EM wave absorber for 28 GHz band without metal backing

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1. Introduction

The recent expansion in the use of electromagnetic (EM) waves has became more important for EM environmental improvement. EM wave absorbers, one of the EMC technology, are usually used with metal backing.

In this study, we proposed a new EM wave absorber without metal backing and evaluated its EM wave absorption characteristics from 26.5 GHz to 40 GHz, including 5G frequencies. This new EM wave absorber is expected to be lighter, thinner, and simplification of sample manufacturing process compared to conventional absorbers. In addition, the transmission characteristics of proposed EM wave absorber were investigated by transmission line calculation.

2. Proposed EM Wave Absorber without Metal Backing

Fig. 1 shows the configuration of the EM wave absorber proposed in this study. It is a two-layered EM wave absorber consisting of a dielectric material and a conductive material [1][2]. The conductive material attenuates EM waves, and the dielectric material prevents reflected waves from the surface of the conductive material. The reflection coefficient Γ and transmission coefficient T of the absorber were calculated using transmission line theory by following equations [1].

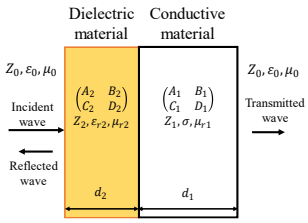

Fig. 1 Configuration of EM wave absorber

$$\Gamma = \frac{A_t + \frac{B_t}{Z_0} - C_t Z_0 - D_t}{A_t + \frac{B_t}{Z_0} + C_t Z_0 + D_t}, \quad T = \frac{2}{A_t + \frac{B_t}{Z_0} + C_t Z_0 + D_t} \quad (1)$$

The four-terminal matrix $\begin{pmatrix} A_t & B_t \\ C_t & D_t \end{pmatrix}$[1] of the absorber was obtained by using the parameters of Fig. 1. Z_0 is the characteristic impedance in free space.

Table 1 Configuration parameters of the EM wave absorber.

Conductive material		
Thickness d_1	Conductivity σ	Relative permeability μ_{r1}
2.0 mm	20 S/m	1
Dielectric material		
Thickness d_2	Relative permittivity ε_{r2}	Relative permeability μ_{r2}
1.0 mm	4.7	1

3. Measured and Calculated Results

Table 1 shows the parameters of the EM wave absorber used in this study. Fig. 2 shows the measured and calculated results of the reflection coefficient of absorber with metal backing using a millimeter-wave band reflection coefficient measurement setup [1]. From this result, we confirmed that the matching condition ($\Gamma \leq -20$ dB) is satisfied in the desired 28 GHz band. Fig. 3 shows the calculated results of Γ, T by changing the thickness of the conductive material d_1 to 2.3 mm. Compared to Fig. 2, Γat around 28GHz is smaller, confirming that T is attenuated below −20 dB from 26 GHz to 40 GHz.

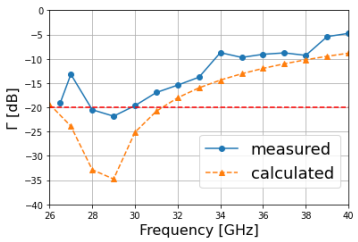

Fig. 2 Reflection characteristics (with metal backing)

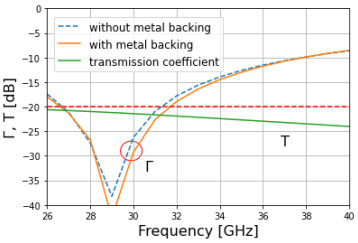

Fig. 3 Calculated results of reflection and transmission characteristics

4. Conclusion

In this study, the new EM wave absorber without metal backing was proposed. The reflection characteristics were evaluated by measurements and calculations. It was confirmed that the matching condition was satisfied at around 28 GHz. In addition, the calculated transmission coefficient was also confirmed to be less than -20 dB.

References

[1] S. Kagekawa, et.al., IEICE Technical Report, EMCJ2022-79, 2023.
[2] S. Kagekawa, et.al., ICETC2022, S12-7, 2022.

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