**Hall Effect**

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**Aim:**

1. To determine Hall Voltage developed across the sample material.

2. To calculate the Hall coefficient and the carrier concentration of the sample material.

**Apparatus:**

* Two solenoids
* Constant current supply
* Four probes
* Digital gauss meter
* Hall effect apparatus (consisting of current generator (CCG), digital milli voltmeter and Hall probe).

**Diagram:**

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JX (Current Density) = I/wt

B - Applied Magnetic Field

w - Width

t - Thickness

JX - Current Density

**Observation Table:**

Material: Gold

Magnetic field B = 0.447 gauss = 0.447 x 10-4 tesla

|  |  |
| --- | --- |
| Thickness t = 0.4 mm | Thickness t = 0.8 mm |
| IH mA | VH mV | IH mA | VH mV |
| 1 | 778.181 | 1 | 389.091 |
| 1.5 | 1167.272 | 1.5 | 583.636 |
| 2 | 1556.362 | 2 | 778.181 |
| 2.5 | 1945.453 | 2.5 | 972.727 |
| 3 | 2334.544 | 3 | 1167.272 |
| 3.5 | 2723.634 | 3.5 | 1361.817 |
| 4 | 3112.725 | 4 | 1556.362 |
| 4.5 | 3501.816 | 4.5 | 1750.908 |
| 5 | 3890.906 | 5 | 1945.453 |

**Graph:**

Plot Hall voltage (Y-axis) v/s Hall current (X-axis) for different thicknesses



**Formula:** carrier concentration $n=\frac{B}{q × t × slope}$

**Calculations**

**For t = 0.4mm**

Slope = $\frac{1167.272-778.181}{1.5-1}$

Slope = 778.182

n = $\frac{B}{q × t × slope}$

where B = 0.447 gauss = 0.447 x 10-4 tesla

 q = 1.6 x 10-19 C

 t = 0.4 x 10-3 m

n = $\frac{0.447 x 10^{-4}}{1.6 x 10^{-19} × 0.4 x 10^{-3} × 778.182}$

n = 9 x 1014

**For t = 0.8mm**

Slope = $\frac{583.636-389.091}{1.5-1}$

Slope = 389.091

n = $\frac{B}{q × t × slope}$

where B = 0.447 gauss = 0.447 x 10-4 tesla

 q = 1.6 x 10-19 C

 t = 0.8 x 10-3 m

n = $\frac{0.447 x 10^{-4}}{1.6 x 10^{-19} × 0.3 x 10^{-3} × 389.091}$

n = 9 x 1014

**Results:**

The value of n for gold is 9 x 1014 for thickness 0.4 mm and 0.8 mm.

**Home Assignment:**

Keep Hall current (IH) fixed at 3 mA. Vary Magnet current in steps of 0.5 A and note Hall voltage. Plot graph of Hall voltage (Y-axis) v/s Magnetic field\* for any one thickness. Calculate carrier concentration using the formula: $n=\frac{I\_{H}}{q × t × slope}$

\*Find magnetic field for different magnet currents by selecting “Magnetic field v/s Current” from the “Select Procedure” drop-down menu of the simulator.

**Observation table for Home Assignment:**

Material: Germanium

Hall current: 3 mA

|  |
| --- |
| Thickness t = 0.4 mm |
| I ampere(magnet current) | B gauss | VH mV |
| 1 | 0.1482 | 21.567 |
| 1.5 | 0.2223 | 32.350 |
| 2 | 0.2964 | 43.133 |
| 2.5 | 0.3706 | 53.917 |
| 3 | 0.4447 | 64.700 |
| 3.5 | 0.5188 | 75.484 |
| 4 | 0.5929 | 86.267 |
| 4.5 | 0.6670 | 97.050 |
| 5 | 0.7411 | 107.834 |

**Graph**

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**Calculations**

Slope = $\frac{32.350- 21.567}{0.2223-0.1482}$

Slope = 145.519

Using formula: $n=\frac{I\_{H}}{q × t × slope}$

where q = 1.6 x 10-19 C

 t = 0.4 x 10-3 m

n $=\frac{3x 10^{-3}}{1.6 x 10^{-19} × 0.4 x 10^{-3} × 145.519}$

we get,

n = 3.22 x 1017