RESISTIVE HUMIDITY SENSOR MADE FROM PALM-OIL-DERIVED GRAPHENE FILM

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ABSTRACT

Graphene is known to be highly conductive and sensitive to adsorbed molecules thus make it suitable for sensor application. The astonishing properties of graphene attracted the attention to develop ultra-high sensitive sensor with very fast response and recovery time. In this project, a resistive humidity sensor which utilizes graphene as the sensing area has been fabricated and characterized. Different types of graphene samples (i.e. single-layer graphene on copper substrate, single-layer graphene on nickel substrate synthesized using thermal CVD, multi-layers graphene on nickel substrate synthesized using thermal CVD) were used in this project to further investigate the effect of crystallinity of the graphene on its sensing behavior. In order to fabricate the sensor device, the 2-terminals and 4-terminals electrodes configuration was chosen. Sensor fabrication process includes photolithography, copper etching and graphene transfer process. Current-voltage measurement of the fabricated is performed at different relative humidity inside dry box. The result of the resistance of the graphene sample responding towards the change of relative humidity shows an inverse exponential association. Measurement result for different type of graphene are compared to assess the relationship between the crystallinity and sensor performance.

ABSTRAK

Grafin diketahui sebagai sangat konduktif dan sensitif terhadap molekul yang terjerap padanya. Dengan itu menjadikannya sesuai untuk aplikasi sensor. Ciri-ciri menakjubkan grafin menarik perhatian untuk penghasilan sensor sensitif ultra tinggi dengan masa tindak balas dan pemulihan yang cepat. Dalam projek ini, sensor kelembapan berdasarkan rintangan yang menggunakan grafin sebagai bahagian deria, telah direka dan dicirikan. Tiga jenis grafin yang dihasilkan menggunakan teknik pemendapan berhaba wap kimia (iaitu lapisan tunggal grafin pada substrat tembaga, lapisan tunggal grafin pada substrat nikel dan pelbagai lapisan grafin pada substrat nikel), telah digunakan dalam projek ini untuk menyiasat kesan tahap penghabluran grafin pada operasi sensor. 2-terminal dan 4-terminal konfigurasi elektrod dipilih sebagai struktur peranti. Proses fabrikasi sensor termasuk fotolitografi, penghakisan tembaga dan proses pemindahan graphene. Pengukuran arus voltan dilakukan pada kelembapan yang berbeza di dalam kotak kering. Gerak balas rintangan sampel graphene terhadap perubahan kelembapan relatif menunjukkan hubungan eksponen songsang. Hasil pengukuran bagi grafin yang berbeza jenis dibandingkan untuk menilai hubungan antara penghabluran dan prestasi sensor.

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LIST OF SYMBOLS

c	-	Speed
Ω	-	Resistance
e	-	Electrical charge
h	-	Plank’s constant
m	-	Mass

CHAPTER 1

INTRODUCTION

1.1 Research Background

Graphene is known to be sensitive to adsorbed molecules thus make it suitable for sensor application. In this project, we fabricate and characterize a resistive sensor which utilizes graphene as the sensing area. The graphene is synthesized from palm oil (i.e. normal cooking oil). Sensing performance of the device will be evaluated. Comparative study on sensor with graphene having different crystallinity quality will be performed.

1.2 Research Objectives

In this project, the objectives of the project is:

a) To fabricate and characterize graphene-based resistive-humidity sensor
b) To investigate the influence of graphene crystallinity to sensing performance

1.3 Scope of work

In this order to achieve the objectives mentioned above, 3 samples of graphene – single layer graphene grown on copper substrate, single layer graphene grown on nickel substrate, and multilayer graphene grown on nickel substrate, have been used to fabricate and characterize resistive humidity sensor. The crystallinity of the samples have been examined through their Raman spectra result. The resistance of the graphene has been characterized and observed to further explore the influence and sensitivity of the sensing device.

1.4 Organization of report

The thesis presents the fabrication and characterization of graphene based resistive humidity sensor. The thesis consists of these few chapters: Chapter 1 (Introduction), Chapter 2 (Literature Review), Chapter 3 (Methodology), Chapter 4 (Results and Discussions), Chapter 5 (Future Recommendations) and Chapter 6 (Conclusion).

Chapter 1 provides the general information and brief idea of the project. It also emphasizes on the objectives of this project and the contents which are going to be discussed in the thesis. Chapter 2 introduces graphene with basic background properties, various fabrication technique, structure of humidity sensor and mechanism of humidity sensing, and applications of graphene as gas and vapor sensors. Chapter 3 covers the stages involved to characterize graphene samples, design and fabricate the device structure, and characterizing the resistance measurement. Besides, the process flows and the details of the procedures are explained. Chapter 4 presents the results and discussions of the project, necessary observations, comparison and justifications

are given to further explain the phenomenon. Chapter 5 discussed some future recommendation to enhance the methodology and also some known challenges in the project. Chapter 6 concludes the project as a whole.

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