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Analysis on Plasma Treated Graphene Thin Film

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Abstract: This paper presents a study on the graphene thin film with sample carbon nanotube (CNT) that has been treated with other gases such as Ar, CH3COOH, ethanol, and NH3. Spectroscopies study in this project includes X-ray photoelectron spectroscopy (XPS), Atomic Force Microscope (AFM), Field Emission Scanning Microscope (FESEM), and Energy Dispersive Spectroscopy (EDS). Besides, a study on the effect of graphene thin film treated by plasma to get the measurement and the criteria for each type of gases. The results on AFM did not provide a clear answer due to the noise on that sample but during FESEM and EDS experiment, there were another results that can make changes. This is because during the FE-SEM experiment, the magnificent resolution can show clearly that the surface topographical and the morphologies. In addition, results from EDS shows the types of material found in the sample.

Keywords: Graphene Thin Film, Carbon Nanotube, Plasma-Treated, AFM, FESEM, EDS

1. Introduction

In the future, graphene will be used as the substitute for silicon in the transistors technology. The graphene thin film is a new material that have an allotrope of carbon in a single layer of atoms. The allotropy is a combination of chemical elements according to a property of some chemical elements. The graphene has its specialty of properties that set it from other materials [1]. It was the single layer on the building block of graphite and carbon nanotubes [1]. This features a 2-dimensional conjugated sp2 atom that has special physical properties, including strong broadband optical clarity (around 98%), high thermal conductivity (maximum 3 kWm-1), and better mechanical resistance (total 130 GPa) [2].

All the characteristics have an impact on a wide variety of transistors, light-emitting, solar and other applications. The composition of graphene oxide (GO) is typically continuously reactive with functional groups oxygenated by interrupting carbonyl epochs, alcohol, carboxides, ketone carbon lattice, and others. The carbon nanotube (CNT) was found by Sumio Iijima in 1991. The CNT has potential use for

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a wide variety of optoelectronic, modern, and gas storage applications [3]. Past experiments have shown that CNT are 100 times mechanically stronger than steel and six times higher in density [3]. Hexagonal boron nitrides (H-BN) are elastic and waterproof for all gases, similar to graphenes [4].

2. Materials and Methods

2.1 Materials

In this research, the equipment used to carry out the experiments to achieve the desired objectives in this project, and this section will describe each step implemented in the project as follows.

- Atomic Force Microscopy (AFM)
- Field Emission Scanning Electron Microscopy (FESEM)
- Energy Dispersive X-ray Spectroscopy (EDS)

2.2 Methods

Method that will be used to identify the surface of roughness for CNT that treated is AFM. The Scanning Force Microscope (SFM) or also known as AFM is a power encountered by a probe that reaches a surface in a few angstroms. The microscope can be used for the strength measurement to determine the forces between the sample and the probe as an imagery response of the sample to those forces that can form in the topography of the sample surface a picture of the three-dimensional form with a high resolution. The forces between the tip and the sample used for manipulation next to keep changing the characteristics of the sample.

Next, these samples which are CNT treated with Ar/CH_3COOH and CNT treated in Ar/Ethanol are charaterised using FESEM. FESEM analyzes were carried out to observe or detect the morphic structure of the sample with different majors up to 100-10 million times of standard scale. The FESEM microscope used an electron of the particles with a negative load instead of the light. The field emission sources were managed by each electron. An electron scans the zig-zag pattern. The usage of FESEM enable to identify the material on the cells and synthetic polymers including the coatings.

Lastly, the sample is characterized using EDS. EDS is a typical microscopic electron research technique. This process is still the standard and most reliable method in the field of analytical electron microscopy and used widely [5]. To induce the x-ray emission, the radiation from the surface that has a high energy beam of charged particles or a directed x-ray was used. Surface radiation is used for causing X-ray emissions with a high-energy beam of loaded particles or with a direct X-ray laser. Usually, each element has a unique atomic structure, which makes the electromagnetic emissions of a unique set of peaks [6]. The EDS technique will detect x-rays emitted by the sample during bombardment to determine the elementary composition of the analyzed volume [7].

