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A Hexa-Band Refractive Index Sensor Using a Symmetrical Boss Cross Terahertz Metamaterial Absorber with Biomedical Applications

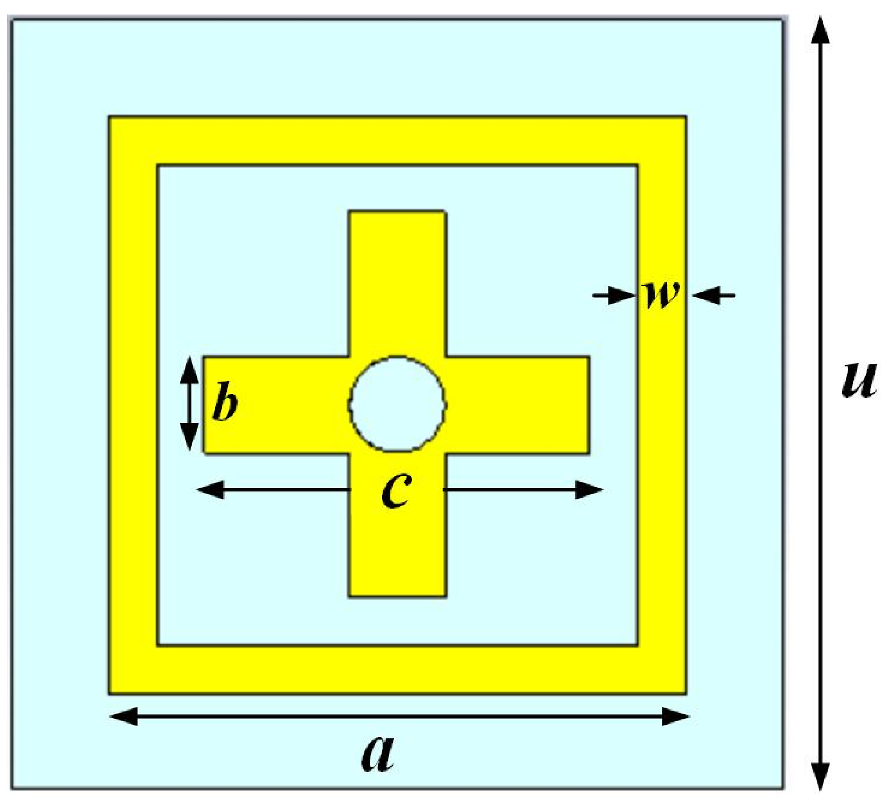
Santosh Kumar Mishra[1], Uddipan Nath[2], Sagnik Banerjee [3], Bhargav Appasani[1], Omprakash Acharya[1], Sunil Kumar Mishra[1], Amitkumar V. Jha[1], Avireni Srinivasulu[4], and Cristian Ravariu[5]

[1]School of Electronics Engineering, Kalinga Institute of Industrial Technology, Bhubaneswar 751024, India
[2]Department of Internet and Technologies for Information and Communication, University of Rome "Tor Vergata", Rome-00133, Italy
[3]Department of Information Engineering, Electronics and Telecommunication, Sapienza University of Rome, Rome-00185, Italy
[4]School of Engineering and Technology, Mohan Babu University, Tirupati 517102, India
[5]University "Politehnica" of Bucharest, Faculty of Electronics ETTI, Dept of Electronic Devices DCAE, Bucharest 060042, Romania

