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WORK INSTRUCTION

1.0 Experiment No: BS/PHP101/07

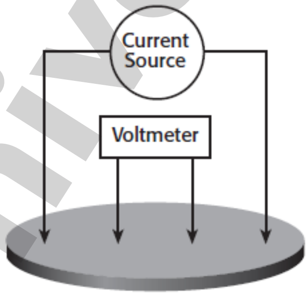
2.0 Name of Experiment: Study Band-Gap OF 'SEMICONDUCTOR'

3.0 Aim: MEASUREMENT OF RESISTIVITY BY USING A DIRECT READING POTENTIOMETER AND TO FIND BAND-GAP OF a 'SEMICONDUCTOR' SAMPLE

4.0 Principle: The crystal or sample has four individually spring loaded probes coated with Zn at tips. The probes are co-liner and equally spread. The Zn coating and individual spring ensure good electrical contacts with the sample. The probes are mounted in a Teflon bush which ensures a good electric flow between the probes. A Teflon spacer near the tips also is provided to keep the probes at stand and leads are provided for current and voltage measurement.

The resistivity of a sample in a four-probe is given by-

$$\rho_0 = \frac{V}{I} 2\pi S$$



Where, V is Potential across voltage probe
I is Constant current through sample
S is distance between probes
ρ_0 is the of resistivity of a material

If ρ be resistivity and E_g be the band gap, then for a particular temperature T, resistivity of a material is given by $\rho = Ae^{E_g/2KT}$, Where K is Boltzmann constant.

So, $\ln\rho = \ln A + E_g/2KT$

$$E_g = \frac{2K\ln\rho}{1/T} + A$$

The slop of the graph between $\ln\rho$ vs. 1/T is equal to $\frac{E_g}{2K}$. From that E_g can be calculated.

If the two edges of the sample are at a distance of x_1 and x_2 from the probes, then the correction factor would be respectively $G_7(x_1/S)$ and $G_7(x_2/S)$.

Therefore the total correction factor for all the probes becomes

$F = G_7(w/S).G_7(x_1/S).G_7(x_2/S)$; Where w is width of the sample.

$G_7(X/S)$ can be approximated as, $G_7(X/S) = 2\frac{S}{X}\ln 2$,

Therefore, $F = 2\frac{S}{w}\ln 2 \times 2\frac{S}{x_1}\ln 2 \times 2\frac{S}{x_2}\ln 2$

With correction term we get the expression for corrected resistivity as

$$\rho = \frac{V}{I}2\pi S\frac{1}{F} = \frac{\rho_0}{F}$$

5.0 Apparatus required:

Four probe arrangement
Semiconductor plate
Oven
Oven Controller
Digital Current Voltage Meter

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6.0 PROCEDURE: (Don't write the procedure in your Lab. Copy)

Switch on the temperature and approx adjust the set temperature

↓

LED would light up indicating the oven is on and the temperature would rising

↓

The controller of the oven would switch on off power corresponding to set temperature

↓

Set the current. For a particular set temperature now note the reading of voltage

↓

From the experimental formula calculate the value of resistivity

↓

Draw a graph to show the variation of resistivity constant with temperature

7.0 Tabulation:

TABLE-1

Table to take temperature vs voltage reading at a constant current

Sample supplied ………..

Room temp=

Current through probe (I)= mA

S= 2.17 mm

w= 0.5 mm

x_1= 2.25 mm

x_2= 2.25 mm

Correction factor $F = 2\frac{S}{w}\ln 2 \times 2\frac{S}{x_1}\ln 2 \times 2\frac{S}{x_2}\ln 2 =$

Serial No.	Temp. (^oC)	Temp in (K)	1/T in ($K^{-1}x10^{-3}$)	Voltage when temperature is		Mean Voltage (mV)	Resistivity $\rho_0 = \frac{V}{I}2\pi S$ (ohm-c.m.)	Resistivity $\rho = \frac{\rho_0}{F}$ (ohm-c.m.)	$\ln \rho$
				Increasing (mV)	Decreasing (mV)				

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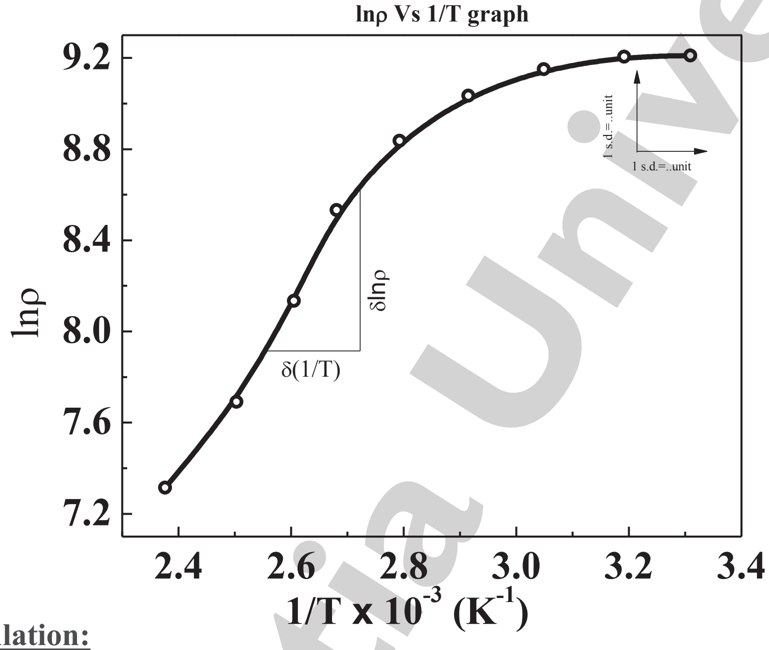
TABLE-2

DETERMINATION OF BAND GAP

Value of $\Delta \ln \rho$ from graph	Value of $\Delta(1/T)\times 10^{-3}$ from graph (K^{-1})	Value of slope (K)	Band gap $E_g = slope \times 2K$ (eV)

Graph: Draw a graph : 1/T along X-axis & $\ln \rho$ along Y-axis



8.0 Error calculation:

We have the experimental formula of band gap as

$$\rho = \frac{V}{I} 2\pi S \frac{1}{F}$$

Taking ln both sides we get,

$$\ln \rho = \ln V + \ln 2 + \ln \pi + \ln S + \ln 1 - \ln I - \ln F$$

After diff. we get $\frac{\delta\rho}{\rho} = \frac{\delta V}{V} + \frac{\delta I}{I}$

Other terms will vanish after diff. as they are constants

δV = error in measuring V=smallest division of the voltmeter.

δI = error in measuring I=smallest division of the ammeter

(Because probability of making error is in one side)

Hence, the percentage error is $\left(\frac{\partial \rho}{\rho} \times 100 \right)$ %

9.0 Discussion:

You have to write all the difficulties you faced during the experiment and their remedies. Also you have to mention some way out that one should adopt during the practical to have a better result.

Viva voice: go through the chapter of Hall effect from these books.

1) Solid State Physics – S. O. Pillai
2) Solid State Physics – Kittle

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