A Chip antenna with Magneto-Dielectric material

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Introduction

As the mobile communication devices are smaller, antenna miniaturization is becoming increasingly important. At this time, one of solutions for the antenna downsizing is using materials with permittivity and permeability which is greater than one. In recent years, many studies on miniaturization of the antenna utilizing magneto-dielectric material have been reported[1-3].

In this paper, a compact chip antenna with the magneto-dielectric material is presented. In general, the magneto-dielectric material has been applied at the low frequency because of the characteristics of that[4]. At this time, I wanted to check out the performance of the antenna at the high frequency when the magneto-dielectric material is applied. The size of the bent antenna is $9.5 \times 3 \times 1$ mm^3 and the bandwidth is about 875MHz(3-3.875GHz) at $S_{11} < -10$dB. Also, the measured maximum gain is 4.92dBi at 3.74GHz. Details of the proposed antenna and supporter design are described and the measured results are presented.

Antenna design

Fig.1 shows the configuration and dimensional details of the proposed chip antenna. The antenna is placed on the topmost right side of a FR-4 substrate with the size $90 \times 150 \times 1$ mm^3 considered to be the circuit board of a PDA terminal. The metal in the main substrate is printed on the only front side and the substrate has a rectangular feeding metal which size is 1.5×10.5 mm^2. Also, the antenna is fed by a 50-Ω coaxial line which inner conductor is directly connected to the feed part in the substrate. As seen in Fig.1(c), the proposed antenna with the size $16 \times 3 \times 0.2$ mm^3 is the n-shaped metal strip and is supported by the material which contains the ferrite powder. Fig.2 shows the characteristics of the ferrite powder at frequency range from 50MHz to 5GHz. For reducing the volume, the antenna element is bent according to the folded line in Fig.1(c). For good impedance matching and miniature characteristics, the metal in the center is removed and the magneto-dielectric material is applied. The proposed antenna and magneto-dielectric material are fabricated and measured. The experimental results are presented in the following section.

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Results and discussion

The proposed chip antenna with the magneto-dielectric material has manufactured and its return loss and radiation patterns are measured in order to get its characteristics. Two materials, polycarbonate and magneto-dielectric material that the ferrite powder 10% add to the polycarbonate, are applied to the antenna as a supporter. Fig.3 and 4show the measured material characteristics and return loss of the fabricated chip antenna. In Fig.3, there are some differences in the imaginary part of complex permeability and permittivity between two materials. As seen in Fig.3(a), the real part of complex permittivity in magneto-dielectric material is higher than one of polycarbonate because of adding the ferrite powder. From Fig.4, when the magneto-dielectric supporter is applied, the impedance matching is better and the resonating frequency is shifting lower because of varying the charateristics of the material. The proposed chip antenna resonates at 3.515GHz with the bandwidth 875MHz starting from 3GHz to 3.875GHz at S_{11} < -10dB. Fig.5 expresses the measured radiation pattern at 3.515GHz and the maximum gain is 4.92dBi at 3.74GHz.

Conclusion

This paper presents a chip antenna with the magneto-dielectric material. The proposed antenna with a supporter has a compact dimension of $9.5 \times 3 \times 1$ mm^3. The bandwidth is 875MHz which range is from 3GHz to 3.875GHz at S_{11} < -10dB and the maximum gain is 4.92dBi at 3.74GHz. In this case, the magneto dielectric material is not perfect because the real value of the complex permeability is not higher than one. So, in the near future, we will try to manufacture again and then apply to the antenna which covers other frequency band.

Acknowledgments

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References:

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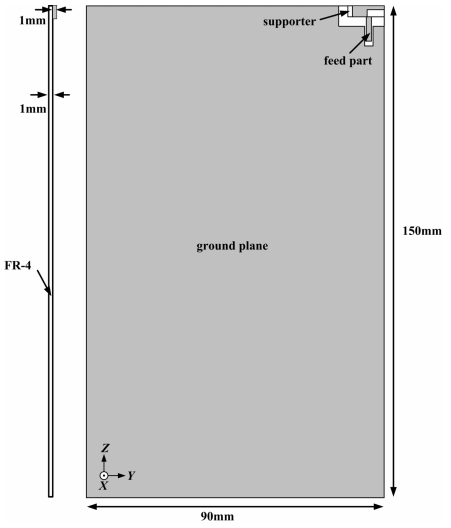
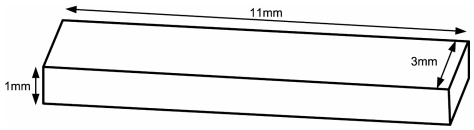
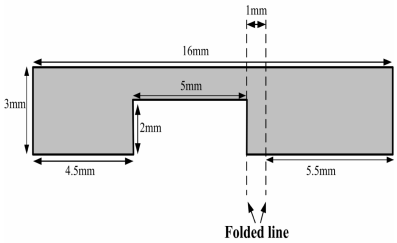


(a) The side and top view



(b) a magneto-dielectric material supporter



(c) Detail dimensions of the proposed antenna

Fig.1. Geometry of the proposed chip antenna with the magneto-dielectric material (unit : mm)

