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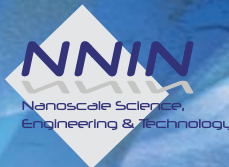
Michigan Engineering

NNIN

National Nanotechnology Infrastructure Network

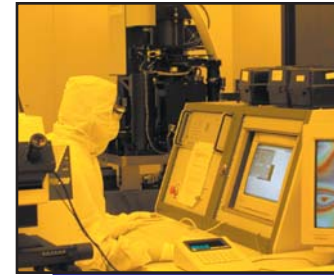
at the University of

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Solid-State Electronics Laboratory

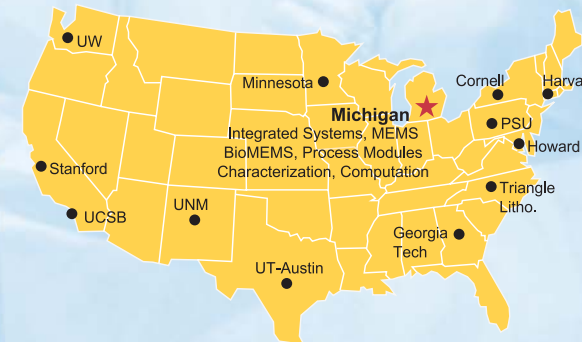
The University of Michigan Solid-State Electronics Laboratory (SSEL) conducts research in electronic, optoelectronic, and micromachined devices, circuits, and microsystems (MEMS). It includes the Michigan Nanofabrication Facility (MNF), a state-of-the-art fabrication facility which serves nationwide researchers.



National Nanotechnology Infrastructure Network

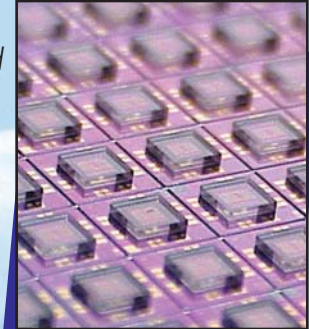
The National Nanotechnology Infrastructure Network (NNIN) is an integrated networked partnership of 13 user facilities, supported by the National Science Foundation since March 1, 2004. The NNIN provides users across the nation open access to leading-edge tools and capabilities to help enable their individual research projects.

The NNIN also has extensive education, training and outreach activities, as well as programs on societal and ethical issues involving nanotechnology.



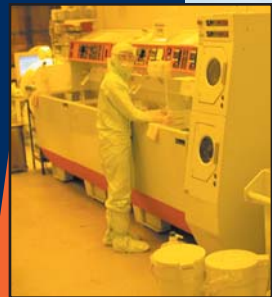
Why Use MNF?

- 30 years of experience in micro- and nano-fabrication, MEMS and compound semiconductor devices and circuits
- One of the few universities with facilities for both Si integrated circuits and compound semiconductor processing
- Extensive experience with non-traditional users



What the NNIN Brings You

- Quick start up
- All academic users pay the same rate
- Full time staff for tool support and mentoring/training of new users
- NNIN pays for technical support and training – Users only pay for lab usage
- IP belongs to user



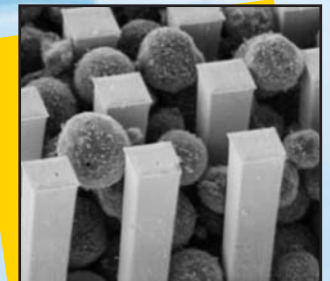
Facilities

6,000 sq. ft. class 1000/100/10 cleanroom - Open 24/7
Dedicated areas for:

- Silicon processing (including diffusion, LPCVD)
- Compound semiconductor devices
- Thin film deposition
- Dry etching
- E-beam lithography
- Metrology
- III-V materials growth

Additional laboratories for:

