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## Effect of Limited Migration of Graphite and Sea Water Electron as a Sensor to Control DC Voltage Regulator (CVR)

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# Effect of Limited Migration of Graphite and Sea Water Electron as a Sensor to Control DC Voltage Regulator (CVR)

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**Abstract.** The aim of this research is to develop a graphite material that can collaborate with seawater to control DC voltage. The electrical characteristic of Pencil Graphite Electrodes (PGE) was tested. The result shows that graphite material has an impedance of 75 kilo ohm which is a semiconductor material. The electrical conductivity of graphite material depends on the particle size which is larger at smaller the particle size. When the PGE are in contact with seawater, their impedance change. As result it can be applied to control a DC voltage. The change of impedance is caused by interaction of the electron of seawater and graphite in producing a new compound.

Keywords : graphite, PGE, control voltage.

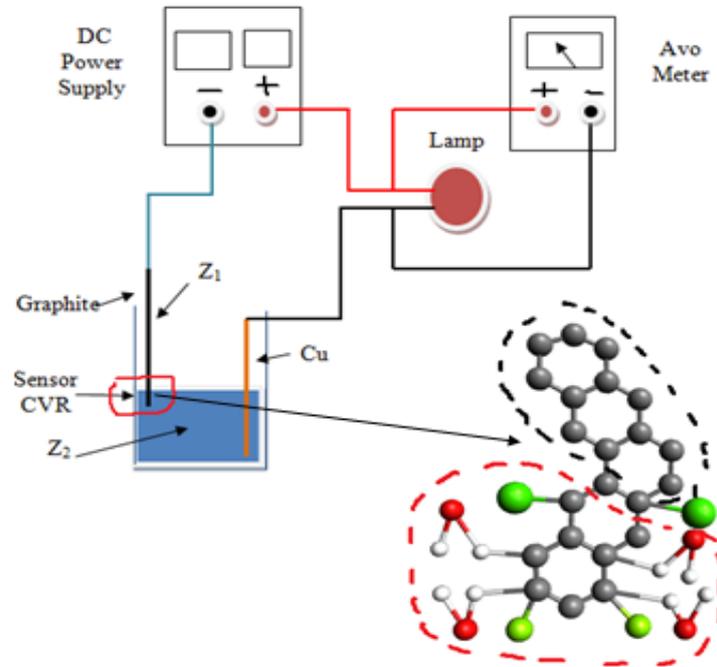
## 1. Introduction

Graphite is a popular material, it has good mechanical stability, efficient adsorption capability and chemical stability. Graphite can be used in various applications such as battery [1,2], sensor [3,4] and solar cells[5-7]. Study of graphite as cell electrodes has attracted a great attention recently. The performance of the cell electrode greatly affects the amount and condition of the charge transfer [8]. This mechanism is associated with the electronic conductivity and the diffusion of electrode and the ionic properties of electrode. The development of the graphite as a electrode has also been done by the various methods and nano-technologies [9-11,1]. Besides, it has good electrochemical properties due to the improvement of the electrical conductivity and the stability of the mechanical properties [12-13].

Commonly, potentiometer is a device to control voltage of dc regulator. Potentiometer is a variable resistor which means that the value of the resistance can be adjusted by turning the knob but the problem is low precision, because the value of resistance will be change due to the knob shifting. In this work, we develop graphite materials for a sensor to control voltage regulator. This study shows that impedance of the graphite changes when it contacts with seawater. This may reveal electron movement on the graphite when contact with seawater. The interaction of graphite and sea water electron may produce new compound, it can change the impedance. Aim the research is explain behavior of electron movement graphite when interact sea water, and electron bonding analysis.



