

MONT

Montana Nanotechnology Facility

An NSF NNCI Node in the Northern Rocky Mountain Region



Year 4 Snapshot

David Dickensheets
NNCI Y4 Annual Conference, Oct.23-25, 2019

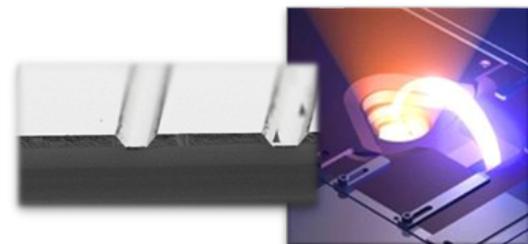
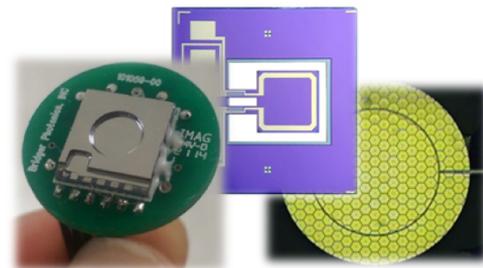
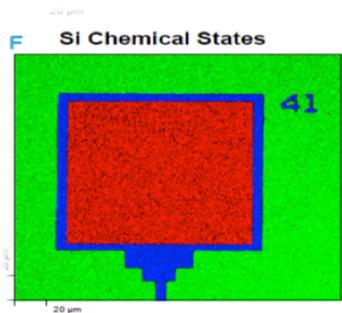
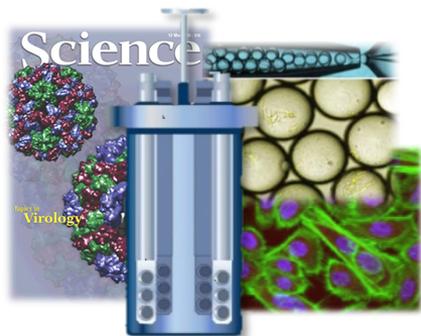
nano.montana.edu



MONT Focus Areas

Program Emphases

- **Optical MEMS and Nanosystems** - with local industrial collaborations
- **Biology and Nanotechnology** - Biofilms and Microfluidics, bio-corrosion
- **Novel optical and high temperature materials**
- **2D Quantum Materials**
- **Nanoscale characterization** - SEM, nanoAuger, XPS, XRD, ToF-SIMS, TEM
- **Education and Outreach** emphasizing undergraduate research, K-12 students/teachers, web-based educational materials with **SERC at Carlton College**



Our Team: Some Changes!



David Dickensheets



Recep Avci
ICAL



Phil Stewart
CBE



Mark Young
CBIN / VPR



Sean Fox
Education Specialist
Carleton College
Science Education
Resource Center



Dave Mogk
Geology /
E&O



Carolyn Plumb
Assessment



Phil Himmer
MMF Manager



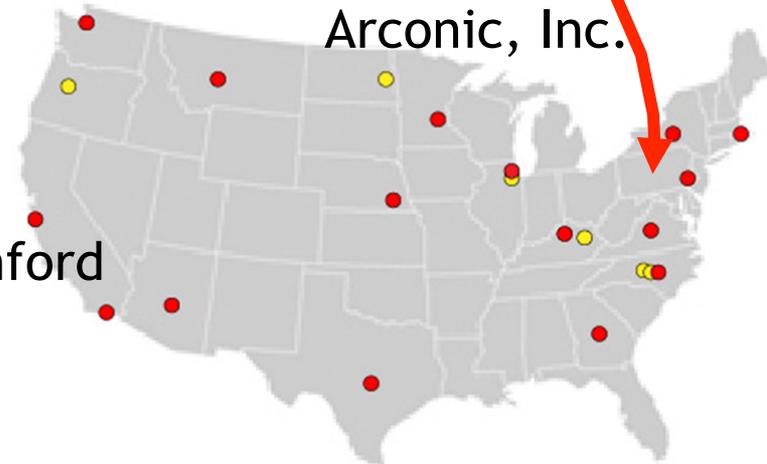
Manjula Nandasiri
ICAL Manager



Heather Rauser
Administrator



nano@Stanford



Arconic, Inc.



