Four Probe Method

1 Aim

To find the resistivity and the band gap of a semiconductor using a four probe measurement.

2 Introduction

The four probe method is the most widely used method to measure the resistivity. The four electrodes are collinearly places on the semiconductor chip. The current is measured on the outer probes and the voltage on inner probes.

3 Apparatus in the lab and Procedure

The apparatus in the lab has the following components:

1. Constant current power supply
   It is an IC regulated current generator to provide a consant current to the outer probes irrespective of the changing resistance of the sample due to changes in temperatures. The supply is hghly regulated constant dc source. The current is measured by the digital panel meters.
2. A toggle switch to swtich the instrument ON/OFF.
3. It is a variable potentiometer to vary output current.
4. A digital voltmeter to measure the potential across the crystal.
5. A current meter.
6. An oven to heat the crystal. The oven is equipped with a voltage regulator to control the heat. A glowing LED indicates that the oven has started.
7. **Probes** There are four individually spring loaded collinear probes, coated with Zn at the tips. A Ge or Si crystal in the form of a chip or slice is provided with the equipment.

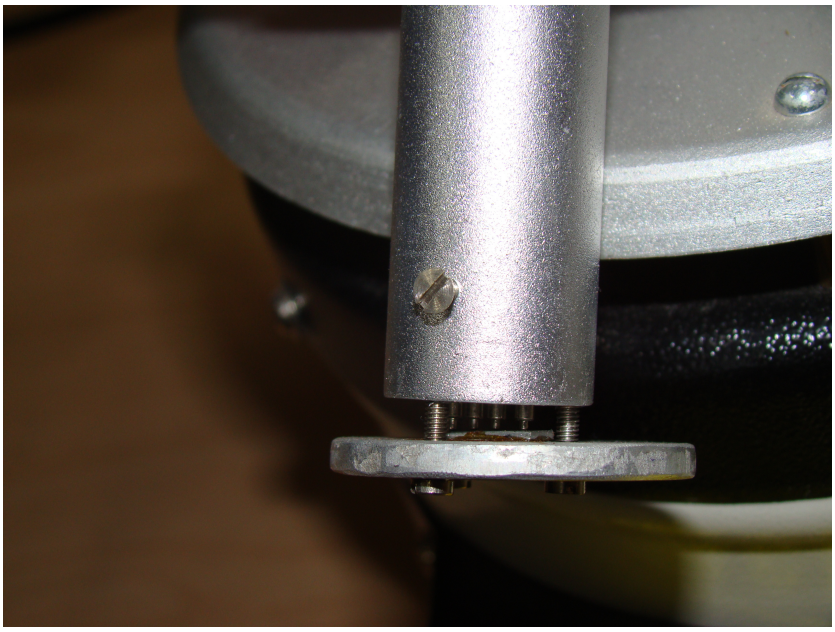

Figure 1: A close view of four probes.

4 Procedure

1. Switch on the AC mains of constant current supply. Adjust the current to a desired value (say 2mA or 175 mV). Note the corresponding voltage reading in the millimeter.
2. Switch the oven on and rotate the control switch to regulate the temperature.

5 Calculations

1. The variation of resistivity with temperature is given by

$$ln\rho = C + \frac{E_g}{2kT}$$

where ρ is the resistivity, C is a constant, E_g is tha band gap and k is the Boltzmann constant. The band gap of the semiconductor can be calulcated using the above expression.

2. Plot variation of voltage with temperature with an increasing current and then let the system cool and plot the voltage as it cools.

6 References

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