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Efficiency Improvement for Horn Antenna Using Gaussian Shape Metamaterial for Wireless Applications

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ABSTRACT

In this paper deals with efficiency improvement for horn antenna for wireless applications using metamaterials. The basic horn antenna provides the gain for 8db, in this paper provides 16 db using metamaterial. The efficiency of this paper is approximately 92% for a horn antenna. The analysis parameters are return loss, input impedance, gain, efficiency and E&H field analysis. The technique has an advantages of low profile, low cost for fabrication. The antenna is simulated by HFSS (High Frequency Structural Simulator) software. The HFSS software is a most advanced 3D structure software. It is used to design for complex RF circuits. The applications for X and Ku –band radar. Metamaterial is also called as zero index material. It is operated at 14GHz frequency. There are many various compositions of Electromagnetic metamaterials available like negative refractive index, double negative metamaterial, single negative metamaterial, electromagnetic band gap metamaterial, double positive medium, bi-isotropic &anisotropic metamaterial, chiral metamaterial which are used for various applications.

Keywords: Horn antenna, Metamaterial and Zero index material.

1. INTRODUCTION

A horn antenna is one of the simplest and probably the most widely used in ultra- high frequency (UHF) and microwave frequency (above 300MHz). A horn antenna is widely applied at various applications. In recent days metamaterial is widely used for wireless applications. Which is can’t find in natural material, this is specially designed composite structure have some unique properties [1]. This is promising the candidates as antenna structure for miniaturization, sensing, bandwidth enhancement and for controlling direction of radiation. Gain improvement of a conventional rectangular horn antenna using the new technique of curved-woodpile EBG structure associated with dielectric is presented. From the obtained results, obviously, the proposed antenna provides the directive gain increasing around 7 dB when such EBG structure was added without its construction enlargement. Because the proper structure of curved-woodpile EBG is capable to enhance the gain of antenna as the additional resonant circuit, which installed at front end of a horn antenna [2][3].

To reduce the distance between a horn and curved-woodpile EBG, the dielectric is inserted in layers of the curved-woodpile EBG [1]. The quadratic-shaped of woodpile Electromagnetic Band Gap (EBG) and the mushroom-like EBG have been utilized to increase the gain instead. The important technique for gain improvement of this method that is, the electromagnetic fields from horn antenna will be transferred through its normal structure, then, 1×22 unit cells of mushroom-like EBG located on two side-wing slabs [4].

It help gain the energy of EM fields and suppress some surface waves that occurred on each side-wing slabs. The producing waves will be transferred forward to the woodpile EBG for improving gain in the last step. The proposed technique has the advantages of low profile, low cost for fabrication and light weight [5][6]. From their widespread applicability stems from their simplicity in construction, ease of excitation, versatility, large gain, and preferred overall performance. Therefore, these applications requiring high gain antenna such as the parabolic reflector can be applied with the horn antenna to enhance the higher gain.

Wongsan et al. presented an additional Electromagnetic Band Gap (EBG) to improve the gain of a rectangular horn antenna by using woodpile EBG structures, transferring the power from its aperture through EBG structures[7][8][9].

2. CONFIGURATION

A. Horn Antenna Configuration

The horn antenna consists of flaring metal waveguide for guide the radio waves into free space(air).The design of a horn antenna(type A) is initiated by the dimensions as follow, as shown in fig.1. To enhance the efficiency and radiation characteristics, a horn antenna will be add a two side-wings on the antenna (type B). In common microwave transmission line is waveguide .which is having a hollow pipe carrying an EM wave.