Our Team: Montana State + Carleton College



David Dickensheets



Recep Avci
ICAL



Phil Stewart
CBE



Mark Young
TEM



Sean Fox
Education Specialist
Carleton College
Science Education
Resource Center



Dave Mogk
Geology /
E&O



Carolyn Plumb
Assessment



Andrew Lingley
MMF Manager



Elif Roehm
ICAL Manager



Heather Rauser
Administrator

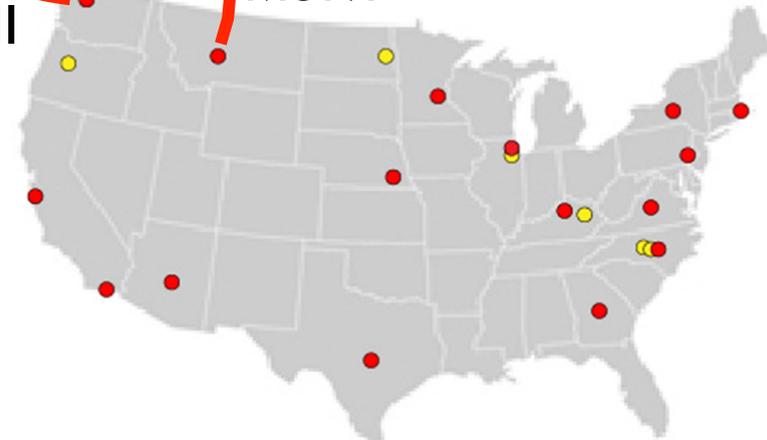


MONTANA
STATE UNIVERSITY

Mountains and Minds

NNI

MONT



Facility Enhancements in Y4

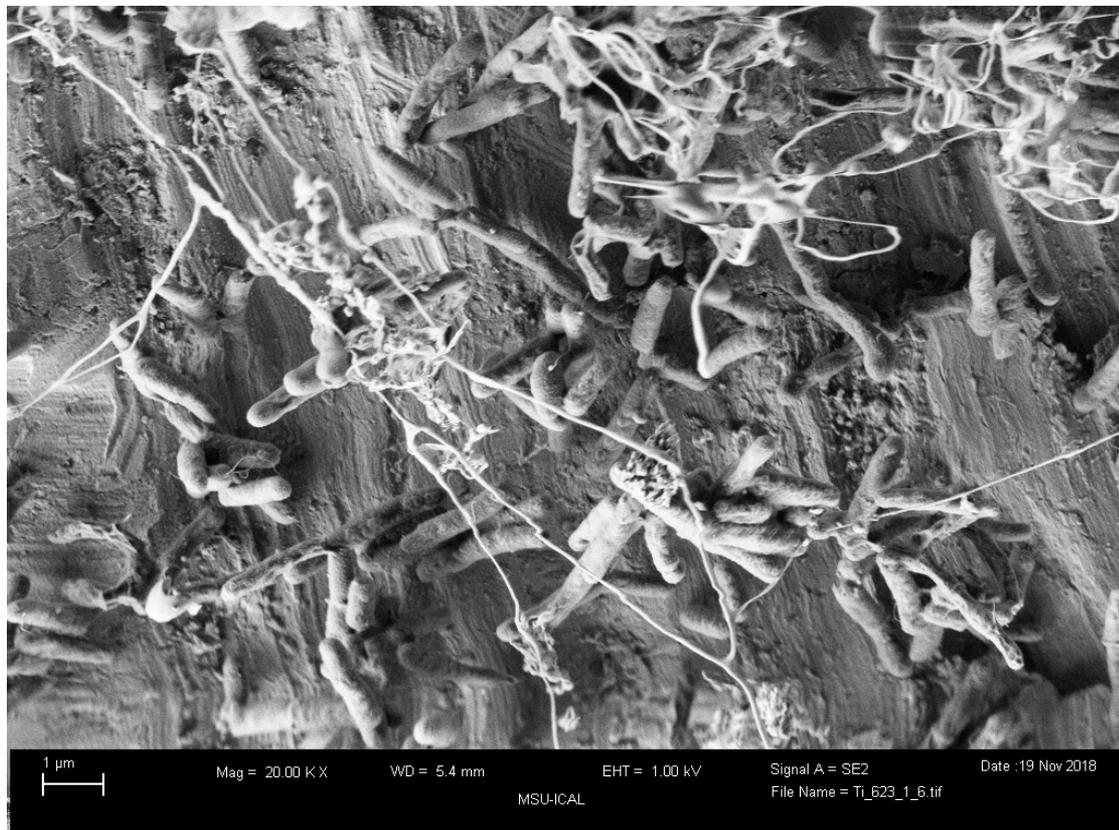
Cryo-FE-SEM (Field Emission Scanning Electron Microscope) image showing the attachment of biofilm formed by a non-tuberculous mycobacterium, *M. chimaera* on a titanium surface.

We are partnering with **Archana Siddam of the US Food and Drug Administration.**

This image provides information about the morphological structure of this biofilm, including these fine “nanowires” that are important in our understanding of the underlying mechanisms through which these biofilms cause pathogenicity. The samples must be cooled to see image these fine features.

The new cryo-stage has catalyzed our partnership with the FDA on this project.

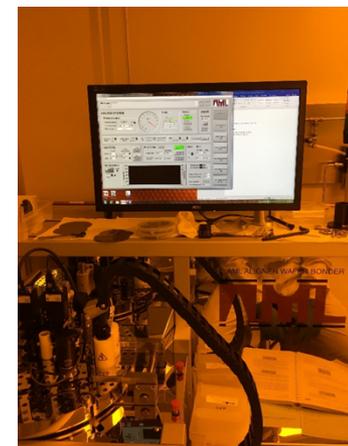
New cryo-stage on Zeiss FE-SEM



Facility Enhancements in Y4

- Two confocal Raman microscopes
- AML Wafer Bonder in service
- Expansion of Cobleigh Cleanroom underway – making space for enhanced microfluidics capabilities
- On the horizon: • Co-PI Young received an NSF MRI award for a **200 keV cryo-TEM** (NSF #1828765)

We continue to leverage our NNCI award as match to secure State and Private investment in our facility.

