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A Consideration on Radiation Properties of Multiband Sierpinski Gasket Microstrip Antenna (SG-MSA)

Shinya TADA, Ridho CHAYONO, Yuichi KIMURA, and Misao HANEISHI
Dept. of Electrical and Electronic Systems, Saitama University
255 Shimo-Ohkubo, Sakura-ku, Saitama-shi, Saitama 338-8570, Japan
E-mail: *haneishi@ees.saitama-u.ac.jp*

1. Introduction

Microstrip antenna (MSA) with fractal sierpinski gasket structure is recently used as a useful multiband planar antenna [1]-[6].

In this paper, a multiband fractal sierpinski gasket MSA (SG-MSA) with inserted triangle elements is proposed as a new type of multiband planar antenna. In addition, a new type of SG-MSA with slits is also proposed here.

In order to verify the performances of these SG-MSAs, some SG-MSA samples are constructed and tested in the S- and X-band. The experimental results reveal that the test antennas perform well in terms of both radiation patterns and return loss characteristics.

Basic design technique and radiation property of these new types of SG-MSA elements are presented here.

2. Design Consideration of a SG-MSA with Inserted Triangle Elements

Basic configuration of the SG-MSA with inserted triangle elements is shown in Fig. 1. Smaller equilateral triangular elements corresponding to the fractal stages are inserted into SG-MSA element. The antenna is fabricated using PTFE substrate with $\varepsilon_r = 2.6$, $\tan\delta = 0.0018$ and 1.2 mm of thickness. The antenna is tested and is also simulated by IE3D[7]. The return-loss characteristics obtained by the measurement and the simulation are presented in Fig. 2. Three resonant frequencies are observed at 3.502, 10.08, and 11.51 GHz, which is associated with dominant mode, 1st higher mode, and 2nd higher one, respectively. The computed results of the return-loss characteristics agree well with the experimental ones.

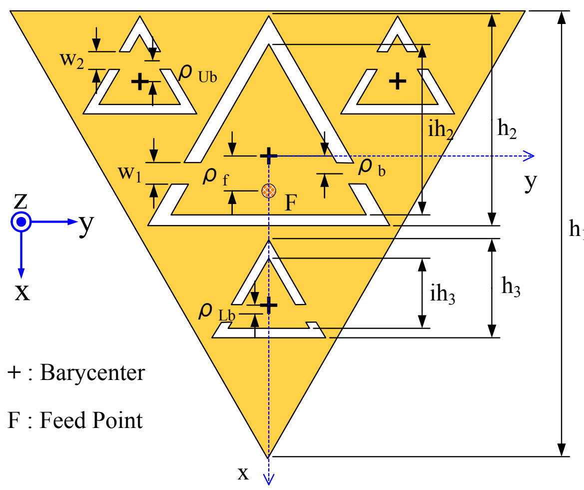

Fig. 1 A Sierpinski gasket microstrip antenna (SG-MSA) with inserted triangle elements

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The radiation patterns of the test antenna are shown in Fig. 3. Unidirectional radiation patterns are obtained for all modes up to 2nd higher order mode as shown in Fig.3.

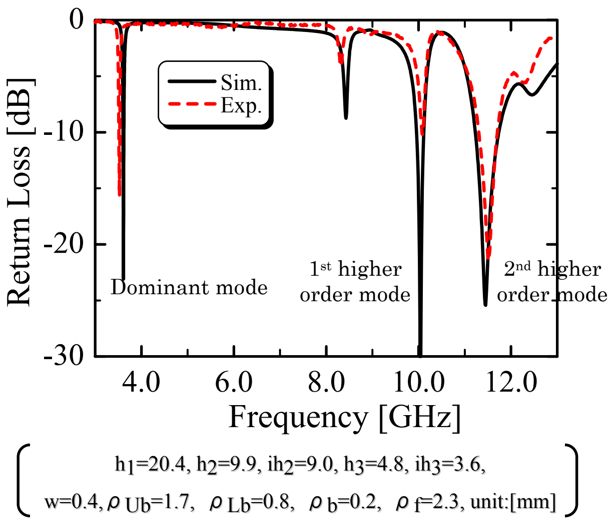


Fig. 2 Return loss characteristics of a SG-MSA with inserted triangle elements

Furthermore, directive gains of 6.9 dBi, 8.0 dBi, and 8.4 dBi are confirmed by the measurement for dominant mode, 1st higher order mode, and 2nd higher order mode, respectively.

3. Design Consideration of SG-MSA with Slits

In order to realize further multiband operation between dominant mode frequency and 1st higher order mode one, a new type of SG-MSA with slits is proposed.

