Figure 2.1: Energy Band gap – Block Diagram

Figure 2.2: Log $I_s$ Vs $10^3/T$

Figure 2.3: Schematic Representation of a p-n Junction Diode
DETERMINATION OF ENERGY BAND GAP - SEMICONDUCTOR DIODE

Expt. No.: Date:

AIM
To determine the band gap energy of a semi-conductor p-n junction diode.

GENERAL OBJECTIVE
To evaluate the band gap energy of a p-n junction diode by measuring the current flow at different temperatures.

SPECIFIC OBJECTIVES
1. To measure the current flow in the p-n junction diode at different temperatures
2. To calculate the band gap energy possessed by the given p-n junction diode from log \( I_s \) vs \( 1/T \) graph
3. To identify the material of the semiconductor diode from the obtained band gap energy value

APPARATUS REQUIRED
- Regulated power supply (3V dc at 150 mA)
- Semiconductor diode
- Thermometer (0-100ºC)
- Electric heater
- Micro ammeter
- Connecting wires

FORMULA
The energy band gap of the given semiconductor diode

\[
\Delta E = \frac{\text{Slope obtained from the graph}}{5.036} \text{ eV}
\]
TABLE-I

To find slope of the graph between $10^3 / T$ and $\log I_s$

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Current $I_s$</th>
<th>Temperature $T$</th>
<th>Temperature $T$</th>
<th>$10^3 / T$</th>
<th>$\log I_s$</th>
</tr>
</thead>
<tbody>
<tr>
<td>μA</td>
<td>(ºC)</td>
<td>(K)</td>
<td>K⁻¹</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PREREQUISITE KNOWLEDGE

1. Valence Band
   The valence band is the highest range of electron energies in which electrons are normally present at absolute zero temperature.

2. Conduction band
   The conduction band is the lowest range of vacant electronic states which are immediate next to the valence band.

3. Band gap energy
   It is defined as the energy gap existing between valence band and conduction band.

4. Semiconductor
   It is a material with a small but non-zero band gap that behaves as an insulator at absolute zero temperature.

5. Diode
   A diode is a specialized electronic component with two electrodes namely anode and cathode. Most diodes are made with semiconductor materials such as silicon or germanium.

PROCEDURE

1. The main leads are connected to mains socket carrying 230V at 50 Hz AC. The diode and the thermometer are inserted into the holes of the oven.

2. The electric oven is switched on.

3. The electric oven heats the semiconductor diode and the temperature of the semiconductor diode increases from the room temperature.

4. When the temperature in the thermometer reaches 80°C, the electric oven should be switched off. Now the temperature of the semiconductor diode falls.

5. Now the readings in the micro ammeter (I_s) are noted for every fall of 2°C starting from 80°C to room temperature.
OBSERVATION
Slope obtained from the graph = ……

CALCULATION

\[ \Delta E = \]
6. A graph is drawn by taking $10^3 / T$ along X-axis and log $I_s$ along Y-axis. The slope of the straight line is calculated and finally the band gap energy is calculated using the formula.

**RESULT**

The energy band gap of the given semiconductor diode $\Delta E = \ldots \ldots \text{eV}$

**APPLICATIONS**

Diodes exists in different forms such as signal diodes, Tunnel Diodes, Zener diodes, varactors, PIN- diodes etc., and they are mainly used as rectifiers (half-wave rectifier, full wave rectifier), light to current conversion (solar cell, photo diode) and current to light conversion (LED).

**VIVA VOCE QUESTIONS**

1. Classify materials based on band gap energy

2. Compare elemental and compound semi-conductors.

3. Explain forward bias.

4. Explain reverse bias.
STIMULATING QUESTIONS

1. The p-n junction diode should be forward biased. Justify the statement.

2. What happens to the electrical conductivity of conductors and semiconductors if the temperature is increased?

FORMATIVE ASSESSMENT

1. Majority carriers of n-type semiconductors are
   a) Holes   b) Electrons   c) protons   d) neutrons

2. Band gap energy of silicon is found to be
   a) 1.1 eV   b) 0.7 eV   c) 1.5 eV   d) 0 eV

3. Movement of majority carriers is represented as
   a) diffusion current   b) drift current
   c) leakage current   d) saturation current