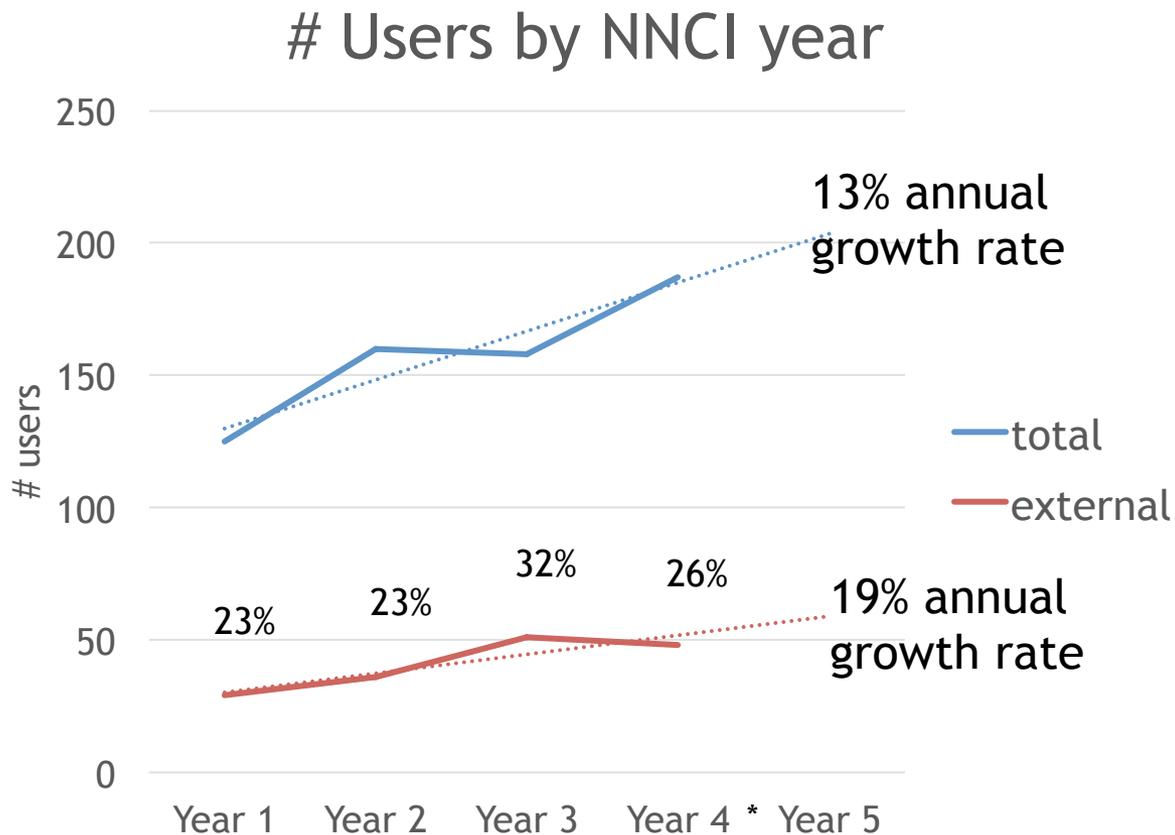


Total investment in new instruments since project inception is

4.8x

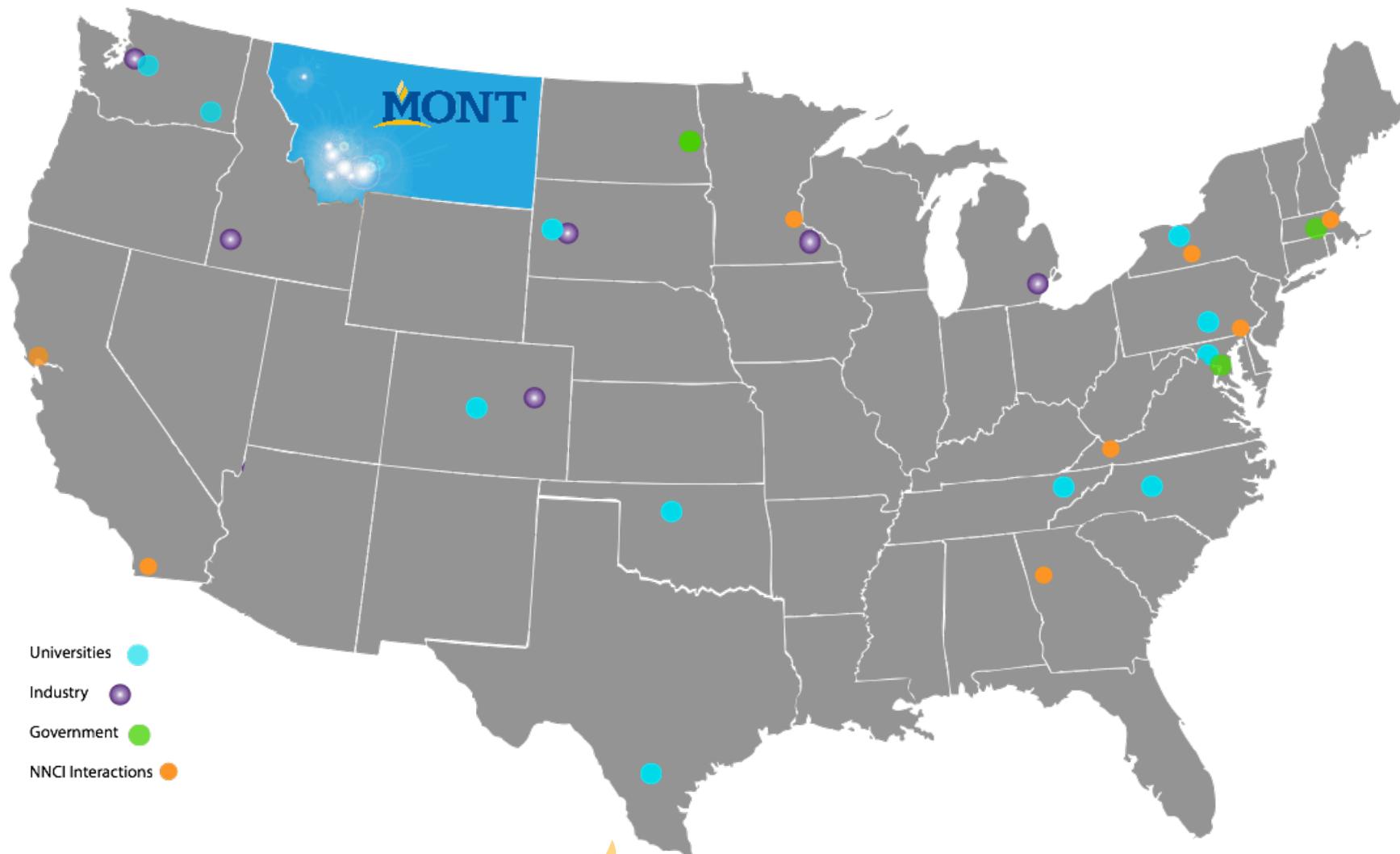
our NNCI capital expenditures.

