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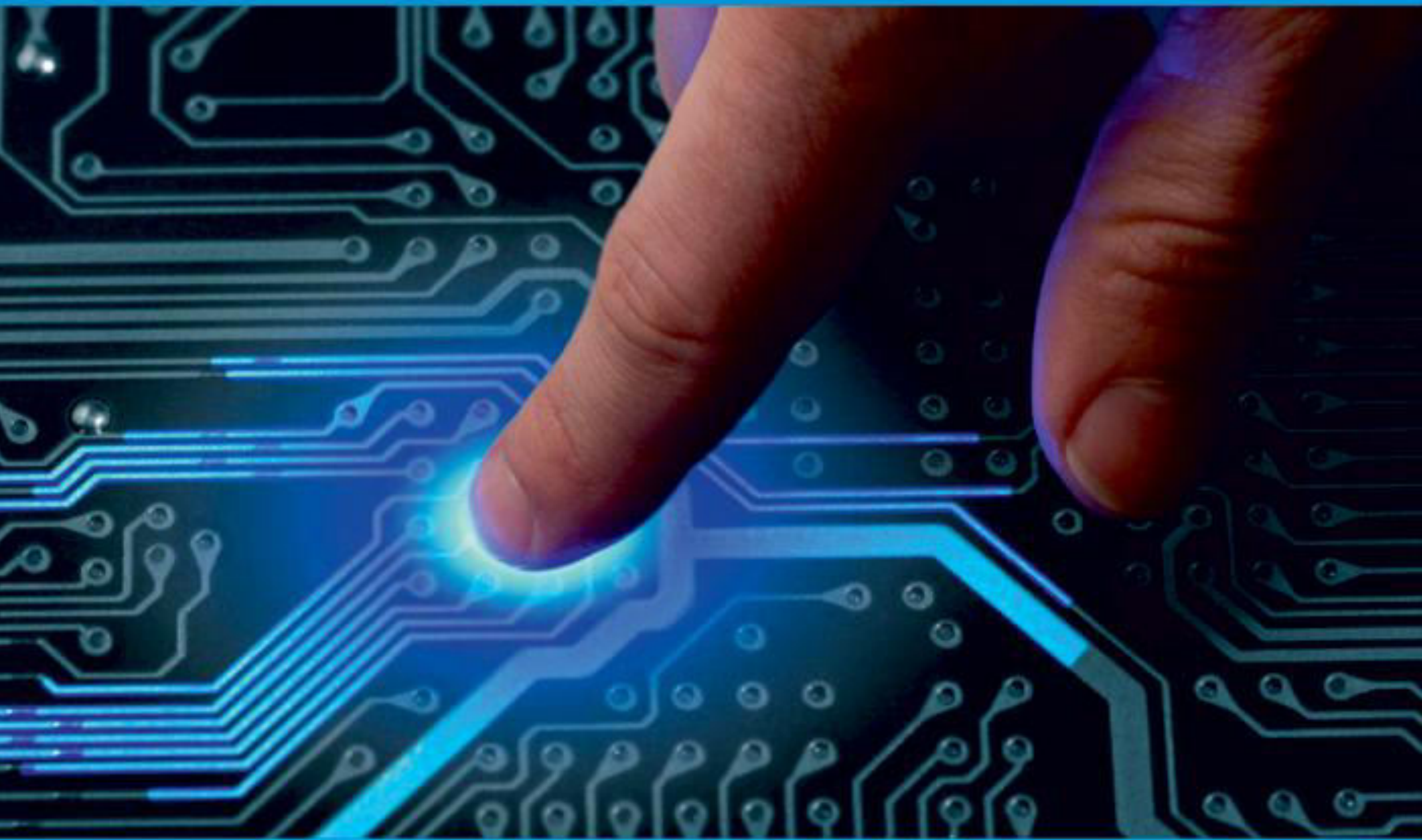

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Design of Trapezoidal Shaped Microstrip Patch Antenna for High Speed THZ Applications Using the Substrate of Photonic Crystal

