Cornell NanoScale Science & Technology Facility

Prof. Chris Ober, Director
Prof. Claudia Fischbach-Teschl, Assoc. Director
Ron Olson, Director of Operations
Lynn Rathbun Ph.D., Laboratory Manager

Annual User Meeting
September 10, 2020

National Nanotechnology Coordinated Infrastructure

Cornell Nanoscale Facility

Status and Accomplishments

Who are we?

Prof. Christopher Ober
PI, Director

Prof. Claudia Fischbach-Teschl,
Co-PI, Assoc. Director

Ron Olson
Director of Operations

Lynn Rathbun, Ph.D.
Laboratory Manager

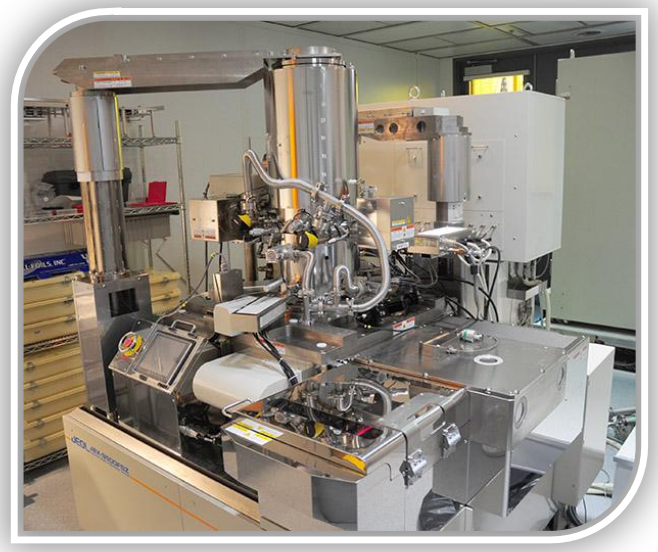
- We are a uniquely capable nanofabrication facility within NNCI
- Site of strong, active biology, physics, electrical engineering and materials research activities
- Educator of the next generation of interdisciplinary engineers and scientists
- Engine of economic development
- Provider to large external user community (~40%)
- 40 years of experience as a successful user facility focused on nanofabrication
  - New strategic directions and activities

Addressing NSF's 10 Big Ideas on Data Revolution, Quantum Leap, Convergence, Rules of Life, Future of Work, …

Equipment Resources

Status and Accomplishments

Most Advanced Lithography Suite in NNCI



JEOL 9500 and JEOL 6300

Most advanced e-beam lithography in NNCI

ASML 300C Deep UV Stepper (248 nm)

Most advanced photolithography and only Deep UV Stepper in NNCI

UV Steppers (i-line and g-line) (x2)
Mask Fabrication (x2)
Contact Lithography (x3)
Nanoimprint
Nanoscribe 3D printer
Extensive resist processing support

CNF STAFF
Innovators and Expertise

Ph.D. User Support Staff




Administrative Staff



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*

Process Engineering & User Support (B.S./M.S.)











