Facile and Benign Method to Produce Large Scale Graphene Nano Sheets

Supeno, Minto; Simanjuntak, Crystina; Siburian, Rikson*[+•]

Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara, Medan, INDONESIA

ABSTRACT: *The large scale production of Graphene Nano Sheets (GNS) has fascinated many researchers. GNS was produced base on a sustainable raw material namely coconut fruit. Coconut fruit was converted directly to be GNS with ethanol assisted. Then, it was characterized by XRD and TEM. Interestingly, XRD data show the C(002) peak is broad and weak appear, indicating GNS was formed. This data is also consistent with TEM data. Therefore, the formation of GNS may definitely be affected by the immersing process of coconut fruit by ethanol. Base on this research, the large scale GNS may be produced with the facile and benign method.*

KEYWORDS: *Graphene nano sheets; Ethanol; Coconut fruit.*

INTRODUCTION

Many researchers have reported about modifying graphite [1-3] and graphene [4], respectively. Their goals are producing graphene with large scale, cheap, fast, sustainable, versatile and facile method. Recently, graphene defenitely may be produced base on graphite as precursor [5-8]. The others method used various of precursors: graphite oxide [8], CNT [9], silicon carbide [10], ethanol [11,12], and hydrocarbon [13,14]. CVD method has been reported in order to generate single or few layers' graphite [15-18]. Non graphite, such as SiC was also reported as the other way to produce graphene [19,20]. Aforementioned, synthesize of graphene seems quite complex, high technology and base on the unrenewable resources as well as their precursors (raw materials), those are graphite and SiC.

In this research, ethanol was used in order to large scale production of GNS. Ethanol may be expected to reduce functional group of charcoal and also convert sp^3 to be sp^2. Base on this research GNS may be generated base on huge and sustainable natural resources.

EXPERIMENTAL SECTION

Effect of ethanol

Each of coconut fruits was soaked into ethanol 80 and 95% for 24 hours, respectively. Then, they were cracked on aluminum vessel at T = 200 ^oC and t = 10 minutes, resulting coconut shell and coconut water. Subsequently, each of coconut shells were pyrolized at T = 600 ^oC and t = 3 hours, resulting GrapheneNano Sheets (GNS). Finally, it was characterized by using XRD, and TEM.

* *To whom correspondence should be addressed.*

+ E-mail: rikson@usu.ac.id; riksonsiburian2000@yahoo.com ;

• Other Address: Carbon Research Center, Universitas Sumatera Utara, Medan, INDONESIA

1021-9986/2020/6/211-214 4/$/5.04

XRD measurement

GNS was analyzed with XRD. It was performed at room temperature employing a two circle diffractometer (PANalytical PW 3050 Philips X'Pert Pro, Cu Kα radiation of 1.541 Å, without monochromator), installed at a line focus X-ray generator. A reflection free Si plate was used as a sample stage. Cu Kα radiation obtained by reflection from a singly bent HOPG crystal was used as the incident X-ray. Diffraction pattern was recorded using a solid state detector (PANalytical X`Celerator) with a scan speed of 0.005 deg. (in 2Θ)/sec up to 90 degrees.

TEM measurement

TEM was used to characterize GNS. It ws carried out using JEOL JEM-1400 electron microscope. It was operated at 80 kV, resolution lattice image 0.20 nm, and resolution point image 0.38 nm.

RESULTS AND DISCUSSION

The coconut fruit was immersed into ethanol and pyrolized, resulting charcoal. Then, it was characterized by XRD (Fig. 1).

The weak and broad peaks were appearance, like GNS peak. It may generated due to it succeed to reduce functional group of coconut fruit by assisting ethanol. Ethanol may role to wetting the surface of coconut fruits, therefore, the functional group's coconut fruit will be separated from its coconut fruit when the cracking process. The different concentrations of ethanol (80 and 95 %) were carried in this research, in order to prove the ethanol role is existence on material. In the presence of ethanol, we may reduce functional groups of coconut fruits to be GNS. Therefore, GNS may be generated. The GNS was also clarified by using TEM. GNS has flat and thin surfaces and the each of graphene sheets are clearly seen (Fig. 2), indicating GNS was formed.

The model formation of GNS assisted ethanol may be seen in Fig. 3.

The formation of GNS has been reported previously. The shadow position to its material cause material properties changed. We believe that shadow is soul of atom where position of soul to its material will affect the material properties [21]. In order to prove this phenomenon, ethanol was used to separate between soul of atom and its material. The formation process of GNS may be explained below as (Fig. 3).

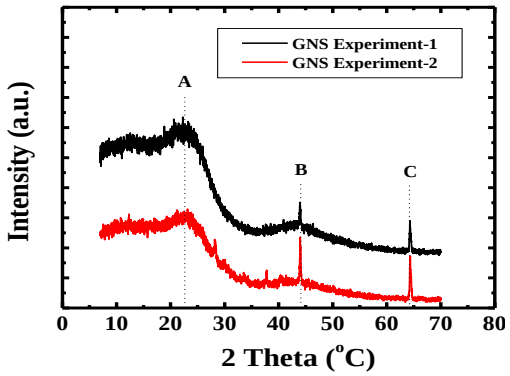

Fig. 1: Difractogram of GNS.

