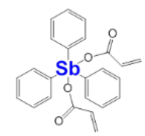
Descriptions of 2019 SURP Positions Available on the Albany Campus of SUNY Poly

Sixteen Professors and 35 Positions

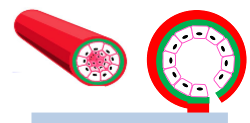
Professor Robert Brainard, RBrainard@SUNYPoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

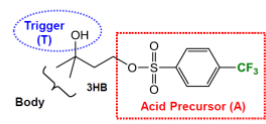
1) **Molecular Organometallic Resists for EUV (MORE).** Metal-based resists for use by the microelectronics industry to fabricate future integrated circuits. Students will synthesize and/or characterize compounds containing antimony. These compounds are designed to undergo chemical reactions when irradiated with 13.5 nm extreme ultraviolet light resulting in a change in solubility. **Student Background:** No experience necessary, but strong background in chemistry, particularly organic chemistry. Rising sophomores welcome.



2) **Bio Roll Up.** The design and synthesis of organic polymers and photoresists focused on a technique designed to engineer small organelles in the human body. Students will synthesize polymers and formulate polymers into photoresists, that will be coated onto silicon wafers into multiple stacks of hydrogel films. Students will study the kinetics of self-assembly of these multi-layer stacks under conditions suitable for cell growth. Students may participate in growing cells onto these stacks. **Student Background:** No experience necessary, but strong background in chemistry and biology required. Rising sophomores welcome.



3) **Artificial Enzymes.** The goal of this project is to design and synthesize molecules that can be used to perform a specific task under biologically-relevant conditions. This task will help support a multi-billion dollar industry, and will help improve human health. **Student Background:** No experience necessary, but strong background in chemistry, particularly organic chemistry. Rising sophomores welcome.
4) **Acid Amplifiers for Biological Applications.** Acid Amplifiers (AA) are molecules that can amplify the concentration of acid. Our group has expertise in the design of AAs for use in polymer matrices at high temperatures (~130 °C). For this project, however, we need to design AAs that can work in aqueous solutions at 37 °C. The intellectual challenge of designing molecules will be similar, but the structure of the AAs in this project will be completely unique. **Student Background:** No experience necessary, but strong background in chemistry, particularly organic chemistry. Rising sophomores welcome.



5) **High-Resolution Lithographic Process for Microelectronics.** This project would require a student to design, synthesize and evaluate the molecules that would be used in a process to produce high-resolution patterns. Ultimately, the goal of this project will be to develop a process can be used to manufacture integrated circuits. **Student Background:** No experience necessary, but strong background in chemistry, particularly organic chemistry. Rising sophomores welcome.
6) **Stochastic Effects in EUV resists.** This project will in collaboration with Professor Greg Denbeaux's group. In our group, a student will prepare a range of polymers with different compositions. He/she will expose the sample with low energy electrons, followed by atomic force microscopy measurements of the subsequent surface roughness. The spatial frequencies and occurrences of pits and valleys will provide insight into the exposure process. **Student Background:** background/experience in chemistry, physics, or materials science preferred.

Professor Nathaniel Cady, ncady@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Neuromorphic Computing.** The Cady research group is focusing on the development of novel chips that are customized for neuromorphic computing applications, based on memristor (resistive memory) technology. The student working on this project will be involved in the testing and/or simulation of these chips at the SUNY Poly site in Albany, NY. **Student Background:** background/experience in electrical engineering, computer engineering, or computer science.
2) **Lyme Disease Biosensor.** The Cady research group is developing biosensors for diagnosing Lyme disease at early stages of infection. The intern on this project will assist with optimization and validation

of the sensor platform that we are developing. **Student Background:** Interest in biology, and can have background in biology, chemistry, or an engineering field. It is preferred that the student researcher have prior hands-on laboratory experience.

Professor Michael Carpenter, mcarpenter@SUNYPoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Plasmonics-Based Sensors.** Gold nanoparticles embedded in metal oxides have rich spectral properties which can be used in a variety of sensing applications including chemical, temperature and pressure sensors. Students will participate in deposition and characterization of these materials as well as test them for their viability as sensors. **Student Background:** No experience necessary, but background in chemistry, physics or other science/engineering fields is needed.

