

# FACILITY GUIDE



## THERMOMECHANICAL & IMAGING NANOSCALE CHARACTERIZATION

ThINC is a core facility of the Advanced Energy Research and Technology Center serving the engineering, chemistry, physical and life science communities. The facility is open to the public and houses wet and dry laboratories, sample preparation suites, and state of the art microscopy and metrology instrumentation. We have PhD scientists ready to run your samples and provide guidance in choosing the best solutions for your materials related problems.



**ThINC**

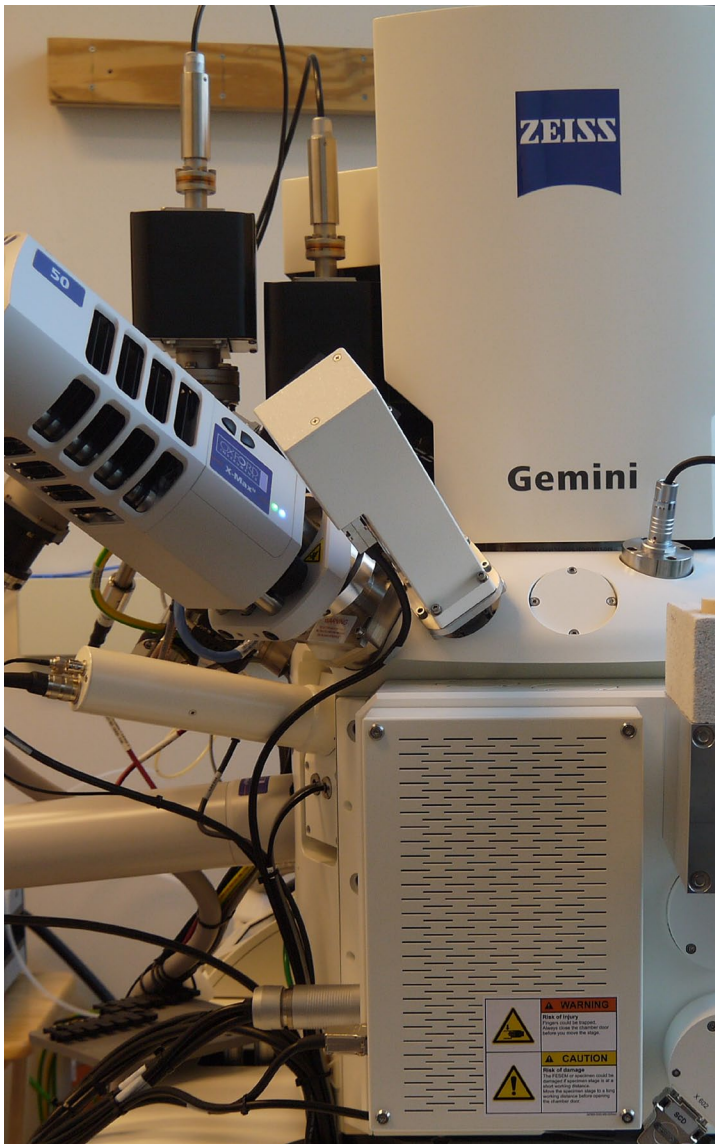
**THERMOMECHANICAL & IMAGING  
NANOSCALE CHARACTERIZATION**

AT STONY BROOK UNIVERSITY

[www.stonybrook.edu/commcms/thinc/](http://www.stonybrook.edu/commcms/thinc/)

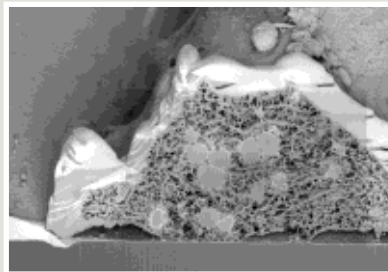
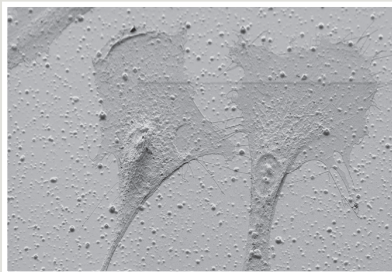
## ELECTRON MICROSCOPY

