Extreme Extraordinary Magnetoresistance in Encapsulated Monolayer Graphene Devices

Bowen Zhou
Technical University of Denmark, Fysikvej, building 309, 2800 Kgs. Lyngby, Denmark
bowez@dtu.dk

Abstract
We report a proof-of-concept study of extraordinary magnetoresistance (EMR) in devices of monolayer graphene encapsulated in hexagonal boron nitride having a central metal shunt [1]. Extremely large EMR values, $MR=(R(B)-R_0)/R_0 \sim 10^7\%$ are achieved, exceeding that achieved in state-of-the-art semiconductor devices by one order of magnitude [2]. The zero-field resistance R_0 approaches or crosses zero as a function of the gate voltage due to ballistic transport. We highlight the sensitivity, dR/dB~30KΩ/T, which in two-terminal measurements is the highest reported for EMR devices and exceeds previous results in graphene-based devices by a factor of 20 [3]. An asymmetry in the zero-field transport is traced to the presence of pn-junctions at the graphene-metal shunt interface. We are improving EMR effect to make better magnetic field sensors.

References

[1] Bowen Zhou, K. Watanabe, T. Taniguchi, and E. A. Henriksen, Appl. Phys. Lett. 116, 053102 (2020)
[2] S. A. Solin, T. Thio, D. R. Hines, and J. J. Heremans, Science 289, 1530–1532 (2000)
[3] J. Lu, H. Zhang, W. Shi, Z. Wang, Y. Zheng, T. Zhang, N. Wang, Z. Tang, and P. Sheng, Nano Lett. 11, 2973–2977 (2011)

Figures

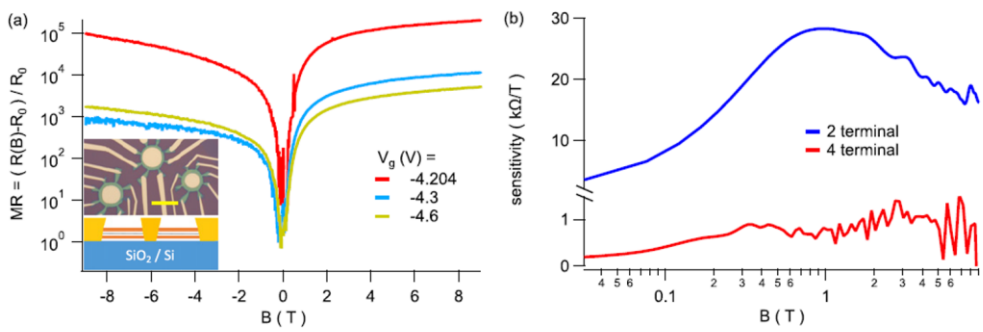

Figure 1: The highest observed magnetoresistance (a) and sensitivity dR/dB (b) for the device at room temperature. The inset shows the microscopic image and schematic side view of the devices; the yellow scale bar is 10 µm long.

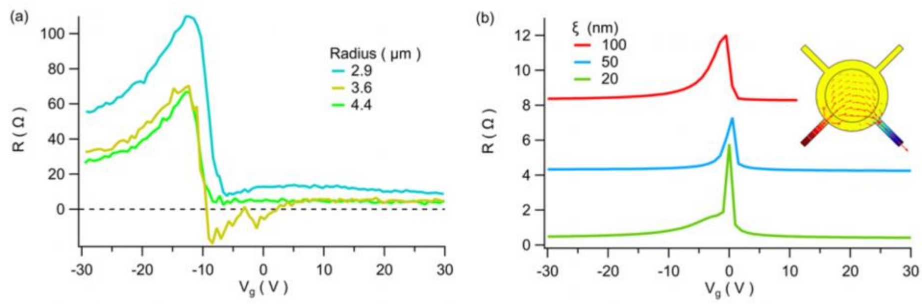

Figure 2: Experimental data (a) and model prediction (b) for asymmetry in the gate-voltage-dependent resistance near the metal-graphene interface at B = 0 T and room temperature. The traces in (b) are offset for clarity. Inset: geometry of the EMR device used in finite element simulation.