Professor Greg Denbeaux, gdenbeaux@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Low energy electron exposures of resist.** We are working toward an understanding of the low energy electron interactions in photoresists for EUV lithography. This summer, our goal will be to test and implement improvements to the power supply and low energy electron gun to get electron energies below 5 eV for exposures of the EUV resist. The primary product will be measurements of the outgassed molecules as an indicator of the chemical reactions that have occurred due to the exposure. Understanding the low energy response of these materials will help in the optimization of better performing, more efficient photoresists for the semiconductor industry. **Student Background:** background/experience in electrical engineering, physics, or materials science preferred.
2) **Stochastic effects in EUV resists.** This project will involve low energy electron exposures of EUV photoresists, followed by atomic force microscopy measurements of the subsequent surface roughness. The spatial frequencies and occurrences of pits and valleys will provide insight into the exposure process. **Student Background:** background/experience in electrical engineering, physics, or materials science preferred.
3) **Nanoparticle measurements from vacuum components.** The ability to detect nanoparticles is of critical importance to the semiconductor industry since the particles landing on the wafers can cause defects and affect the yield of the process. We are working on techniques for measuring particles in vacuum systems. The student will work with particle measurements of valves for vacuum systems and custom measurements of the defect generation within turbo pumps. **Student Background:** background/experience in physics, or materials science preferred.
4) **Photo-decomposable quenchers for EUV lithography** There is current interest in the use of photo-decomposable quenchers to enhance resolution in EUV photoresists. The fundamental mechanism is unclear since at a basic level the photo-decomposable quencher will be competing with the photoacid generator for the exposure. In this project, we will examine the exposure mechanism for the photo-decomposable quenchers and help determine how the presence of the photo-decomposable quenchers affects the reaction rate in the photoacid generators. **Student Background:** background/experience in physics, or materials science preferred.
5) **Negative resist crosslinking rates.** Little is known about the number of reactions between neighboring molecules in negative resists, how efficient those reactions are to the exposure, and how many reactions are required before the resist becomes insoluble in developer. This experimental plan will use EUV and electron exposures followed by development and then gel permeation chromatography (GPC) or dynamic light scattering (DLS) to deduce the number and size of the resulting agglomerates due to the exposure. **Student Background:** background/experience in electrical engineering, physics, or materials science preferred.

Professor Spyros Gallis, sgalis@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Development of CMOS-compatible silicon carbide nanostructures based on ultrathin self-aligned nanowire arrays**. We will develop new scalable silicon carbide (SiC) nanostructured materials for use in a plethora of emerging applications, such as nanowire-based sensing, single-photon sources, quantum LEDs, and quantum photonics. We will investigate how synthesis, integration methods, and fundamental factors (e.g., nanostructure, defect density), affect the optical and electrical properties of

these deterministically-fabricated SiC nanowire arrays. **Student Background:** Materials Science and Engineering; Electrical Engineering. **Additional info:** https://www.mdpi.com/2079-4991/8/11/906

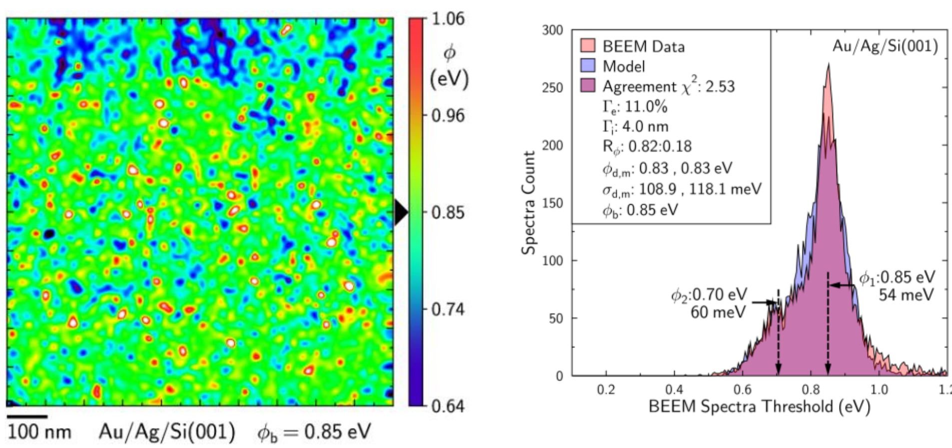
2) **Engineering telecom C-band emission and placement of rare-earth ions by self-aligned nanophotonic structures.** The Gallis (SGNano) research group is developing novel rare-earth doped nanophotonic structures for telecom C-band quantum communication applications. The underlying theme is to design ultrathin nanostructures to modify the local electromagnetic environment of rare-earth ions, significantly changing their emission rate and radiation distribution. Theory and modeling will be employed to investigate the effects of synthesis, doping, and the geometry of the nanophotonic structures on the emission properties. **Student Background:** Physics; Engineering. **Additional info:** http://arxiv.org/abs/1707.05738