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ABSTRACT: Overthe electromagnetic spectrum(30-1000GHZ) the terahertz technology is widely used in many applications. This current paper gives an outline of trapezoidal shaped patch antenna for high speed THZ applications. Using the photonic crystal substrate. The coupling of antenna and source is provided by a microstrip line used for the patch antenna.The proposed design antenna is utilized over the frequency band ranging from 0.88 to 1.62. The proposed antenna developed is used over high speed THZ applications.In a patch antenna its performance limitations is due to the leaky waves the surface limitations.Its performance is enhanced by implanting photonic crystals in dielectric substrate .Using the photonic crystal substrate. The VSWR,return loss&gain obtained shows a huge improvement.The photonic crystal implanted in dielectric substrate exhibits wider bandwidth.

I. INTRODUCTION

As of today,terahertz frequencies are widely used for many applications most of the researchers are considering terahertz frequency in antenna designing areas over scientific applications. For the frequencies greater than 100GHZ .The performance is limited by the transit time of semiconductor devices to over come this limitation. The photoconductive mixers are heterodyne with opticals. When the wireless system is under design there are some important characteristics that have to be cosidered (High data rate,Broader bandwidth,Low cost,system efficiency etc).

The terahertz systems are preferable because of miniaturization in size,broader band width,directivity. Demonstrated photo conductive folded half wave length dipole antenna for high speed THZ applications.A simple analytical nodel devided based on the equivalent circuit to measure the pulsed THZ signals.The output power in these half wave length dipole antennas are observed to be high[1].Terahertz generation method from multiple dielectric coated Gallium Arsenic(GaAs)antenna in this proposed method it is observed that SIN_4 coated Gats antenna improves THZ wave generation as the breakdown field is increased[2]. A yagi uda terahertz antenna for high input impedance.At the resonance frequency the high input impedance(2600Ω) is obtained by using λ-dipole as driven element[3].

A bowtie antenna with coplanar stripline feeding for THZ frequency applications. The comparision of broadband and radiation characteristics of proposed antenna with a dipole antenna gave a greater result of the proposed antenna with bandwidth 64% (1-10THZ) and radiation patterns with same characteristics as those of dipole antenna. This proposed antenna have a higher gain of 2.2dB then dipole antenna[4].The techniques of optical scanning for characterizing the photo conductive THZ antenna array radiation properties.A14 element equally spaced array structure is designed on low - temparature using proposed methods[5].

The design and analysis of pyramidal horn antennas for THZ applications. This design provides large bandwidths ,good directivity and low reflection coefficient. To process this type of horn antenna KOH feching of silicon is used. For main antennas pyramidal horn is prefered and for feeding antenna inverted pyramidal horn is prefered[6].Different types of integrated antennas this antenna network provided THZ wireless systems[7].The circular polarized antenna design operating at 996 GHZ.The proposed antenna is utilised for security applications. The photonic band gap struture prevents the flow of certain frequency bands[8].A rectangular microstrip patch antenna with photonic band gap crystal over 60 GHZ communications. It observed that photonic band gap structure is used to improve the gain and bandwidth of the antenna[9].The microstrip patch antenna and its characteristics are different bandwidth enhancement techniques over patch antenna by cutting slots in patch area is proposed in this antenna and employing photonic band gaps using thick substrate for better performance. The scope of paper is to be provide a design of trapezoidal antenna for THZ

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frequencies and the performance enhancement of antenna by implantation of hexagonal shaped photonic crystals over substrate layer[10].

II. CONFIGURATION OF PROPOSED ANTENNA

The primary issues in wireless systems are the miniaturization and the high performance. Miniaturization means the requirement of reduction of device size which results in the reduction of energy required by the device.Gain,return loss and bandwidth describes the performance of the antenna. This section demonstrates the trapezoidal shaped microstrip patch antenna with photonic band gaps obtained by implanting hexagonal photonic crystals in the substrate layer.

