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SYNTHESIS OF GRAPHENE NANOSHEETS FROM COCONUT SHELLS AT A ROASTING TEMPERATURE OF 220°C AND A PYROLYSIS TEMPERATURE OF 500°C USING SEM-EDX OBSERVATIONS AND PERFORMANCE TESTS

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Abstract
To synthesize graphene nanosheet (GNS) using coconut shell as a basic material. The synthesis process involves two play stages of initial roasting at 220 °C and pyrolysis at 500 °C. After the pyrolysis process, the synthesis results were analyzed using SEM and EDX to characterize the morphology and elemental composition of the resulting graphene nanosheets. Observations via SEM show a thin layer structure typical of graphene while EDX analysis confirms the dominance of carbon elements, indicating success in graphene formation. The results of the electrical conductivity work test were carried out to determine the DHL produced with a voltage of 40 V producing DHL 42.925, a voltage of 44V DHL 40.954, a voltage of 48 V DHL 36.875, a voltage of 51 V DHL 34.784, a voltage of 55 V DHL 33,290, it was found that the smaller the voltage used, the greater the electrical conductivity produced and the greater the voltage used, the smaller the electrical conductivity produced. The results of this research show that coconut shell can be an effective and environmentally friendly alternative material in graphene production, with a relatively simple and cheap synthesis method.

Keywords: Graphene, Coconut shell, Roasting, Pyrolysis, SEM-EDX, DHL

INTRODUCTION

There are numerous coconut plantations in Indonesia. These plantations produce coconut shell waste. However, many Indonesians still don't know how to utilize this waste. shell coconut the. Wrong the only one waste shell Coconuts can be used as a carbon source by converting them into charcoal through a carbonization process. The resulting material can be synthesized into graphene. Although still rare, graphene, a two-dimensional carbon material, has enormous potential. wide And can used in various application. Because its nature Which unique and extraordinary, graphene can be used in various applications, such as in batteries, filler polymer, sensors, conversion energy, And in field other (Hidayat et al., 2019).

In the coconut shell itself, there are organic compounds, namely cellulose, lignin, and hemicellulose, which produce carbon when processed. Because of the valence number with atom carbon, carbon can form Lots allotropes, like diamonds, carbon nanotubes, fullerenes, fullerites, graphene, and graphite. Coconut shell charcoal can used So material standard For make graphite. Graphite can used It is used as a material for dry cell batteries, paint, dynamo brushes, and pencils because it is non-flammable and insoluble in water. The utilization of coconut shell waste allows them to be used as a raw material for making graphene oxide, the main raw material for graphene (Honorisal et al., 2020).

Since graphene was first isolated in 2004, it has become an attractive material for electrochemical energy storage devices. The aim of this study was to compare Mg/graphite and Mg/graphene electrodes with commercial primary electrodes for battery cathodes. This study was an experimental study of laboratory-synthesized graphene, Scanning Electron Microscopy-Energy Dispersive X-Ray (SEM-EDX), and conductivity, respectively (Simanjuntak et al., 2021).

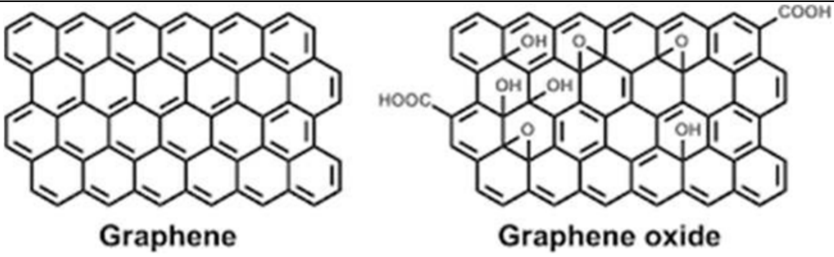
SEM is a type of electron microscope that uses an electron beam to reflect the surface profile of an object. It is suitable for situations where observation of rough surfaces is required at magnifications between twenty and fifty thousand times (Kusumaningtyas, 2019). Energy-dispersive X-ray (EDX) is method analysis composition chemistry material with characteristic radiation X-rays. Basically, elemental analysis using EDX relies on the detection of X-rays emitted in the target material (Hartini, 2014).

The process of forming (fabricating) shells into carbon and activated charcoal goes through several stages, the first stage is cleaning the shells from dirt and other remains, the second stage is heating the shells to produce charcoal, and the third stage is heating the shells to produce charcoal. grinding the shells to achieve the desired results. certain size, then discarded. Then the activation process is carried out through chemical or physical means, the latter involving the use of chemical solutions or steam at a certain temperature. The purpose main stage This make carbon active Which porous And own uniform pore distribution, so it can function effectively as an absorbent. Converting coconut shells into charcoal increases the carbon content, while increasing the ash percentage, removing moisture and reducing content easy evaporate. Charcoal experience other Which general found in the food industry, for example corn stalk charcoal, rice grains, and cocoa fruit shells (12-20% C), have a higher carbon content than coconut shell charcoal, so that it can cause its active form to be lower. carbon source. Chemical content of coconut shell cellulose (34%), hemicellulose (21%) and lignin (27%) element composition includes carbon (74.3%), Oxygen (21.9%), Silicon (0.2%), Potassium (1.4%) Sulfur (0.5%) And Phosphorus (1.7%) (Ratna Sari 2021). (Tamado et et al., 2013) Reduced graphene oxide (rGO) was prepared using a modified version of the Hummer method previously used by Chen et al., 2013. 6 g of coconut shell charcoal was added to a beaker containing 140 ml of concentrated sulfuric acid. The beaker was placed in an ice bath, and 18 g of $KMnO_4$ was added at a time until temperature mixture No more from 20°C, Then added 300 mL water DM.

