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A reconfigurable multiband nano-antenna design for photonic applications

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***Abstract*---**The Antenna that comprises metal patches set on the Dielectric which is given by coplanar transmission line is known to be a patch antenna. It can also be known as Microstrip patch antenna. The foremost downside is the efficiency of the antenna. A M-patch antenna includes a patch i.e a radiating patch, ground plane on one side and a thin flat metallic region on the other side of dielectric substrate. There are various feed methods such as offset feed, centre feed, inset feed and quarter wave line feed. Microstrip patch antennas have better advantages over conventional antennas. In this paper we develop Multiband Antenna for photonic application. The proposed antenna is designed in a patch model. And in the patch, a cylindrical

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shape graphene is placed over the patch in which we use this for photonic application. And this antenna is designed in flexible material such as copper tape, Kaptonmaterial and nano materials. Nano based cylindrical antenna was not done previously.In this, we have achieved a gain of 8dB which is comparatively better with other antenna after many implementation.

***Keywords*---**microstrip patch antenna, dielectric, cylindrical patch.

Introduction

Over the last few years, the study and design of antennas is the major evolution in optical domain. It is widely used in optical receiver and transmitter, imaging etc. The light application generation, identification and influence via amplification, signal processing etc is called as photonics. In spite of concealing every photonic application on top of entire spectrum near infrared and visible region is the main photonic application. The word “photonics” originated from the very first feasible light emitting semiconductor in the initial 1960’s and the optical fibre development in 1970’s. It has vast range of applications. Processing information, holography, photo detection, medical field like vision correction, monitoring health, surgery, calibration and communication, robotics, military application, X-ray, infrared reflectography, XRF are sprinkle of covered topics. Photonics unique uses are continuing to develop, many applications in electronics enlarge considerably on the transistor that was first invented in 1948. High powered lasers, printing based on xerography , telecommunication based on fibre optic, optic data recording are all economically relevant uses for semiconductor photonic devices and synthesis of chemical, diagnostics in medical field and some other uses of photonics are only a few of the possibilities.

To propagate, transmit and receive EM (electromagnetic) waves an antenna is used which is often related to radio waves. Many antennas are resonant devices. In a narrow frequency band, it can be operated efficiently. It should be tuned to the radio system of the same frequency. Failing that it may be impaired. Since the demand for IOT, wearable devices, 5G tech and other communication devices has increased, flexible antennas are used. This involves various fabrication methods or techniques etc. It is application specific, materials that are used, innovation and process for the fabrication of antennas. For an electronic device to be flexible, a proper integration of this antenna must be used. The market of flexible antennas and its demand is growing rapidly. Conductive materials are used for flexible antennas. It is selected based on conductivity like radiation efficiency and performance[14]. To transmit embedded sound waves, a small sized antenna is used which is known as Nano antenna with radio wave technology. It can be categorized into three different types. Metallic or Plastic N-antenna, Dielectric N-antenna, metallic dielectric N-antenna and they have an extraordinary transmission.

Literature survey

In terahertz band communication in nano network the device that is in nanoscale and its corresponding network is the expected application in many fields. Factors like power and size restrict the application of wireless communication. This explains the nano antenna which is graphene based that utilizes the SPP waves in semi finite size GNR's. [1]The conductivity is studied from the Kubo formation and then to capture electron lateral confinement. And then the propagating SPP waves are analysed, followed by this propagated length and wave vector are measured. The frequency response is determined after the resonant plasmonic cavity is modelled. This results in graphene based nano antennas operated in lower frequencies. This will enable electromagnetic communication.

Nano antenna coupled infrared detector design

For many decades, the IR imaging and detection with respect to wavelength in a couple of atmospheric windows has been deeply researched. It has undergone many improvements and developments that have been used in various fields like space science, military etc. In recent research, the detectors are in need of high-speed detection when conducted in coupled IR with room temperature antenna detectors are promising to reach these requirements. This paper explores the outline concepts and the challenges behind the detectors.[2] The design of antenna and the sensor is explained with challenging elements like impedance matching followed by the fabrication technique and insights of future work. In nano antenna, several models of electromagnetic in graphene are analysed and put in to evaluate scattering, extinction and absorption. Scattering resonances are similar to longitudinal FabryPerot resonances in the Terahertz band. To prognosticate resonant properties of the antenna, this is proposed. The potential for a variety of nano antennas is discussed. [3]

