The Cornell NanoScale Facility: NNCI Overview

Prof. Christopher Ober
Lester B. Knight Director

CNF: founded 1977

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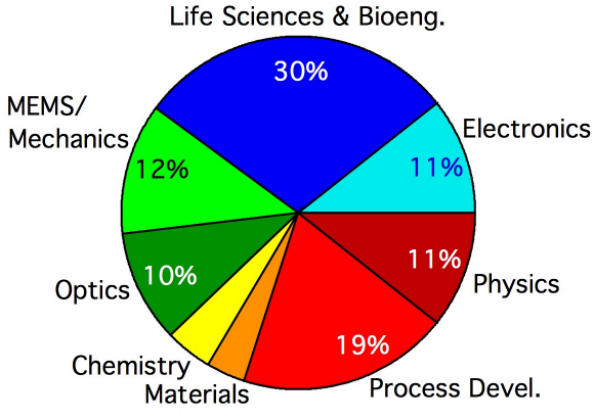
CNF Highlights

- 2017 is CNF's 40th Anniversary as an NSF funded User Facility
- Using NNCI definitions: 53% Non-traditional
- 23 (20.7 FTE) scientific and technical staff - (+4 admin) provide on-site user support (~4000 training sessions/year)
- 15 NNCI *Technical Experts* among staff
- First meeting of external advisory board



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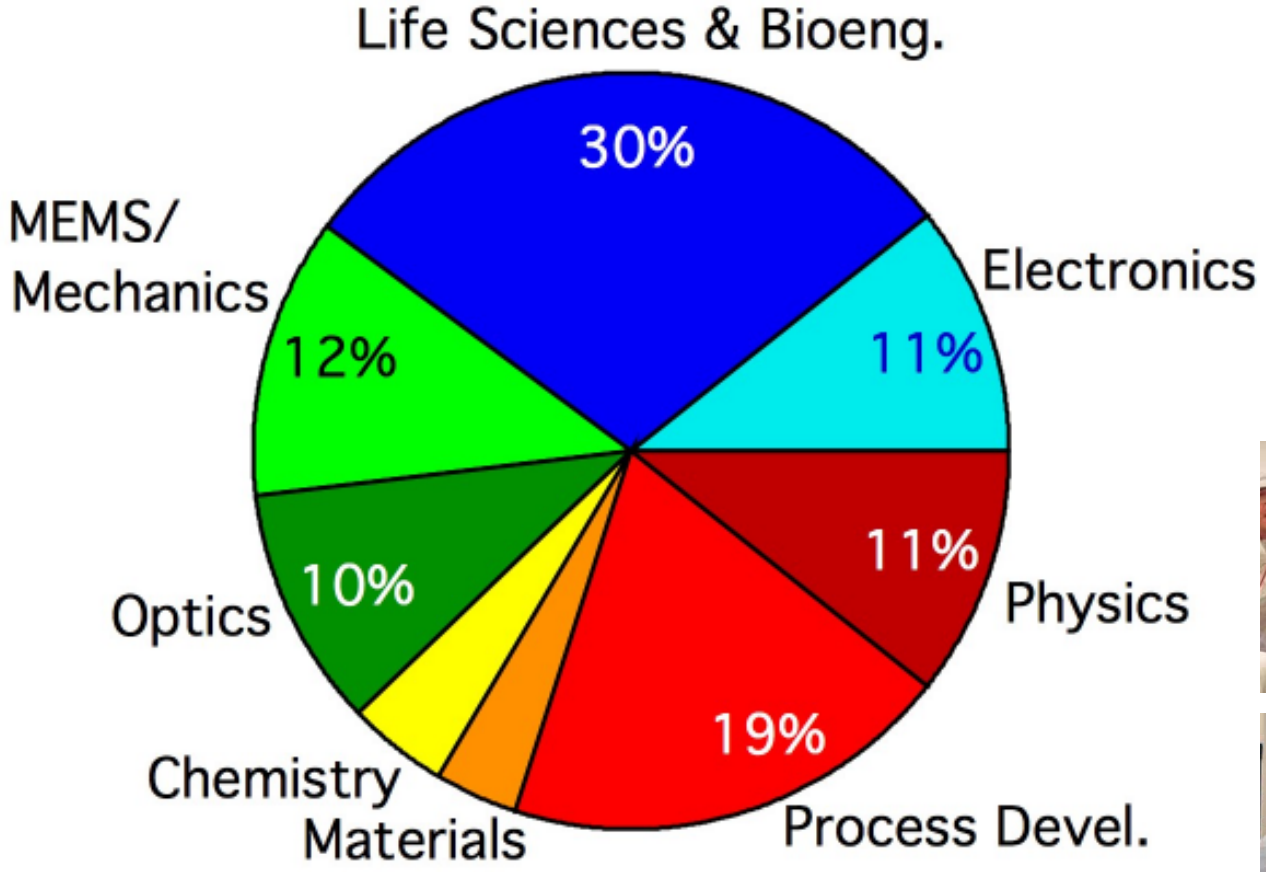