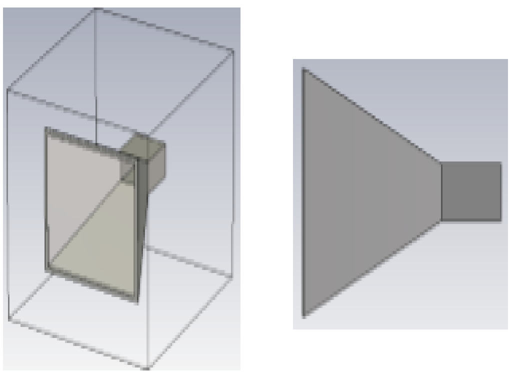


Fig.1. Conventional rectangular horn antenna

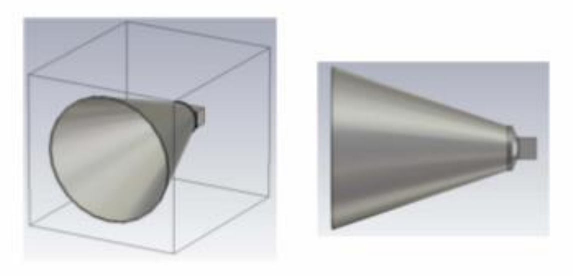


Fig 2. (a) Perspective view (b) side view

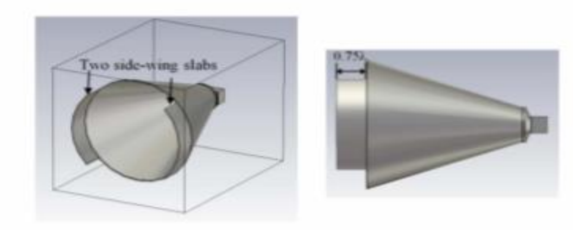


Fig.2 (a) perspective view (b) side view

(a) Front view (b) side view

B. Metamaterial Configuration

From the investigation, the sector of Gaussian shaped woodpile metamaterial is more suitable for beam shape of horn antenna [11]. In this paper applies the similar geometry of the Gaussian shaped woodpile metamaterial structure shown in fig.3.

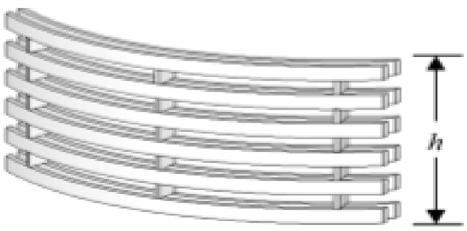
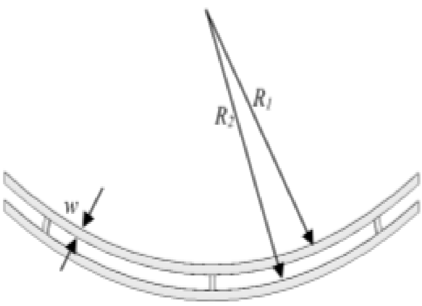
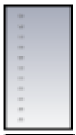
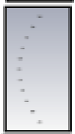


Fig 3. (a) Perspective view



(b) Top view

Table 1. Formulation of elementary geomaterial function

Distributed functions	Formulations	Shapes of EBG Structures
Planar	-	
Triangular	$f(x,y)=A\left(1-\frac{2}{D}\sqrt{x^2+y^2}\right)$	
Quadratic	$f(x,y)=A\left[1-\left(\frac{2}{D}\sqrt{x^2+y^2}\right)^2\right]$	
Circular	$f(x,y)=A\sqrt{1-\left(\frac{2}{D}\sqrt{x^2+y^2}\right)^2}$	
Gaussian	$f(x,y)=Ae^{-\left(\frac{2}{D}\sqrt{x^2+y^2}\right)^2}$	

