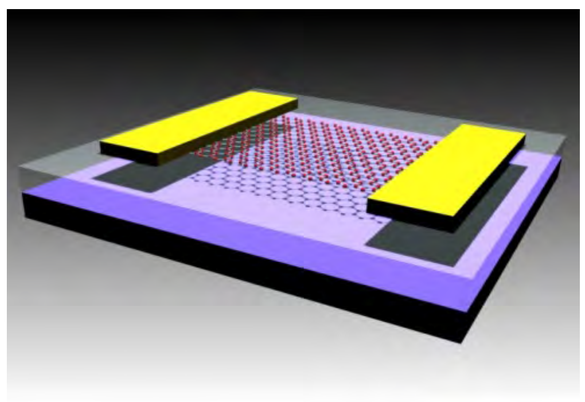
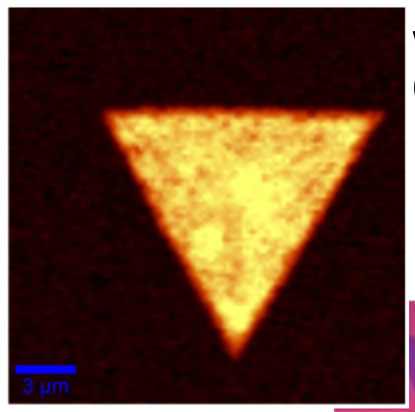
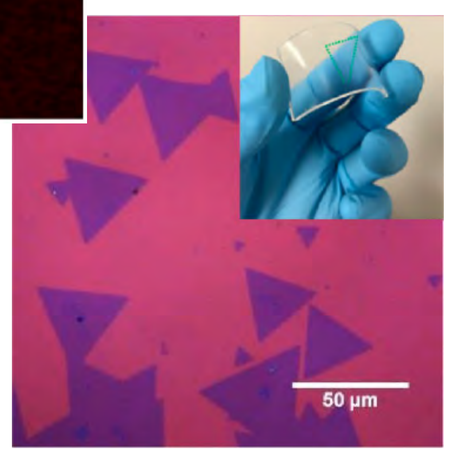
Novel Atomically Thin Materials for Electronics



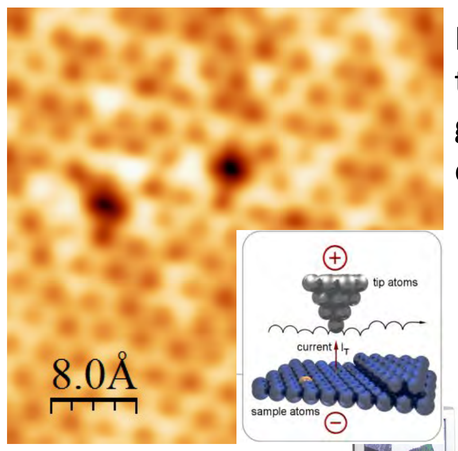
Monolayer graphene with electrical contacts



WS_2 on PDMS
(with C. Zheng, Q. Bao)



Photoluminescence of MoS_2
(with C. Zheng, Q. Bao)



Low-temperature scanning tunneling microscopy of Na_3Bi grown by molecular beam epitaxy

Low-temperature scanning tunneling microscope

Lead Scientist

Prof. Michael S. Fuhrer
ARC Laureate Fellow

Research Expertise

Prof. Fuhrer's research group is exploring the electronic properties of novel atomically thin materials such as graphene, layered transition metal dichalcogenides (e.g. MoS_2), layered topological insulators (e.g. Bi_2Se_3). The goals are to understand the mechanisms of electronic conduction in these materials and exploit their electronic properties in novel device concepts.

Key Contact

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Applications

Transistors. Graphene has an intrinsic mobility exceeding 100,000 cm^2/Vs and can be used for very high speed transistors [1]. Layered semiconductors like MoS_2 and WS_2 have bandgaps of ~2 eV, and show mobilities in the 100's of cm^2/Vs and are compatible with flexible substrates [2].

Transparent conductors. Doped few-layer graphene can achieve a visible transparency of 91.7% and resistivity of 3 Ohms/square [3].

Photosensors. Graphene's broadband absorption is useful for THz photodetection [4].

Novel electronic devices. Topological insulators can be used as the basis of new electronic switches with zero resistance at room temperature.

Fuhrer group references:
[1] *Nature Nanotechnology* **3**, 206 - 209 (2008).
[2] *Appl. Phys. Lett.* **102**, 042104 (2013).
[3] *Nature Communications* **5**, 4224 (2014).
[4] *Nature Nanotechnology* **9**, 814–819 (2014).

Research Facilities

Nanofabrication. Fuhrer's group uses electron beam lithography in-house and at the Melbourne Centre for Nanofabrication to construct nanodevices from novel materials.

Device characterization. Fuhrer's group has expertise in characterizing the electronic properties of devices, including at low temperature and high magnetic fields.

Molecular beam epitaxy. Fuhrer's group uses MBE to grow novel materials and heterostructures.

Scanning tunneling microscopy. Fuhrer's group has two low-temperature, high magnetic field STMs with unique capabilities to grow new materials *in situ* and study their electrical transport properties as well as atomic structure.