

Conductivity of different materials in electric circuit

The City College of New York

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ENGL-210
Lab Report Final Draft

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Abstract

The function of the circuit is to convert the electrical energy to other forms of energy. Therefore, some physical quantities are used to indicate the state of the circuit and the relationship of energy conversion between the various parts. The simplest circuit consists of power supplies, electrical appliances (loads), wires, switches and other components. Electric circuit is crucial to maintain our society's well-being; and wire is the most important part of an electric circuit. (James, 2008) The ability of an object to conduct electrical current is called electrical conductivity. Metals, semiconductors, electrolyte solutions or molten electrolytes and some non-metals can conduct electricity. The conductance is a crucial property of a material. In our modern society, people rely on technology; and the key component of technology is logic circuits. Since electronic circuit is so important to our society, and conductivity is a main property that measures the performance of an electric circuit, finding a material that has both better conductivity and value is important for our society's wellbeing. In this lab, several materials were used to test their conductivity. The material with best conductivity was found in this experiment.

Introduction

In this lab, understand the basic concepts of Ohm's Law, Kirchhoff Current Law and Kirchhoff Voltage Law is required.

Ohm's Law is given by the formula $V=I \cdot R$, where I is the current flowing in a circuit loop, V is the voltage across the detect resistor, and R is the resistance of the resistor.

Kirchhoff Current Law describes that for any node in the circuit, the sum of the currents in the loop has to be equal to zero, the formula is given as: $\sum I = 0$. The fundamental concept of this formula is the conservation of charge. (Horowitz, 1989)

Kirchhoff Voltage Law describes that for any closed path in any electric circuit, the sum of all voltages must equal to zero for any loop in the circuit. The formula is given as: $\sum V = 0$. The fundamental concept of this formula is the conservation of energy. In order to maintain the accuracy, we have checked all the resistors used to build the circuits.

Electrical conductance is a measure of the ability of an object or circuit to transmit current from a certain point to another point, depending on the conductivity and geometry and size of the object. Now the unit of the International System of Units for this value is Siemens (Siemens, abbreviation "S"). In the past, the unit of conductance was "Mho", which was reversed by the alphabetical order of the word Ohm, or the reversed Ω . (Halliday, 2005)

The circuit was build was shown on the figure #1.

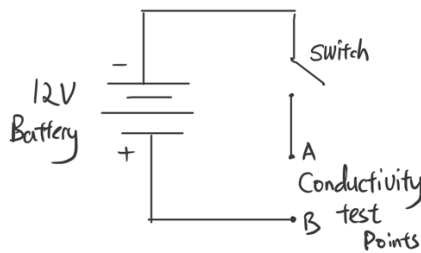


Figure 1. Circuit Diagram

Materials

- 1) A 12V battery
- 2) Wires
- 3) A switch
- 4) A multimeter
- 5) A potentiometer
- 6) Materials for conductivity test

Procedure

Firstly, build a circuit as shown in figure #1. Connect the 12V battery positive node to a wire with a switch. Connect the potentiometer at one side of the wire. Connect the negative node to a wire with labeled as node A. The wire where is located at the switch was labeled as Node B. Then, obtain the material which ready for test. Cut the material as a uniform length wire. the cross-sectional area of the material should be identical. Connect the Node A to a side of the material, then connect the material into node B, with node B at the opposite edge. Obtain a multimeter and turn the multimeter to voltage mode. connect the multimeter to the two nodes of the material. Place the multimeter and measure the voltage drop between the node A and B.

Result

| Material | Test 1 (V) | Test 2 (V) | Average Voltage drop (V) |
|----------|------------|------------|--------------------------|
| Copper | 0.2 | 0.3 | 0.25 |
| Aluminum | 0.3 | 0.3 | 0.3 |
| Iron | 0.5 | 0.4 | 0.45 |
| Gold | 0.1 | 0.2 | 0.15 |
| Silver | 0.1 | 0.3 | 0.2 |