Simulation results

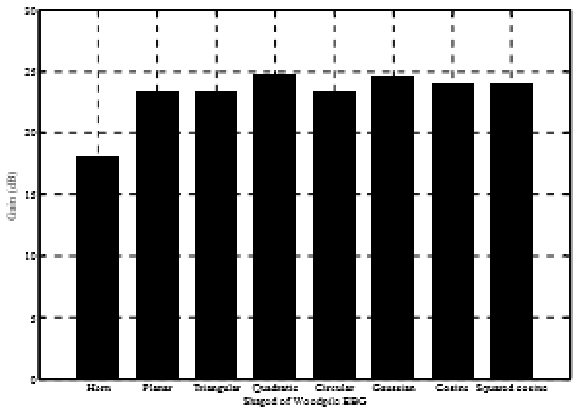


Fig 4. Gain for the various shaped woodpile structure

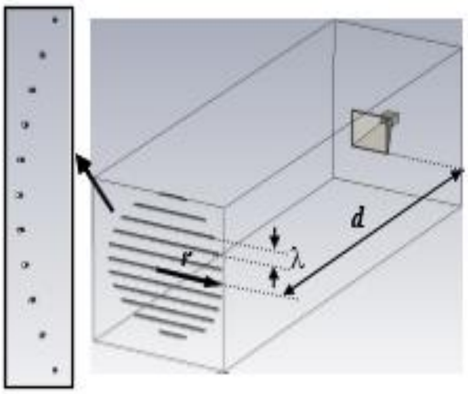


Fig 5.(a) A horn with quadratic shaped metamaterial

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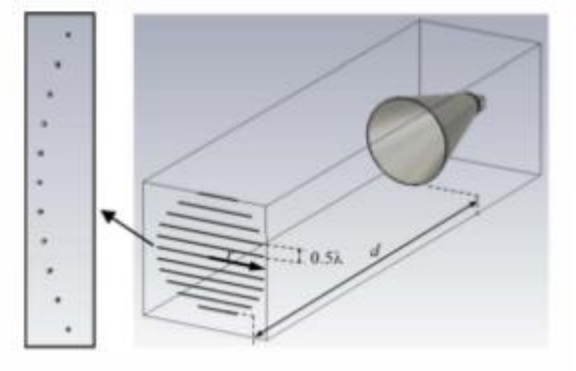


(b) A horn antenna with Gaussian shaped woodpile metamaterial

3. RESULTS AND DISCUSSION

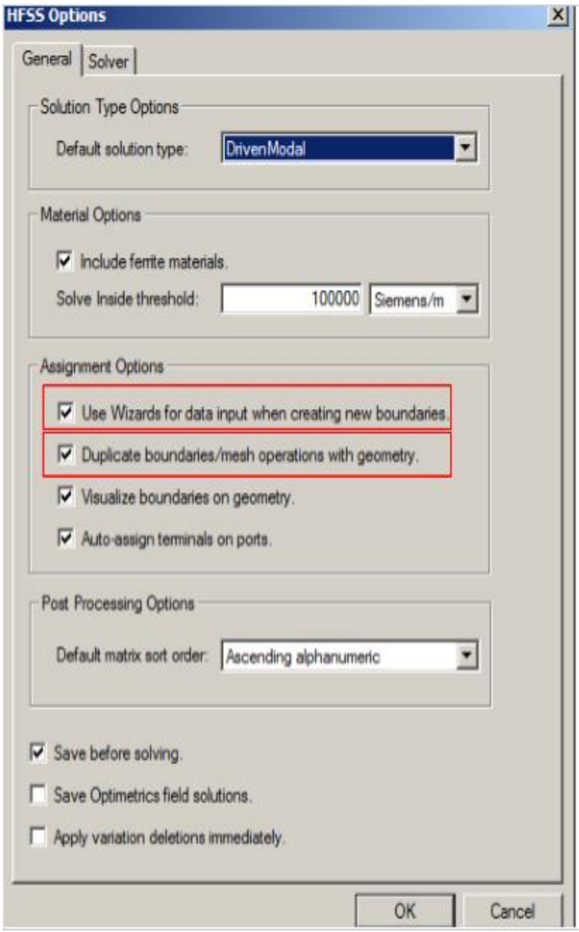
Analysis parameters

1. Return loss
2. Gain in 2D
3. Gain in 3D
4. Polar plot
5. Input impedance

4. INTRODUCTION FOR SIMULATION SOFTWARE

ANSYS HFSS (High Frequency Structural Simulator) is an industrial standard tool for simulating 3D full wave electromagnetic fields. It is used to design for complex RF electronic circuits. IT bases its design &analysis method on the finite element method.