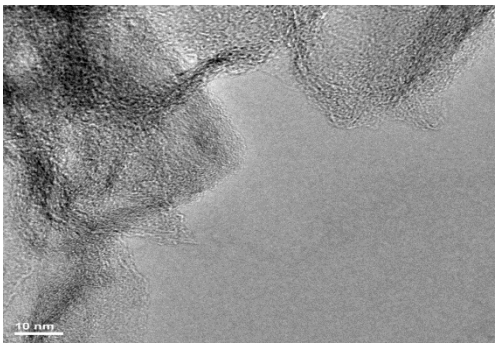

Fig. 2: TEM image of GNS.

Step-1. Cleaned coconut fruit consists of coconut fruit and its soul of atom. Coconut fruit cannot convert to be GNS when its soul of atom embedded on coconut fruit. Therefore, in the first step we immersed cleaned coconut fruit into ethanol. Ethanol will interact between surface of cleaned coconut fruit to form coconut fruit including its soul.

Step-2. Ethanol gradually may separate between coconut fruit and its soul of atom. Thereby, ethanol may attract soul of atom to generate coconut fruit without its soul.

Step-3. Coconut fruit was pyrolized to form GNS.

CONCLUSIONS

In this paper, we concluded: i) Every material is whose shadow, it definitely has soul; ii) Soul of material may be reduced by ethanol and iii) Soul of atom can affect the physical and chemical properties.

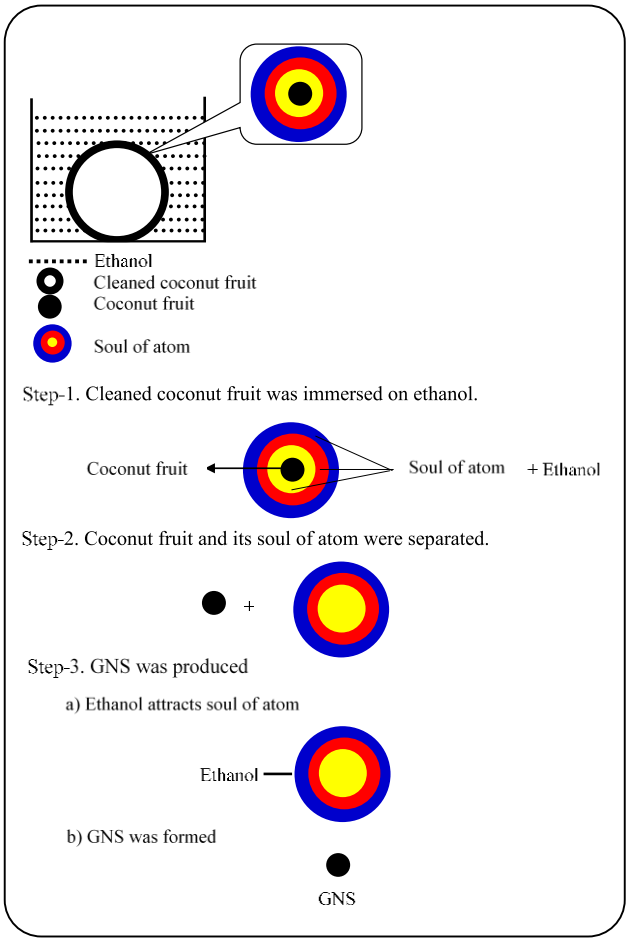

Fig. 3: Model of ethanol effect to generate GNS.

Acknowledgments

All authors would like to thankful for DRPM-Menristek/BRIN who supported our research funding (Penelitian Dasar No. 22/UN5.2.3.1/PPM/KP-DPRP/2020)

Received : May 27, 2019 ; Accepted : Sep. 2, 2019

REFERENCES

[1] Samad S., Loh K.S., Wong W.Y., Lee, T.K., Sunarso J., Chong S.T., Wan Daud W.R., Carbon and Non-Carbon Support Materials for Platinum-Based Catalysts in Fuel Cells, *International Journal of Hydrogen Energy*., **43(16)**: 7823-7854 (2018).

[2] Li Y.Y., Li C.T., Yeh M.H., Huang K.C., Chen P.W., Vittal R., Ho K.C., Graphite with Different Structures as Catalysts for Counter Electrodes in Dye-Sensitized Solar Cells, *Electrochim Acta*., **179**: 211-219 (2015).

[3] Peera G., Asokan A., Sahu A.K., Nitrogen and Fluorine Co-Doped Graphite Nanofibers as High Durable Oxygen Reduction Catalyst in Acidic Media for Polymer Electrolyte Fuel Cells, *Carbon*., **93**: 130-142 (2015).

