DESIGN MICROSTRIP PATCH ARRAY ANTENNA WITH GRAPHENE SUBSTANCE BY USING CST SOFTWARE

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UNTUK IBU DAN AYAH YANG TERSAYANG YANG SENTIASA MENYOKONG.

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Abstract

Antenna is a device that converts electric power into radio waves and vice versa. It usually consists or operates with a transmitter and receiver. This all components can be classified as an electrical device. To transmit the waves or data, it will oscillate the frequency current to the antenna terminals and antenna will radiates the energy from transmission to electromagnetic waves. Antenna's essential with all components that use radio waves such as broadcast televisions, radars, satellites, cell phones and many more. Antenna can be classified in several ways. Frequency band of operation or physical structure and design are one of it. New antennas development in technologies has allowed an antenna to rapidly change its pattern to support technology nowadays that operates in high frequency. This design is to produce radiation pattern that have desirable characteristics. Its performance that is important to be covered to ensure whether the antenna is good or not based on pattern, gain, polarization and efficiency. Graphene is an element that nowadays is used as an element in producing an antenna which is performed to overcome lagging. Graphene has advantage in their physical structures that are made from carbon layer mostly. The advantages are strong, light, nearly transparent and good conductor of heat and electric. The electrons in graphene are in high mobility which is able the antenna to perform in faster frequency.

Abstrak

Antena adalah salah satu peranti yang berkemampuan untuk menukarkan tenaga elektrik ke tenaga gelombang radio dan sebaliknya. Peranti ini umumnya terdiri daripada sebuah pemancar dan penerima untuk beroperasi sepenuhnya. Kesemua komponen ini adalah komponen elektrik. Untuk beroperasi dengan menghantar data yang dikehendaki, kekerapan dalam penghantaran gelombang tenaga dari satu terminal ke satu terminal. Gelombang ini di dalam bentuk gelombang elektromagnet. Kesemua peralatan seperti televisyen, radar, satelit, telefon bimbit dan lain lain menggunakan gelombang radio ini. Pembangunan dalam teknologi ini telah membolehkan antena menyokong teknologi yang berkembang pesat pada hari ini di mana kesemua aplikasi berfungsi pada frekuensi yang tinggi. Memberi tumpuan kepada pembangunan antena jenis tampal dan disusun dalam segi empat tepat. Dalam satu lapisan tampalan di tambah dielektrik asas mewujudkan prestasi yang lebih baik berbanding yang lain bagi mengatasi masalah yang sering dihadapi. Keberkesanan antena ini bergantung kepada factor factor seperti corak radiasi, polarisasi dan kecekapannya. Elemen graphene adalah salah satu elemen yang diguna pakai sekarang untuk mengatasi masalah kelembapan dalam menghantar data. Elemen ini mempunyai kelebihan dalam struktur fizikal seperti kuat, ringan, hampir telus dan konduktor haba yang baik. Elektron elemen ini mempunyai kelajuan yang tinggi dan mampu beroperasi di dalam frekuensi yang tinggi.

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Chapter 1

Introduction

1.1 Introduction

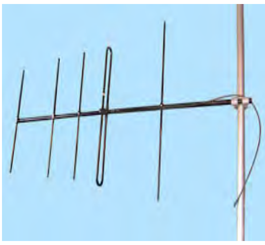
Antenna is a transducer designed to transmit data and receive data in electromagnetic waves. It converts electric power into radio waves and vice versa in order performing its operation. To transmit the waves or data, it will oscillate the frequency current to the antenna terminals and antenna will radiates the energy from transmission to electromagnetic waves. In reception, electromagnetic wave that has been transmitted will be intercepting by it then be amplified according to compatibility of the component or device that connected with the receiver. Most system or component that are connected wireless are using antenna such as radar, cell phones, walkie-talkie, broadcast radio or televisions, Bluetooth, satellite communications and many more that has same properties as those in in's operation.

Antennas consist of metallic conductors connected to receiver electrically through transmission line. An oscillating current of electrons forced through the antenna by a transmitter will create an oscillating magnetic field around the antenna elements, while the charge of the electrons also creates an oscillating electric field along the elements. There can be a connection between transmitter and receiver which serve direct radio waves into a beam or any other pattern such as reflective elements. Sometimes antenna that is fully equipped with a device will be hidden such as antennas in cell phones or laptop.

Antennas can be categorized into two types as according to its application. The categories are omnidirectional and directional. Omnidirectional is a weak directional antennas will receive or transmit in all directions. Sometimes it refers to horizontal direction and reduced performance in sky. It is used at low frequency and low applications where directional antenna is not highly required as to maintain the priced. Example of omnidirectional antennas is whip antenna. Directional antenna is vice versa to omnidirectional antennas. It is intended to maximize its coupling electromagnetic field in its direction. It will receive and transmit in particular direction and large frequencies are needed to operate it and high cost compared with omnidirectional antennas.