## 2. Experimental Method



**Figure 1.** The experiment of sensor voltage regulator

Experimental set up to demonstrate the effect of seawater on pencil graphite electrode (PGE) is shown in Figure 1. The system consists of an electrical circuit of DC power supply, lamp, two electrodes of PGE and Cu, and an avometer to measure voltage. PGE electrode was as negative (cathode) and Cu electrode was as positive (anode). The two electrodes were dipped in sea water. The effect of level dip of graphite in sea water on circuit impedance was observed. The two electrodes (anode and cathode) were connected to power supply of 10 volts. The level of graphite electrode in sea water was varied from 1 mm up to 15 mm.

Composition of sea water was tested that contains elements as shown in Table 1.

**Table 1.** Chemical elements of sea water

No	Element	Analysis Results (mg/L)	Analysis Method Reagent	Method
1	Ca	57.45 + - 0.04	HNO <sub>3</sub>	AAS
2	K	322.1 + -0.03	HNO <sub>3</sub>	AAS
3	SO <sub>4</sub> <sup>2-</sup>	1000+ -0.00	HCl- BaCl <sub>2</sub>	Spectrometry
4	Cl	8.88 + -0.00	AgNO <sub>3</sub>	Argentometry
5	Mg	0.65 + -0.00	HNO <sub>3</sub>	AAS
6	Na	14.32 + -0.01	HNO <sub>3</sub>	AAS

## 3. Result and Discussion

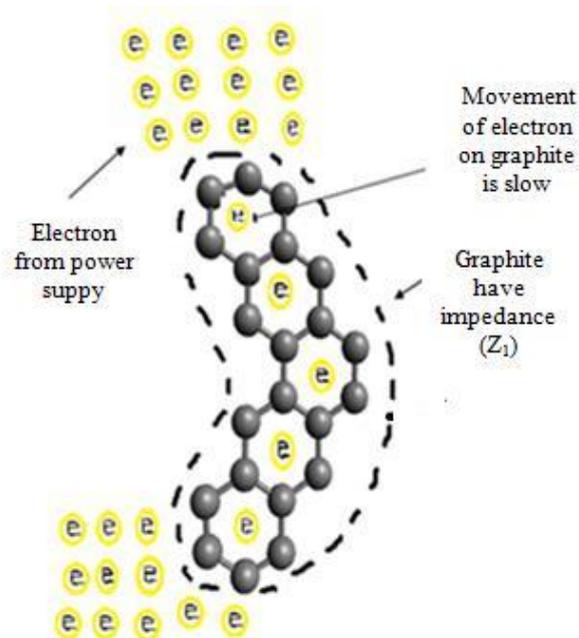
Graphite structure is hexagonal. When a graphite interacts with other elements having low energy, there is no tendency of graphite atoms to lose their electrons because it has a high electron density. The effect of high electron density causes high impedance ( $Z_1$ ). Cu is a better conductor, because it has low impedance ( $Z_3$ ), Figure 1 shows that graphite ( $Z_1$ ), sea water ( $Z_2$ ), Cu ( $Z_3$ ) are connected in

series circuit. Tabel 2 show current and impedance of graphite, seawater, cu when graphite was dipped in sea water of 1 mm.

**Table 2.** Impedance of graphite, sea water and Cu

Materials	Power supply (V)	Current (A)	mpedance( Ohm)
Graphite (Z1)	10	$13 \times 10^{-8}$	$75 \times 10^3$
Sea water (Z2)	10	$13 \times 10^{-8}$	$75 \times 10^6$
Cu (Z3)	10	$13 \times 10^{-8}$	$1,01 \times 10^{-7}$

Figure 1 shows that the graphite was connected to negative power supply, it means as negative polar. While Cu was connected to positive power supply. Graphite and Cu are dipped in sea water. When negative electron of power supply flows in sea water, it causes electron of H, Mg and Ca of sea water get energy. It make their elements (H,Mg,Ca) bond with graphite electron. As a result the impedance of sea water ( $Z_2$ ) increases.



**Figure 2.** Behavior electron movement on graphite

Figure 2 shows that the electrons from power supply flow in graphite very slowly. it is caused the bonding force of electron in graphite is very strong. Moreover, density of electron in the graphite is very high. Those cause impedance of graphite ( $Z_1$ ) is very high.