*

IT Staff

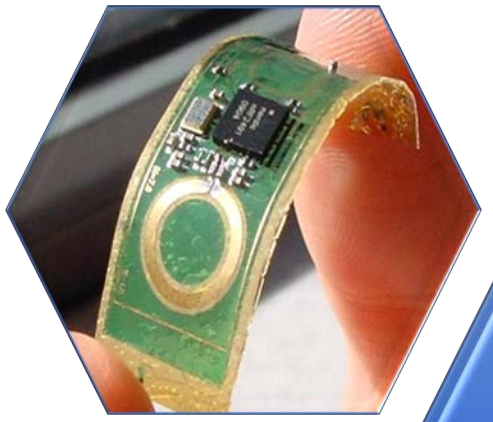

Technicians


National Nanotechnology Coordinated Infrastructure

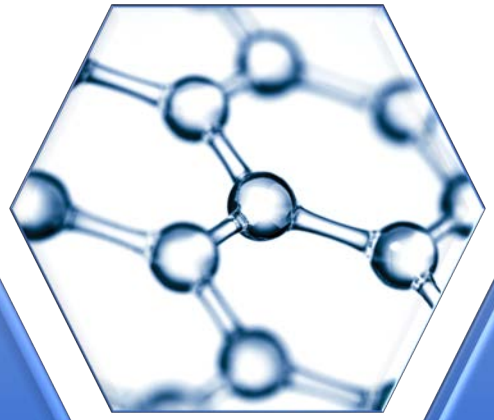
CNF is a major creator of startups

- Current users include 30 small companies, 10 large companies
- Pacific Biosciences, a $1B company valuation, is a CNF startup from 2010
- 12 new start ups from Cornell technology in first 4 Years of NNCI (Xallent, Esper Biosciences, FloraPulse, Ultramend, Jan BioTech, Heat Inverse, JR2J, White Light Power, Odyssey Semiconductor, GeeGah, OWIC Technologies, Soctera)
- PRAXIS: Engineering and Physical Sciences Business Incubator, co-located in Duffield Hall – 5 new startups next door
- NILT from Denmark set up its North American operation in Ithaca specifically to take advantage of CNF's JEOL 9500 and ASML stepper
  - Now a major industrial user

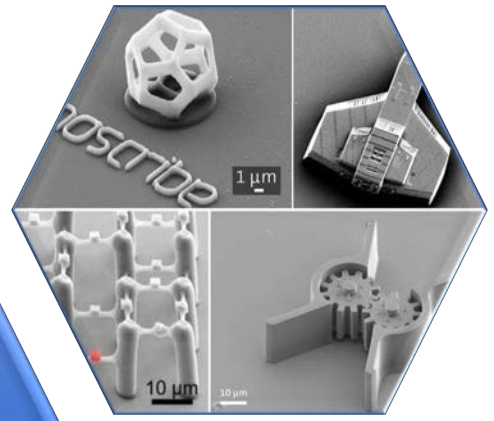
CNF STRATEGIC FOCUS
Plans and New Capabilities



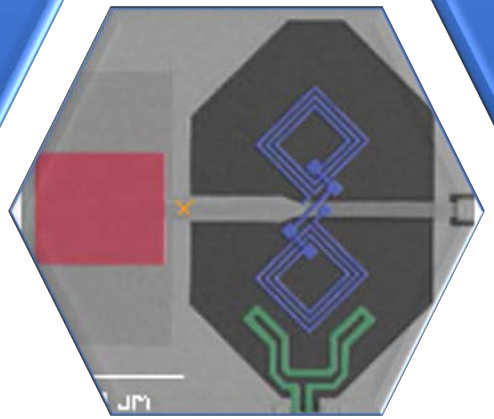
Quantum Information Devices



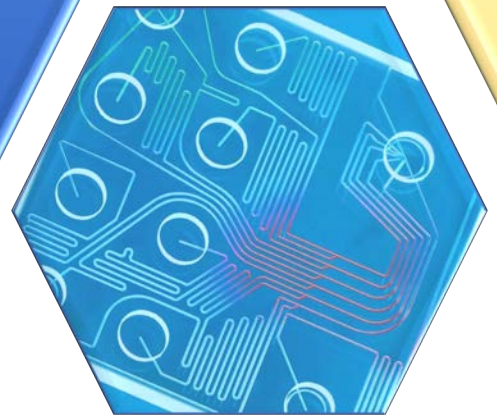
Life Sciences



Hetero-integration



2D Materials



3D Fabrication and Characterization

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NSF

New 3D Printing Capability in the Multiscale 3D Fabrication Facility (M3FF)

CNF Nanoscribe

3D printing lab

- Through CNF's strategic planning process, identified a need for improved 3D fabrication and characterization to serve needs in:
  - Nanobiotechnology (tissue scaffold, organ on a chip device, 3D cell movement control, neural electronics)
  - Heterointegration (nanophotonics, photonic crystals, microautonomous systems, nanosonic fluidics, new integrated mechanical structures)
- **By partnering with existing Cornell resources we will be able to deploy this capability now covering length scales from nm to mm**
- CNF will build on its new Nanoscribe 3D Lithography System and existing 3D printers by absorbing 9 additional printers to create a 3D printing facility.
- CNF will provide booking and billing entry point for this remote user and hands-on service.
- Current CNF staff will be trained in new tool use and repair.