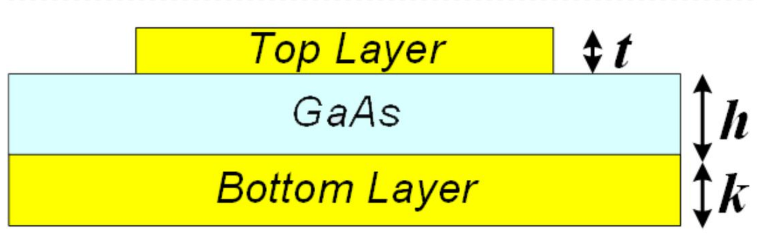
INTRODUCTION & AIM

Terahertz metamaterial absorbers (TMAs) specifically cater to applications in the terahertz frequency range. Terahertz radiation lies between microwave and infrared radiation and has unique properties that make it useful for biomedical sensing, spectroscopy, and security screening. The absorption peaks of TMAs can be tailored by modifying the material properties or adjusting the micro-structures, allowing precise control over the absorption spectrum. The versatility and tunability of the TMAs make them an essential tool in advancing terahertz-based technologies and applications. Researchers have developed multi-band, broad-band, and tunable TMAs. Tunable TMAs have absorption characteristics that vary with the surrounding medium's refractive index, which can assist in bio-medical sensing. In 1994, Landy et al. presented the first metamaterial absorber. Subsequently, absorbers with single, dual, triple, quad, penta, and hepta bands. For detection, absorbers having high FoM can be employed. Numerous investigators have suggested multiband absorbers made by fusing several metallic resonators, that is, in [1], the proposal for quad-band absorbers was made by utilizing four distinct resonator sizes; in [2-3], triple and Dipolar resonance was used to build quad-band absorbers. Changes in refractive index can also be sensed by THz metamaterial absorbers [4]. In order to identify biological substances, this work presents a straightforward design for a TMA-based unit cell that is polarisation insensitive and has three concentric square and two concentric cross-shaped resonators placed onto it. It provides an extremely high and tunable absorption spectra, consisting of six prominent absorption peaks, when the surrounding medium's refractive index is varied between 1.3 and 1.4, aiding in biomedical sensing applications.

