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Design and Analysis of Bromine Doped Conducting Polymer Based Microwave Absorber

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Abstract: Microwave absorber is one of the elements that must have in the anechoic chamber. RF Shielded anechoic chambers are widely used to provide RF isolated test regions to simulate free-space test environment. Microwave absorbing materials and structures have to meet general requirements that can be summarized by the following: (i) it should minimize the reflection of EM waves at the air to absorber interface; (ii) it should have strong absorption of electromagnetic waves; (iii) it is expected to have broad bandwidth and angular response; (iv)it should have low weight and thickness. Based on the above properties of microwave absorber, wide band microwave absorbers are designed and simulated. Conducting polymers were taken as the absorbing materials and pyramidal structure microwave absorber was simulated. The simulation results show wideband frequency absorption.

Keywords: Conducting polymer, absorber, microwave, narrow band.

I. INTRODUCTION

An understanding of the interaction of microwaves with metal surfaces is integral to a vast array of modern technologies which are becoming ever more ubiquitous, including Wi-Fi and cellular phones, to name but two examples. Unsurprisingly therefore, research into microwaves and microwave materials constitutes a huge and growing field of interest and covers many different areas, from high impedance ground planes which improve the performance of cellular phone handsets, microstrip antennas and new ultra-small antenna configurations for radio frequency tagging. Materials which allow the passage of microwave radiation to be manipulated are hence of great use in an environment where radio frequency contamination is an ever-increasing problem. An understanding of the interaction of microwaves with metal surfaces is integral to a vast array of modern technologies which are becoming ever more ubiquitous, including Wi-Fi and cellular phones, to name but two examples. Unsurprisingly therefore, research into microwaves and microwave materials constitutes a huge and growing field of interest and covers many different areas, from high impedance ground planes which improve the performance of cellular phone handsets, microstrip antennas and new ultra-small antenna configurations for radio frequency tagging. Materials which allow the passage of microwave radiation to be manipulated are hence of great use in an environment where radio frequency contamination is an ever-increasing problem. EM waves with lower frequency have lower energy.