### Focused Ion Beam-Scanning Electron Microscope (FIB-SEM, ZEISS Xbeam 340)



FE-SEM combines the 3D imaging and analytical performance of the GEMINI column with the ability of FIB for material processing and sample preparation on a nanoscopic scale

- High Vacuum or Variable Pressure mode available
- Multiple detectors available: InLens Duo (SE and BSE mode), SE2, VPSE
- Capella FIB column with Ga-Liquid metal ion source
  - Resolution at 30kV: 3nm
  - Voltage range: 500V-30kV
  - Probe current range: 1pA-100nA
- Equipped with Gas Injection System of Platinum precursor
- Equipped with Micromanipulator, capable of TEM lamellas specimen preparation
- Equipped with Oxford EDAX and EBSD detectors
- Equipped with Atlas 5, a powerful integrated software, capable of 3D tomography imaging and nano-patterning process
- Equipped with Leica cryo system



#### FIB-SEM IMAGES

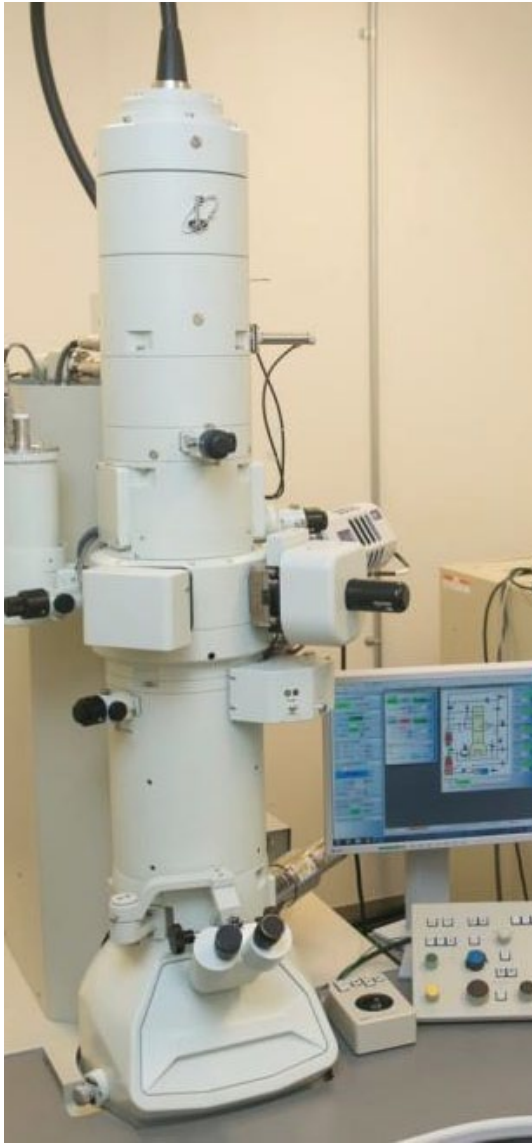
(left) Human dermal fibroblast cells treated with  $\text{TiO}_2$  nanoparticles, courtesy of YC Chuang, ThINC;

(middle) FIB cross-sectioned view of the dental pulp stem cell, courtesy of YC Chuang, ThINC;

(right) Ice crystal structure, courtesy of L Zhang, ThINC

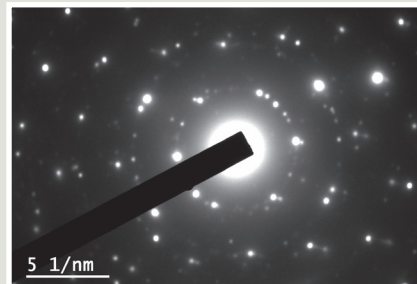
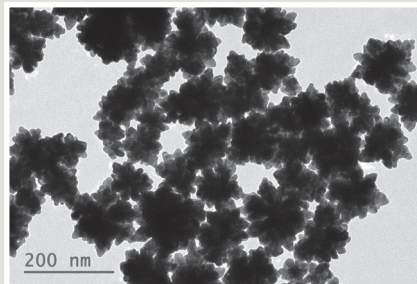
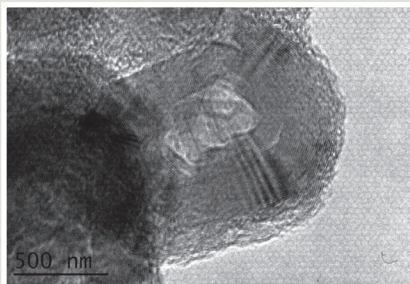
# ELECTRON MICROSCOPY

## Transmission Electron Microscope (TEM, JEOL JEM 1400)



The JEM-1400 achieves the best image quality and analytical performance in 120kV class high-resolution analytical electron microscopes, which is suitable for materials science, polymer and biological applications. It also features cryotomography, STEM, and EDS for element identification.