Parabolic antenna

Dipole antenna



Yagi-Uda antenna

Whip antenna

Figure 1.1: Type of antennas

Basic antennas such as dipole and vertical design are less used in nowadays as technology rapidly growth. Complex antenna has been developed to increase the directivity and the gain of the antenna. Gain of the antenna can be described as the radiated power in a particular angle of space as in spherical radiation. Power has to be maintaining at the desired direction as there is no increasing power at transmitter. Grounding for antennas is a structure of conductive element. To have proper functions, it need to have natural ground that well functioned. Impedance matching is a between the antenna and transmitter or receiver. To reduce losses in transmission, standard resistive impedance are needed to operate at its optimum operation as to improve the standing wave ratio (SNR) of the antenna.

Nowadays, as growth of technology, world facing problem in transmitting and receiving the data without lagging or losses that consumes in large amount. Nowadays all equipment or technology are performing in wireless communication such as cell phones in messaging or calling, Wi-Fi, social network, broadcast television, radar in military and many more required in wireless as in borderless world nowadays. Thus, in this new era, it required an antenna that can perform better and less cost in producing it.

Microstrip antenna is an antenna that newly developed to overcome most of the problem. Microstrip antenna low profile, its weight is light, high gain, simple in constructing this antenna as it reliability, mobility and has high efficiency characteristic. Because of all these advantages make microstrip popular usage as antennas in radar communications, medical application, satellite and many more. Different configuration can give different expectation in result such as high gain, wide bandwidth, and greater efficiency. Feeding network of the array is responsible in distribution of the voltages into one point. Proper impedance matching provides efficiency microstrip antenna.

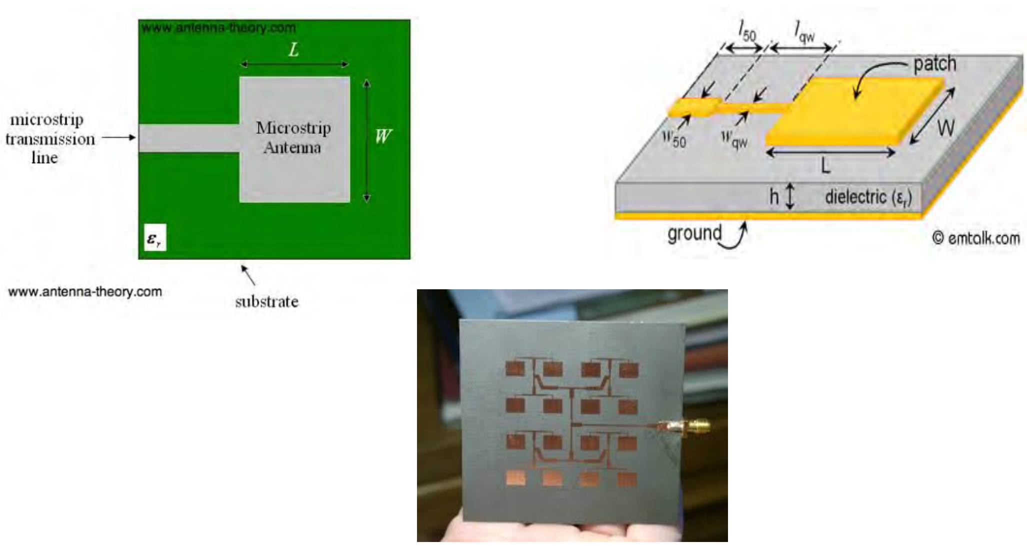


Figure 1.2: Example of microstrip antenna

Performance of an antenna are depends on its parameters such as dielectric material, height, length, thickness, frequency and many more. To have miniature size of microstrip, it can be by using high permittivity substrates. Microstrip patch array antenna consists of very thin metallic strip patched on ground plane according to structure designed on its thickness and height which restricted according to its value. Numerous substrates and dielectric suitable to be used for microstrip patch array antenna. Performance of this antenna depend on its dimension of frequency, directivity, radiation efficiency, return loss, standing wave ratio, and other parameter that can be influenced on its performance.

Resonant frequency means that tendency of a system to oscillate with greater amplitude at some frequency. At this frequency, small periodic forces can produces large amplitude oscillations because this system has stored vibrational energy. This phenomenon occurs at all types of waves. This phenomenon can have loss at small amount and called as damping.

Gains of an antenna are a key performance of this device. Plot of the gain as a function of direction is called the radiation pattern. From this, we can see the efficiency of this antenna on transmitting and receiving data. Usually this ratio is expressed in decibels, and these units are referred to as "decibels-isotropic" (dBi). An antenna's effective length is proportional to the square root of the antenna's gain for a particular frequency and radiation resistance. Due to reciprocity, the gain of any antenna when receiving is equal to its gain when transmitting.

Bandwidth is another fundamental antenna parameter. Bandwidth describes the range of frequencies over which the antenna can properly radiate or receive energy. Often, the desired bandwidth is one of the determining parameters used to decide upon an antenna. For instance, many antenna types have very narrow bandwidths and cannot be used for wideband operation. IEEE defines bandwidth as *“The range of frequencies within which the performance of the antenna, with respect to some characteristic, conforms to a specified standard.’’* This definition may serve as a practical definition however, in practice bandwidth is typically determined by measuring a characteristic such as SWR or radiated power over the frequency range of interest.