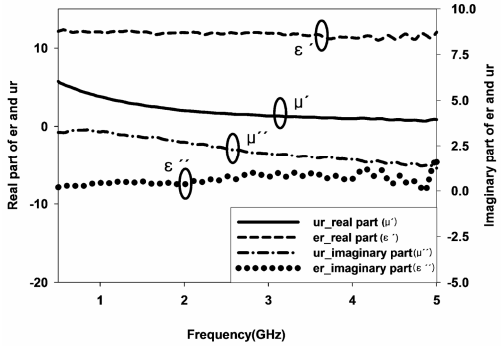
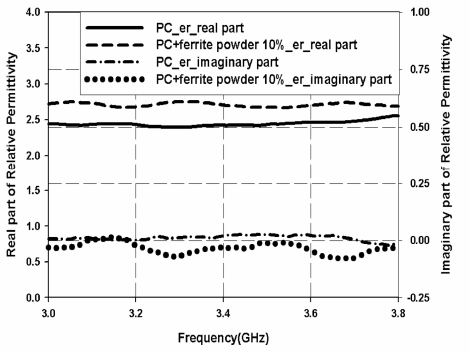
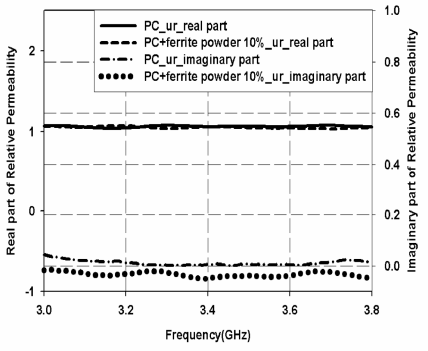


Fig. 2. The measured characteristics of the ferrite powder



(a) The complex permittivity



(b) The complex permeability

Fig.3. The compared characteristics of the Polycarbonate and PC+ferrite powder

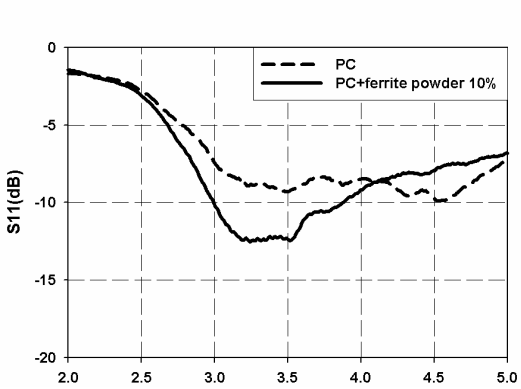


Fig. 4. The measured return loss of the proposed antenna with magneto-dielectric material

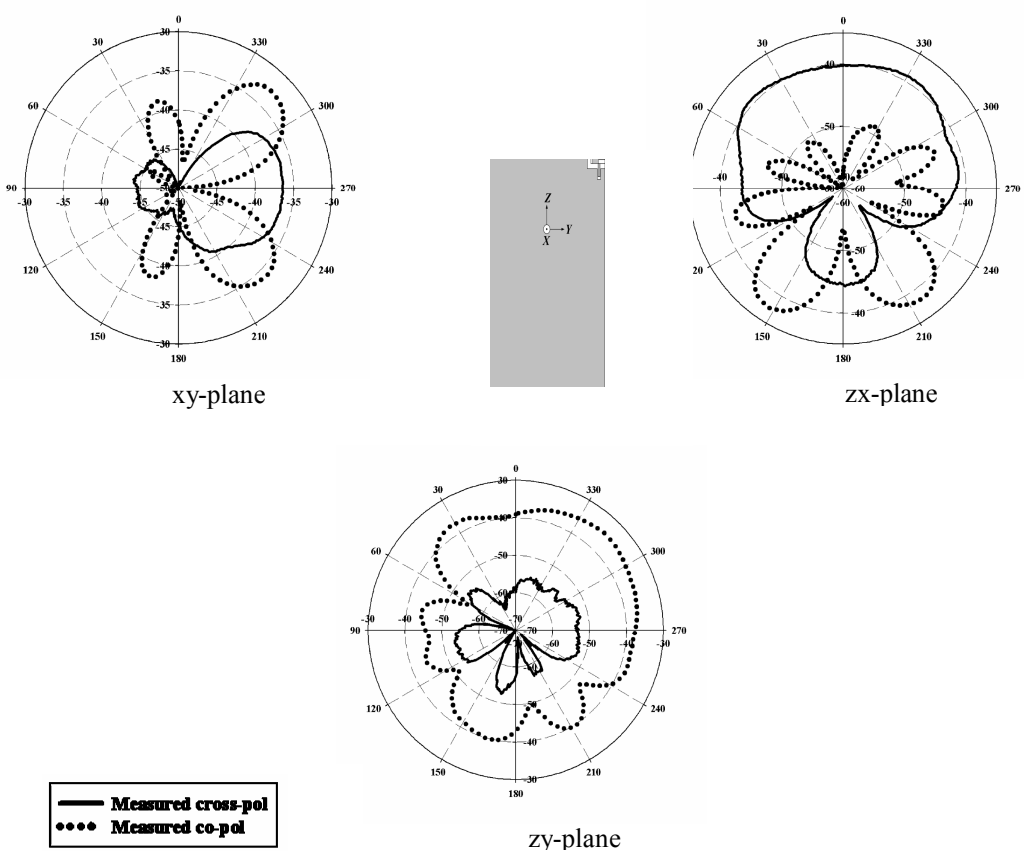


Fig. 5. Measured radiation patterns of the proposed antenna with magneto-dielectric material at 3.515GHz