A WIDEBAND OMNIDIRECTIONAL PLANAR MICROSTRIP ANTENNA FOR WLAN APPLICATION USING GRAPHENE

MOHD REDZUAN BIN SHAKIL AHMAD

This Report Is Submitted In Fulfilment of Requirement for the Bachelor Degree of Electronic Engineering (Wireless Communication) With Honors

Faculty of Electronic and Computer Engineering

Universiti Teknikal Malaysia Melaka

JUN 2015

UNIVERSTI TEKNIKAL MALAYSIA MELAKA

FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

BORANG PENGESAHAN STATUS LAPORAN

PROJEK SARJANA MUDA II

Tajuk Projek : A Wideband Omnidirectional Planar Microstrip Antenna For WLAN Application Using Graphene

Sesi Pengajian :

1	4	/	1	5

Saya MOHD REDZUAN BIN SHAKIL AHMAD
mengaku membenarkan Laporan Projek Sarjana Muda ini disimpan di Perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Laporan adalah hakmilik Universiti Teknikal Malaysia Melaka.
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan laporan ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (**√**) :

☐	**SULIT***	*(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)
☐	**TERHAD****	**(Mengandungi maklumat terhad yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	**TIDAK TERHAD**	

Disahkan oleh:

_____ _____

(TANDATANGAN PENULIS) (COP DAN TANDATANGAN PENYELIA)

STUDENT DECLARATION

"I hereby declare that this report is the result of my own work except for the quotes as cited in the references"

Signature :……

Author : MOHD REDZUAN BIN SHAKIL AHMAD

Date : 9 JUN 2015

SUPERVISOR DECLARATION

"I hereby declare that I have read this report and in my opinion this report is sufficient in terms of the scope and quality for the award Bachelor Degree of Electronic Engineering (Wireless Communication) With Honors"

Signature :…….

Supervisor Name : Mr. AZMAN BIN AWANG TEH

Date : 10 JUN 2015

Special dedication to my loving father, Shakil Ahmad Bin Badaruddin and my mother Noor Jahan Binti Izharul Haq, my kind hearted supervisor, Mr Azman Bin Awang Teh, my brother and sister, my dearest friend especially Yully Erwanti Binti Masrukin, Nurul Syuhada Binti Hasim, Fatimah Binti Baharin, Hayatun Hazirah Binti Hamdan, thank you for all support until complete my thesis.

ACKNOWLEDGMENT

My most sincere thanks go to my supervisor, Mr Azman Bin Awang Teh for his dedication to his student and patience in assisting me with this thesis. I would like to thank to him for his valuable advice and efforts offered during the completion of this thesis.

Special thanks go to my classmates and friends for their invaluable assistance towards this thesis project. I appreciate their friendship and sympathetic help which made my life easier and more pleasant during graduate studies. Lastly, I would like to my lovely parents and family for their enormous encouragement and assistance, without them this project would not have been possible.

ABSTRACT

Antenna is a very important device in telecommunication field used to transmit or receive radio frequency signal. Normally most of the antenna is built up of copper because it is suitable material for it. Recently graphene is claimed as a promising element to replace the copper. Thus, in this project graphene is use as a patch antenna in designing wideband omnidirectional planar microstrip antenna with the frequency range of 2.4GHz for WLAN application. This antenna is designed using graphene and copper as patches, and FR4 as dielectric (∈r 4.30). Two different thicknesses of graphene were assessed, that are 0.035mm and 0.355nm whereas the thickness of copper is 0.035mm. The antenna is simulated by using CST Studio Suite 2011 software. Parameters that have been investigated are bandwidth, return loss, directivity, radiation pattern and gain of antenna. The highest bandwidth, directivity, return loss and gain are 0.6279 GHz, 7.814 dBi, -24.964 and 7.814 dB respectively which is obtained from the analysis of 1x4 patch antenna. From this project, the best optimization design is using 1x6 patch antenna. Graphene material with 0.355nm thickness shows a better performance compare to copper as the patch material have also been proved in this thesis.

ABSTRAK

Antena adalah sesuatu peranti yang sangat penting dalam system telekomunikasi di mana digunakan untuk menghantar atau menerima isyarat radio frekuensi. Biasanya, kebanyakan antena adalah dibina menggunakan tembaga kerana ia adalah bahan yang sesuai untuk antena. Baru – baru ini graphene didakwa sebagai elemen yang lebih baik untuk menggantikan tembaga. Dengan itu, projek ini menggunakan graphene sebagai antena penampal dalam bentuk jalur lebar satah semua arah mikrostrip antena dengan julat frekuensi 2.4 GHz untuk aplikasi WLAN. Antena ini adalah direka menggunakan graphene dan tembaga sebagai penampal, dan FR4 sebagai pemalar dielektrik (∈r 4.30). Dua ketebalan berbeza daripada graphene dinilai,iaitu 0.035mm dan 0.355nm manakala ketebalan tembaga adalah 0.035mm. Antenna ini disimulasi dengan menggunakan perisian CST Studio Suite 2011. Parameter yang telah dikaji adalah lebar jalur, pembalikan kehilangan, keterarahan, bentuk radiasi dan gandaan. Nilai tertinggi bagi lebar jalur, keterarahan, pembalikan, kehilangan dan gandaan adalah 0.6279 GHz,7.814 dBi, -24.964 and 7.814 dB masing – masing yang diperolehi daripada analisis 1x4 antena penampal. Daripada projek ini, pengoptimuman reka bentuk yang terbaik adalah dengan menggunakan 1x6 penampal antena. Tesis ini juga menunjukkan bahawa graphene dengan ketebalan 0.355nm menunjukkan prestasi yang lebih baik berbanding tembaga.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Introduction