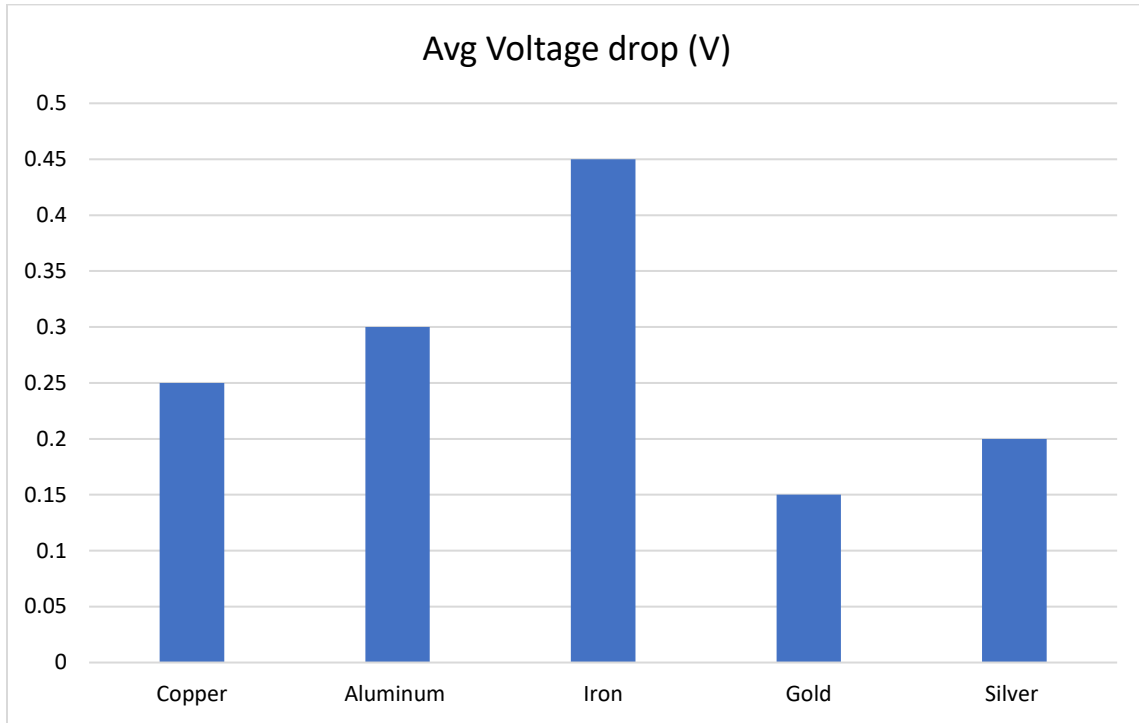


Figure 2

Price Index of Materials:

| Material | Price \$/ ton |
|----------|---------------|
| Aluminum | 2323 |
| Gold | 413750000 |
| Iron | 700 |
| Copper | 6157 |
| Silver | 394345 |

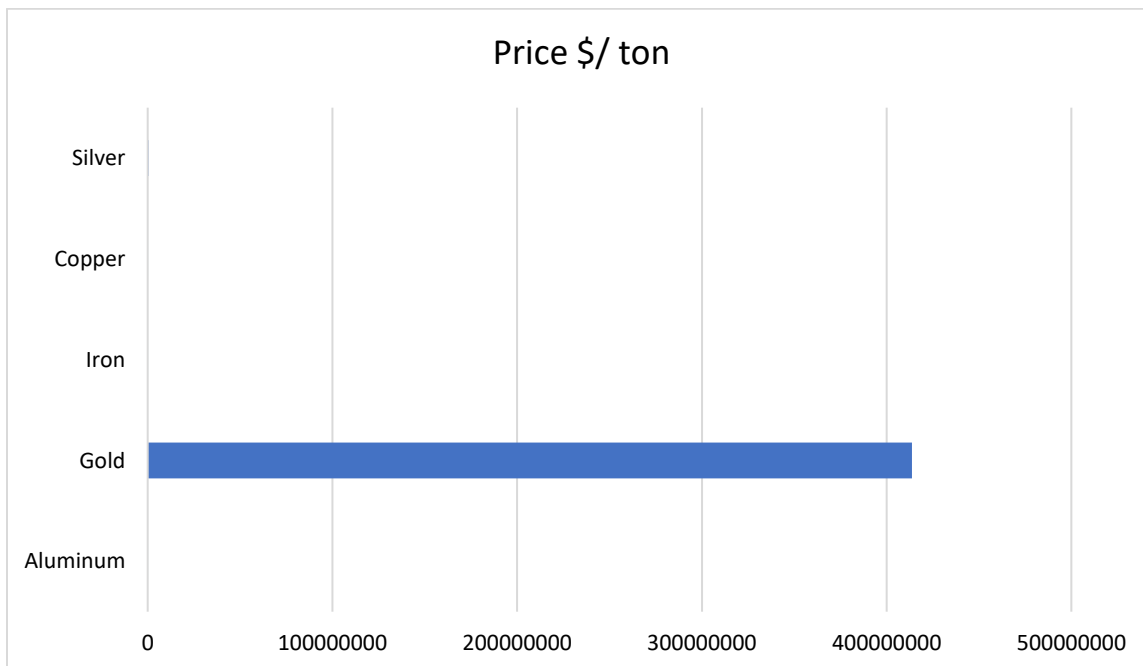


Figure 3

Discussion

As the result, gold has the best conductivity amount all materials we tested. However, gold isn't a material that people can wisely use for wires; in other words, gold is too expensive to use as a wire even though it has the best conductivity. In many countries, gold is also a strategic material. Since then, gold is not the best option uses for making electronic devices. In comparison, aluminum has slightly lower conductivity than gold, but it is a much cheaper material that people can afford. For commercial users, the best value of a material is much important than the conductivity. Businesses and government projects will consider the price of a material much more than consider the conductivity. It's not always the case, in contrast, for some projects such as NASA's Mars mission, landing to the moon, the performance is more important than the price.