METHOD

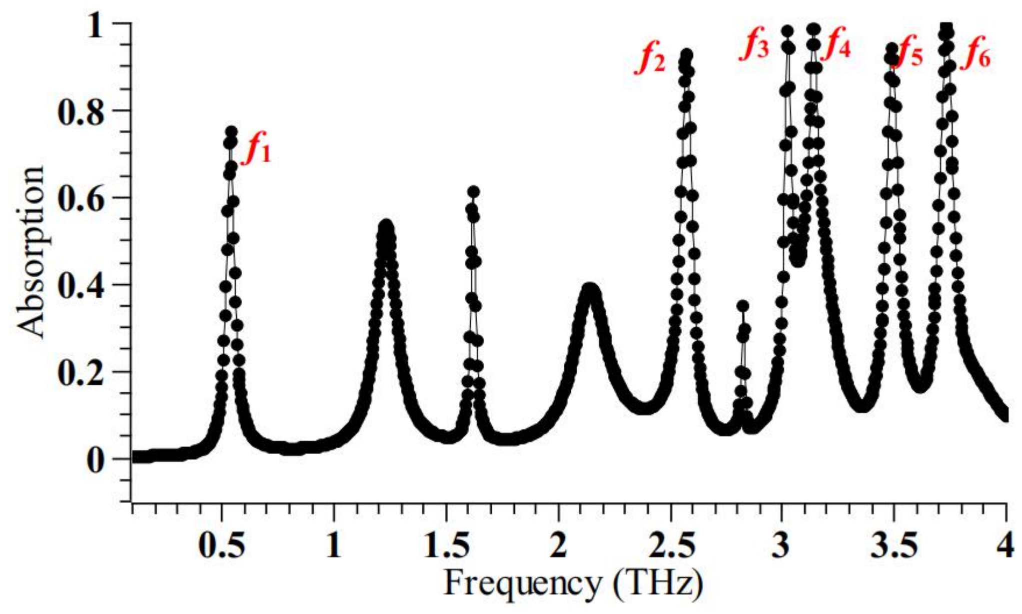


Design Parameter	Magnitude (μm)
h	8
u	80
a	60
t	4
k	7
c	40
b	5
w	5

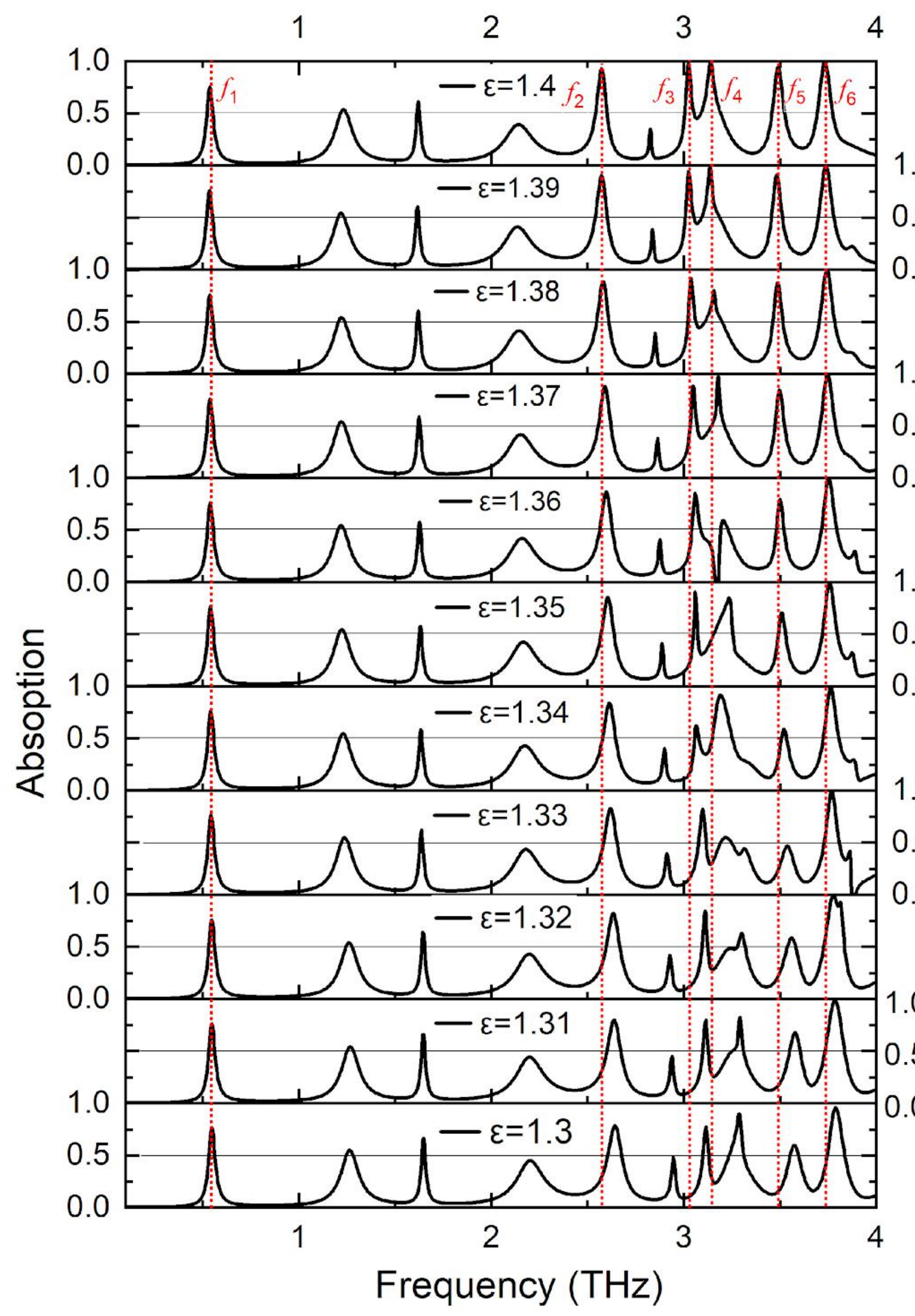


The top and bottom planes of the structure are built of gold because gold has a conductivity of 4.10 x 107 S/m. Due to its broad bandgap and high resistivity, the dielectric spacer built of gallium arsenide (GaAs) has a permittivity of 12.94 and a loss tangent of 0.006. The gold-made rear layer's thickness, t = 7 μm, has been selected to block electromagnetic wave transmission.

RESULTS & DISCUSSION



Frequency Band	Frequency (THz)
f_1	0.5368
f_2	2.5726
f_3	3.025
f_4	3.142
f_5	3.4891
f_6	3.7387



The suggested absorber can serve as a very effective refractive index sensor since the absorption peak varies noticeably with even a little change in the media's refractive index. Because many biological samples have refractive indices of 1.3, the refractive index range from 1.3 to 1.40 with a step size of 0.01 has been studied. The blood of a healthy person's body, for instance, has a refractive index of 1.3, whereas the blood of someone who has T-type leukaemia has a refractive index of 1.39. The suggested sensor might therefore be used to detect cancer cells.

CONCLUSION

This investigation and analysis of the design of a unique metamaterial absorber, which may be utilized to identify biological samples, particularly cancer cells, in the terahertz range, are presented in this publication. The suggested absorber is extremely sensitive to changes in the surrounding medium's refractive index. Due to the abundance of biological samples within this range, it may thus function as a superb refractive index sensor when altered in the range of 1.34 to 1.39. The sensor has a high FoM of 25 and a Q-factor of 44. Combined with machine learning, the spectra generated by this sensor can be used for effective detection of biomedical specimens.

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