- Resolution (Lattice Image/Point Image): 0.20 nm/0.38 nm
- Illumination Emitter: Precentered single-crystal LaB6 filament
- Accelerating Voltage (Steps/ Variable steps/ Stability): 40, 60, 80, 100, 120kV/ 33V min. step/  $2 \times 10^{-6}$  per min.)
- Magnification (Mag mode/ Low Mag mode): x 5K-2M/x 120-4K
- Specimen Stage: microactive goniometer with piezo drives
- Specimen chamber (Specimen per Load/ specimen tilt angle (X-axis)): 1/  $\pm 25^\circ$  ( $\pm 70^\circ$  with high tilt holder)
- Specimen Movements (X, Y, Z direction):  $\pm 1.0$  mm,  $\pm 1.0$  mm,  $\pm 0.5$  mm
- Equipped with anti-contamination device and cryofin
- Equipped with Gatan ORIUS SC1000B CCD camera
- Equipped with energy dispersive X-ray and Oxford X-MAX 80T detector

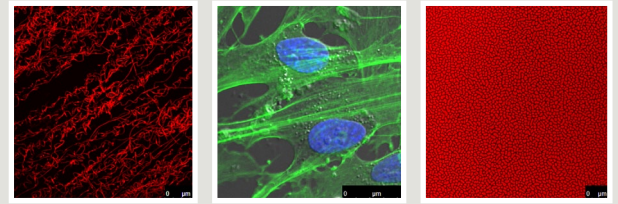
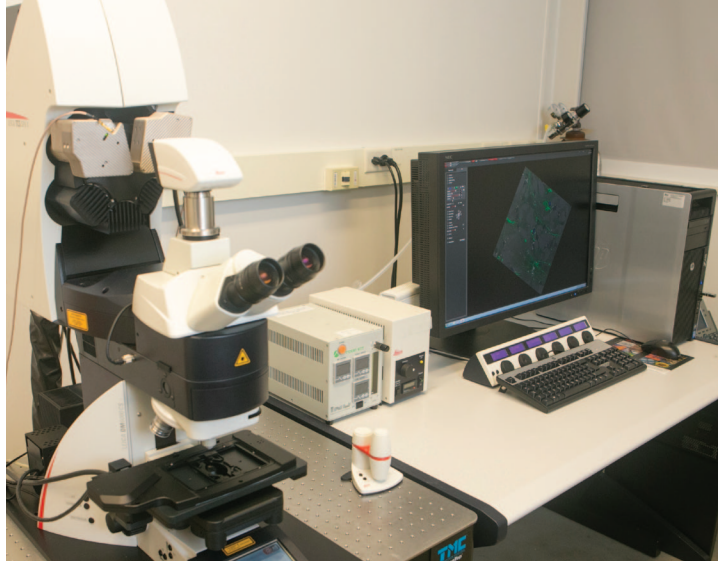


### TEM IMAGES

(left) Graphitized carbon, showing a distance between graphene layer of approximately  $3.4 \text{ \AA}$ , courtesy of C Chang;  
(middle) Synthesized gold nanoparticles, with average size  $\sim 80 \text{ nm}$ , L Zhang, ThINC, sample provided by T Mironava;  
(right) SAED of copper alloy, courtesy of YC Chuang, ThINC

# LIGHT MICROSCOPY

## Upright Confocal Microscope (Leica TCS SP8X)



### CONFOCAL MICROSCOPE IMAGES

(left) Organic photovoltaic polymer MEH-PPV electrospun fibers, courtesy of Y Liu;  
 (middle) Dental pulp stem cells with micro-sized beads taken together by incident (fluorescence) and transmitted (DIC) lights. Stained with AF Phalloidin 488 (actin filaments) and DAPI (nuclei), YC Chuang, ThINC, sample provided by Y Yu;  
 (right) Organic photovoltaic polymer P3HT blended with PMMA, L Zhang, ThINC, sample provided by C Pan

