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TEMPERATURE DEPENDENCE OF HALL EFFECT

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ABSTRACT

The Hall Effectdescribes the behavior of free carriers in a semiconductor when electric and magnetic fields are applied. According to change in electric and magnetic field. Hallcoefficient, Hall mobility, carrier concentration , type of semiconductor, conductivity etc. properties can be determined. But Hall Effect in Ge with reference to change in temperature is studied at different constant electric and magnetic field. Due to increase in temperature of Ge specimen all the properties mentioned above are studied with respect to temperature. The strong magnets for variable magnetic fieid , resistors to change temperature of Ge specimen , LM35DZ sensor to measure temperature of Ge and Hall probe are calibrated at room temperature. As temperature increases at different magnetic field Hall coefficient decreases ,carrier concentration increases and Hall mobility decreases.

***Keywords:Teflon sheet, gauss magnets, Ge semiconductor, Hall probe,Sensor LM35DZ,surface mount resistors*.**

I. INTRODUCTION

Semiconductor and effect of temperature on semiconductors is wide research field in electronics as well as thermal semiconductors. Hall effect was discovered by Edwin Herbert Hall in1879 while he was working on his doctoral degree in Maryland. The production of a voltage difference across an electrical conductor, transverse to both electric and magnetic field is studied by Hall. Hence Hall coefficient, Hall mobility, carrier concentration, type of semiconductor, conductivity etc. properties can be determined by using experimental observation for any semiconductor. It may for Silicon .Gallium Arsenide, Germanium etc. Properties of semiconductor changes according to temperature change . Effect of temperature on Si, GaAs etc are already studied by many researchers .But along with electric and Magnetic field effect (Hall Effect) on semiconductors at room temperature, there is wide area for research in same at higher temperature. Temperature dependence of Hall Effect is done by using Germanium semiconductor specimen ,low cost magnetic field variation arrangement and specially designed probe.

II.EXPERIMENTAL

2.1. Instrument design

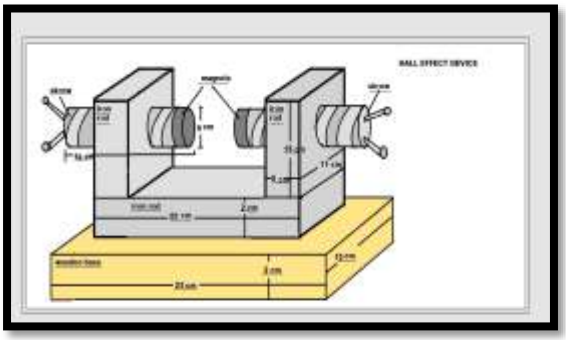


Fig. 1 **Fig. 2**

To study Hall Effete above set-up is designed "Fig 1". Two gauss magnets are fixed at the end of two iron screws, it is fitted in iron body. Whole set up is placed on wooden base. It gives homogeneous magnetic field. Field can be varied by rotating screws. It costs only □ 2000/-. It is shown in "Fig 2".

2.2 Probe design

2.2.1 Glass and Resistors

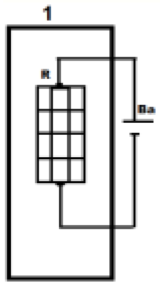
Probe is designed such that it should have heating arrangement for that we used glass slide so that heat can transfer from one face to another face. One face of glass we placed surface mount resistors .Each resistor is of 51Ω ,connected each other in series and parallel combination to give resultant of 51Ω. We used 4 x4 resisters. These are fixed on glass ,by supplying Current it will heat glass surface. The power generated is from 0.5W to 2.0W in 5V to 10V supply.

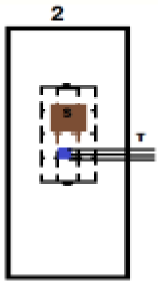
2.2.2 Semiconductor sample

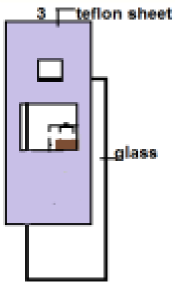
Germanium Sample is placed on another face of glass .Dimensions of Ge are thickness -0.5mm Length -1.1cm , Breadth -0.8cm .To hod sample teflon sheet is used.

2.2.3 LM35DZ Sensor

This is temperature sensor used to measure the temperature produced by surface mount resistors.This is chosen because it gives direct conversion from voltage totemperature, It has low cost, small in size, operating voltage-4to30volts, less than 60μA current drain, temperature range- from 55 ° c to150 ° c, calibrated directly in ° Celsius.