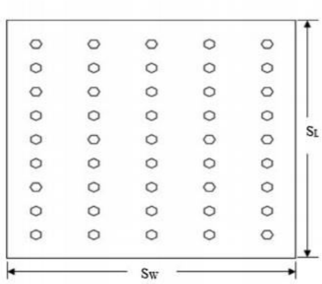

Fig 1(a):PBG implanted substrate antenna

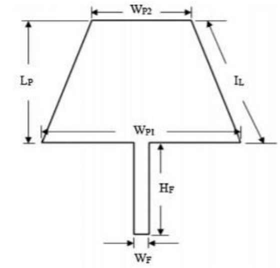

Fig 1(b):Trapezoidal shaped micro strip patch antenna

The material prefered for the antenna components Ground:Gold,Patch:Graphene,Substrate:Pdymide(lossy).The hexagonal photonic crystals are radius 20μm and vertical 20μm overall 40μm each are given in the substrate layer.The creation of these photonic band gaps suppress the surface leaky waves beneath and improves the performance of antenna designed.PBG structures prevents the electro manetic waves propagating through substrate by forming a stop band at certain frequency.

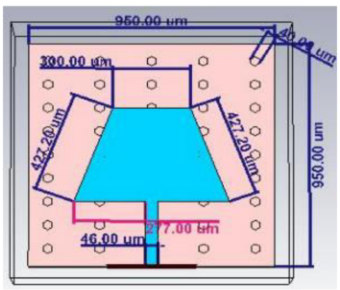

Fig 2(a): Front- Veiw of the design

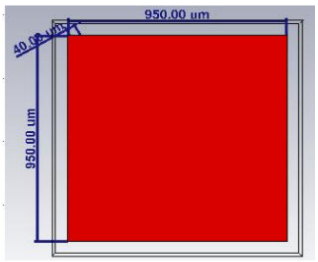

Fig 2(b) Back-view :of the design

As the PBG structures prevents EM waves propagating through substrate. These will be enhancement of bandwidth at the resonant frequency by creating step band.

Parameters	Dimensions(μm)
w_{p1}	554.00μm
w_{p2}	300.00μm
I_{L1}	427.20μm
I_{L2}	427.20μm
w_F	046.00μm
S_w	950.00μm
S_L	950.00μm

Table 1: Parameters of Proposed Antenna

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The dimenssions of proposed Antenna are obtained through mathmatical equations:

$Wp=1/2f_r\sqrt{\mu_0\varepsilon_n}$; $Lp=\lambda/2\sqrt{\varepsilon_{reff}}-2\Delta L$

Where,
Wp is width of patch
Lp is length of patch
Fr is resonant frequency
$\varepsilon_{reff}=(\varepsilon_r+1)/2 + (\varepsilon_r-1)/2[1+12 h/w]^{-1/2}$

The proposed antenna is designed with the obtained dimension using computer simulation technology (CST) software. Which gives the dynamic behaviour & mathmatical models of systems. CST software is a featured software package for EM analysis & design over high frequency range. Through the software we can obtain the 3D characteristics of the design.

III. RESULTS OF PROPOSED ANTENNA AND DISCUSSION

The design of the proposed antenna is as shown in fig 3.Later the simulation results obtained describes the performance of the antenna. Result of antenna includes s.parameters (Reflection coefficient),VSWR,surface current distribution. real part imaginary part, impedance, radiation pattern over E-field and H-field. gain of the antenna , directivity of the antenna and efficiency of the antenna.

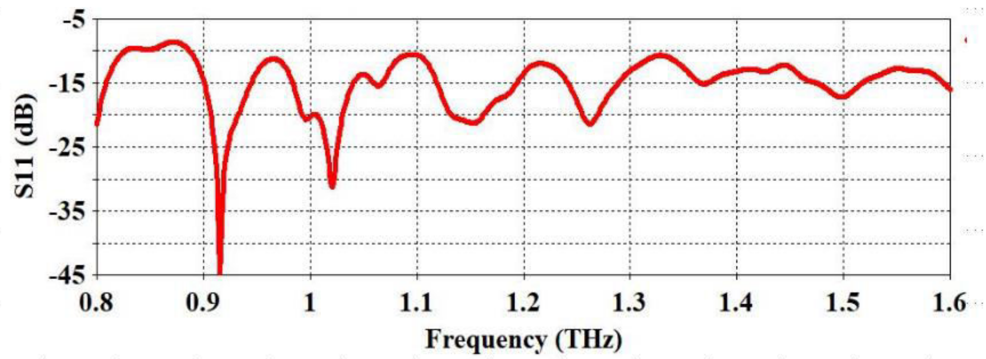

fig 3:Reflection Coefficient(S_{11})

