

Nanophotonics: Enabling Technology for Next Generation Bioanalytical Devices

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Abstract:

Healthcare is undergoing a paradigm shift from reactive treatment to preventive, personalized, and globally accessible care. Realizing this transformation requires fundamentally new bioanalytical and diagnostic technologies that can deliver rapid, accurate, and affordable results. Towards this goal, our laboratory is pioneering next-generation nanophotonic platforms that enable ultra-sensitive, quantitative, multiplexed, real-time detection of biomolecules through advances in optical biosensing, imaging, and spectroscopy. Nanophotonics provides a powerful technological foundation for bioanalytical devices by enabling strong light-matter interactions with confined lights at subwavelength scales. Building on this capability, we engineer nanophotonic metasurfaces operating over a broad spectrum from visible to mid-infrared to leverage complementary optical detection principles such as label-free refractometric sensing, molecular, structural and chiral sensitive surface enhanced spectroscopy, ultra-sensitive digital nanophotonic biosensing and multi-modal chemical-hyperspectral imaging approaches [1-5]. We develop wafer-scale nanofabrication processes compatible with low-cost and high-throughput manufacturing of disposable biosensor chips, and integrate them with microfluidics to enable rapid, automated, and efficient sample handling. In parallel, we employ advanced data science approaches to enhance the performance of our platforms by multiparametric analysis of spectrally, temporally, and spatially resolved data. This talk will highlight some of our recent work on these fronts with selected demonstrations.

Keywords:

Nanophotonic biosensing, metasurfaces, advanced vibrational spectroscopy, multi-modal imaging, lab-on-a-chip integration

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