Cornell Nanoscale Facility

Cornell University

National Nanotechnology Coordinated Infrastructure

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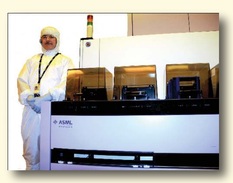
(NNCI-1542081)

An Open National User Facility for Advanced Nanotechnology

Equipment, Resources & Expertise

Housed in a 17, 000 sq. ft clean room in Duffield Hall, CNF maintains more than 150 advanced instruments in support of all types of nanotechnology. Areas of particular expertise and resource include:

- Ebeam Lithography
- DUV Stepper, & UV Stepper Photolithography
- Photomask Fabrication
- Thin Film Etching
- Thin Film Depostion and Growth
- Silicon Furnace Processing /LPCVD/Oxidation
- Deep Silicon Etch
- Atomic Layer Deposition
- Nanotube and Graphene Growth
- Microfluidics
- Nanoparticle and film characterization



Staff

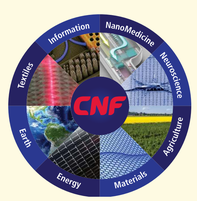
Twenty Two Technical staff including 6 Ph.D.s to support users

- Instruction
- Process Development
- Project Management
- Equipment Maintenance
- Consultation , including technical liaisons in Life Science, MEMS , and File Line Patterning

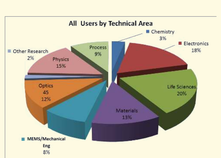
>500 years of tech experience

User Program

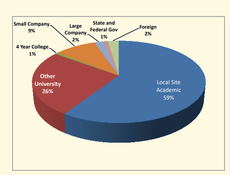
Broad geographical, institutional, and technical distribution of users



User Distribution by Technical Area



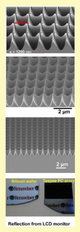
User Distribution by Institution Type



Academic Research Highlights

Nanostructures Enable More Efficient Light Harvesting

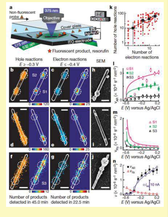
In ACS Nano, the Lin group at Rensselaer Polytechnic Institute in collaboration with researchers at the University of Toronto and National Chiao-Tung University used the Cornell Nanoscale Facility to create a teepee-like photonic crystal (PC) structure on crystalline silicon (c-Si) designed to fulfills two critical criteria in solar energy harvesting through a (i) its Gaussian-type gradient-index profile for excellent antireflection and (ii) near-orthogonal energy flow and vortex-like field concentration via the parallel-to-interface refraction effect inside the structure for enhanced light trapping. Depending on PC thickness, the capture of weakly absorbing wavelengths in significantly increased and angular dependence measurements show that the high absorption is sustained over a wide angle range (θinc = 0–60°) for teepee-like PC structures.



ACS Nano 2016, 10, 6116–6124

Photoelectrocatalysis: Water to Hydrogen

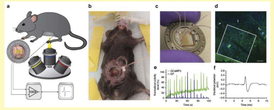
In Nature, the Peng group at Cornell , working with researchers from Colorado Mesa University, and the University of Michigan, used CNF to produce a device for both wide-field single-molecule fluorescence imaging of photoelectrocatalysis by semiconductor nanorods via two-laser total internal reflection excitation, and for sub-nanorod photocurrent measurements via focused laser excitation, in a three-electrode microfluidic photoelectrochemical cell. The splitting of water photoelectrochemically into hydrogen and oxygen represents a promising technology for converting solar energy to fuel. This work enabled mapping of both the electron- and hole-driven photoelectrocatalytic activities on single titanium oxide nanorods. These findings suggest an activity-based strategy for rationally engineering catalyst-improved photoelectrodes. This work is a step towards the realization of atomically-thin integrated circuitry.