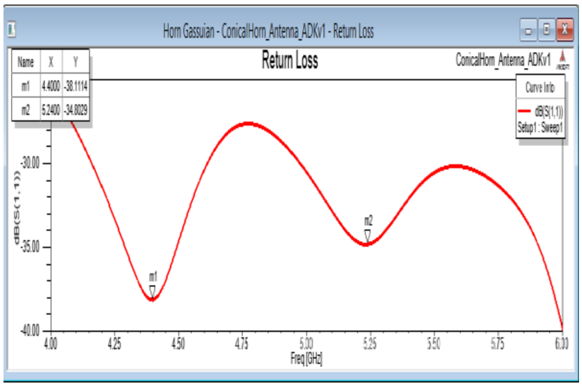
GETTING STATRED



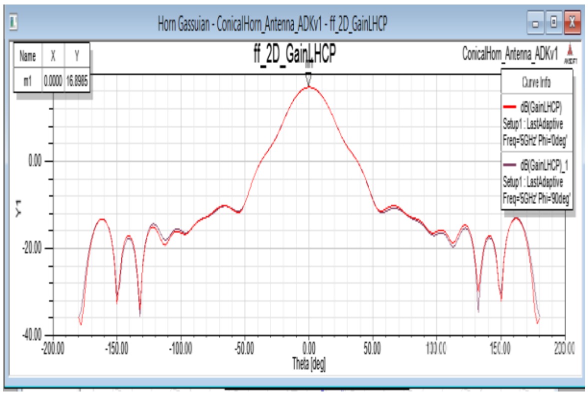
Launch HFSS

Start->all programs->ANSSYS Electromagnetic->HFSS 15.0->Windows 64 bit->HFSS->15.0

