YAYASAN AKRAB PEKANBARU
Akrab Juara : Jurnal Ilmu-ilmu Sosial
Volume 10 Nomor 1 Edisi Februari 2025 (1-7)
https://doi.org/10.58487/akrabjuara.v10i1

1

OPTIMIZATION OF THE TWO POINT PROBE METHOD FOR THE CHARACTERIZATION OF PHOTOELECTRIC PROPERTIES OF MATERIALS

Boisandi, Nurussaniah
P. MIPA & Teknologi IKIP PGRI Pontianak Kalimantan Barat
(Naskah diterima 1 Januari 2025, disetujui 28 Januari 2025)

Abstract

This research aims to obtain the electrical characteristics and photoelectric material measured by two point probe method using I-V measurement and to know the photoconductivity of the material measured by two point probe method with the multimeter circuit. Research using experimental method. The activities of research on the design of electrical characterization tools with two point probe method and optimization. Electrical characterization testing is carried out with material conductivity characteristics and compares it with a Elkahfi I-V meter as standar measurement. This result of research can be concluded that two point probe method with multimeter can be used to measure the conductivity and photoconductivity of the material. The results of conductivity measurement of ethanol as test solution using two point probe method is.
Keywords: *Conductivity; photoconductivity; Two point probe methode*

Abstrak

Tujuan penelitian ini adalah mengetahui karakteristik listrik dan fotolistrik material yang diukur dengan metode *two point probe* menggunakan pengukuran I-V dan mengetahui fotokonduktivitas material yang diukur denganmetode *two point probe* dengan rangkaian. Penelitian menggunakan metode eksperimen. Kegiatan penelitian pada perancangan alat karakterisasi listrik dengan metode *two point probe* dan optimasinya. Pengujian alat karakterisasi listrik dilakukan dengan karakteristik konduktivitas material dan membandingkannya dengan alat ukur standar yaitu Elkahfi I-V meter. Berdasarkan hasil penelitian dapat disimpulkan bahwa metode *two point probe* dengan multimeter dapat digunakan untuk mengukur konduktivitas dan foto konduktivitas material. Adapun hasil pengukuran konduktivitas etanol sebagai larutan uji menggunakan metode two point probe adalah $7 \times 10^{-3}\,\Omega^{-1}$.
Kata kunci: Konduktivitas; Foto konduktivitas; Metode *two point probe.*

I. INTRODUCTION

Characterization of the electrical properties of materials can be done by the Two Point Probe method. If a potential difference is given at the ends of a material, there will be an electric current flowing through the material. The amount of electric current flowing depends on a quantity called electrical resistance (R). Resistance is the ratio between the

voltage applied to the material (V) and the flow of electrical current generated (I). In other words, resistance indicates the ability of a material to resist an electric current.

Conductivity is a measure of how strongly a material can conduct electricity. For example, in liquids, the value of conductivity is a measure of the total concentration of electrolytes in the solvent. The ability of a solute to conduct an electric current is called electrical conductivity which is defined as the conductivity of one gram equivalent of a solute between two electrodes with a distance of 1 cm from the two electrodes (Supandi, 2011).

Conductivity can be used as an indicator of the electrical properties of a material. Various applications in the field of physics require material conductivity data, for example in the fields of materials physics and electronics. Determination of the conductivity properties of materials can help researchers to uncover the electrical properties of various materials. Conductivity characterization can be done with electrical characterization tools such as Elkahfi and Keithley. Thus the voltage current (I-V) graph will be displayed on the monitor and the conductivity of the material can be determined.

II. THEORETICAL STUDIES

Michael Faraday proposed the definition of electrodes, which are conductors used to come into contact with non-metallic parts or media of a circuit (e.g. semiconductors, electrolytes or vacuums). The two-point probe method can be used to determine the current and voltage of a material. The advantages of the two-point probe method are easy measurement techniques and inexpensive equipment. The working principle of the two point probe method is that the electric current is flowed to the electrode with a certain distance and area which is then measured by the current and voltage produced.

