# Circular slotted THz Microstrip Patch Antenna for detection of constitutes of peptides in human body

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***Abstract***— *This paper presents a novel ultra wideband circular slotted terahertz antenna design for detection of peptides in human body. In the proposed antenna design, the FR4 material has been used as a substrate having dielectric constant (εr) 4.4 and thickness of 1.5 μm. The ground, patch and feed line are made up of Copper material with thickness of 0.02 μm. The performance of terahertz antenna has been analysed in terms of bandwidth (THz), return loss (dB), directivity (dBi), gain (dB), VSWR and impedance (ohms). The designed antenna resonates at 6 THz with the bandwidth of 2375 GHz (5.423 THz - 7.798 THz). The return loss of the proposed antenna is -43.58 dB at the resonating frequency of 6 THz. The VSWR of the proposed antenna design is 1. For feeding the antenna, the microstrip feed line technique has been employed for proper impedance matching and the proposed antenna has an input impedance of 48.23Ω. The proposed terahertz antenna design has a gain and directivity of 7.547 dB and 7.247 dBi, respectively at the resonating frequency of 6 THz. The antenna has been designed and simulated using Computer Simulation Technology (CST) Microwave Studio 2014. The proposed antenna can be suitably employed for the detection of constituents of peptides in human body.*

**Keywords—** *CST Microwave Studio, dB, dBi, FR4, High gain, High directivity, Optical antenna, Peptides, Wide band, THz, VSWR*

## I. INTRODUCTION (SIZE 10 & BOLD)

With the advancement of technology of nanomaterials, the fabrication techniques of very small dimensions have received significant attention in the past few decades. The designing of optical antennas in technological applications is primarily associated with their small scale dimensions [1]. The increasing demand for higher bandwidth and higher speed wireless communication motivates the exploration of higher frequency bands. According to the classification of the International Telecommunications Union (ITU), the terahertz radiation com- prises the electromagnetic waves in the frequency band from 300 GHz to 10 THz, with corresponding wavelength approximately between 1 mm and 100 m is envisioned as one of the key players to meet the demand for such higher bandwidth and data rates. As THz frequencies region lies between microwaves and infrared light in the electromagnetic spectrum, terahertz waves combine the advantages of the two bands, and it is considered as the main role in scientific and technological application areas [2-5]. The optical antennas fulfil the rapidly increasing demand of faster information exchange that requires large bandwidth [6][7][8]. The optical antennas are also useful for biomedical applications terahertz technology is being widely used in diverse fields like spectroscopy, sensing, imaging, astronomy, radars for concealed object detection, nano-biotechnology etc. [9][10][11]. The proposed antenna finds its application in the bio-medical field technology where it is used for the detection of the constituents of short-chain solid- state polypeptides having high-degree of complexity which mainly are a sub-part of amino acids. The molecules that have been detected in the spectrum shown by the proposed antenna are GlyAla, AlaAla, ProGly and LeuGly [12]. In general, the addition of another amino acid to a dipeptide chain adds additional absorption features arising from increased mode and spectral density. Each spectrum is uniquely identified and other tripeptide solids exhibit similar but characteristically different and equally complex spectral structure including spectra for solid glutathione. This demonstrates that a mixed tripeptide species exhibits multiple features in the 115 THz range that are persistent and weakly temperature dependent [13].

Section II (Antenna Configuration) describes the geometry of the proposed antenna including side view, top view and bottom view of antenna illustrating the dimensions of patch, substrate and ground plane.

Section III (Simulated Results) describes the performance of the designed antenna in terms of return loss ($S_{11}$), bandwidth, gain, directivity, VSWR and impedance.

Section IV (conclusion) proposes the suitability of designed antenna for various applications.

## II. ANTENNA GEOMETRY

In the proposed antenna design, the substrate of thickness 1.5 μm has been used and the thickness of the patch and ground is 0.02 µm. The substrate is of FR4 material having dielectric constant of 4.4. The fig. 1(a), fig. 1(b) and fig. 1(c) illustrates the geometry of the proposed antenna. The substrate, patch, ground and feed line arrangement has been shown in fig. 1(a). The patch is a ring shaped structure with inner radius 9 mm and outer radius of 35 mm which has been demonstrated in fig. 1(b). The 3-D view of the proposed antenna has been shown in fig.1(d).

