Frequency and Absorptivity Reconfigurable Plasma Absorber

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***Abstract*—A frequency and absorptivity reconfigurable plasma absorber has been proposed, which consisted of 3-layer plasma column which is encircled by glass tube and metallic ground. The proposed absorber works in a particular polarized mode (TM mode). The results show that the absorber owns an excellent reconfigurable performance, no matter the operation frequency or the absorptivity can be refactored by the changed plasma frequency.**

Keywords—plasma; absorber; reconfiguration

I. Introduction

The research of metamaterials can be traced back to the 1970s [1], it covers a lot of areas, used to implement various physical phenomena, including natural and anomalous effects. The perfect absorber [2] is a significant branch of metamaterials. In the field of the absorber, the tunable absorber [3-5] shows great potential applications in all aspects. Of course, the above-mentioned tunable absorber also has some limitations, for example, the regulation states are relatively simple. The plasma have been extensively investigated as metamaterials [6-8] which shows excellent tunable performance, own more tunable elements. In the previous research [9], the electromagnetic wave can be absorbed regulatory, via the different states of plasma and defect.

In this paper, a frequency and absorptivity reconfigurable plasma absorber has been proposed, the results show that frequency or the absorptivity can be refactored by change the plasma frequency. The frequency point can be changed at any frequency range, the absorption point is f_1=0.528GHz, f_2=1.086GHz, f_3=1.572GHz, f_4=1.992GHz, when the plasma frequency (ω_p) changed from 1 to 4GHz, which the interval is 1GHz. Moreover, the absorption rate can be tuned.

II. Design, Simulation and Discussion

Fig. 1 illustrates cross profile of proposed plasma absorber, which are structured in 3-layer glass tube that fill plasma (like a PPCs), periodic structure in x direction, the period is Λ, the length of tubes are infinite (y direction). The distance between the adjacent two tubes is Λ in z directions. The inner radii of glass tube is r_0 = 5mm, and also whose thickness is Δd = 1mm. The metallic ground is used to prevent transmission, whose thickness (t_m) is larger than the skin depth.

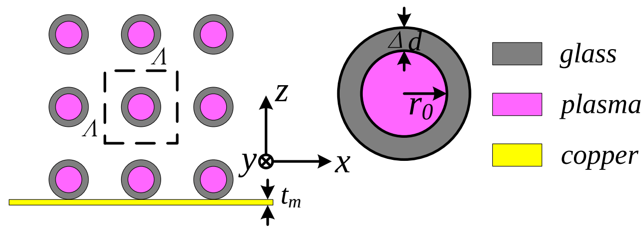

Fig. 1. The cross profile structure of proposed absorber.

Fig. 2 shows the s parameter spectra under TE and TM modes, respectively, in addition, the proposed structure without the complete metal plate who art as a reflector, in this condition, the it can be considered as a plasma photonic crystal (PPC). From Fig. 2, we can see that, under TE mode, the electromagnetic waves are transmitted, different from TE mode, there is an electromagnetic response (photonic bandgap) under TM mode. Fig. 2 indicates that the electromagnetic response mode can be introduced more and more easily in TM mode in the interested frequency region, so the following research only considers TM mode.

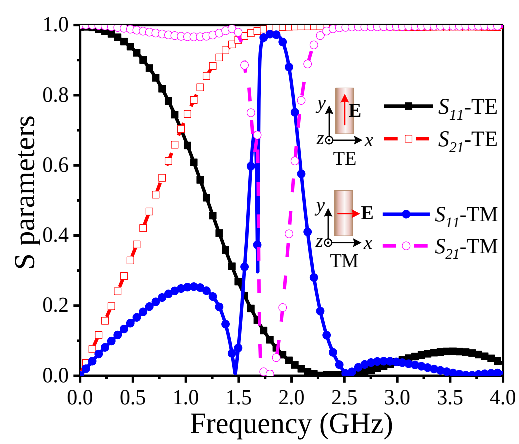

Fig. 2. The S parameters under different polarization modes.