The limitations faced by some laboratories are the availability of inadequate karkar-terized equipment. In fact, there are still many who do not have electrical characterization tools. Therefore, this study aims to design an electrical characterization tool with the two-point probe method and its optimization. This research is expected to be a solution in an effort to overcome the limitations of laboratory equipment, especially in the field of Physics of Materials and Electronics. A common problem that arises regarding the optimization of the two-point probe method as a tool for characterizing the electrical properties (conductivity) of materials with the two-point probe method. The sub-problems include (1) How are the conductivity characteristics of materials measured by the two-point probe method using I-V measurements. (2) What are the characteristics of the conductivity of the material measured by the two-point probe method with a circuit. The

objectives of this study are: (1) To find out the characteristics of material conductivity measured.

III. RESEARCH METHODS

The research was conducted in the physics laboratory of the Faculty of Mathematics and Natural Sciences & Technology IKIP PGRI Pontianak. The research was carried out from March to October 2017. The research uses experimental methods. Research activities on the design of electrical characterization tools using the two-point probe method and its optimization. The test of the electrical characterization tool was carried out with the characteristics of the conductivity of the material and compared with the standard measuring instrument, namely the Elkahfi I-V meter. The research limited the test material as the standard, namely ethanol solutions obtained from Sigma Alderich. As a comparison, the results of conductivity measurement in this study were used using Elkahfi I-V cashew.

A. Research Diagram

The research activities are presented in the research diagram of Figure 1.

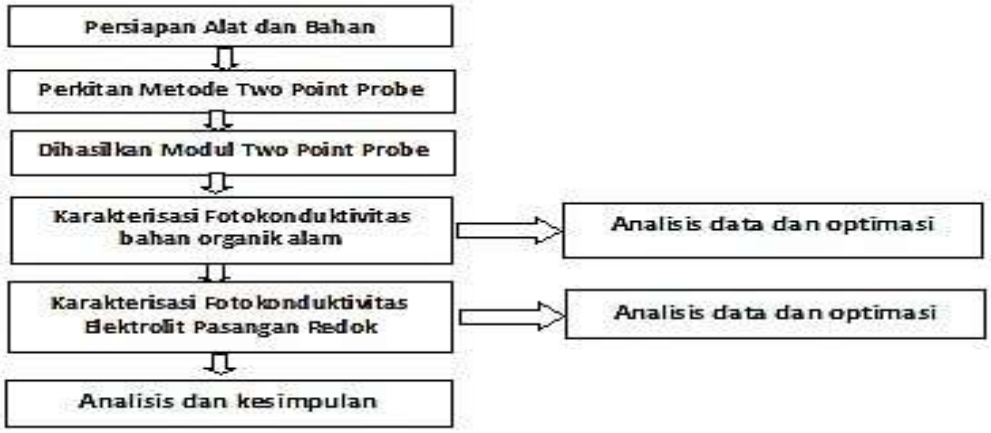

Figure 1 Flow chart of Two Point Probe Method Optimization Research. The research flow chart Figure 1 is described as follows:

1. Preparation of tools and materials

The preparation of the research includes the preparation of tools and materials, especially the components of the test kit series to be assembled as shown in Figure 3.2. The components that make up the two-point probe method consist of:

a. Power supply 1 piece
b. Connecting cable
c. Copper electrodes
d. Two multimeters Lux Meter
e. Light source intensity 100 mW/cm2

2. Ethanol test solution

Two Point Probe Method Assembly

The measurement scheme with the Two Point Probe method is shown in Figure 3.2.

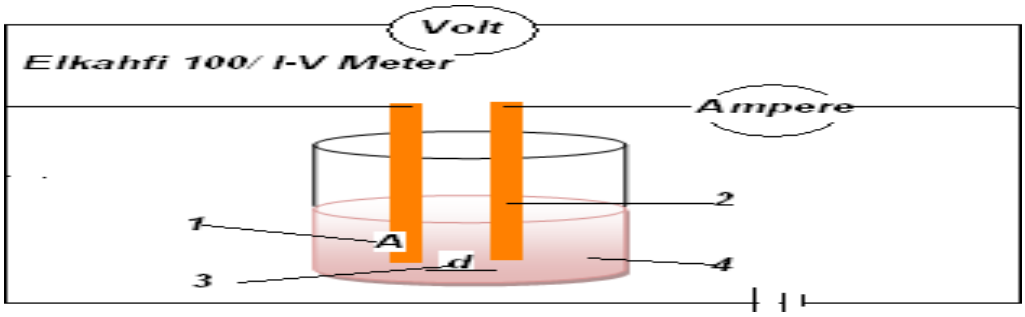

Figure 2 Measurement scheme of the Two Point Probe method using two electrodes and two multimeters.

