



Effect of the composition of carbon from coconut shell and paraffin on the performance of a carbon paste electrode for the detection of Pb(II)

Haadi Farros Habibi^{1,*}, Ratnawulan¹, Yenni Darvina¹, Riri Jonuarti¹

¹ Department of Physics, Universitas Negeri Padang, Padang 25131, Indonesia

Article History

Received : June, 27th 2025

Revised : August, 28th 2025

Accepted : Sept, 12th 2025

Published : Sept, 30th 2025

DOI:

<https://doi.org/10.24036/jeap.v3i3.117>

Corresponding Author

*Author Name: Haadi Farros Habibi

Email: haadifarros86@gmail.com

Abstract: This study examines the effects of the composition ratio of carbon paste electrodes made from coconut shell-derived carbon and evaluates their feasibility as working electrodes in the cyclic voltammetry method for measuring lead Pb(II) concentrations. In this study, measurements were performed on Pb(II) solutions using a working electrode composed of a carbon paste electrode derived from coconut shell charcoal. The sensitivity, repeatability, and linearity of the electrode were assessed in the measurement of Pb(II) by cyclic voltammetry. The objective of this study was to determine the optimal electrode composition for Pb(II) measurement using cyclic voltammetry. Three electrode composition ratios 6:4, 7:3, and 8:2 were tested to evaluate their effect on measurement sensitivity. The feasibility of carbon paste electrodes as working electrodes was also examined by testing different Pb(II) solution concentrations: 1 ppm, 2 ppm, 4 ppm, and 8 ppm. The results indicate that the composition of the carbon paste electrode significantly affects the measurement performance. The optimal composition, 8:2, yielded the highest peak anodic (I_{pa}) and cathodic (I_{pc}) currents compared to other compositions. Furthermore, carbon paste electrodes made from coconut shell charcoal demonstrated good repeatability and linearity, meeting established analytical standards. Therefore, these electrodes are considered suitable for use as working electrodes in electrochemical analysis.

Keywords: Carbon Paste Electrode, Coconut Shell, Heavy Metal Waste Pb(II), Cyclic Voltammetry.



Journal of Experimental and Applied Physics is an open access article licensed under a Creative Commons Attribution ShareAlike 4.0 International License which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. ©2024 by author.

1. Introduction

The use and utilization of metal raw materials can cause adverse effects, such as pollution caused by the large number of industries that use excessive amounts of metal raw materials, which certainly affects the quality of the environment. The impact of heavy metals can be said to be very

How to cite:

H.F. Habibi, Ratnawulan, Y. Darvina, R. Jonuarti, 2025, Effect of the composition of carbon from coconut shell and paraffin on the performance of a carbon paste electrode for the detection of Pb(II), *Journal of Experimental and Applied Physics*, Vol.3, No.3, page 38-50. <https://doi.org/10.24036/jeap.v3i3.117>

dangerous to humans. Heavy metals can cause poisoning and even death [1]. Lead metal Pb(II) is classified as a heavy metal. Pb compounds are among the most durable and difficult to break down. Exposure can occur through consumption of food, beverages, air, water, and dust that has been contaminated with lead compounds[2]. Abdominal cramps, stomach pain, constipation, nausea, vomiting, severe stomach pain, headache, confusion, difficulty thinking, difficulty speaking, and frequent fainting or coma, decreased IQ, difficulty reading and writing, hyperactivity and behavioral disorders, growth and visual and motor function disorders, hearing disorders, anemia, and damage to the liver, brain, liver, kidneys, nerves, and digestive system, lethargy, coma, seizures, or epilepsy may result from lead exposure[3]. Due to the negative impacts caused, various studies have been conducted to examine heavy metal levels in the environment. One of the most widely used methods is voltammetry. With its high selectivity, fast analysis time, and low operating costs. Stripping cyclic voltammetry is one of the methods used to measure heavy metal waste[4].

Voltammetry is a technique for analyzing samples by measuring the electric current that appears in an electrochemical cell when voltage is applied[5]. There are two steps in cyclic stripping voltammetry. The first step is the deposition process, during which chemical substances are electrolytically deposited on the electrode surface under constant potential conditions, forming an insoluble layer. The second step is the stripping process, during which the electrode potential is altered, causing the insoluble chemical layer on the electrode surface to be electrolytically released back into the solution at a specific potential[6]. Voltammetry result is voltammogram. A cyclic voltammetry system has four parts: an electrolysis cell, a potentiostat, a current-to-voltage converter, and a data acquisition system. The working electrode's potential changes over time, while the reference electrode stays the same. This produces a voltammogram. In voltammetry, there are three types of electrodes: the working electrode, the auxiliary electrode, and the reference electrode. Redox reactions or electron transfer occur at the working electrode[7].

Carbon paste electrodes are often used as working electrodes. Voltammetry is one of the strategies to analyze heavy metals. This method measures current as a function of potential. One important aspect of voltammetry is the use of working electrodes. Solid working electrodes are widely used because they are easier and cheaper to use[8]. Previous research conducted by M. R. Wachid & Setiarso (2014) on the use of carbon paste electrodes for metal analysis by cyclic stripping voltammetry stated that carbon paste electrodes work well in heavy metal analysis using the electrochemical voltammetry method[9]. Carbon paste electrodes have attracted much attention as sensor electrodes in electrochemical analysis. These electrodes can be easily made by mixing active carbon powder with liquid paraffin[10]. Activated carbon materials are often derived from coal, which has high economic value and is difficult to obtain. Therefore, organic materials have become an alternative source of activated carbon, offering more affordable prices and easier access. Agricultural byproducts, plastic waste, and paper can be used as carbon sources. By burning these materials into charcoal, they can then be processed through activation to convert the charcoal into activated carbon [11]. Organic materials that are abundant and easily found, such as coconut shells. According to research conducted by Nurfitria, N., et al (2019) Activated carbon made from coconut shells can be used as an adsorbent for Pb²⁺ metal ions in water samples. With activated carbon activated with 1 M KOH, the amount of Pb²⁺ metal ions absorbed was 86% of the initial concentration. From the research conducted on activated carbon from coconut shells, activated carbon from coconut shell charcoal can be used as a carbon source for carbon paste electrodes[12].