Suspensi Then stirred two O'clock in temperature 35°C. Furthermore suspension left alone 5 days. After oil oxidation, the next step is to add 500 ml of water and 15 ml of H_2O_2 (reduction process), this step will produce foam and increase the temperature of the solution. During this time, the color of the mixture will change from dark brown to yellow. The mixture is then treated with 1 L of HCl solution (1: 10 ~ HCl: aqua DM) using filter paper and a funnel, this procedure removes most of the ion metal from mixture. On stage This made mixture Then dried at 60°C for 6.5 hours until a solid forms. The solid is then separated into 500 ml of water and allowed to stand for 3 hours. The purification procedure involves flooding the suspension with a large amount of water in DM. The pH increases from 1 to 5 as more washing processes are carried out. Next, the paste collected from the filter paper is mixed with 300 ml of deionized water and then sonicated for 20 minutes with a sonicator. The resulting brownish graphene oxide (rGO) dispersion is then centrifuged at a speed of 100 °C. 4000 rpm during 30 minute For differentiate form graphite oxide that does not peel off. After centrifugation, the rGO is placed at the bottom of the container, and the containment process is facilitated by eliminating gravity-related problems, such as the decantation process. Next, dry rGO is obtained through a dehydration method. The dehydration stage begins by heating the rGO at 30°C for 2 minutes, then 40°C for 2 minutes, 50°C for 2 minutes, and finally 90°C during 1 O'clock. flakes rGO obtained with take solids rGO from the cup. (Hidayat et al., 2019) . Writer want to analyze Graphene Nanosheets after being given a baking temperature of 220 °C and Pyrolysis of 500 °C and conducting SEM-EDX and Electrical Conductivity testing. The results of the baking and pyrolysis, in this study, can be used for primary battery electrodes and from the baking process at 220 °C and pyrolysis at 500 °C, it is expected to improve the quality of battery electrodes for development in the industrial world.

LITERATURE REVIEW

Graphene namely an interesting material that has a two-dimensional framework that is not normal with structure hexagonal layer mono-molecular single atom hybridized carbon sp2. Graphene has interesting interest Which strong in Lots field science and technology due to its unique properties such as excellent electronic, thermodynamic, and mechanical properties. Graphene has a wide range of applications such as transparent conductive films, field effect transistors (FETs), water purification, energy storage devices, and sensors due to its extraordinary physical and chemical properties. The first fabrication nanosheets graphene single layer is done using a peeling technique called the tape method Scotch from bulk graphite and by epitaxial chemical vapor deposition. However, the drawback of these methods is that they are not applicable to graphene manufacturing. in industrial production. Synthesis nanosheets graphene using mechanical peeling method is not applicable For production scale big. By Because That, development method scale synthesis big from material Which in a way structural similar with Graphene has draw attention study Which increase . Wrong One approach Which most general and attractive for large-scale graphite exfoliation is through the use of active oxidizing agents in chemical reactions to produce graphene oxide (GO) Which is material carbon with characteristic hydrophilic non-conductive (Sujiono et al., 2020).



Picture 2. 1 Graphene Structure and Graphene oxide (Daughter et al., 2023).

In 2004, Andre K. Geim and Kostya Novoselov discovered graphene use Scotch tape affixed in graphite take sample powder carbon. Graphene's Young's modulus is 1 TPa, its thermal conductivity is 3000 Wm/k, and its electron mobility is 15000 cm2 V-1 S-1. Graphene has many applications in various fields, including sensors, nanocomposites, nanoelectrics, battery, supercapacitor, semiconductor, And transparent electrode. (Honorary et al., 2020). Graphene namely derivative from graphite, is an allotrope of carbon, which has carbon in the form of a thin plate with sp2 orbitals arranged hexagonally. Graphene oxidation is very interesting because of its thermal, mechanical, and And the electricity Which outside normal. Moment This, oxide graphene Lots intermediates used in the manufacturing process graphene. The first material with a two-dimensional crystalline form, namely graphene. One unit of graphene hexagonal consists of two atom carbon with wide area 0.052 nm2. Besides that, conductivity value graphene heat is 401 Wm-1K-1, whereas copper own 401 Wm- 1K- 1. Graphene It has a thermal conductivity ten times that of copper. Graphene can be used as a chemical detector, a base material for composites, or as a fuel (Kusumattaqiin et al., 2020). With form sheet thin shaped hexagonal two dimensions, graphene is the allotrope of carbon with the strongest bonds among the allotropes carbon other. Graphene with characteristic physics And chemistry unique, including quantum effects, electron mobility, and high conductivity. In addition, graphene have a price low, easy obtained, And characteristic surface outside normal. (Agustina & Princess, 2018).

Shell Coconut

Most Indonesians are quite familiar with coconut, one type of plant from ethnic group Arecaceae, or ethnic group sugar palms, Which own many benefits. Almost all parts of this plant are used by humans, making it considered as plant multipurpose. Coconut (Cocos nucifera L) is A plant that generally grows in island nations and can reach heights of up to 30 meters. Coconuts are used for daily consumption and in industry. agriculture, with waste in the form of shell. Part most keas from coconut fruit is the shell, Which thickness around 3–5 mm. Shell hard This made of a mass of hard and dense material, so that when rubbed until smooth, the surface appears shiny and fibrous with extraordinary characteristics (Balai et al., 2015).