Conclusion

Based on the experiment, the material with best conductivity was found. Gold has the best conductivity amount all the tested materials. Iron has the worse conductivity, which the average voltage drop is 0.45 V. If we use iron as a wire in a simple direct current circuit with a 12V battery as power supply, and the voltage drop of the iron is 0.45 V, then the device will receive only 11.5V, 5% of energy wasted during the electron transition, the rest of the voltage took out from the iron wire. Moreover, since the iron will take 0.45V of the voltage differences, is the current pass through the iron is large, say 100-Amps, total of 500W of power will be wasted as thermal energy, and it will damage the entire circuit. In compression, gold has the best conductivity that only drops 0.2 V. Gold is the best material to uses as a wire.

Reference

Halliday, David; Robert Resnick, Jearl Walker. Fundamental of Physics 7th. USA: John Wiley and Sons, Inc. 2005. ISBN 0-471-23231-9

James William Nilsson & Susan A. Riedel (2008). Electric circuits. Prentice Hall. p. 29. ISBN 978-0-13-198925-2

Horowitz, Paul; Winfield Hill (1989). The Art of Electronics (2nd ed.). Cambridge University Press. p. 13. ISBN 0-521-37095-7

Reflection

The lab report for our group is focusing on the conductivity of different materials. It is an interesting topic. Before we pick up this topic, we were considering writing reports which is about social media, but there's no point to make measurements on social media for a report. Conductivity, however, is a property of a material, and it's a measurable quantity; write a report about conductivity is making sense that follows the purpose of this course - writing for engineering. Research is required for writing this lab report. By doing online research, I found that the format of a lab report is important.

Since we don't have any experimental analysis in real, and the data were "imaginary", to make the report reliable is a challenge. After a little research on the conductivity, we decided to include serial points into our report. Conductance, as well as resistance, values and force mechanics are the major properties that engineers considered. In this lab, we decided only focusing on the conductivity and value of materials. Even though it is a made-up lab report, I must follow the science. I have checked many concepts that mentioned and discussed in this report that must follow the general science. As an engineering student, I would have many reports to write in the future. If I have any sentence or statement that is not obey the rule, my report will be unreliable, and it will also have negative impact on my carrier.

The audience of the report should be professional electrical engineers that working on small electronic circuits and power grid. Government project planners are also considered the audiences, since the nation is running on electric power supplies, and power grids are constructing and maintaining. The report provided both information about the best conductivity and the best value of a material. As the result shows the iron has the cheapest price per ton. However, engineers and governors should not consider iron as a wire since the conductivity of

iron is 50% less than copper or aluminum. Since power grid / wires are being used for hundred years, the power wasted due to the lack of conductivity should be considered. After doing this lab report, I am more familiar with writing a report for engineers and governors. Price is not always the most important thing that we should consider, the performance of a material is also important.

The purpose of this lab report is to help me understand the general format and basic rules of writing lab report. The audience analysis of the report is also important. The report itself should be reliable and able for others to re-create the experiment. Lab reports also have similar format as a scientific paper. The abstract and introduction are the important parts for readers. The first part that shows to a reader is the abstract. The abstract should be including all information about the lab report. As a reader, I will read the abstract first to find if the report is the thing I want. Therefore, the abstract is a crucial part of the lab report, which should contain enough information about the experiment that I did and also attractive to readers.

The assignment meets the course learning outcome 4 and 5. I was in a group that discussed and decided the “body” of this lab report. We did a peer review for the first draft of the report. I had some ideas about how to improve my writing skills, especially writing a lab report. My group mates helped me a lot. In this report, I used multimodal composing through digital and print to explain my experiment.

AUDIENCE PROFILE SHEET

Reader's Name: N/A

Reader's Job Title: Engineers, college students, Governors

Education: project management, undergraduate student, professional engineers

Professional Experience: Project Management/ lab experiments

Job Responsibilities: N/A

Personal Characteristics: N/A

Cultural Characteristics: ANY

Attitude Toward the Writer: Respectful and professional.

Attitude Toward the Subject: what the material should use with the government/commercial can buy on its budget due to meet the performance

Expectations About the Subject: The topic will be honest, focused, geared towards create better circuit/ power grid

Expectations About the Document:

Reasons for Reading the Document: To offer suggestions on what the best material at an affordable price so that a solid decision can be made.

Ways of Reading the Document: *** (depending on who is reading this at any given point will impact how they read it. Someone from purchasing would only read the "dollars and cents" part. The coaches would read elements like product specifications, etc to make sure that what is being ordered is the correct thing and suitable for the athletes, the athletic director might just skim it to make sure things are going smoothly with tennis and see how much money is being spent for approval, so this has to be considered before checking the boxes below)*

Skim it ___ Study It X Read a portion of it ___ Which portion?

Modify it and submit it to another reader ___ (if it needs modifications then yes)

Attempt to implement recommendations ___ (possibly, if the author thinks that one racquet is better than another, despite possibly being a little more pricey)

Use it to perform a task or carry out a procedure ___ (overall, yes, as the athletics department/tennis coaching staff wishes to purchase racquets for the teams)

Use it to create another document ___ (possibly, this document, or parts of this document might be used for purchasing to create a purchase order, but it's not entirely necessary)

Running Head: Conductivity of different materials in electric circuit

Other ____ Explain

Reading Skills: the intended audience reads at the level connected to their education

Reader's Physical Environment: ANY