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Carbon based Patch Antenna Design

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Abstract

The advancements in graphene-based electronics have opened the door to electromagnetic communications in the nano-scale. Performance analysis of carbon based patch nanostrip antenna is carried out in this work. With antennas made from conventional materials like copper, communication between low-power nano machines would be virtually impossible. Graphene have very good electrical conductivity, thermal conductivity and very high electron mobility. By taking these unique properties of graphene, nano devices can be connected forming a network. Experimentally, Antenna gain of activated carbon coated microstrip was found to be 8.72 dB and that for only copper microstrip was only 8.34 dB for a frequency of 1.47GHz. Theoretically, antenna gain of graphene, graphite and copper patch nano antenna is found to be 1.5339 dB, 1.5218 dB and 1.4807 dB respectively and the best performance is given by graphene patch nano antenna.

Keywords: *Graphene, Patch Antennas, Antenna Gain*

1. Introduction

To Graphene-enabled wireless communications constitute a novel paradigm which enable wireless communications at nano-scale [1]. Graphene has a unique structure, wherein, electrons are able to move with minimal resistance. This enables electricity to move at a much faster speed than in metal, which is used for current antennas. Furthermore, as the electrons oscillate, they create an electromagnetic wave atop the graphene layer, referred to as the surface plasmon polariton wave. This would enable the antenna to operate at the lower end of the terahertz frequency, which would be more efficient than the current copper based antennas. Based on the honeycomb lattice of carbon atoms, graphene-based nano-antennas can radiate electromagnetic wave, which is also

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referred to as the Surface Plasmon Polariton wave (SPP) at the terahertz band [2].

The conductivity of graphene has been studied both for DC and for frequencies that range from the Terahertz Band (0.1-10 THz) up to the visible spectrum and it has been shown that it drastically changes with the dimensions or the chemical potential. A Graphene sheet at zero chemical potential has been found to be essentially independent of frequency [3], [4].

The lateral confinement of electrons in semi-finite-size graphene nano-ribbons (GNRs) enhances the material conductivity in the Terahertz Band. In accordance to its conductivity, the propagation of Surface Plasmon Polariton (SPP) waves on doped graphene has been recently analytically studied and experimentally proved. SPP waves are confined EM waves coupled to the surface electric charges at the interface between a metal and a dielectric material. Many metals support the propagation of SPP waves, but usually at very high frequencies (e.g., near infrared and optical frequency bands) [5].

2. Materials and Methods

2.1 Carbon Sample Preparation:

Seeds of lapsi (Choerospondias axillaris), the indigenous plant of Nepal is taken and washed, then dried for days. Then it is crushed and made into powdered form.

2.2 Activation of the sample:

The powdered form of raw material in mixed with phosphoric acid. Then the mixture is filled into quartz tube of tube furnace with controlled supply of nitrogen gas at 400oC. After heating, unwanted dust and chemicals are separated leaving behind the activated carbon in the quartz tube.

2.3 Characterizing the sample

X-ray Diffraction (Bruker D2 phaser Diffractrometer) is used for the identification of crystalline phase of carbon sample. It is also used to measure the average crystalline size, strain, or micro-strain effects in Carbon sample.

2.4 Antenna design:

A patch antenna consists of conducting patch on a ground plane separated by substrate. The parameters in a rectangular patch antenna design control the properties of the antenna.

3. Experimental Results

From the table 3.1, it is clear that the highest antenna gain is achieved from activated carbon coated microstrip patch antenna. Graphite coated microstrip patch antenna also shows some increment in antenna gain. In term of VSWR or reflection coefficient, copper patch shows best performance with minimum value of reflection coefficient and VSWR. Performance analysis of carbon based patch nanostrip antenna is carried out based on experimental results.

Table 3.1 Antenna parameters for various micro-strip antennas

Antenna Parameters	Copper Patch Microstrip Antenna	Activated Carbon Coated Patch Microstrip Antenna	Graphite Coated Patch Microstrip Antenna
Reflection Coefficient	0.29	0.47	0.46
Voltage Standing Wave Ratio	1.82	2.78	2.72
Reflected Power	8.5%	22.2 %	21.4 %
Mismatch Loss (dB)	0.38	1.09	1.04
S_{11} Parameter (dB)	-10.75	-6.55	-6.705

4. Conclusion

The operating frequency of the designed antenna is 1.47 GHz which lies in the spectrum of ultrahigh frequency band. An antenna having high gain whereas low VSWR and low reflection coefficient is required. Due to this low operating frequency compared to other antennas they can be used in telecommunications, radio, radars and GPS. Performance analysis of graphene patch nano-antenna, graphite patch nano-antenna and copper patch nano-antennas is carried out on simulation results. The best result was found by graphene patch antenna. A designed patch antenna with a fractal slot of a swastika symbol resonates at more than one particular frequency. This helps the antenna to be used in multiple frequencies. Various designs with different slots and substrates are being tested for the antennas to work at higher frequencies like 5G communications.

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References

[1] Geim , A.K., Novoselov, K.S. (2012).The rise of graphene. Nature Materials, 183–191.

[2] Falkovsky, L. and Pershoguba, S. (2007). Optical far-infrared properties of a graphene monolayer and multilayer. Physical Rev. B, 76

[3] Falkovsky, L., and Varlamov, A. A. (2007). Space-time dispersion of graphene conductivity. European Physical J. B, 56

[4] Dubinov, A. A., Aleshkin ,V.Y., Mitin, V., Otsuji ,T., and Ryzhii, V. (2011). Terahertz surface plasmons in optically pumped graphene structures. J. Physics: Condensed Matter, 23

[5] Geim, A.K. (2009).Graphene: Status and prospects Science, 52, 23-56