All-dielectric metasurface infrared absorber with symmetry-protected bound stated in the continuum

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Abstract: The exceptional resonances excited by symmetry-protected quasi-bound states in continuum (Q-BICs). Q-BIC absorption ~ 90% at the communication wavelength was demonstrated by a germanium nanohole metasurface without a back reflector involved.

Keywords *Germanium, nanohole, absorption, boundary in continuum, metasurface*

1. Introduction

A high-quality absorber has less studied in BIC until recently. In the traditional absorber, it was usually produced by the Fabry–Pérot (F-B) cavity and metal-insulator-metal (MIM) structures. In applications, the absorpted energy could be further converted into heat or an electrical signal as a sensor or solar cell[1]. In quasi-BIC absorption development, lately, Yu et.al[2] provided the Si metasurface with the back reflector in critical coupling.

The germanium (Ge) metasurface was useful in the shrinkage of silicon photonics or devices as a result of its high refractive index and low loss intrinsic property[1, 3]. Therefore, we theoretically studied the ultrathin germanium nanohole (GNH) metasurface, without a back reflector involved, using the TCMT and FDTD method. Localized and quasi-BIC absorption was simulated ~90% in the remaining 90 nm Ge. In addition, the primary measurement results were discussed.

2. Results and Discussion

The finite difference time domain (FDTD) method has been used to calculate the absorption. In this modeling, the GNH structure was designed as a circle hole arrays with diameters of 360 nm. The period of the square unit cell was as 500 nm, as shown in Figure 1 (a). The ~ 90% absorption of the remaining Ge thickness at 90 nm without back reflector was calculated and achieved. The super-radiant and the symmetry-protected BIC modes were both shown to have high absorption at the communication wavelength as shown in Figure 1 (b). When the effective k-vector was tuned, quasi-BIC absorption appeared at the off-Γ point. The preliminary experimental results were shown: the reflectance was measured with the remaining Ge thickness of 200 nm using the microscope (N.A. = 0.4). As the hole diameters are larger, the spectrum would be blue shifted. After the improved etching process, the remaining thickness will be trimmed to match the thickness of the modeling. However, the resolution of the measurement for the Q-BIC was also important to show the high Q resonance.

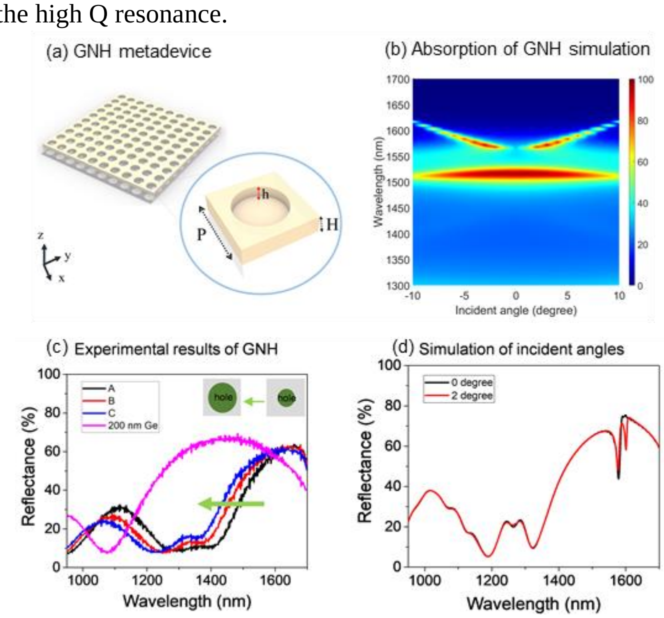

Figure 1 (a) The structure of GNH metadevices and its quarter-wavelength thickness was 300 nm. (b) The super-radiant mode and the symmetry-protected BIC modes had high absorption near 90% at the communication wavelength (c) experiment results and (d) simulation fitting at 0 degree (only super-radiant mode) and 2 degree (super-radiant and symmetry-protected BIC modes).

3. References

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