3. Results and Discussion

The results and discussion section presents data and analysis of the study. The result from each type of gas properties on the graphene thin film was obtained from AFM, FESEM, and EDS to identify the spectra of material and to determine their topologies.

3.1 AFM

There are three samples in this experiment, which are CNT treated in Ar/CH_3COOH, CNT treated in Ar/Ethanol, Carbon Nanotube treated in Ar/NH_3 and CNT treated in Ar gas. This experiment is to identify the roughness for every sample.

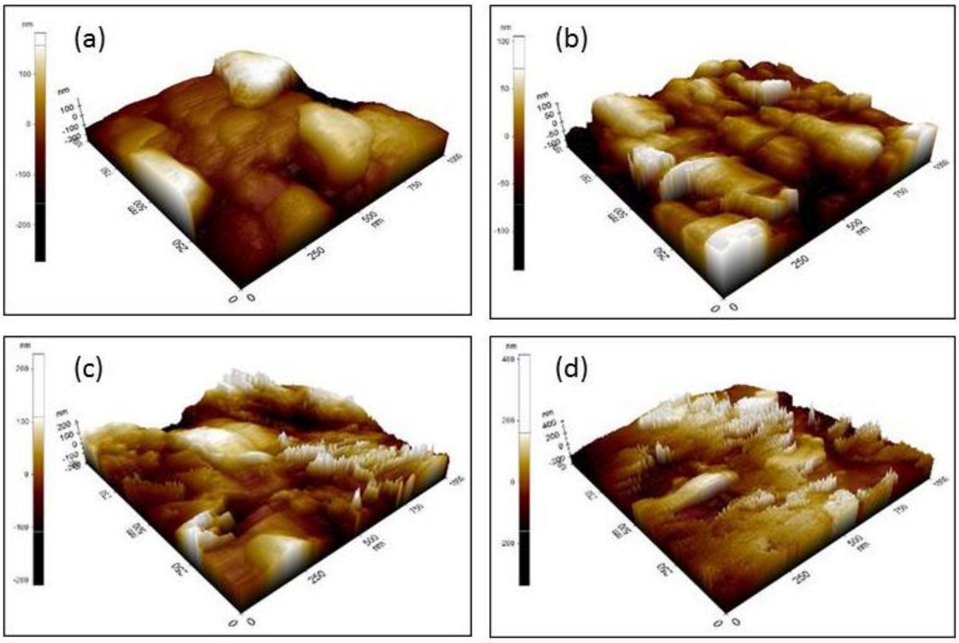

Figure 1: AFM results for sample CNT (a) treated in Ar/CH_3COOH; (b) treated in Ar/Ethanol; (c) treated in Ar/NH_3; (d)) treated in Ar

Figure 1 shows that sample (a) has 59.004nm while the sample (d) has 51.543nm. However, the roughness for sample (b) and (c) is 28.306nm and 16.832nm. This shows that the roughness in both samples (a) and (d) is better than samples (b) and (c).

3.2 FESEM

For the FESEM experiment, a sample is chosen to identify the total topographical surface of the samples. Furthermore, topographic and elementary magnification information ranges from 10x to 300,000x with an almost limitless file depth. The samples that are selected for this experiment are those treated with Ar/CH_3COOH and Ar/Ethanol. There is a difference in the magnified size of the particles.

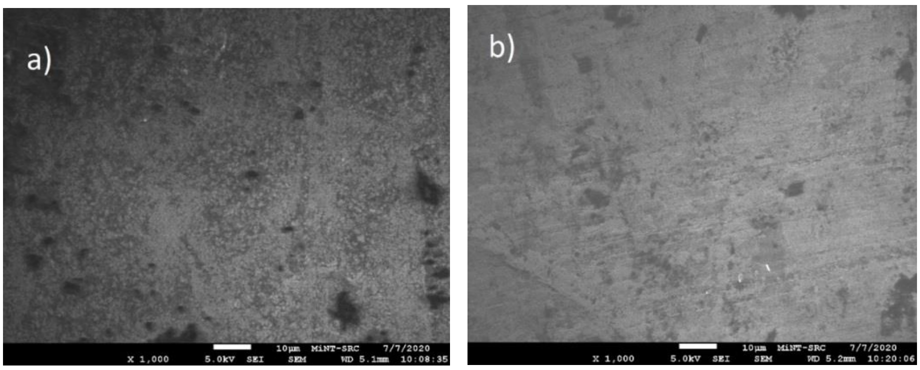

Figure 2: FE-SEM images at 1,000x magnificent (a) CNT treated with Ar and CH_3COOH; (b) CNT treated with Ar and ethanol