3) **Study of emerging layered semiconductor materials**. We will study new chemical strategies to the surface treatment of emerging layered gallium telluride (GaTe) nanomaterials to ensure effective surface passivation against oxidation. We will study and develop different designs of GaTe-based layered nanosystems for solid-state quantum emission applications. We will leverage passivation to obtain the time-evolution physical properties of these GaTe nanosystems (e.g., polarization-dependent light-matter interactions, defect-related photoluminescence). **Student Background:** Physics; Materials Science and Engineering.

Professor Vincent LaBella vlabella@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Computational Modeling of Hot Electron Scattering for Nanoscale Schottky Barrier Visualization.** Electrostatic barriers at material interfaces are the foundation of electronic and optoelectronic devices. Their nanoscale uniformity is of paramount concern with the continued scaling of devices into the sub 10 nm length scale and the development of futuristic nanoscale devices. The electrostatic barrier at metal-semiconductor and metal-insulator-semiconductor interfaces can be visualized using a scanning tunneling microscope in a mode called ballistic electron emission microscopy (BEEM). The BEEM method measures the fraction of the tip current that makes it from the metal into the semiconductor as a function of tip bias and position. The local barrier height is measured by acquiring tens of thousands of BEEM spectra on a grid of tip positions and then fitting them to extract the threshold for onset of BEEM current, which is a measure of the minimum energy the carriers need to surmount the barrier. A false color image or map as well as histograms of these thresholds for a mixed Au/Ag/Si(001) sample are displayed in the figures.



Computational modeling has been developed to extract information about the interface composition and inelastic and elastic scattering rates from the measured histograms. The modeling for the mixed Au/Ag system indicates a mixture of two barrier heights from the individual metal species as well as a skewing to higher energy from the scattering of the hot electrons. Incomplete silicide formation as well as nanometer thick dielectric layers have also been studied and provides new insight into their effects on the electrostatics that is not possible with conventional bulk transport measurements. **Student Background:** Physics, and computer programming: Matlab, C/C++, Python, PHP, SQL. Knowing how to program for GPU boards (Nvidia CUDA) would be a plus but not required.

Professor James Lloyd jlloyd@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Statistics of Failure.** No two devices are created equal, and no two wafers are identical, especially with respect to reliability. Thus, there are serious wafer to wafer and within wafer variations that need to be addressed when extrapolating test data to real chips. Note that a typical test uses 16 samples and a typical device may have a half a billion circuits. Thus the correct way to measure is important. Proposed here is to perform some reliability tests and sampling by different methods and comparing what the predictions would be. 1) "random" sampling from the entire population from several wafers, 2) finding the failure distribution of several wafers and extrapolating from there or 3) getting all my data from one wafer and seeing how other wafers might change the predictions. We have samples that can be used. The student would prepare the samples, run the tests, analyze the data and we would discuss the meaning of what we discovered. This should be publishable. **Student Background:** Materials Science, Mechanical Engineering, Physics.

Professor Woongje Sung wsung@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A or C.

1) **Theoretical comparison between Planar and Trench type SiC MOSFETs:** A trench MOSFET is expected to provide a lower on-resistance in comparison with a planar MOSFET. However, in SiC, the corner of the trench not only degrades the breakdown voltage but also introduces a high electric field at the gate oxide. It is important to theoretically compare the performance of trench and planar MOSFETs. The student working on this project will conduct extensive 2-D device simulations. **Student Background:** Semiconductor device physics.
2) **Avalanche capability of SiC MOSFETs:** It is very important that a power MOSFET does not undergo a destructive failure while it is under an avalanche breakdown condition up to a sufficiently large current. In order to achieve high avalanche energy, a power MOSFET needs to be designed in such a way that the avalanche condition is initiated in the cell structure instead of the edge termination, periphery, or metal routers. The student will use 2-D device simulator, propose a novel idea, and test the avalanche capability. **Student Background:** Semiconductor device physics.
3) **Reliability of SiC MOSFETs:** The reliability assessment of SiC MOSFETs becomes more important as static performances are getting almost ideal. This project intends to 1) survey reliability tests for SiC MOSFETs, 2) study test conditions, 3) identify any difficulties in the reliability evaluations, 4) understand metrics and current status of SiC MOSFETs, 5) propose device designs or process schemes to improve reliability of SiC MOSFETs. **Student Background:** Semiconductor device physics.

