

PERFORMANCE ANALYSIS OF 2D-EBG UNDER MONOPOLE ANTENNA

K. Praveen Kumar¹, Dr. Habibulla Khan²,

¹Associate Professor, Dept of ECE, MLRIT, JNTUniversity Hyderabad, A.P, India,

²Professor Dept of ECE, KL University, Guntur, A.P, India,

ABSTRACT

The artificial properties in two dimensional electromagnetic structures (2D-EBGs), such as PMC and Band Reject Region are investigated for a proposed structure of square shaped mushroom. The radiation characteristics of monopole antenna over this 2D-EBG is tested by considering two cases. During first case monopole antenna is made to operate within band rejection region. Second case monopole antenna made operate outside the band rejection range. The obtained results during first case is showing enhancement in operating band width and smoother radiation pattern. In second case the effect is null and 2D-EBG resembles like conventional plane reflector. The simulated results are presented.

KEYWORDS

Reflection Phase, Surface wave band gap, Monopole antenna

1. INTRODUCTION

The periodic structures are became popular from the past decade because of its artificial characteristics, which are not possible to exhibit by natural materials. Based on the periodicity they are classified as one, two and three dimensional structures. One dimensional structures have ability to produce slow wave nature in one direction only. The best example of 1D-EBG's are corrugated surfaces. Two dimensional EBG structures have a ability to produce slow wave nature and has a band rejection range for EM surface waves in two directions. Most popular 2D-EBG's are mushroom high impedance surfaces proposed by Sevenpper in year 2009[1]. The three dimensional EBG's can suppress EM surface waves in all three dimensions that means it can produce universal band gaps. Three dimensional EBG is proposed and designed in [2]

In present paper square shaped mushroom 2D-EBG is designed. The design and optimization is given in [3-4]. The architecture consists of periodic arrangement of protrusions over dielectric substrate having a permittivity 2.55 and protrusions are connected to under lying by means of via. This structure exhibits two major properties of zero phase reflection between inward and reflected waves and band rejection range where this proposed structure does not allow any EM surface waves (neither TM not TE) to propagate through it. In order to measure these two properties an electromagnetic simulation software of Ansoft HFSS version 13 is used. This structure can be easily designed using PCB technology.

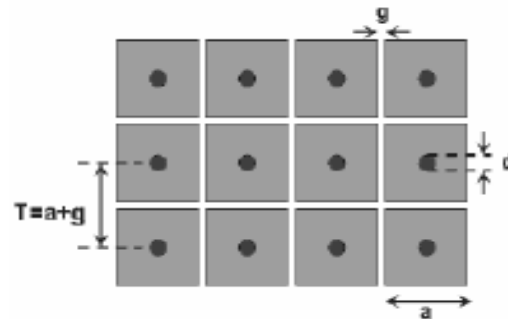
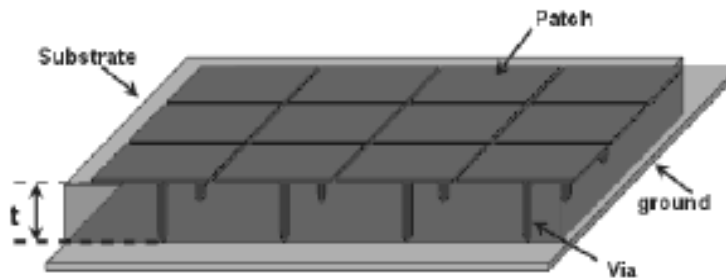
2. METHDOLOGY

2.1. 2D-EBG Design Specification

The proposed 2D mushroom EBG is designed with following specifications.

Table 1. Design Parameters Specifications

Parameter	Notation	Specification	Units
Dielectric Permittivity	ϵ_r	2.55	---
Thickness Dielectric Material	t	2.4	mm
Protrusion width or period	a	7.2	mm
Gap	g	1.2	mm
Diameter of Via	d	0.6	mm



The figure 1 is depicting the two dimensional arrangement of unit cells. where a unit call can be defined as a specific model or architecture which is a sand which of dielectric substrate and metal.

2.2. Dispersion Diagram

In determining the dispersion characteristics of periodic structures, There is no need to consider and model the complete architecture, but instead on can consider a single unit cell. Hence in

present case a unit cell is modeled in Ansoft HFSS software with the specification given in [5] by applying periodic boundary on four walls and a PML on the top to produce normally incident plane waves. The arrangement is shown in figure 2.

