RESEARCH ARTICLE | MAY 03 2023

Graphene derived from rice husk

Fanny Fahriatunnisa Muliawanti ✉; Evvy Kartini; Muhammad Fakhrudin

AIP Conference Proceedings 2517, 020007 (2023)
https://doi.org/10.1063/5.0139958

Graphene Derived from Rice Husk

Fanny Fahriatunnisa Muliawanti [1, a)] Evvy Kartini [2, 3, b)], Muhammad Fakhrudin [3]

[1] *Departement of Physics Faculty of Mathematic and Natural Science, Padjadjaran University, Jl. Raya Bandung Sumedang KM.21, Jatinangor, Kabupaten Sumedang, Jawa Barat 45363, Indonesia.*
[2] *National Battery Research Institute, 2nd Floor EduCenter Building Unit 22260 BSD, South Tangerang 15314, Indonesia.*
[3] *The Center for Science Technology of Advance Materials – National Nuclear Energy Agency of Indonesia, Puspiptek Area, South Tangerang, Banten 15314, Indonesia.*

[a)] *Corresponding author: fannyfahriatunnisa05@gmail.com*
[b)] *evvy.kartini@n-bri.org*

Abstract. Synthesis graphene using environmentally friendly biomass resource such as rice husk was successfully. Graphene was synthesis using rice husk ash (RHA) and potassium hydroxide (KOH) at 900°C for 2h with 1:5 ratio. Utilize RHA as a source carbon for synthesis of graphene and used to prevent oxidation during annealed process at high temperature. The result XRD and SEM confirmed a present of graphitic structure. Novelty of this synthesis graphene using environmentally friendly biomass resource can be one of technique to reduce the use of toxic chemical and natural precursor.

INTRODUCTION

Graphene is an single layer structure of covalently bonded sp2-hybridized carbon atoms arranged in a hexagonal honeycomb network [1]. Graphene can be described as a one-atom thick layer of graphite [2]. Graphene has outstanding properties like excellent electrical, thermal conductivity, flexibility, optical transparency, high specific surface area and much more [3]. Each carbon atom is equipped with a unhybridized π-bond giving graphene its high intrinsic mobility and ballistic transport [4]. The combination of the σ-bonds and π-bond helps with an the toughness of the structure with radical ions presence all around the structure. Hence, graphene can withstand extreme temperatures without damaging its structure [5].

Synthesis single layer have been reported in 2010 by Andre Geim and Konstantin Novoselov using mechanical exfoliation method with scotch tape [6]. There are some other synthesis of graphene can be divided into two main categories, top down and bottom up. For top down, there are two commonly used methods which are the mechanical exfoliation and chemical method. And for bottom up, there are two commonly used methods which are the chemical vapor deposition and epitaxial growth [7]. But for these methods have disadvantages like expensive and the highlight is these methods utilize many toxic chemicals throughout the synthesis process. Using toxic chemical for this synthesis is not good for our environment. Therefore, we are trying to develop green synthesis for graphene using environmentally friendly biomass resource such as chitosan, sugarcane bagasse, oil palm leaves and rice husk [8][9][10][11]. The purpose of green synthesis process is to use less toxic chemical and natural precursor [3].

The International Conference on Battery for Renewable Energy and Electric Vehicles (ICB-REV) 2021
AIP Conf. Proc. 2517, 020007-1–020007-5; https://doi.org/10.1063/5.0139958
Published by AIP Publishing. 978-0-7354-4444-7/$30.00

FIGURE 1. (a) Rice husk (b) Rice husk ash (RHA)

Rice is the primary source of food for billions of people around the world [12]. Rice husk is the hard-protecting coverings of grains of rice and removed from rice by during the milling process [13]. The product of this process is rice hush ash (RHA) which comprises 25% of the raw material [14]. Rice husk is one of the most widely available agricultural wastes in many rice producing countries of the world [13]. Therefore, utilization of rice husk is to reduce the waste of agriculture in the word.

TABLE 1. Composition of rice husk [13]

Property	Range
Bulk density (kg/m^3)	96-160
Hardness (Mohr's scale)	5-6
Calorific value (MJ kg^{-1})	12-15
Ash (%)	22-29
Carbon (%)	~35
Hydrogen (%)	4-5
Oxygen (%)	31-37
Nitrogen (%)	0.23-0.32
Sulphur (%)	0.04-0.08
Moisture	8-9

The green synthesis graphene has been reported by Marumatsu *et al.* [3] Singh *et al.* [11] Che Otman *et al.* [15] from rice husk using KOH and carbon black. In this research we demonstrate that it is possible to produce a few layers of graphene from rice husk using KOH.