As mentioned earlier, carbon paste electrodes are made by combining carbon and paraffin as a binder. The composition of carbon and paraffin can affect conductivity, porosity, and performance for electrochemical analysis. The optimal ratio of carbon and paraffin determines how well the electrode can conduct electricity, which is very important for electron transfer in electrochemical processes. In previous research, Puspita & Noviandri (2021) made carbon paste electrodes with a graphite and paraffin composition with a weight ratio of 7:3, which were heated at a temperature of 70 degrees Celsius and stirred until homogeneous. The paste was then molded and connected with copper wire[13]. Research was also conducted by Irdhawati et al (2021). Carbon paste electrodes were made by mixing 100 mg of graphite with 35 μ L or 0.035 ml of liquid paraffin, ground until homogeneous, and molded[14].

Although the successful production of carbon paste electrodes (CPE) has been achieved by previous researchers, there is no standard composition for their production. The materials used are still too difficult to obtain, the price is fairly expensive, and the use of materials from non-renewable natural resources is a problem. The aim of this research is to make carbon paste electrodes (CPE) using basic, easily available materials and to study the influence of the composition of activated carbon and paraffin oil on the performance of carbon paste electrodes for detecting heavy metal waste lead.

2. Materials and Method

Research examines making carbon paste electrodes from coconut shells with ratios of 6:4, 7:3, 8:2, and conducting voltammetry tests to determine their performance in cyclic voltammetry electroanalysis with lead Pb(II) test solutions of 1 ppm, 2 ppm, 4 ppm, and 8 ppm.

Samples were dried in the sun for seven days, then carbonized at temperatures ranging from 400°C to 600°C in a horizontal furnace. The coconut shell was then transformed into coconut shell charcoal, ground into a powder, and sifted through a 120-mesh sieve to create fine powdered charcoal. Two methods can activate carbon: chemical with alkali hydroxides, carbonate salts, chlorides, sulfates, alkaline earth phosphates, and ZnCl_2 , and thermal with temperatures ranging from 800°C to 900°C. Activation is influenced by activation duration, temperature, particle size, ratio of activated material to total mass, and activation method[15].

the study used chemical activation using a KOH solution for carbon activation. Activated carbon is activated with water, carbon, and 1M KOH at a 1:1:4 ratio. The mixture was heated and stirred at 80°C for four hours. It was allowed to stand for 24 hours, after which a precipitate formed. The filtrate was discarded. The activated carbons were then physically activated in an oven at 110°C for four hours. Activated carbon was used to make carbon paste electrodes. This is the activation stage that was carried out in the previous study[12].

the electrodes are made from coconut shell charcoal and paraffin oil at ratios of 6:4, 7:3, and 8:2. This ratio is determined by comparing the weight of carbon and paraffin oil. For example, if the electrode is made with a weight of 10 g, a ratio of 6:4 means that 6 out of 10 of the electrode's weight is carbon and 4 out of 10 of the electrode's weight is paraffin oil. Then, the electrode body is inserted manually with a spatula to press and bond the carbon paste with copper wires. The electrode surface is rubbed until it is smooth, flat, and shiny.

Cyclic voltammetry testing is carried out using electrodes that have been made to obtain performance data from these electrodes. Cyclic Voltammetry (CV) is a technique that employs a

potentiostat to administer a voltage to a working electrode situated within an electrochemical cell, concurrently assessing the current that arises as a consequence. Research shows that optimal conditions for analyzing heavy metals are a 60-second deposition time, a -1.3 volts deposition potential, a 200 mV/second scanning speed, and a positive direction. The Pb peak potential at -0.4 V and pH 6 with a pH range between 4 and 7 is obtained.

in this study, we used a voltammetry cell with 20 mL of Pb(II) standard solution (1 ppm) and 20 mL of 100 ppm KCl solution. Then, we added 10 mL of pH 6 citrate buffer solution. We made current measurements at -1 V to 1 V, 60 seconds, and 20 mV/second. We compared the voltammograms to find the best carbon paste electrode composition. We determined the repeatability of the electrodes by measuring them repeatedly. The data obtained was a voltammogram of the applied potential curve versus peak current. We made repeatability measurements on a voltammetric cell with 20 mL of Pb(II) standard solution (1 ppm) and 20 mL of 100 ppm KCl solution and 10 mL of pH 6 acetate buffer solution. We performed repeated measurements on the electrode under optimum conditions. We compared the voltammograms obtained by the potential curve applied to the peak current. We found the linearity of the measurement by making a calibration curve. We measured 20 mL of Pb(II) standard series solution (1 ppm, 2 ppm, 4 ppm, and 8 ppm) using a voltammetric method. We added 20 mL of KCl solution (100 ppm) and 20 mL of acetate buffer solution (pH 6). We took measurements with the optimum condition. We compared the voltammograms obtained by the potential curve applied to the peak current. We obtained a voltagram of the standard solution curve and determined the absorption value of lead in the test.

Furthermore, it is necessary to analyze the data by comparing the data in the form of voltammogram graphs and statistical calculations and reporting the results so that it can be seen how the performance of carbon paste electrodes as working electrodes in the voltammetry system. In a voltamogram, there are important variables, namely the cathodic potential peak (E_{pc}), the anodic potential peak (E_{pa}), the cathodic current peak (I_{pc}), and the anodic current peak (I_{pa}) [5]. The peak (I_{pa}/I_{pc}) then calculated using the equation $\text{Current 1 minus Current 2}$, where Current 1 is highest value at peak current and Current 2 is lowest value at peak current.

3. Results and Discussion

3.1. Best Electrode Composition

The test was conducted using the cyclic voltammetry method with a carbon paste electrode serving as the working electrode, Optimum Measurement Conditions and the test solution was a lead solution with a concentration of 1 PPM. The following figures present the voltammograms of the test results for carbon paste electrodes derived from coconut shell charcoal, with variations in electrode composition of 6:4, 7:3, and 8:2, as indicated in Figures 1, Figures 2 and Figures 3.