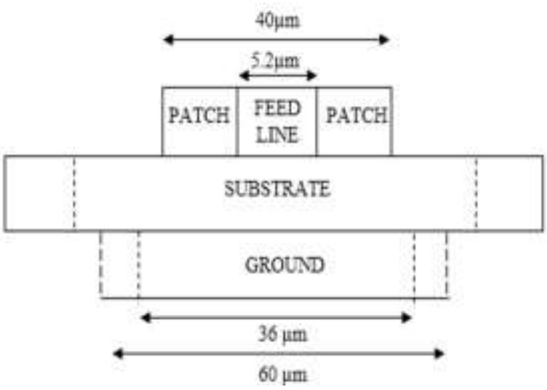


Fig. 1(a) Side View of the proposed antenna

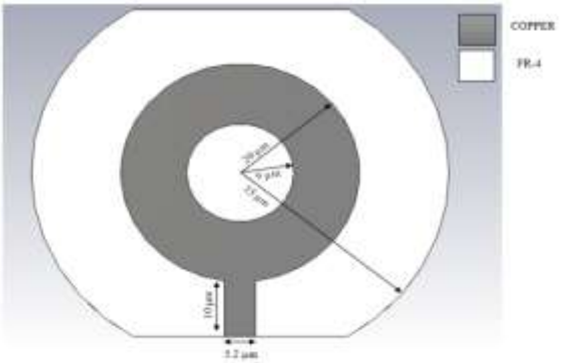


Fig. 1(b) Top View of the proposed antenna

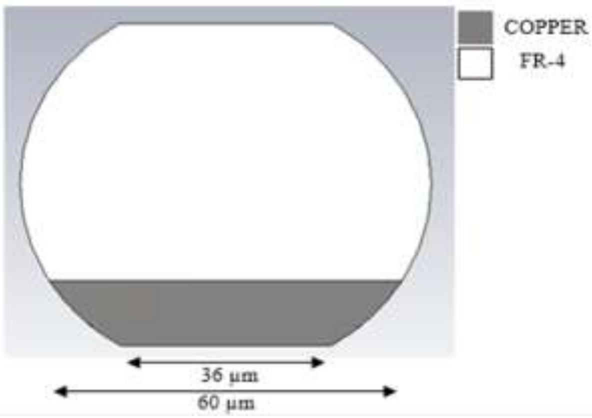


Fig. 1(c) Bottom View of the proposed antenna

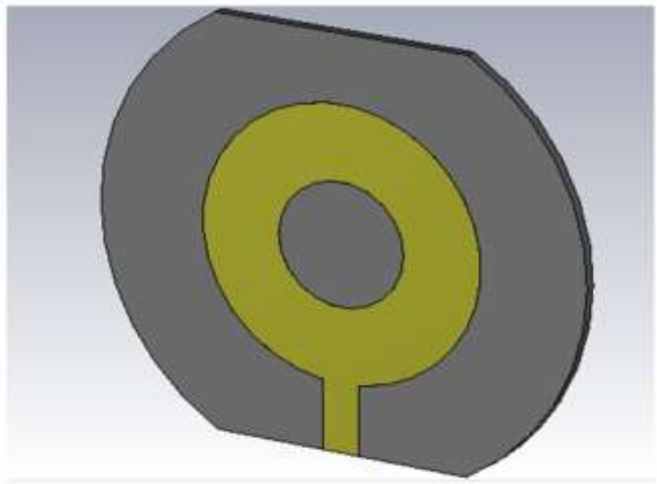

Fig. 1(d) 3-D View of the proposed antenna

## III. RESULTS

The performance of designed antenna has been analyzed in terms of its resonant frequency (THz), bandwidth (GHz), return loss plot (S11) (dB), gain (dB), directivity (dBi), VSWR and impedance. The CST Microwave Studio 2014 has been used to design the propose optical antenna. The return plot illustrates that the antenna is resonant at 6 THz with the return loss of -43.58 dB which has been shown in fig. 2. The fig. 3 represents Smith Chart of the proposed antenna which implies that the designed antenna has a impedance of 48.23 ohms. The gain and directivity of antenna at the resonating frequency of 6 THz is 7.547 dB and 7.247 dBi respectively as illustrated in Fig. 4 and Fig. 5. The VSWR plot of the proposed optical antenna has been shown in Fig. 6 which implies that the value of VSWR of the proposed antenna design lies below the minimum acceptable value of 2.