Return loss is the loss of signal power resulting from the reflection caused at a discontinuity in a transmission line or optical fiber. This discontinuity can be a mismatch with the terminating load or with a device inserted in the line. It is usually expressed as a ratio in decibels (dB).

$$RL(dB) = 10log\frac{\mathrm{Pi}}{\mathrm{Pr}} \tag{1.1}$$

Where RL (dB) is the return loss in dB, Pi is the incident power and Pr is the reflected power. Return loss is related to both standing wave ratio (SWR) and reflection coefficient (Γ). Increasing return loss corresponds to lower SWR. Return loss is a measure of how well devices or lines are matched. A match is good if the return loss is high. A high return loss is desirable and results in a lower insertion loss. Return loss is used in modern practice in preference to SWR because it has better resolution for small values of reflected wave.

Radiation pattern for common antenna is narrow where pact antenna desirable for assembly into array or patch array antenna. These arrays can be electronically steerable where it can be vary phase shift and power to each element. Dipole like directivity and unidirectional are combined for array gain.

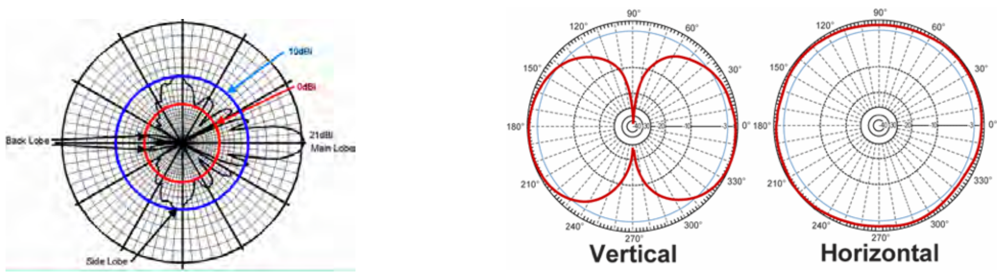


Figure 1.3: Gain in Radiation Pattern of an Antenna

Graphene are the substrate that will revolutionized this century as the greatest dielectric. Graphene is a 2 dimensional of single layer carbon atoms. It is the thinnest and yet as the strongest material on earth where it about 200 times stronger than steel. It can conduct electric and heat efficiently. Graphene almost transparent and so dense until the smallest atom in periodic table which is helium cannot pass through it.

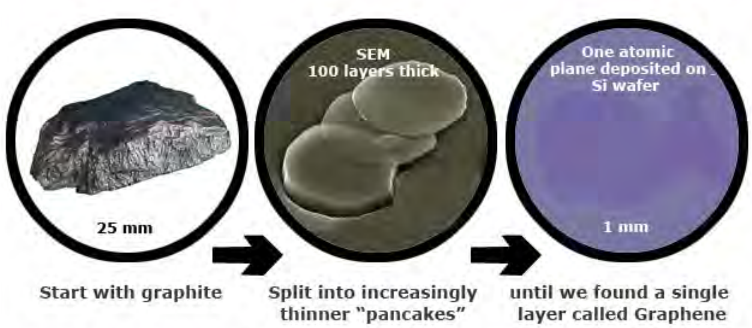


Figure 1.4: Discovering Graphene

One of the most properties of grahene is that graphene is a zero overlap semimetal with greater efficiency in electricity conductivity. There is highly mobility electron on graphene sheet. The electronic properties of graphene are dictated by the anti-bonding and bonding of the orbital of high mobility electron. Electronic mobility of graphene is very high where are about 15,000 cm2 V-1 s-1 and potential limits of 200,000 cm2 V-1 s-1. Graphene electrons lack of mass thus its mobility same as photons. It is able to moves without scattering and this phenomenon known as ballistic transport.

Other than electronic properties, graphene has extraordinary properties in mechanical strength. Graphene has been known as the strongest material has been discovered nowadays left behind diamond and steel. Approximately about 130,000,000,000 Pascal compared to 400,000,000 for structural steel or 375,700,000 for Aramid substance that been used to build Kevlar. Even though graphene has this strength, it only 0.77 milligrams per square meter and is 1000 times lighter than one square per meter of paper. Graphene also has elastic properties even after being strain.

An optical property of the graphene is ability to absorb a large amount of white light. This property has connection with electronic properties on electron mobility. Graphene's opacity of $\pi\alpha \approx 2.3\%$ equates to a universal dynamic conductivity value of $G=e2/4\hbar$ (±2-3%) over the visible frequency range. This is an important characteristic for the mode locking fiber lasers. Full band of fiber lasers has been achieved with capability of obtaining wavelength as large as 30mm due to these properties of graphene. [1]

The electronic and materials properties of Carbon Nanotubes (CNT) and Graphene are remarkable. Depending on their structure, carbon Nanotubes are either single walled or multiwall. Both properties are appealing for applications in the field of electronics or for the refinement of materials. Properties of graphene shows the better performance compared to other material such as copper, single-walled carbon nanotubes (SWCNT) and multi-walled carbon nanotubes (MWCNT). The different properties of these element has been shown in the table respectively according to conductivity,