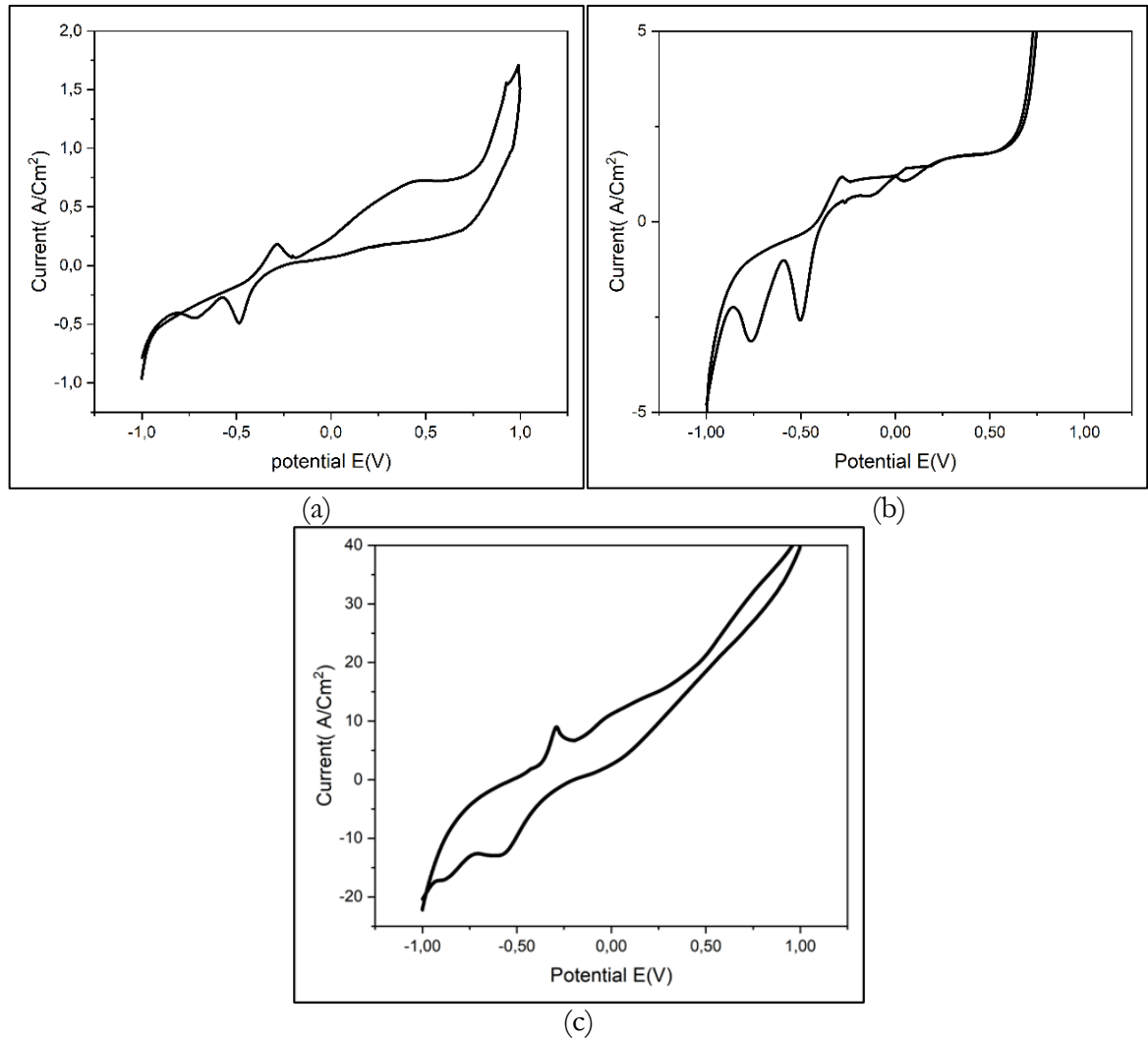


Figure 1. Voltamogram of Cyclic Voltammetry Test Results with Coconut Shell Charcoal CPE on Lead Pb(II) Solution. (a) composition 6:4 (b) composition 7:3 (c) composition 8:2

The ability of carbon paste electrode for lead(II) analysis by cyclic voltammetry was determined by determining the best composition of the electrode by making variations in electrode composition. The data obtained were voltammograms of applied potential versus peak current curves for each composition variation. The composition of the carbon paste electrode is said to be the best if the composition provides high sensitivity as indicated by the high peak current in the voltammogram. The peak (I_{pa}/I_{pc}) then calculated using the equation $\text{Current 1} - \text{Current 2}$, where Current 1 is highest value at peak current and Current 2 is lowest value at peak current. The voltammograms, which were obtained by measuring the variations in electrode composition on a standard solution of Pb(II) 1 ppm, demonstrate that all electrodes exhibit current peaks in the measurements. However, the peaks observed in the carbon paste electrodes, which exhibited variations in the ratio of carbon to paraffin (7:3), were less pronounced. In contrast, electrodes with variations in the ratio of 6:4 and 8:2 demonstrated a more pronounced peak current. The peak current value of each electrode variation was obtained based on the voltammogram of the cyclic voltammetry test results on carbon paste electrodes derived from coconut shell charcoal. The following section presents the data obtained from the testing of carbon paste electrodes derived

from coconut shell charcoal, with variations in electrode composition (6:4, 7:3, and 8:2) as show in Table 1.

Table 1. Cyclic Voltammetry Test Results Data with Variations of Coconut Shell Charcoal CPE on Lead Pb(II) Solution.