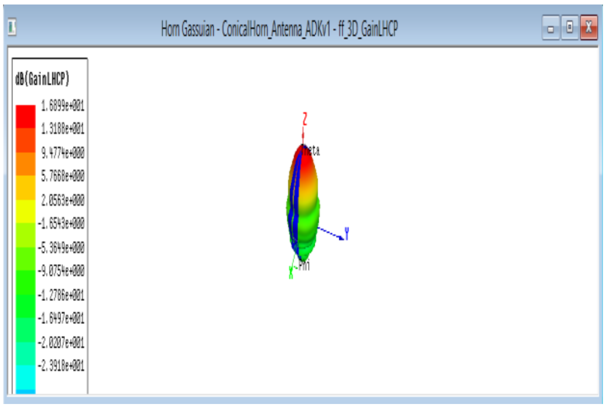
1. RETURN LOSS



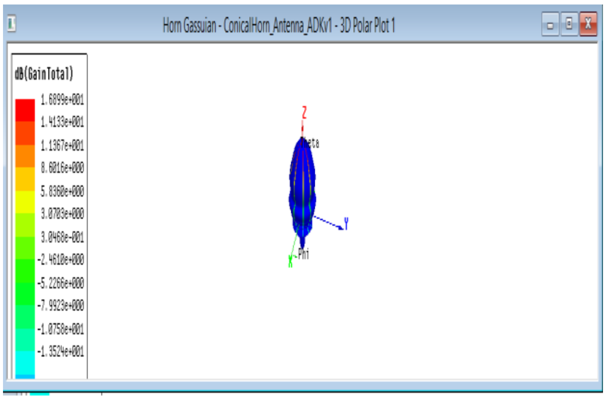
2. GAIN IN 2D



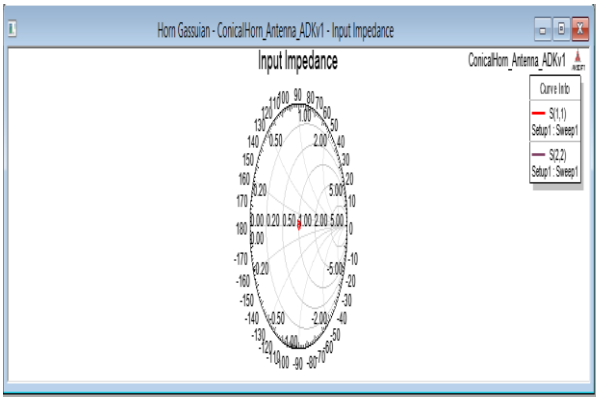
3. GAIN IN 3D



4. POLAR PLOT



5. INPUT IMPEDANCE



ANTENNA DESIGN

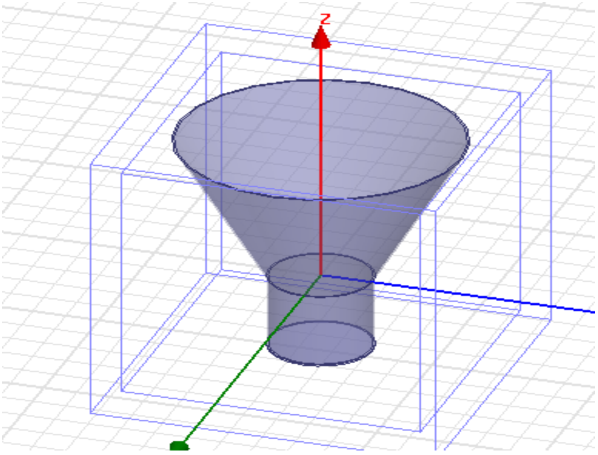


Table 2. Comparison of efficiency

S.NO	ANTENNA	EFFICIENCY
1	Circular horn antenna with EBG	13.6%
2	Conical horn with metallic discs	62%
3	Rectangular horn antenna with EBG	72%
4	Horn antenna with gaussian shaped metamaterial	92%

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5. CONCLUSION

Efficiency Improvement For Horn Antenna With This Nee Technique of gaussian shaped woodpile metamaterial structure is presented.because this structurehas a capable to increace the efficiency and life time of the antenna.in this antenna is used at wireless communications such as radio telephony,radio astronomy and radar applications.this anteena is used to eliminate the need for frequently changing the antenna.it provides gain about 16.18 db,return loss is below 2 and input impedance is unity.in this praposed antenna accords to the requirements of efficiency enhancement of conventional circular horn antenna.

REFERENCES

[1] Paowphattra Kamphikul, Rangsan Wongsan, “Gain improvement for rectangular horn antenna by using curved woodpilemetamaterial” *www.researchgate.net/puplication*, 2016.

[2] S. Kampeephat, P. Krachodnok, and R. Wongsan, “Gain Improvement for Conventional Rectangular Horn Antenna with Additional EBG Structure,” *in The 2014 International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology (ECTI-CON 2014)*, Nakhon Ratchasima, Thailand, May 2014.

[3] S. Kampeephat, P. Krachodnok, and R. Wongsan, “Gain Improvement for Rectangular Horn Antenna with Additional EBG,” *in The 2013 Thailand-Japan MicroWave (TJMW 2013), Bangkok, Thailand,* December 2013.

[4] S. Kampeephat, P. Krachodnok, and R. Wongsan, “A Study of Gain Enhancement of Horn Antenna Using Various Shaped Woodpile EBG,” *in The 2012 Thailand-Japan MicroWave (TJMW 2012), Bangkok, Thailand,* August 2012.

[5] F. Yang and Y. Rahmat-Samii, “Electromagnetic Band Gap Structures in Antenna Engineering,” *Cambridge University Press, Cambridge,* 2009.

[6] M. Clenet and L. Shafai, “Investigations on Directivity Improvement of Wide Flare Angle Conical Horns Using Inserted Metallic Discs,” *IEEE Proceedings on Microwaves Antennas and Propagation*, Vol. 147, No. 2, 2000, pp. 100-105.

[7] F. Yang and Y. Rahmat-Samii, “Reflection phase characterizations of the EBG ground plane for low profile wire antenna applications,” *IEEE Transactions on Antennas and Propagation,* Vol. 51, No. 10, 2003, pp. 2691–2703.

[8] M. A. Koerner and R. L. Rogers, “Gain Enhancement of a Pyramidal Horn Using E- and H-Plane Metal Baffles,” *IEEE Transactions on Antennas and Propagation,* Vol. 48, No. 4, 2000, pp. 529-538.

[9] P. de Maagt, R. Gonzalo, Y. C. Vardaxoglou, and J. M. Baracco, “Electromagnetic bandgap antennas and components for microwave and (sub) millimeter wave applications,” *IEEE Transactions on Antennas and Propagation,* Vol. 51, No. 10, 2003, pp. 2667–2677.