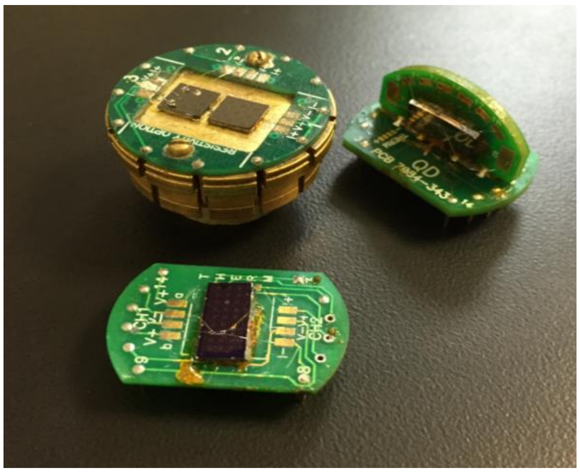
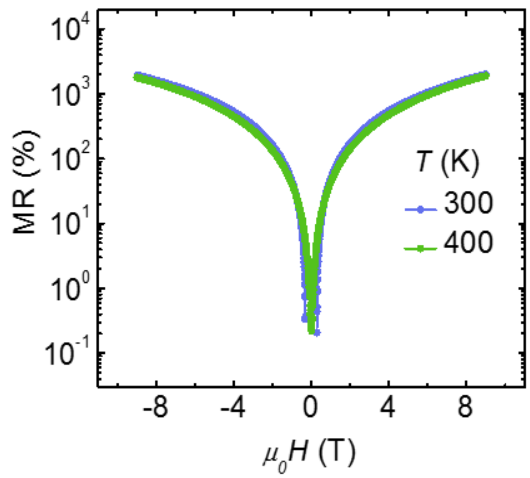
Centre for Advanced 2D Materials

Joint Development Opportunity

A Highly Sensitive Graphene-based Magnetoresistance Sensor


Prototypes of graphene-based magnetoresistance sensor



Graph of *MR* as a function of magnetic field strength *H* at 300 K and 400 K

Ref: K. Gopinadhan, Y. J. Shin, R. Jalil, T. Venkatesan, A. K. Geim, A. H. Castro Neto & H. Yang, ***Nature Comm.*** 6, 8337, 21 Sep 2015

Technology Background

This invention is a thin film sensor has a *few-layered graphene structure deposited on substrates like hexagonal boron-nitride*. The degree (in %) to which its electrical resistance changes as a result of exposure to an external magnetic field is its **magnetoresistance** (**M**R). The greater the MR, the more sensitive the sensor is. This *sensitivity depends on the material's intrinsic carrier density and carrier mobility*, which can be tuned in this sensor using varying gate voltages.

Application Areas

- Highly accurate and sensitive positional, rotational and displacement sensing;
- High temperature environments where reliability and precision are crucial, such as automobiles, aeronautics, biomedicine, robotics, ultraprecision machines;

***Office of Industry and Innovation*, Centre for Advanced 2D Materials**
6 Science Drive 2, Block S16-06-01, National University of Singapore, Singapore 117546; +65 6601 3763

- Consumer electronics, information and communications technology, biotechnology and automotive technology

Performance

Source	Sensitivity (mV/mT)	Temperature drift (%/°C)	MR (%)
Commercial	50 – 175*	≤ 1*	≤ 3, ≤ 20, ≤ 40 → AMR, GMR and TMR devices, resp.*
Invention *(lab conditions)*	**Up to 18**	**-5×10^{-4}**	**2,000 (local, at 400 K) and 90,000 (non-local, at 300 K)**

**References from market data*

Benefits Offered

- Very small (compact footprint) for higher spatial resolution and sharper signal resolutions;
- Drastically reduces raw material costs;
- Vastly improved ruggedness and reliability (i.e. the ability to withstand vibrational effects and shock impacts);
- Fully operational in high temperature environments;
- Very stable performance between room temperature and 400 K;
- Mobility of charge carriers (which affects the response of the sensor to magnetic field changes) in the graphene multilayers is partially adjustable by tuning voltage across sensor;
- Novel, scalable and economical process using graphene instead of silicon and indium antimonide

Solutions to Problems

- No need for additional circuitry to compensate for temperature drift;
- Massive reduction in sensor size with corresponding advantages in increased range of applications especially in highly space-constrained environments, e.g. medical areas and construction;
- High sensitivity to low magnetic fields;
- Wide range of applicable substrates unlike the limitations presented in silicon and indium antimonide sensors

Contact: oiiquery@nus.edu.sg and +65 66013763