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CNF Staff

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External Advisory Board

Bob Celotta, NIST
(Chair)

Chuck Black, BNL

Alice White,
Boston University

Steve Turner
PacBiosystems

Advisory board met this past November

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Key Technologies and Experience

- Advanced Lithography: 3 Steppers, EBL -> JEOL 9500, JEOL 6300
- In-House mask making
- Plasma Processing (17 plasma etchers)
- Strong Local Emphasis:
  - Silicon Photonics
  - Magnetic Materials
  - Fluidics-> Life Sciences; NanoAg
  - MEMS, NEMS
  - 2-D Materials
- Proximity to other NSF centers: CCMR (MRSEC), PARADIM (MIP), CHESS
- 468 years of Staff Tech Experience
- Success commercializing research (17/12)

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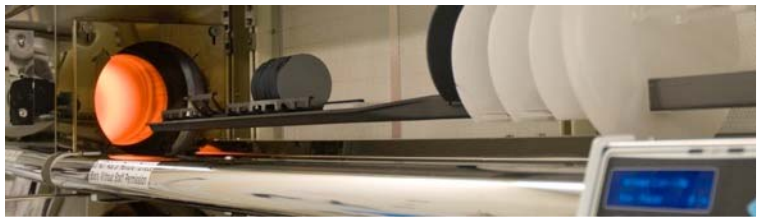
CNF Equipment Resources

Equipment highlights (> 120 major tools):

- 2 state-of the-art electron-beam lithography systems.
- DUV Stepper, i-line, g-line, contact and proximity photolithography.
- In-house mask making capabilities.
- 5 hot-process banks (20 tubes) for growth and deposition
- Comprehensive set of etching tools (~16) including DSE, ICP etchers
- Plasma Enhanced deposition
- High resolution SEMs, AFM, Optical Metrology
- Chemical Mechanical Polishing
- Ion Implantation
- Molecular Vapor Deposition (SAMs)
- Atomic Layer Deposition
- Materials Ink Jet Printing
- 3D Printing
- NanoImprint Lithography and Hot Embossing