Fig. 3 shows the absorption spectra of proposed absorber with different ω_p. When ω_p=1GHz, the absorption rate of the absorber is 49.03% at 0.528GHz, accordingly, the absorptivity is 76.06%, 97.17%, and 98.35%, respectively, when ω_p=2GHz, ω_p=3GHz and ω_p=4GHz, in proportion to the absorption point f_2=1.086GHz, f_3=1.572GHz, f_4=1.992GHz. We can see that, the position of the absorption frequency shows blue shift with the increase of ω_p. Moreover, the absorption rate increase when ω_p increased, the higher absorption rate for the higher ω_p. The results indicate that frequency or the absorptivity can be refactored effectively via change the plasma frequency.

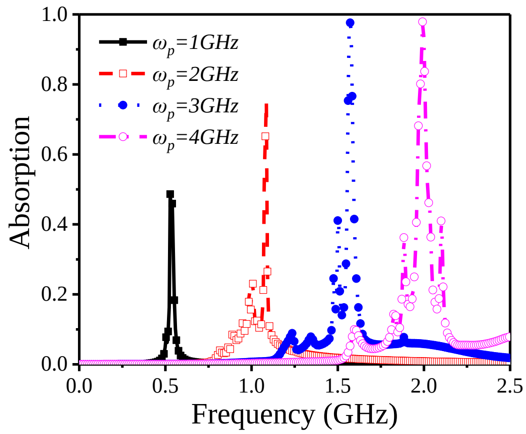

Fig. 3. The absorption spectra of proposed absorber with different ω_p.

Fig. 4 is the absorption rate spectra with different Λ when ω_p=3GHz. From Fig. 4 we can see that double of operation frequency and absorptivity can be tuned by change the period (Λ). The working central frequency is shifted to the higher frequency with the increase of period. In addition, the absorptivity also can be adjusted by the different period.

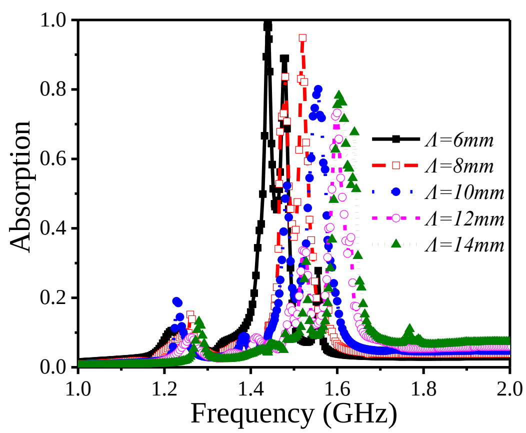

Fig. 4. The absorption spectra of proposed absorber with different Λ.

Fig. 5 shows the E field distribution with the different absorption point, Fig. 5(a) ~ (d) stand for f_1=0.528GHz, f_2=1.086GHz, f_3=1.572GHz, and f_4=1.992GHz, respectively. Fig. 3 indicates that the energy will be dissipated more and more, and the penetration depth also will be increased with the increase of ω_p, if the plasma considered as an equivalent medium with thickness.

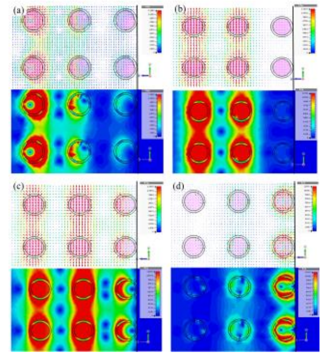

Fig. 5. The E field distribution of the absorption frequency. (a) @0.528GHz, (b) @1.086GHz, (c) @1.572GHz, (d) 1.992GHz.

III. CONCLUSION

In this paper, a reconfigurable plasma absorber has been proposed whose frequency and absorptivity can be refactored, the results indicate that frequency or the absorptivity can be refactored via change the plasma frequency, the absorption point is f_1=0.528GHz, f_2=1.086GHz, f_3=1.572GHz, and f_4=1.992GHz, respectively, when the plasma frequency (ω_p) ranged from 1 to 4GHz, which the interval is 1GHz. Moreover, the absorption rate can be tuned.

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