Electrode Variation	Current(A/Cm^2)		Ipa (A/Cm^2)	Epa (V)	Current(A/Cm^2)		Ipc (A/Cm^2)	Epc (V)
	Current 1	Current 2			Current 1	Current 2		
6:4	0.182	0.069	0.114	-0,283	-0.490	-0.282	-0.208	-0,486
7:3	1.170	1.040	0.128	-0,279	-2.590	-1.090	-1.500	-0,503
8:2	8.980	6.680	2.300	-0,292	-12.500	-13.000	0.479	-0,561

Based on Table 1, it can be seen that the composition of carbon paste electrodes produces different peak current values and electrode variation ratio 8: 2 has a higher value in the anodic reaction and cathodic reaction. The composition of carbon paste electrodes is influenced by the amount of liquid paraffin mixed, because too much paraffin oil will make the paste too liquid. The dominant paraffin weight in the CPE composition inhibits current flow on the electrode surface. This causes the peak current response in the oxidized region to decrease during measurement [16]. Based on the data analysis that has been carried out, the composition of carbon paste electrodes in this study obtained electrodes with a composition ratio of 8:2 to be the electrode with the best composition. This is because the 8:2 electrode has more carbon than electrodes with other compositions. This means that electrodes with more carbon allow more Pb ions to attach, enabling greater anodic and cathodic reactions, resulting in more sensitive readings of Pb ions.

3.2. Electrode Repeatability

Cyclic voltammetry testing with repetition aims to determine how the repeatability of carbon paste electrodes in the test. This also determines the performance of the carbon paste electrode so that the electrode can be used for the measurement of Pb(II) lead values. Measurement repeatability is a precision test that indicates the degree of agreement between individual test results, measured by the variation of individual results from the mean when a procedure is repeated[15]. Repeatability measured by measuring the current generated in repeated measurements. Where is the concentration of the analyte in kg. Measurement repeatability is calculated using Ratio HorRat. The Horwitz Ratio is obtained from the quotient of CV with CVHorwitz [17]. The acceptable Horwitz Ratio value for measurement repeatability is < 2 [9]. The standard deviation (SD), relative standard deviation (RSD), coefficient of variation (CV), the predicted CV according to Horwitz and Ratio HorRat of the multiple replicates are then calculated using the following equation[18].

$$SD = \sqrt{\sum \frac{(x - \bar{x})^2}{(n - 1)}} \quad (1)$$

$$RSD = \frac{SD}{\bar{x}} \quad (2)$$

$$CV = RSD \times 100\% \quad (3)$$

$$CV_{Horwitz} = 2^{1-(0,5\log C)} \quad (4)$$

$$HorRat = \frac{cv}{CV_{Horwitz}} \quad (5)$$

The test was conducted using the cyclic voltammetry method with a carbon paste electrode serving as the working electrode, Optimum Measurement Conditions and the test solution was a lead solution with a concentration of 1 PPM. The following figures present the voltammograms of the test results for carbon paste electrodes derived from coconut shell charcoal. The following is a voltammogram of the test results of carbon paste electrodes from coconut shell charcoal with variations in electrode composition, namely 6: 4 as shown in Figure 2.

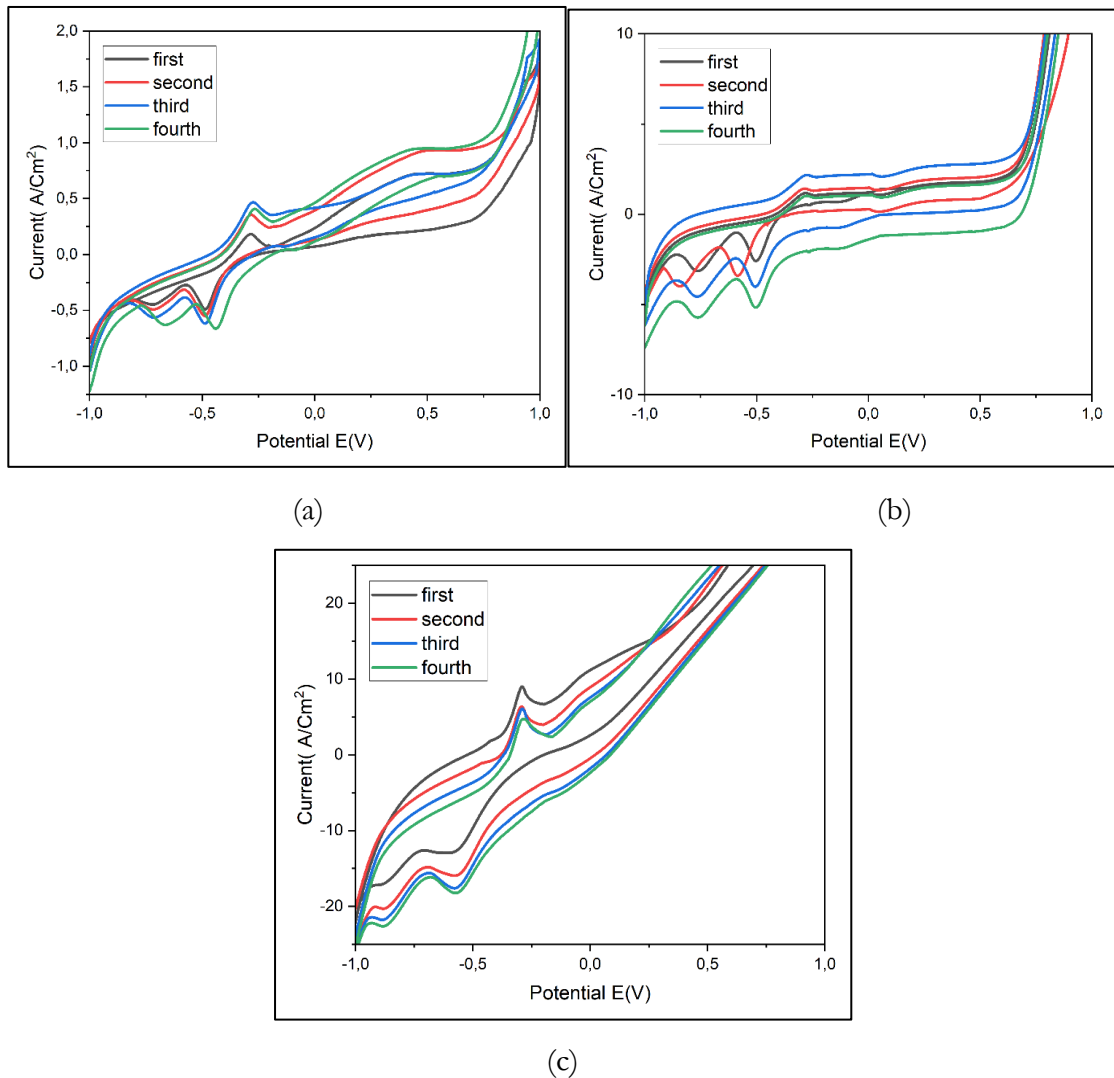


Figure 2. Voltammogram of Cyclic Voltammetry Test Results of Coconut Shell Charcoal CPE with repetition in Pb(II) Lead Solution (a) composition 6:4 (b) composition 7:3 (c) composition 8:2