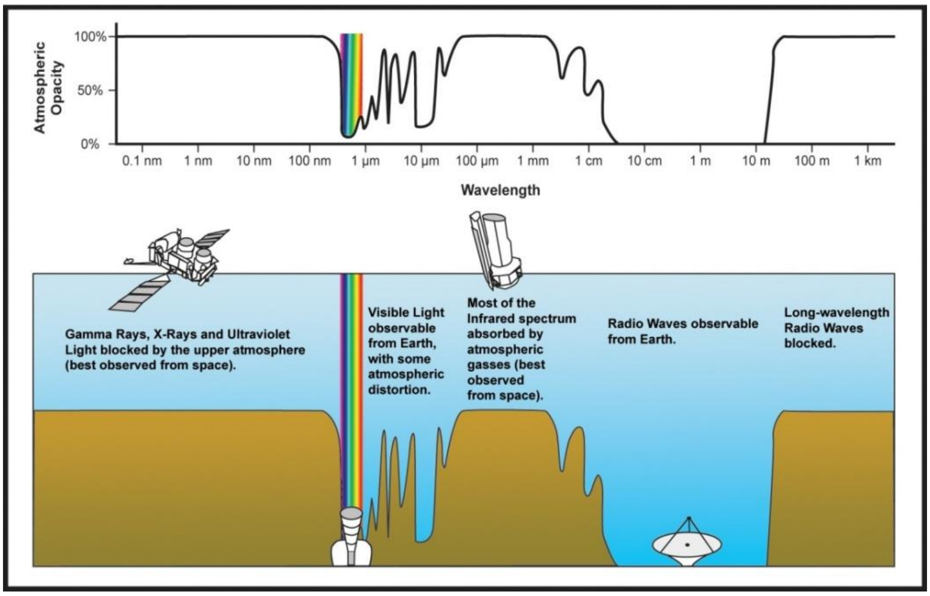

Fig.1 Atmospheric opacity

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II. SIMULATION PROCESS FLOW

Simulation of pyramidal microwave absorber is carried out in following steps: creating single pyramidal geometry, then duplicating it to form 3x3 array of pyramidal microwave absorbers, assigning material to the geometry, validating the simulation, and analyzing the structure in frequency domain. Steps of geometry created for single pyramid is creating a square base of dimensions 10.16 mm x 10.16 mm. Select the draw tab of the workspace and click on the box button, click on the workspace and drag the cursor in x-axis, y-axis, and z-axis. After releasing the button a box will appear. Open the property setting and sign the exact dimensions to the box as per requirement. Creating the pyramid: In order to create the pyramid another box is created with its base starting from 22.86 mm above the z-axis. The using the polyline geometry drawing option all the faces of the pyramid are created and the upper box was deleted as shown in figure. Open the Edit tab of the software and click on the Select option. In the subsection click on the select by object option and click on the single pyramid structure. Again open Edit tab and click on Duplicate option and in the sub-section click on the Along the Line option to create the duplicate structure. The designed pyramidal microwave absorber is simulated and frequency sweep was carried out from 0-30 GHz for geometry of dimensions in millimeters and also the same geometry was analyzed for dimensions in centimeters. Figure 4.8 shows the reflection losses (S_{11}) for geometry in millimeter.

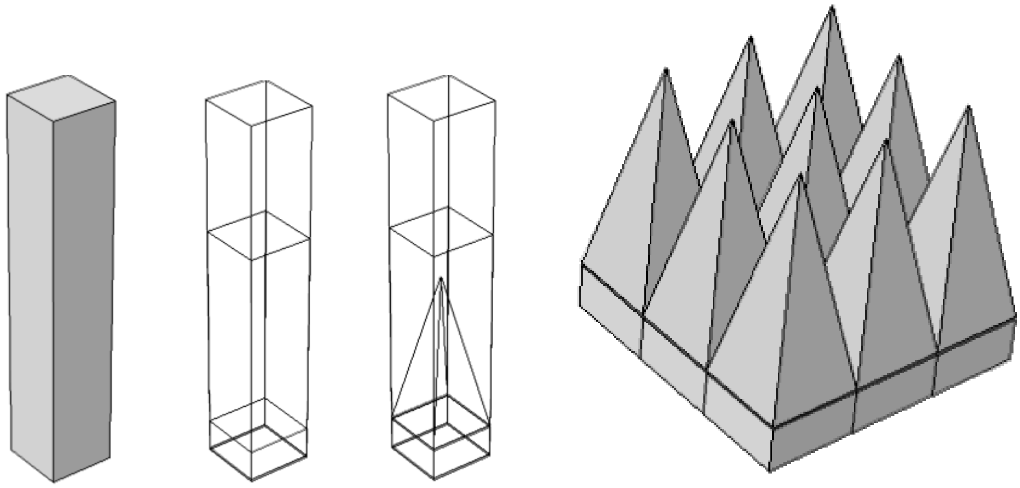

Fig.2 (a) Formation of square box (b) Base formation of the structure (c) single pyramid structure (d) Formation of 3x3 array of pyramidal structure.

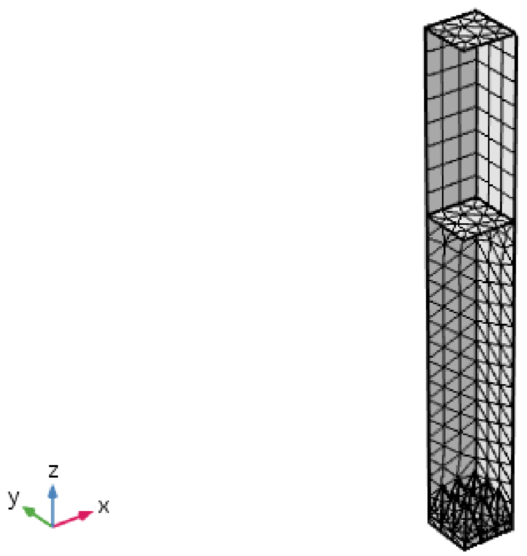

Fig. 3 Meshing of the structure.

