

**Opportunity Title:** Silicon Nanostructures by Metal Assisted Etching

**Opportunity Reference Code:** DOE-MSIPP-16-19-ANL

**Organization** U.S. Department of Energy (DOE)

**Reference Code** DOE-MSIPP-16-19-ANL

**How to Apply** A complete application must include the following to be considered:

- Completion of all required fields in the application
- Undergraduate transcripts
- One Recommendation (minimum)

If you have questions, send an email to Elizabeth Nelson at [Elizabeth.Nelson@orau.org](mailto:Elizabeth.Nelson@orau.org) . Please include the reference code for this opportunity in your email.

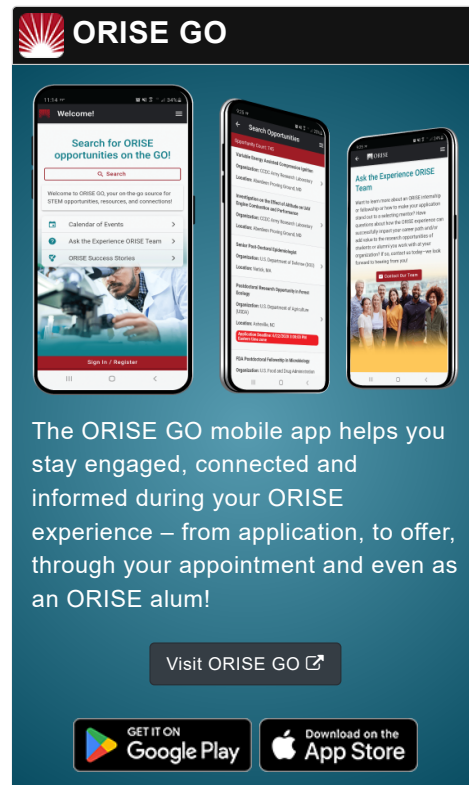
**Application Deadline** 3/16/2016 11:59:00 PM Eastern Time Zone

**Description** The Minority Serving Institutions Partnership Program (MSIPP) Internships is a new program to promote the education and development of the next generation workforce in critical science, engineering, technology, and math (STEM) related disciplines that complement current and future missions of DOE national laboratories. The MSIPP Internship program is designed to provide an enhanced training environment for next generation scientists and engineers by exposing them to research challenges unique to our industry.


MSIPP Interns will be given the opportunity to complete Summer Internships aligned with ongoing U.S. Department of Energy Office of Environmental Management (DOE-EM) research under the direction of a host national laboratory. The internship will be performed at the host national laboratory, utilizing their facilities and equipment under the guidance of a research staff member.

Minority Serving Institutions are institutions of higher education enrolling populations with significant percentages of undergraduate minority students.

Ordered arrays of high-aspect-ratio micro/nanostructures in semiconductors stirred a huge scientific interest due to their unique one-dimensional physical morphology and the associated electrical, mechanical, chemical, optoelectronic, and thermal properties. Metal-assisted chemical etching enables fabrication of such high aspect ratio Si nanostructures with controlled diameter, shape, length, and packing density, but suffers from structure deformation and shape inconsistency due to uncontrolled migration of noble metal structures during etching. In a typical metal-assisted chemical etching procedure, a Si substrate partly covered by a noble metal is subjected to an etchant composed of HF and an oxidative agent. Typically, the Si beneath the noble metal is etched much faster than the Si without noble metal coverage. As a result, the noble metal sinks

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into the Si substrate, generating pores in the Si substrate or, additionally, Si wires. The detailed geometries of the resulting Si structures depend mostly on the initial patterns of the noble metal coverage. A Ti adhesion layer helps in stabilizing gold structures, preventing their migration on the wafer surface while it does not impede the etching. Based on this finding, the method will implement to fabricate Fresnel zone plates. A circular FZP is a diffractive grating consisting of concentric zones in which the period decreases with radius so that different diffraction orders add up forming multiple focal points. Fresnel zone plates focus x-rays into a diffraction-limited spot with a diameter of about 1.2 times the width of the outermost zone.

This research project will focus on experimental investigations of contacting surfaces and the material/lubrication response in vehicle technology and wind energy. Specifically one project may include the investigation of wind turbine bearing reliability.

The student will perform the following tasks:

1. Learn of basic chemistry for metal-assisted etching,
2. Learn of use of the optical lithography system,
3. Etching process optimization,
4. Process characterization (optical microscopy, Atomic Force Microscopy (AFM), Scanning Electron Microscopy).
5. Using the e-beam lithography for patterning linear and circular Zone Plates.

**Qualifications** The successful candidate should have some chemistry knowledge and experience working with chemicals.

Eligibility Requirements:

1. Be currently enrolled as a full-time undergraduate or graduate student at an accredited Minority Serving Institution \*see criteria for Minority Serving Institutions here <http://srnl.doe.gov/msipp/internships.htm>
2. Be working towards a science, technology, engineering, or mathematics (STEM) degree
3. Have an undergraduate cumulative minimum Grade Point Average (GPA) of 3.0 on a 4.0 scale
4. Be a United States citizen
5. Pass a drug test upon selection to participate in the MSIPP  
\*The process and timing for drug testing varies from lab to lab. Use of Marijuana/Cannabis or its derivatives if prescribed is legal in some states. However, having these drugs in your system is NOT legal at United States Federal Contractor sites and National Laboratories.
6. Reference must be received by March 6, 2016 at 11:59 PM ET

For more information about The Minority Serving Institutions Partnership Program (MSIPP) Internships, please visit

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<http://srnl.doe.gov/msipp/internships.htm>

To see all MSIPP position postings visit:

[www.orise.orau.gov/MSIPP](http://www.orise.orau.gov/MSIPP)

**Eligibility  
Requirements**

- **Citizenship:** U.S. Citizen Only
- **Degree:** Bachelor's Degree or Master's Degree.
- **Overall GPA:** 3.00
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12 )
  - **Computer, Information, and Data Sciences** (16 )
  - **Earth and Geosciences** (21 )
  - **Engineering** (27 )
  - **Environmental and Marine Sciences** (14 )
  - **Life Health and Medical Sciences** (45 )
  - **Mathematics and Statistics** (10 )
  - **Physics** (16 )
  - **Science & Engineering-related** (1 )

**Affirmation**

I certify that I am pursuing or have completed coursework towards a degree in science, technology, engineering, mathematics, or a related field.