From the graph shown in Figure 2, it can be seen that the carbon paste electrode with a 6:4, 7:3, 8:2 ratio variation has a similar peak point and shape. It can be concluded that the electrode has a peak current that tends to be stable. Based on the voltamogram of cyclic voltammetry test results on carbon paste electrodes from coconut shell charcoal composition 6: 4, 7:3, 8:2 with repetition, the peak current value of each repetition is obtained. The result data can be seen for composition 6: 4 in table 2, for composition 7:3 in table 3, for composition 8:2 in Table 4.

Table 2. Cyclic Voltammetry Test Result Data of CPE Coconut Shell Charcoal Composition 6:4 with Repetition on Lead Pb(II) Solution

no	Current (A/Cm^2)		Ipa (A/Cm^2)	Epa (V)	Current (A/Cm^2)		Ipc (A/Cm^2)	Epa (V)
	Current 1	Current 2			Current 1	Current 2		
1	0.182	0.069	0.114	-0,283	-0.490	-0.283	-0.207	-0,486
2	0.355	0.240	0.115	-0,282	-0.549	-0.315	-0.234	-0,487
3	0.467	0.353	0.114	-0,273	-0.617	-0.385	-0.232	-0,487
4	0.225	0.111	0.114	-0,267	-0.663	-0.444	-0.219	-0,439

From the repetition data table for the variation of carbon paste electrodes from coconut shell charcoal, the average peak current value generated for CPE 6: 4. With this data can be processed and obtained the average for electrode repetition in anodic reactions with variations in electrode composition 6: 4 which is $0.114 A/Cm^2$. In the cathodic reaction, the average Ipc value is $-0.223 A/Cm^2$. From the data, the standard deviation and relative standard deviation can be determined. sd, rsd and cv of 0.001, 0.005 and 0.5% in the anodic reaction and in the cathodic reaction of 0.013, -0.057 and 5.7%. where the horwitz ratio value for electrode composition is 6:4 for anodic reaction of 0.031, cathodic reaction of 0.356.

Table 3. Cyclic Voltammetry Test Result Data of CPE Coconut Shell Charcoal Composition 7:3 with Repetition on Lead Pb(II) Solution

no	Current (A/Cm^2)		Ipa (A/Cm^2)	Epa (V)	Current (A/Cm^2)		Ipc (A/Cm^2)	Epa (V)
	Current 1	Current 2			Current 1	Current 2		
1	1.172	1.044	0.128	-0,279	-2.589	-1.015	-1.574	-0,503
2	1.421	1.298	0.123	-0,283	-3.405	-1.839	-1.566	-0,584
3	2.178	2.052	0.125	-0,273	-4.015	-2.441	-1.574	-0,506
4	1.021	0.896	0.125	-0,274	-5.172	-3.598	-1.574	-0,504

From the repetition data table for the variation of carbon paste electrodes from coconut shell charcoal, the average peak current value produced for CPE 7: 3 for anodic reactions is $0.125 A/Cm^2$. In the cathodic reaction, the average Ipc value is $-1.572 A/Cm^2$. The results of data processing for CPE with a composition of 7: 3 get sd, rsd and cv values of 0.002, 0.018 and 1.8% in the anodic reaction and in the cathodic reaction 0.004, -0.003 and 0.3%. The horwitz ratio value for the 7: 3 ratio electrode obtained a value of 0.113 for the anodic reaction and 0.019 for the cathodic reaction. And for 8: 2 ratio electrode in table 4. From the repetition data table for the variation of carbon paste electrode from coconut shell charcoal, the average peak value of current generated for CPE 8: 2 for anodic reaction is $2.337 A/Cm^2$. In the cathodic reaction, The average

I_{pc} value is obtained -1.275 A/Cm^2 . From table 5, it can be the results of data processing for CPE with a composition of 8: 2 get sd, rsd and cv values of 0.044, 0.019 and 1.9% on anodic reactions and on cathodic reactions 0.952, -0.746 and 74.6%. The calculation of the Horwitz CV value and horrat ratio can be found. The horwitz ratio value, In the electrode with a composition of 8: 2, it is 0.119 in the anodic reaction and 4.644 in the cathodic reaction.

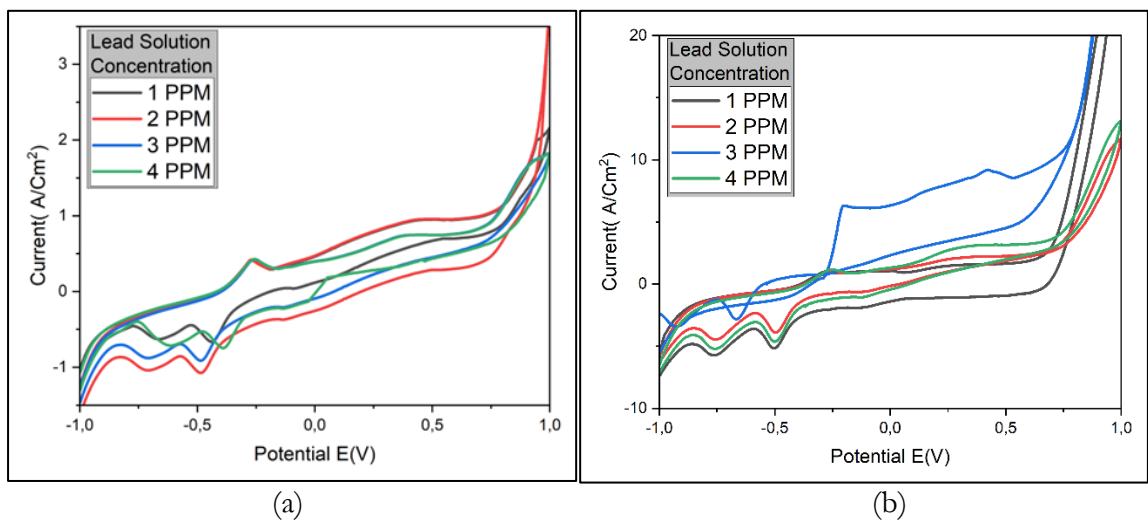
Table 4. Cyclic Voltammetry Test Result Data of CPE Coconut Shell Charcoal Composition 8:2 with Repetition on Lead Pb(II) Solution

