文部科学省先端研究施設共用イノベーション創出事業ナノテクノロジー・ネットワーク

平成２２年度米国NNIN施設利用の夏期研修プログラム参加者募集要項

平成２２年３月１６日
独立行政法人　物質・材料研究機構
国際ナノテクノロジーネットワーク拠点

１．米国NNIN施設利用の夏期研修プログラムの趣旨

本米国NNIN施設利用の夏期研修プログラム（International Research Experience in Nanotechnology –NNIN and NIMS)は、日米科学技術協力協定に基づいたナノテクノロジー分野での文部科学省(MEXT)と米国科学財団（NSF）との協力の一環として、学部生及び大学院生を相互に派遣し、ナノテクノロジー研究分野における国際的な人材とネットワークを育成することを目的として平成２０年度より行っております。

本研修プログラムは、選ばれた日米両国のナノテクノロジー分野の学生を共に相互に相手国のナノテクノロジー関連研究機関に派遣し、派遣された機関の施設を利用する事を通して研究の視野と交流を広めることで、国際的な研究者ネットワークを形成するとともに共に、国際的なリーダーシップを発揮できる人材の育成を目指します。

２．応募対象研究分野：Nanotechnology
関連技術分野：Engineering, Materials, Physics, Chemistry, Biology 他

３．事業概要

（１）　対象研究分野：ナノテクノロジー全般
（２）　派　遣　者：学部生及び大学院生
（３）　派 遣 期 間：６～10週間程度
（４）　派　遣　先：米国NNIN参加４大学の以下の受入研究室（詳細別紙）
Georgia Tech；Prof. Bernard Kippelen, Prof. Paul Kohl, Prof. Kenneth Brown, Prof. Ali Adibi
Cornell；Prof. Bruce Van Dover, Prof. Ulich Weisner, Prof. Edwin Kan
Texas Austin；Prof. Sanjay Banerjee, Prof. Brian Korgel
U. Michigan；Prof. John Hart, Prof. Wei Lu, Prof. Khalil Najafi
（５）　派 遣 人 数：５名程度

４．応募資格

本プログラムの申し込み対象者は下記の項目に該当する者とする。

（１）ナノテクノロジー・ネットワーク拠点関係機関に在籍する学部生及び大学院生（ただし、派遣期間中に学籍を離れる予定の者は除く）。
（２）所属機関で研究テーマを有し、訪問先施設を利用した研修を行う意欲を有し、将来我が国のナノテクノロジーの発展に寄与する意思のあること。
（３）受入米国側大学の**夏季休暇（おおむね平成２２年６月～８月）期間**に参加が可能で、派遣までに**米国ビザ（入国査証）**取得が可能であること。

５．経費負担

（１）派遣先までの交通費（日本国内交通費、米国往復航空運賃等)、滞在費およびビザ申請料金等を独立行政法人物質・材料研究機構の旅費規程にそって支給します。

６．申請書の提出

（１）添付の申請書に必要事項を記入して下記提出先まで送付願います。
（２）提出先

〒305-0047　茨城県つくば市千現1-2-1
独立行政法人　物質・材料研究機構
NIMSナノテクノロジー拠点運営室　平原　宛（E-mail: HIRAHARA.Keijiro@nims.go.jp）

７．申請受付期間

平成２２年3月１７日（水）～4月１２日（月）

８．選考および結果の通知

提出された申請書により、受入機関との整合を確認した上でNIMS国際ナノテクノロジーネットワーク拠点において派遣者を決定し、結果を平成２２年４月下旬までに申請者に電子メール及び文書をもって通知します。

９．その他

（1）NNIN側の指示により、派遣期間中は派遣機関の指定する保険に加入すること。費用は当機構にて負担致します。

（2）採用者は、本プログラム終了後、別に定める様式によって報告書（Ａ４・２枚程度）を提出すること。なお、報告書は後日刊行物として公表することがあります。

（3）採用者の氏名および所属を必要に応じて公表することがあります。

（4）なお、本プログラムは、参加者の研究領域の拡大および日米間の共同研究に発展する研究者ネットワークを形成するためのものであり、その後の共同研究費用の拠出を予定しているものではありません。

１０．問い合わせ先

独立行政法人　物質・材料研究機構

国際ナノテクノロジーネットワーク拠点運営室　平原　宛

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以上

Potential Research Hosts for Nanonet Graduate Students Visiting NNIN Sites

National Nanotechnology Infrastructure Network
Summer 2010

The following NNIN Staff and Professors have agreed to host visiting graduate students from Japan (maximum one each) for approximately 10 weeks during the summer 2010. The Research Areas cited cover a broad range of nanotechnology topics. Projects will take place both in the shared NNIN fabrication facilities and in individual professor's research laboratories.