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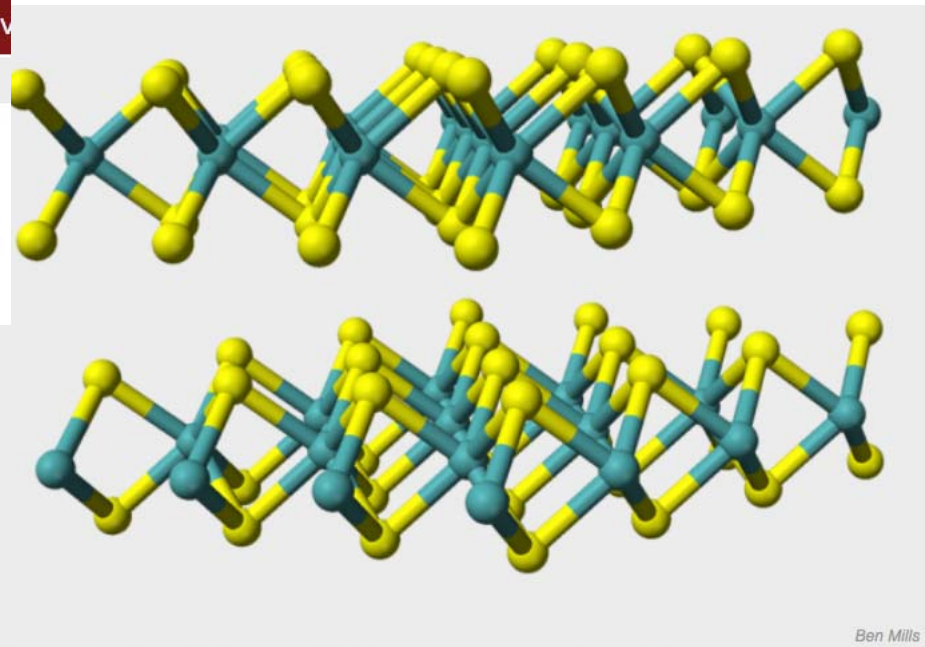
2-D Electronic Materials

The Park group at Cornell University successfully demonstrated batch fabrication of high performance field-effect transistors from monolayer molybdenum disulfide (MoS_2) at the full 4-inch wafer scale. Transfer of the monolayer films allows multi-level fabrication of vertically stacked transistor devices for three-dimensional circuitry. This work is a step towards the realization of atomically-thin integrated circuitry.

nature International weekly journal of science

NATURE | NEWS

Batches of ultra-thin transistors made from 2D materials



Ben Mills

A 2D material called molybdenum disulfide can be grown in single-layer films across silicon wafers, opening up new vistas for flexible electronics.

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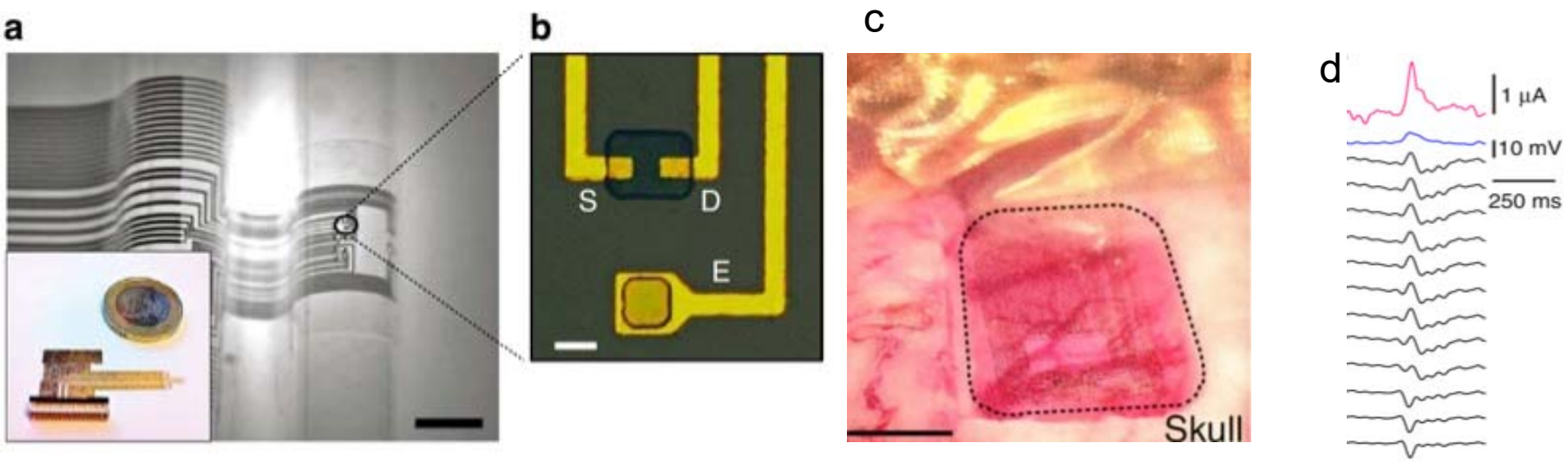
Listening to the Brain with a Transistor

