Tunable Feeding Point THz Antenna with Butterfly Type Slot Based on Ceramic Material Substrate

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***Abstract*—A new type of tunable feeding point Terahertz (THz) slot antenna with a butterfly type metallic body structure on ceramic substrate is proposed in this paper. Slots are produced by symmetrically cutting a copper plate. Implementation of the based slot body offers a better directivity and radiation efficiency. Full-wave simulation results showed that the THz band slot antenna works at 0.224THz with a -10dB bandwidth of 11.60GHz and the maximum directivity is 11.8dBi. It is very flexible and convenient to adjust the center frequency of antenna by properly adjusting the feed point position. These interesting THz slot antenna was suggested a promising application in various fields such as biosensors, artificial vision restoration system and THz communication system.**

I. INTRODUCTION

WITH the ever-growing need for fast data wireless transmission, the extension of the operating frequency towards higher spectrum regime has been one of the hottest topical discussions in academic laboratories, technical conferences corporate boardrooms and application engineering [1-4]. On this way, in the past decade, Terahertz (THz) from 0.1THz to 10THz has been explored. This frequency span is capable of playing an important role in several fields, such as bio-sensing, imaging, radar and high speed wireless communication, electronic information, and homeland security [5-7], etc. Metallic slot antennas which are fabricated by machining processes have shown promising performance [8, 9] in the microwave band. Technically, any lower frequency antennas can be scaled up to their higher frequency counterparts [10, 11]. Exceptional properties of THz, such as high resolution, high confidentiality, high penetrability of smoke dust and wide bandwidth have been applied successfully for THz imaging, communication and THz detectors. Improvement and investigate in visual perception are especially desired and pursued in THz range, where the THz photon energy are typically in milli electron volts, because THz waves are absorbed by the water molecules and limited the depth into the body, it will does not produce harmful ionization for biological issue.

In this paper, we proposed a tunable feeding point THz antenna by introducing a designed butterfly type structure model on ceramic material substrate. It may be used in the artificial visual perception microchips. Designed slot antenna exhibits that centre frequency and bandwidth can be adjusted by fine tuning feeding point position.

II. DESIGN AND SIMULATION OF THE BUTTERFLY TYPE THZ SLOT ANTENNA

The structure shown in Fig. 1 is the proposed butterfly type metallic body structure of THz antenna, which is on the top side of the ceramic substrate. The structure of metal layer is assumed to be a perfect electric conductor, and the substrate of antenna is modeled as the ceramic materials. The ceramic material was used because it exhibits very low absorption loss, small rejection and small refractive index variation for human body in microwave and THz frequency range. The side view of the antenna is illustrated in Fig. 2, the antenna includes three parts: radiation elements, substrate and feeding points, where radiation parts are defined on the top side of the ceramic substrate, the feeding points are defined on the radiation elements, and in the centre region of radiation elements. The geometry configuration of designed slot antenna plays the vital role in modifying the whole antenna performance. Then the slot and the metal width values are optimized by finite-integral time-domain method to achieve the optimal antenna performance.

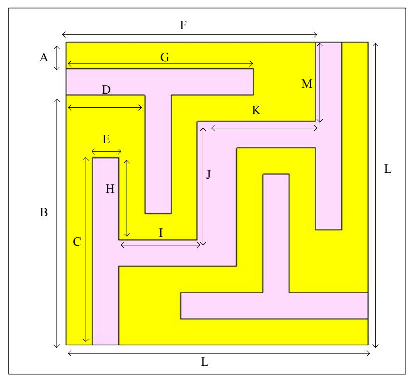

Fig.1 Slot patch antenna diagram

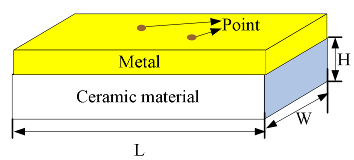

Fig. 2. Schematic diagram of the two layer THzantenna. The metal layer is patterned on a ceramic..