METHODOLOGY

Materials for this synthesis were rice husk as a main material and KOH as the activating agent. First of all, raw rice husk was washed with (deionized) DI water for several time, and then rice husk was dried in oven for 2 hours at 120^{o}C. After rice husk was dried, carbonization process. Rice husk was compacted into ceramic crucible and then furnace for 4 hours at 400^{o}C. after this treatment we have Rice Husk Ash (RHA). RHA and KOH was mixed 1:5 and followed by grinding process. After this treatment we have powder mixed RHA and KOH. The mixed RHA and KOH was compacted into ceramic crucible and for the upper we covered with glass wool and RHA. And the

ceramic crucible was placed in the mind point of larger ceramic crucible. Empty spaced around ceramic crucible was covered by glass wool and RHA to prevent oxidation. The ceramic crucible was annealed at 900ºC for 4 hours. The sample was washed with DI water until pH normal around 7. And the sample was dried in oven for 2 hours at 100ºC. after all treatments we have graphene. The steps of the research are shown at figure 2.

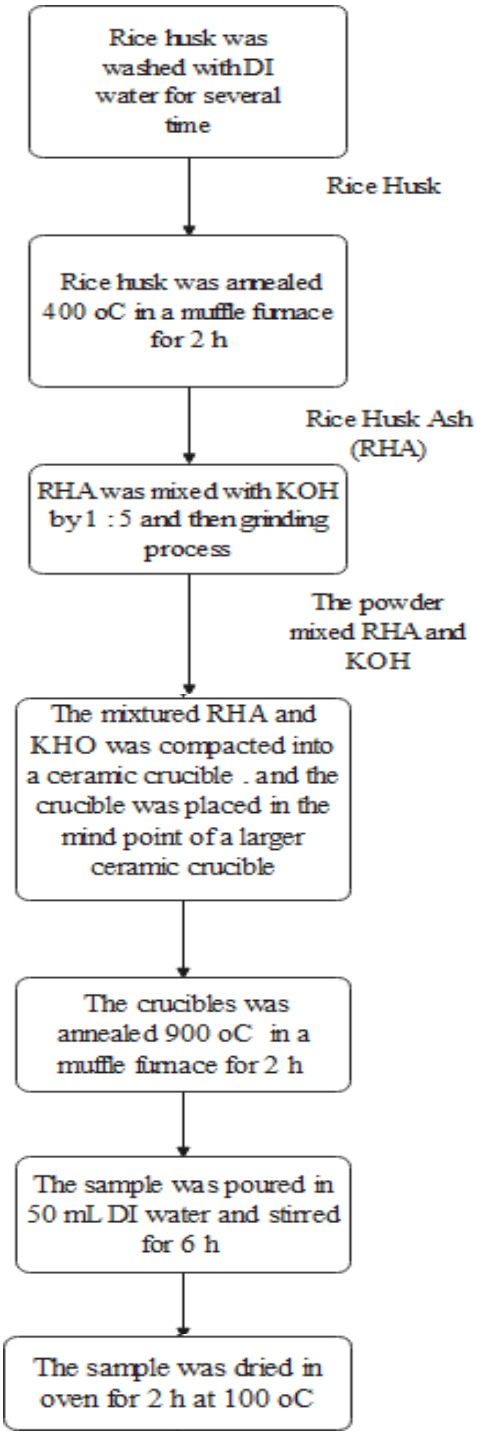

FIGURE 2. Flowchart of synthesis graphene

RESULTS AND DISCUSSION

In Figure 3 (a). There is XRD pattern of RHA showed peak around 23° indicates that silica in the rice husk initially exists in the amorphous form and there is free carbon in the RHA. And in Figure 2(b). There is XRD pattern of graphene derived from rice husk. We can see result characterization with XRD showed that the diffraction peaks arounds 22° and 41° and it confirmed to graphitic structure. In Figure 4. There are SEM images and showed the morphological analysis, with flakes of graphene with silica nanoparticles.