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III. Results And Discussion

In this section results obtained from simulation of pyramidal microwave absorber based on conducting polymer material are presented and discussed briefly. The optimized device is showing in Fig. 5.1. Set of modeling and simulations were carried to estimate s-parameter, voltage standing ratio, magnetic and electric flux interaction with the designed structure. Bromine doped polyacetylene conducting polymer were considered for the simulation process. Bromine doped polyacteline based device is degined and simulation is carried out in frequency domain. Parametric sweep as well as frequency sweep is carried for the s-parameter. Resonant frequency obtained in frequency sweep was used for the parametric sweep for emwave interaction at various elevation angles. Figure 4 shows the plot shows quantitatively that the absorber performs well for a range of incident elevation angles. Figure 5 s-parameter plot for frequency ranging from 1GHz to10 GHz, it is observed from the graph that device show sharp dip around 5.14 GHz frequencies.

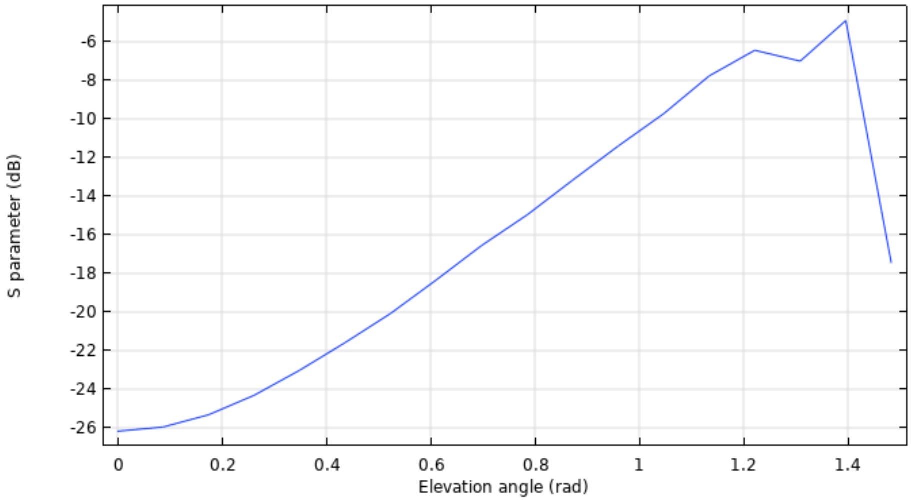

Fig. 4 S-parameter plot as a function of incident angle.

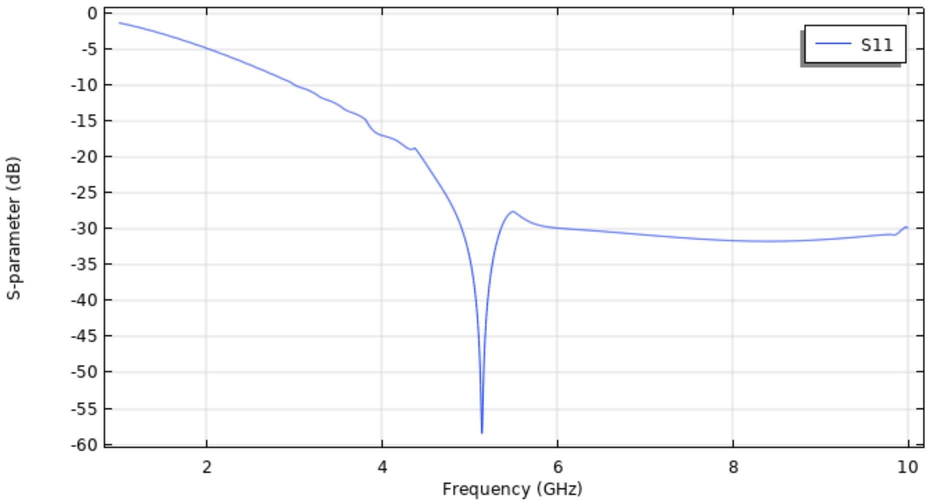

Fig. 5 S-parameter plot as a function of frequency.