Table.1 is the metallic layout overall parameters of the optimized antenna. Table.2 is the parameters of the proposed antenna substrate.

TABLE 1 PARAMETER LAYOUT OF ANTENNA

Parameter	L	A	B	C	D
Value (mm)	0.46	0.04	0.38	0.285	0.12
Parameter	E	F	G	H	I
Value (mm)	0.04	0.38	0.285	0.125	0.12
Parameter	J	K	M	thickness	
Value (mm)	0.18	0.18	0.12	0.013	

TABLE 2 PARAMETER OF CERAMIC MATERIAL SUBSTRATE

Parameter	L	W	H
Value (mm)	0.46	0.46	0.013
Parameter	Dielectric constant ε	Density ρ	
Value (mm)	6	2400 kg/ m^3	

By using finite-integral time-domain method, we have been obtained the simulation results of the antenna performance and material loss is taken into consideration. Simulation results of S parameter, the radiation surface current, the gain of far field and the antenna pattern of the optimized antenna are shown in Fig.3, Fig.4, Fig.5 and Fig.6, respectively.

As seen in Fig.3-Fig.6, it is revealed that the antenna resonates at 0.224THz. The -10dB bandwidth is about 11.6GHz. It is seen in Fig.7, the maximum antenna directivity is 11.8dBi.

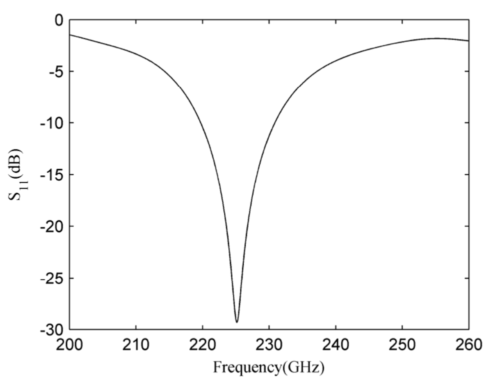

Fig.3 S parameter simulation result of slot antenna

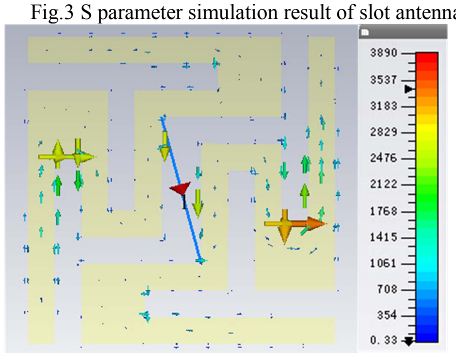

Fig. 4 0.224THz antenna radiation surface current and antenna structure contrast figure

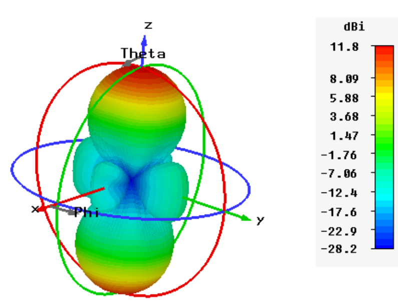

Fig.5 The far field gain simulation result of slot antenna

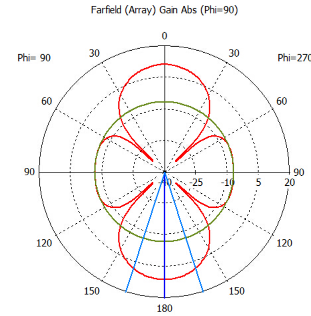

Fig.6 The simulation result of slot antenna pattern

III. SUMMARY

In this paper, a type of tunable feeding point slot antenna with butterfly type slot is analyzed and designed. The S_{11} parameters of the antenna and its directivity have been predicted by using finite-integral time-domain method. The simulation results reveal the centre frequency is 0.224THz, the centre frequency and bandwidth can be adjusted by fine tuning feeding point position. This antenna has a perfect performance. It can be used to visual prosthetic engineering

IV. ACKNOWLEDGEMENT

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