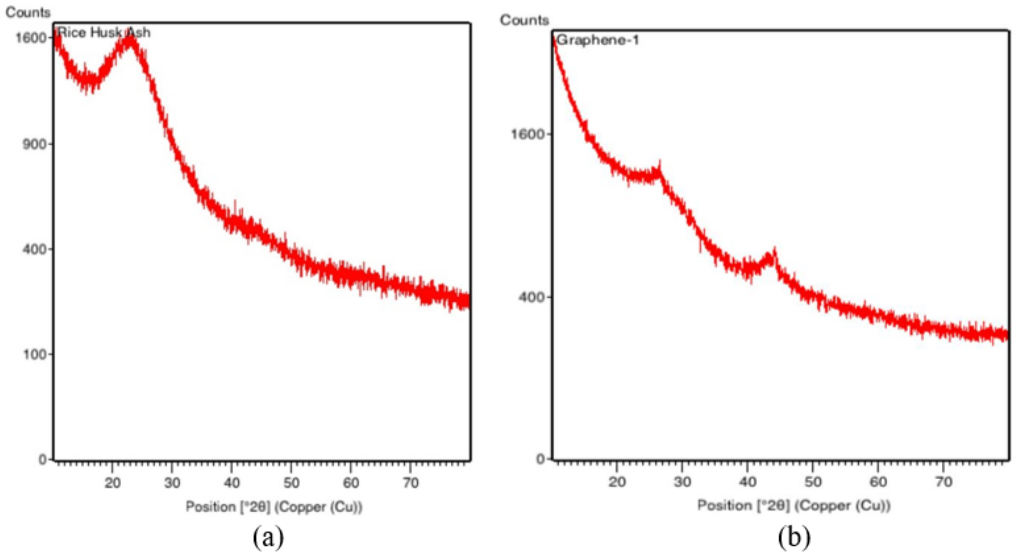

FIGURE 3. XRD pattern of (a) Rice Hush ash (b) Graphene from RHA

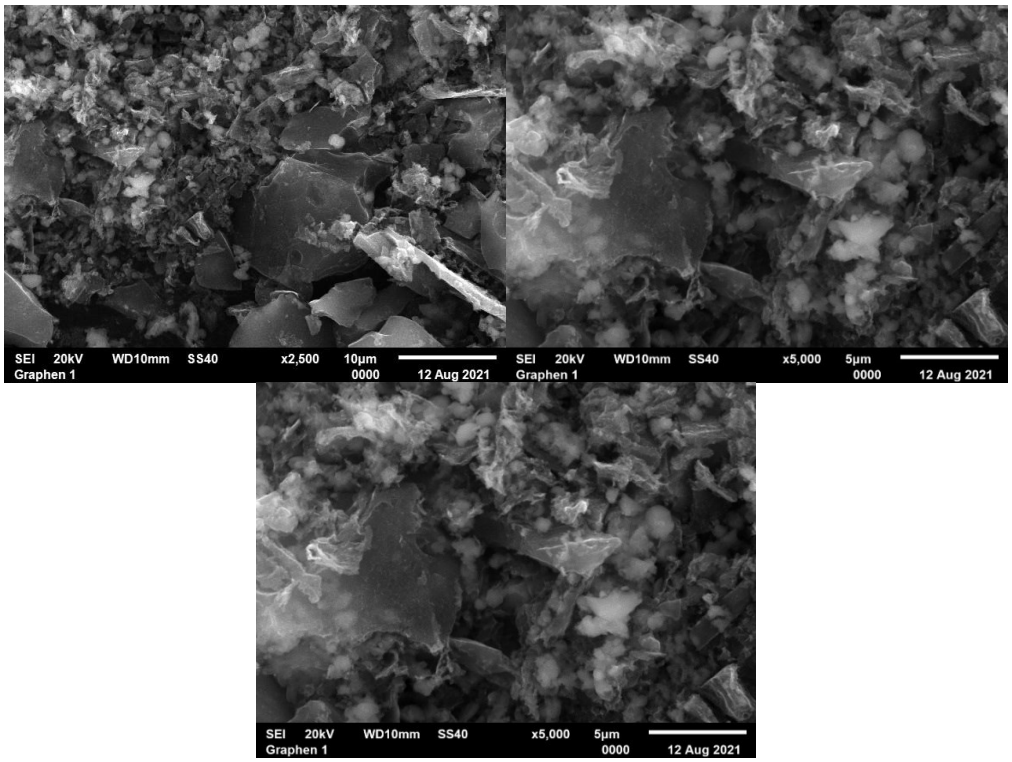

FIGURE 4. SEM images of graphene

CONCLUSION

For this method we can conclude that we can get graphene from rice husk using KOH. And it is possible to synthesis graphene derive from rice husk as a source of carbon, using KOH as the activating agent. We can develop green synthesis of graphene and using environmentally friendly biomass resource.

