NNCI: The Montana Nanotechnology Facility (MONT) (ECCS-1542210)

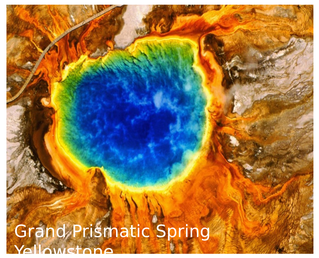
David Dickensheets, Recep Avci, David Mogk, Phil Stewart and *Sean Fox

Montana State University, Bozeman MT 59717; *Carleton College, Northfield, Minnesota

MONT and its Core Facilities

The Montana Nanotechnology Facility (http://www.nano.montana.edu)

at MSU is the Northern Rockies hub of the NNCI community, providing researchers from academia, government and the private sector with leading-edge fabrication and characterization tools and expertise within many disciplines of nanoscale science, engineering, and technology. It is located in a region with vibrant and emerging high tech companies that conduct research on optics, biomedical applications, energy systems and earth and environmental materials.



MONT comprises four core facilities at MSU:

Montana Microfabrication Facility (MMF: http://www.mmf.montana.edu/)

provides class 1000/10000 cleanrooms for lithography, thin films growth, deposition and etch, metrology, packaging and test.

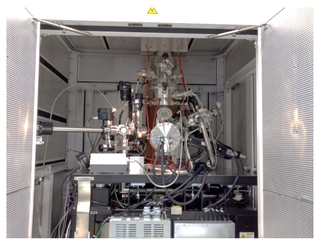
Class 1,000 cleanroom facility

Imaging and Chemical Analysis Laboratory (ICAL: www.physics.montana.edu/ical)

offers state of the art microscopy and spectroscopy equipment, Instrumentation include FEM, SEM, XPS, TOF-SIMS, Hybrid Auger Nanoprobe, AFM, XRD, Optical Microscopes.

Center for Biofilm Engineering (CBE: http://www.biofilm.montana.edu/)

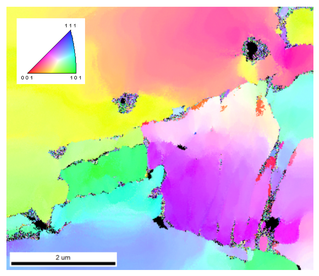
advances the basic knowledge, technology, and education to understand, control and exploit biofilm processes. CBE facilities include an Optical/Confocal Microscopy Lab, Microscope Resource Room, Digital Imaging Lab, and experimental chambers to observe microbial growth under a range of experimental conditions.



Hybrid Auger nanoprobe

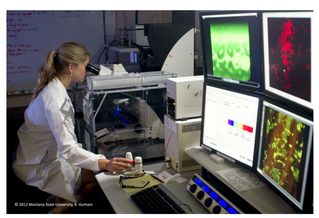
Proteomics, Metabolomics, and Mass Spectrometry Facility (http://www.montana.edu/massspec/)

offers a full range of services from single samples to complete proteomics and metabolomics projects. Instrumentation includes GCMS, LCMS, IMS, MALDI-TOF, ESI-QTOF, and ESI-IonTrap.



EBSD orientation map of carbon steel

State-of-the art capabilities at Mass Spectrometry facility



Microscopy at CBE

Education and Outreach Activities

MONT has a comprehensive education and outreach effort with the goals of:

- Increasing awareness about the impacts and potential of nanoscience to the interested public
- Providing mentoring and internship opportunities for students
- Reaching out to companies invested in nanoscience research, to facilitate technology transfer as a regional economic driver
- Facilitating professional development and collaborative research
- Providing on-line resources to teachers of nanotechnology

Specific E&O activities include:

- Co-authored *Science* review article "Natural, incidental, and engineered nanomaterials and their impacts on the Earth system."
- Short courses and training for new users
- Short courses for K-12 science teachers
- Annual workshops for representatives of regional and national industries
- Webinars on topics of interest to support distance learning
- Convening Nanoscience in Earth and Environmental Sciences at the 2017, 2018 & 2019 international Goldschmidt conferences