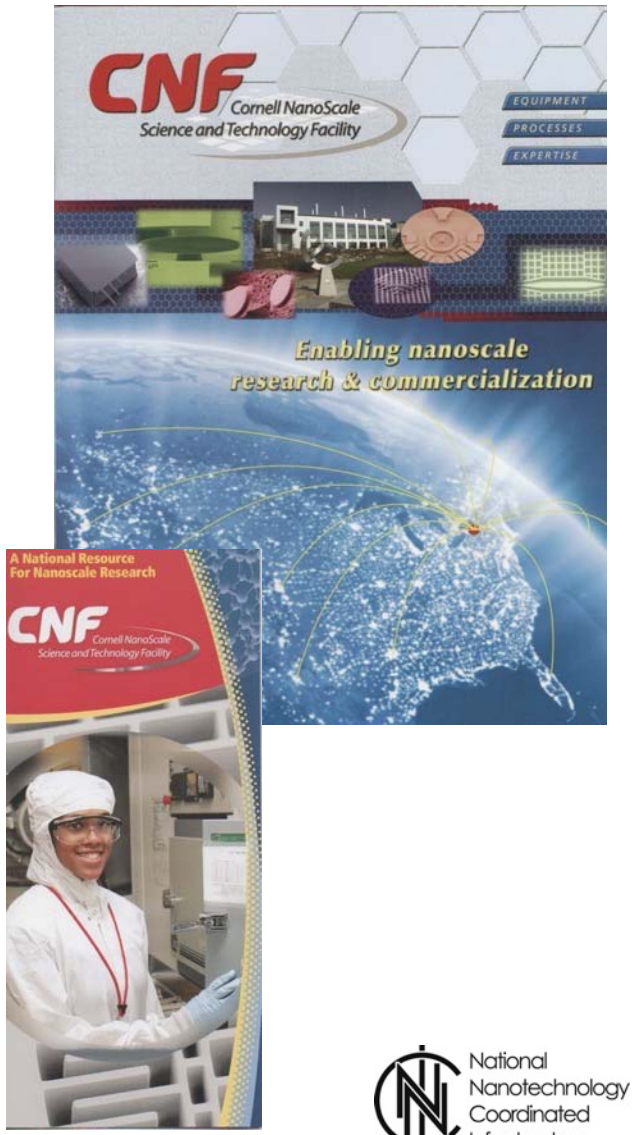
In ***Nature Communications*** Khodagholy et al from NYU and Ecole des Mines reported recording the electrical activity of a large number of neurons providing a pathway to understand the brain and its information-processing capabilities. Such neural recordings are used in clinics for diagnosis in patients with epilepsy and brain tumors, and to help paralyzed people control prosthetic limbs. A solution to the challenges of probing these signals is to use a biocompatible and flexible organic transistor as the recording device. This transistor, which operates in a manner similar to that found in microprocessors, amplifies the signal while recording it. As a result, recordings show a 10-fold improvement in signal quality.



Flexible organic brain probe(a) with integrated amplifier (b) implanted in a rat brain(c) used to record (d) a bicuculline-induced epileptiform spike from a transistor (pink), a surface electrode (blue) and penetrating electrodes (black).