ACKNOWLEDGMENTS

This work is partially supported by LPDP number 84/E1/PRN/2020through the National Research Priority (PRN) Mandatory on Energy Storage 2020 under the Ministry Research and Technology.

REFERENCES

1. A. Adetayo and D. Runsewe, "Synthesis and Fabrication of Graphene and Graphene Oxide: A Review," *Open J. Compos. Mater.*, vol. 09, no. 02, pp. 207–229, 2019, doi: 10.4236/ojcm.2019.92012.
2. T. Radadiya, "A properties of graphene," no. June, 2021.
3. P. Singh, J. Bahadur, and K. Pal, "One-Step One Chemical Synthesis Process of Graphene from Rice Husk for Energy Storage Applications," *Graphene*, vol. 06, no. 03, pp. 61–71, 2017, doi: 10.4236/graphene.2017.63005.
4. K. I. Bolotin *et al.*, "Ultrahigh electron mobility in suspended graphene," *Solid State Commun.*, vol. 146, no. 9–10, pp. 351–355, 2008, doi: 10.1016/j.ssc.2008.02.024.
5. M. T. Safian, U. S. Haron, and M. N. Mohamad Ibrahim, "A review on bio-based graphene derived from biomass wastes," *BioResources*, vol. 15, no. 4. pp. 9756–9785, 2020, doi: 10.15376/biores.15.4.safian.
6. A. K. Geim and K. S. Novoselov, "The rise of graphene," *Nanosci. Technol. A Collect. Rev. from Nat. Journals*, pp. 11–19, 2009, doi: 10.1142/9789814287005_0002.
7. M. S. Ismail *et al.*, "Synthesis and characterization of graphene derived from rice husks," *Malaysian J. Fundam. Appl. Sci.*, vol. 15, no. 4, pp. 516–521, 2019, doi: 10.11113/mjfas.v15n4.1228.
8. P. Hao *et al.*, "Graphene-based nitrogen self-doped hierarchical porous carbon aerogels derived from chitosan for high performance supercapacitors," *Nano Energy*, vol. 15, pp. 9–23, 2015, doi: 10.1016/j.nanoen.2015.02.035.
9. P. D. Tang *et al.*, "Fabrication and characterization of graphene microcrystal prepared from lignin refined from sugarcane bagasse," *Nanomaterials*, vol. 8, no. 8, 2018, doi: 10.3390/nano8080565.
10. M. Fathy, R. Hosny, M. Keshawy, and A. Gaffer, "Green synthesis of graphene oxide from oil palm leaves as novel adsorbent for removal of Cu(II) ions from synthetic wastewater," *Graphene Technol.*, vol. 4, no. 1–2, pp. 33–40, 2019, doi: 10.1007/s41127-019-00025-w.
11. H. Muramatsu, Y. A. Kim, and T. Hayashi, "Synthesis and characterization of graphene from rice husks," *Tanso*, vol. 2016, no. 275, pp. 182–190, 2016, doi: 10.7209/tanso.2016.182.
12. A. Muthadhi, R. Anitha, and S. Kothandaraman, "Rice husk ash - Properties and its uses: A review," *J. Inst. Eng. Civ. Eng. Div.*, vol. 88, no. MAY, pp. 50–56, 2007.
13. S. Kumar, S., Sangwan, P., Dhankhar R.M.V., Bidra, "Utilization of rice husk and their ash : A Review," *Res. J. Chem. Enviromental Sci.*, vol. 1(5), pp. 126–129.
14. S. K. S. Hossain, L. Mathur, and P. K. Roy, "Rice husk/rice husk ash as an alternative source of silica in ceramics: A review," *J. Asian Ceram. Soc.*, vol. 6, no. 4, pp. 299–313, 2018, doi: 10.1080/21870764.2018.1539210.
15. F. E. Che Othman *et al.*, "Methane adsorption by porous graphene derived from rice husk ashes under various stabilization temperatures," *Carbon Lett.*, vol. 30, no. 5, pp. 535–543, 2020, doi: 10.1007/s42823-020-00123-3.