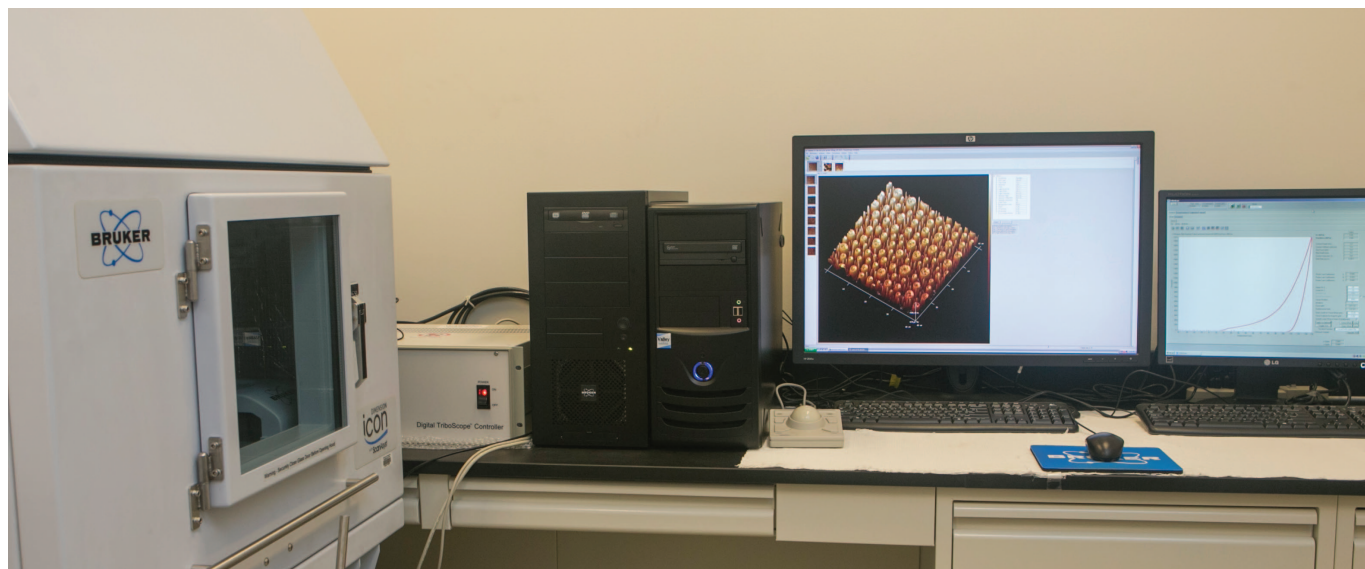
- Upright Leica DM 6000 with adaptive focus, motorized XY-Stage (15 nm step size) and Super Z Galvo (1500 $\mu$ m/3nm step size)
- Tandem scanner 8 kHz:
  - Non-resonant mode: 1-1800 Hz (3600 Hz vidirectional), 7fps for 512x512 pixels, Max frame size 8192x8192 pixels
  - Resonant mode: 8kHz (16kHz bidirectional), 28fps for 512x512 pixels, Max frame size 1024x1024 pixels
- WLL (White Light Laser 470-670nm), Laser UV 405nmDMOD flexible
- Detection range: 400-800nm
- Internal detection channels: 2x PMT, 2x HyD
- Transmitted light detectors: Brightfield
- Fluo filters: A (BP 340-380, LP 425), I3 (BP 450-490, LP 515), N2,1 (BP 515-560, LP 590)
- All objectives have a corresponding DIC condenser prism for DIC measurement in confocal mode
- Equipped with Tokai Hit Stage Incubator providing 37 °C and 5% CO<sub>2</sub> for live cell imaging