User Data: Annual Growth Rates



* year 4 data is preliminary

External Users: Geographic Representation

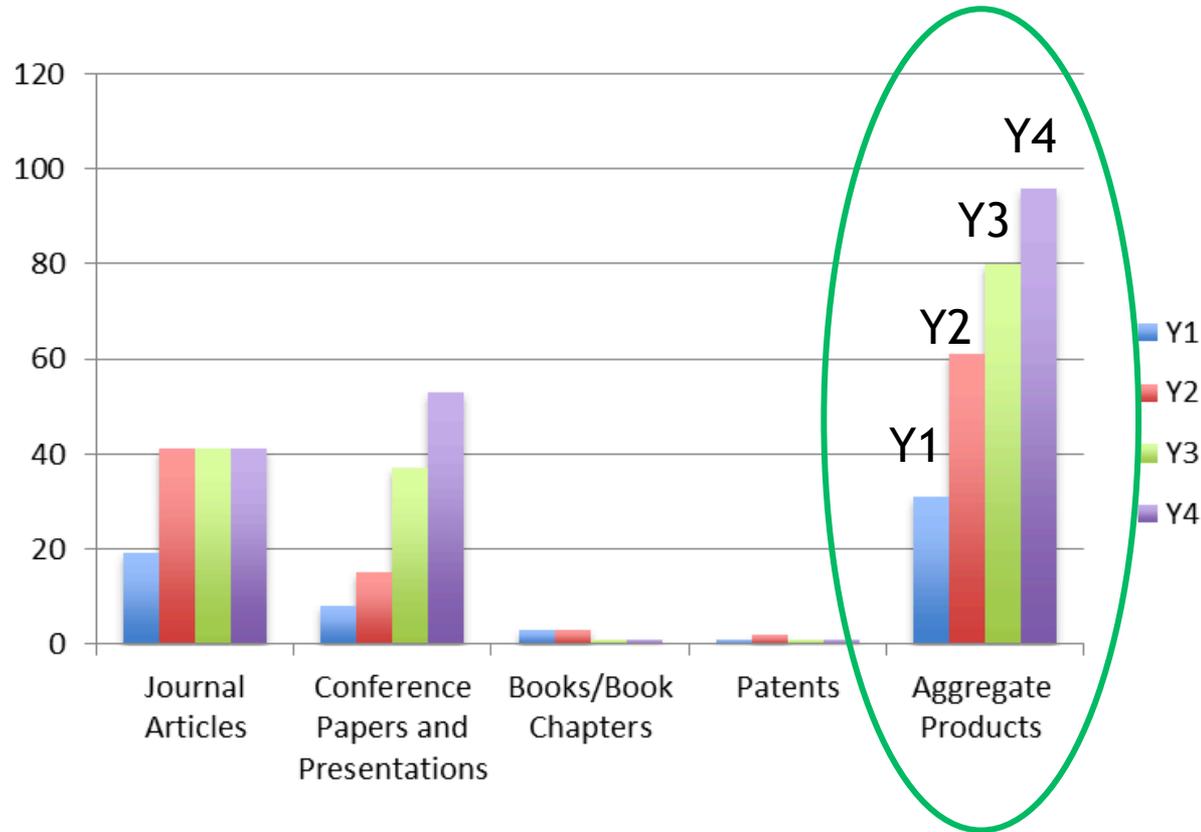


Publications in 2018

96 Publications total

- 41 Journal Articles
- 53 Conference papers
- 1 book chapters
- 1 patent

Up 20% over 2017

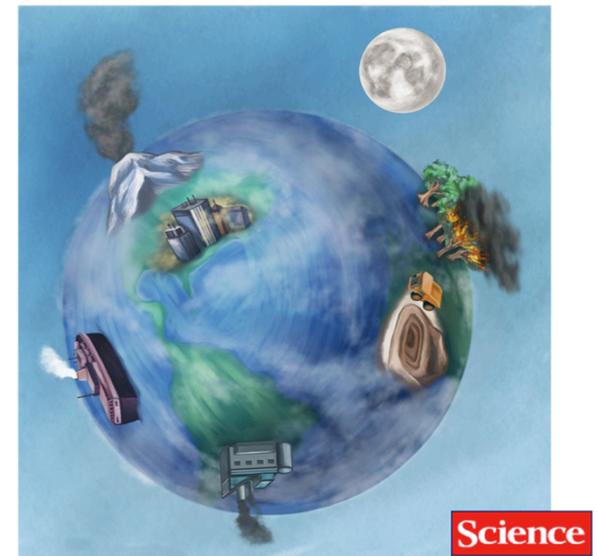


Publications in 2018

- Hochstein, R., et. Al. *Structural studies of Acidianus tailed spindle virus reveal a structural paradigm used in the assembly of spindle- shaped viruses.* **PNAS** 115:2120-2125, 2018.
- Tianbo Liu et. al., *MEMS 3-D Scan Mirror With SU-8 Membrane and Flexures for High NA Microscopy,* **Journal of Microelectromechanical Systems** Volume: 27 , Issue: 4 , Aug. 2018.
- Hunt KA, et. al. *Multiscale analysis of autotroph-heterotroph interactions in a high-temperature microbial community,* **PLoS Comput Biol.** 2018 Sep 27;14(9)
- Jay ZJ, Beam JP, Dlakić M, Rusch DB, Kozubal MA, Inskeep WP. *Marsarchaeota are an aerobic archaeal lineage abundant in geothermal iron oxide microbial mats.* **Nature Microbiol.** 2018 3(6): 732-740
- MH Schweitzer, et. al., *Preservation potential of keratin in deep time.* **PloS one** 13 (11), e0206569

MONT PI David Mogk co-authored the *Science* review article “**Natural, incidental, and engineered nanomaterials and their impacts on the Earth system.**” This invited review grew out of an NSF-sponsored workshop Mogk and lead-author Michael Hochella from NanoEarth hosted in 2018. Dr. Hochella serves on the MONT External Advisory Board.