On the attached application, applicants should rank those projects which they are interested in and for which they feel most qualified. ***Please be sure to list in your application those skills and experiences that are relevant to the selected projects.***

Approximately four or five students total will be selected and assigned to the most appropriate projects.

Unless extraordinary circumstances exist, the visit to the US will occur from approximately ***June 4 to August 14****. While some scheduling flexibility exists, there is significant advantage to sticking to this schedule. Difficulties obtaining housing limit the ability to shift the time to later dates.*

	Project Leader	Project	Site
1	Prof. Bernard Kippelen	Fabrication and characterization of organic solar cells	Georgia Tech
2	Prof. Paul Kohl	Fabrication and Evaluation of Multi-Layered, Ultra-low Loss, Chip-to-Chip Interconnects	Georgia Tech
3	Prof. Kenneth Brown	Microfabricated Ion Traps for Quantum Computation	Georgia Tech
4	Prof. Ali Adibi	Development of optimal surface coating techniques for high-throughput, dense- multiplexed integrated nanophotonic biosensor arrays in lab-on-chip applications	Georgia Tech
5	Greg Book	Electronic Applications of Carbon Nanotubes	Georgia Tech
6	Prof. Bruce Van Dover	Thin Film Solid Oxide Fuel Cell	Cornell Univ.
7	Prof. Ulich Wiesner	Self-assembly of metal nanoparticle – block copolymer composites for energy related applications	Cornell Univ.
8	Prof. Edwin Kan	Embedding functionalized organic molecules in engineered dielectric	Cornell Univ.
9	Prof. Sanjay Banerjee	Spin-dependent tunneling through shape-specific ferromagnetic nanoparticles	U. Texas Austin
10	Prof. Brian Korgel	Solvent-based Deposition processes for High-efficiency Photovoltaic Devices	U. Texas Austin
11	Prof. John Hart	Carbon nanotube microsensors and microactuators for biomedical Microsystems	U. Michigan
12	Prof. Wei Lu	Heterogeneous Integration of p- and n-Type Nanowires for Complementary Nanowire Circuits	U. Michigan
13	Prof. Khalil Najafi	Low-Temperature Metal-Metal Wafer Bonding for MEMS Packaging	U. Michigan

----------------------------NNIN Site Map at END------------------

Potential Projects for Summer 2010
NNIN-NIMS/NanoNet Exchange Program

1) Fabrication and characterization of organic solar cells

Prof. Bernard Kippelen

Electrical and Computer Engineering
Georgia Tech, Atlanta, Georgia
http://www.ece.gatech.edu/research/labs/krg/

The proposed project is in the area of organic photovoltaics, the technology to convert sun light into electricity by employing thin films of organic semiconductors. The low-temperature processing of organic small molecules from the vapor phase or polymers from solution can confer organic semiconductors with a critical advantage over their inorganic counterparts, as the high-temperature processing requirements of the latter limit the range of substrates on which they can be deposited. Particularly attractive for organic semiconductors are flexible plastic substrates that can lead to applications and consumer products with lower cost, highly flexible form factors, and light weight.

Bernard Kippelen is a Professor at the School of Electrical and Computer Engineering at the Georgia Institute of Technology. His research interests range from the investigation of fundamental physical processes (nonlinear optical activity, charge transport, light harvesting and emission) in organic-based nanostructured thin films, to the design, fabrication and testing of light-weight flexible optoelectronic devices based on hybrid printable materials. He serves as Co-Director of the Center for Organic Photonics and Electronics and as Associate Director of the DOE Energy Frontier Research Center for Interface Science.

