Fabrication of Nanoscale T-Structures for the Realization of Metasurfaces with Double-Peak Absorbance

Jacob Waitkus, Ke Du
Chemical and Environmental Engineering, University of California, Riverside, CA, 92507
jake.waitkus@email.ucr.edu

Shuai Feng, Theodore Ndukaife, Sui Yang
Material Science and Engineering, Arizona State University, Tempe, AZ 85281

Metasurfaces are appealing for use in bio and chemical sensors due to their specialized characteristics and sensitivity to changes in local refractive index and other key electrical properties.[1,2] The parameters that govern these systems are carefully chosen through fabrication of complex nanoscale geometries with subwavelength features.[3] This work presents the fabrication of a unique metasurface capable of sensitive detection to changes in the surrounding refractive index. Through combination of nanoscale T-structures with a bar-like structure separated from the base of the "T" by only 20 nm, as shown in Figure 1, a double peak absorbance spectrum is produced with a separation less than 50 nm. The desired spectrum can be best observed in the gap between features due to their close proximity. These devices incorporate a simplistic fabrication process flow, requiring only deposition, e-beam lithography, and metal etching to form the desired structures. The device is made of a polysilicon (polySi) layer deposited on a quartz substrate. The thickness of the deposition layer can be altered to adjust the peak wavelength values, where thicker substrates exhibit a redshift in wavelength. In combination with the planar substrate surrounding the features, the peak wavelength value becomes sensitive to the surrounding environmental conditions which was simulated in Figure 2. Alterations to the enveloping media composition can produce shifts in the absorbed wavelengths. This can be further extended in the future for the detection of biological components on the surface such as viral RNA targets.

---

[1] La Spada, L. Metasurfaces for Advanced Sensing and Diagnostics. *Sensors* **2019**, *19*, 355.
[2] Tabassum, S.; Nayemuzzaman, S.; Kala, M.; Kumar Mishra, A.; Mishra, S.K. *Sensors* **2022**, *22*, 6896.
[3] Roxana Tomescu, Cristian Kusko, Dana Cristea, Ramona Calinoiu, Catalin Parvulescu, Solid State Electronics Letters, Volume **2**, 2020

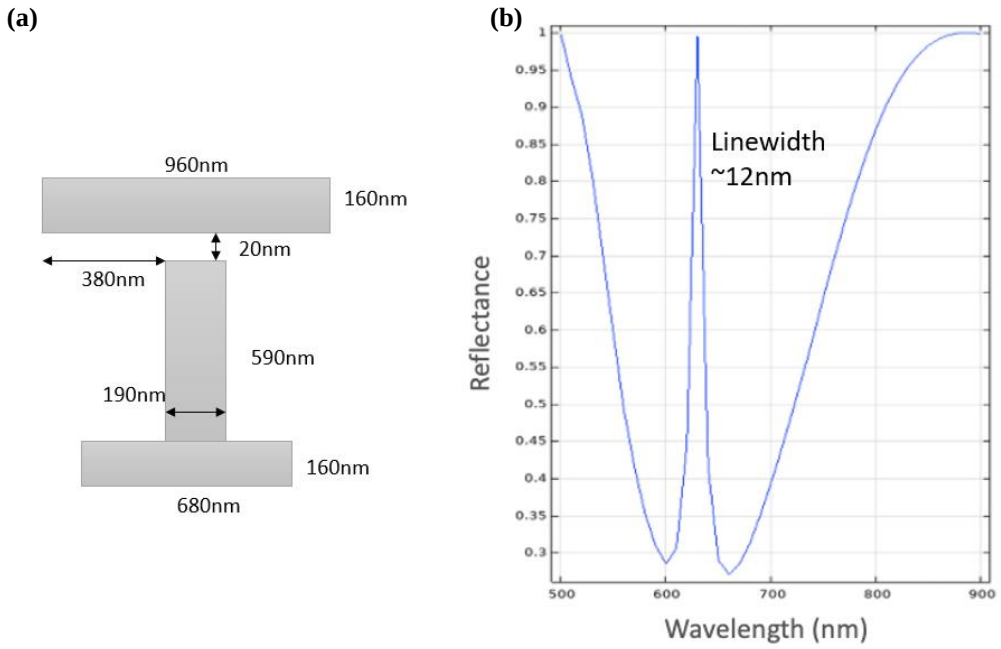

Figure 1: (a) The dimensions of the T-structure metasurface feature are shown here. (b) The accompanying simulation of the transmission spectrum for the features on a quartz substrate.

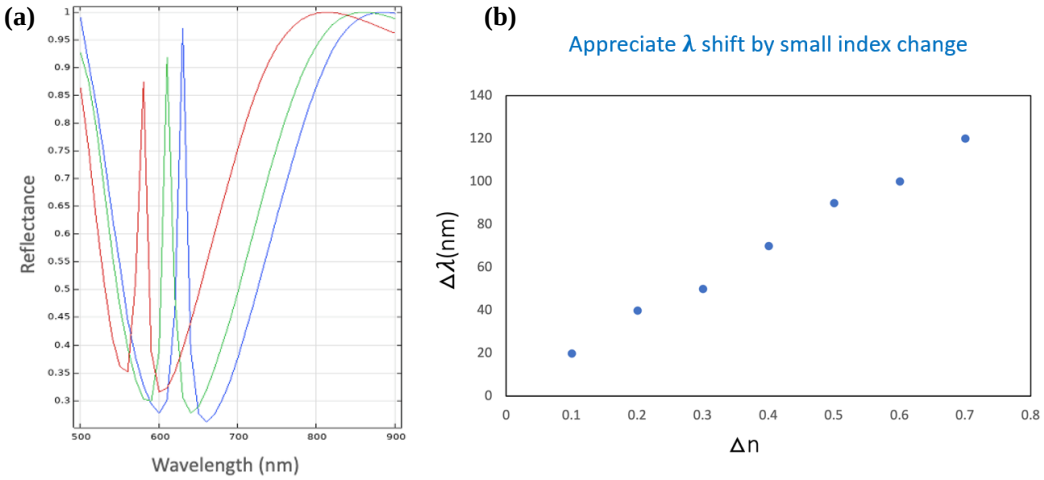

Figure 2: (a) Varying the environment surrounding the metasurface causes sensitive changes in the peak wavelength values as shown by the redshift in transmission. (b) The linear plot of refractive index changes against changes in peak wavelength value exhibit the correlation.