1.1 Introduction

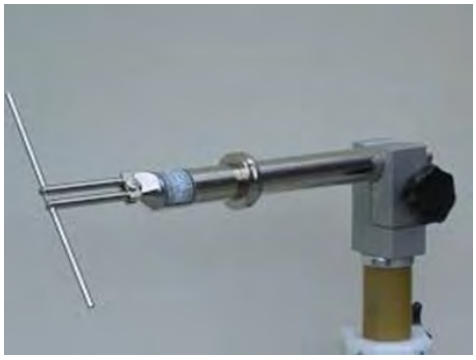
Antenna is a transducer designed to transmit data and receive data in electromagnetic waves. It converts electric power into radio waves and vice versa in order performing its operation. To transmit the waves or data, it will oscillate the frequency current to the antenna terminals and antenna will radiates 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 have the same properties as those in its 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. [1]

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. [2]

(a) Parabolic antenna



(b) Dipole antenna

(c) Yagi-Uda antenna

(d) 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 [1].

Nowadays, as growth of technology, world facing problem in transmitting and receiving the data without lagging or losses that consumes in large amount. 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.

Graphene are the substrate that will revolutionized this century as the greatest conductor. 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.

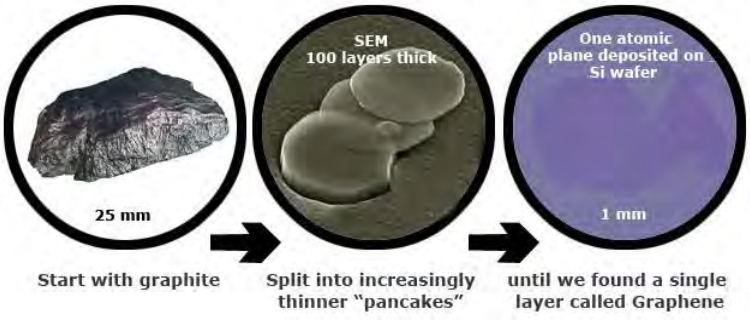


Figure 1.2: Discovering graphene

One of the most properties of graphene 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 $cm^2\ V^{-1}\ s^{-1}$ and potential limits of 200,000 $cm^2\ V^{-1}\ s^{-1}$. 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. [5]

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. [5]

1.2 Problem Statement

Antenna is a device that is used to transmit and receive data which enables us to communicate with each other regardless neither the place nor the region. The most commonly used antenna for these recent years is the antenna built from copper substance. However, antenna with copper substance has its disadvantages. One of the disadvantages is that it lags the process of receiving and transmitting of data. This matter is important to be discussed on followed by proper solution in order to increase the efficiency of a communication process. Therefore, to overcome this problem, graphene substance is likely to be introduced to replace the copper substance. Graphene substance has the ability to increase the magnitude value of the power transmitted from a transmitter to a receiver, giving it a strong justification to replace the existing antenna. Graphene substance will also increase the gain and directivity of the transmitted signal. This matter can be proven so, which is by applying graphene substance onto a wideband omnidirectional planar microstrip antenna, whereby a Wideband Omnidirectional Planar microstrip antenna is a thin layered rectangular shape structure that can be in form of 1x4, 1x6, 1x8 and 1x10 or else.

1.3 Project Objective

To make sure this project work as planned, a few objectives were determined where these objectives will be followed as a guide through the whole completion process of this project in order to achieve the desired output. These objectives were provided by sequence of project from beginning until the end of project. A detailed explanation for each objective will be discussed. There are several objectives that are to be achieved at the end of the project which includes:

1) To design 1x4, 1x6, 1x8 and 1x10. Omnidirectional Planar Microstrip antenna using Graphene and design it using CST Microwave studio software.
2) To compare the performance of copper and graphene as conductor for A Wideband Omnidirectional Planar Microstrip Antenna for WLAN Application.
3) To optimize the design the antenna design.

1.4 Scope

As to ensure the completion of project achieves the stated objectives, the project shall be completed within these scopes:

1) Focus on 1x4, 1x6, 1x8 and 1x10. Omnidirectional Planar Microstrip antenna using graphene as material.
2) Simulation using CST Microwave Studio software.
3) Target frequency from 2.4 GHz.
4) To compare performance of 1x4 coppers as patch material versus 1x4 graphene as patch material.
5) Parameter involved is for radiation pattern, parameter, bandwidth, gain, realize gain and directivity.

1.5 Brief explanations on methodology

To achieve the goal that has been set in the objectives of this project, there are so many works that need to be done. The first stage is learning the concept of microstrip patch antenna and electronics properties of graphene and how the implementations in antenna. The next stage are designing and simulating the antennas model in CST software. Finally, compare and analyze the performance of the antennas. A detail explanation for the parts will be explained in Chapter 3.

1.6 Report organizations

In this report, there are 5 chapters which are introduction, literature review, methodology, result and conclusion and discussion. Not included in chapter is a reference, abstract, table of content, table of picture and appendices.

Chapter one shows the introduction of this project. It contains the background of the project and briefly explanation about the project methodology.

Chapter two consists of literature review of project. It covers the study of the project such as the basic information of antenna, planar microstrip antenna, basic information of graphene, and electronic properties of graphene that used in the project for the future plan.

After that, it shows the choices can be made after all the study have been finished. Chapter three shows about the methodology of the project. This chapter includes the flow chart and Gantt chart of the project that shows the process of this project from start till the end. By using the flow chat and Gantt chart, it can reduce an assumption that can be made when doing the analysis.

Chapter 2

Literature Review

2.1 Literature Review

This chapter discuss about reviews of existing project created to get an idea about the project design, conception and any information that related to improve the project. With different concept and design, there are other creations and innovations of projects done by other people.