Performance Analysis of EBG based Dual Bow-Tie Shaped Patch Antenna with Periodic Slot on Slant Edges for Terahertz Application

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Abstract

Objectives: To achieve application in the area of terahertz dual bow tie EBG based fractal antenna is used. Methods/Statistical Analysis: The antenna is designed and analyzed at solution frequency 1.56 THz for frequency range of 1.1-1.8 THz. The feature of EBG-inspired structure is a magnetic conductor used along with ground plane to extent performance of the design. Results: The analysis is fetch at different THZ frequencies to analyze the results. The maximum gain of 3.06 dB and return loss of -16.14 dB are achieved at 1.56 THz and 1.75 THz respectively. Application/Improvements: HFSS simulation software is used for simulation of the design.

Keywords: Dual Bow Tie Patch Antenna, EBG, Tera Hertz (THZ)

1. Introduction

Electromagnetic waves propagating at frequencies in terahertz range are called as terahertz radiation and it is termed as sub millimeter radiation and terahertz waves. Innovation of RF component leads to terahertz as an emerging field. To enable internal structure analysis, Terahertz waves can transmit through plastic and wood and the penetration will not affect the chemical behavior of materials. Terahertz has frequency range varies from 100 GHz-10 THz. Resolution of image produced by Terahertz waves is similar to that of images viewed with the human eye under visible light.

Fractal antenna can able to design in various shape and size. These antennas have an excellent feature of maintaining high radiation efficiency even though antenna size is minimized. Because of the fractal shape, the designed bow tie antenna always has an advantage of miniaturization effect compared to normal fractal antenna and has a possibility of saving chip size and consequently cost. On chip fractal antennas are used in wireless communication system. Imaginary image of two triangular patches are combined to form single bow-tie patch antenna which is fabricated in a single substrate discussed in. Bow tie antenna is easy to fabricate and install due its features of light weight, low profile and small size. These kinds of antennas are able to use for RF and microwave frequencies with suitable fabrication of monolithic microwave integrated circuits. Self similarity and space filling property of fractal antenna will be able to use for broad band coverage. Self similarity is the property of antenna which helps to operate with similar performance at different frequencies and has outstanding input impedance. Fractal antenna has another property of achieving multiple bandwidths and each single band shows increased bandwidth called multiband or wide band by this instantaneous spectrum access. Penetration loss of terahertz frequency and delay are well described.

EBG based dual bow tie shaped fractal antenna is designed and analyzed in this paper. The antenna will possess multi band characteristics which is applicable for Terahertz application. The performance of the designed
antenna like return loss and gain well explained in the preceding sections. Commercially useful GaAs semiconductor is used for the design of antenna. The proposed antenna has been designed and simulated using High Frequency Structure Simulator software.

The contents of this paper are as follows:
Antenna design described in Section I
Detailed study of performance of proposed antenna is described in Section II.
And remarks in the proposed design is mentioned in Section IV

2. Antenna Design

The given model consist the dual Bow tie patch Antenna is shown in Figure 1. Frequency range consider in terahertz between 1.1-1.8 THz. The electromagnetic band gap is used in the ground plane. Antenna is designed on gallium arsenide substrate. The basic configuration of the substrate is 90×152×22 μm³. In this paper the periodic slots are present in dual bow tie patch antenna.

3. Simulated Results and Discussion

The validity of the analyzed model is emphasizing the results such as return loss, VSWR, Gain, Radiation Pattern in HFSS Software. Antenna is designed in such a way to obtain the utmost Gain and return loss which is appropriate for Terahertz applications.

The return loss vs. frequency graph of this model is shown in Figure 2. Two maximum peaks are obtained at frequencies 1.3709 THz, 1.7543 THz. The maximum return loss obtain is -16.1407 DB at frequency 1.7543 THz.

The VSWR of the antenna designed is shown in Figure 3. It is perceived that each impedance bandwidths is measured for the value of VSWR ≤ 2 (abs).

The plot shows the gain of the antenna is shown in Figure 4 variation gain is obtained in Φ-plane for various values of θ angle for frequency 1.56 THz. It can be observed that the maximum gain obtained is 3.06 dB.

The E-plane and H-plane radiation patterns are shown in Figure 5 for frequency 1.56 THz. As observed at this frequency maximum RL obtained. The radiation patterns obtained at frequency 1.56 THz in the E-Plane
and H-Plane. In both plane observed the directional patterns. It is observed that maximum gain obtained is 2.27 dB in both vertical planes $\Phi = 0^\circ$ & $\Phi = 90^\circ$ at frequency 1.56 THz.

![Simulated radiation patterns in E & H Plane of the proposed antenna at 1.56 THz](image)

**Figure 4.** Total gain of proposed antenna verses angle $\Phi$ for various angles $\theta$

**Figure 5.** Simulated radiation patterns in E & H Plane of the proposed antenna at 1.56 THz

### 4. Conclusion

The paper inscribed the issues of designing simple, compact, and miniaturized fractal antenna. The Dual bowtie patch antenna is used in this paper expected to work efficiently for terahertz applications. Dual bowtie patch antenna mounted on gallium arsenide material with $\varepsilon_r = 12.9$ and EBG based dual bow tie shaped patch antenna enhanced the performance. Above antenna E plane and H plane radiation patterns predicted useful for terahertz applications. The dimension of antenna taken $90 \times 152 \times 22$ $\mu$m$^3$. Thus it is one of the perfect examples for Terahertz applications.

### 5. References

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