The measurement scheme is described as follows: (1) and (2) are copper electrodes with an area / (/), (3) the distance between the electrodes (/), and (4) the solution will be measured at a large current and voltage using two multimeters.

3. Electrical Characterization (Photoconductivity)

This research is in the form of optimization of the two point probe method for the characteristics of the photoconductivity properties of organic and inorganic materials which are then compared with the photoconductivity of standard materials. The electrical properties of organic and inorganic probes can be determined using the two-point probe method, namely by conducting current on two copper electrodes with a certain distance and area (Supriyanto, et al. 2007). Measurements are taken in the dark and under lighting. Two electrodes are dipped in the solution and then the current begins to flow from the source voltage to the test solution (Figure 3.2). The conductivity of the solution can be determined using the Equation:

$$\sigma = \frac{1}{R}\frac{d}{A} \quad (1)$$

From Equation (1), / is the conductivity of the material (/)-1 and R is the resistance of the material (/), while / and / are the distance between two electrodes (/) and the area of deviation (/).

IV. RESEARCH RESULTS

This research was carried out in March-October 2017 at the Physics Education Laboratory of IKIP PGRI Pontianak. This research has developed a simple model to measure the resistivity of materials. The model is the two-point probe method. The two

point probe method is a four point probe method that is commonly used to measure the resistivity of materials. The El-Kahfi I-V meter (Figure 3) is a resistivity measuring instrument that uses the two-point probe method. The two-point probe method is easier to apply because there are only two probes manipulated. The two-point probe method in the study is a measurement method used to measure the resistivity of a solution. Measurements using the two-point probe method with a multimeter can be seen in Figure 4.

Gambar 3. El-Kahfi I-V meter

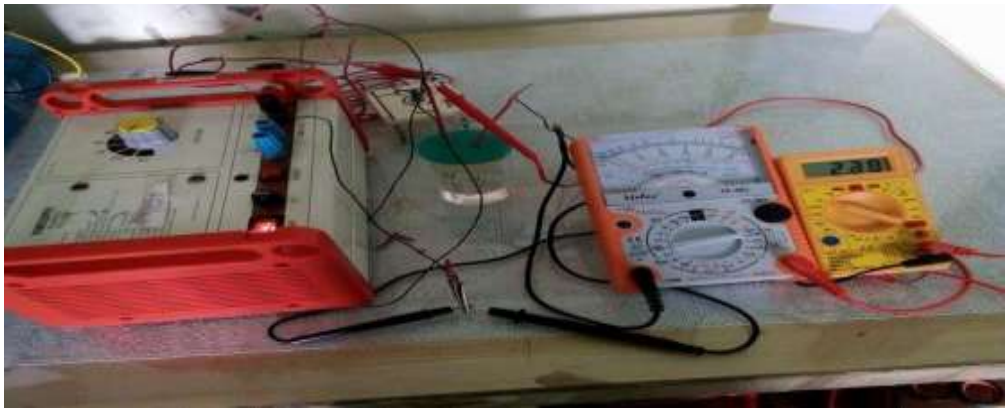

Figure 4. I-V measurement of ethanol solution with Two Point Probe Method with Multimeter.

The results of the I-V measurement of ethanol solution by the two-point probe method are presented in Table 1.

Table 1. Test Data of Two Point Probe Method with Multimeter

Metode Pengukuran	**V (Volt)**	**I (Ampere)**
Two Point Probe	0,51	0,000002
	2,38	0,000006
	4,17	0,000012
	6,12	0,000014
	8,06	0,000022

	9,74	0,00003
	11,68	0,0000375

To determine the feasibility of the two-point probe method with a multimeter, the data from the measurement results of I-V with the two-point probe method with a multimeter are compared with the I-V measurement results with Elkahfi 100 as a standard measuring tool. In detail, the data from the comparison results can be seen in Table 2.

Table 2. Compare the test results of the Two Point Probedi Method with the Elkahfi 100 Two Point Probedi Method test data.

Metode Pengukuran	Jarak Elektroda (m)	Luas Penampang elektroda (m^2)	*R* (Ohm)	Konduktivitas (Ohm^{-1})
Two Point Probe	$6 x10^{-3}$	$8 x10^{-6}$	$0,1x10^{6}$	$7 x10^{-3}$
I-V Meter	$6x10^{-3}$	$8x10^{-6}$	$0,3x10^{6}$	$2 x10^{-3}$

Based on Table 2, it can be seen that the resistivity (R) and conductivity (Ohm- 1) of ethanol produced by the two-point probe method. In this measurement, the distance and area of the electrode are kept constant.