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2) Fabrication and Evaluation of Multi-Layered, Ultra-low Loss, Chip-to-Chip Interconnects

Prof. Paul Kohl

School of Chemical and Biomelecular Engineering
Georgia Tech, Atlanta, Georgia
http://www.chbe.gatech.edu/kohl/

The project involves the design, fabrication, and evaluation (electrical and mechanical) of multi=layered chip-to-chip interconnects. High bandwidth, off-chip connections are a critical part of modern electronic systems. As off-chip frequencies rise and power levels decrease, there is an urgent need for higher performance interconnect. The project involves standard and new fabrication methods. They include metal sputtering and plating, photolithography, dielectric deposition and curing, laser ablation, and device testing. Contributions in some of these areas is sufficient to contribute to this project. New structures will be created and tested.

Paul Kohl received a B.S. degree from Bethany College in 1974 and Ph.D. from The University of Texas, both in Chemistry. After graduation, Dr. Kohl was employed at AT&T Bell Laboratories in Murray Hill, NJ from 1978 to 1989. During that time, he was involved in new chemical processes for silicon and compound semiconductor devices and their packaging. In 1989, he joined the faculty of the Georgia Institute of Technology in the School of Chemical and Biomolecular Engineering, where he is currently a Regents' Professor. He is also the Editor of *Journal of The Electrochemical Society* and past founding editor of *Electrochemical and Solid-State Letters.*

Dr. Kohl's research interests include new materials and processes for advanced interconnects for integrated circuits, and electrochemical energy devices for energy conversion and storage. Dr. Kohl is the Director of the MARCO Interconnect Focus Center whose goal is to create new technological solutions for interconnect in Giga-scale integrated circuits. He also has extensive programs in micro-fuel cells, for self-powered integrated circuits, and the use of ionic liquids in electrochemical devices.

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3) Microfabricated Ion Traps for Quantum Computation

Prof. Kenneth Brown

Chemistry and Biochemistry

Georgia Tech, Atlanta, Georgia

http://ww2.chemistry.gatech.edu/groups/brown/

Computers built from quantum mechanical systems are predicted to be vastly more efficient at solving many important problems, such as the factoring of keys used in cryptography, or full CI quantum chemistry calculations. Quantum computers (QC's) based on the interactions of ultracold (~1 mK) trapped atomic ions and laser fields are rapidly developing, but suffer from a few difficulties. Notably, ion trap processors containing a few quantum-bits (qubits) are difficult to scale up to the many tens of qubits required to solve problems that are intractable on classical computers. One solution is to miniaturize the trap and integrate it into a MEMS device amenable to production by photolithography.

At Georgia Tech, an interdisciplinary group of researchers is working to develop the next generation of novel scalable multiplexed ion traps (SMIT) for large quantum computers. To successfully contribute to this research, an applicant will develop skills in photolithography, RIE plasma processing, thin film deposition and various metrology techniques such as ellipsometry and SEM. Each of the major components of the trap have been previously prototyped and tested . Current work focuses on optimization and integration of the components to build a finished mature design. The student will contribute to this effort by designing and optimizing processes to integrate the major trap components.

Kenneth Brown is an Assistant Professor in the Schools of Chemistry and Biochemistry; Computational Science and Engineering; and Physics. His research interest is the application of quantum computational tools and technologies to physical sciences.

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4) Development of optimal surface coating techniques for high-throughput, dense- multiplexed integrated nanophotonic biosensor arrays in lab-on-chip applications

Prof. Ali Adibi

Electrical Engineering

Georgia Tech

Atlanta, Georgia

http://www.ece.gatech.edu/research/photonics/adibi.html

New advances in integrated nanophotonic biosensors arrays and lab-on-chip technology are pushing the limits of label-free mass detection to the sub-femtogram and attogram ranges. Here, a critical requirement for these emerging biosensor arrays is the ability to develop highly specific surface coatings with reduced background (non-specific) binding. The goal of this research project will be to compare the existing surface coating approaches and develop optimum surface coating strategies for dense arrays of integrated nanophotonic biosensors arrays with dielectric (e.g. Si, Silicon-nitride) as well as metallic (gold, silver) surfaces. Ability to work in cleanroom and characterize surfaces (e.g. X-ray photoelectron spectroscopy (XPS),AFM, ellipsometry) after each step in surface coating process is critical.

