

Graphene Spin Transistors

Graphene is a single atomic layer of carbon in a planar hexagonal lattice. The discovery and electrical characterization of graphene in 2004 has generated great excitement in the physics and engineering community due to its extraordinary electrical properties. It is naturally a nanoscale material with remarkably high electron mobilities. The magnetic and spin dependent properties of graphene are just beginning to be explored.

The goal of the proposed research is to demonstrate a graphene-based spin field-effect transistor (spinFET), a device in which the spin-polarized current of electrons flowing through a graphene channel between two magnetic contacts is modulated by the electric or magnetic field of a gate. The proposed device and its mode of operation are illustrated in the figure shown on the right. The graphene spinFETs will consist of ferromagnetic metal source and drain contacts on a single-layer graphene (SLG) or few-layer graphene (FLG) channel. Spin polarized electrons injected into the channel from the magnetic source travel to the magnetic drain contact where they are admitted with low impedance only if their spin orientation matches the magnetization of the drain. While travelling through the channel, the spin polarized electrons may precess around an effective magnetic field produced by the gate. If the resulting orientation of the spin is opposite of the drain, they are not admitted into the drain and the device will be in a high resistance or “off” state.

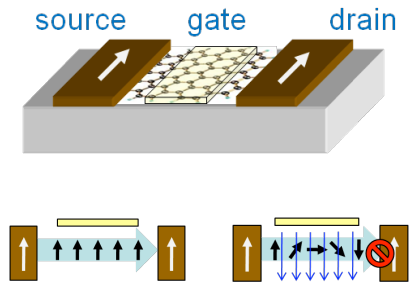


Illustration of the structure of a spinFET (top).
Operating principle of the spinFET (bottom).

Devices such as these may some day replace conventional “charge-based” field effect transistors in integrated circuit, offering higher speed and lower power operation at nanoscale dimensions.

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Investigators: Dr. Albrecht Jander, OSU
Dr. John Conley, OSU
Dr. Raj Solanki, Portland State University