Picture 2. 2 Waste shell coconut (Hall et et al., 2015)

Coconut shells can be turned into products with higher selling value. For increase mark economy public. Wrong One potential village To improve the community's economy, coconut shells are used. The obstacle to optimizing coconut shell waste is the limited ability of residents to utilize its potential. The goal of this community empowerment program is raise welfare public. Method training used This implementation involves delivering theoretical and practical learning materials. Coconut shell charcoal and activated carbon are made from coconut shell charcoal. Carbon active is material per pore Which absorb impurities water, like water filter (Nustini & Allwar, 2019).

Excess Graphene

One of the advantages of its electrical properties is that graphene has conductivity optics universal ($\sigma 0 = \pi e2$ /

2h) in range energy infrared to visible light. Due to its relatively high conductivity, thermal conductivity, extraordinary chemical stability, extraordinary mechanical strength, and high surface-to-volume ratio compared to carbon materials, graphene has been So material most ideal For application storage energy (Z h u & E r t e ki n , 2 0 1 6) . Due to by dimensions And thickness order atom graphene, which is very transparent, graphene still Have density Enough tall, 0.77 mg/m2.

Graphene can used For various objective. Graphene used as supercapacitor battery And cell solar in field source energy. Graphene used ink and adhesives for conductive inks or EMI screen inks. It is used as a semiconductor for high-speed RFIC transistors and as a thin-film TCO for flexible touchscreen panels. Graphene is then used as a barrier, as a chemical sensor, like purification water, as distributor hot, like light LED ECUPC, and composites, are used in airplanes, cars, and vehicles (Papageorgiou et al., 2017).

Lack Graphene

Graphene has the best quality and is the least affected. Because it is too expensive For produced And No can measured, That not So candidate compete with activated carbon for supercapacitor applications. Today, the majority of research on graphene with base supercapacitors concentrate graphene nanoplatelets, graphene nanoplatelets, and graphene derivatives, such as graphene oxide, chemically modified graphene, etc. Unlike graphene produced from process CVD, graphene shape This generally covering two or Graphene nanosheets are stacked and subjected to strong chemical, mechanical, or thermal exfoliation. Furthermore, one of the main factors to consider when creating an effective supercapacitor device is its cost. Furthermore, its irreversible conductivity makes graphene useless as a semiconductor. However, researchers are exploring various substances to overcome this problem. Chemical processes are a solution. Graphene can be used as a replacement transistor silicone super fast, Which reach capacity maximum, in some devices. Another limitation is that graphene can currently be synthesized in small crystals, but has a hundred times the electron mobility of silicon. While this is sufficient for researchers to test its properties and understand its benefits, it is not yet sufficient for mass production for commercial use. (Papageorgiou et al., 2017).

Pyrolysis

Pyrolysis, also known as devolatilization, is the fractionation of material by temperature. This started temperature around 230 degrees Celsius, moment material Which not stable Thermal and volatile in the waste breaks down and evaporates along with other materials. Three type product pyrolysis generally covering gas (H_2, CO, CO_2, H_2O, And CH_4), tar And charcoal. Product liquid Which evaporate usually contain tar and hydrocarbons polyaromatic. Because connection Which complex between Parameters that affect the rate of pyrolysis reaction, the mathematical model of the pyrolysis reaction rate equation developed by each researcher always uses a different empirical formula. Pyrolysis comes from the word "lyo", which means release, and "pyro", which means fire or flame. Pyrolysis is the simplest way to recycle plastic because it involves heating organic materials with A little or No There is oxygen. Process This involving cracking plastic at high temperatures, around 230 degrees Celsius. (Viridi & Purba Asmara, 2019). Pyrolysis is the combustion of organic materials with low oxygen concentrations. This process produces by-products such as gas, charcoal, ash, and unburned materials (Hadi et al., 2015). Pyrolysis is influenced by various factors. These include level water, size particle, rate warmup, temperature, material, test material composition, nitrogen rate, solids residence time, volatiles residence time, and pyrolysis type. Pyrolysis, a waste processing method that can reduce weight and volume, is considered quite promising (Jamilatun et al., 2015).

Pyrolysis And thermolysis often called together. defined as process in where temperature tall implemented on something material without presence air. In short, pyrolysis is a combustion process that does not contain oxygen. Pyrolysis has long been used to make charcoal from plant waste. In the 18th century, pyrolysis was used to determine plant parts. Pyrolysis is also often called dry distillation. Pyrolysis is a process frequently used in the chemical industry. This includes the production of activated carbon, methanol, charcoal, and other chemicals from wood; the production of coke from coal; the production of gas from biomass; the production of safe substances from waste; and the production of hydrocarbons. medium-heavy from oil become gas. Pyrolysis Also called distillation damage or distillation dry. This is process decomposition organic irregularities caused by heating without contact with outside air. Time, level of water material, temperature, And size is factor main Which influence pyrolysis. A complete description is below:

a. High feed moisture content increases pyrolysis time and liquid concentration, but char activity increases because water vapor oxidizes substances on the char surface.
b. Size material related type material and tools; material with wide smaller surface per unit mass speed up propagation hot to bait And collision frequency. Material with a diameter of 1.5 cm, for example pyrolyzed

more quickly.

c. Due to the increased amount of decomposed and vaporized matter, high process temperatures result in decreased char yields and increased liquid and gas yields. A temperature of 456°C is required for the pyrolysis of sawdust.