Prof. Adibi is the director for the Center for Advanced Processing-tools for Electromagnetic/acoustics Xtals (APEX) at Georgia Institute of Technology. He received his B.S.E.E. from Shiraz University (Iran) in 1990, and received his M.S.E.E. and Ph.D. degrees from the Georgia Institute of Technology (1994) and the California Institute of Technology (2000), respectively. His Ph.D. research resulted in a breakthrough in persistent holographic storage in photorefractive crystals.

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5) Electronic Applications of Carbon Nanotubes

Greg Book
Microelectronics Research Center
Georgia Tech

The student will work in a team environment exploring the applications of CNTs to form a 3-D light-trapping array for novel photovoltaic cells; as a field emission source for Hall Effect thrusters for satellite propulsion; and as anodes for Li ion batteries. The student will utilize e-beam and thermal evaporators, sputterers, photolithography, clean room tools, electrical probe stations, scanning electron microscopy (SEM), x-ray diffractometers (XRD), chemical vapor deposition (CVD), molecular beam epitaxy (MBE), ion beam assisted deposition (IBAD) equipment and other tools during the internship. Prior experience is useful but not necessary as thorough training will be provided. Other CNT-enabled applications being studied are electrochemical double layer supercapacitors and CNT-functionalized carbon, quartz and basalt fabrics as well as the use of CNTs in biological applications such as neural prosthetics.

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6) Thin film solid oxide fuel cell

Prof. Bruce VanDover
Dept of Materials Science
Cornell University
http://people.ccmr.cornell.edu/~vandover/Home.htm
http://www.mse.cornell.edu/mse/people/profile.cfm?netid=rbv2

Thin film solid oxide fuel cells have recently been demonstrated by various groups, incorporating thin film membranes fabricated using MEMS-style processes. The membranes are a thousandfold (or more) thinner than in conventional solid-oxide fuel cells, which allows them to operate at significantly reduced temperatures thereby enabling new technological applications in small-scale and mobile devices. Thin film fuel cells also represent an opportunity to extend the combinatorial materials science paradigm to the discovery and characterization of new electrolyte materials being developed in the van Dover group. This project will involve MEMs processing to yield Si_3N_4 membranes using CNF facilities, then deposition of electrolyte films and electrodes using van Dover group equipment, followed by further CNF processing and packaging. SEM inspection and X-ray diffraction experiments will be used to confirm the integrity of the materials and devices. Completed fuel cell structures will be evaluated using a custom test stand in the van Dover group.

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7) Self-assembly of metal nanoparticle – block copolymer composites for energy related applications

Prof. Ulich Wiesner
Dept of Materials Science
Cornell University, Ithaca, New York
http://people.ccmr.cornell.edu/~uli/pages/people.htm

The Wiesner group recently succeeded in the synthesis of the first nanoporous Pt metal structures from block copolymer assembly in the bulk.[1,2] This opens up a new class of bottom-up nanostructured materials with tunable length scale and morphology, with applications for energy conversion, energy storage, catalysis and novel optical elements.

The proposed project is focused on expanding this self-assembly approach to other metal species, and involves materials synthesis (nanoparticles, polymers, composites) and characterization (including small angle x-ray scattering and transmission electron microscopy). An ideal researcher will have a background in self-assembly, chemistry and/or materials science.

References

[1] S. C. Warren, L. C. Messina, L. S. Slaughter, M. Kamperman, Q. Zhou, S. M. Gruner, F. J. DiSalvo, U. Wiesner, *Ordered mesoporous materials from metal nanoparticle-block copolymer self-assembly*, Science **320** (2008), 1748-1752.

[2] Z. Li, H. Sai, S. C. Warren, M. Kamperman, H. Arora, S. M. Gruner, U. Wiesner, *Metal Nanoparticle / Block Copolymer Composite Assembly and Disassembly*, Chem. Mater. **21** (2009), 5578-5584.