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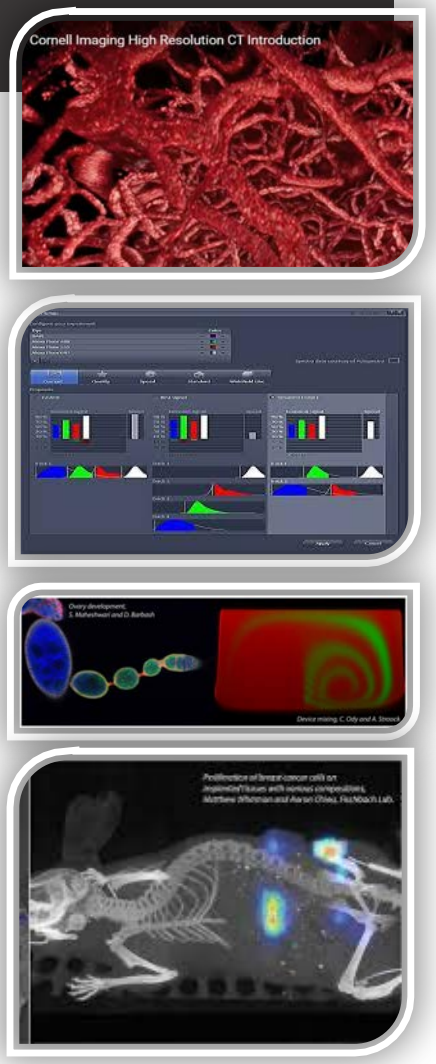
3D FABRICATION AND CHARACTERIZATION
Plans and New Capabilities

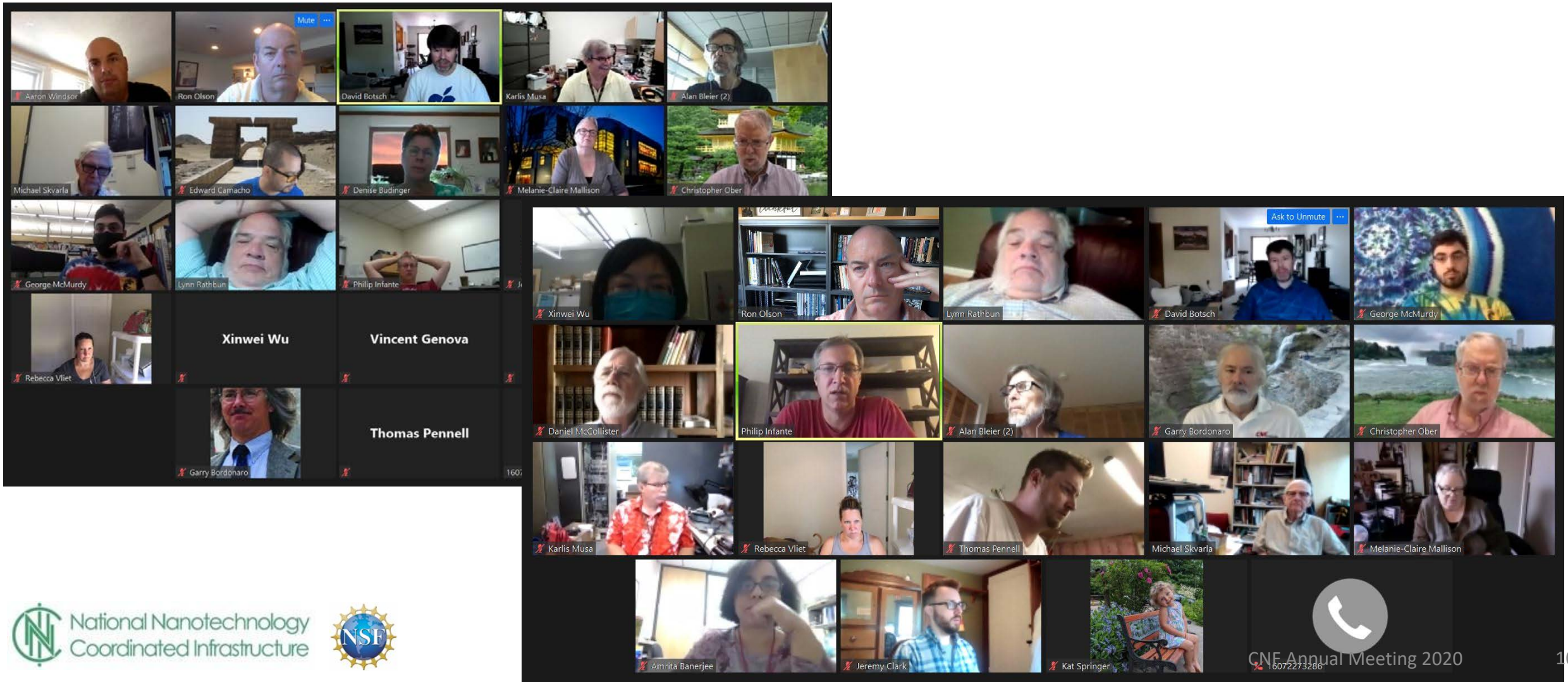
New 3D Visualization Facility (3VF)

