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An optofluidic metasurface for lateral flow-through detection of cancer biomarker

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The rapid growth of point-of-care tests demands for biomolecule sensors with higher sensitivity and smaller size. We developed an optofluidic metasurface that combined silicon photonics and nanofluidics to achieve a lateral flow-through biosensor to fulfill the needs. The metasurface consists of a 2D array of silicon nanoposts fabricated on a silicon-on-insulator substrate. The device takes advantage of the high-Q resonant modes associated with the optical bound state and the nanofluidic delivery of analyte to overcome the problem of diffusion-limited detection that occurs in almost all conventional biosensors and offer a high refractive index sensitivity. We used rigorous coupled wave analysis and finite element analysis to design and optimize the device. We will present its photonic band diagram to identify the optical bound state and high-Q resonance modes near 1550 nm. The device was fabricated using e-beam lithography followed by a lift-off and reactive ion etching process. Reflectance of the sensor was measured using a tunable laser and a photodetector. The preliminary result shows a refractive index sensitivity of 720 nm/RIU. Furthermore, we implemented the optical metasurface as a lateral flow-through biosensor by covering the nanoposts using a PDMS cover. The nanofluidic channels are formed between the nanoposts for the flow of samples. The lateral flow-through sensor was used to detect the epidermal growth factor receptor (ErbB2), a widely used protein biomarker for breast cancer screening. The results show that the device can quantitatively measure the binding of ErBb2 antibody and ErBb2 by the continuous monitoring of the resonant wavelength shift.