Simple and Green Approach Strategy to Synthesis Graphene Using Rice Straw Ash

M.N.A. Uda1,2, Subash C.B. Gopinath1,2, U. Hashim2, M.N. Afnan Uda3, Nur hulwani Ibrahim1, N.A. Parmin2, N.H. Halim2 and Periasamy Anbu4

1School of Bioprocess Engineering, Universiti Malaysia Perlis, 02600 Arau, Perlis.
2Institute of Nano Electronic Engineering, Universiti Malaysia Perlis, 01000 Kangar, Perlis.
3School of Microelectronics Engineering, Universiti Malaysia Perlis, 02600 Arau, Perlis.
4Department of Biological Engineering, College of Engineering, Inha University, Incheon 402-751, Republic of Korea

E-mail: uda@unimap.edu.my

Abstract. Abundant resources of rice straw and carbon-neutral have a lot of potentials to be converted into various value-added product and become more green due to less utilization of chemical usage. Graphene is one of value-added had been converted from rice straw and was successfully synthesized by using activating rice straw ash (RSA) using potassium hydroxide (KOH) at 700 oC with 1:2.5 impregnation ratio. scanning electron microscopy (SEM), field emission scanning electron microscopy (FESEM), EDX Analysis with a field emission transmission electron Microscope (FETEM) and atomic force microscopy (AFM). The current results can be the model for comparing the synthesize graphene from other plant sources.

1. Introduction

Rice straw is of non-valuable materials and the byproduct of rice production at harvest. Rice straw is removed from the rice grains during harvest and left in the paddy field. For instance, In Malaysia, approximately more than 3-4 million tonnes of rice straw was produced every year but most of the rice straw left in the field and burned as faster action to dispose of all rice straw by the farmers. However, this action leads to the loss of almost nutrients needed by the paddy to grow well. Apart from that, the worst part is lead to the air pollutions where it will give an impact to all living things. Thus to avoid this problem the utilization of rice straw is must and make its more valuable things. Its is because rice straw is rich with activated carbon after undergoing carbonization process where its possess with high porosity, high surface area and consists of various sizes produced such as in macro, meso, micro even nano sizes[1,2]. Currently, graphene attracts a lot of research attention for use in production using agro plant product [3].

Graphene has special properties such as high capacity in thermal, electronic, mechanical, chemical and physical properties. It is proof that graphene is much stronger compare with steel in terms of weight and has extraordinary conduct heat and electricity. Based on structure properties, graphene is considered as nanomaterial with 2-dimensional where it consist of element carbon atom looks like a honeycomb with a lattice structure. To make it easier to understand, graphene in structure consists of a carbon element where it is linked with other three carbon atoms. Briefly the structure of graphene in hexagonal
shapes and held together by covalent bond whereas its different with graphite where it is composed of few layers of graphene and arranged together and held by the electrostatic force called van der Waals bonding as shown on figure 1. Recently, everybody talks about nanotechnology due to broad application in today worlds like biosensor [4-9], medical [10-12], agriculture [13-17] etc. Apart from that, anything related to green technology also raised a lot of attention from researchers around the world. It is due most of the green technology process use less toxic chemicals, sustainable and natural resources. For instance, many researchers are involved in developed graphene using green synthesis method [18]. Based on the report from Pushpendra et al, they are successfully synthesized graphene using rice husk as a carbon source. In our research work, we successfully utilized rice straw ash as a carbon source for graphene synthesis and used KOH as an activation agent. The obtained analysis, proof that successful synthesis of graphene with morphological analysis such as SEM, FESEM, EDX and AFM.

![Figure 1.](image)

**Figure 1.** (a) Layer of graphene with in hexagonal shapes. (b) Few sheet of graphene held together to form graphite.

2. **Methodology**

2.1 **Materials**

Rice paddy straw was obtained from the nearest rice mill, Perlis, Malaysia. Distilled water was used throughout the experiments. All chemicals were used as received without further purification.

2.2 **Chemical synthesis process of Graphene from paddy straw**

The overall schematic diagram for the chemical synthesis of graphene process is shown in figure 2. Briefly, 3-4 gm of ash was mixed with 12-16 gm of KOH using mortar and pestle. This mixture was compressed together using mortar and pestle in a white porcelain crucible. Next, all mixture go through annealing process where porcelain crucible needs to close by using crucible cap. The process was annealed in high temperature at 700°C for 2 h in a muffle furnace. After the annealing process, this mixture was stirred continuously for 6 h. At the last stage, the sample was purified from debris using distilled water and filtered to remove any excess of KOH. The filtered are ready and dried at 150°C for 24 h.
Figure 2. Schematic Diagram for Synthesis of Graphene. (a) Paddy straw was collected. (b) Raw paddy straw after burned was a mixture with KOH. (c) Annealing process at high temperature using furnace (d) Fine graphene powder produced.

2.3 Surface Morphological Analysis
In this study, several morphological and characterization were carried out along the experiment. There is a high power microscope (HPM), scanning electron microscope (SEM), field-emission scanning electron microscope, 3D nano profilometry. All sampling preparation were the same for all characterization. Briefly, 1-2 mg graphene nanomaterial was dissolved in 100 μl of distilled water. Then, all solution need to mix well using bench portable mixture. After that, a drop of graphene was dropped on small pieces of silicon wafer before the characterization being started.

3. Results and Discussion
In this experiment, the SEM and FESEM images are successfully captured as shown in figure 3 and 4. From this morphological analysis, SEM images show particles of graphene in compacted and dense together with each other. So this images was revealed after treatment with KOH as activation agent.

Figure 3. Surface morphological images for graphene (a) SEM images at 4000 magnification (b) FESEM images at 30,000 magnification.
This activation agent has created a dual function where it can be used as removal of amorphous carbon element and separate the layer of a graphene sheet by insertion of a molecule of potassium atoms. Whereas, for FESEM images we can observe flakes of graphene particles. To reveal the final elemental analysis and understand the impurities for graphene sample, FETEM images with EDX analysis was carried out as shown in figure 4. Based on EDX analysis we can reveal that the highest atomic percentage for graphene are consists of element O (45.12%), C (40.37%), Si (10.34%) and Al (4.37%). The highest element of O and C is due to the carbonization process. Its proved that the composition of elemental percentages is very close as shown in previous research [19].

![Figure 4. Elemental analysis using (a) FETEM electron images b) EDX analysis](image)

The behaviour surface topography of graphene was studied by using tapping mode images. Based on figure 5a the images show the top view of graphene, apart from that the lateral sizes of graphene were revealed as shown in figure 5b. Based on the lateral images, one section of graphene was selected and measured, where the red line shows the highest peak (48.32 nm). Moreover based on lateral images, the distance sizing of particles also taken, where the average size distance is around 979 nm.

![Figure 5. Surface topography of graphene. (a) Top view images (b) Lateral images](image)

4. Conclusions

In conclusion, a simple and green approach where one chemical method used to synthesize graphene from rice straw. In addition, since the synthesis process is considered as cost-effective where it is used agriculture by-product and involves the simple procedure, this approach has a huge potential to be applied in synthesizing graphene structures in large quantities or mass production for future application.
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