- New imaging capabilities available within the **Cornell Institute for Biotechnology** will be linked to CNF/NNCI for non-destructive imaging of 3D structures
- Adding 3D imaging capabilities largely new to NNCI
- Tools include confocal and multiphoton microscopes, super-resolution microscopes, X-ray CT, ultrasound, and bioluminescence/ fluorescence macro imaging systems for nm to mm size range.
- This hands-on facility will add important imaging capabilities to NNCI and will be accessed through CNF, employing a new CNF-supported staff member.



Dealing with COVID

Dealing with COVID – 19



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NSF

FACILITY OPERATIONS
Current Status

CNF Cornell NanoScale Science and Technology Facility

March 2020	April 2020	May 2020	June 2020	July 2020	Aug 2020	Sept 2020	Oct 2020

March 17 : CNF was closed do to Covid-19

Restart idle equipment

USERS
- Gradually brought back local, internal academic users.
- Allow current CNF users from outside NYS on a CASE by CASE basis

NUMBER OF USERS
- 50 Users
- 100 Users
- Removed limit on number of authorized users

OPERATING HOURS
- M -Th 9 to 5
- M –Th 9 to Midnight
- M -Sat 7 to Midnight
- August 17th 24/7

OCCUPANCY LIMITS
- 20 users + staff
- 25 after 5 pm Monday - Friday with occupancy on Saturdays set at 25 users

CAPABILITY
- Access the resist spinners and hot plates located in the teaching lab

STAFF/USER SCHEDULES
- Team A & Team B : Non-overlapping work groups
- 2-week Transition
- Elimination of the 2-team concept Development of flexible/productive staff schedule

NEW USERS
- Training users on equipment Accept new users in September

National Nanotechnology Coordinated Infrastructure NSF

New Equipment

Photo

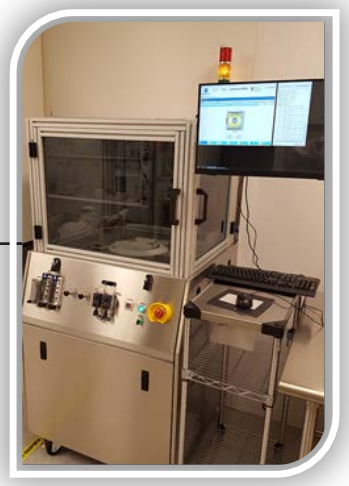
Nanoscribe Photonic Professional GT 2 3D Laser Lithography System --National Science Foundation **Major Research Instrumentation Award** (MRI)

- Sub-micron scale 3D micro and nanofabrication tool
- Based on precise implementation of 2-photon processes
- Enable the fabrication of nano-, micro- and mesostructures with feature sizes down to 160 nm up to several millimeters
- **Supports our efforts in Biotechnology and new emerging materials and chemistry technologies**

Wet

C&D Semiconductor

- Automated wet process lift off tool
- Reclaim of precious metal and reduction of chemical use
- Improved quality, reliability and process repeatability



New Equipment

Etch

YES EcoClean

- Single wafer, downstream ICP stripper
- Photoresist SU8 and polyimide strip, descum, and inorganic substrate cleaning/surface modification
- Remote ICP source produces a high-density oxygen plasma
- Wafers of 2 to 8" diameter
- 3,000 W RF power and hot plate temperature up to 300 C for fast resist removal