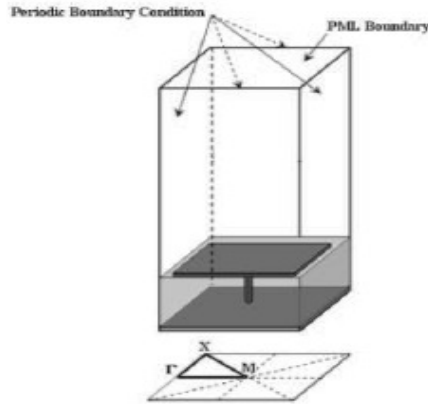


Figure 2. Model analysis

With obtained results a diagram is plotted for a unit cell a band gap between first mode (intersection point of TM and light line) and second mode (intersection point between TE and light line) is 4.6GHz 7.9GHz can be seen in figure 3. The region highlighted is called as stop band region (EM wave suppression region) where neither TM surface waves nor TE surface waves are not allowed to propagate. The region other that highlighted region is called as pass band region. During pass band region the 2D-EBG supports the propagation of both the waves. Hence during this region the 2D EBG function as similar to conventional metal ground reflector. During this region 2D-EBG has null effect on antenna radiations lying over to it.

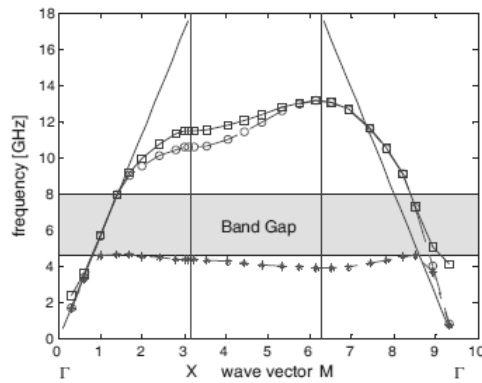


Figure 3. Dispersion Diagram

2.3. Reflection Phase

The figure 4 is showing the reflection phase characteristics of 2D-EBG. The reflection phase is of structure changes continuously from $+180^{\circ}$ to -180° verses frequency.

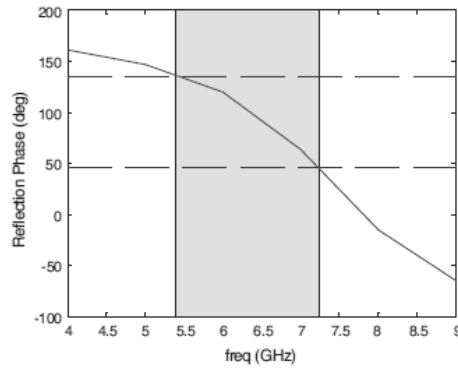


Figure 4: Reflection Phase of HIS

The highlighted region shown in the figure 3 is indicating the stop band region, where the EBG structure functions like artificial magnetic conductor (AMC).

3. MONOPOLE ANTENNA

Monopole antennas are popular for wide range wireless communication applications. They are easy to fabricate and low cost. Present paper a monopole antenna is designed to operate at 6GHz placed over conventional ground plane and tested. Next the conventional ground plane was replaced with 2D-EBG structure whose specifications are described in Table 1. One can find a shift in operating point of monopole antenna. This effect is occurred due to change in impedance region. Now the dimensions of radiating antenna is altered by trial and error method and brought the operating point to 6GHz, that is within the stop band region of 2D-EBG. Then we found an enhancement in band width of monopole antenna. which are shown in figure 5.

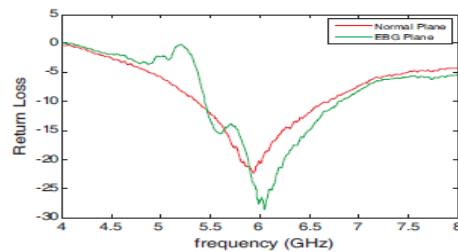


Figure 5: Return Loss of Monopole on normal plane and HIS

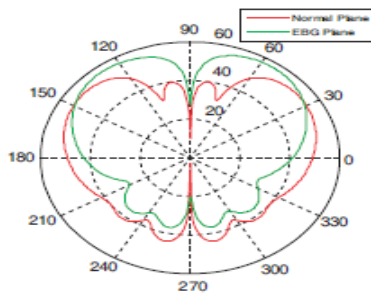


Figure 6: Radiation Pattern on normal plane and HIS

The figure 6 is showing the radiation patterns of monopole antenna under conventional reflector ground and 2D-EBG ground. The smoother radiation pattern is observed under 2D-EBG case.