A compact nano antenna based graphene in nano network

The nano devices and its network are widely used. Due to the communication antenna and power limitation, miniaturization has become a major difficulty. Reduced size of nano antenna is required to give a proper signal coverage at mid IR frequencies. This model utilizes the principle of SPP waves which results in miniaturization that attains half the size when weighed with conventional nano antennas. [4]. By using the 3D finite method, a design is proposed for energy harvesting. An elliptical shaped nanoantenna with an air gap is proposed. To improve the efficiency of energy harvesting within the wavelength of 400 to 1400 nm, various simulations were computed. As a result, it has an efficiency of 74.6% and an improvement of 32.7% of total harvesting efficiency.[5]

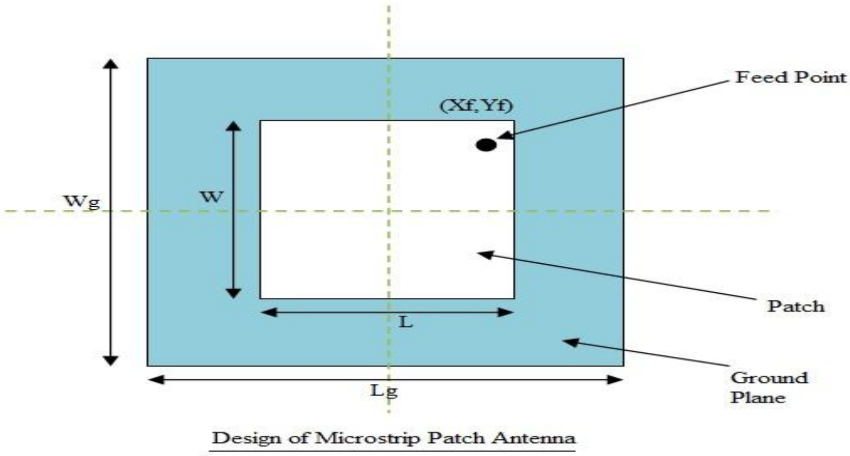


Fig 1. Microstrip patch antenna

Optical nano antenna: Dimensional development towards aviation signalling

With radio frequency radiator optical antennas can be scrutinized. The matching and tuning properties of a pair of closely spaced nano size particles and its viable method to operate is laid out. Beyond the limit of propagating and localized fields, an added potential to influence the synergy between the two is provided by the nonlinear optical antenna is the favourable way to direct optical information. [6]

A review article on dielectric resonator nano antenna

To resolve current, dispense of a dielectric resonator, excited with arbitrary polarization. By outlining CNT integrated equilateral triangular, we inquire into promising benefits by feeding 1×2 feed networks.[7] With this we are computing phase, scattered far field amplitude and polarization. This method is effective to examine the large design parameter space.

Nano antenna- A review

We study how the thermal energy radiated by the sun is converted into electricity with a nano antenna. As the conventional photovoltaic cells are inefficient, the mid IR wavelengths are targeted by the nano antenna.[8] IR radiation can also be generated Industrially by the process of coal fire plants as it is a rich source of energy. The principle and method are discussed as the Nantenna collects and re-emits those days at harmless wavelengths.

Smart optical cross dipole nanoantenna with Multibeam pattern

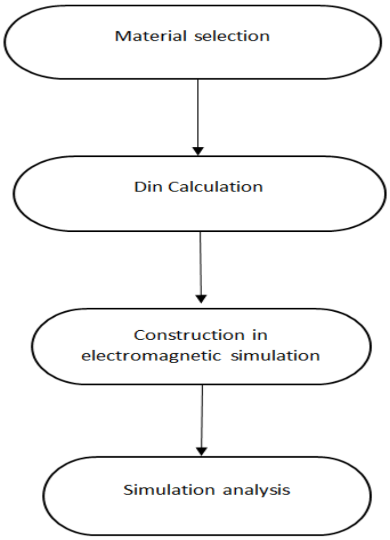
Multibeam cross dipole nanoantenna has been designed to direct the accessibility of every receiver by the graphene has great absorption properties. By applying a single layer of graphene, the antenna is dynamically managed.