Sonication

Sonication use energy voice For stir particle sample for various purposes. For example, using sound energy to move sample particles for the extraction of certain substances from plants, microalgae, or seaweed. By using sonication, the principle of breaking down intermolecular reactions can be accelerated. process dissolution something material, produce particle sized Nano. Sonication means subjecting a material to ultrasonic treatment under certain conditions until it undergoes a chemical reaction. The term "ultrasonication" refers to ultrasonic waves in the frequency range of 20 kHz to 10 MHz. Sonication own various effect chemistry And physique. Term "sonochemistry" Sonication is used to describe how sonic waves affect chemical systems. Molecular interactions do not produce chemical effects. Research shows no direct relationship between sonochemistry and acoustic fields. Sonication can be used to make biofuels, desulfurize crude oil, polymers, epoxy processing, cell disruption, and nanoparticles such as liposomes, wax emulsions, and nanocrystals. Various industries, such as pharmaceuticals, food, cosmetics, water, coatings, inks, paints, and manufacturing metal, maintenance wood, manufacturing metal, nanocomposites, pesticide, fuel, wood products, and more, using the sonication process. Sonication facilitates and speeds up dissolution with break interaction between molecules and track the dynamics and kinetics of molecular reactions during molecular cleavage (Candani et al., 2018).

Scanning Electron Microscope (SEM)

SEM to identify the microstructure, morphology, and thickness of the material. This method prints an image of the sample that scans the surface. sample with ray electron Which focus to scale certain (Honorary et al., 2020).

Tool SEM-EDX own two monitor. Tool This use system vacuum. Before the analysis begins, the gas is sealed to remove any air molecules in it. This is crucial because collisions will move the electrons that travel through the chamber. going to target before about target If There is molecule air other. This happens because electrons are very small and light. This instrument has an electron gun that emits a beam of electrons accelerated by an anode. The electron beam is focused onto the sample by a magnetic lens and then used by a scanning coil to scan the sample. the entire sample. To begin, use the camera to position the sample surface. After that, adjust the magnification, brightness, and focus of the sample. The SEM-EDX method sets the spot size on the SEM monitor and collects it on the EDX microscope. This method is a methodology study beginning Which can give information about type The minerals found in rocks can be identified by identifying their elemental and oxide content. We can also study the physical and chemical properties of minerals. SEM-EDX identification tools can provide faster and more accurate results, and the method is easy to use and requires a short research time. Area analysis is used to analyze each SEM-EDX measurement sample. Electron beam from area bullet sent to sample. After ray electron about sample, Columb optical electrons focus the flow of electron beams. The irradiated sample experiences interactions, which are detected and converted into images by SEM analysis and graphs by EDX analysis (Julinawati et al., 2015).

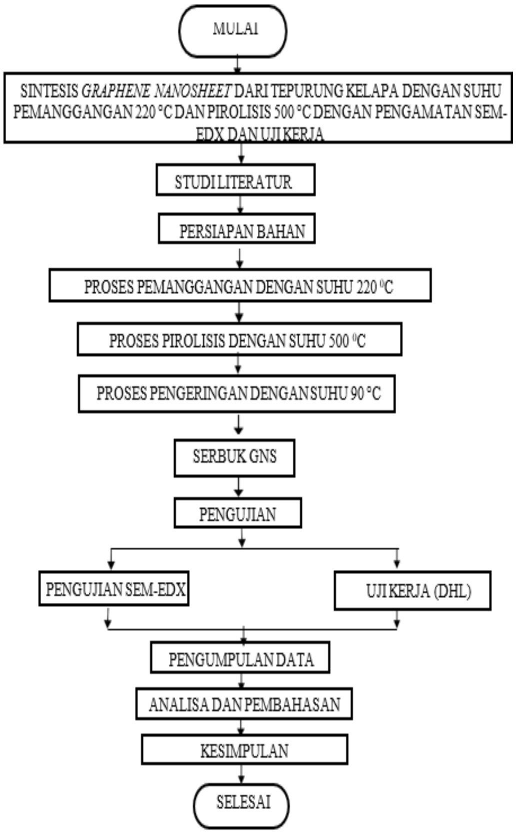
METHOD

The methodology used is field inspection, visual data collection, test material samples, testing, literature research for support the hypothesis, processing data, And analysis up to research completed to determine the feasibility of the operation.

Research process of Graphene Nanosheet Synthesis from coconut shell with a roasting temperature of 220 °C and a pyrolysis temperature of 500 °C with SEM-EDX observations and work tests:

1. Identification problem.
2. Collection data study.
3. Test laboratory And analysis temperature.
4. Analysis and discussion.
5. Conclusion

6. Test Laboratory in the Lab. Material University Engineering Pamulang



Picture 3. 1 Diagram Research Flow

Procedure Study

In this step, the research work is outlined, which explains the research:

Collection data

A survey field For gather data primary And supporters, and the procedure for taking operational data, namely: Investigative survey and material identification, visual inspection including direct inspection of the coconut. Visual inspection is significant before in-depth inspection to identify surface defects and material damage conditions. Carbon material test sampling. In addition to collecting primary data, researchers also need secondary data.
Data warmup 2 coconuts O'clock, recorded per 10 minute temperature, Analysis test data graphene wear test SEM-EDX Spectroscopy , and Data test Work For analysis Power deliver graphene electricity with weak current voltage variations and measured with a multimeter.

Observation and testing

Among the visual observations during the research on coconut material, namely the manufacture, inspection, as well as test. Including test spectroscopy SEM-EDX and electrical conductivity test.

a. Observation

To obtain accurate data, visual observation of the coconut before taking Photo documentation. Do observation important visuals determine is coconut it is good or No.

b. Testing SEM- EDX Spectroscopy

Identification And analysis phase materials use tool spectroscopy SEM- EDX. This test looks at the crystal structure of a sample of graphene nanosheet powder.

c. Power testing conduct electricity.

