Polymer Metamaterial for an Ultrathin THz Wave Fresnel Zone Plate

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Metamaterial has shown its magical ability to control the electromagnetic wave propagation by its constituted subwavelength resonators. Among the metamaterial based electromagnetic devices, such as filter, modulator, polarizer, etc., phase control is desired in the applications of spectroscopy and imaging system, especially for the relatively rare devices and components in the terahertz (THz) wave range. Researchers have reported using metamaterial to build up THz wave Fresnel Zone Plate (FZP), but the transmittance is usually low [1, 2] and polarization dependent. In this work, we propose to use flexible film metamaterial with polarization independent unit resonator structure to obtain a phase difference of 1/4 π for a phase FZP with high transmittance.

The metamaterial unit resonators are shown in **Fig. 1**. The two resonators are both electric coupling to the normal incident electromagnetic wave, while since the split gap is closed for the structure in **Fig. 1(b)**, it forms a different fundamental resonance mode from that of inductance-capacitance (*LC*) resonance of the structure in **Fig. 1(a)**. In the design of **Fig. 1(b)**, an additional resonator is added in the backside of the substrate, which makes a relative complex resonating unit for the entire structure, resulting in the phase difference of 1/4 π compared with that of **Fig. 1(a)**. The simulation results on the transmission parameters are shown in **Fig. 2**. It is seen that the phase difference of 1/4 π is obtained at 0.7 THz, while still keeping the high transmittance. The proposed FZP is a 2-dimension array combination of the two type resonators with the thickness of 30 μm, as schematically shown in **Fig. 3**. It is supposed to code resonator array with other arrangement as well for functional devices, such as grating and deflector, to control beam direction.

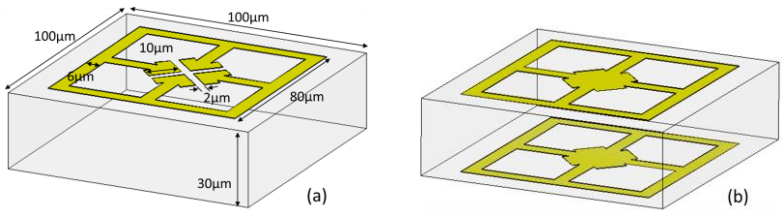
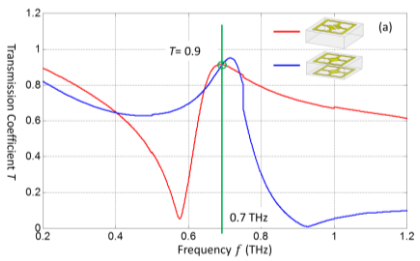


Fig. 1 Design of the etamaterial unit resonator. (a) one layer split ring resonator (SRR). (b) two layer SRR with closed gap.



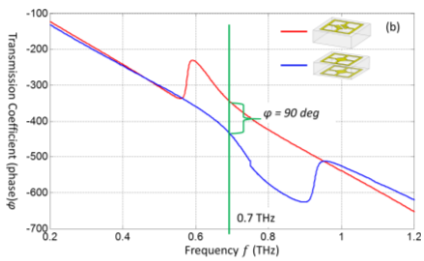


Fig. 2 Transmission of the two type resonators from simulation. (a)Amplitude (b) phase.

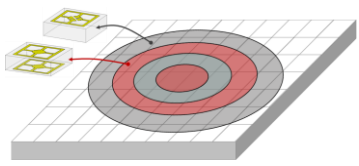


Fig. 3 Schematic of FZP device.

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