Plasmonicnano antenna, enhancing light matter interactions at the nanoscale

When analogizing with conventional electronics, plasmonic gives a nano design with fastest and very less energy consumption. Between nanoscale electronics and microscale dialect photonic devices are operated.[9]Plasmonic designs are created by the optic and nanotechnology advancement. Responses of photo dynamic and nonlinear of different nano antennas were collected. Compact high sources,nano switches with low power are envisioned[10].

Antenna design methodology

The process of fabrication is a technique of (LP-RLSA) antenna and also to improve the S11 response, on top FR4 board is added. Conceptually, by producing a signal with varying phase, the reflection coefficient is reduced by FR4 dielectric material propagating within the antenna cavity. In FR4 boards, copper parts are utilized as radiating elements, and simple and low-cost etching can be obtained. The LP-RLSA is very much faulty in S11 value. An oval ring of slots is produced in Beamquint technique but this is not optimum. More slots are needed to be cut on the background or on the radiating element of the antenna in the cancelling slot. Hence, the cost of fabrication increases. The distance of λg/2 between two slots where the wavelength is denoted as λg.



FLOWCHART: Fig (1.1)

The LP-RLSA with FR4, fabrication process becomes easier because of the copper region. Slots of FR4 board shall be used in the process of engraving photolithography. The FR4 can decrease the reflection coefficient as the dielectric changes the phase [13]. The Antenna has a metallic patch and ground within the dielectric medium known as substrate. It is used in communication peculiarly in civil and military applications. It is also widely used in WLAN, Bluetooth, Wi-Fi etc. It depends on the dielectric constant value and resonant frequency for dimensions.

The width is calculated by,

$$W = \frac{C_0}{2f_r}\sqrt{\frac{2}{\varepsilon_{r+1}}}$$

Where,
C_0= Speed of light
ε_r= Dielectric substrate value
W= Width

Effective Refractive index:

$$\varepsilon_{r\,eff} = \frac{\varepsilon_{r+1}}{2} + \frac{\varepsilon_{r-1}}{2}\left[1 + 12\frac{h}{W}\right]^{\frac{-1}{2}} \text{........(1.1)}$$

Where,$\frac{W}{h} > 1$

Length:

$$\frac{\Delta L}{h} = 0.412\frac{\left(\varepsilon_{r\,eff} + 0.3\right)\left(\frac{W}{h} + 0.264\right)}{\left(\varepsilon_{r\,eff} - 0.258\right)\left(\frac{W}{h} + 0.8\right)} \qquad \text{........(1.2)}$$

Where, h = height of substrate

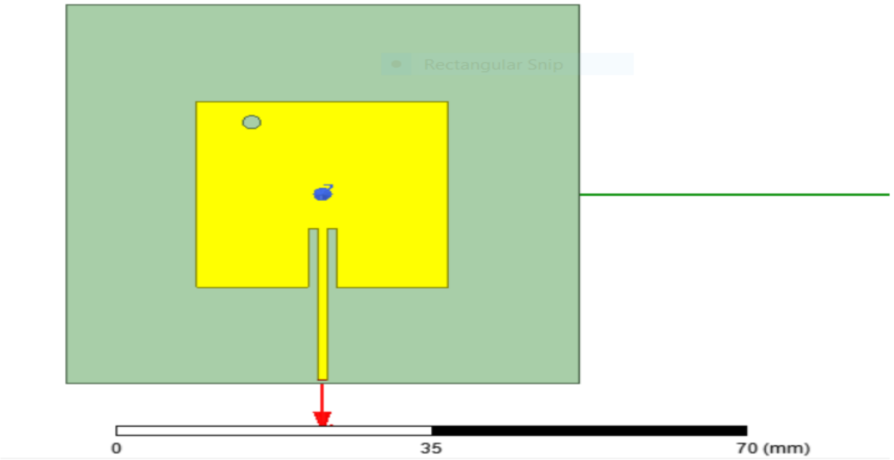
$$\mathrm{L} = \frac{C_0}{2f_r\sqrt{\varepsilon_{r\,eff}}} - 2\Delta L \qquad \text{........(1.3)}$$

$$L_g = 6h + W$$
$$W_g = 6h + W$$

Where,L_g - Length of ground plane
W_g - Width of ground plane.