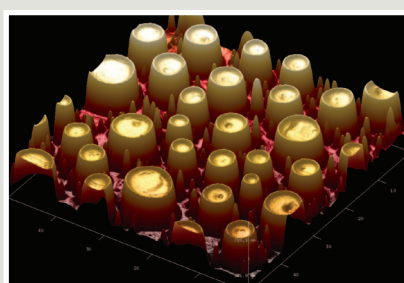
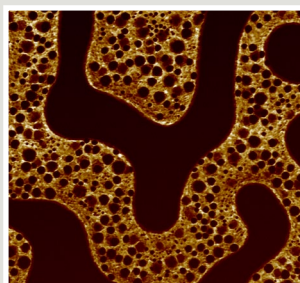
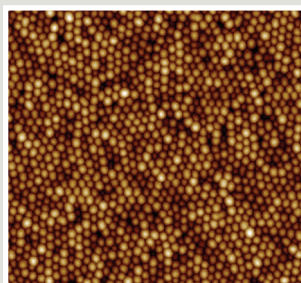
## Fluorescent Microscope (AMG EVOS FL)

- Light cubes: DAPI (Ex 360nm/ Em 447nm), GFP (Ex 470nm/ Em 525nm), White (for non-transparent samples)
- Objectives: 4x, 10x, 20x, 40x LWD objectives and 100x coverslip-corrected oil objective
- Equipped with Bioptechs stage temperature controller providing 37 °C for live cell observation

## Atomic Force Microscope (AFM, Bruker Dimension ICON)



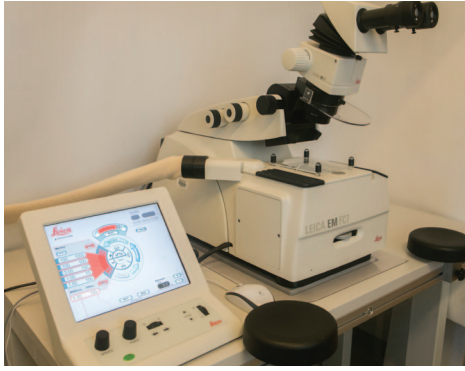
- Multi-mode available: PeakForce Tapping, ScanAsyst in Air/ Fluid, Contact Mode in Air/ Fluid, Tapping Mode in Air/ Fluid, Scanning Tunneling Microscopy (STM), PeakForce QNM (Quantitative Nanomechanical Mapping), PeakForce TUNA, Surface potential detection (Kelvin Probe FM)
- Heating and Cooling: Execute temperature control and thermal analysis on samples from  $-35^{\circ}\text{C}$  to  $250^{\circ}\text{C}$  while scanning in various modes
- Scanner specifications:  $90\mu\text{m}$  x  $90\mu\text{m}$  in X-Y direction;  $6\mu\text{m}$  in Z direction
- Sample size:  $\leq 200\text{mm}$  (8 inch) in diameter and  $\leq 15\text{mm}$  (0.65 inch) in thickness
- Applications: Materials mapping, nanomechanics characterization, nanoelectrical characterization, biological characterization



### AFM IMAGES

(left) Monolayer of gold particles deposited on silicon wafer, with average size  $\sim 40\text{nm}$ , YC Chuang, ThINC, sample provided by V Ricotta;  
(middle) Conductivity measurements of organic photovoltaic polymer solar cell, L Zhang, sample provided by C Pan;  
(right) 3D image of blend polymeric matrix (PS/PMMA), C Chang, ThINC, sample provided by Z Yang

# SAMPLE PREPARATION



## Ultramicrotome & Cryo-ultramicrotome (Leica EM UC7/ FC7)

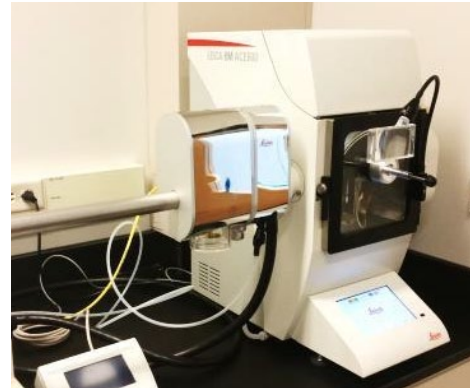
- Prepare excellent quality semi- and ultra-thin sections, as well as the perfectly smooth surfaces for LM, EM and SPM examination

## Freeze plunger (FEI Vitrobot)

- Perform the cryo-fixation process at constant physical and mechanical conditions
- Produce high quality and reproducible cryo-fixation results

## Turbo Freeze Drier (EMS 775)

- Reduce the distortion during drying process
- Operating temp. range: -140~40 °C