Generally,the impedance performance of the proposed antenna is given by s-parameters(s11).Return loss is measured in describes dB to have the better performance the return loss should be less than 10 dB. i.e,s11<-10 dB
s-parameter gives the amount of power delivered by the input device by calculating the power reflected back to the input device.s<-10dBdemonstrates that 90% of power is delivered and 10% is reflected back.

From the fig 3 the return loss at the resonant frequency 0.913THZ is observed to be -45dB(s<-10dB).Which satisfies the condition of return loss. This observation of return loss result in good performance of the proposed antenna. The absolute bandwidth of the proposed antenna is 0.8 THZ over the frequency band of 0.8-1.6 THZ. According to the obtained return loss value,it is acceptable but to enhance the bandwidth of the antenna . PBG structure are to be used and using PBG structure result in less return loss at different resonant frequencies 0.913 THZ,1.04 THZ& 1.5 THZ .With return loss -45dB,-32dB,-22dB respectively.

VSWR (voltage standing wave ratio)is the other factor that effects the performance of the antenna. With VSWR<2 the performance of the antenna can be enhanced VSWR of the antenna demonstrates .The The amount of power reflected due to the mismatch level should be less than 2 .So that the performance can be better for a good antenna,the VSWR should be always less than 2.Only then the desired antenna with required performance characteristics can be obtained. In imaginary part is -0.98Ω.For a perfect impedence matching imaginary part should be 0.2 .But the obtained results are acceptable as the VSWR of the proposed antenna at operating frequency 0.913 THZ is less than 2(VSWR<1.2).

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Which means the mismatch of antenna & feed is less and it is acceptable .Impedance differs frequencies surface current distribution is the other key factor that involves in performance characteristics of proposed antenna the actual electric current induced by applied electromagnetic field is known as surface element.

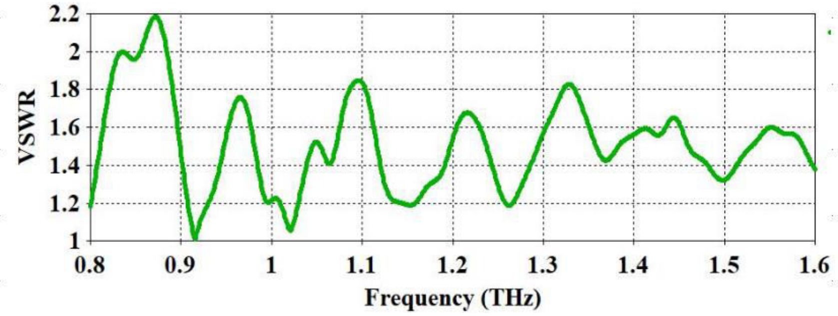

Fig 4:VSWR

From the fig 4 The VSWR of the proposed antenna at the resonant frequency 0.98THZ is about 1.2 .Which results in better performance of the antenna. VSWR<2 of an antenna demonstrates the antenna is perfect ,good and it is acceptable for fabrication. The observation over different resonant frequencies 1.04 THZ ,1.15THZ is 1.22,1.2 respectively.