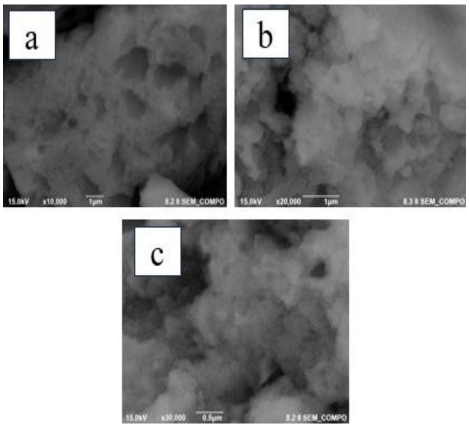
Measurement Power deliver electricity use multimeter For measure weak current voltage variations assess the electrical capacity of graphene.

Process The research conducted was:

1. Retrieval fruit coconut
2. Warmup coconut
3. Cooling And cleaning
4. Pyrolysis
5. Refinement
6. Sifting
7. Washing And Sedimentation
8. Filtering
9. Warmup with temperature 100 °C
10. Testing Power deliver electricity (DHL)

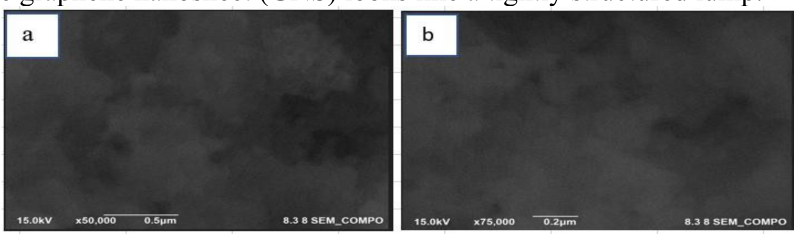
RESULTS AND DISCUSSION

U ji SEM on sample graphene nanosheet (GNS). Tool SEM-EDX used to conduct morphological tests because SEM shoots electrons at the sample surface with sufficient energy so that the scattering is detected by the sensor and maps the micro-scale shape of the sample. The purpose of EDX is to identify sample components.



Picture 4. 1 Results test SEM For sample graphene nanosheets (GNS) magnification a.10000x, b.20000x c.30000x

Test SEM use look for know morphology surface sample. On **Picture 4.1.a** shows the surface morphology of the graphene nanosheet (GNS) sample. The surface of the graphene nanosheet (GNS) sample looks layered and graphene has begun to form. Meanwhile, in **Figure 4.1.b,** the morphology of the graphene nanosheet (GNS) is enlarged, the particles are seen to have cavities that form groups in the graphene nanosheet (GNS) sample. **Figure 4.1.c,** the morphology of the graphene nanosheet (GNS) looks like a tightly structured lump.

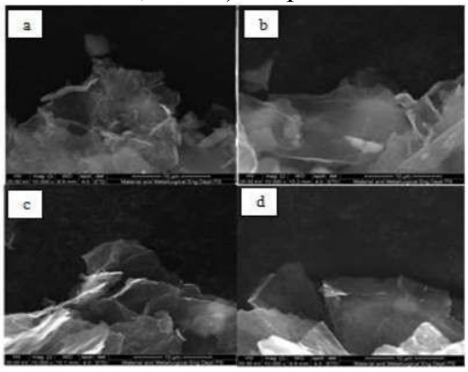


Picture 4. 2 Results test SEM-EDX For sample graphene nanosheets (GNS) magnification a.50,000x and b.75,000x.

On sample graphene nanosheets (GNS) enlargement 4.2.a.50000x And 4.2. b.75000x shows that the graphene samples are stacked, this indicates that graphene has formed.

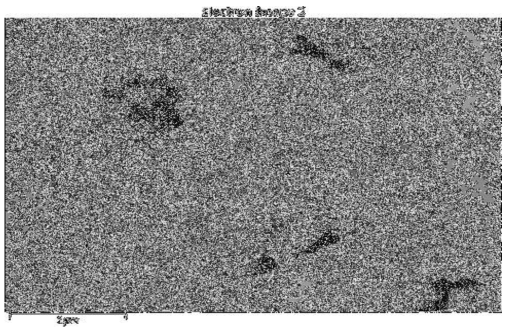
The results of SEM-EDX testing show that the graphene nanosheet (GNS) sample has formed graphene, as seen from the sample showing the presence of layers and stacking on the graphene nanosheet (GNS) sample. The following parameters are from the results of previous research.

Picture 4. 3 Results SEM magnification 10,000x a) Graphene without doping; N-Graphene with the addition



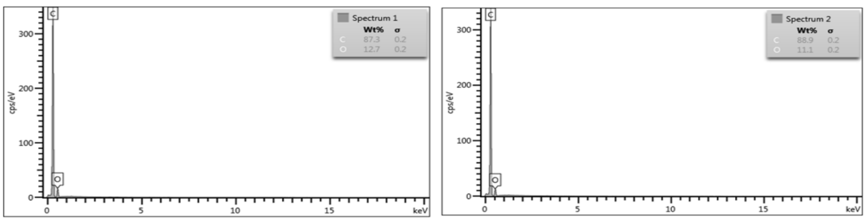
of NH4OH b) 0.1 ml c) 0.3 ml d) 1 ml.

Figure 4.3 shows the morphology of the results of nitrogen doping of graphene with addition NH4OH 0.1 milliliter, 0.3 milliliter, And 1 milliliter. From all results the, Can known sample graphene Have form morphology almost The same, namely a thin transparent sheet covering various layers of graphene stacked until it looks thick, and sometimes looks like a single layer. Observing the morphology of nitrogen-doped graphene looks the same and is difficult (Safitri et al., 2017).



Picture 4. 4 Spectrum Graphene Nanosheets (GNS)

Surface composition of Graphene Nanosheet (GNS) with Spectrum 1, 2, 3, 4, 5, 6, 7, 8 shows the analysis location of EDX.