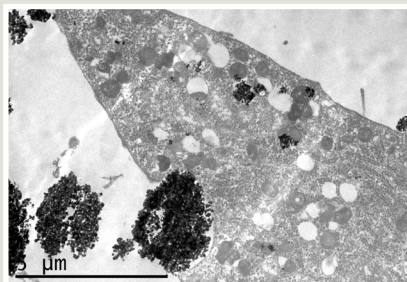
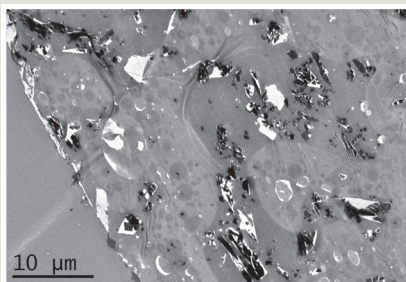
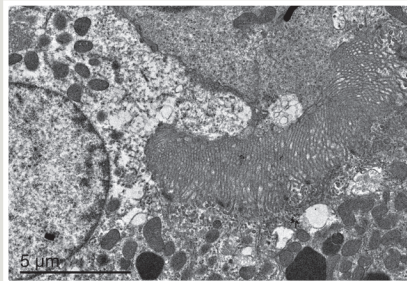
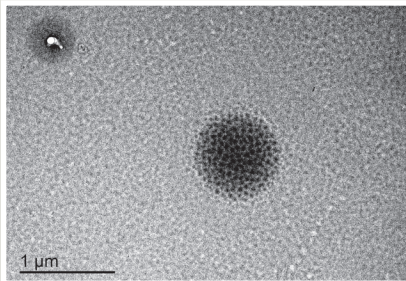
## High Vacuum Coater/Freeze Fracture Unit (Leica EM ACE 600)

- Freeze fracture to reveal internal structures of a frozen specimen
- Freeze etching provides details of the fracture faces by subliming superficial ice layers under vacuum



## Cryo Transfer SEM Sample Holder (Leica VCT 100)

## Cryo Transfer TEM Specimen Holder (Gatan Gat-626)



- Comprehensive sample preparation station for microscopy characterization including EM, LM and SPM
- Conventional biological sample preparation for EM characterization
- Rapid plunge freezing for Cryo-fixation and Cryo EM characterization
- Applicable samples including polymer, gels, emulsions and biological samples

## Dynamic Mechanical Analysis (DMA, TA Q800)



- Obtain mechanical properties as a function of time, temperature, and frequency
- Temp. range:  $-145\sim 600\text{ }^{\circ}\text{C}$
- Force range:  $0.0001\sim 18\text{N}$
- Frequency range:  $0.01\sim 200\text{Hz}$
- Available clamps: Dual/ single cantilever, compression, 3-point bending, tension (film)



## Thermal Gravimetric Analysis (TGA, TA Q50)

- Monitor weight changes in a material as functional of temperature and time
- Temp. range:  $\text{ambient}+5\text{ }^{\circ}\text{C}\sim 1000\text{ }^{\circ}\text{C}$
- Sensitivity:  $0.1\mu\text{g}$



