficient analyte handing [6, 8-9, 12-13]. We leverage data science tools to achieve high sensor performance [7-9, 12-14]. In this talk, I will present some of our recent works on surface enhanced mid-infrared spectroscopy such as an AI-aided Mid-IR optofluidic biosensor capable of differentiating misfolded disease proteins and high-Q gradient mid-IR metasurfaces for ultra-broadband operation, describe nanophotonic single-cell and organoid microarrays capable of high-throughput monitoring of extracellular secretion for screening applications and introduce biosensors that can enable continuous monitoring.

[1] Altug et al, Nature Nanotechnology, 17, p.5-16 (2022)
[2] John-Herpin et al, Advanced Materials, 2110163, (2022)
[3] Tseng et al. ACS Photonics 8, p.47-60 (2020)
[4] Oh and Altug. Nature Communications 9, p.5263 (2018)
[5] Tittl et al. Angewandte Chemie Int. Edition. 58, p.14810-22 (2019)
[6] Belushkin et. al. Small (2020)
[7] Yesilkoy et al. Nature Photonics 13 p.390-6 (2019)
[8] Jahani et al. Nature Communications, 12, 3246 (2021)
[9] Ansaryan et al. Nature Biomedical Engineering (2023)
[10] Tittl et al. Science 360, p.1105-9 (2018)
[11] Leitis et al. Advanced Materials, 33, 2102232 (2021)
[12] Kavungal et al. Science Advances (2023)
[13] John-Herpin et al Advanced Materials, 33, 2006054 (2021)
[14] Cachot et al Science Advances, eabe3348, (2021)

Bio:

Hatice Altug is Full professor at Ecole Polytechnique Federale de Lausanne (EPFL), School of Engineering and the head of BioNanoPhotonic Systems Laboratory. She received her Ph.D. in Applied Physics from Stanford University in 2007 and her BS in Physics from Bilkent University (Turkey) in 2000. From 2007 to 2013 she has been professor at Boston University Electrical Engineering Department and in 2013 she moved to EPFL. Prof. Altug is a world-leading expert on the application of nanophotonics to life sciences and biomedical fields. Her laboratory is developing next-generation optical biosensors, spectroscopy and bioimaging systems for ultra-sensitive, high-throughput, real-time and rapid detection of biological samples, including disease biomarkers, pathogens, drugs, and living cells. Her lab has extensive expertise to combine nanophotonics with advanced nanofabrication, microfluidics, surface chemistry, and data science techniques.

Prof. Altug is the recipient of numerous awards including European Physical Society Emmy Noether Distinction, Optical Society of America Adolph Lomb Medal, U.S. Presidential Early Career Award for Scientists and Engineers, IEEE Photonics Society Young Investigator Award and Koc University Science Medal. She has been named to Popular Science Magazine's "Brilliant 10" list in 2011. She received ERC Consolidator and Proof of Concept Grants, U.S. ONR Young Investigator Award, U.S. NSF CAREER Award, Massachusetts Life Science Center New Investigator

Award. She is the elected fellow of Optical Society of America and senior member of SPIE. In 2023, she has named highly cited researcher by Clarivate.

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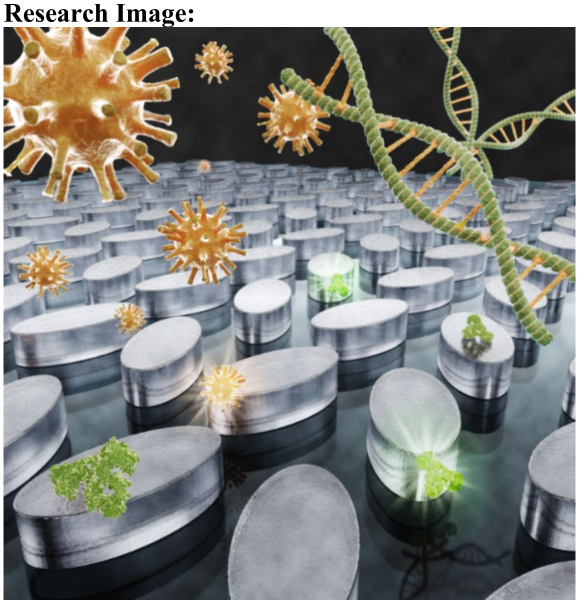
Research Image:



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