Data Integration
Project report

Antoni Forzpanczyk and Jedrzej Szor

May 29, 2020

Abstract

The report is a conclusion of work done to implement the practical assignment. In this document we will describe the wrappers used, the safety measures taken and the decisions made in order to provide a useful and secure application.

1 Introduction

The aim of that experiment is to familarize with the phenomenon of Hall effect. Hall effect appears in a conductor through which current is flowing, when placed in magnetic field. We examined dependence of Hall voltage on electric current, magnetic field and temperature. With the results we obtained during experiment, we could calculate Hall's constant, charge carriers' density and mobility as well as conductivity. The report consists of three parts. First, in which we present a scheme of setup for analyzing Hall effect and give the method of measuring the Hall voltage. In the second part, we present the results of our measurements and calculations. The final part is a conclusion of our analysis and calculations.

2 Measurement method

Table 1: List of used symbols and corresponding quantities

Symbol	Meaning
I_p	Current
U_H	Hall voltage
B	Magnetic induction
T	Temterature
I	Driving current
R_H	Hall constant
e	Electron charge
l	Germanium sample length
a	Germanium sample width
d	Germanium sample thickness
p	Charge carriers' concentration
σ	Conductivity
R	Sample resistance
R_B	Sample resistance with B=0T

The setup consists of a power supply, teslameter, electromagnet and the sample of p-germanium placed in its gap and a DMM which plays the role of voltmeter

The p-germanium sample used in the exercise is ? x ? x ? (**a x l x d** respectively), has resistance R equal to R = ????? Ω and is placed on a plate in the gap of an electromagnet.

In the first measurement, the magnetic field B was constant and set to 300mT. We kept change the current starting at 0mA increasing it up to 40mA with a step of 5mA. Then we changed the direction of the current and measured Hall voltage again the same way with B = -300mT.

In the second measurement, the driving current Ip was constant and set to 30mA. We kept changing the magnetic field B starting from almost 0mT and increasing it up to 400mT simultaneously measuring the Hall voltage every 50mT. Then we changed the direction of the current and measured the Hall voltage the same way from 0mT up to -400mT.

Formula for the calculation of the Hall voltage:

$$U_h = \frac{1}{eq} jBa \tag{1}$$

Where:

- $\frac{1}{eq} = R_H$ (Hall coefficient).
  The Hall coefficient can be used to determine the kind of charge carriers.

Knowing the Hall coefficient we are capable of calculating the mobility and concentration p of all carriers with the following formulas:

$$\mu = \sigma R_H \tag{2}$$

$$p = \frac{1}{eR_H} \tag{3}$$

The sample conductivity σ can be computed with the knowledge of its its resistance and dimensions:

$$\sigma = \frac{l}{Rda} \tag{4}$$

3 Results of our measurements

Unfortunately, our measurements do not match to the characteristics of sample measurements. We were not able even conduct proper comppputation based on that data. Based of agreement with supervisor we used data send by an email to compute desired results.

Table 2: Measurement of the Hall voltage U_H with the respect to the current Ip flowing through the sample in constant magnetic field

I_p[mA]	U_H[mV]	B[mT]
0	3	300
6	17	300
10	24	300
16	33	300
19	38	300
24	48	300
30	56	300
34	64	300
40	74	300

Table 3: Measurement of the Hall voltage U_H with the respect to the current Ip flowing through the sample in constant magnetic field

I_p[mA]	U_H[V]	B[mT]
-40	-63	300
-35	-54	300
-30	-45	300
-26	-39	300
-20	-30	300
-15	-19	300
-10	-11	300
-6	-4	300

Table 4: Investigation of the Hall Voltage U_H dependence on magnetic induction B in constant temperature T≈????$°C$ with constant driving current

I_p[mA]	U_H[V]	B[mT]
30	386	72
30	381	72
30	359	68
30	341	65
30	321	61
30	300	58
30	282	54
30	261	51
30	238	47
30	221	44
30	202	41
30	181	37
30	164	34
30	143	30
30	121	26
30	101	23
30	84	20
30	59	16
30	42	13
30	24	10
30	1	6

I_p[mA]	U_H[V]	B[mT]
30	-26	1
30	-44	-1
30	-63	-4
30	-83	-8
30	-107	-12
30	-121	-14
30	-144	-18
30	-163	-21
30	-184	-25
30	-205	-28
30	-223	-31
30	-246	-35
30	-259	-37
30	-278	-40
30	-297	-43
30	-323	-47
30	-343	-50
30	-361	-53
30	-383	-57
30	-398	-59

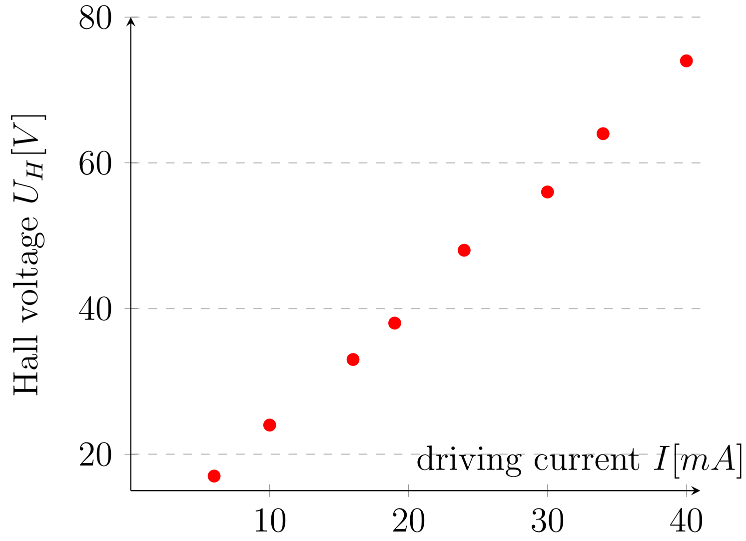

Figure 1: Dependence of I on U_H with constant B=300[mT]