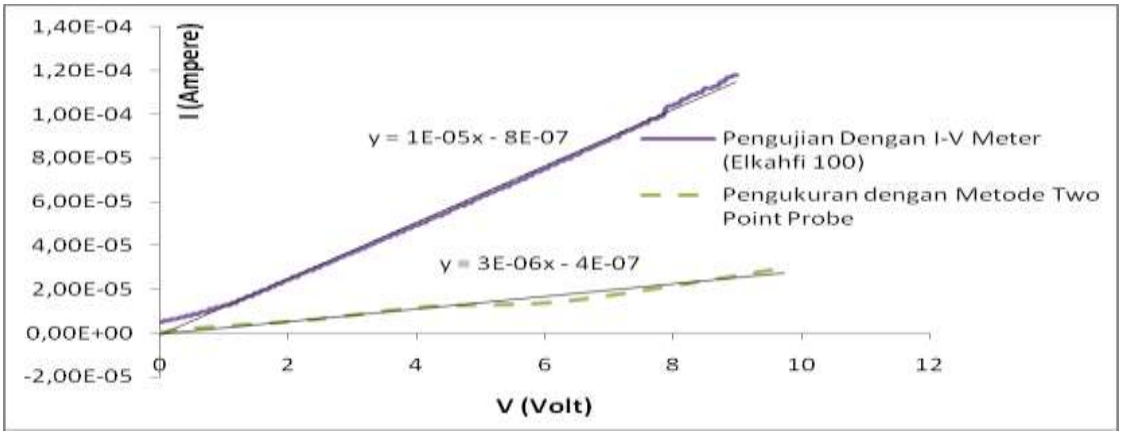

Figure 5 Graph of Two Point Probe Method Testing with Multimeter (Broken Line) and Two Point Probe Method Testing with Elkahfi 100.

Based on Figure 5, it can be seen that the results of the test of the two point probe method with a multimeter and the test of the two point probe method with Elkahfi 100 show the relative slope of the graph. The graph shown is a graph of the resistance of ethanol solution. The relatively equal graph slope of the two graphs in Figure 5 shows that the two-point probe method with a multimeter can also be used to measure the recitance and condition of a solution. Although the measurement results show the same order, the measured value is still much different when viewed with the Elkahfi 100 standard.

Therefore, there is still a need to further research on the accuracy of the two-point probe method with a multimeter made by the researcher. Based on the results of the researcher and the weaknesses observed, an electrical measuring instrument with a very wide measurement limit is needed to increase the measurement range with the two-point probe method. The results of this study also have implications for the measurement of photosynthesis.

V.CONCLUSION

Based on the results of the study, it can be concluded that the two-point probe method with a multimeter can be used to measure the conductivity of materials which in this study used an ethanol solution. The results of measuring the conductivity of ethanol solutions use the two-point method. The probe is 7 101 and uses an I-V meter (Elkahfi 100) of 2103.

REFERENCE

Dieter K. Schroder. 2006. Semiconductor Material and Device Characterization, Third Edition. John Wiley & Sons.

Callister, WD Jr dan Rethwisch, DG. 2009. *Materials Science and Engineering an Introduction*. USA: Wiley.

Khan M. A., Khan S. M. M., Mohammed M A, Sultana S., Islam J. M. M., dan Uddin J, 2012, Sensitization of Nanocrystalline Titanium dioxide Solar Cells using Natural Dyes: Influence of Acids Medium on Coating Formulation, *American Academic & Scholarly Research Journal,* Vol. 4, No. 5, Sept 2012.

Omar, M. A. 1993. Elementary Solid State Physics. Addison-Wesley Publishing Company, Inc.

Supadi. 2011. Titrasi Konduktometri. Diakses pada tanggal 24 Juni 2013.

Supriyanto A., Kusminarto, Triyana K., Roto, 2007, Optical and Electrical Characteristics of Chlorophyll- Porphyrin Isolated from Spinach and Spirulina Microalgae for Possible Use as Dye Sensitizer of Optoelectronic Devices, *International Conference On Chemical Sciences* (ICCS-2007), Yogyakarta-Indonesia.