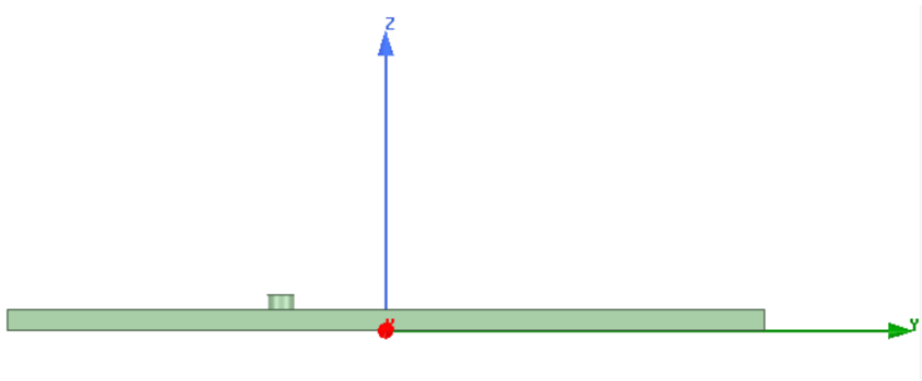
Proposed nano antenna structural layout

A silver material is used to create a strip line of nano metallic at the bottom. Over the upper part of the substrate, a square shaped aperture was likewise engraved from the silver based on the (metallic) strip. Gold, on the other hand, has a higher conductivity and a lower oxidation rate than silver. Silver, on the other hand, is less expensive and does not oxidise quickly when used indoors. As a result, silver is the best material for the suggested antenna. Drude's model determined the dissipate substance of silver material utilized in the suggested antenna design. Graphene's electron band structure is incredibly simple. ε1,2(p) = ±vp is energy bands at the K points with the constant velocity of two Dimension Brillouin zone with v = 108 cm/s near energy = 0. In K points, C3v is the tiny group has 2D characterization, the symmetry is degenerated. The carrier concentration is reduced and the conductivity of graphene is minimum response at very low temperature. Many conceptual attempts have gone wrong into determining the minimum conductivity in various ways. The smearing is caused by electron relaxation processes.