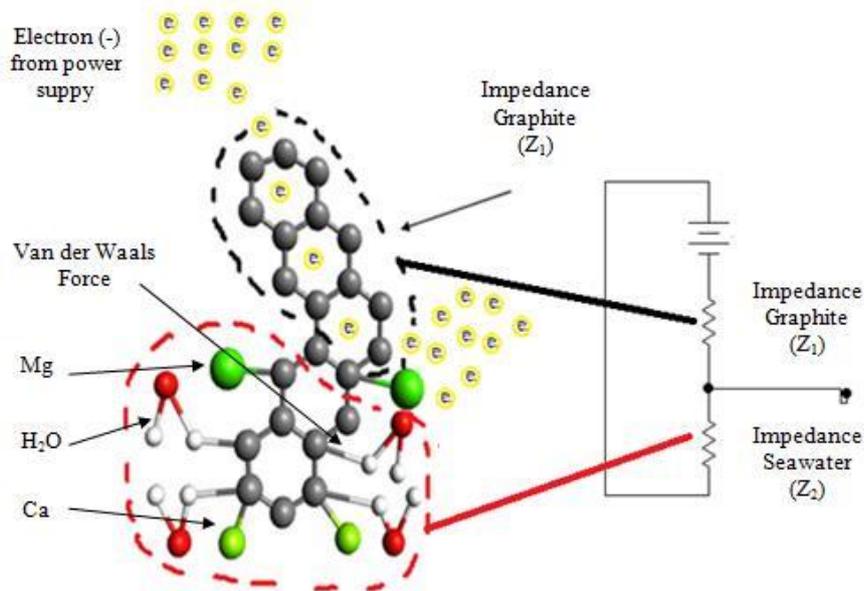


Figure 3. Behavior electron movement when graphite is dipped in sea water

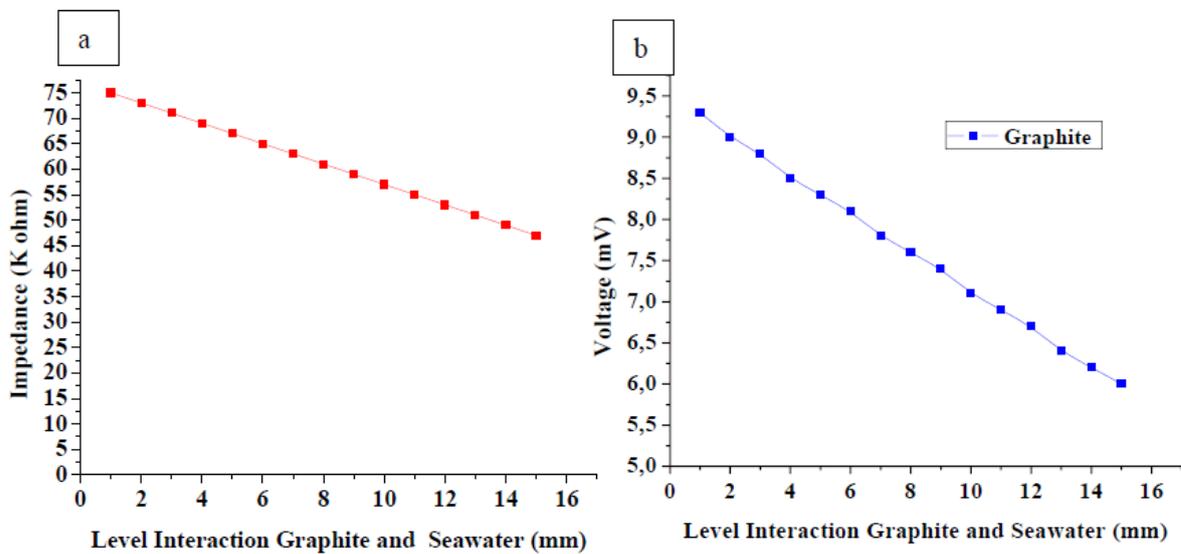
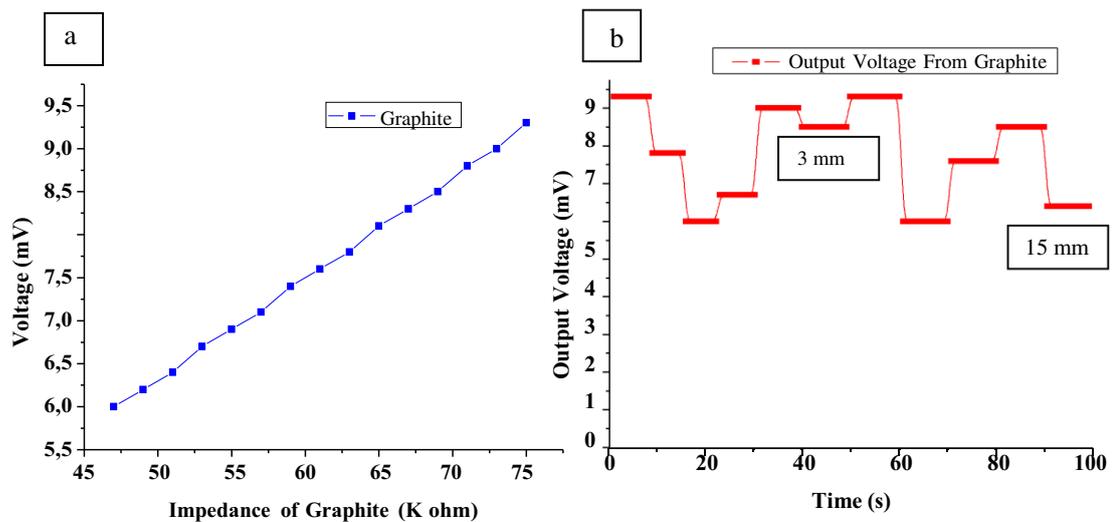


