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PHY350 Lab Report
Registration No.: 11912610 Section: G2903

Aim

To study the variation of the resistivity of a Ge sample and determine its band gap using the four-probe method.

Methods

We used the VirtualLab platform for performing this experiment *in silico* (see Figure 1).

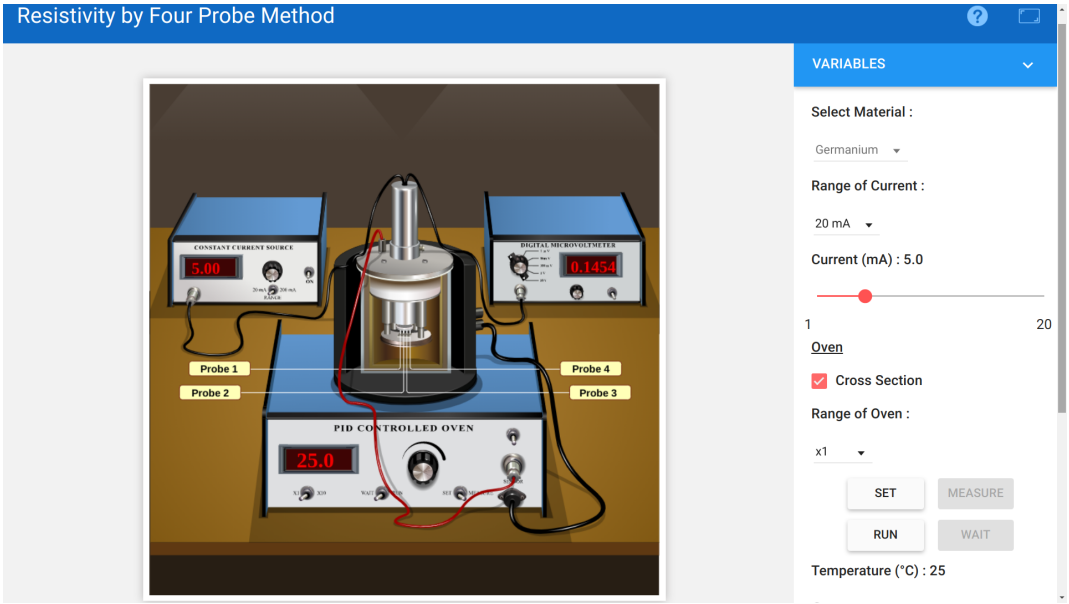

Figure 1: The four-probe apparatus on the VirtualLab platform of Amrita Visvavidyapeetham

A Ge sample was picked from the adjustables and for different temperature values set using a PID Controlled Oven, different values of resistivity were read out directly from the platform. We report our measurements in Table 1.

Since the resistivity of a semiconductor varies as

$$\rho = A \exp\left(\frac{E_g}{2kT}\right)$$

we can obtain the band-gap E_g by finding the slope of the straight line

$$\log \rho = \log A + \frac{E_g}{2kT}$$

where k is the Boltzmann constant and T is in Kelvins. The constant $\log A$ will determine the intercept of the plot and for our purposes, can be ignored.

Results

Temperature (^{o}C)	ρ (Ohm cm^{-1})
25	6.2011
40	5.6819
55	5.2479
70	4.8809
85	4.5672

Table 1: Measured values of resitivity (ρ) for different temperatures.

When $\log \rho$ is plotted against $1/T$

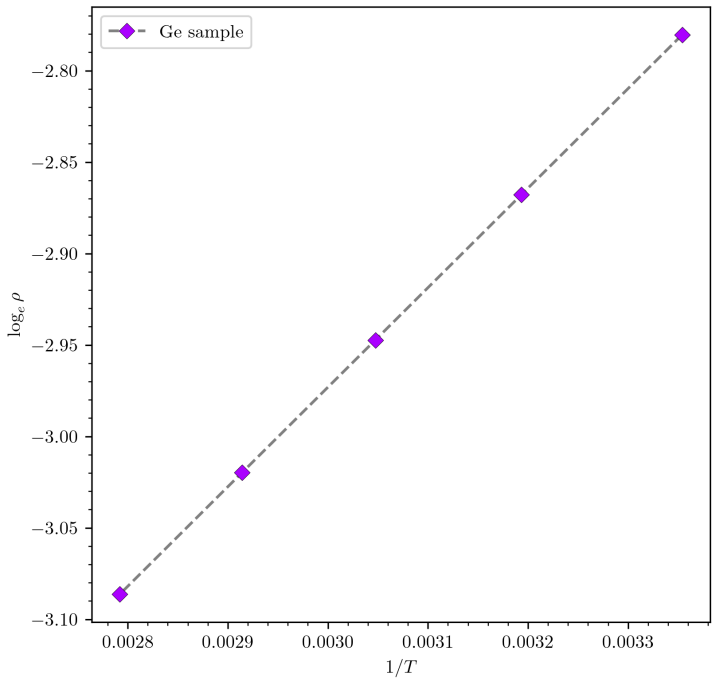

Figure 2: Variation of resistivity with temperature

The slope, found by a simple linear regression using the `scipy` Python package, turns out to be, $m = 544.28$. Since $m = E_g/2kT$, we get an $E_g = 2mkT$.

which upon unit conversion gives an $E_g = 0.093$eV, not in line with the true value of around 0.67eV.
The python script used for the estimation here