Modern Earth, from a nanoperspective.



Michael F. Hochella Jr. et al. *Science* 2019;363:eaa08299



Soft-gel microchannels to better understand neural disorders

Abnormalities in the folding landscape of the cerebral cortex have been linked to epilepsy, autism, and schizophrenia. Here we grow dissociated primary neurons under confined curvature patterns within soft-gel microchannels to study the impact of curvature on calcium communication. We use the MMF to fabricate a **poly(dimethyl-siloxane) mold** to create hydrogel barriers within a cell culture assay. This project tests growth and transport behavior of degenerative signals in primary cortical neurons.

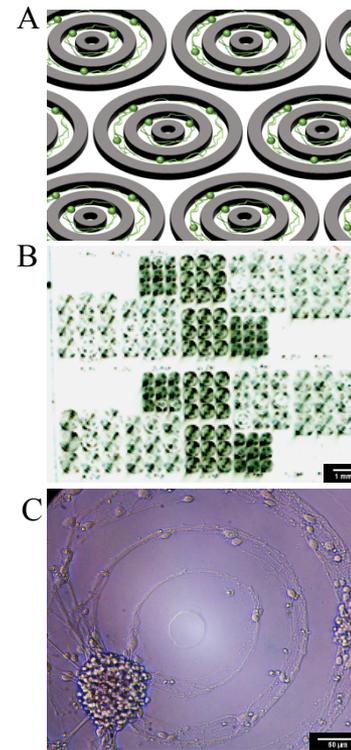


Figure 1. Neuronal cell growth and signaling multi-curvature based soft-gel micro channels. A) Schematic shows the 3D design of the multi-curvature-based cell assay. B) PDMS pattern shows high-throughput array of the cell assay. Scale bar = 1 mm. D) DIC image of neurons grown in multi-curvature channels. Scale bar = 50 μm . E) Calcium signaling in curved neuronal networks, 9 days in vitro. Scale bar = 50 μm .

Hammad Khan, Connor Beck, Anja Kunze, Montana State University
 NSF CAREER Award #1846271 (ENG)
 Work performed at Montana State University, MONT facility: MMF

MONT Impact – CAREER Awards

MSU professor wins prestigious award from National Science Foundation

Marshall Swearingen, MSU News Service
 MARCH 15, 2019
 f t e



Anja Kunze, right, is shown working with undergraduate students in her lab, where small networks of brain cells are gently stretched using precise magnetic force. MSU Photo by Adrian Sanchez-Gonzalez

BOZEMAN — Some electrical engineers design the giant dynamos and transmission lines that power society. Others apply their prowess to electronics in cars and televisions, or — still smaller — the microprocessors in phones and watches.

Montana State University's [Anja Kunze](#), assistant professor in the [Department of Electrical and Computer Engineering](#), studies the tiny electrochemical signals that occur between individual brain cells to produce thought and awareness.

"We are actually very versatile," Kunze said of electrical engineers.

Prof. Kunze received an NSF CAREER award!

Prof. McCalla received an NSF CAREER award!

Congratulations!

MSU professor wins prestigious National Science Foundation award

Marshall Swearingen, MSU News Service
 MARCH 21, 2019
 f t e



Stephanie McCalla, right, in her lab with an MSU student on October 30, 2017. MSU photo by Kelly Gorham

BOZEMAN — One day, a technician in a small, rural hospital may be able to reliably diagnose breast cancer, Alzheimer's disease or traumatic brain injury using a tab of paper that would change color like a pH strip dipped in vinegar.

A small sample of blood or other fluid is all that would be needed to trigger the tool's engineered biochemicals, which would be sensitive enough to detect tiny amounts of protein or DNA associated with illness.

Just as computing was revolutionized with more efficient digital on-off transistors, switch-like biosensors have the potential to transform medical diagnosis and research, according to Montana State University's [Stephanie McCalla](#).

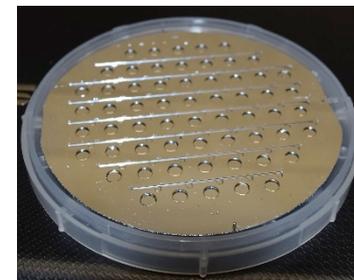
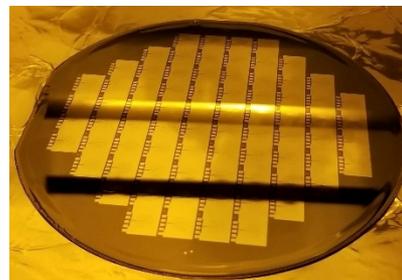
Designing the biosensors remains a complex challenge, but the end goal "is something that's cheap and simple, that could be used in any clinic," said McCalla, assistant professor in the [Department of Chemical and Biological Engineering](#) in the [Norm Asbjornson College of Engineering](#).

Deformable Membrane Mirror Development

During the past year Revibro Optics has utilized the MMF to develop tunable mirror technology. These efforts have been funded through two grants: a Phase II SBIR from NSF and an MBRCT grant. Our work in the MMF is producing active mirrors with an industry-leading combination of high-speed and long focusing range.

“The MMF has been an invaluable resource for commercializing this technology.”