no	Current (A/Cm^2)		I_{pa} (A/Cm^2)	E_{pa} (V)	Current (A/Cm^2)		I_{pc} (A/Cm^2)	E_{pa} (V)
	Current 1	Current 2			Current 1	Current 2		
1	8.985	6.685	2.300	-0,292	-12.677	-12.616	-0.061	-0,570
2	7.134	4.754	2.380	-0,293	-15.830	-14.856	-0.974	-0,561
3	5.832	3.462	2.370	-0,29	-17.611	-15.624	-1.987	-0,580
4	5.482	3.184	2.298	-0,289	-18.256	-16.178	-2.078	-0,574

Based on the % RSD value in this study obtained small than 2%, the Horwitz Coefficient of Variation (CV Horwitz) equation is used according to [10], as a condition of acceptance. It can be concluded that the repeatability of the method in this study is still in a good category because the Horwitz Ratio value is less than 2. The acceptable Horwitz Ratio value for measurement repeatability is < 2 [8]. With this, the carbon paste electrode with coconut shell charcoal a 6:4, 7:3 and 8:2 ratio variation can be declared to have good performance in testing with cyclic voltammetry on lead pb(II) solution.

3.3. Electrode Linearity

The results of the cyclic voltammetry test, conducted using an CPE Coconut Shell Charcoal composition of 6:4, 7:3 and 8:2 with a variation of lead solution concentration Pb(II), are presented in Figure 4.



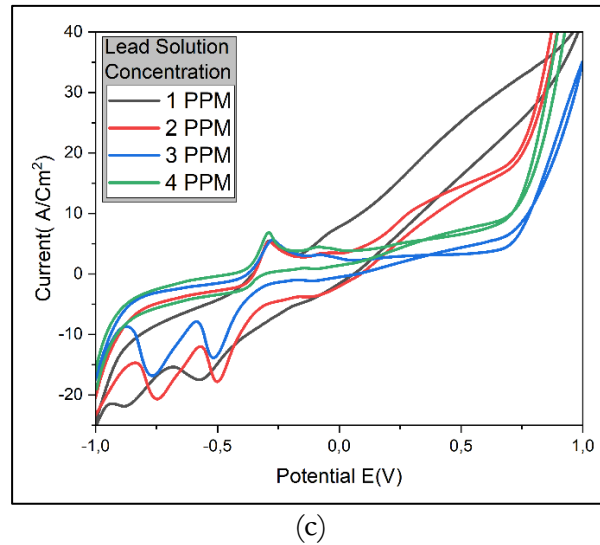


Figure 3. Voltamogram of Cyclic Voltammetry Test Results of Coconut Shell Charcoal CPE with Variation of Lead Solution Concentration of Pb(II), (a) 6:4 Composition (b) 7:3 Composition (c) 8:2 Composition

Based on the data table 5 and graph in Figure 3, it can be seen that the current peak in the anodic 6:4 composition reaction in pb(II) solution with concentrations of 1, 2, 4, 8 ppm has a similar shape and peak, it can be concluded that measurements using carbon paste electrodes with a composition of 6:4 tend to be stable in anodic reactions. For the 7:3 electrode, shows that the current peak in the pb(II) solution with a concentration of 1, 2, 8 ppm has a peak current shape and a similar graph but for measurements at a solution concentration of 4 ppm the peak shape and graph are very different. The current peak on the graph also looks unclear. This is due to the carbon paste electrode from coconut shell has low conductivity. For the 8:2 electrode, It can be seen that the peak current in the pb(II) solution with a concentration of 1, 2, 4, 8 ppm in the anodic reaction has a peak current shape and a similar graph but has a different graph shape. For cathodic recitation of the peak current shape measurements can be said to be very different for each concentration of pb(II) solution.

Table 5. Cyclic Voltammetry Test Result Data of CPE Coconut Shell Charcoal with Variation Concentration Lead Pb(II) Solution

Electrode Composition	Concentration (PPM)	Current (A/Cm^2)		Ipa (A/Cm^2)	Epa (V)
		Current 1	Current 2		
6:4	1	0,408	0,294	0,114	-0,267
	2	0,419	0,302	0,118	-0,274
	4	0,427	0,303	0,123	-0,254
	8	0,430	0,301	0,128	-0,258
7:3	1	1,021	0,896	0,125	-0,274
	2	1,042	0,879	0,163	-0,255
	4	1,060	0,856	0,204	-0,202
	8	1,021	0,896	0,125	-0,274
8:2	1	5,482	3,182	2,300	-0,289
	2	5,334	2,846	2,488	-0,289
	4	5,627	3,000	2,627	-0,274
	8	6,851	3,804	3,047	-0,289

Measurement at a solution concentration of 1 ppm cathodic peak shape produced is not clear for a concentration of 2 ppm is not found cathodic peak and at a concentration of 4 and 8 ppm has the same shape. Based on the voltammogram of the results of cyclic voltammetry testing on carbon paste electrodes from coconut shell charcoal composition 6: 4 with varying concentrations of lead solution pb (II) obtained peak current values for solutions with concentrations of 1, 2, 4, 8 ppm. With this data, the graph for linearity is obtained in Figure 4.