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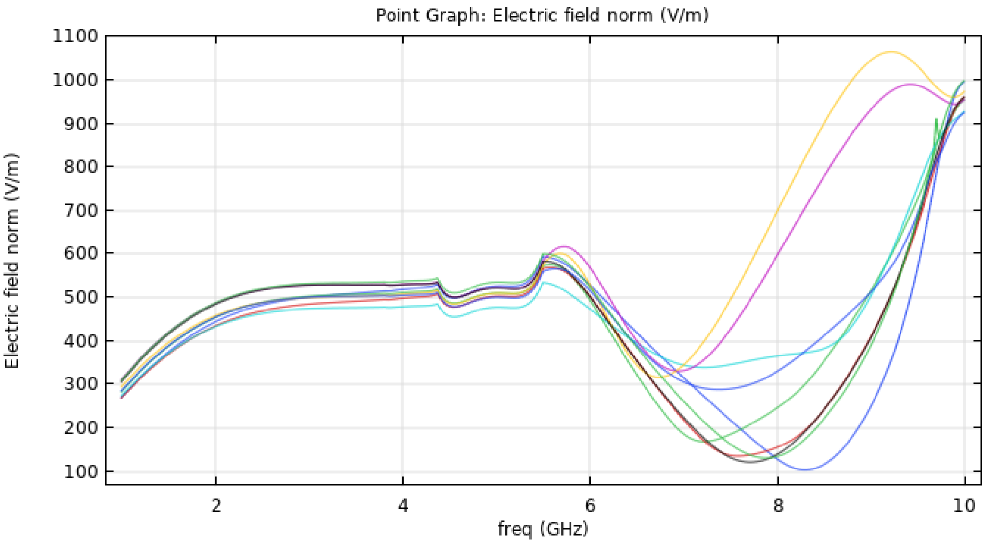

Fig. 6 Electric field plot at tip pyramid as a function of frequency.

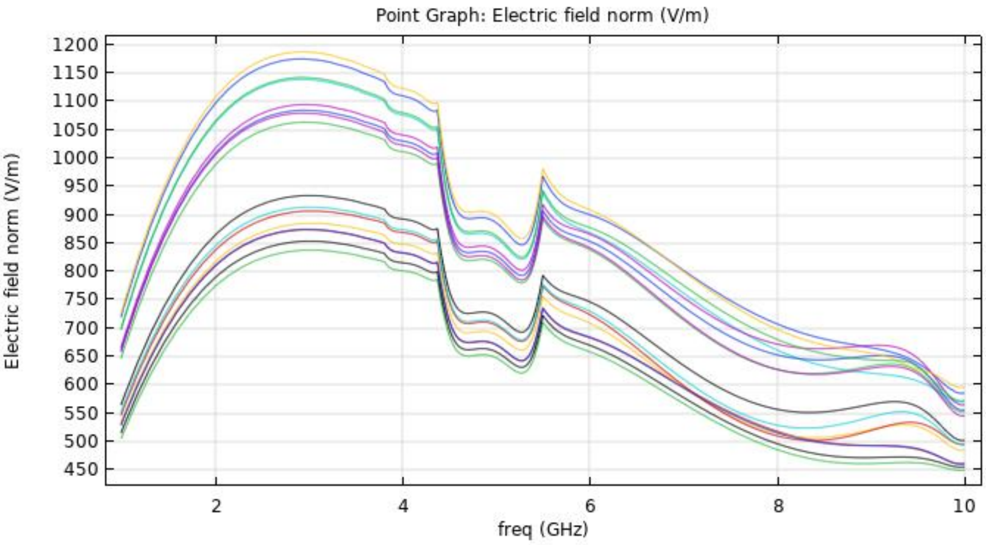

Fig. 7 Electric field plot at base of pyramid as a function of frequency.

The interaction of emwave with the tip of pyramid structure and electric field norm (V/m) as a function frequency ranging from 1 GHz from 10 GHz shown in Fig. 6. The electric field displacement at the base of the pyramid of the microwave absorber is shown in Fig. 7. Power flow as electric field displacement at various elevation angles is shown in Fig. 8.

