# Hall Effect

Chirag Verma
Course : B.Sc. (H) Physics - III year
College Roll Number: 31830172
University Roll Number : 18036567028

November 4, 2020

| | |
|---|---|
| Date Performed: | September 29, 2020 |
| Instructor: | Prachi Yadav |

## Aim

To determine the Hall Voltage developed across the sample material.
To calculate the Hall Coeffcient and the carrier concentration of the sample material.

## Apparatus Required

Two solenoids, Constant current supply, Four probe, Digital gauss meter, Hall effect apparatus (which consist of Constant Current Generator (CCG), digital milli voltmeter and Hall probe).

## Formula Used

Hall Coefficient,

$$R_H = \frac{V_H * t}{I * B}$$

where, $R_H$ is the Hall Coefficient, $I$ is the Hall Current, $B$ is the mag. field across the semiconductor, $t$ is the thickness of the semiconductor sample.
Also,

$$R_H = \frac{1}{n \cdot e}$$

where, $n$ is the no. of charge carriers and $e$ is the electronic charge.

# Observations

1. Magnetic field in the solenoid for a particular current value:

| S.No. | Current(A) | Magnetic Field (G) |
|---|---|---|
| 1 | 1 | 0.1482 |
| 2 | 1.5 | 0.2223 |
| 3 | 2 | 0.2964 |
| 4 | 2.5 | 0.3706 |
| 5 | 3 | 0.4447 |
| 6 | 3.5 | 0.5188 |
| 7 | 4 | 0.5929 |
| 8 | 4.5 | 0.6670 |
| 9 | 5 | 0.7411 |

2. Hall Effect Material: Germanium Thickness: 0.0005m

i. I = 1A, B = 0.1482G

| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 5.751 |
| 2 | 1.5 | 8.627 |
| 3 | 2 | 11.502 |
| 4 | 2.5 | 14.378 |
| 5 | 3 | 17.253 |
| 6 | 3.5 | 20.124 |
| 7 | 4 | 23.005 |
| 8 | 4.5 | 25.880 |
| 9 | 5 | 28.756 |

ii. I = 1.5A, B = 0.2223G

| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 8.627 |
| 2 | 1.5 | 12.940 |
| 3 | 2 | 17.253 |
| 4 | 2.5 | 21.567 |
| 5 | 3 | 25.880 |
| 6 | 3.5 | 30.193 |
| 7 | 4 | 34.507 |
| 8 | 4.5 | 38.820 |
| 9 | 5 | 43.133 |

iii. I = 2.0 A, 0.2964G

| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 11.502 |
| 2 | 1.5 | 17.253 |
| 3 | 2 | 23.005 |
| 4 | 2.5 | 28.756 |
| 5 | 3 | 34.507 |
| 6 | 3.5 | 40.258 |
| 7 | 4 | 46.009 |
| 8 | 4.5 | 51.760 |
| 9 | 5 | 57.511 |

iv. I = 2.5 A, B = 0.3706G

| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 14.378 |
| 2 | 1.5 | 21.567 |
| 3 | 2 | 28.756 |
| 4 | 2.5 | 35.945 |
| 5 | 3 | 43.133 |
| 6 | 3.5 | 50.312 |
| 7 | 4 | 57.511 |
| 8 | 4.5 | 64.700 |
| 9 | 5 | 71.889 |

v. I = 3.0 A, B = 0.4447G

| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 17.253 |
| 2 | 1.5 | 25.880 |
| 3 | 2 | 34.507 |
| 4 | 2.5 | 43.133 |
| 5 | 3 | 51.760 |
| 6 | 3.5 | 60.387 |
| 7 | 4 | 69.814 |
| 8 | 4.5 | 77.640 |
| 9 | 5 | 88.267 |

vi. I = 3.5A, B = 0.5188G

| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 20.129 |
| 2 | 1.5 | 30.193 |
| 3 | 2 | 40.258 |
| 4 | 2.5 | 50.322 |
| 5 | 3 | 60.387 |
| 6 | 3.5 | 70.451 |
| 7 | 4 | 80.516 |
| 8 | 4.5 | 90.580 |
| 9 | 5 | 100.645 |

vii. I = 4.0A, 0.5929G

| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 23.005 |
| 2 | 1.5 | 34.507 |
| 3 | 2 | 46.009 |
| 4 | 2.5 | 57.511 |
| 5 | 3 | 69.014 |
| 6 | 3.5 | 80.516 |
| 7 | 4 | 93.028 |
| 8 | 4.5 | 103.520 |
| 9 | 5 | 115.023 |

