Nanomaterial and Nanodevice Fabrication

During this internship, the undergraduate USRA researcher will work on a team of researchers and gain hands-on experience with preparing and characterizing new nanomaterials and fabricating next-generation sensors or electronics. The student will learn to prepare materials as thin as one atomic layer in thickness and incorporate these materials into devices for new applications. At these low physical dimensions, nanomaterials exhibit extraordinary properties not observed in bulk materials such as tunable bandgap, high carrier mobility, high surface-volume ratio, flexibility, and piezoelectricity. The student will be supervised by Dr. Michael Adachi, and work in the Nanodevice Fabrication Group. This internship involves gaining hands-on experience using fabrication equipment used in the microelectronics industry.

Responsibilities will include a subset of the following, depending on time and project of interest:

- Prepare nanomaterials using microfabrication equipment.
- Characterize electrical or optical properties of nanomaterials.
- Fabricate semiconductor devices incorporating nanomaterials.
- Characterize the piezoelectric response of sensors.
- Characterize the effect of temperature, electrical bias, gas, on device performance.

The student can select one of the following projects:

**Project 1: Fabrication of nanoelectronic devices**

Conventional diodes are formed between p-type Si with n-type Si. In 2D materials, diodes can be formed between different layers. The USRA student will fabricate diodes/photodetectors in the cleanroom using 2D materials. This project consists of patterning metal electrodes, fabricating devices, and characterizing devices.

**Project 2: Development of Piezoelectric sensor**

Theoretical and experimental studies in the literature have shown that MoS$_2$ sheets with an odd number of layers is piezoelectric; monolayer MoS$_2$ has a piezoelectric coefficient similar to that of conventional piezoelectric materials (ZnO and AlN). The USRA student will fabricate piezoelectric sensors in the cleanroom using MoS$_2$ for underwater sonar applications.

**Project 3: Characterization of tunable bandgap nanomaterials**

The bandgap of quantum confined materials is tunable (ie. their emission wavelength can be controlled) making them promising for light-emission and photodetection applications. The student will investigate the effect of mechanical strain, applied vertical electric field, or adsorption by alkali ions on the bandgap of 2D materials. This project involves preparing 2D materials in the cleanroom and measuring the electrical/optical properties of these materials.
The thickness of a nanosheet can be controlled to be as thin as a monolayer (Fig 1a), and two metal contacts are connected to the 2D material to make a diode (Fig 1b).

Figure 1: Microscope images of a) thickness control from bulk to a monolayer and b) a fabricated diode.

**Desired qualifications:**

- Taken electronic devices/microelectronics courses (e.g. Ensc 324 and 225).
- Previous experience working in a cleanroom or research laboratory.

This is an excellent USRA internship for a student looking for an undergraduate thesis project, or interested in potentially pursuing graduate studies.

More information about the group’s activities can be found on the group website [http://nanodevice.fas.sfu.ca](http://nanodevice.fas.sfu.ca).

**Application process:** Email applications (resume and transcript) directly to Dr. M. Adachi (Email address: mmadachi@sfu.ca) before Jan. 19th, 2018.