Professor Scott Tenenbaum, stenenbaum@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Structurally-Interacting RNA (sxRNA).** Alginate hydrogel is a biocompatible and FDA-approved materials for biomedical applications. The student working on this project will learn how to make alginate hydrogel microstrands and further optimize the process for controlled release of growth factors and/or 3D cell culture. **Student Background:** A basic understanding of molecular biology and genetics would be helpful.

Professor Susan Sharfstein, ssharfstein@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Project 1.** Development of novel methods for rapid measurement of heparin activity in cell culture medium Currently heparin is purified from animal tissues, with the concomitant risks of disease and contamination. Through metabolic engineering, we have developed Chinese hamster ovary cell lines that can produce elevated levels of glycosaminoglycans, particularly heparin. However, in order to perform bioprocess optimization, it is necessary to be able to rapidly assess the levels of glycosaminoglycans and their biological activity. **Student Background: Chemistry, biochemistry, biology, chemical engineering.**
2) **Project 2.** Optimization of scaffolds for production of a bioengineered salivary gland (joint with Yubing Xie) Loss of salivary gland function due to disease, surgery, radiation treatment or aging creates a host of health and quality of life issues. Current treatments are woefully insufficient with side effects that are

often worse than original symptoms, creating an impetus to address this issue with regenerative medicine strategies. This project will focus on novel cryoelectrospun scaffolds to produce an engineered salivary gland that can be used to study salivary gland function and pathologies and potentially as an implantable device to restore salivary gland function. **Student Background: Chemical or biomedical engineering, chemistry.**

Professor Carl A. Ventrice, Jr., cventrice@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Electron Interactions with Alkanethiol Self-assembled Monolayers on Au(111).** Self-assembled monolayers (SAMs) are often used for applications such as molecular electronics, selective deposition, and various forms of surface modification. Advanced lithography within the semiconductor industry is adopting ever-shorter wavelengths of light such that the interaction of secondary electrons with the organic resist is becoming the primary mechanism for photo-initiated electro-chemical solubility changing reactions. In order to study the interaction of low energy electrons with thin organic films, measurements will be performed on the electron decomposition of alkanethiol molecules grown on Au(111) substrates. The SAMs will be grown via both solution and vapor phase methods. These monolayers arrange into two distinct phases commonly referred to as the lying down phase and the standing up phase. The lying down phase is a physisorbed layer that is only weakly interacting with the substrate via Van der Waals forces. Conversely, the standing up phase is a chemisorbed species that is more strongly bound to the substrate. Various surface analysis techniques will be used to characterize the monolayers before and after electron exposure. Low energy electron diffraction (LEED) will be used to determine the structure of the SAM and the rate of decomposition. Temperature programmed desorption (TPD) will be used to evaluate the thermal stability and bonding strength of the attached SAMs and the decomposition products from electron exposure. High-resolution electron energy loss spectroscopy (HREELS) will be used to determine the decomposition pathway of the SAMs. **Student Background:** Physics, chemistry or materials science.

Professor Chris Borst and Thomas Wallner twallner@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Python for photonics data collection and analysis:** The AIM photonics group is currently scaling up a wafer scale integrated photonics test environment. This is an opportunity to get in at the ground level of the growing world of integrated photonics. There are opportunities to be an integral part of script/software development in test automation, gui, and big data analysis. **Student Background:** Engineering, Physics, Computer Science.
2) **Edge couple photonic testing:** The AIM photonics group currently has excellent wafer scale testing equipment, but lacks a die level edge coupled testing system. This is an opportunity for a hands-on person to learn the art of photonics testing and create a test solution that will be used in the real world. **Student Background:** Engineering, Physics, Computer Science.

Professor Yubing Xie, yxie@sunypoly.edu

Will accept undergraduate researchers from SURP Programs A-C.

1) **Microfabricated Scaffolds for Three-dimensional Cell Culture.** Advancement in biomaterials development and micro-/nanfabrication provides scaffolds that support three-dimensional (3D) cell growth that is able to recapitulate the morphology and function of the tissue in vivo. 3D cell culture are widely used for understanding diseases, drug screening and testing and cell replacement therapy and tissue regeneration. The student working on this project will learn how to make microfabricated scaffolds, optimization the process, characterization, and further used for 3D cell culture. **Student Background:** Chemical engineering, chemistry, biomaterials, and/or biology.