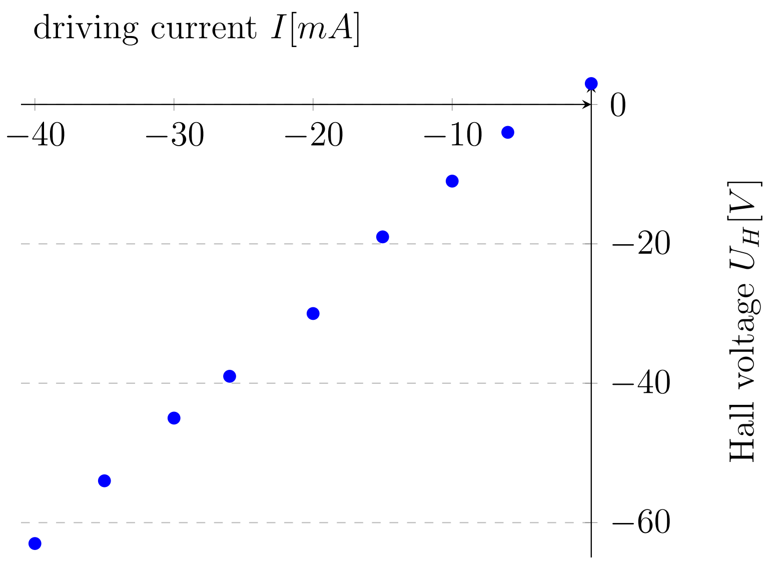

Figure 2: Dependence of I on U_H with constant B=300[mT]

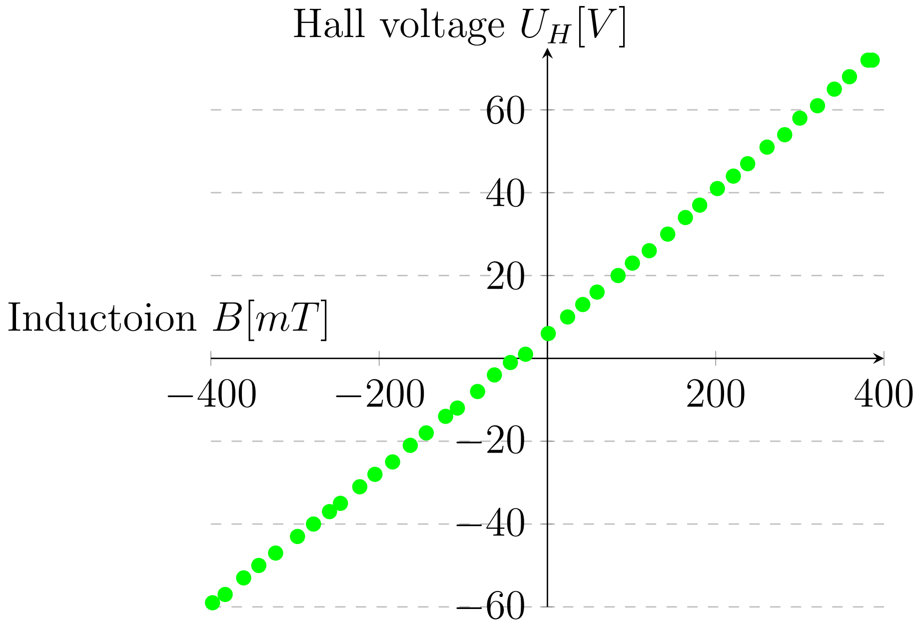

Figure 3: Dependence of B on U_H with constant I=30[mA]

Slope coefficient a, its error Δa were determined using the least square method:

$$a = 0,1683 \pm 0,0005$$

Calculating Hall constant:

$$-$$

Calculating concentration of charge carriers:

$$-$$

Calculating the conductivity σ:

$$-$$

Calculating the mobility μ of the carriers:

$$-$$

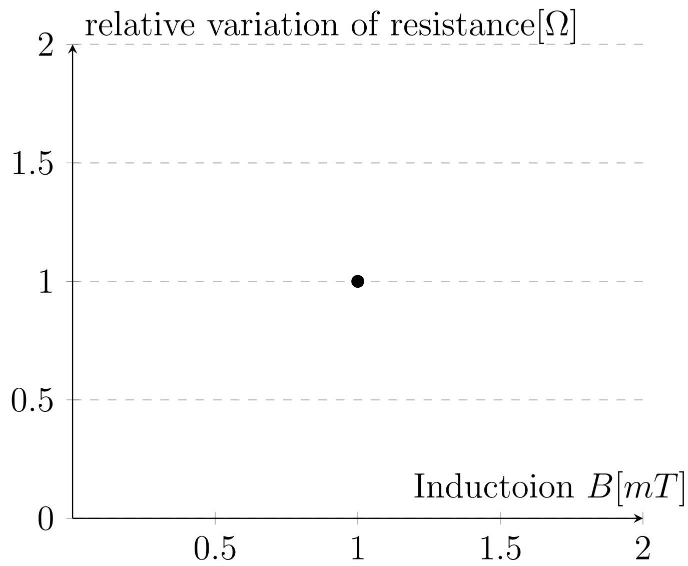

Figure 4: The relative variation of resistance $\frac{R-R_B}{R}$ plotted on magnetic induction B

4 Conclusions

5 References

[1] Perfect raport: https://ftims.edu.p.lodz.pl/pluginfile.php/94757/mod_resource/content/1/perfect_report.pdf

[2] Excercise procedure D-80: https://ftims.edu.p.lodz.pl/mod/resource/view.php?id=42953