Tuning extra ordinary transmission peaks in near-field coupled hole arrays

Vaishnavi Sajeev, and Dibakar Roy Chowdhury*

Ecole Centrale School of Engineering, Mahindra University, Hyderabad, Telangana – 500043, India

vaishvaish2015@gmail.com

Since the discovery of extraordinary transmission (EOT), the optical properties of subwavelength apertures have been a promising field worldwide [1]. It is found that the interaction between the electromagnetic wave and surface plasmon polaritons (SPPs) is responsible for the enhanced transmissions. Significant advances in understanding light diffraction by subwavelength apertures were accomplished, and several novel applications were proposed [2][3]. Earlier, the tuning of surface plasmon resonance (SPR) has been done by changing the periodicity [4]. In this pretext, we numerically demonstrate a facile approach for modulating THz SPR through near-field electromagnetic coupling in hole arrays.

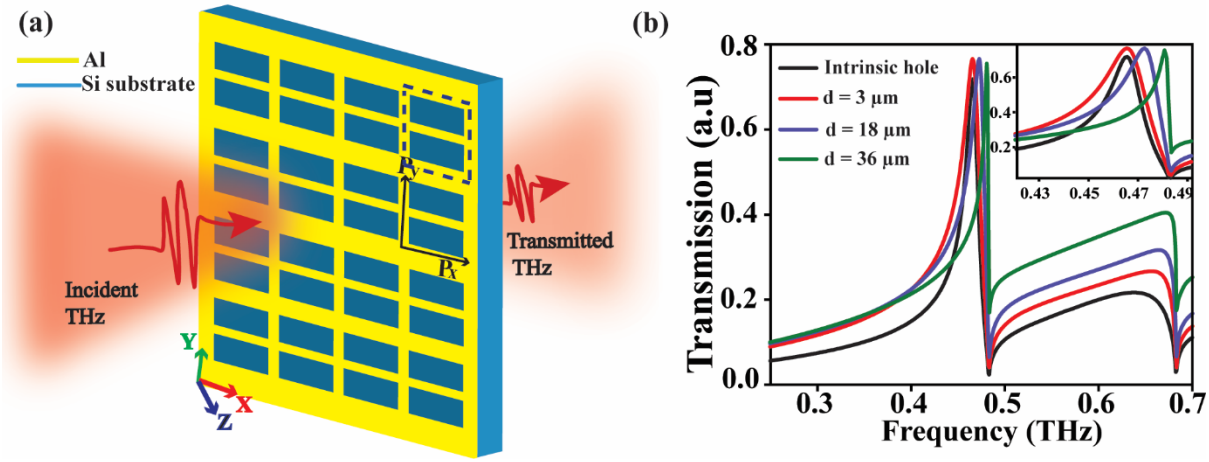

Fig. 1: (a) Schematic of THz passing through the rectangular hole array. (b) Transmission spectra by varying the separation distance 'd' between the rectangular holes

Schematic in Fig. 1(a) depicts the THz transmission through the rectangular hole array (two holes with a separation distance 'd' within the unit cell) system where the blue dashed line represents the unit cell of the proposed structure. The rectangular metal film is supported on the Si substrate of thickness 500 µm. The periodicity is considered to be 180 µm along both x- and y- directions. The width and length of the hole considered in our study are 25 µm and 90 µm respectively. A single rectangular hole is considered as the intrinsic case to interpret the results for other structures. For a separation distance d = 3 µm, the SPR peak is observed at 0.465 THz which is similar to the intrinsic case. However, a blue shifting of 7 GHz and 15 GHz are observed by increasing the distance to d = 18 µm and 36 µm, respectively, Figure 1(b). The resonance frequency shifts can be attributed to effective permittivity of the system. This work could be useful in THz based devices (sensors, filters etc.).

References:

1. T. W. Ebbesen, H. J. Lezec, H. F. Ghaemi, T. Thio, and P. A. Wolff, Nature **391**, 667 (1998).
2. S. Banerjee, N. L. Abhishikth, S. Karmakar, D. Kumar, S. Rane, S. Goel, A. K. Azad, and D. R. Chowdhury, J. Opt. (United Kingdom) **22**, (2020).
3. S. Kaur, S. Karmakar, A. Jana, S. Rane, R. K. Varshney, and D. Roy Chowdhury, iScience **25**, (2022).
4. S. Mei, T. Jie, L. I. Zhi-Yuan, C. Bing-Ying, Z. Dao-Zhong, J. Ai-Zi, and Y. Hai-Fang, Chinese Phys. Lett. **23**, 486 (2006).