This indicates the suppression of surface waves avoided the multi patch propagation. One more advantage we found that the ripples in forward direction are significantly less, hence very less amount of power is wasted in back lobes. This 2D-EBG also providing a shielding to the components back to this. This also reduces the interference between neighboring elements in the complex environment.

Now monopole antenna is designed to operate at 8GHz which is beyond the band gap range shown above, is tested over normal plane and HIS surfaces. The figure 7 is showing the radiation characteristics from which we can conclude that the characteristics of 2D-EBG in pass band region resembles similar to conventional reflector. Hence obtained characteristics are similar.

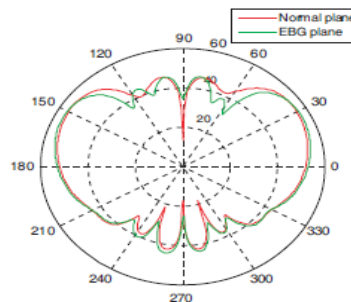


Figure 7: Radiation Pattern at 8GHz on normal plan & HIS

4. CONCLUSIONS

The dispersion and reflection phase characteristics of two dimensional electromagnetic band gap structure was analysed. The effect of 2D EBG on radiation parameters of monopole antenna are presented when comparing with convectional design. The obtained results are showing that the 2D EBG has EM surface wave suppression property enabling smoother radiation pattern and enhancement in operating bandwidth.

ACKNOWLEDGEMENTS

The Author want to thank management MLR Institute of Technology, Hyderabad for their support and encouragement.

REFERENCES

- [1] D.Sevenpiper. **High Impedance EM Surface**, Ph.D. dissertation, University of California, Loss Angeles, 1999.
- [2] K. Praveen Kumar, Dr Habibulla Khan **Design of Multi Layer High Impedance Surface for Antenna applications**, International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 2, Issue 4, April 2013
- [3] Peter Kovacs **Design and Optimization of EBG structures**, PhD dissertation, BRNO University of technology,2010
- [4] Michel A Foreman, **Reduced Volume Antenna with Integrated High Impedance Electromagnetic Surface**, Sandia National Laboratories Albuquerque, New Mexico 87185 and Livermore, California 94550
- [5] www.ansys.com

- [6] Golla, Kevin J. **Broadband Application of High Impedance Ground Planes** MS thesis, AFIT/GE/ENG/01M-11. Graduate School of Engineering and Management, Air Force Institute of Technology (AU), Wright Patterson AFB OH, March 2001.
- [7] Cakiroglu, Bora, **Construction and Testing of Broadband High-Impedance Ground Plane for Surface Mount Antennas**, MS thesis, AFIT/GE/ENG/08M-02. School of Engineering, Air Force Institute of Technology, Wright-Patterson AFB OH, March 2008.

Authors

K.Praveen Kumar Associate Professor, was born in india, A.P in 1980. He received B.E(ECE) from Visveswaraiah Technological University, Belgaum. And M.Tech(Microwave Engg) Acharya Nagarjuna University, Guntur. He has more than 10 years of teaching experience. 14 International Journals, 03 International Conference in his credit. He is a research scholar of JNT University, Hyderabad. In the field of Microwave Antenna.



Prof. Habibulla khan born in India, 1962. He obtained his B.E. from V R Siddhartha Engineering College, Vijayawada during 1980-84. M.E from C.I.T, Coimbatore during 1985-87 and PhD from Andhra University in the area of antennas in the year 2007.He is having more than 20 years of teaching experience and having more than 20 international, national journals/conference papers in his credit. Prof. Habibulla khan presently working as Head of the ECE department at K.L.University. He is a fellow of I.E.T.E, Member IE and other bodies like ISTE. His research interested areas includes Antenna system designing, microwave engineering, Electromagnetics and RF system designing.