viii. I = 4.5A, B = 0.6670G

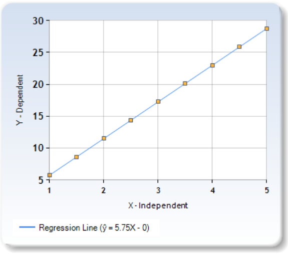
| S.No. | Hall Current(mA) | Voltage (mV) |
|---|---|---|
| 1 | 1 | 25.880 |
| 2 | 1.5 | 39.520 |
| 3 | 2 | 51.760 |
| 4 | 2.5 | 64.700 |
| 5 | 3 | 77.640 |
| 6 | 3.5 | 90.580 |
| 7 | 4 | 103.520 |
| 8 | 4.5 | 116.460 |
| 9 | 5 | 129.400 |

ix. I = 5.0 A, B = 0.7411G

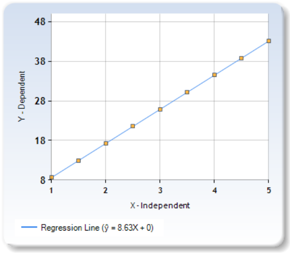
| **S.No.** | **Hall Current(mA)** | **Voltage (mV)** |
|---|---|---|
| 1 | 1 | 28.756 |
| 2 | 1.5 | 43.133 |
| 3 | 2 | 57.511 |
| 4 | 2.5 | 71.889 |
| 5 | 3 | 86.267 |
| 6 | 3.5 | 100.645 |
| 7 | 4 | 115.023 |
| 8 | 4.5 | 129.400 |
| 9 | 5 | 143..778 |

# Calculations

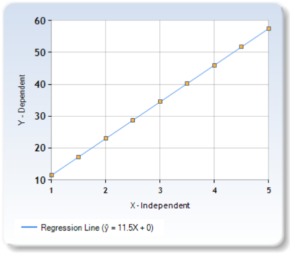
x independent $= I$
y independent $= V_H$



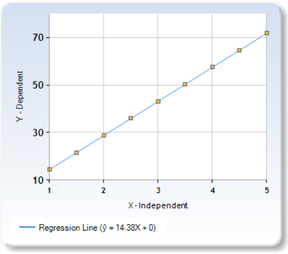

(a) I = 1A, B = 0.1482G



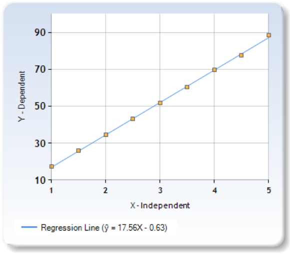

(b) I = 1.5A, B = 0.2223G



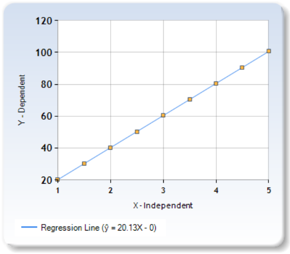

(c) I = 2A, B = 0.2964G



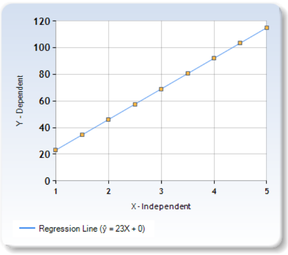

(d) I = 2.5A, B = 0.3706G



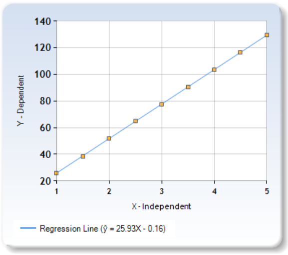

(e) I = 3A, B = 0.4447G



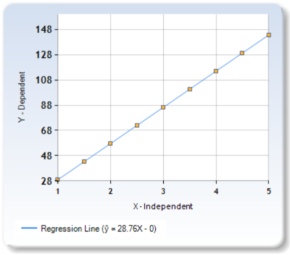

(f) I = 3.5A, B = 0.5188G




(g) I = 4A, B = 0.5929G




(h) I = 4.5A, B = 0.6670G




(i) I = 5A, B = 0.7411G

Calculations for the aforementioned graphs:

| **S.No.** | **Magnetic Field(G)** | **Slope(V/A)** | $R_H(VmG^{-1}A^{-1})$ | $n$ **(x $10^{20}$)** |
|---|---|---|---|---|
| 1 | 0.1482 | 5.75 | 0.019399 | 3.217 |
| 2 | 0.2223 | 8.63 | 0.019410 | 3.215 |
| 3 | 0.2964 | 11.5 | 0.019399 | 3.217 |
| 4 | 0.3706 | 14.38 | 0.019400 | 3.217 |
| 5 | 0.4447 | 17.56 | 0.019743 | 3.161 |
| 6 | 0.5188 | 20.13 | 0.019400 | 3.217 |
| 7 | 0.5929 | 23 | 0.019396 | 3.217 |
| 8 | 0.6670 | 25.93 | 0.019437 | 3.210 |
| 9 | 0.7411 | 28.76 | 0.019403 | 3.216 |

# Result

Hall Coefficient of the material = 0.019 Vm/(AG)
Carrier concentration = 3.2e+20 $m^{-3}$