Figure 4 (a) Test of interaction level seawater affects graphite impedance (b) Test of interaction level seawater affects graphite voltage

Figure 3 shows behavior of graphite when it interacts with sea water. The electron graphite bond the positively elements of Mg, Ca, and H. That is occurred by van der waals force. This because the increases of impedance ( $Z_2$ ). So the negative charges power supply can't pass it. When graphite is dripp in sea water, it can reduce impedance of graphite ( $Z_1$ ). In that condition, graphite is as a voltage divider because impedance  $Z_2$  is higher than impedance  $Z_1$ . Figure 4a shows the change of graphite impedance ( $Z_1$ ) when the graphite is dipped in sea water. The data shows the change of depth level 1 mm results in a change of impedance around 5 kilo ohms.

Figure 4b shows the change output voltage when graphite is dipped into sea water. Change of voltage occur about 9.5 mV to 6 mV when depth level is changed from 1 mm to 15 mm. It caused the movement of electrons from the power supply is limited and  $Z_2$  has an impedance greater than  $Z_1$ .



**Figure 5** (a) Test of graphite impedance affects voltage (b) Test of interaction level seawater affects graphite voltage

Figure 5a shows correlation of impedance and voltage is linear. This is because the impedance affects the number of electrons flowing. Each change of graphite impedance of 5 ohms, causes a change in voltage of 0.5 mv. Figure 5b shows that graphite is able to change the voltage when dipped in sea water. This shows that graphite is as CVR sensor device. Voltage changes occur due to limitation of electrons passing in graphite, because of compound formation from sea water and graphite.

#### 4. Conclusions

- Graphite have impedance of about 75 Kilo Ohm, it caused the movement of electrons flow from power supply to graphite is inhibited.
- When graphite interacts with seawater, the electrons of Mg, Ca, H (positive polarity) bond electron graphite, so it was influenced by van der Waals force.
- Van der Waals force on graphite electrons and seawater cause change of graphite impedance. The effect is limited of movement electron inside graphite. This shows that graphite is a CVR sensor device.

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