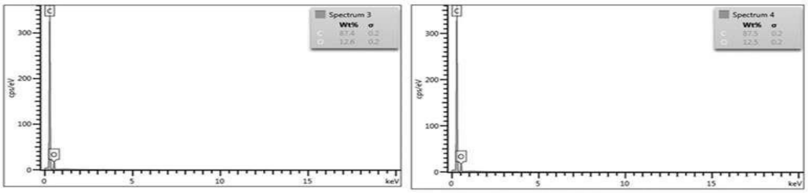


Picture 4. 5 Results EDX spectrum 1 And 2

Table 4. 1 Composition graphene nanosheets (GNS) Spectrum 1 And 2

Spectrum	Carbon	Oxygen
1	87.3%	12.7%
2	88.9%	11.1%

SEM-EDS analysis of spectra 1 and 2 is shown in Table 1. The percentage range of elements in the composite mass, visualized in the appropriate voltage range, is calculated in electron-volt seconds. keV: accelerating voltage range used for EDX analysis, kilo-electron-volts (keV). cps/eV: count per second per electron-volt. (cps/eV: counts per second per electron-volt).



Picture 4. 6 EDX Results spectrum 3 And 4

Table 4. 2 Composition graphene nanosheets (GNS) Spectrum 3 and 4

Spectrum	Carbon	Oxygen
3	87.4%	12.6%
4	87.5%	12.5%

SEM-EDS analysis of spectra 3 and 4 is shown in table 2. The composition contained in graphene nanosheet (GNS) spectrum 3 is carbon 87.4%, Oxygen 12.6% and in spectrum 4 carbon 87.5%, Oxygen 12.5%.

Picture 4. 7 EDX Results spectrum 5 And 6

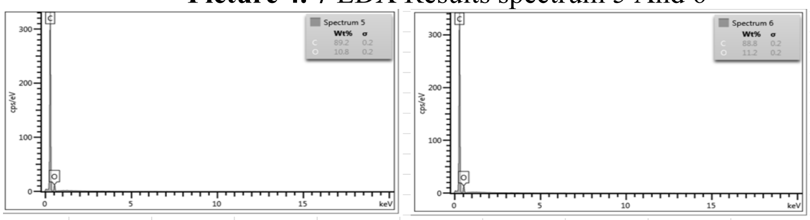


Table 4. 3 Composition graphene nanosheets (GNS) Spectrum 5 And 6

Spectrum	Carbon	Oxygen
5	89.2%	10.8%
6	88.8%	11.2%

SEM-EDS analysis of spectra 5 and 6 is shown in table 3. The composition contained in graphene nanosheet (GNS) spectrum 5 is carbon 89.2%, Oxygen 10.8% and in spectrum 6 carbon 88.8%, Oxygen 11.2%.

Picture 4. 8 EDX Results spectrum 7 And 8

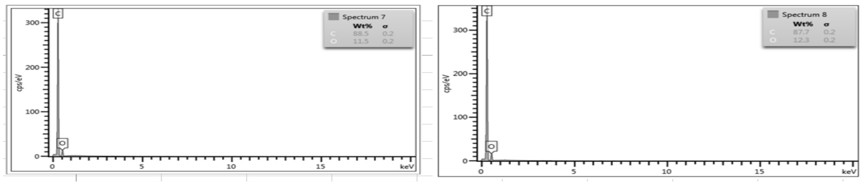


Table 4. 4 Composition of graphene nanosheets (GNS) Spectrum 7 And 8

Spectrum	Carbon	Oxygen
7	88.5%	11.5%
8	87.7%	12.3%

SEM-EDS analysis of spectra 7 and 8 is shown in table 4. The composition of graphene nanosheet (GNS) spectrum 7 is carbon 88.5%, Oxygen 11.5% and in spectrum 8 carbon 87.7%, O7oxygen 12.3%.

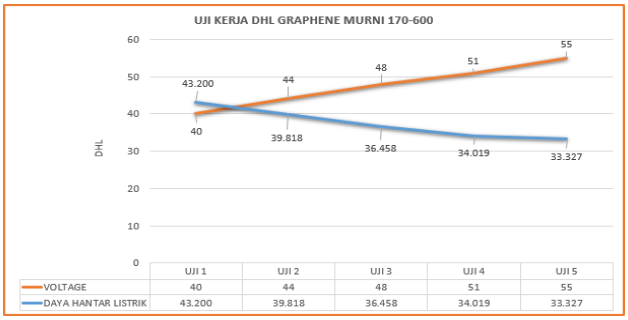
Test Work

The work test process for SEM-EDX sample testing is also prepared to carry out conductivity testing. For the conductivity test, the sample is inserted into in fuse 0.3 ampere. Make sure sample filled with Good in fuse so that current The current that is flowing can be conducted well. Next, test by conducting current electricity through the fuse using power supply with variation voltage between 40 And 55 volts. Then, using a multimeter, measure the current conducted by the fuse. Once the data is complete, calculate the resistance and electrical conductivity. The following table shows the electrical conductivity analysis of the DHL from GNS.

