MANUAL

ENERGY GAP OF A SEMICONDUCTOR w/o oil

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ENERGY GAP OF A SEMICONDUCTOR

Aim: - To determine the energy band gap material given semiconductor diode.

App: - D.C Power Supply, Semi-conductor diode (Germanium or Silicon), thermometer, heating arrangement to heat the diode, Voltmeter, Microammeter and connecting wires.

Principal & Formula: -

The Energy gap (E_g) of a material is defined as the minimum amount of energy required for an electron to get excited from the top of the valance band to the bottom of the conduction band. The energy gap for metals is zero since valance band and conduction band overlap each other whereas the energy gap for the insulators is very high. The energy gap for the semiconductors lies between the values for metals and the insulators.

The resistance of a semiconductor varies with the temperature as $R = R_0 E^{\frac{Eg}{KT}}$ ----- *(1)*

Where R_0 is the resistance of the semiconductor at absolute zero.

K is the Boltzman constant and T is the temperature of the material.

By applying logarithms of both sides of the equiation (1), we get

$log_{10} R_0 + (\frac{Eg}{KT}) log_{10}^{e}$ --------- (2)

This is a linear equation between log_{10}^{R} and 1/T and its slope is obtained from:

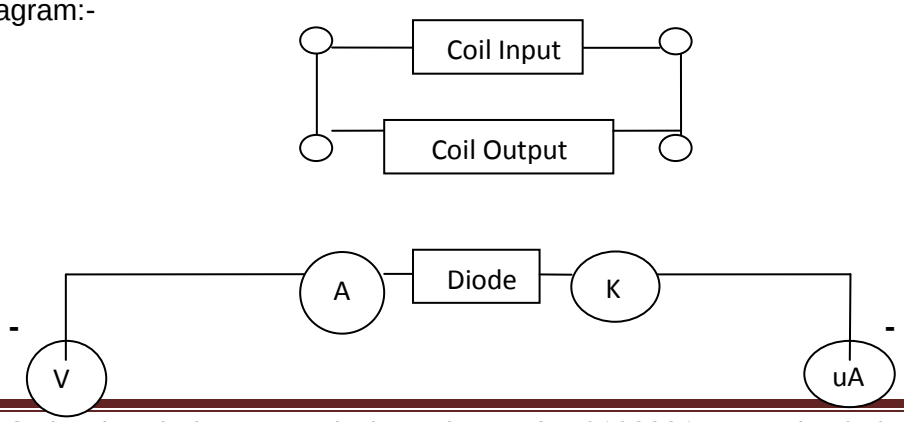
Slope = $E_g \frac{log_{10}^{e}}{K}$

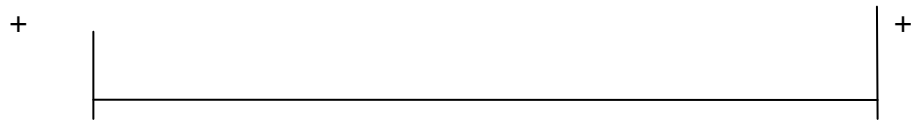
E_g = Slope$\frac{K}{log_{10}^{e}}$

E_g = (1.9833x10^{-4} x slope) eV ..... (3)

In a semiconductor, there is an energy gap between its conduction and valence band. Forthe conduction of electricity a certain amount of energy is to be given to the electron so that it goes from the valence band to the conduction band. The energy so needed is the measure of the energy gap, between two bands. When PN junction is placed inreverse bias, the current flows through the junction due to minority charge carriers. Theconcentration of these charge carriers depends on band gap

Circuit Diagram:-





Procedure: - The experimental arrangement comprises a heater which is provided with sockets at its mouth. The sockets are used to insert the thermometer and the semiconductor diode. A heating element is fixed inside which used to raise the temperature by connecting to the AC main supply. The reverse biasing voltage can be adjusted by means of the voltmeter and the reverse saturation current can be measured with the help of a microammeter.

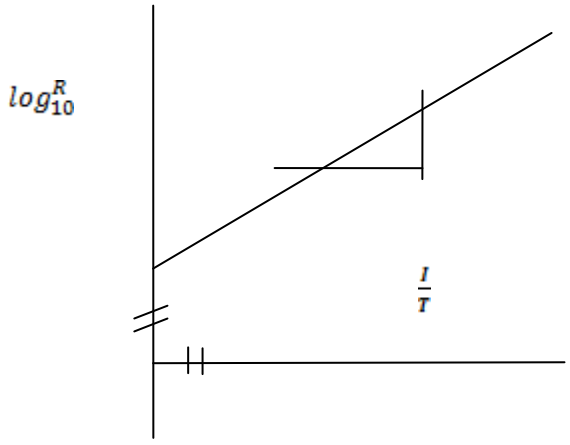
Connecting the two terminals of the given semiconductor diode (Germanium or Silicon) to the DC Power supply and microammeter in such a way that the diode is reverse biased. Insert the thermometer at same level as that of the diode.

Switch on the DC Power supply and adjust the reverse bias voltage to 5 Volts. Switch on the AC main supply, then the temperature gradually increase. Consequently, the current through the diode also increases. Note the value of the current of every 5°c increase of the temperature, When the temperature reaches to about 65°c, then switch off the AC supply. Then, the temperature will rise and stabilizes at about 70°c. Note the temperature and the current through the diode. After few minutes, the temperature will begin to fall and the current through the diode decreases. Note the value of the current of every 5°c decrease of the temperature, till the temperature falls to the room temperature.

Tabulate the values of current and temperature. Repeat the experiment for two or three different voltages.

Graph:- Draw the graph taking $\frac{I}{T}$ on the X – axis and log 10^R on the Y –axis. One should get a straight line which does not pass through the origin. Find the slope of the straight line.

$\therefore$ $E_g = (1.9833 \times 10^{-4} \times \text{slope})$ eV



OBSERVATIONS

S.No	Temperature (T)		Current		Mean	Resistance		
	$^{\circ}$c	K	Increaseing temperature	Decreasing temperature	uA	$R = \frac{V}{I}$= in x10^6 ohms	log_{10}^{R}	$\frac{I}{T}$

1	30							
2	35							
3	40							
4	45							
5	50							
6	55							
7	60							
8	65							
9	70							

Result :

The Band gap(Eg) of the given semiconductor is found to be _____ ev

Precautions:-

1) Do not exceed the temperature above 65 ^{0}c to avoid over heating of the diode
2) The Voltmeter and the ammeter reading should initially be at zero mark.
3) The thermometer should be inserted well in the glass
4) Reading of the micro ammeter should be taken when temperature is increasing
5) Reading of current and temperature must be taken simultaneously.