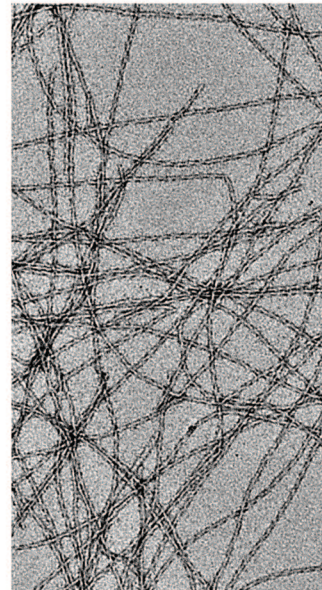
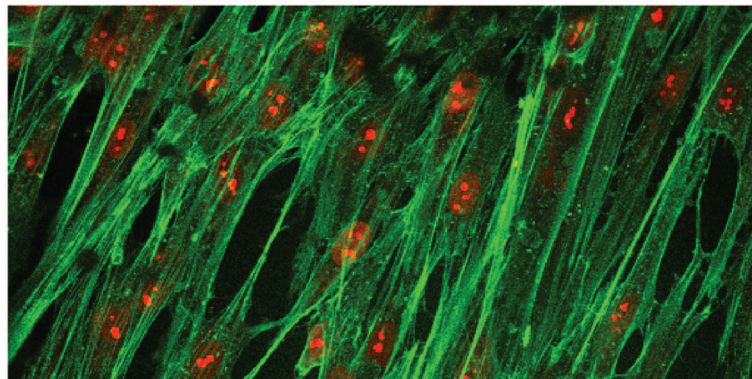
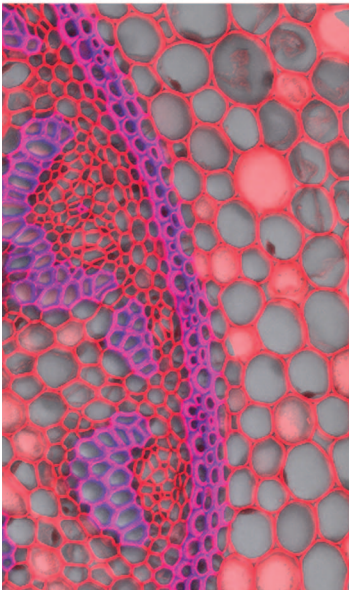
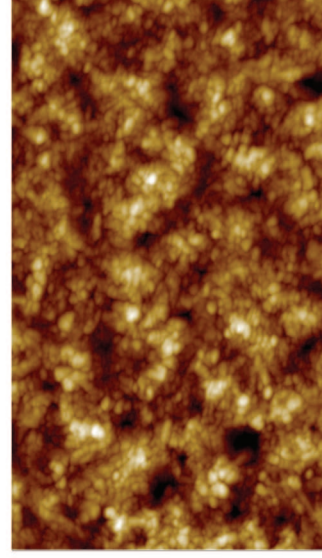
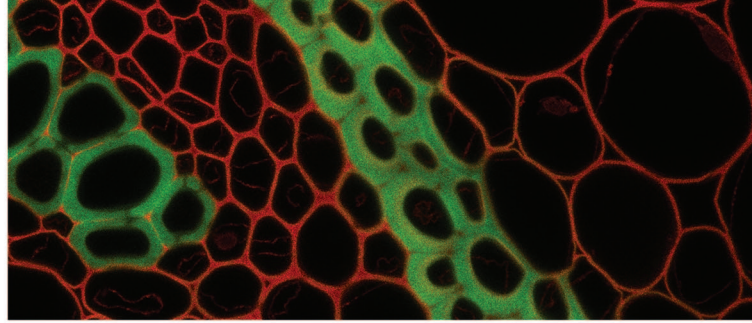
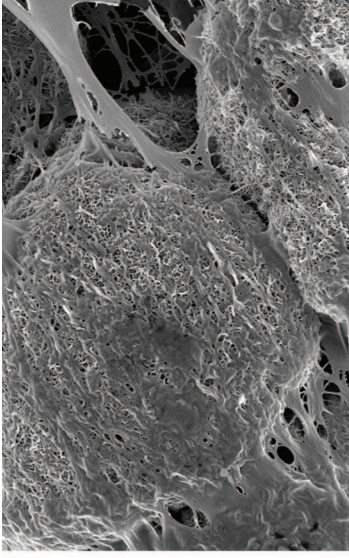
## Thermal Conductivity meter (DTC-300)

- Measure thermal conductivity of a material accordance with the ASTM E1530 standard
- Temp. range:  $-20\sim 300\text{ }^{\circ}\text{C}$
- Thermal conductivity range:  $0.1\sim 40\text{ W/m.K}$
- Specimen size: 2" in diameter,  $\leq 1$ " in thickness



## Differential Scanning Calorimetry (DSC, TA Q2000)

- Measure temperature and heat flows associated with thermal transitions in a material
- Temp. range:  $-90\sim 550\text{ }^{\circ}\text{C}$
- Tzero Hermetic pans available for liquid and volatile samples



Courtesy of L Zhang, YC Chuang, and Y Xue, ThINC



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AT STONY BROOK UNIVERSITY

Advanced Energy Center™  
1000 Innovation Road  
Stony Brook, NY 11794-6044  
Phone: 631.216.7412  
ThINC@stonybrook.edu

[www.stonybrook.edu/commcms/thinc](http://www.stonybrook.edu/commcms/thinc)

Director:  
Dr. Chung-Chueh Chang  
chung-chueh.chang@stonybrook.edu



Stony Brook University