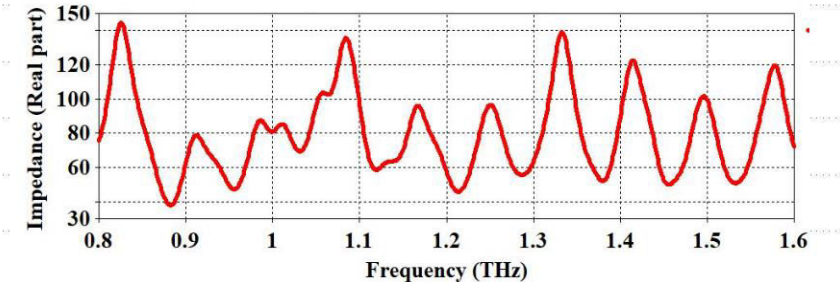

Fig 5(a):Real-Part Impedance

Impedance matching is the other factor that resembles the performance of the antenna. The input impedance of the antenna demonstrates the impedance matching between the source and antenna which defines the power radiated to the input device. Like wise impedance and VSWR play a vital role in the performance characteristics of the antenna. Input impedance consists of real part and imaginary part which combines the resistance and conductance respectively. Fig 5(a) represents the real part of the input impedance. The reactance(real part)of the impedance demonstrates the radiating power of the antenna absorved power of the antenna.

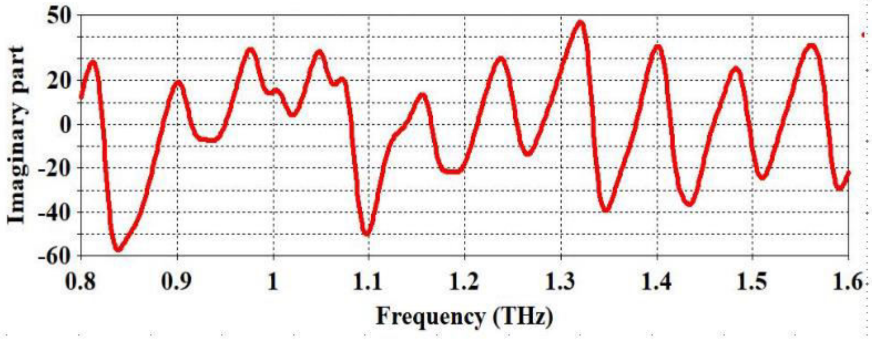

Fig 5(b):Imaginary-Part Impedance

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Fig 5(b)represents the imaginary part of the antenna. The conductance(imaginary part)of the impedance demonstrates the non-radiating power of the antenna,i.e,tha power that is stored in the antenna. The connect matching between the patch and the microstrip feed line is represented by the input impedance. If the input impedance approaches 50Ω then the antenna performance is said to be perfect as there is perfect impedance matching.

Generally,input impedance is measured in ohms(Ω)it imaginary part(conductance)is taken under the consideration ,then we cannot take ohm(Ω)measurement for the input impedance. As of the performance characteristics that real part of impedance is taken in to consideration and from fig 5(a) input impedance of proposed antenna at operating frequency 0.913THZ is 80Ω from fig 5(b) input impadance of proposed antenna at operating frequency 0.913 THZ

considering all the simulation results one can get the performance characteristics of the antenna.when an antenna is design it is most important to analyze all the aspects of the proposed antenna designed.The microstrip patch antenna is designed by fabricating patch on the ground plane and separate by the substrate layer with dielectric material. With the required design parameter dimensions.

Generally,the impedance performance of the proposed antenna is given by s-parameters(s_{11}).Return loss is measured in describes dB to have the better performance the return loss should be less than 10 dB. i.e,s11<-10 dB
s-parameter gives the amount of power delivered by the input device by calculating the power reflected back to the input device. s<-10dBdemonstrates that 90% of power is delivered and 10% is reflected back.

From the fig 3 the return loss at the resonant frequency 0.913THZ is observed to be -45dB(s<-10dB).Which satisfies the condition of return loss. This observation of return loss result in good performance of the proposed antenna. The absolute bandwidth of the proposed antenna is 0.8 THZ over the frequency band of 0.8-1.6 THZ. According to the obtained return loss value,it is acceptable but to enhance the bandwidth of the antenna .PBG structure are to be used and usingPBG structure result in less return loss at different resonant frequencies 0.913 THZ,1.04 THZ& 1.5 THZ .With return loss -45dB,-32dB,-22dB respectively.

