High Gain Spiral Antenna with Conical Wall

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***Abstract*-This paper presents design for a spiral antenna with conical wall to realize the high gain. To improve the axial ratio and the gain of spiral antenna, the conical wall and the optimized Archimedean slit on ground plane are novel designed for the conventional antenna with the circular cavity wall and with the 4.5-turn slit. The good axial ratio of 1.9 dB below and the improved gain of 9.5 dBi above are measured by the added conical wall and the novel designed slit on ground plane, respectively. The measured E-field radiation patterns and main beam directivity toward +z axis direction are agreed well with the simulated results.The proposed antenna will be applied for the NLJD system.**

I. INTRODUCTION

In recent years, the electronic semi-conductor device industry has rapidly developed and becomes minimization. The super minimal semi-conductor with the high performance is frequently used for memory chips with big capacity. To detect a tiny chip made by the semi-conductor or the false junction material which is composed of a semi-conductor and a metal, a non-linear junction detector (NLJD) system has been developed [1]. In this paper, authors designed the high gain spiral antenna with novel Archimedean spiral slit on ground plane to realize the circular polarization and designed the novel cavity added conical wall to realize the high gain.

II. ANTENNA DESIGN

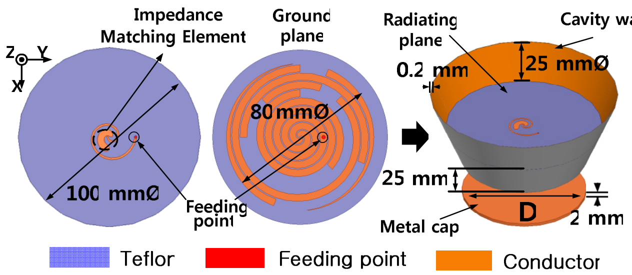


Figure 1. Spiral antenna composed of conical wall and optimized spiral slit ground structure.

Figure 1 shows spiral antenna composed of conical wall and optimized spiral slit ground structure. A diameter of the spiral antenna is 80 mmØ, and Archimedean slit is located on ground plane. The substrate of antenna is used for the teflon dielectric material having relative permittivity of 2.1 and height of 0.6 mm. The cavity wall thickness of 0.2 mm with FR-4_epoxy and metal cap thickness of 2 mm are considered in design. The required antenna bandwidth including transmitting frequency and receiving frequency is from 2.4 GHz to 7.36 GHz. The Tx band is from 2.4 to 2.48 GHz, and the Rx band is from 4.84 to 4.92 GHz for 2nd harmonic frequency and from 7.28 to 7.36 GHz for 3rd harmonic frequency.

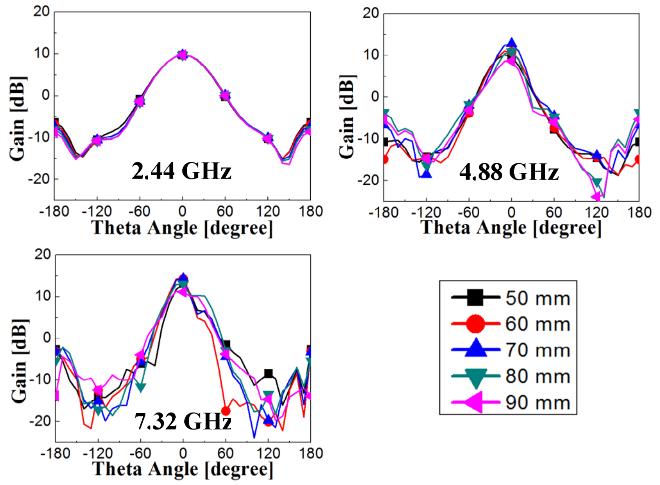


Figure 2. Simulated radiation pattern(X-Z) by variation of D.

Figure 2 shows the simulated radiation pattern characteristics by variation of the metal cap diameter D. Gain shows the maximum value at the 2nd and the 3rd frequency, when D equals 70 mmØ. The simulated gain of spiral antenna added conical wall at 2.44 GHz, 4.88 GHz and 7.32 GHz of center frequency of interested bands appears 9.74 dBi, 12.67 dBi and 14.05 dBi. Gain at Tx frequency, 2nd and 3rd harmonic frequency shows higher about 2.5 dBi, 5.4 dBi and 3.5 dBi than conventional one of refernce [2], respectively.

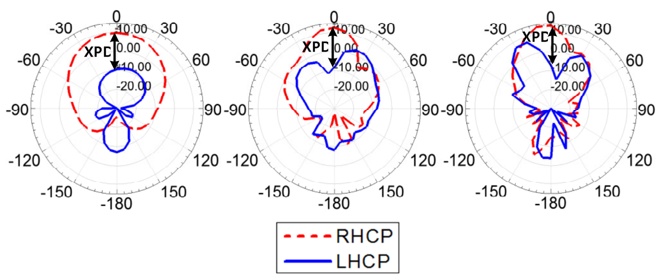


Figure 3. Simulated radiation patterns of LHCP and RHCP for antenna structure in figure 1.