Nature, 530, 77, 2016

Enteric Nervous System

In Nature Communications, the Shen group and colleagues at Cornell in a highly collaborative project with researchers from Duke Univ., Johns Hopkins Univ. and the Howard Hughes Medical Institute used CNF to create a graphene sensor on an abdominal window made from borosilicate glass for surgical implantation. The enteric nervous system (ENS) is a major division of the nervous system and vital to the gastrointestinal (GI) tract and its communication with the rest of the body. Unlike the brain and spinal cord, relatively little is known about the ENS in part because of the inability to directly monitor its activity in live animals. In this study researchers integrated a transparent graphene sensor with a customized abdominal window for simultaneous optical and electrical recording of the ENS in vivo. The implanted device captured ENS responses to neurotransmitters, drugs and optogenetic manipulation in real time.



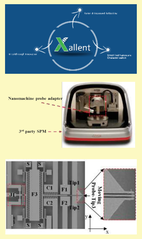
Nature Communications, | 7:11800 | DOI: 10.1038/ncomms11800 |

Industrial Research Highlights

Water Sensor for Precision Agriculture

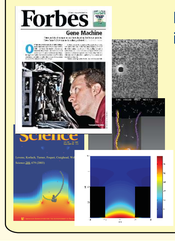
FloraPulse is a startup aimed at commercializing a MEMS based "water potential" sensor for the agricultural market. The first target markets are grape and nut growers in California's Central and Napa valleys. They are developing a service for growers to know exactly when, where and how much to irrigate. Much like a blood pressure gauge for humans, the sensor reads the water pressure inside the plant. When plants are thirsty, their water pressure is low, sometimes even negative. The sensor reads this pressure inside the plant to help growers ensure plant health and optimize water use in drought-stricken agricultural areas. The sensor, made in CNF, is a silicon chip with a tiny cavity that holds water. When the chip is embedded in a plant with drought stress, water leaves this cavity through a nanoporous membrane and the resulting tension is turned into an electrical signal.

NEMS Probes for Wafer Testing



Xallent is a start-up developing a next generation diagnostic tool to more rapidly and economically test semiconductor devices and thin film materials during manufacturing. This is made possibel by Xallent's innovative nanoscale imaging and probing technology developed at the Cornell NanoScale Facility . The ability to rapidly probe and measure electrical components at the nanoscale for diagnostics and failure analysis non-destructively is expected to tap a broad range of industry applications using characterization platforms such as scanning electron microscopes (SEM), scanning probe microscopes (SPM), and a range of automated test equipment (ATE). Xallent and CNF have partnered to win a NYS Manufacturing Innovation Fund Grant that is being used to adapt Xallent's nanomachine platforms to analytical instruments at the CNF for validation, user interface focus, and reliability studies to ready the company for product launch and scale up..

Rapid Gene Sequencing using Zero-Mode Waveguides



Pacific Biosciences, a rapidly growing company in Menlo Park, CA, is developing a transformative platform for single molecule real time detection of biological events. Their mission is to commercialize a DNA sequencing technology that enables sequencing of individual genomes as part of routine medical care. Pacific Biosciences has been highlighted in articles in Forbes, the New York Times, and other leading business publications. The heart of the system is the single modewaveguide detector which was fabricated at CNF using electron beam lithography. In November 2018, **Illumina** entered into a purchase agreement to buy PacBio for approximately $1.2 billion in cash.

PACIFIC BIOSCIENCES

Education and Outreach

Annual Technical Symposium

- One Day Symposium
- Invited speakers
- User speakers
- Over 50 Posters
- 5 Student Awards
- Over 25 Vendor Sponsors
- 2017 40th anniversary included Half Day Workshop on Future Directions in Nanotechnolgy

Semi-Annual Lab Short Course

Fee waivers for graduate students available

REU and International REU with Japan

Host 5 undergraduate researchers at CNF and 6 in Japan each summer

Nanodays & Other Group Activities

NYS 4H Career Explorations

FIRST Jr. Lego Expo

Secondary Disbributors Welcome---Request quantities for outreach activities