REVIBRO
OPTICS



Chris Arrasmith & Scott Gneiting, Revibro Optics LLC
NSF SBIR Phase II #1831287, MBRCT Grant #19-51-037(A)
Work performed at Montana State University, MONT facility **Montana Microfabrication Facility**

MONT Impact – 10 SBIR Awards, private investment

SBIR Phase II: Closed-loop control of MEMS deformable mirror for two-photon microscopy

Amount: \$749,608.00

This Small Business Innovation Research (SBIR) Phase II project will enable video-rate three-dimensional (3D) imaging within two-photon microscopes (2PMs) by developing novel deformable membrane mirror ...

SBIR Phase II 2018 National Science Foundation

SBIR Phase I: High-power laser compatible MEMS deformable mirrors for confocal and two-photon microscopy

Amount: \$225,000.00

This Small Business Innovation Research (SBIR) Phase I project will enable video-rate three-dimensional (3D) imaging within two-photon microscopes (2PMs) through the use of an electrostatically actuated MEMS deformable mirror ...

SBIR Phase I 2017 National Science Foundation

Revibro Optics,
Congratulations on NSF SBIRs!

7 Companies with 10 Active SBIR Awards worth \$4.5M

+ private investment
+ corporate revenue...

Economic Impact = ?

Frequency Agile Se

Amount: \$124,958.00

The overall goal of the SBIR effort is to develop a frequency agile sensor that can compensate for frequency drift in a laser ...

SBIR Phase I 2018 National Aeronautics and Space Administration

Polarization Entanglement

Amount: \$749,996.00

The overall goal of this NASA effort is to develop a quantum entangled photon pairs for use in quantum communication ...

SBIR Phase II 2018 National Aeronautics and Space Administration

Congratulat

es to enhance their
(NCI) is the u ...

new capabilities and improved efficiency for industrial sensor applications, has closed its Series A funding round in November 2018. The internationally leading technology enterprise in the fields of optics and optoelectronics, ZEISS, is the sole minority investor of the round.

Bridger Technologies, Congratulations on your acquisition by Bio-Rad!

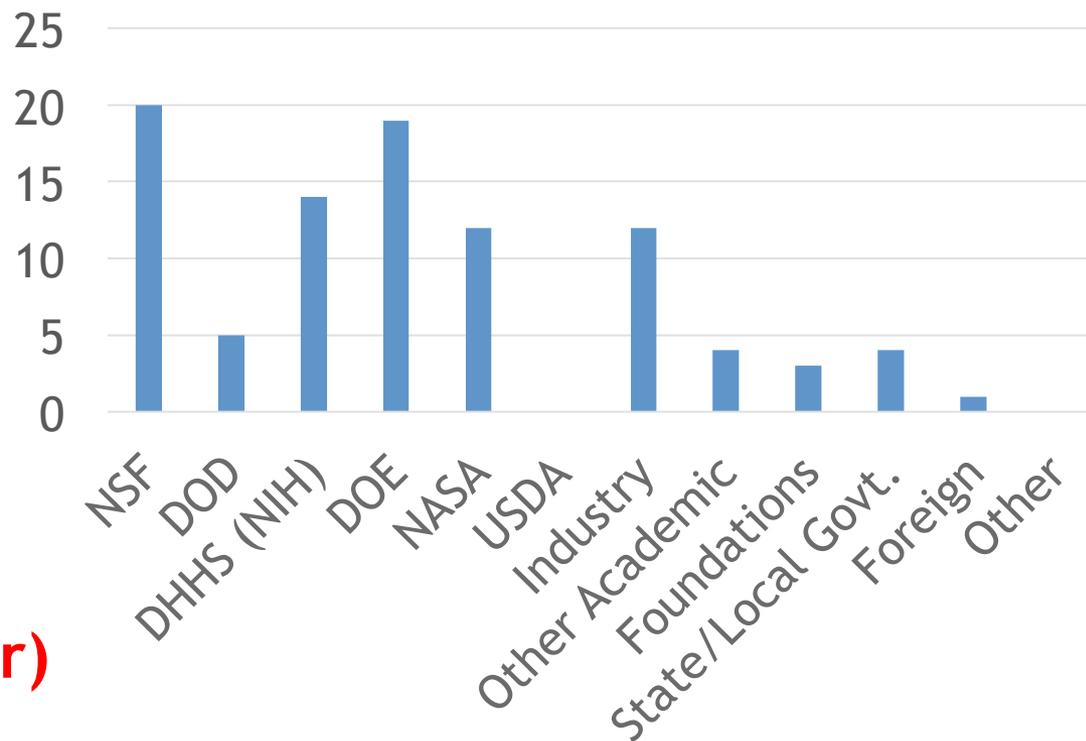


MONT Impact – Montana State Grant Data

94 of 107
on-campus users
supported by
56 “grants”
totaling
>\$23M

(\$23M/107 = \$215k / user)

Distribution of Users by Extramural Funding Source

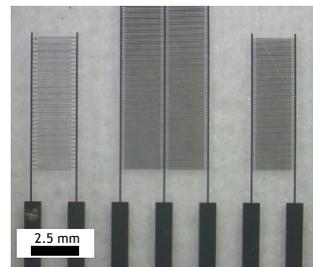


MONT Impact: 9 Research Initiation Grants in Y4

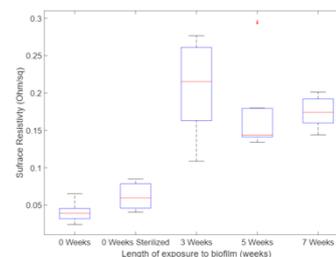
Effects of Biofilm Growth on Thin Films

Biofilms can inhibit the performance of micro-fabricated water monitoring sensor platforms. A bacterial strain (*Escherichia coli* K12) that forms corrosive biofilms may alter surface and material properties and consequently sensor performance.

An inert interface between the active sensor surface and the aqueous media is required for reliable operation. This study investigates common thin films (Al, poly-Si, Au and a:Si_xN_y-H) regarding material degradation and studies how biofilm growth influences sensor performance such as impedance spectroscopy sensors to study microbial loads in groundwater.