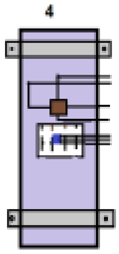


Fig. 3 **Fig. 4** **Fig. 5** **Fig. 6**

R-resistorsS –sampleT - sensor Ba –Battery

Connection are made according to Flemings left hand rule. Mounting all components on glass for probe preparation is as shown in “Fig.3”,“Fig. 4”,“Fig. 5”and “Fig. 6”.

2.3. Calibration of devices

2.3.1 Calibration of surface mountresistors and sensor LM35DZ

We have chosen different places on resistor area. At all places we measured temperature and it shows same temperature at all places. It shows uniform sample heating. Voltage to degree centigrade conversion of temperature sensor LM35Z and temperature measured by thermometer are same.

2.3.2 Calibration of Hall instrument

We fixed two magnets at inner ends of screw. By using tangentgalvanometer wemarked north and South Pole. By using gauss meter magnetic field is measured with changing distance between two magnets .It shows same magnetic field as in electromagnet device. At room temperature and at different magnetic fields parameters like Hall coefficient, mobility, resistivity and carrier concentration values are matching with the values for the same taken by standard probe and electromagnets.

2.4 Recordofobservations

Readings are taken at different temperature and magnetic fields and corresponding hall coefficient (R_H) , Carrier concentration (n) and Hall mobility(μ) are calculated and are summarized in “Table 1” and graphical representation can be shown in “Fig.7”, “Fig.8”and “Fig.9”.

Table 1

Sl .No.	**Magnetic Field G In Tesla**	**Parameters**	**Temperature**		
			30^0C	**35^0C**	**40^0C**
1.		IR_HI	0.0201	0.0175	0.0139

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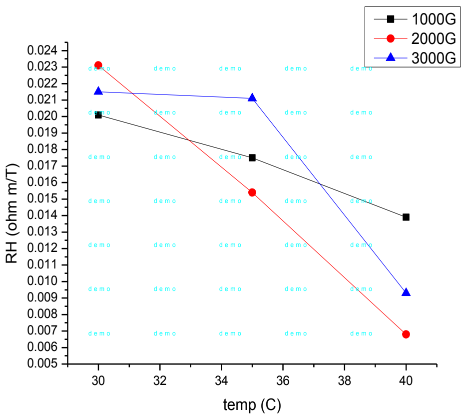
	1000	Ωm/T			
2.		n X 10^{20} per m^3	3.0950	3.5630	4.4750
3.		μ $m^2/Vs.$	0.0154	0.0133	0.0106
4.	2000	IR $_H$I Ωm/T	0.0231	0.0154	0.0068
5.		n X 10^{20} per m^3	2.6970	4.0550	9.0660
6.		μ $m^2/Vs.$	0.0176	0.0110	0.0050
7.	3000	IR $_H$I Ωm/T	0.0215	0.0211	0.0093
8.		n X 10^{20} per m^3	2.9040	2.9570	6.7030
9.		μ $m^2/Vs.$	0.0164	0.0161	0.0071

Temperature Vs Hall coefficient temperatureVsCarrier concentration



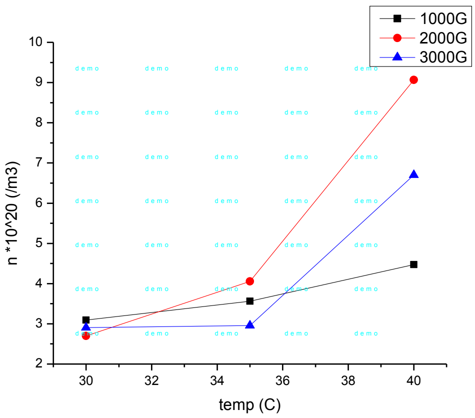


Fig. 7

Fig. 8

Temperature Vs hall mobility

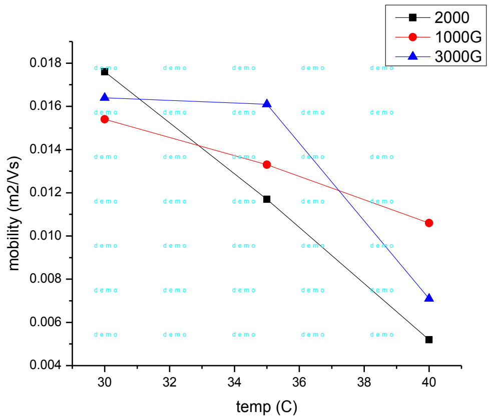


Fig. 9

III. CONCLUSION

For Ge sample of semiconductor Hall coefficient decreases,mobility decreases and carrier concentration increases with increase in temperature.Hall effect principle is used in IC switches hence it is used as Open/close detector in many portable devices, Screen orientation in devices in digital camera , tablets etc. and in many devices at higher temperature.

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