

High Sensitivity Optical Biosensor based on silicon dimer arrays

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Traditional optical biosensor based on noble metal particles are usually highly sensitive to the analyte. However, the sensitivities of the plasmonic designs are limited intrinsically by the low quality factors induced by metal losses. Very recently, to circumvent the issues of loss and heating, high refractive index dielectrics have stimulated lots of research.^{1,2}

Here, we proposed silicon dimer arrays with low-loss and strong magnetic response as a new nanosensor for biomolecule detection. To our knowledge, it's the first time to use silicon nanodimer as the building block for optical sensing metasurface. The sensing mechanism is based on the wavelength-shift of the magnetic resonance of the metasurface with a narrow and dramatic transmission valley. The narrow dip of the transmittance spectra of the periodical silicon dimers mainly come from their magnetic dipole resonance. A strong collective resonance arising from coherent far field dipole coupling due to the periodicities of the arrays. Then we investigate the dependence of two factors: the periods and the polarized directions (Figure.1c and d). We also investigated the influences of the periods and polarized directions. Sensitivity of the biosensor is also discussed using the finite-difference time-domain (FDTD) method, spectral sensitivity as high as 528nm/refractive index unit (RIU) which is higher than the reported highest 289 nm/RIU.³ These findings showed that monitoring the change of the wavelength-shift of nanodimer will be widely used in biomolecule detection.

¹ A. I. Kuznetsov, A. E. Miroschnichenko, M. L. Brongersma, Y. S. Kivshar, B. Luk'yanchuk. *Science*, **354**, 6314 (2016).

² O. Yavas, M. Svedendahl, P. Dobosz, V. Sanz, R. Quidant, *Nano Lett.* **17**, 4421 (2017).

³ Y. Yang, et al.. *Nat. Commun.* **5**, 5753 (2014).

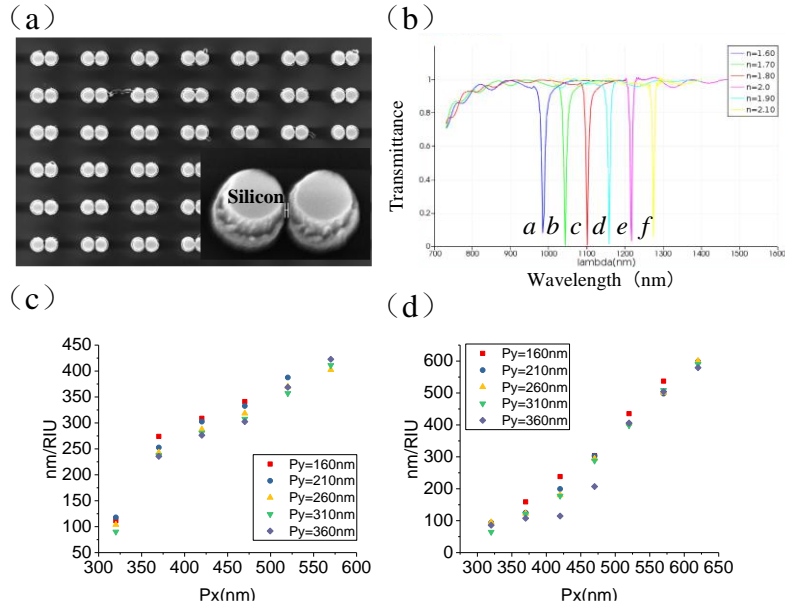


Figure 1: (a) SEM figure of dimer arrays sensor. Inset: a unit cell of nanodimer. (b) Transmittance spectra of the dimer arrays when the background index ranging from 1.15 to 1.50. (c) Summary of the RIU values obtained for different periods with X-polarized light. (d) The RIU values with Y-polarized light.