Figure 3 shows the simulated radiation patterns of LHCP and RHCP for antenna structure in Figure 1. The XPD (cross polarization discrimination) is about 19.225 dB, 20.9 dB and 21.142 dB at 2.44 GHz, 4.88 GHz, and 7.32 GHz, respectively, where theta = 0° and phi = 0°. Therefore, the good axial ratio with 3 dB below as shown in Figure 5(b) is obtained at the interested bands.

III. MEASUREMENT

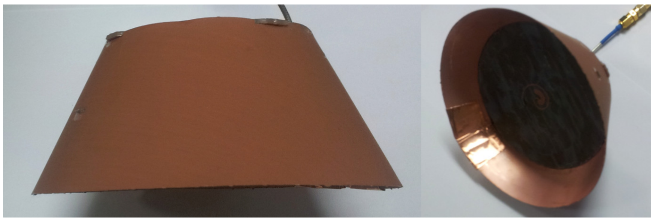
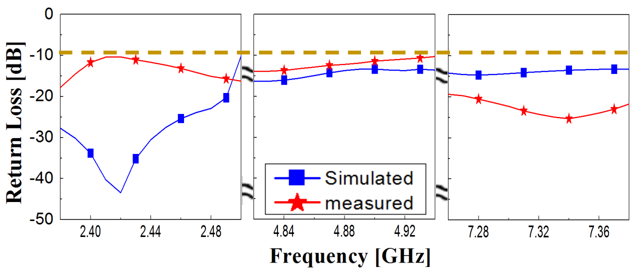
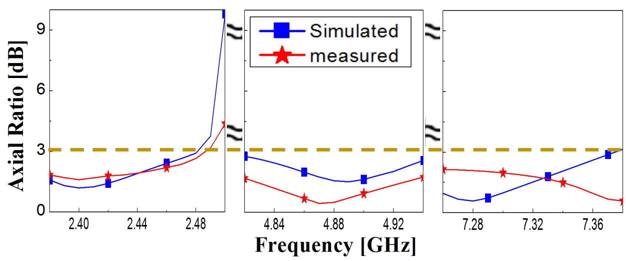


Figure 4. Photograph of a fabricated antenna.

In order to verify the propriety of a proposed antenna, the novel antenna with the optimized slit on ground plane and with the added conical wall was fabricated as shown in Figure 4. Figure 5 (a) shows the comparison between the simulated and the measured return loss of designed and fabricated antenna, respectively. The measured return loss shows reasonable agreement with the simulated one, even it is slightly different. Figure 5 (b) shows the comparison of the simulated and the measured axial ratio. The simulated axial ratio and the measured axial ratio show good agreement and it keeps 3 dB below at the interested band.



(a) Return loss



(b) Axial ratio

Figure 5. Comparison between the simulated result and the measured result of a proposed novel antenna.

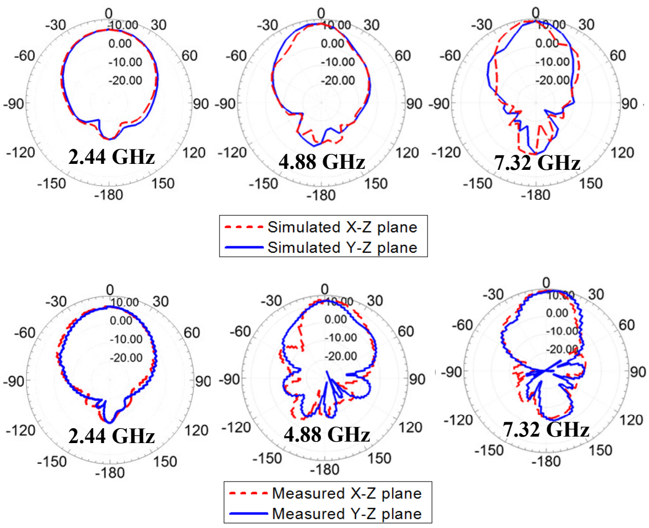


Figure 6. Simulated and measured gain patterns (Solid line: y-z plane, Dotted line: x-z plane).

Figure 6 shows the comparison between the simulated and the measured 2-D gain patterns at 2.44 GHz, 4.88 GHz and 7.32 GHz. Solid line and dotted line indicate the main E-field polarization of the x-z plane and of the y-z plane, respectively. The measured E-field gain patterns are showed very good agreement with the simulation results as shown in Figure 6.

IV. CONCLUSION

This paper proposed a design for the spiral antenna with conical wall to obtain the high gain. An application of the proposed antenna is the NLJD system. To improve the gain and the axial ratio of spiral antenna, the conical wall and the newly designed Archimedean slit on ground plane are considered for the conventional antenna with the circular cavity wall and with the conventional 4.5-turn slit. The improved gain of 9.74 dBi, 12.67 dBi and 14.05 dBi at 2.44 GHz, 4.88 GHz and 7.32 GHz and the good axial ratio of 1.9 dB below at the interested band are realized by the added conical wall and the newly designed slit from current distribution control on ground plane, respectively. The measured return loss, axial ratio and E-field patterns are agreed well with simulation results.

ACKNOWLEDGEMENT

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