Outreach & Workforce Training

- CNF Fellows and Ambassadors
- Technology and Characterization at the NanoScale Short Course held in January and June 2017. Going on this week.
- NNCI Intranetwork Plasma Processing Workshop
- GenISys Workshop for users & staff
- Annual Symposium held in September
- REU program – 5 interns, 10 weeks; mini convocation held jointly with PARADIM interns
- Revised Promotional Brochures
- Produced 20 Nanonuggets for NNCO 10-9 NanoDay



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Educational Outreach - LEGO

Annual 1 Day Event brings ~ 20 teams of elementary school age participants

4H

2 Events Annually:

4H Leaders Program (Cornell is NYS HQ) and Career Exploration Program (HS age groups)

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REU

- Rapidly spun up program for 5 Interns
- Combined some events with PARADIM REU to reach critical mass
- Organized a mini-convocation
- Rathbun successful IRES grant to initiate iREU sent 5 past REUs to Japan

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Nanooze @ Disney

NSF Award supplement to Update Exhibit

Nanooze the Exhibit opens at EPCOT, Walt Disney World

So it started as a web site, next a magazine and now an exhibit. On February 22, 2010 , ***'Take a Nanooze Break'*** opened at EPCOT Walt Disney World in Florida. The interactive exhibit has a number of opportunities for guests to explore the nanoworld and get a feel for things that are too small to see. The exhibit is on long term display located in Innoventions where new science and technology is showcased. You can sit and listen to stories about nanotechnology, play with a simple to use hand-held microscope, take molecules for a spin and zoom i number of different common objects.

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Partnerships & Commercialization

Company News:

- **1 New Start up – Esper Biosciences**
- **2 Small Company applicants for FuzeHub Manufacturing Innovation Grants**
- **1 *StartUp* CNF Award – NYS program**
- **2 Commercialization Foundry Partners**
- **http://www.cnf.cornell.edu/cnf_stctoolmap.html**
- **http://www.cnf.cornell.edu/cnf_novatitoolmap.html**

Key Partnerships:

- **JEOL – electron beam lithography**
- **GenISys – CAD**
- **Oxford Instruments – Plasma Processing & ALD**
- **Suss – Alta Spray, SCIL**
- **PARADIM – NSF funded material innovation platform, a materials user facility**

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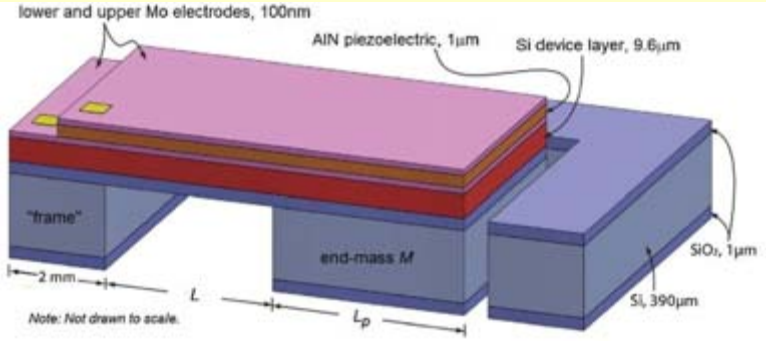
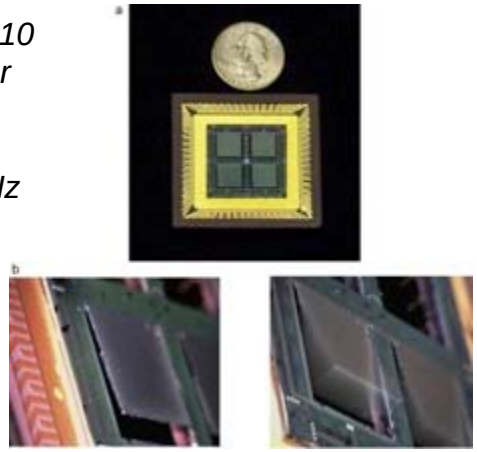
Research to Commercialization -energy harvester chip

MicroGen Systems, is designing and manufacturing nanotechnology/MicroElectroMechanical Systems micro-power and micro-sensor products for wireless sensor and mobile electronics. MicroGen developed its baseline piezoelectric vibrational energy harvester (PZEH) technology at the Cornell NanoScale Facility and is now manufacturing its platform technology at the X-FAB foundry in Germany.



Output voltage OCV > 10 Volts, and output power Pload 25-100 uW @ f1 and G @ 0.1 G Where f1 is 100 -600 Hz



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