VSWR (voltage standing wave ratio)is the other factor that effects the performance of the antenna. With VSWR<2 the performance of the antenna can be enhanced VSWR of the antenna demonstrates .The amount of power reflected due to the mismatch level should be less than 2 .So that the performance can be better for a good antenna,the VSWR should be always less than 2.Only then the desired antenna with required performance characteristics can be obtained.In imaginary part is -0.98Ω.For a perfect impedance matching imaginary part should be 0.2 .But the obtained results are acceptable as the VSWR of the proposed antenna at operating frequency 0.913 THZ is less than 2(VSWR<1.2).

Which means the mismatch of antenna & feed is less and it is acceptable .Impedance differs frequencies surface current distribution is the other key factor that involves in performance characteristics of proposed antenna the actual electric current induced by applied electromagnetic field is known as surface element.

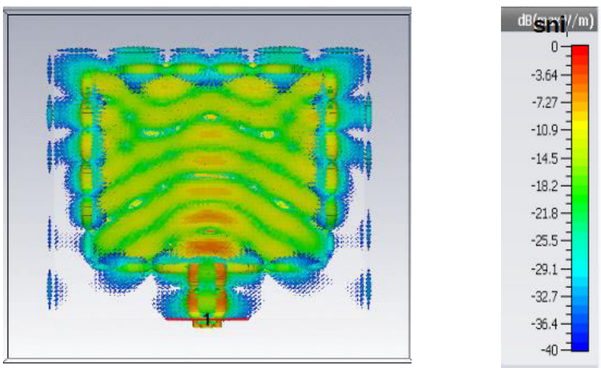

fig 6 :surface current distribution at 0.915 THZ.

Generally,there are different feed techniques like microstrip line& coaxial. Based on the requirement feed technique differs .For the proposed terahertz antenna,the microstrip line feed is given the feed of the antenna provides

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supply(current)to the antenna. When the supply is fed through the microstrip line,the all induced current will flow towards the field at a time.

To maintain equivalent current supply over the surface of the antenna,the current is distributed over the surface equally. From the fig 6 the dB/max scale represents the magnitudes of the antenna at different frequencies and the colour represents the amount of current distribution over the surface of the antenna. When an antenna is designed,the important factor that is to be verified is its gain. For any antenna it is the essential criteria as the gain defines the power transmitted by the antenna over the specific direction.

Fig 7.gain of the proposed antenna power transmission is important for any antenna as this basic feature explains the capacity of the antenna based on the applications.

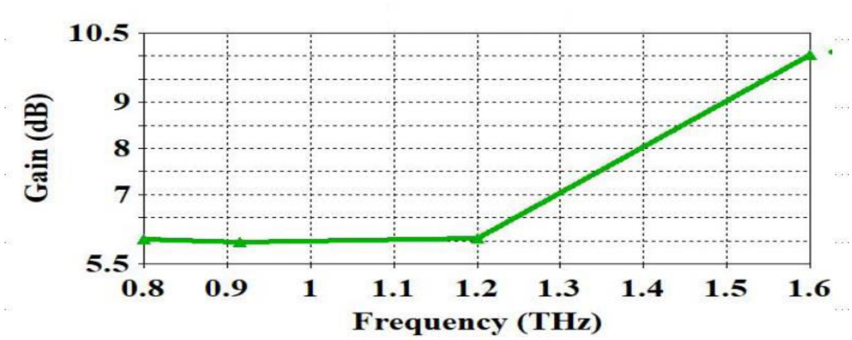

Fig 7:Gain of Proposed design

Demonstrates the gain of the proposed THZ antenna operating at 0.913THZ is 6dB and the gain of proposed THZ antenna over the frequency band ranging from 0.8-1.2 thz is about 6dB .The other important performance parameter which defines the direction of the antenna i.e,directivity of the antenna.