Table 4. 5 Test DHL Work GNS Temperature 170-600 °C

Test Work DHL Graphene (PURE) 220-500 °C			
Voltage (V)	Current (μA)	Obstacle (R)	DHL (1/R) (μS/cm)
40	1728	0.023148148	43,200
44	1752	0.025114155	39,818
48	1750	0.027428571	36,458
51	1735	0.029394813	34,019
55	1833	0.030005456	33,327

Table 4.2 shows the results of the electrical conductivity test producing electrical conductivity with voltages of 40V, 44V, 48V, 51V, and 55V. The sample was heated to 600 °C producing electrical conductivity:



Picture 4. 9 Test Graph Work Power Send Electricity GNS 170-600 °C

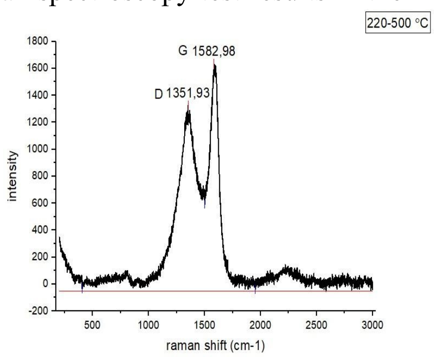
Electrical conductivity data shows a significant decrease in conductivity electricity Graphene. Decline Which most significant on voltage 44-48 volts, which reaches 43,200-33,327 µS/cm. The resulting GNS structural regularity can be give influence How electron deliver current electricity. This shows that the smaller the voltage, the greater the electrical conductivity produced, and the greater the voltage, the smaller the electrical conductivity produced.

Test Raman

Graphene synthesis in this study used Raman spectroscopy to determine the quality of graphene and the number of graphene layers in the sample. done with use long wave laser 532 nm. to find out the intensity value I_D / I_G and the average value of the crystallite size in the sample. As reference, sample GNS with roasting 220 ºC And pyrolysis 500 ºC samples were taken using the synthesis method.

Picture 4.1 Results testing Raman spectroscopy Sample GNS 220-500 °C

Based on the data from the Raman spectroscopy test results in the Raman Spectroscopy Test Results Graph



for GNS 220-500 °C Samples, it shows that GNS 220-500 ^{0}C has high intensity, with the peak intensity of the D band reaching 1351.93 And peak intensity band G reach 1582.98 . For ratio I_D/I_G GNS 220-500 °C only has a value of 0.8540 and the sample is indicated to be not yet in the form graphene pure or graphene quality Good Because No There is the emergence of the 2D band peak at Raman Shift 2600-2700 cm^{-1}. (honorisal) So that the sample is still in the form of graphene oxide with better GNS quality results at 220-500 °C because the ratio value of I_D/I_G which is larger and approaches the ratio value of 1.

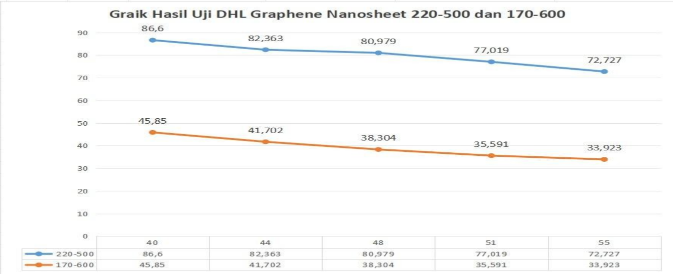
Analysis Power deliver electricity (DHL)

This DHL analysis was carried out using 5 voltage variations (Volts) to determine the ability and quality to conduct electricity from GNS 220-500 °C Analysis Power Send Electricity (DHL) from GNS 220-500 °C can seen in the Table.

Table 4.3 Conductivity GNS Electricity 220-500 °C

GNS 220-500 °C			
Voltage (V)	Current (μA)	Obstacle (R)	DHL (1/R) (μS/cm)
40	3464	0.011547344	86,600
44	3636	0.012101210	82,636
48	3887	0.012348855	80,979
51	3928	0.012983706	77,019
55	4000	0.01375	72,727

From the table data above, it shows that the DHL GNS 220-500 °C at a voltage of 44-55 V continues to decrease slowly and the average DHL GNS 220-500 °C is 341.77 μS/cm. However, the decrease ratio of DHL GNS 220-500 is not very significant. And more Good. Although more Good, will but GNS 220-500 °C It is not yet capable of controlling the mobility of electrons flowing when conducting electric current. The following is a graph of the electrical conductivity of GNS 220-500 °C and GNS 170-600 °C with 5 voltage variations.



Picture 4.5 chart Variation Power Send Electricity GNS 220-500 °C And GNS 170-600 °C

Based on the DHL variation graph above, it shows that GNS 220-500 °C has electrical conductivity that is still less good compared to GNS 170-600 °C. This is because GNS 220-500 °C has a larger surface area. And thermal conductivity Which lower compared to GNS 170-600 °C Quality Power deliver electricity will more Good If wide surface the contact area and its thermal conductivity are of high quality (Rikson)

CONCLUSION

The following conclusions can be drawn : In the SEM test of the pyrolysis results with a temperature of 170-600 °C magnification of 10,000x, 20,000x, 30,000x, 50,000x and 75,000x the morphology of graphene nanosheets (GNS) looks stacked and graphene has formed. At 75,000x magnification the graphene sample looks layered. From the results of the EDX test, the composition of carbon atoms in graphene nanosheets (GNS) is very dominant in graphene nanosheets (GNS). Synthesis of graphene nanosheets from coconut shells at a roasting temperature of 220°C and a pyrolysis temperature of 500°C with Raman testing, it can be concluded that the results of the sample GNS 220-500 °C Still shaped graphene oxide Which own a small carbon layer with an average ID/IG ratio of 0.8540. In the results of the electrical conductivity work test using voltage variations of 40V, 44V, 48V, 51V, 55V produce Power deliver electricity 42,925 (μS/cm) ,40.954(μS/cm), 36.875(μS/cm), 34.784(μS/cm), 33.290 (μS/cm) it is recognized that the electrical conductivity produced is greater with the voltage, and the smaller the voltage used, the smaller the electrical conductivity produced. Meanwhile ability Power deliver electricity (DHL) on sample GNS 220-500 °C is not yet capable enough to control the mobility of electrons flowing when conducting electric current because it has a low surface area and thermal conductivity, as evidenced by the highest value at a voltage of 40 V of 86.699, but at a voltage of 44-55 V it continues to decrease. Use method mixing material chemistry For get results Graphene more good is suggestion Which noticed for study furthermore.