A L-probe is used as a feeding probe for exciting the test antenna. Figure 4 shows the basic configuration of this new type of the SG-MSA with slits. Both configuration and its feeding system for the test antenna are shown in Fig. 4, respectively.

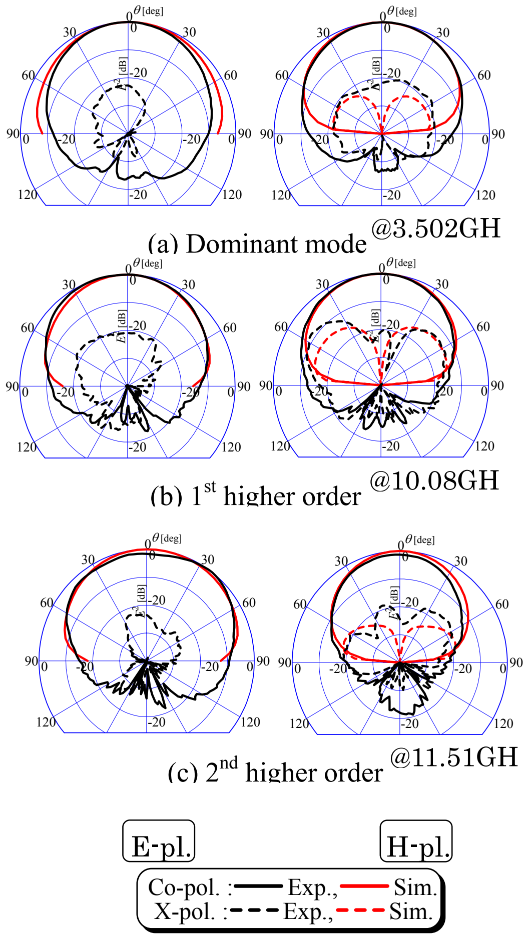
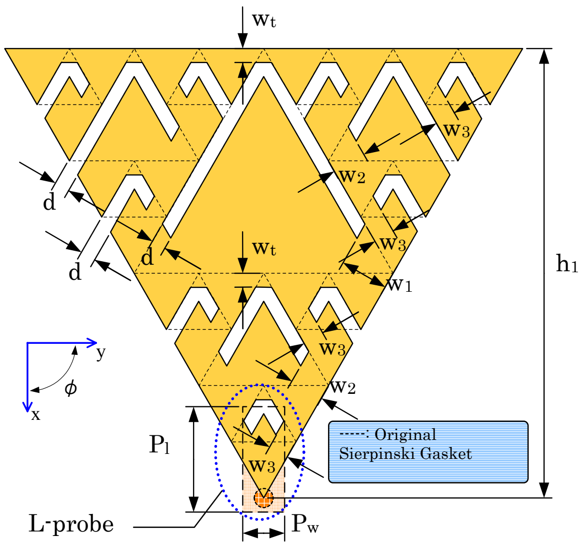
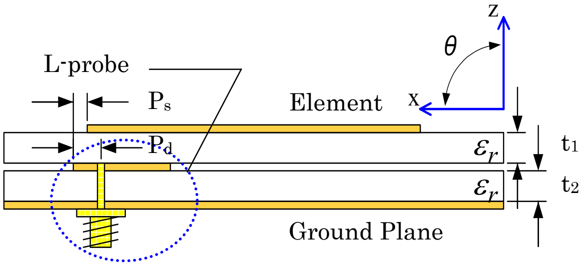


Fig. 3 Radiation patterns of a SG-MSA with inserted triangle elements

The return-loss characteristics and radiation patterns of the test antenna are obtained by IE3D simulation. Figure 5 shows the return-loss characteristics of the SG-MSA with slits. Radiation patterns in E- and H- planes of the SG-MSA with slits are shown in Fig. 7. Symmetrical unidirectional radiation patterns are achieved for both E- and H-planes in every resonant frequency. From these results, it is confirmed that this antenna exhibits good performance in both return loss characteristic and radiation patterns.