- Packaging
- Testing

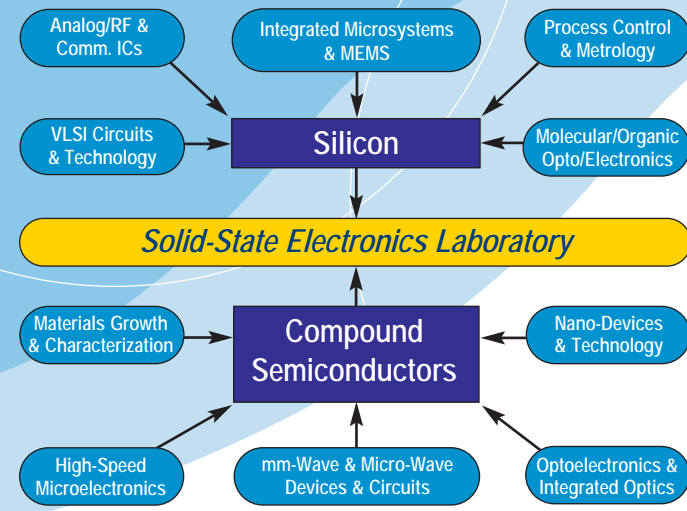


www.eecs.umich.edu/ssel

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Research Activities



Education and Outreach

Research Experiences

REU (Research Experience for Undergraduates) program during the summer

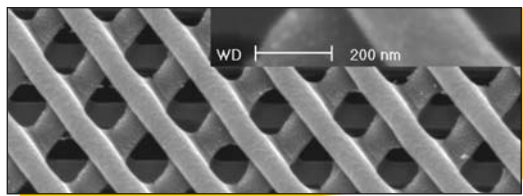
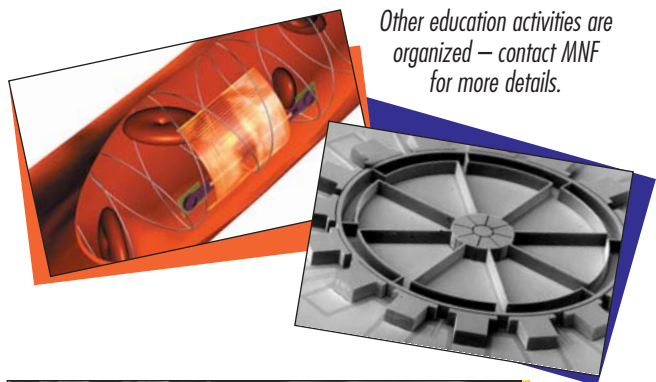
Courses

College-level web-accessible courses on MEMS and Microsystems
Seminar course on Societal Impact of Microsystems

K-12 Outreach

Collaboration with local high schools and middle schools

Other education activities are organized – contact MNF for more details.



MNF Equipment and Processes Available to Users

Lithography/Coating

Raith 150 4" ultra-high resolution e-beam lithography and metrology (SEM) tool, minimum feature < 50 nm
GCA AC 200 4/6/8" line stepper, minimum feature ~ 500 nm
ElectroMask II 4" pattern generator, minimum feature ~ 1500 nm
EVG 620 4" double-sided contact alignment/lithography, minimum feature ~ 2µm
Suss MA/BA 6 4" double-sided contact alignment/lithography, minimum feature ~ 1µm
EVG620 bond aligner, minimum feature ~ 2µm
Suss MA-45 4" contact alignment/lithography, minimum feature ~ 2µm
Suss MJB-3 4" contact alignment/lithography, minimum feature ~ 2µm
Quintel Q2001 4" contact alignment/lithography, minimum feature ~ 2µm
Suss 4" ACS-200 C-to-C coater-developer

Diffusion/Oxidation/Annealing

Thermco 9K 4" auto-load high temperature furnaces, P and B diffusion and drive-in
Thermco 9K 4" auto-load high temperature furnaces, thermal oxide (dry and wet) and gate oxide (dry gate)
Thermco 9K 4" auto-load high temperature furnaces, anneal/sinter (Si, contacts)
JetFirst 150 rapid thermal process tool

LPCVD

Tempress 6604 4/6" auto-load cantilevered high/low temperature furnaces, LTO, HTO, Si₃N₄, doped polySi, polySi and low stress nitride
Thermco 9K 4" auto-load high/low temperature furnaces, LTO, HTO, Si₃N₄ and polySi

PECVD

SemiGroup dual-chamber, materials: Si₃N₄, SiO₂ and a-Si.
GSI 4/6" single-chamber, materials: DLF, Si₃N₄, SiO₂, PSG, BPSG and a-Si

PVD

4" e-beam evaporators (EnerJet, Cooke, SJ-20, SJ-26) for metals (Al, Au, Cr, Pt, Ti, In, Ni, Pd, Sn, Zn, Nb,), Dielectrics (Al₂O₃, SiO₂, SiO, MgO, MgF), compounds (ZnSe), and semiconductors (Ge)
4" sputter coaters (EnerJet, Denton Explorer 14) for metals (Ag, Al, Au, C, Cr, Cu, Ir, Mo, Ta, Ti, Yt, compounds (Al-2% Si, Al-1% Si, ITO, W-10%Ti) and dielectrics (SiO, SiO₂, Si₃N₄)

