Performance of Magnetometer Based on Hall Sensor THS118

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Introduction

The purpose of this study is to construct (Fig. 1) and examine the performance of a Hall sensor magnetometer at low temperature and high magnetic field. The Hall sensor used in this construction is the GaAs Hall Sensor THS118 made by the Toshiba Corporation (small black rectangular device in Fig. 2).

Figure 1. Soldering Hall sensor to 8DP holder

Figure 2. 8DP placed into 16DIP holder to test.

Hall Effect Sensors are devices which are activated by an external magnetic field. We know that a magnetic field has two important characteristics flux density (field strength, B) and polarity (North and South Poles). The output signal from a Hall effect sensor is the function of flux density around the device.

Hall Effect and Its Applications

Hall effect based devices make up the largest part of all commercial magnetic sensors (for example, see them used in a car: Fig. 3).

Figure 3. Hall sensors as used in automotive

Figure 4. Hall effect and voltage diagram (+)

Figure 5. Hall effect and voltage diagram (-)

The Hall effect (Figs. 4 and 5) is due to the current in a conductor and consists of the movement of many small charge carriers, typically electrons, holes, ions or all three. In the absence of magnetic field path of charge carriers is straight between collisions (for example, with impurities).

If a magnetic field with a perpendicular component is applied, the paths of the charges between collisions are curved, due to a Lorentz force, and charges are accumulated on faces of the material leading to an asymmetric distribution of charge density across the Hall element that is perpendicular to both the path and applied magnetic field.$$
V_H = \frac{IB}{Ned}
$$

Experiment

1. Made a model of a probe used in the NHMFL magnets.
2. Designed and made a sensor holder which properly fit in the probe.
3. Assembled an experimental set up consisting of a current source and a voltmeter.
4. Soldered four THS118 sensors to the sensor holders: see Fig. 6.

5. Tested THS118 sensors on the bench (Fig. 7). I was looking for similarity in the parameter of the sensors. I placed a permanent magnet on the top of the sensor. On the current source I selected the current and took the reading of the Hall voltage. Results of these tests are presented in the following graphs (Figs. 8 and 9):

Figure 6. Soldering the THS118 to the 8DP holder

Figure 7. Inserting the THS118 to the 16DIP holder

Figure 8. The performance of the sensors when tested at room temperature.

Figure 9. Ratio of the sensor Hall voltage to the current used.

6. It is seen in the figures that sensors #1 and #4 have the closest parameters. These sensors have been installed on the same sample holder.

7. Sample holder with sensors #1 and #4 has been mounted on a probe (see Fig. 10) and tested in 16 Tesla magnet. The result of this test is shown in Fig. 11.

Magnetometer

A magnetometer is an instrument that measures the phenomenon in terms of magnetic flux density. Substances and materials that disturbs this flux are called magnetic. In the presence of magnetic materials, a magnetometer detects the amount of distortion these materials cause, and also measures the strength of magnetic fields.

Figure 10. Probe used to test my magnetometer

Conclusion

I constructed and tested a magnetometer using two Hall Sensors THS118. The data collected showed that the selected THS118 had similar characteristics in the magnetic field below 6 Tesla.

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