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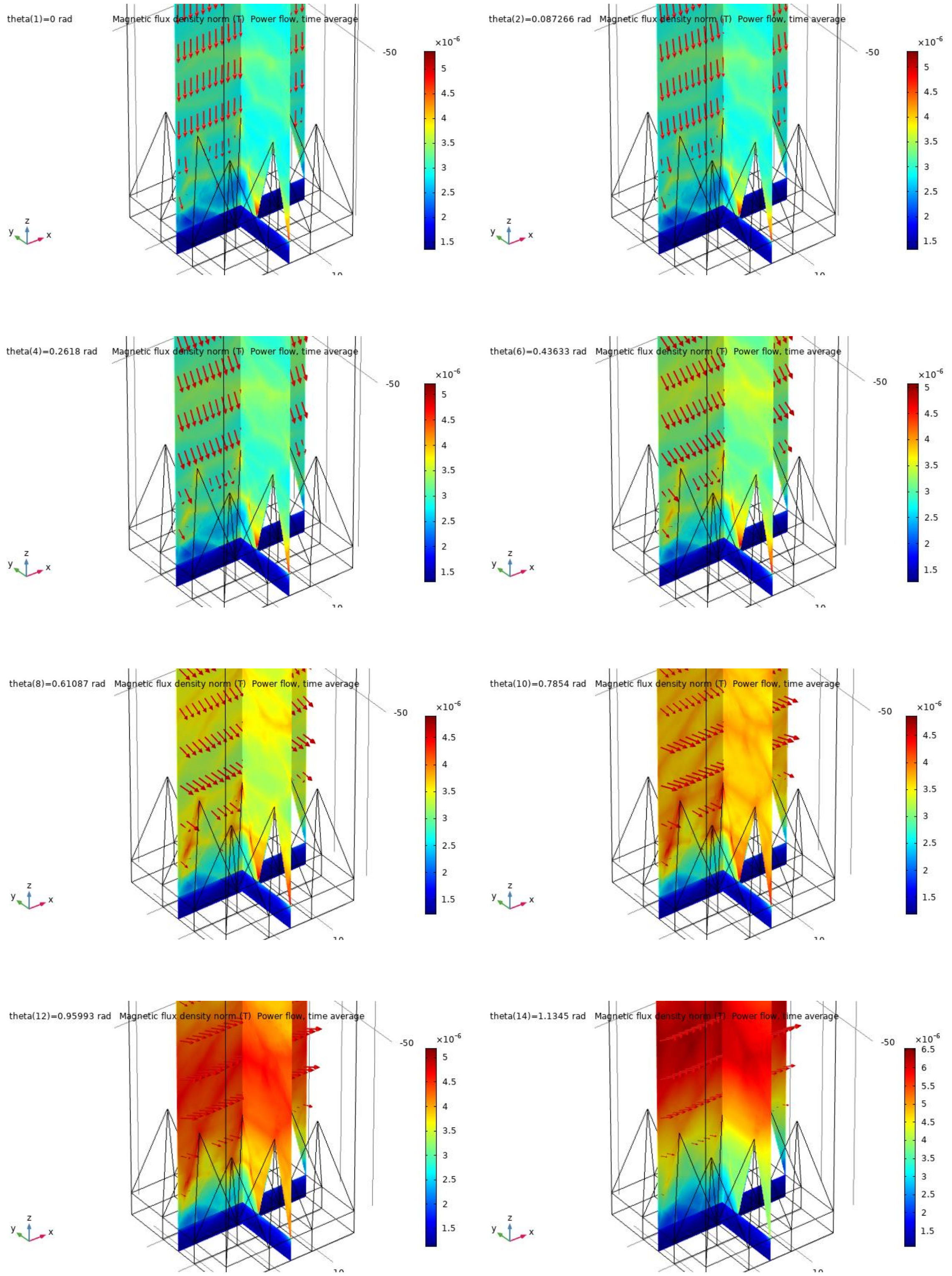

Fig. 8 Power flow distribution with respect to elevation angle.

IV. CONCLUSION

Microwave frequency corresponds to frequency range between 300 MHz and 300 GHz [8]. These frequencies are equal to wavelengths between 1 mm and 1 m. Nowadays, electronic devices operates with using microwave frequency. Frequency domain analysis is to be carried out to estimate various electrical parameters. Bromine doped polyacetylene showed narrowband absorption properties. Structure of the device played critical role in the absorption phenomena. Set of experiment were done to analyze the structural effect with above mentioned conducting polymers.

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