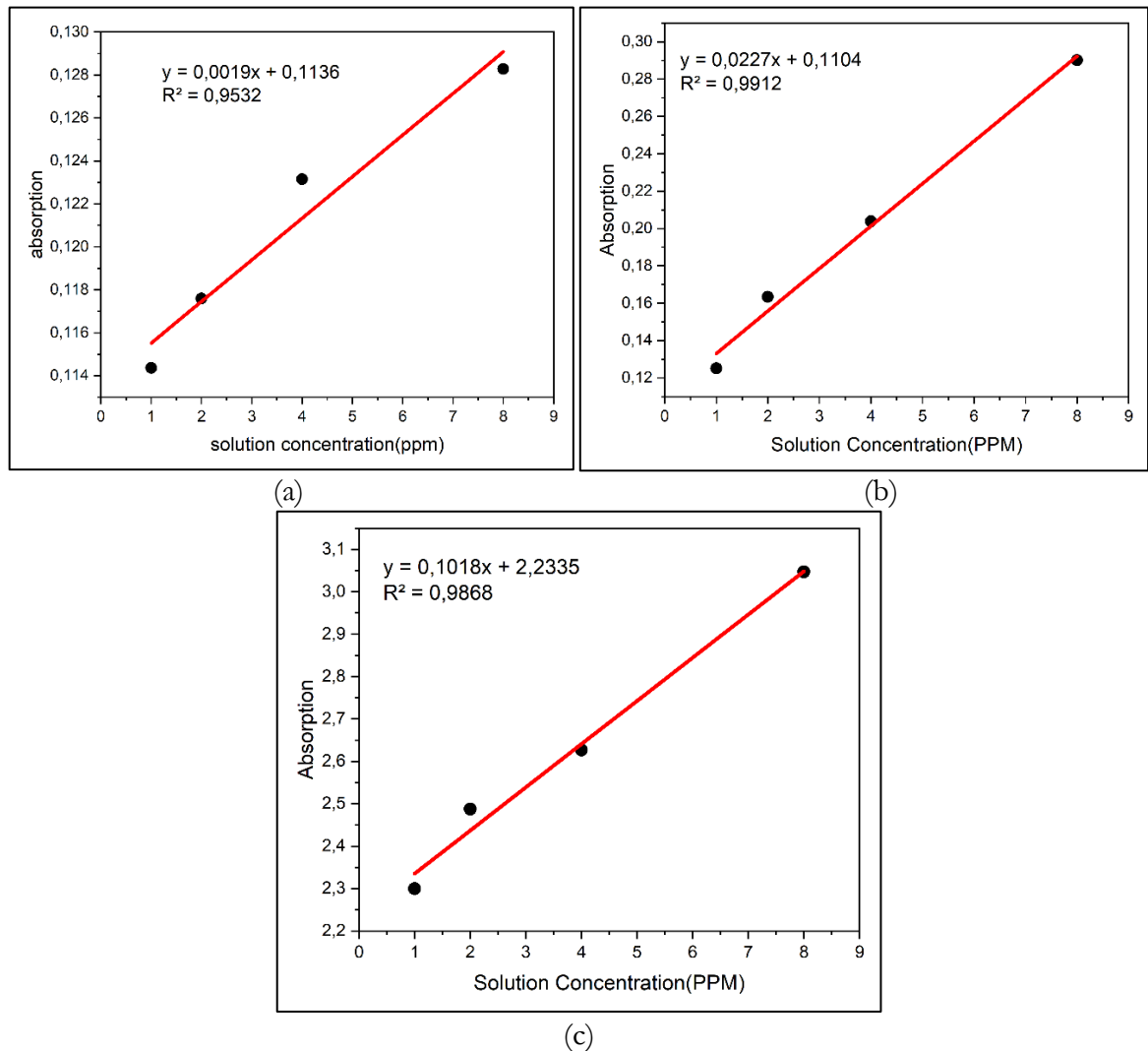


Figure 6. Linear graph of (a) 6:4 carbon paste electrode, (b) 7:3 carbon paste electrode, (c) 8:2 carbon paste electrode.

Viewed from the graph in Figure 4, obtained values for the y equation and linear regression (R^2) were obtained, for 6:4 electrode namely $y = 0,0019x + 0,1136$ dan $R^2 = 0,9532$. For 7:3 electrode namely $y = 0,0227x + 0,1104$ dan $R^2 = 0,9912$. For 8:2 electrode namely $y = 0,1018x + 2,2335$ and $R^2 = 0,9868$. The graph shows the relationship between peak current and concentration which states that the higher the concentration from 1 ppm to 8 ppm, the greater the peak current produced. This is because the higher the concentration, the more ions accumulate on the electrode surface so that the current generated is also higher. Based on the analysis obtained linearity relationship graph can be seen in Figure 4 shows the relationship between the peak current with concentration, it can be seen that the greater the concentration in the pb(II) solution, the peak

current value obtained is also higher. This is in accordance with research conducted[19]. Which states that the higher the concentration, the greater the peak current produced. This is due to the fact that the higher the concentration, the higher the current produced because more ions accumulate on the electrode surface. With the value (R^2) obtained from each electrode based on the opinion of Nurdin, Muhammad et al (2020) which states that the level of correlation value R with a range of 0.80-1.0 has a very strong linearity relationship. With this, the carbon paste electrode with coconut shell charcoal can be declared to have good performance in testing with cyclic voltammetry on pb(II) lead solution[20].

4. Conclusion

Based on the research that has been carried out, The optimal composition of activated carbon and paraffin oil on carbon paste electrodes in this study is an electrode with a composition ratio of 8:2, resulting in the highest current peak and exhibiting anode and cathode current peaks. The value of I_{pa} was 0.994 A/Cm^2 , while I_{pc} was 1.9512 A/Cm^2 , this is because the 8:2 electrode has more carbon than electrodes with other compositions. The dominant paraffin weight in the CPE composition inhibits current flow on the electrode surface. That indicating stable electrode repeatability and good linearity, which produced good graphs in cyclic voltammetry testing. Then, based on the analysis carbon paste electrode using carbon from coconut shell charcoal on the value of repeatability and linearity, the performance of the electrode meets the standardization and can be used in testing lead pb(II) solution by cyclic voltammetry method.