The FESEM images of CNT treated by Ar and CH_3COOH and CNT treated by Ar and ethanol are shown in Figure 2. Figure 2(a) shows that a significant number of particles such as the Ar and CH_3COOH surfaces attached to the CNT are treated. The particles are clustered together in an angle of the surface. As compared to the structure of Figure 2(b), it has a smoother surface.

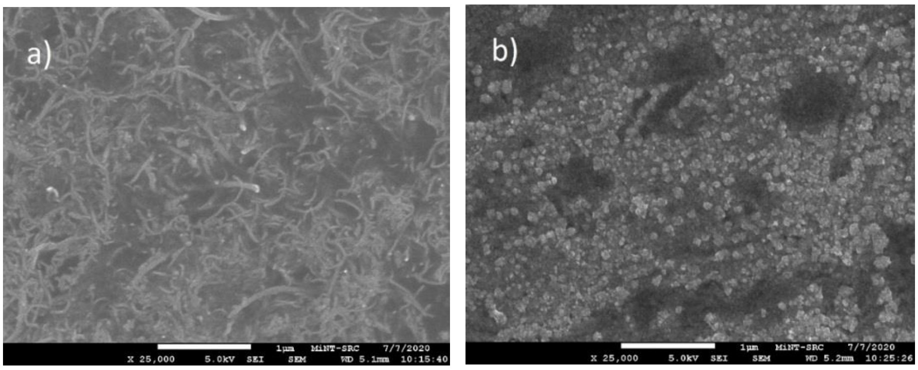

Figure 3: FESEM images at 25,000x magnificent (a) CNT treated with Ar and CH_3COOH; (b) CNT treated with Ar and ethanol

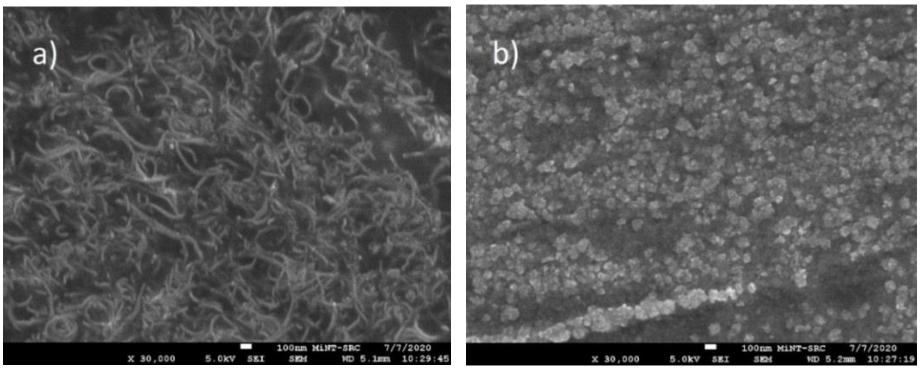

Figure 4: FESEM images at 30,000x magnificent (a) CNT treated with Ar and CH_3COOH; (b) CNT treated with Ar and ethanol

Such particles naturally stay in a whole group after zooming out into 25,000x and 30,000x. In similar condition [8], CNT is a material that is conducting and a metal substitution. It can happen if the filler particles' aspect ratio is higher than the load needed to achieve a certain conductivity. This is possible since CNTs have high carbon fiber aspect ratio.

3.3 EDS

EDS is a typical process, which elementary compositions can be characterized and quantified in an extremely small material. EDS enables measurement of the coating thickness of metallic coatings. However, the accuracy of the sample that measured was also influenced by the sample itself. There has a detection limit to detect the sample surface conditions. This is because if the surface of the sample was smooth, so the EDS did not have any limit to check the material. Furthermore, it can define each element that has a unique atomic structure that allows its emissions spectrum to have a unique set of peaks.