Partnership with Carleton College Science Education Resource Center

- Web portal to support instruction on nanotechnology, digital library technologies providing a broad array of learning resources on nanotechnology

Science Education Resource Center @ Carleton College

User Activities and Collaborative Research

Academic collaborations:

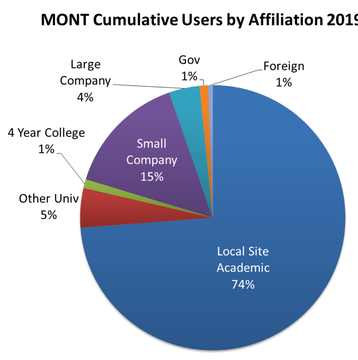
- MONT supports students, faculty members, and researchers from various academic institutions
- Students from more than 25 different states have used MONT
- Summer REU program
- Summer American Indian Research Opportunities (AIRO)

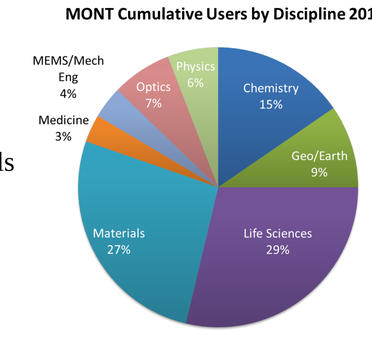
Industrial collaborations:

- More than 50 industrial collaborators utilize the MONT facilities, including more than 30 small companies in Montana

Broad Range of Disciplines:

- Fundamental sciences and materials
- Environmental sciences
- Biological sciences and health technologies
- Optical technologies

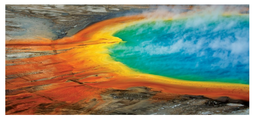


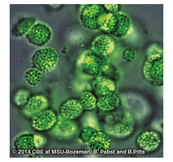


Focus Areas

Bio-inspired and bio-derived nanomaterials

- Energy solutions
- Environmental technologies
- Health/medical biofilms
- Biofilm control strategies
- Industrial processes
- Standardized methods
- Water systems



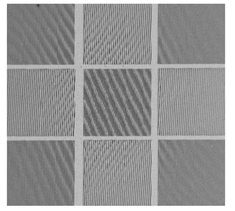


Bio-mediated nanoscale processes

- Biocorrosion and biodegradation
- Biomineralization
- Bacterial patterning and sorting

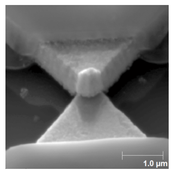
Functional nanostructured materials

- Nanostructured optical devices and metamaterials
- Quantum 2D materials



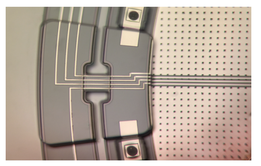
High temperature materials

- High temperature corrosion in fuel cells, turbines. engines, boilers, and batteries
- High temperature corrosion in polycrystalline silicon manufacturing



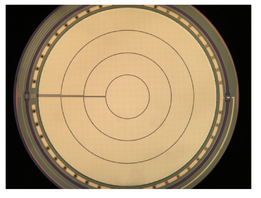
Geological materials

- Evolution of Precambrian crust in southwestern Montana
- Characterization of the morphology, composition, structure, and surface chemistry of minerals to support resource development and environmental remediation



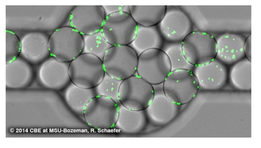
MEMS, MOEMS

- Polymer MOEMS and Micro-Optical Systems
- Microsensors



Microfluidics applications

- Healthcare and personalized medicine
- High-throughput screening and assaying at the single cell level
- Cell discovery
- Engineering new biomaterials



Montana: The Treasure State

We invite the nanotechnology community to visit our MONT facility and establish scientific collaborations with us, and take advantage of the natural treasures found in the rugged beauty of the Northern Rockies and several nearby National Parks.