[4] Choi H.J., Jung S.M., Seo J.M., Chang D.W., Dai L., Baek J.B., Graphene for Energy Conversion and Storage in Fuel Cells and Supercapacitors, *Nano Energy*., **1**: 534-551 **(**2012).

[5] Novoselov K.S., Geim A.K., Morozov S.V., Jiang D., Zhang Y., Dubonos S.V., Grigorieva I.V., Firsov A.A., Electric Field Effect in Atomically Thin Carbon Films, *Science*., **306**: 666-669 (2004).

[6] Taghioskoui M., Trends in Graphene Research, *Materials Today*., **12(10)**: 34-37 (2009).

[7] Castro Neto A.H., Guinea F., Peres N.M.R., Novoselov K.S., Geim A.K., The Electronic Properties Of Graphene, *Rev. Mod. Phys.*, **81(1)**: 109-162 (2009).

[8] Stankovich S., Dikin D.A., Piner R.D., Kohlhaas K.A., Kleinhammes A., Jia Y., Wu Y., Nguyen S.T., Ruoff R.S., Synthesis of Graphene-Based Nanosheets *via* Chemical Reduction of Exfoliated Graphite Oxide, *Carbon*., **45(7)**: 1558-1565 (2009).

[9] Choucair M., Thordarson P. and Stride J.A., Gram-Scale Production of Graphene Based on Solvothermal Synthesis and Sonication, *Nature Nanotech*., **4**: 30-33 (2009).

[10] Hernandez Y., Nicolosi V., Lotya M., Blighe F.M., Sun Z.Y., De S., McGovern I.T., Holland B., Byrne M., Gun'ko Y.K., Boland J.J., Niraj P., Duesberg G., Krishnamurthy S., Goodhue R., Hutchison J., Scardaci V., Ferrari A.C., Coleman J.N., High-Yield Production of Graphene by Liquid-Phase Exfoliation of Graphite, *Nature Nanotech*., **3(9)**: 563-568 (2008).

[11] Kim K.S., Zhao Y., Jang H., Lee S.Y., Kim J.M., Kim K.S., Ahn J.H., Kim P., Choi J.Y., Hong B.H., Large-Scale Pattern Growth of Graphene Films for Stretchable Transparent Electrodes, *Nature*., **457(7230)**: 706-710 (2009).

[12] Murugan A.V., Muraliganth T., Manthiram A., Rapid, Facile Microwave-Solvothermal Synthesis of Graphene Nanosheets and Their Polyaniline Nanocomposites for Energy Storage, *Chem. Mater.*, **21(21)**: 5004-5006 (2009).

[13] Emtsev K.V., Bostwick A., Horn K., Jobst J., Kellogg G.L., Ley L., McChesney J.L., Ohta T., Reshanov S.A., Röhrl J., Rotenberg E., Schmid A.K., Waldmann D., Weber H.B., Seyller T., Towards Wafer-Size Graphene Layers by Atmospheric Pressure Graphitization of Silicon Carbide, *Nature Mater*., **8(3)**: 203-207 (2009).

[14] Sutter P.W., Flege J.I., Sutter E.A., Epitaxial Graphene on Ruthenium, *Nature Mater*., **7(5)**: 406-411 (2009).

[15] Brownson D.A., D.K. Kampouris C. E. Banks., Graphene Electrochemistry: Fundamental Concepts Through to Prominent Applications, *Chem. Soc. Rev.* **41(21)**: 6944-6976 **(**2012).

[16] Chen S., Cai W., Piner R.D., Suk J.W., Wu Y., Ren Y., Kang J., Ruoff R.S., Synthesis and Characterization of Large-Area Graphene and Graphite Films on Commercial Cu-Ni Alloy Foils, *Nano Lett*., **11(9)**: 3519-3525 (2011).

[17] Huang P.Y., Ruiz-Vargas C.S., Van der Zande A.M., Whitney W.S., Levendorf M.P., Kevek J.W., Garg S., Alden J.S., Hustedt C.J., Zhu Y., Park J., McEuen P.L., Muller D.A., Grains and Grain Boundaries in Single-Layer Graphene Atomic Patchwork Quilts, *Nature*., **469(7330)**: 389-392 (2011).

[18] Walter A.L., Nie S., Bostwick A., Kim K.S., Moreschini L., Chang Y.J., Innocenti D., Horn K., McCarty K.F., Rotenberg E., Electronic Structure of Graphene on Single-Crystal Copper Substrates, *Phys Rev B*., **84**: 195443 (2011).

[19] Dimitrakopoulos C., Wisnieff R., Grill A., Antoniadis D.A., McArdle T.J., Liu Z., Effect of SiC Wafer Miscut Angle on the Morphology and Hall Mobility of Epitaxially Grown Graphene, *Appl. Phys. Lett*., **98**: 222105 (2011).

[20] McDonald A.H., Bistritzer R., Graphene Moiré Mystery Solved?, *Nature*., **474**: 453-454 (2011).

[21] Supeno M., Siburian R., New Route: Convertion of Coconut Shell Tobe Graphite and Graphene Nano Sheets, *Journal of King Saud University-Science*.