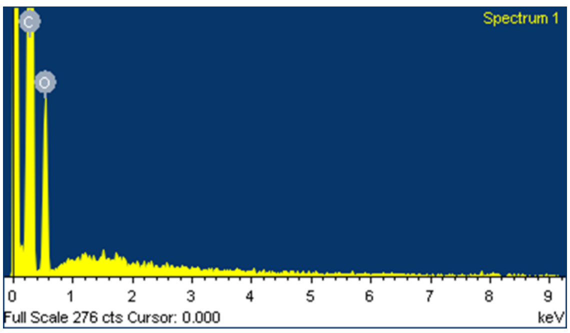

Figure 5: The EDS for CNT treated with Ar/CH_3COOH

Table 1: EDS analysis result for CNT treated with Ar/CH_3COOH

Element	Shell	Weight %	Atomic %
C	K	85.08	88.37
O	K	14.91	11.63
Totals		100	100

Figure 5 and Table 1 show that the result of EDS for CNT treated with Ar and CH3COOH. From that, the material of the sample has carbon as the dominant element in the sample, and oxygen was also found in the sample.

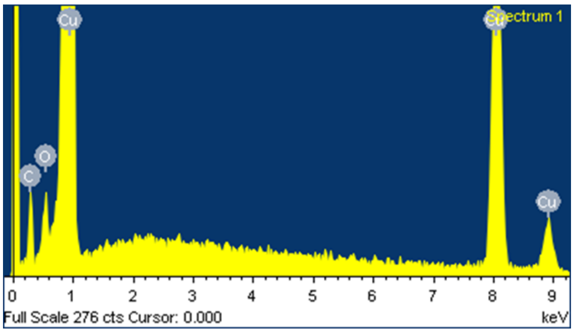

Figure 6: Result of EDS for existing dicing blade

Table 2 EDS analysis result for CNT treated with Ar/ethanol

Element	Shell	Weight %	Atomic %
C	K	7.61	29.26
O	K	1.64	4.74
Cu	L	90.75	66.00
Totals		100	100

Figure 6 and Table 2 show the results of EDS analysis for the shows that the CNT treated with Ar/ethanol. It can be seen that copper is the highest element in the sample, although carbon oxygen was also found in that sample.

4. Conclusion

This work performs few experiments to analyze the effect of the plasma treatment on graphene thin film. The method of this work employed few equipments such as the AFM, XPS, FESEM, and EDS method. This work successfully analyze the effect of the plasma treatment by used the AFM. Besides, the FESEM was able to identify the roughness and the grain size for treated CNT samples. Lastly, the material on the sample can be identified by using EDS.

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References

[1] T. Ohta et al., "Morphology of graphene thin film growth on SiC(0001)," New J. Phys., vol. 10, no. 1, 2008

[2] I. Banerjee, S. K. Mahapatra, C. Pal, A. K. Sharma, and A. K. Ray, "Effect of plasma power on reduction of printable graphene oxide thin films on flexible substrates," Mater. Res. Express, vol. 5, no. 5, 2018

[3] O. Akhavan, "The effect of heat treatment on formation of graphene thin films from graphene oxide nanosheets," Carbon N. Y., vol. 48, no. 2, pp. 509–519, 2010

[4] L. He et al., "Isolating hydrogen in hexagonal boron nitride bubbles by a plasma treatment," Nat. Commun., vol. 10, no. 1, pp. 1–9, 2019

[5] S. Ebnesajjad, Surface and Material Characterization Techniques. 2014

[6] "Energy-dispersive X-ray spectroscopy," Wikipedia. [Online]. Available: https://en.wikipedia.org/wiki/Energy-dispersive_X-ray_spectroscopy. [Accessed: 08-Jul-2020]

[7] "Energy Dispersive X-Ray Spectroscopy (EDS)," Materials Evaluation And Engineering, INC. [Online]. Available: https://www.mee-inc.com/hamm/energy-dispersive-x-ray-spectroscopyeds/

[8] "Applications of Carbon Nanotubes," 2018. [Online]. Available: https://www.azonano.com/article.aspx?ArticleID=4842. [Accessed: 08-Jul-2020]