Design of multilayered high-pass space filter using conductive film grid array sheets and dielectric material

Yuji Taniguchi†, ***Student member***, **Shinichiro Yamamoto**†, ***Member***, **Satoru Aikawa**†, ***Member***, **Shigeki Matsuoka**††, ***Non member***, **Masaki Nagao**††, ***Non member***

1. Introduction

In recent years, various wireless communication devices, such as smartphones and Wi-Fi routers, have been developed rapidly. On the other hand, undesired electromagnetic waves generated by these devices have been problematized that adversely affects the system. The electromagnetic shielding materials are used to solve this problem.

In this study, the authors fabricated a sheet with a periodic array of conductive films in a grid pattern [1] and designed a space filter that can be installed on a wall with a structure in which both sides of the dielectric material are sandwiched by the sheets. Next, the transmission coefficients of the designed space filters were measured and compared with the calculated values based on the transmission line theory.

2. Conductive film grid array sheet

Fig.1 shows a construction of the conductive film grid sheet fabricated in this study. Here, the thickness of the sheet t was fixed at 0.04 mm, the width of the conductive film d was fixed at 1 mm, and the grid spacing a[mm] was varied to evaluate the transmission coefficient.

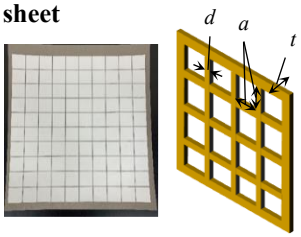


Fig. 1 Construction of conductive film grid

3. Construction of Space Filter and Measurement Result

The structure of the space filter proposed in this study is shown in Fig.2. The transmission coefficient was measured by the free space measurement setup. The transmission coefficients were calculated using transmission line theory [2]. Fig.3 shows the measured and calculated transmission coefficients of the space filter when the grid spacing a is 15 mm, the dielectric material thickness t_d is 2 mm, and the relative permittivity of the dielectric material (Foam material) ε_r = 1.2, and comparison of calculated transmission coefficients when the number of layers is increased, regarding the structure in Fig. 2 (a) as 3-layer.

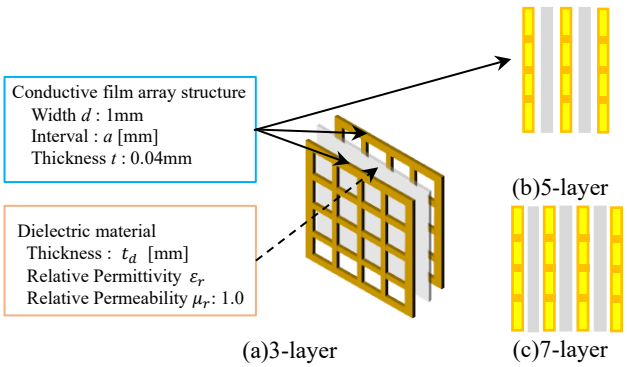
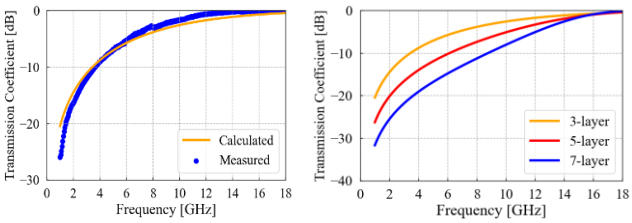


Fig. 2 Space filter structures proposed in this study

From this result, we confirmed that the proposed structure operates as a filter that shields electromagnetic waves around 1 to 2 GHz and transmits higher frequencies, and the measured and calculated values are in good agreement. In addition, by increasing the number of filter layers, it was found that it is possible to fabricate filters with steeper transmission characteristics.



(a)$\varepsilon_r = 1.2$ (Foam material) (b) Comparison of number of layers

Fig. 3 Transmission characteristics of proposed space filters

4. Conclusion

In this study, we proposed a space filter with a new structure using conductive film grid array sheets. We have confirmed that the measured and calculated values give the characteristics of the high-pass filter. Band-pass characteristics can be obtained by changing the structure of Fig. 2.

References

[1]R. Ebara, et.al., IEICE Communications Express, Vol.10, No.5, pp.254-259, 2021.
[2]T. Nishiuchi, et.al., IEICE Technical Report, EMCJ 2019-14, pp.7-12, 2019.

†The authors are with Graduate School of Engineering, University of Hyogo, Shosha, Himeji-shi, Hyogo, 671-2280 Japan.
††The authors are with Zippertubing (JAPAN), Ltd, 3-2-8 Takatsukadai, Nishi-ku, Kobe-shi, Hyogo, 651-2271 Japan.