REFERENCES

Agustina, L., & Putri, N. P. (2018). Analisis Band-Gap Reduced Graphene Oxide (rGO) Berbahan Dasar Tempurung Kelapa (Cocos nucifera L). Jurnal Inovasi Fisika Indonesia (IFI), 07, 59–62.

Balai, E. E., Kerajinan, B., & Batik, D. (2015). IDENTIFIKASI POLA LAMINASI

TEMPURUNG KELAPA Identification of Lamination Motif on Coconut Shell. Dinamika Kerajinan Dan Batik: Majalah Ilmiah, 32(2), 107116.

Candani, D., Ulfah, M., Noviana, W., & Zainul, R. (2018). A Review Pemanfaatan Teknologi Sonikasi. INA-Rxiv, 26, 1–9.

Hadi, A., Gafur, A., Udiantoro, & Mukhlis. (2015). Desain Instalasi Pirolisis Limbah Pertanian dalam Rangka Minimalisasi Emisi Gas Rumah Kaca di Lahan Basah. In Prosiding SNST ke-6 (pp. 207–215).

Hartini, L. (2014). 10630041.

Hidayat, A., Setiadji, S., & Hadisantoso, E. P. (2019). Sintesis Oksida Grafena Tereduksi (rGO) dari Arang Tempurung Kelapa (Cocos nucifera). Al-Kimiya, 5(2), 68–73. https://doi.org/10.15575/ak.v5i2.3810

Honorisal, M. B. P., Huda, N., Partuti, T., & Sholehah, A. (2020). Sintesis dan karakterisasi grafena oksida dari tempurung kelapa dengan metode sonikasi dan hidrotermal. Teknika: Jurnal Sains Dan Teknologi, 16(1), 1. https://doi.org/10.36055/tjst.v16i1.7519

Jamilatun, S., Setyawan, M., Salamah, S., Purnama, D. A. A., & Putri, R. U. M. (2015). Pembuatan Arang Aktif dari Tempurung Kelapa dengan Aktivasi Sebelum dan Sesudah Pirolisis. In Seminar Nasional Sains dan Teknologi (Issue 0258, pp. 1–8).

Julinawati, Marlina, Rosnani Nasution, & Sheilatina. (2015). Applying Sem-Edx Techniques To IdentifyTypes of Mineral of Jades (Giok) TakengoFying theon, Aceh. Jurnal Natural, 15(2), 45–48.

Kusumaningtyas, R. (2019). Karakterisasi FTIR dan SEM-EDX Arang Aktif Eceng Gondok Berdasarkan Variasi Suhu Karbonisasi.

Kusumattaqiin, F., Ramli, R., Kurnyawaty, N., Halik, A., & Hira, T. (2020). Analisa

Struktur Oksida Grafena Tereduksi. Dalton: Jurnal Pendidikan Kimia Dan Ilmu Kimia, 3(1), 32–41. https://doi.org/10.31602/dl.v3i1.3107

Nustini, Y., & Allwar. (2019). Pemanfaatan Limbah Tempurung Kelapa Menjadi Arang Tempurung Kelapa Dan Granu. Prosiding Seminar Nasional Mewujudkan Masyarakat Madani Dan Lestari, 9, 172–183.

Papageorgiou, D. G., Kinloch, I. A., & Young, R. J. (2017). Mechanical properties of graphene and graphene-based nanocomposites. Progress in Materials Science, 90, 75–127. https://doi.org/10.1016/j.pmatsci.2017.07.004

Putri, A., Arifin, Z., & Supardi, I. (2023). Sintesis Dan Karakterisasi Graphene Oxide (Go) Dari Bahan Alam. 12, 47–55.

Safitri, D. A., Susanti, D., & Nurdiansah, H. (2017). Analisis Pengaruh Doping Nitrogen Terhadap Sifat Kapasitif Superkapasitor Berbahan Graphene. Jurnal Teknik ITS, 6(1), 90–95. https://doi.org/10.12962/j23373539.v6i1.21409

Simanjuntak, R. R., Siburian, R., Sebayang, F., Hutagalung, F. Y. S. T., Aritonang,

S. P., & Simanjuntak, C. (2021). Performance of electrodes Mg/Graphene nanosheet (GNS) and Mg/N-Graphene nanosheet (N-GNS) as anode of battery. IOP Conference Series: Materials Science and Engineering, 1122(1), 012088. https://doi.org/10.1088/1757- 899x/1122/1/012088

Sujiono, E. H., Zabrian, D., Dahlan, M. Y., Amin, B. D., & Agus, J. (2020). Heliyon Limbah tempurung kelapa berbasis graphene oxide: sintesis dengan metode dan karakterisasi Hummers yang dimodifikasi. 6(November 2019).

Viridi, S., & Purba Asmara. (2019). Rancang Bangun Alat Pirolisis Sederhana Untuk Mengolah Limbah Plastik Polipropilena (PP) Menjadi Bahan Bakar Cair (BBC). Prosiding Snips 2018, 2(May), 116–122. https://www.researchgate.net/publication/333056738

Zhu, T., & Ertekin, E. (2016). Phonons, Localization, and Thermal Conductivity of Diamond Nanothreads and Amorphous Graphene. In Nano Letters (Vol. 16, Issue 8, pp. 4763–4772). https://doi.org/10.1021/acs.nanolett.6b00557