Etch

Plasma-Therm Atomic Layer Etch (ALE) system

- Joint development agreement with Plasma-Therm for Atomic layer etching
- CNF will be providing process development support
- ALE allows precise (atomic layer by layer)
- This supports our strategic focus in 2D Materials

New Equipment

Metrology

Woollam RC2 Spectroscopic Ellipsometer

- Measuring thin film thicknesses and optical constants of multilayer thin film stacks
- Parallel detection for rapid measurement and full wafer mapping of film properties
  - Replaces the older technology Woollam ellipsometer

Metrology

Woollam M-2000 in situ Spectroscopic Ellipsometer

- The M-2000 will be attached to the Plasma-Therm Atomic Layer Etch (ALE) system
- Real time in situ measurements of thin films

New Equipment

Deposition

AJA Orion 5 Sputtering system (AJA #3)

- Load locked sputter deposition system
- 3 targets expandable to 5 targets
- Simultaneous co-sputtering of targets, and can deposit magnetic materials
- Supports our efforts in 2D materials and Quantum Information Systems

Deposition

HDP-CVD System from Plasma-Therm

- High density SiO_2, Si_3N_4, a-SiC, and a-Si films at low temperatures, ranging from 80°C to 175°C
- Supports efforts in 2D materials and Heterointegration

NEW EQUIPMENT *Timeline*

Nanoscribe Photonic Professional GT 2 3D Laser Lithography System

-Enable the fabrication of nano- micro- and mesostructures - 160 nm up to millimeters.

YES EcoClean

- Single wafer downstream ICP stripper

AJA International Orion-5 sputter deposition system (Aug)

- 3 targets expandable to 5
- Simultaneous co-sputtering

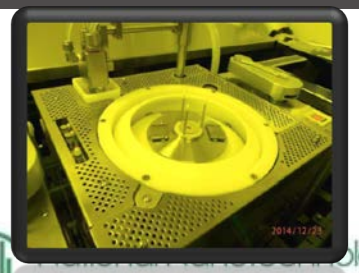
Woollam M-2000 in-situ (Oct/Nov)

- In-situ measurements of thin films (ALE).

Q4 2019 | Q1 2020 | Q2 2020 | Q3 2020 | Q4 2020 | Q1 2021

C&D Semiconductor Lift off

- 100 mm to 200 mm wafers



RC2 Tabletop Spectroscopic Ellipsometers (July)

-Characterization of all types of materials.

Plasma-Therm Atomic Layer Etch (Oct)

-Joint Development Program

HDP-CVD System from Plasma-Therm

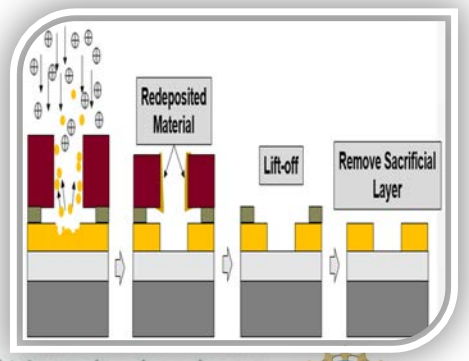
- Capable of high density SiO2, Si3N4, a-SiC, and a-Si films

NEW Capabilities
Etch and Dep Highlights

Patent Disclosure

Joint Patent Disclosure

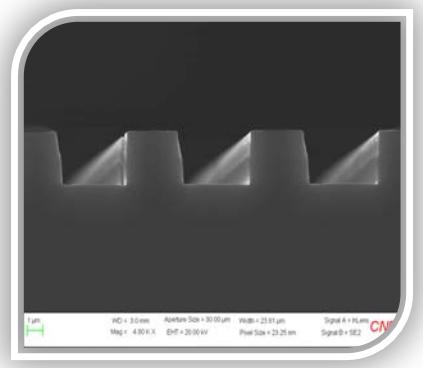
- *Removal process for redeposited material during dry pattern transfer of non-volatile materials*



