Quantum Hall Effect on Packaged 2DEG Hall Sensors

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Introduction

Most Hall sensors are based on bulk permanent magnets, III-V materials, and Silicon. These sensors have limited service temperature range, limited magnetic field range, low field resolution, and planar Hall effect. Hall sensors based on two-dimensional electronic gas (2DEG) could address these limitations. Several 2DEG Hall sensors in bare chip form have been demonstrated in the last decade. However, data related to fully packaged, commercial grade 2DEG Hall sensors is still scarce. Moreover, it is still not clear how the Quantum Hall effect would ultimately affect maximum detectable magnetic field of 2DEG Hall sensors at cryogenic temperatures.

Experimental

2DEG Hall sensors are fabricated and packaged using proprietary techniques developed at Lake Shore Cryotronics. Sensors with and without encapsulation were used to evaluate effect of encapsulation. Measurements were conducted using the SCM-2 system. Temperatures below 5K were controlled using a Lake Shore capacitance sensor (model CS-501GR) in a AA can package.

Results and Discussion

Fig. 1 shows Hall voltage at 18T as a function of time. Excitation current is 1mA and temperature is 4.2K. As seen, there is an 1% increase in Hall voltage response after encapsulation probably due to stresses imposed by encapsulation. Both sensors show negligible drift over time (< $7.2*10^{-9}$ V/s or < 2.6 µV/hr, which is equivalent to 50 µT/hr.) We also performed field sweep (-18T to 18T), current sweep (0.1 to 1.0 mA), and temperature (1.7K to 77K) sweep, no hysteresis (data not shown) was observed for both sensors. Fig.2 shows Hall voltage as a function of magnetic field. Blue line is experimental data while read line represents curve fitting result. Quantum Hall effect becomes apparent at ~8T and Hall voltage retains monotonic response when magnetic field is below ~30T.

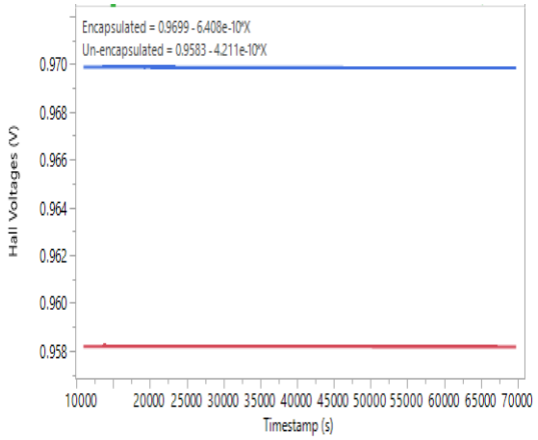

Fig.1. Hall voltage as a function of time for encapsulate (blue) and un-encapsulated (red) sensors at 18T.

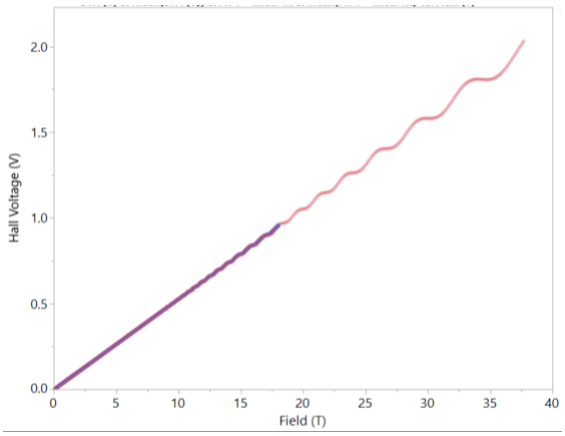

Fig.2. Hall voltage as a function of magnetic field at 4.2K. Blue line is experimental data; red line represents curve-fitting data.

Conclusions

Stability of a packaged 2DEG Hall sensor has been demonstrated. The result indicates the maximum detectable magnetic field is above 18 Tesla.

Acknowledgements

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References

[1] Koide, S., *et al.*, Journal of Physics: Conference Series 352, 012009 (2012).