RIE

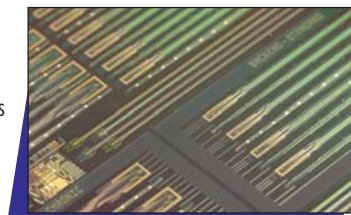
Lam 6" 9400-se C-to-C polySi etcher
STS 4" high-density ICP deep trench etcher
Trion 4" two-chamber C-to-C cluster tool, polySi etcher
Plasma/RIE chambers (Technics, March, SemiGroup, PlasmaTherm), polySi, dielectric, III-V, II-VI, polymer, wax, and PR etching

Wet Chemistry

Cleaning (RCA, HF, Piranha)
Etching (EDP, KOH, TMAH, HF, HF/NH₄)
Organic / Nanofabrication processes
Plating (Au, Cu, Pb/Sn, Ni, Ag)
Polishing

Wafer Bonding

EVG 501 (anodic, vacuum bond)
Suss SB-6 (anodic, Si-Si, fusion, eutectic)



Metrology

Zygo New View 5000 interferometric surface profilometer
Spectrometers (Leitz SP and Nanospec 6100) for thin film measurement
DekTak 6M contact surface profilometer
JEOL JSM-840 SEM w/Lab 6 cathode
Nikon Dual Scope DME (scanning probe and optical microscope)

General Utility

Low temperature bake ovens
Tousimis 915B CPD systems for release
SCS Labcoater 1 PDS 2010 (parylene deposition system)
Semitool spin rinse dryers
Precision hot plates

Wire Bond/Packaging/Test

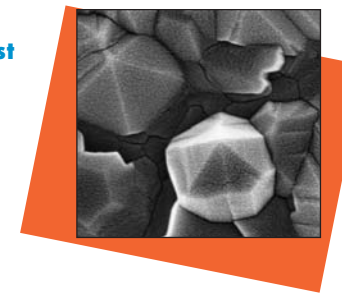
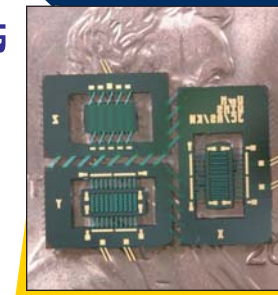
K&S 4123 wedge bonder
Alessi 3200A probe stations
Solder reflow

Environmental Test

Environmental chambers (temperature, humidity, autoclave, vibration analysis, rotation table)

CAD

Layout
Circuit simulation



Associated Labs for Additional Capabilities

Electron Microscopy and Analysis Laboratory (EMAL)

JEOL 2010F analytical electron microscope
JEOL 3011 high resolution electron microscope
FEI Quanta 200 3D dualbeam focused ion beam workstation
Digital Instruments scanning force microscope IIIA
Digital Instruments scanning force microscope E (with hystitron triboscope picointender)
Perkin Elmer / PHI 5400 X-ray photoelectron spectrometer
FEI Nova NanoLab dualbeam focused ion beam workstation
Philips XL30 FEG scanning electron microscope

Michigan Ion Beam Surface Modification and Analysis Laboratory (MIBL)

Tandemron Accelerator 1.7MV (Rutherford backscatter spectrometry, nuclear reaction analysis, elastic recoil detection)
Varian Associates CF3000 200kV implanter (5-200kV)
Ion beam assisted deposition - IBAD (100-1200eV)
Vacuum furnace (up to 1200°C)
Buehler nano indenter
Sloan Dektak surface profiler

How to Use MNF

1. Define your goals and needs
2. Contact Sandrine Martin (734-763-6719 or sandrine@umich.edu) to discuss your project
3. Fill in necessary forms (see MNF website www.eecs.umich.edu/ssel)
4. Start training (online courses available on MNF website)
5. Come to Ann Arbor (remote processing is also available – limited capabilities only)
6. Complete safety and equipment training
7. Work in the lab!



Travel and Accommodations

The Michigan Nanofabrication Facility (MNF) is part of the Electrical Engineering and Computer Science Building (EECS), which is located on North Campus in Ann Arbor.

Ann Arbor is in Southeast Michigan, 45 miles west of Detroit, 240 miles east of Chicago, and 35 miles north of the Ohio state line. It is served by all major airlines through Detroit Metro Airport (25 miles from MNF). Ann Arbor can also be reached from Chicago, Toledo, Cleveland, Pittsburgh by train (Amtrak) or bus (Greyhound).

NNIN Personnel at MNF

For all inquiries about the MNF, please contact Dr. Sandrine Martin at 734-763-6719 or sandrine@umich.edu

Prof. Khalil Najafi
NNIN Site Director
MNF Director

Prof. Fred Terry
NNIN Site Deputy Director

Betty Cummings
NNIN Administrative Manager

Dr. Dennis Grimard
MNF Laboratory Manager

Dr. Sandrine Martin
NNIN Site Manager

