Biosensing with high Q-factor dielectric metasurfaces

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Metasurfaces are an array of subwavelength resonating particles that strongly interact with the immediate surroundings[1-3]. Metasurfaces provides a great platform for the miniaturised sensing devices[3]. Current optical sensors for diabetes and multiple sclerosis are bulky lab-based devices with low sensitivity and requires labelling of biomarkers. As a result, health diagnosis is very expensive, and not readily available. In this work, we employ, dielectric nanoresonators to obtain high sensitivity (see Figure 1) which are non-invasive, label-free, and robust. Also, dielectric materials offer low loss and CMOS compatible fabrications methods, as a result, cheaper and miniaturised sensors which can be easily integrated into point-of-care devices[3].

Metasurfaces are not selective to biomarkers, hence by immobilising particular functional layers we selectively capture target biomarkers. That results in a refractive index change in the vicinity of the metaatoms, leading to a characteristic shift of the resonance dips. As shown in Figure 1, we have attached the protein G-antibody complex by using a small silane linker molecule onto our amorphous silicon (a-Si) metasurfaces. As demonstrated in Figure 1b, we are in the process of optimising the platform to detect lower levels of biomolecules in a microfluidic setup. This process can be extended to a comprehensive range of biomarkers (antibodies, antigens, proteins, glycans, etc.) by using the appropriate surface anchors to selectively retain them.

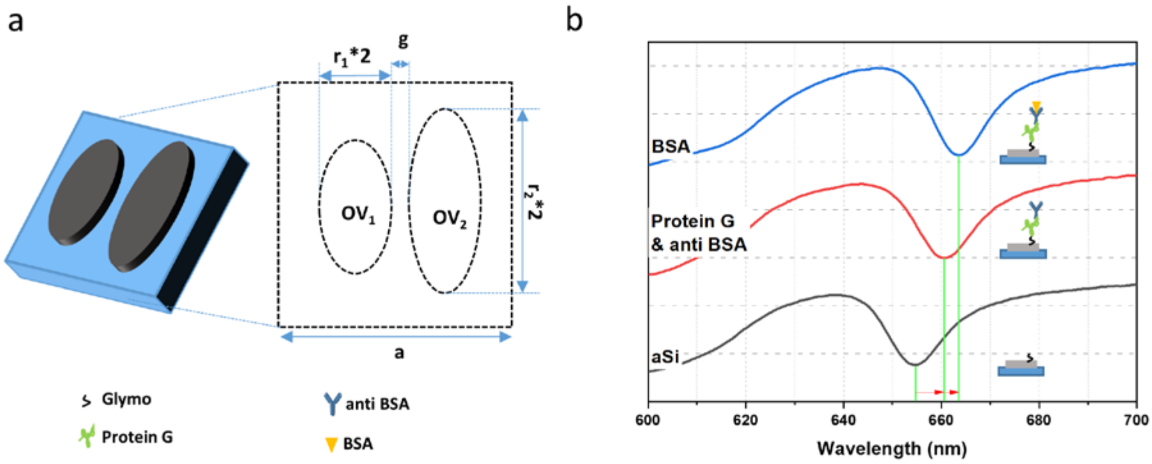

Figure 1: a) Schematics of a single unit-cell of the metasurfaces, where a = 420 nm, r_1 = 60 nm, g = 60 nm, r_2 (OV_1) = 130 nm, r_2 (OV_2) = 160 nm, and height of the disks is 70 nm. b) Transmission spectra measured after attaching the each biomolecule.

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[3] F. Yesilkoy, et al., Nat. Photonics, 2019, 13, 390-396.