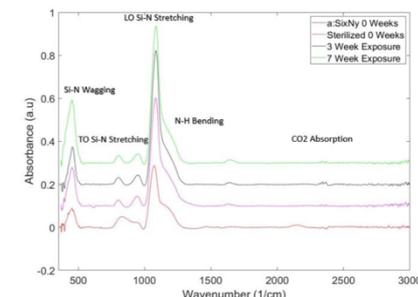


A)



C)

B)



D)

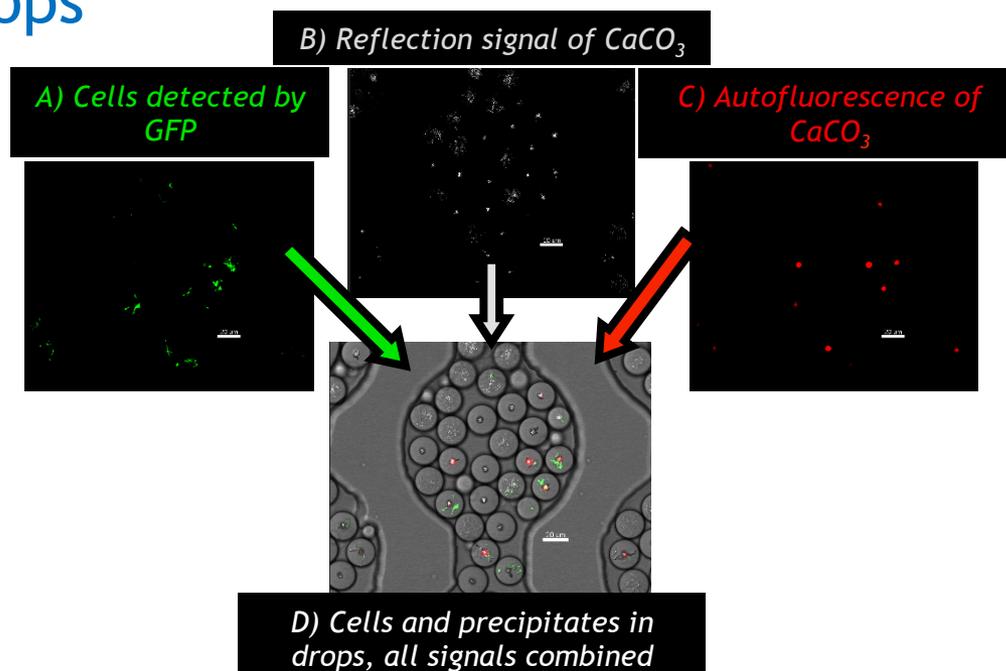
A) **Micro-fabricated Impedance Spectroscopy sensor** used to monitor biofilm growth (feature size: 30 μm). B) Biofilm reactor to control biofilm growth. C) Surface resistivity increase of Al due to prolonged biofilm exposure. D) FTIR of potential inert a:Si_xN_y-H encapsulation layer (no changes in vibration modes after biofilm exposure).

M. McGlennen, S. Warnat. Mechanical & Industrial Engineering. C. Foreman. Chemical & Biological Engineering Montana State University Startup (S. Warnat). Thornton Excellence in Engineering Research (Warnat, Foreman). Work performed at Montana State University, MONT facility **Montana Microfabrication Facility**

MONT Bringing PIs Together

Mineral precipitation in drops

The inverted confocal scanning laser microscope was used to image droplets containing ureolytic bacterial cells (detected by GFP, figure panel A). The drops also contain dissolved urea and calcium. The ureolytic bacteria hydrolyze the urea, leading to an increase in surrounding alkalinity and pH. This causes the dissolved calcium to precipitate out of solution as calcium carbonate (CaCO_3), a process called **Microbially Induced Calcium carbonate Precipitation (MICP)**. The precipitates were detected by their strong reflection signal (figure panel B). The CaCO_3 crystals that formed in the drops also exhibited autofluorescence (figure panel C). This work allows the visualization of MICP at the single-cell level in real time and *in-situ*.



Multi-channel imaging using the confocal scanning laser microscope allowed for the detection of bacterial cells and microbially induced calcium carbonate precipitation in drops.

Neerja Zambare, Robin Gerlach, and Connie Chang Montana State University
 NSF CAREER #1775332 (DMR), and DOE STTR DE-SC0010099
 Work performed at Montana State University, MONT facility **Center for Biofilm Engineering**

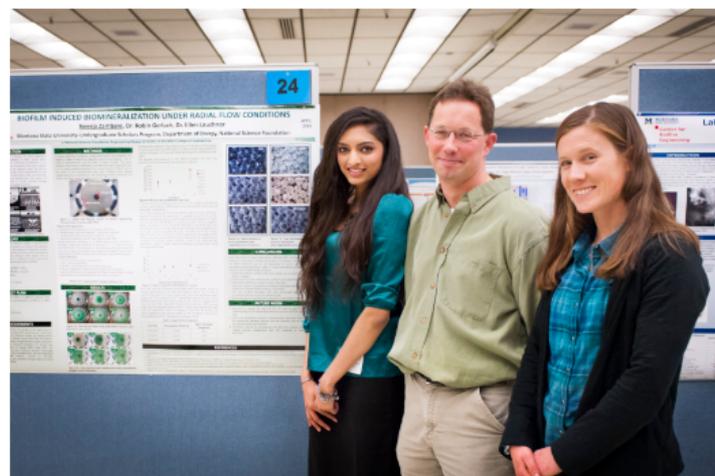
MONT: Developing the Workforce

- Neerja Zambare began working in MONT as an undergraduate
- Continued studies on biomineralization with MONT PI Prof. Gerlach
- Will complete Ph.D. in 2019
- Neerja was a featured speaker at the MONT Users' Meeting in May, 2019.



