Microwave metamaterial EM wave absorber using square metal pattern periodic array structure

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1. Introduction

With the recent expansion of electromagnetic (EM) waves, undesired EM waves generated by device can cause malfunctions of other electronic equipment and communication failure. EM wave absorbers are widely used as countermeasures against these problems. Therefore, EMC (Electromagnetic Compatibility) technology is required to improve the electromagnetic environment.

In this study, a microwave metamaterial EM wave absorbers using a sheet with a periodic array of square metal patterns were designed and its reflection characteristics at vertical incidence were experimentally evaluated.

2. Proposed Electromagnetic Wave Absorber

2.1 Metal pattern periodic array sheet

Fig. 1 shows the structure of the metal pattern periodic array sheet used in this study [1]. In this study, the copper foil was used as the metallic pattern. When an electric field is applied parallel to this sheet, it exhibits resonant dispersion properties. By using this property, the sheet operates as EM wave absorber near the resonant frequency.

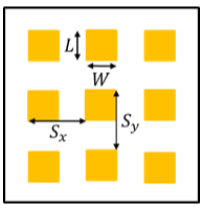


Fig.1 Metallic pattern array sheet

2.2 Structure of proposed EM wave absorber

Fig.2 shows the structure of the proposed EM wave absorber. An acrylic plate (thickness: 2 mm) which is a dielectric layer, is placed on top of the metal plate, and a metal pattern periodic array is directly stacked on top of the acrylic plate to simplify fabrication and improve material strength. When electric fields are incident to the absorber, the specific permeability exhibits a resonant dispersion property [1].

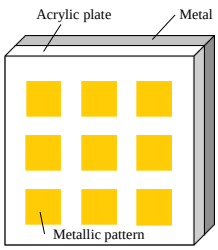
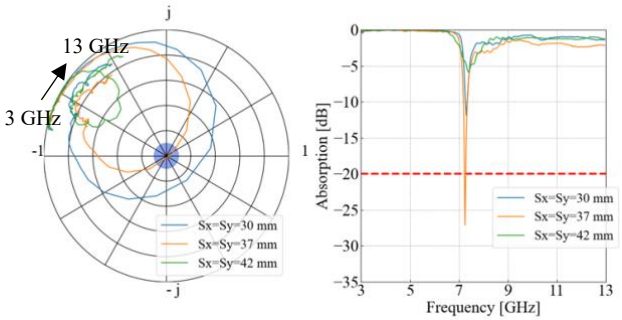


Fig.2 Proposed EM wave absorber

3. Reflectance Characteristic Measurement Result

The measurement frequency range was set from 3GHz to 13GHz so as to cover microwave band technology. Fig. 3 shows the measured reflection characteristics when structural parameters of the metal pattern periodic array sheet L, W are fixed at 11 mm and S_x, S_y are varied from 32 to 42 mm.

Fig. 3(a) shows that the size of the resonant circle depends on the array spacing of the metal pattern. From Fig. 3(b), it can be seen that the resonant frequency hardly changes when the array spacing is changed, indicating that the amount of absorption can be changed by setting the array spacing and varying the density. For the structural parameters of $L = W$ = 11mm and $S_x = Sy$ = 37mm, the matching condition (Less than -20 dB) is satisfied around 7.2 GHz. In this study, the resonance frequency is designed to be near the center of the measurement frequency range.



(a) Reflection coefficient (b)Reflection characteristics

Fig. 3 Reflection characteristics of the proposed metamaterial EM wave absorbers ($L = W$ = 11 mm, $S_x = S_y$ =37 mm) .

4. Conclusion

In this study, reflection characteristics of a metamaterial EM wave absorber with a square metallic pattern periodic array structure were evaluated. It was experimentally confirmed that the matching condition can be obtained when the copper foil is directly attached to the acrylic plate.

References

[1] K.Fujii, et, al., IEEJ Transactions of Fundamentals and Materials, Vol. 142, No. 4, pp.166-167, 2022.

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