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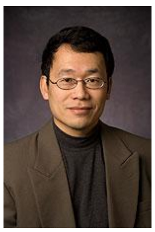
8) Embedding functionalized organic molecules in engineered dielectric

Prof. Edwin Kan
Dept of Electrical Engineering
Cornell University, Ithaca, New York
http://people.ece.cornell.edu/kan/
http://www.ece.cornell.edu/peo-detail.cfm?NetID=eck5



The student will do the fabrication integration of functionalized organic molecules in an engineered dielectric, and use CV and IV techniques to investigate the redox-gated and light-gated electronic structure of the molecule. The student should have some experience in clean room and probe stations for device analysis.

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9) Spin-dependent tunneling through shape-specific ferromagnetic nanoparticles

Professor Sanjay Banerjee
Electrical Engineering
University of Texas at Austin
http://www.mrc.utexas.edu/
Postdoctoral Project Mentor:
Dr. Domingo Ferrer (Ph.D., Waseda University)

This research project aims at fabricating magnetic random access memory (MRAM) devices with ferromagnetic nanocrystals as the free ferromagnetic layer. MRAM is a universal memory that uses as a memory bit the magnetization orientation (parallel or antiparallel) of a free ferromagnetic layer with respect to a fixed layer separated by a thin tunneling barrier. Novel ferromagnetic colloidse.g. L10 alloys PtFe, CoPt, NiPt with controlled morphologies (rods, cubes and spheres) will be employed in these efforts. DC and pulsed transport and magneto-transport characterization will be performed to realize spin tunneling switching. The visiting student will engage in the device fabrication flow process, and will be guided by postdoctoral and graduate researchers. Some desired but not indispensable skills for this project are: device fabrication knowledge (photolithography, metallization), I-V testing, magnetometry, electron microscopy.

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10) Semiconductor Nanocrystal "Inks" for Printed Photovoltaics

Prof. Brian Korgel
Dept of Chemical Engineering
U.Texas Austin
http://www.engr.utexas.edu/che/directories/faculty/korgel.cfm
http://www.che.utexas.edu/korgel-group/

This project focuses on developing new low-temperature, solvent-based deposition processes for fabricating high-efficiency photovoltaic devices. The project involves the development of new synthetic routes to nanocrystals of Cu(In,Ga)Se_2 (CIGS) and Cu_2ZnSnS_2 (CZTS). The nanocrystals are then printed into thin film layers and incorporated into functioning photovoltaic devices (PVs). The student will synthesize nanocrystals and characterize them using electron microscopy and X-ray techniques. The student will then fabricate prototype PVs with the nanocrystal films as the light-harvesting layer and test their performance using a solar simulator and other spectroscopic and electrical characterization tools.

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11) Carbon nanotube microsensors and microactuators for biomedical Microsystems

Prof John Hart

Mechanical Engineering
University of Michigan
http://www-personal.umich.edu/~ajohnh/mechanosyn/

This project will focus on the fabrication and integration of three dimensional 3D carbon nanotube (CNT) microstructures as multi-directional actuators and sensors in MEMS. We anticipate these unique and multifunctional structures will find use in biomedical microsystems, where the mechanical robustness, electrical conductivity, and chemical viability of CNTs are complementary for use in stimulation and recording of cell growth and communication (e.g., for controlled cell differentiation, and neural/prosthetic operation). Despite their outstanding properties, there are relatively few examples of integration of ordered CNTs at the MEMS scale, and this is limited by the low density of CNT growth and challenges in addressability and substrate compatibility. To meet this need, we have recently developed a novel technology for manufacturing of complex and robust 3D CNT structures, and this technology will be a basis for the present project.

The student will work both in the Lurie Nanofabrication Facility (LNF) cleanroom, and in the laboratory of the Mechanosynthesis Group, directed by Prof. John Hart. During the project, the student will

- Deposit and lithographically pattern CNT growth catalyst and contact electrodes in the MNF, and perform associated device processing based on the specific device designs chosen at the initial project phase.
- Grow and post-process vertically aligned CNT "forest" microstructures to create 3D features using custom built equipment in the Mechanosynthesis group.
- Characterize the mechanical properties and electrical conductivity of the CNT structures, using a micro-compression tester and probe station.
- Develop and test a protocol for spatial delivery of cells onto the patterned CNT structures.
- Evaluate the actuation and sensing performance in the presence of the cultured cells.