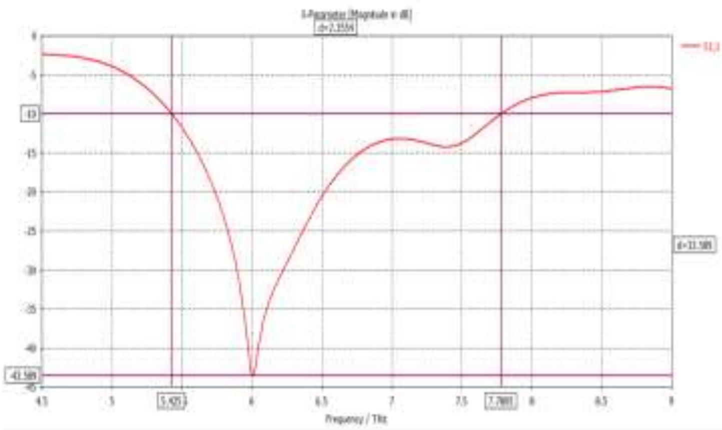

Fig. 2 Return Loss plot for the proposed antenna

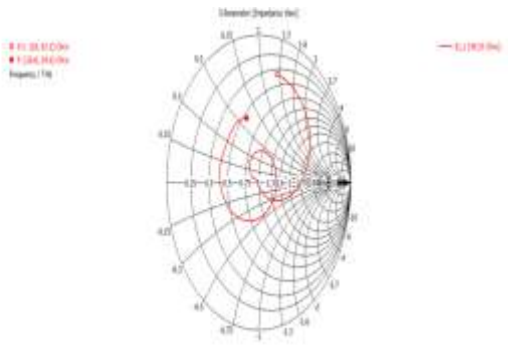

Fig. 3 Smith Chart for the proposed antenna

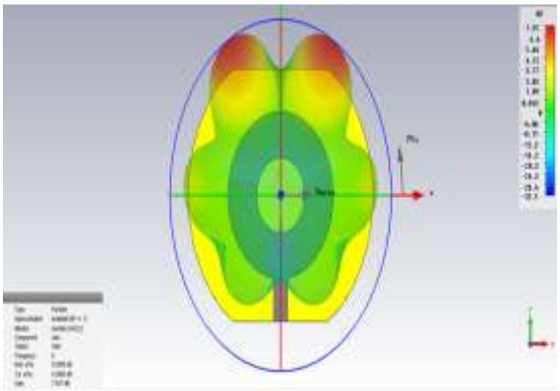

Fig. 4 Gain of the proposed antenna

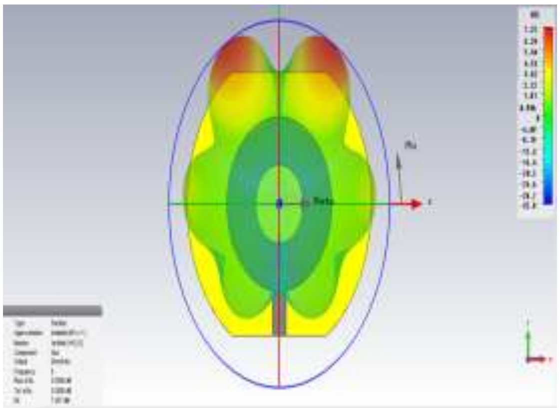

Fig. 5 Directivity of the proposed antenna

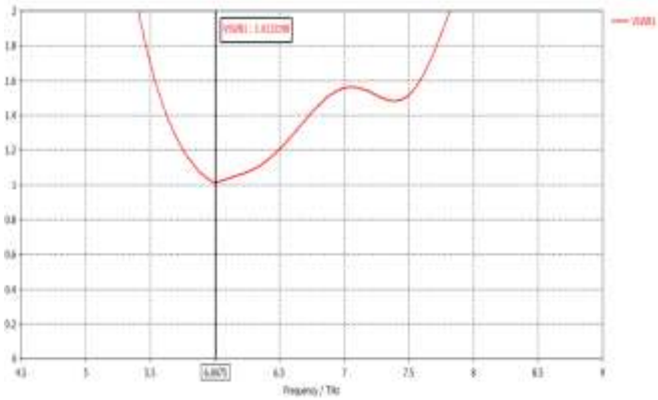

Fig. 6 VSWR plot for the proposed antenna

The Fractional Bandwidth (FBW) of the proposed THz Microstrip patch antenna can be computed as:

$$FBW=\frac{f_2-f_1}{f_c} \quad (1)$$

where,

$f_1$= Lower cut off frequency

$f_2$= Upper cut off frequency

$f_c$= Resonant frequency/ Centre frequency

$$FBW=\frac{7.798-5.423}{6}=0.399 \quad (2)$$

FBW= 0.399×100 = 39.9%

Since, the fractional bandwidth of the proposed THz antenna is more than 20% but less than 50%, it is a ultra wide band antenna.

TABLE I : PROPOSED ANTENNA PARAMETERS

| S. No | Antenna Parameters | Magnitude |
|---|---|---|
| 1. | Return Loss | -43.58 dB |
| 2. | Impedance | 49.53 Ω |
| 3. | Gain | 7.54 dB |
| 4. | Directivity | 7.24 dBi |
| 5. | VSWR | unity |


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