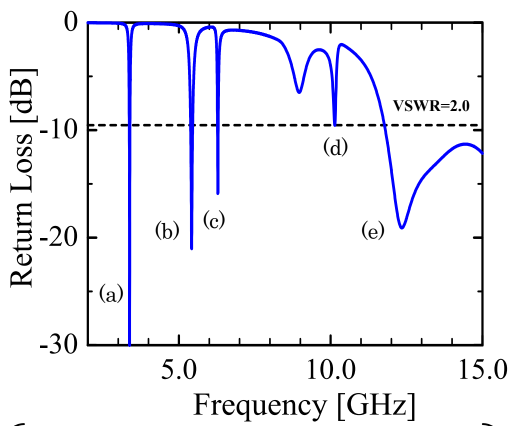


(a) Slit SG-MSA configuration



(b) L-probe feeding system

Fig. 4 Geometry of a SG-MSA with slits and its feeding system



h_1=20.4, d=0.4, w_t=0.4, w_1=2.0, w_2=1.6, w_3=0.8, P_l=3.8, P_w=1.5, P_s=0.8, P_d=0.8, t_1=0.6, t_2=0.6, unit:[mm], ε_r =2.6

Fig. 5 Return-loss characteristics of a SG-MSA with slits

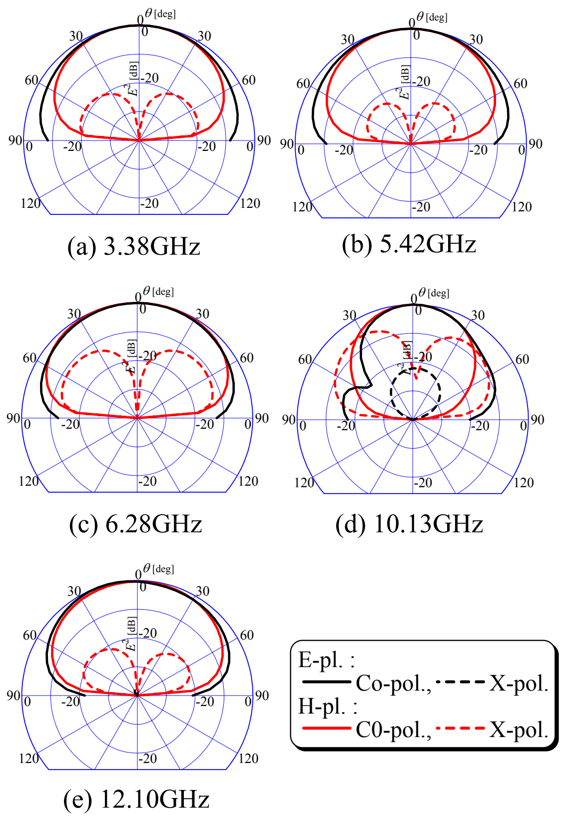


Fig. 6 Radiation patterns of a SG-MSA with slits

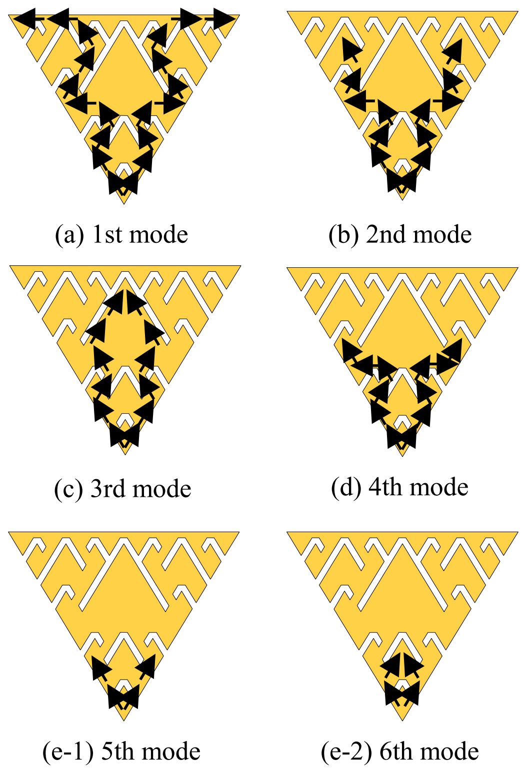


Fig. 7 Current distributions of the proposed SG-MSA with slits

Current distributions of the test antenna for each resonant frequency are also presented in Fig. 7 (a), (b), (c), (d), (e-1) and (e-2), respectively. The start point of each current is at the bottom of the SG-MSA with slits, as shown in Fig. 7. For this reason, the L-probe is set at the bottom of the SG-MSA for exciting the test antenna, as shown in Fig. 4. The resonant frequency of (e) 12.12 GHz is regarded as a mixture of the current distributions of (e-1) 5^{th} mode and (e-2) 6^{th} mode.

4. Conclusion

The radiation properties of the SG-MSA with inserted triangle elements and the SG-MSA with slits are presented in this paper. The simulations and measurements are carried out at the S- and X-band. Satisfactory performances of these SG-MSAs for multiband operation are achieved in terms of both radiation patterns and return-loss characteristics. Therefore, these types of SG-MSAs are considered to be a useful model for multiband planar antennas.

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