SPECIALY DESIGNED GRAPHENE STRUCTURE BASED NANO MICROSTRIP PATCH ANTENNA

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Abstract: -

This paper presents a design of graphene structure-based Nano microstrip patch antenna and experimentally studied on IE3D, an electromagnetic simulation package by Zeland Software Inc. This design technology is achieved by cutting the Graphene structure in square patch microstrip antenna and placing a single coaxial feed. graphene structure-based Nano microstrip patch antenna is designed on a FR4 substrate of thickness 1.524 mm and relative permittivity of 4.4 and mounted above the ground plane at a height of 6 mm. High Bandwidth is achieved with stable pattern characteristics, such as gain and cross polarization, within its bandwidth. Impedance bandwidth, antenna gain and return loss are observed for the proposed antenna. Details of the measured and simulated results are presented and discussed.

Keywords: - Graphene, Nano structure, Microstrip antenna, Radiation pattern, Returns loss.

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I. INTRODUCTION

In high performance aircraft, spacecraft, satellite, and missile applications where size, weight, cost, performance, ease of installation, low profile, easy integration to circuits, high efficiency antennas may be required. Presently there are many other government and commercial applications, such as mobile radio and wireless communication to meet these requirements microstrip antenna can be used. These antennas are low profile, conformal to planar and non-planar surface, simple and inexpensive to manufacture using modern printed circuit technology, mechanically robust when mounted on rigid surface; compatible with MMIC designs and when the particular shape and mode are selected, they are very versatile in terms of resonant frequency, polarization, field pattern and impedance. Microstrip antenna consist of a very thin metallic strip (patch) placed a small fraction of a wavelength above a ground plane. The patch and ground plane are separated by dielectric material. Patch and ground both are fabricated by using conducting material. [2]

However, the major disadvantage of the microstrip patch antenna is its inherently narrow impedance bandwidth. Much intensive research has been done in recent years to develop bandwidth enhancement techniques.[9] These techniques include the utilization of thick substrates with low dielectric constant. The use of electronically thick substrate only results in limited success because a large inductance is introduced by the increased length of the probe feed, resulting few percentages of bandwidth at resonant frequency.

The purpose of this work is to design a microstrip patch antenna using commercial simulation software like IE3D [10]. The IE3D by Zeland Software Inc. has been recently considered as the benchmark for electromagnetic simulation packages. It is a full wave, method of moment (MOM) simulator solving the distribution on 3D and multilayered structures of general shape. The primary formulation of the IE3D is an integral equation obtained through the use of green's functions. In the IE3D, it is possible to model both the electric current on a metallic structure and a magnetic current representing the field distribution on a metallic aperture.

In this paper, Graphene structure based microstrip patch antenna is proposed. The patch mounted on FR4 substrate (thickness=1.524mm) and above from ground plane at a height of 6mm. It is found that proposed design can also cause significant lowering of antennas fundamental resonant frequency due to increased length of the probe feed.

The organization of the paper is as follows. Section 2 discusses the properties of graphene structure. Section 3 discusses the proposed Graphene structure based microstrip patch antenna design. Section 4 investigates the results of the impedance bandwidth and far-field radiation pattern of the proposed antenna. Conclusions are made in Section 5.

II. GRAPHENE STRUCTURE

Graphene is a promising material due to its excellent electrical conductivity, electromagnetism and electromechanical properties for next generation molecular electronics [12]. Graphene nano structure has potential applications of high frequency transistors [13], modulators [14], wireless nano sensors [15], organic electronics and devices operating in terahertz band . Graphene nanoribbon-polymer composites based conformal antennas are needed, because a metallic thin film is prone to fail due to micro cracks . The next generation wireless communication system requires ultra-broadband antenna with low transmitting power in a high mobility environment. For the terahertz frequency regime, the microstrip patch antenna is an essential device because of its compatibility for miniaturization. The microstrip patch antennas are broadly used in satellite and missile applications due to its advantages of conformal to planar and nonplanar surfaces [10]. The conformal patch antenna consists of parallel electric conductors, separated from the flexible dielectric material and can be fabricated using thin film deposition and nano lithography techniques [11]. The low dielectric permittivity material is needed for improving the radiation efficiency in the desired direction [12]. Previous researchers in this topic are unable to achieve high gain ($\geq 2\text{dB}$), broad impedance bandwidth ($>5\%$) and better radiation efficiency [13]. The present work discusses the designing and radiation characteristics of a graphene structure based Nano microstrip patch antenna on the FR4 Epoxy substrate in terahertz band. In Ref. [14], graphene based patch antenna has been designed.

III.DESIGN OF NANO PATCH ANTENNA

Designing an antenna in the Wi-max band meant that the antenna dimension could be bulky which is un-welcomed. Owing to it objective is to design a reduced size wide band microstrip antenna; the design idea was taken from broadband antennas to make the antenna work in a large band of frequencies of the many broadband antennas, square patch antenna was chosen [4].Hence the chosen shape of the patch was cutting of square slot, with an aim to achieve smaller size antenna [5]. The geometry of graphene structure based Nano microstrip patch antenna is presented in fig.1 with front (top) view. The actual size and the zoomed size of designed antenna is given in fig.2 with top view.

Fig.1,2 Geometry of proposed graphene structure based Nano microstrip patch antenna with dimensions $a=1\text{mm}$, $b=1\text{mm}$, $t=1.524\text{mm}$, permittivity=4.4 and grid size=.0025mm. (actual and zoomed structure)

This square microstrip patch antenna with Graphene structure is fabricated on a FR4 substrate of thickness 1.524 mm and relative permittivity of 4.4. It is mounted above the ground plane at height of 6 mm.[6] In this work, co-axial or probe feed technique is used as its main advantage is that, the feed can be placed at any place in the patch to match with its input impedance (usually 50 ohm). The software used to model and simulate the graphene structure based Nano microstrip patch antenna was IE3D, it can be used to calculate and plot return loss, VSWR, radiation pattern, smith chart and various other parameters.

IV. RESULTS AND DISCUSSION

The proposed antenna has been simulated using IE3D by Zeland software Inc. [10]. Fig.3 shows the variation of return loss with frequency. Plot result shows resonant frequency 1.1667 GHz. And total available impedance band width of 770 MHz that is 65.67% from the proposed antenna. Minimum -25.7847 db return loss is available at resonant frequency which is significant. Fig.5 shows the input impedance loci using smith chart.

Fig. 3 Return loss vs. Frequency curve for proposed antenna.

Input impedance curve passing near to the 1 unit impedance circle that shows the perfect matching of input. Fig.4 shows the VSWR of the proposed antenna that is 1:1.10832 at the resonant frequency 1.1667 GHz.

Fig. 4 VSWR curve for proposed antenna.

Fig. 5 Smith Chart for proposed antenna.

V. CONCLUSIONS

The design has demonstrated that a single probe feed square patch antenna with Graphene structure can be used to form an antenna with impedance bandwidth of 65.67% working in Wi-max wireless communication system with resonant frequency 1.1667 GHz [11]. These modern communication systems require antennas with broadband and/or multi-frequency operation modes. These goals have been accomplished employing slotted patch for the radiating element, with the aim to preserve compactness requirements and to maintain the overall layout as simply as possible and keeping the realization cost very low. In future by cutting slots on square microstrip antenna reduced patch size and improved bandwidth can be achieved.

VI. REFERENCES

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