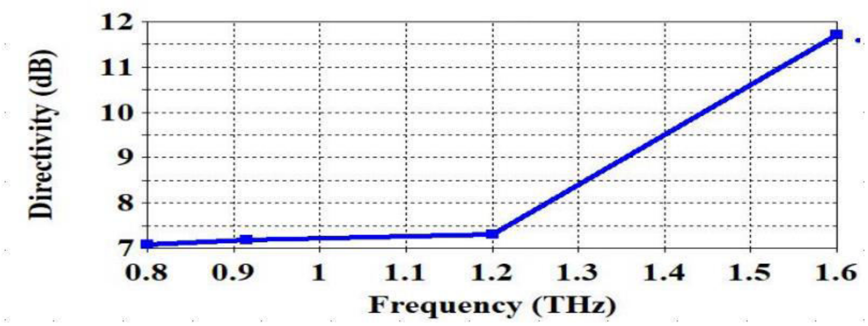

Fig 8: Directivity of Proposed Antenna

Analysing the directivity of the antenna is essential because the antenna may limit its frequency band over applications if its not directional. From fig 8 the directivity of the proposed antenna is over the bandwidth of the antenna. i.e,The proposed antenna is directional.

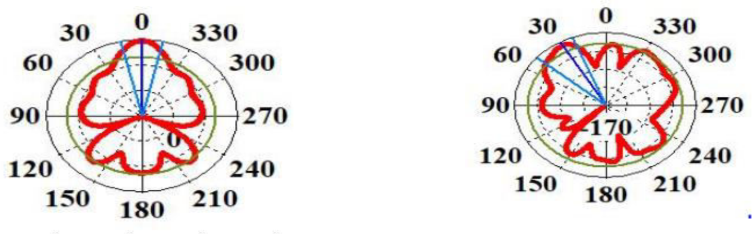

Fig 9(a) E-FIELD(XZ -plane) fig 9(b) H-FIELD(XY-plane)

Fig 9:RadiationPattern(0.913THZ)

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Radiation pattern is the other performance factor which defines the variation of power radiated by the antenna.Fig9 (a)demonstrates the radiation pattern of the proposed antenna at operating frequency 0.9137THZ.in E-field (XZ-plane)The radiation over certain angle is observed by considering radiation pattern at operating frequency.fig 9(b) demonstrates the radiation pattern of proposed antenna at operating frequency 0.913THZ in H-field(YZ-plane).

For the proposed antenna ,the radiation pattern type is field pattern as we consider E-field and H-field patterns.From fig 9(a) the power radiation in e field i.e,XZplane is over 0° and from the fig 9(b)the power radiation in Hfield i.e,YZ-plane is over 170°.The figures shows that the radiation is more in Hfield when the compared to the E-field.To analyze any antenna performance,efficiency is taken into consideration. i.e, Antenna efficiency demonstrates how efficient is the antenna working and how much power delivered to device. So,it is important to calculate the efficiency of antenna.

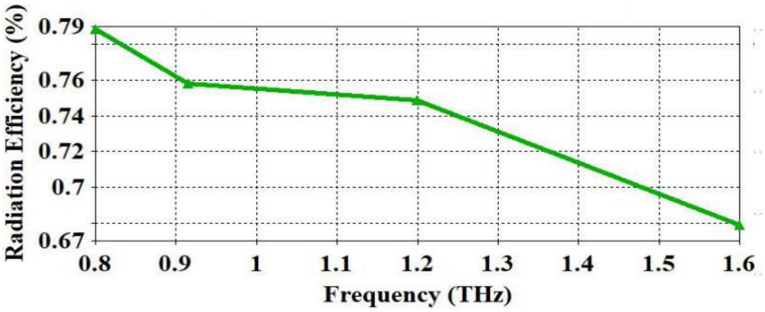

Fig 10:Efficiency of proposed Antenna

Fromthefig10The THZ antenna proposed exhibits 75.98% efficiency at the operating frequency 0.913 THZ .For any antenna exhibits 50% efficiency can be considered. i.e,The proposed antenna design is very efficient and it is acceptable for fabrication.

IV. CONCLUSION

The proposed design of trapezoidal shaped microstrip patch antenna using the implanted substrate of photonic crystals.For high speed THZ applications is having the better performance.As the photonic band gap structure are created to enhance the band width of the antenna.The antenna designed exhibits broader bandwidth,high data rate(over 100Gb/s)which results in increase communication speed ,better radiation performance over miniature size,More directivity and better efficiency.