References

- [1] Widowati and dkk, *Efek Toksik Logam*. . Yogyakarta: C.V ANDI OFFSET, 2008.
- [2] A. Rohmaniyah, S. Jurusan, K. Fmipa, F. Matematika, D. Ilmu, and P. Alam, "Penggunaan Bentonit Sebagai Modifier Elektroda Pasta Karbon Untuk Analisis Pb 2+ Pada Daging Kupang Putih (Corbula Faba Hinds) Secara Diferensial Pulsa," 2014.
- [3] ATSDR, "Agency for Toxic Substances and Disease Registry. Departemen of Health Service and Human Service," *Public Health Service, division of Toxicologi and Environmental Medicine*, 2007.
- [4] Ginting and Ir. Perdana, *Sistem Pengelolaan Lingkungan Dan Limbah Industri*. . Yrama Widya.Bandung, 2007.
- [5] D. Skoog, T. Holler, and F. Nieman, *Principles of Instrumental Analysis*, 5th ed. Philadelphia: Harcourt Brace, 1998.
- [6] Winda Raidah, Rusnadi, and Prim Setiarso, "Pembuatan Elektroda Nano Karbon Untuk Analisis Logam Pb(Ii) Secara Siklik Voltametri," 2020.
- [7] K. S.P, *Voltammetric Techniques in Handbook of Instrumental Techniques for Analytical Chemistry*. Upper Saddle River, NJ. : F.A. Settle (Ed.) Prentice Hall PTR, 1997.
- [8] E. Putri and P. Setiarso, "Sintesis dan Karakterisasi Graphene Oxide-Nanozeolit Sebagai Elektroda Kerja Dalam Siklik Voltametri," *UNESA Journal of Chemistry*, vol. 9, no. 1, pp. 64–70, 2020.
- [9] M. R. Wachid and P. Setiarso, "Pembuatan Elektroda Pasta Karbon Termodifikasi Bentonit untuk Analisis Logam Tembaga (Ii) Dengan Ion Pengganggu Timbal (Ii) dan Merkuri (Ii) Secara Cyclic Voltammetry Stripping," *UNESA Journal of Chemistry*, vol. 3, no. 3, 2014.

- [10] Z. N. Habibah and P. Setiarso, "Pembuatan Elektroda Pasta Karbon Termodifikasi Bentonit untuk Analisis Ni(II) pada Kerang Darah (*Anadara Granosa*) Secara Voltametri Siklik," *UNESA Journal of Chemistry*, vol. 5, no. 2, 2016.
- [11] Lempang and Mody, "Pembuatan Dan Kegunaan Arang Aktif," *Balai Penelitian Kebutuhan Makassar*, vol. 11, 2014.
- [12] N. Nurfitriya *et al.*, "Pengaruh Konsentrasi Aktivator Kalium Hidroksida (KOH) pada Karbon Aktif dan Waktu Kontak Terhadap Daya Adsorpsi Logam Pb dalam Sampel Air Kawasan Mangrove Wonorejo, Surabaya," *Akta Kimia Indonesia*, vol. 4, no. 1, p. 75, May 2019, doi: 10.12962/j25493736.v4i1.5071.
- [13] F. Puspita and I. Noviani, "Optimasi Pembuatan Elektroda Pasta Karbon Termodifikasi Poli(Metil Jingga) untuk Penentuan Bisphenol A Secara Voltametri," *Warta AKAB*, vol. 45, no. 1, pp. 14–20, 2021.
- [14] I. Irdhawati, N. K. N. Titasia, and E. Sahara, "Voltametri Pelucutan Anodik Menggunakan Elektroda Pasta Karbon Termodifikasi Bentonit untuk Penentuan Kadar Ion Cd(II) dalam Sayur Sawi Putih," *Jurnal Riset Kimia*, vol. 12, no. 2, Sep. 2021, doi: 10.25077/jrk.v12i2.417.
- [15] Singgih Hartanto dan Ratnawati, "Pembuatan Karbon Aktif dari Tempurung Kelapa Sawit dengan Metode Aktivasi Kimia," *Jurnal Sains Materi Indonesia*, vol. Vol.12, No. 1, pp. 12–16, 2010.
- [16] M. B. P. Honoris, N. Huda, T. Partuti, and A. Sholehah, "Sintesis dan karakterisasi grafena oksida dari tempurung kelapa dengan metode sonikasi dan hidrotermal," *Teknika: Jurnal Sains dan Teknologi*, vol. 16, no. 1, p. 1, Jun. 2020, doi: 10.36055/tjst.v16i1.7519.
- [17] Y. Bow and I. Hajar, "Penentuan Logam Berat Secara Anodic Stripping Voltammetry Menggunakan Elektroda Grafit Pensil," vol. 27, 2015.
- [18] D. B. Hibbert and J. J. Gooding, *Data Analysis for Chemistry : An Introduction Guide for Students and Laboratory Scientist*. New York : Oxford University Press, 2006.
- [19] I. Irdhawati, H. Suyanto, and P. Y. Andani, "Zeolite-Modified Carbon Paste Electrode For Determination Of Copper Using Anodic Stripping Voltammetry Method," *Jurnal Penelitian Kimia*, vol. 13, no. 1, p. 1, Apr. 2017, doi: 10.20961/alchemy.v13i1.1808.
- [20] Muhammad Nurdin, Maulidiah, and La Ode Agus Salim, "Nanopartikel TiO₂ Nanopartikel TiO₂ 2 2 (Epk-TiO₂ (Epk-TiO₂ 2 2) Untuk Penentuan Pestisida) Untuk Penentuan Pestisida Sipermetrin Secara Voltametri Sipermetrin Secara Voltametri," *Jurnal Kimia Mulawarman*, 2020.