Oxford Cobra ICP

SiC

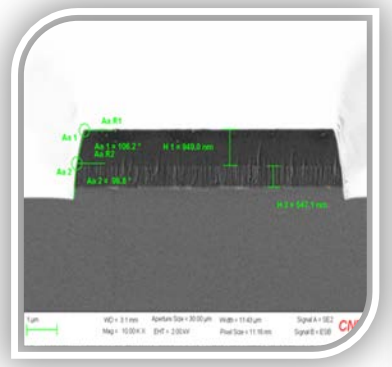
- *Microtrench-free etch*
- *500 nm/min*
- *46:1 selectivity to Nickel*

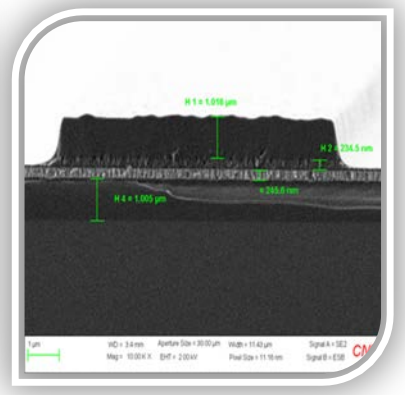


PT770L

AlN and AlScN

- *ICP etch development*





NEW Capabilities

Atomic Layer Deposition-Highlights

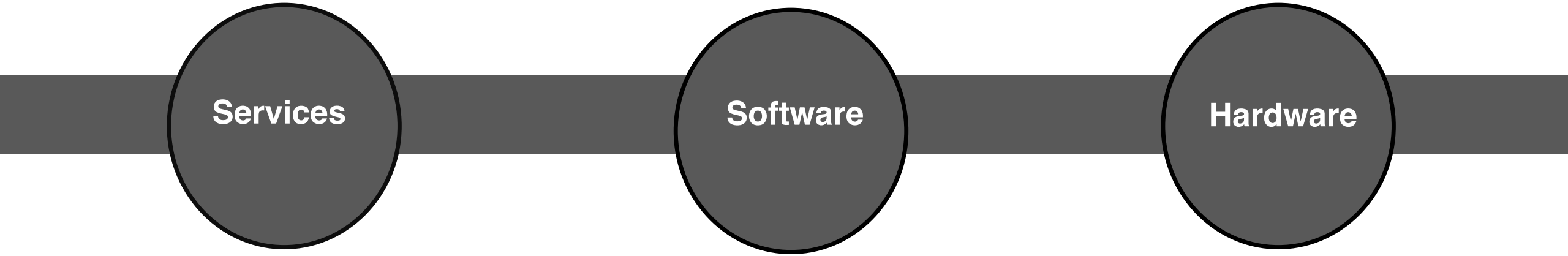
Oxford FlexAL ALD

- *New Ta source TBTDET replaces PDMAT.*
- *Increased source/process reliability*
- *Newly derived processes:*
- *- plasma Ta_2O_5*
- *- thermal Ta_2O_5*
- *- plasma TaN*
- *- thermal TaN*

Arradiance ALD

- *TiN process developed*
- *New ozone processes for Pt, Al_2O_3, and TiO_2.*
- *Addition of 2 new precursors:*
- *- Hf: TDMAHf*
- *- Zr: TDMAZr*
- *High-k dielectrics: HfO_2 & ZrO_2. H2O and O_3 based process development.*
- *Future development of ferroelectric $HfZrO_x$ thin film.*

NEW Capabilities
IT Highlights



Computer-Aided Design
- Remote access to software services *Virtual CAD room available (soon)*

Information
- *Tech Sessions via Zoom*
- *New Website launched after last user meeting*

New Software
- *Cadence*

New Servers
- For CNF Thin – Hot desking solution
- To run CORAL, local CNF websites, CNF email, lab transfer share, and more

Thank You For Your Service

CNF Retirees

- ***Jerry Drumheller -*** with 26 years of service at CNF retired on January 31st