THZ frequencies are used in several applications,like radar communications military applications.The three layered antenna is designed by placing patch on the substrate of photonic crystal placed on the ground with microstrip line feediy.The proposed antenna exhibits less return loss at 45dB when compared to [11][13][14]with return loss 25dB,25.6dB&42dB respectively.

Performance parameter of antenna	Performance result of proposed antenna at operating frequency 0.913THZ
Return loss(dB)	-45dB
VSWR	1
Input Impedence	80+ j(-0.98)
Gain	6 dB
Efficiency	75.98%

Table 2 .Over view of performance of proposed Antenna

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The above table 2 represents the overall performance parameters of the proposed antenna operating at frequency 0.913 THZ. Observing the performance parameters the proposed antenna exhibits broader bandwidth with good radiation performance and good radiation loss which result in good amount of power radiated &delivered by the antenna respectively .Providing Broader bandwidth is the main criteria of the Terahertz antenna proposed.

REFERENCES

[1]K.Moon,H.Han,I.Park,Terahertz folded half-wavelength dipole antenna for high output power ,Appl.Phys.Lett.85(January 2004)1622-1624.

[2] J,Xu,W.Shi,L.Hou,W.Jia,K.Liu,X.Xie,X.-C.Zhang, Terahertz generation from multiple transparent dielectric coated GaAs antenna,Joint 29th International Conference on Infrared and Millimeter Waves 4(2004)315-316.

[3]K.Moon,H.Han,Park,Terahertz folded half-wave length dipole antenna for high output power,in:Yopical Meeting Microwave Photonics,Seoul,Korea,2005,pp,301-304.

[4]Y-J.Ren,P.Lv,K.Chang,Broadband terahertz antenna for wide band gap semiconductor photoconductive switches,in:antennas and Propagation Society International Symposium,2008,AP-S 2008.

[5]Y.Yuan,Y.Liu,X.Lv,Novel integrated MEMS Horn antenna for terahertz applications,in:34th International Conference on Infrared,Millimeter,and Terahertz Waves,IRMMW-THZ 2009,21-25 Sept.,2009,pp.978-979.

[6]H.F.Tiedje,D.Saeedkia,M.Nagel,H.K.Haugen,Optical scanning techniques for characterization of terahertz photoconductive antenna arrays,IEEE Trans,Microw.Thoer.Tech.58(7)(July 2010)2040-2045.

[7]N.Llombart,G.Chattopadhyay,A.Skalare,I.Mehdi,Novel terahertz antenna based on a silicon lens fed by a leaky wave enhanced waveguide,IEEE Trans.Antennas Propag.59(6)(June 2011)2160-2168.

[8]L.Lin Guo,F.Huang,X.Tang,Analysis and design of the pyramidal horn antennas for terahertz applications, in:IEEE International Workshop on Metamaterials(Meta),Nanjing,China, 8-10 Oct.,2012.

[9]K.Wu,Y.J.Cheng,T.Djerafi,W.Hong,Substrate-integrated millimeter-wave and terahertz antenna technology,Proc.IEEE 100(7)(July 2012)2219-2232.

[10]K.Pitra,Z.Raida,H.L.Hartnagel,Design of circularly polarized terahertz antenna with interdigital electrode photomixer,in:7th European Conference on Antennas and Propagation(EUCAP),2013,pp.3119-3122.

[11]R.N.Tiwari,P.Kumar,N.Bisht,Rectangular microstrip patch antenna with photonic band gap crystal for 60 GHz communications,in:Prog.Electromagn.Res.Symp.Proc.,Suzhou,chaina,2011,pp.256-259

[12]Amandeep singh,Surinder Singh,Miniaturized Wideband Aperture Coupled Microstrip Patch Antenna by Using Inverted U-Slot,"International Journal of Antennas and Propagation,vol.2014,pp.1-7

[13]M.EI-Nawawy,A.M.M.A.Allam,D.Korzec,The design of a 0.35 THz microstrip patch antenna on LTCC substrate,J.Electr.Electron.Eng.1 (2011)1-4.

[14]A.Sharma,G.Singh,Rectangular microstrip patch antenna design at Thz frequency for short distance wireless communication systems, J.Infrared Millim.Terahertz Waves 30(2009)1-7

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