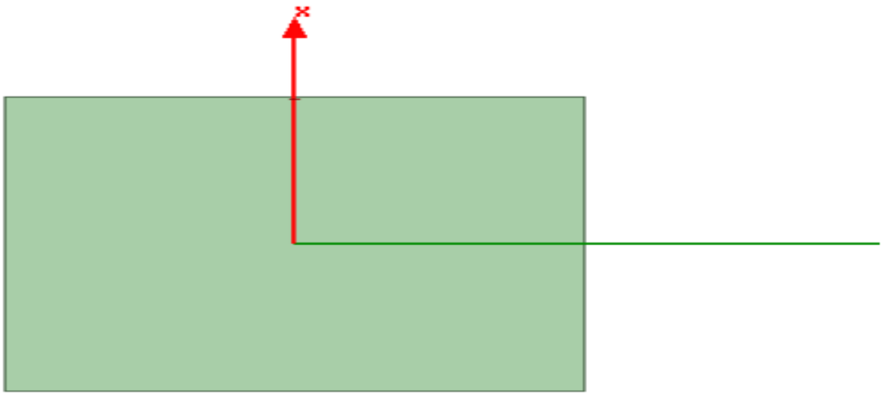
TOP VIEW

Fig (1.2) microstrip patch design



SIDE VIEW

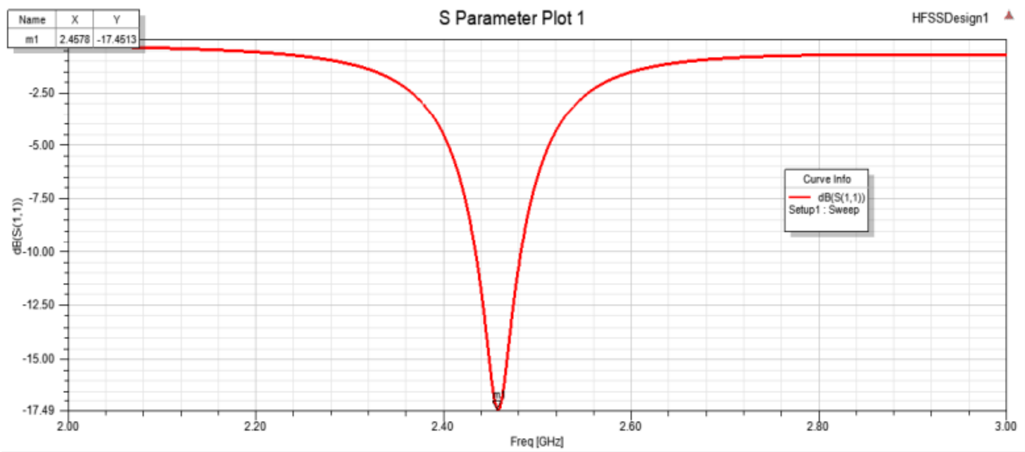
Fig (1.3)



BOTTOM VIEW

Fig (1.4)

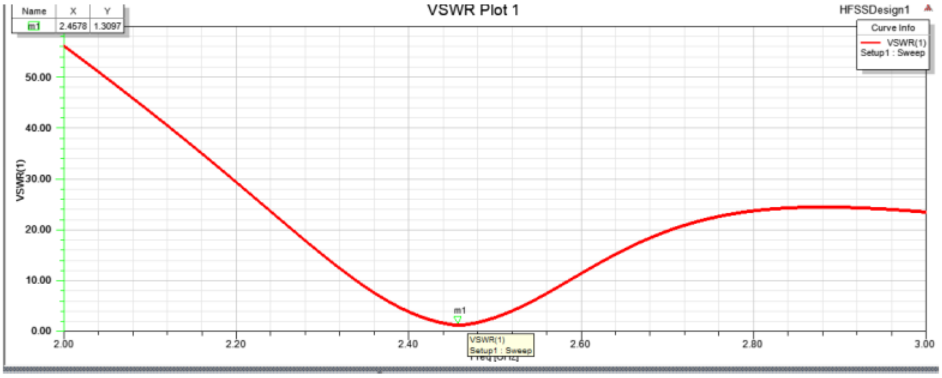
Result



S11

Fig (1.5)

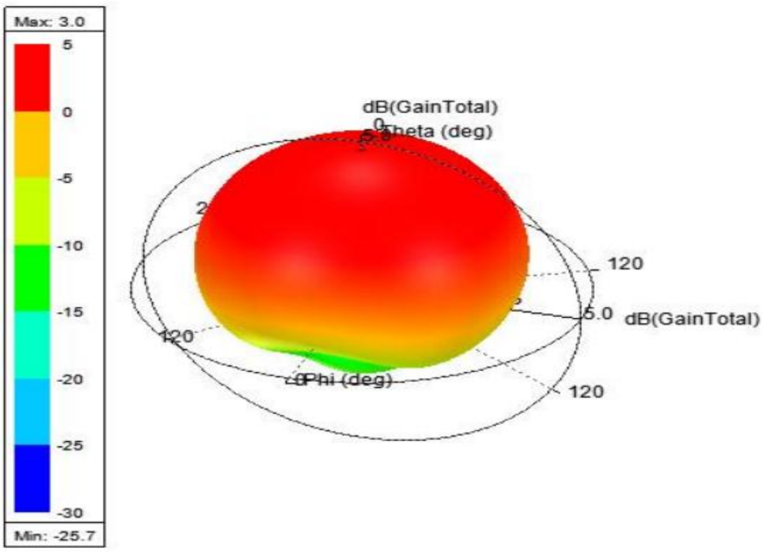
Power that is reflected from antenna also known as reflection coefficient (S11) attained is 16.5 dB. S11 is a metric that measures how well the power you send to an antenna stays there and does not bounce back into your radio. The amount of power emitted into the air, as well as energy losses inside the antenna, are included in "stays there."



