Investigation on metamaterial absorber with appropriate absorption bandwidth

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•Abstract

Many previous studies in the field of metamaterial absorbers have showed either wide or narrow absorption bandwidth. In this study, we propose a new electromagnetic metamaterial absorber with an appropriate bandwidth. In addition, the absorption turns out to be insensitive to the polarization of incident electromagnetic wave, and maintains a greatly high absorption even at a large incident angle such as 45 degrees. The absorption band can be adjusted easily with the parameters of structure, and the absorber itself is also flexible, which is good for the practical applications. We believe that the design concept provides a new candidate for some fields where the absorption bandwidth is required specifically, and this suggested absorber can be applied in many practical fields, additionally because of the low cost and superior performance.

•Introduction

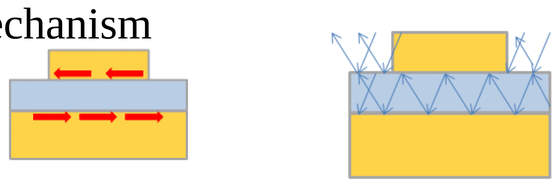
Metamaterials are artificial materials possessing the properties which might not be found in nature. The metamaterials mentioned here refers to metamaterials in the field of electromagnetism. They are usually structured on a size scale smaller than the wavelength of external electromagnetic wave, and expected to impact the entire range of technologies where electromagnetic radiation is used. Potential applications of metamaterials include superlens, cloaking devices, antennas, metamaterial (MA), and so on. MA was proposed by Landy et al. in 2008. (Phys. Rev. Lett. 100, 207402 (2008)).

•Research methods

1.Simulation

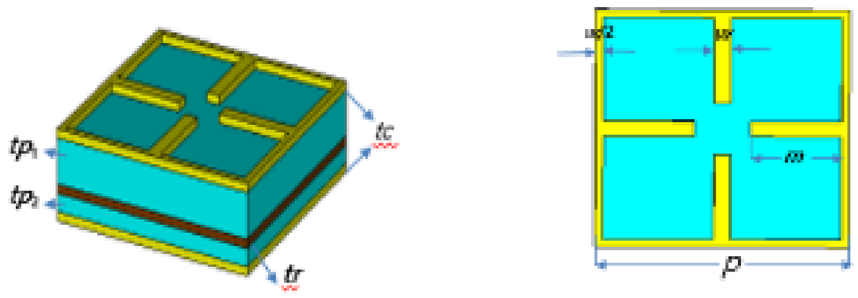
All the simulation results in this work were carried out by using CST software package.

2. Mechanism

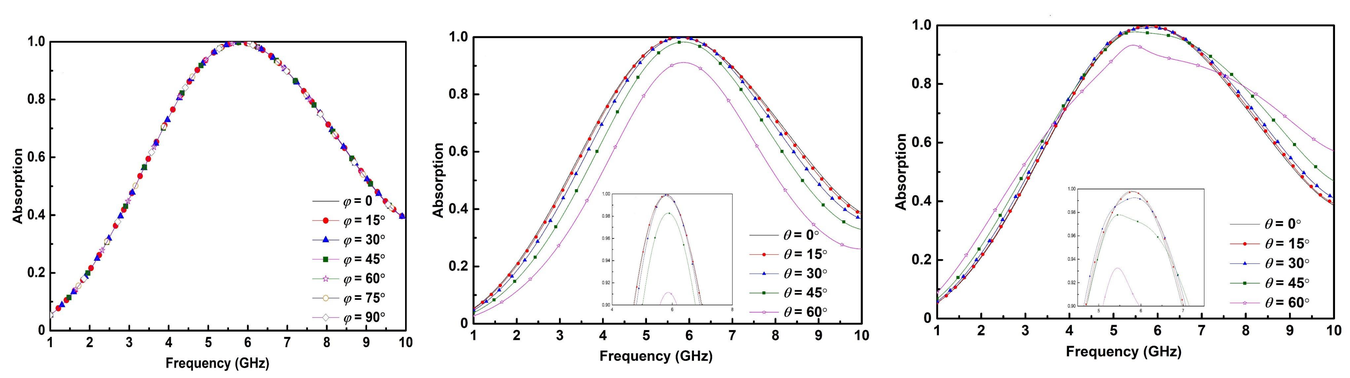


(1) Electric or magnetic resonance on the surfaces of two metallic layers, or
(2) multi-reflections (such as Fabry-Perot interference).