- **Denise Budinger-** with 26 years at CNF retired on August 7th

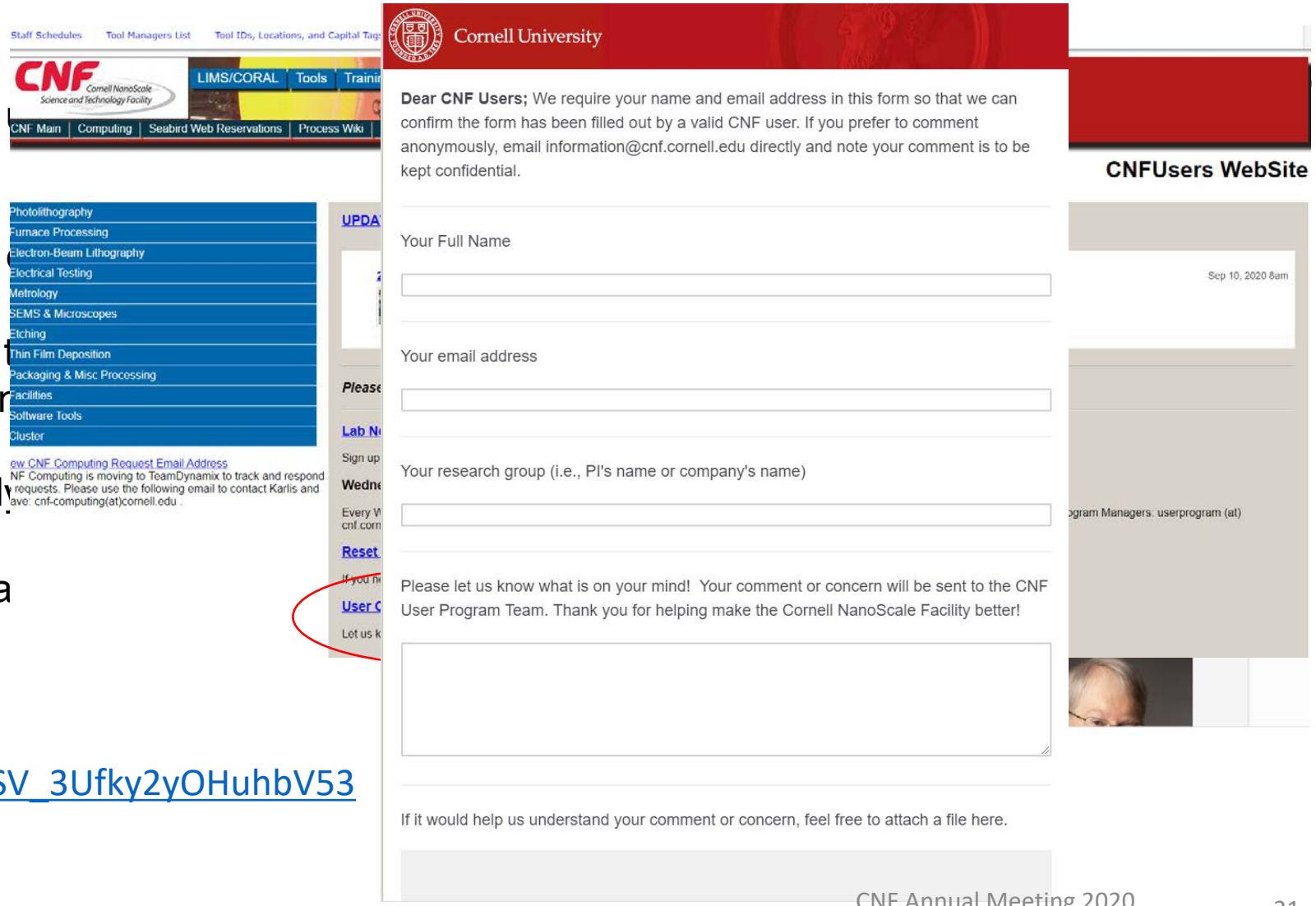
- ***Kathy Springer -*** with 17 years of service at CNF will retire on September 15th

Continual Improvement
User Feedback Form

Feedback

- We would love to here back from our
  a better CNF
- Please visit the online feedback form
- It now has a option for attaching files
  of the feedback and provide a solution
- If you prefer to comment anonymously
- information@cnf.cornell.edu directly a
  confidential.

https://cornell.qualtrics.com/jfe/form/SV_3Ufky2yOHuhbV53



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CNF Cornell NanoScale Science and Technology Facility

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