VSWR

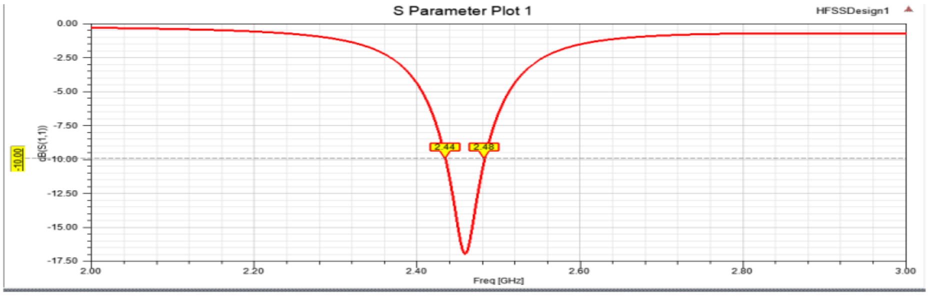
Fig (1.6)

Voltage standing wave ratio, the efficiency of power frequency which is transmitted through a transmission line by a power source into load. And the VSWR value attained is 2.3.



Gain

Fig (1.7)



Bandwidth= (22.48-2.44) GHz

= 0.08GHZ

Fig (1.8)

In this, the antenna's bandwidth can be computed using a VSWR=2 reference level, a reflection coefficient of -10dB, or a return loss of 10dB. The centre frequency is defined as (fmax + fmin)/2 (fc). As a result, percent bandwidth must be calculated in terms of centre frequency for wideband antennas.

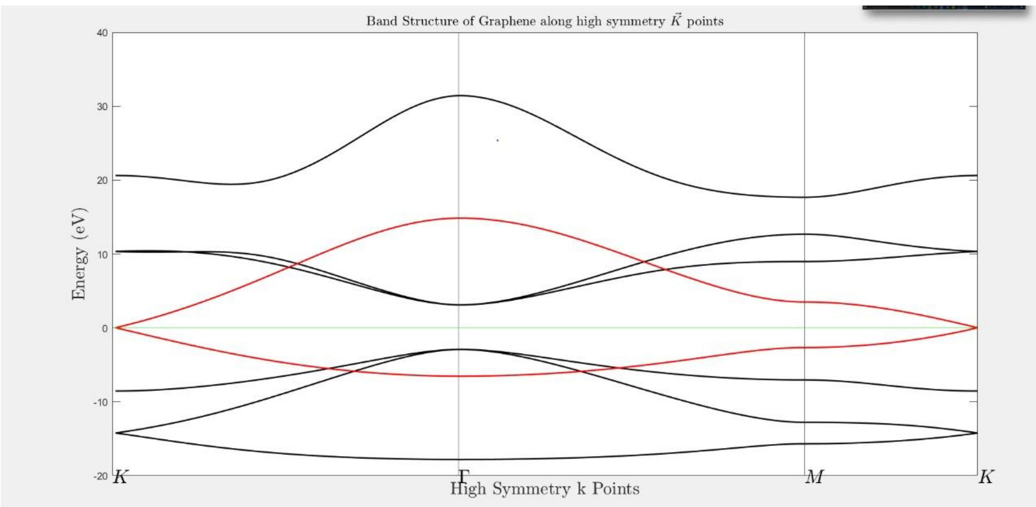


Fig (1.9)

Graphene has a flat optical optical density of 2.3 percent for photon energies above 0.5 eV. Only 2.3 percent of visible light is absorbed by a single sheet of graphene, which is a zero-band gap semiconductor with extraordinarily high carrier mobilities8, 9. As a result, graphene could be a potential contender for use as a transparent conductor.

Conclusion

In our paper, we have efficiently put forward and successfully implemented a nano based cylindrical antenna. Many downsides are minimized. And it can be widely used in photonic application.A Nano antenna based on ceramic has been mapped out and studied in this communication. Optical antenna is reconfigured by cylindrical and the purpose of this is to measure the angle of the beam from LED.In this, there is a better gain and we attained 8dB of output. By achieving this, it will be widely helpful in photonic application. One of the potential possibilities is the fabrication and measurement of such Nano antennas. Some construction methods for antennas at the nanoscale, such as ion beam, are known in the literature.Electron-beam lithography and milling. Circular polarisation and MIMO are included into the design. Another essential future component is a feature with multiband properties.

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