•Structure



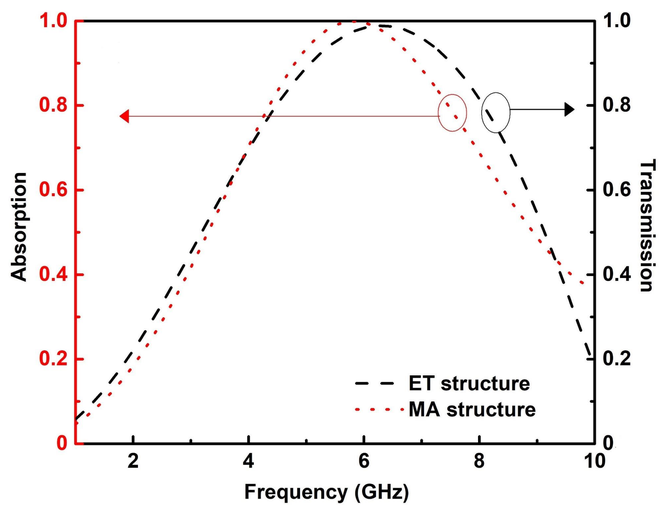
- Polyimide with a dielectric constant of 3.5 and a loss tangent of 0.0027
- Copper with conductivity of $5.8 \times 10^7 S/m$
- Resistive sheet with resistance 540 Ω/sq



Insensitive to polarization

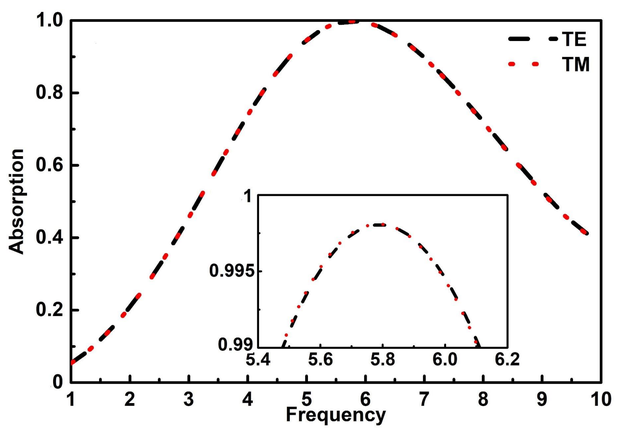
Wide incident angle

Absorption was insensitive to both, since the structure is symmetrical. The absorption remains above 97% in a frequency range from 5.55 to 6.05 GHz, when the incident angle changes from 0 to 45°. The maximum of absorption is still above 90% even at an incidence of 60°.



Two spectra very close but the spectrum of transmission broader than that of absorption. The localized electric and magnetic fields on the surface of MA structure seem to be stronger than that those of EOT one.

•Results and Discussion



The maximum absorption is 99.8% at 5.79 GHz in the case of TE polarization. Absorption over 99% in a frequency range from 5.48 to 6.1 GHz.

•Conclusions

1. A medium-bandwidth MA with superior performance was designed and investigated systematically. The MA was based on the extraordinary-transmission effect.
2. The central frequency of MA is 5.8 GHz, which is useful in our daily life. The absorption is above 99% and 97% for the normal incidence and an oblique incidence of 45°, respectively, in a range of 5.55 to 6.05 GHz.
3. The medium-bandwidth MA turns out to be feasible, and we believe that this MA can be applied to many practical fields, because of its superior performance and relatively-low cost.

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