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12) Heterogeneous Integration of p- and n-Type Nanowires for Complementary Nanowire Circuits

Prof Wei Lu

Electrical Engineering and Computer Science
University of Michigan
http://www.eecs.umich.edu/~wluee/

As the size of semiconductor devices approaches several fundamental and practical limits, nanostructures such as one-dimensional nanowires or carbon nanotubes will likely be employed in future electronics to sustain the device scaling. Semiconductor nanowires are single-crystals with diameter of a few nanometers and length of tens of micrometers. Unlike conventional semiconductor devices that are fabricated in a "top-down" fashion, nanowires are synthesized "bottom-up" atom-by-atom and exhibit superior electrical and material properties. To date, great effort and progress have been made on nanowire-based electronic, optical and bio-sensor devices. For example, the PI's group at UM has recently demonstrated nanowire-based, high-performance, fully transparent and flexible electronics on plastic and glass substrates for possible applications such as transparent and/or foldable electronics.

However, in most previous studies, a single type of nanowire is used to build the circuits which lead to high power dissipation and slow switching speed. In this REU project, the student will help develop a heterogeneous integration technique to build complementary circuits based on p- and n-type nanowires. The idea is to transfer different types of nanowires in a layer-by-layer fashion. The student is expected to optimize the contact printing nanowire transfer technique developed by the PI's group, and solve the disturbance and isolation issues related to multiple-layer transfer processes. With the help of a graduate student, the student will attempt to fabricate simple complementary circuits based on the transfer techniques he/she developed.

Participation of the project will provide the student a broad range of training and experience from both commercial clean-room fabrication technologies such as photolithography, evaporation and electron microscope imaging, to nanowire growth, novel device concepts and techniques currently explored in emerging nanoelectronics.

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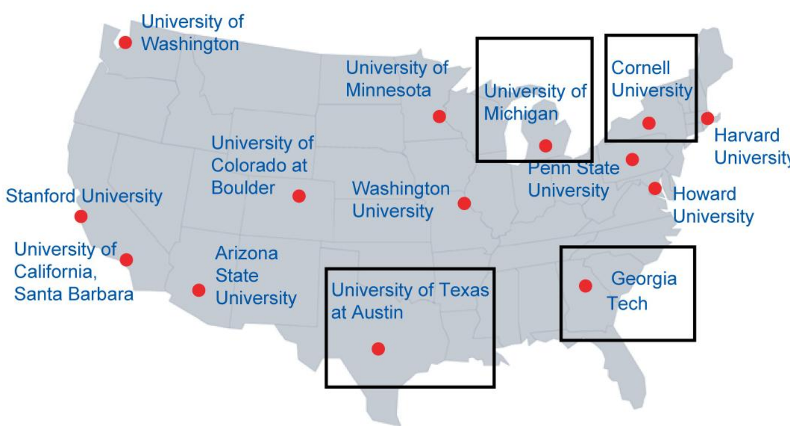
13) Low-Temperature Metal-Metal Wafer Bonding for MEMS Packaging

Prof Khalil Najafi
Electrical Engineering and Computer Science
University of Michigan
http://www.eecs.umich.edu/najafi/

Wafer bonding has become and indispensable technology for both the MEMS and IC industries. In MEMS, it is used for hermetic and possibly vacuum packaging of micromachined sensors and actuators. Our group has conducted significant research in wafer-level packaging, and has used various solder materials for wafer bonding. This project continues work in this area but focuses on low-temperature wafer bonding using intermediate metal layers. Metals of interest include copper, gold, platinum, titanium, and possibly others. The student will conduct wafer bonding in the facilities at Michigan and will help characterize the bond quality and optimize bonding conditions. There is a significant amount of published literature. As part of this proposed research the student will also conduct a comprehensive literature survey and will update existing information in our group. Familiarity with basic semiconductor fabrication technologies is desirable and needed. Familiarity with MEMS and IC technologies is desired.

Map of NNIN sites



The end