MSU student's research on bio-cement selected as one of the top posters in U.S.

By Carol Schmidt, MSU News Service
APRIL 25, 2013



The innovative research of a Montana State University student who traveled half way around the globe to study engineering at MSU has taken her just a bit farther.

Neerja Zambare, a senior from Pune, India, majoring in both chemical engineering and biological engineering, was selected as one of the country's undergraduate researchers for her poster about a bio-cement that effectively plugs cracks near wells and drilling sites.

Zambare exhibited her research poster, "Biofilm induced biomineralization in a radial flow reactor," at the Council on Undergraduate Research's Posters on the Hill Exhibition April 23-24 in Washington, one of the country's most prestigious undergraduate research fairs. Zambare was accompanied by Robin Gerlach, MSU professor of chemical and biological engineering and Zambare's research mentor.

Impacts summary

MONT sees its impact through:

- **User's research accomplishments:** increasing publications, prestigious grant awards (CAREER, SBIR, etc.)
- **Economic impact:** new businesses who now rely on MONT, successful commercialization of technology
- Increased **cross-disciplinary research** – nano is going places, like food science!
- **Catalysis of new research thrusts:** New Ph.D. in Materials Science (NSF supported), Q-AMASE-I 2D Quantum Materials Foundry (NSF proposal), New ARL research facility
- **Education and workforce development:** 70-100 users are students; coursework brings 80-100 students into the facilities each year

NNCI amplifies MONT's impact through:

- Lets us **focus on external users** while improving service for all users
- Network of services and expertise – **our users have access to all of NNCI!**
- **Improvement of local capabilities:** >\$2M in new instrumentation so far

Education & Outreach Activities

MSU Family Science Day is MONT's largest outreach event. The event features research in nanotechnology and other small-scale science and engineering projects from MSU faculty and students.

MONT also hosts:

- a photovoltaics summer course for K-12 teachers,
- technical webinars, workshops and seminars.

Our collection of on-line tutorials with partner SERC (at Carleton College), reached 1249 unique visitors.

Green boxes show activities which were evaluated.

MONT 2018 Education & Outreach Events		
MSU-Location of MONT	# Participants	Percentage
Family Science Day	601	30%
REU and Convocation	3	<1%
Teacher Courses (MSSE)	9	<1%
Technical Events	205	8%
Online tutorials (with Carleton College)	1249* *unique visitors	59%
Students in courses	80	4%
Total MONT	2147	

Screen shots of Web Modules at SERC

Nanotechnology in STEM

What is Nanotechnology

Why Teach Nanotechnology

How to Teach Nanotechnology

Ethics

Nanoscience in the Earth and Environmental Sciences

Methods

Nanoscience Topics in Earth Science

Instructional Resources

Nanotechnology Workshops & Events

Goldschmidt Workshop 2017

NanoEarth Workshop 2018

Goldschmidt Workshop 2018

MONT Workshops & Events

MONT Activities

Get Involved

Contribute Materials

Join the Email List

Nanoscience Pop-Up User Survey

Teaching Nanotechnology Across the Undergraduate STEM Curriculum

Jump down to: What is Nanotechnology | Why Teach Nanotechnology | How to Teach Nanotechnology | Examples of Nanotechnology Courses and Curricula | Instructional Resources | Tutorials on Nanoscience Instruments and Methods | Applications of Nanotechnology | Profiles of Nanotechnology Research Projects | Ethics and Nanotechnology | Get Involved

Nanotechnology is an exciting emerging field of research with applications in all STEM disciplines including the physical, chemical, life, Earth and environmental sciences and allied disciplines in materials science and engineering. Nanotechnology provides unprecedented opportunities for frontier research at the interfaces between these STEM disciplines by studying the properties of materials on the nanoscale (~1 billionth of a meter). The development of engineered nanomaterials has applications in such diverse fields as energy capture and storage devices, delivery of pharmaceuticals, environmental health and safety (related to both natural and engineered materials), and development of next generation computational devices. Nanotechnology is and will be a major economic driver into the 21st Century, and there is high demand for a workforce trained in the methods of characterization and fabrication of nanoparticles. The **National Nanotechnology Initiative Strategic Plan** (PCAST, 2014) has set four goals: 1) Advance a world-class nanotechnology research and development program, 2) Foster the transfer of new technologies into products for commercial and public benefit, 3) Develop and sustain educational resources, a skilled workforce, and a dynamic infrastructure and toolset to advance nanotechnology, and 4) Support responsible development of nanotechnology.

This website has been developed to meet the need of introducing nanotechnology education across the STEM curriculum:

- For faculty, resources, tutorials, course descriptions, and teaching activities are provided to facilitate instruction in nanotechnology within established STEM courses or in a dedicated course on nanotechnology;
- For students, resources are provided to introduce and expand student understanding of nanotechnology, and to prepare for potential careers in nanotechnology.

Agilent scanning system at the Montana Microfabrication Facility

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MONT Activities

Tutorials of Methods Used in Nanotechnology

Browse Geochemical Analytical Instruments and Techniques

Each of these pages contains information about each instrument or technique including what it is, fundamental principles, how it works, application/limitations, sample preparation, data collection, results, and preparation, and if available, literature and teaching activities/resources.

X-ray Crystallography

- Single-crystal X-ray Diffraction--Christine M. Clark, Eastern Michigan University and Barbara L. Dutrow, Louisiana State University
- X-ray Powder Diffraction (XRD)--Barbara L. Dutrow, Louisiana State University and Christine M. Clark, Eastern Michigan University

Electron Microbeam

- Electron Probe Micro-analyzer (EPMA)--John Goodge, University of Minnesota-Duluth
- Scanning Electron Microscopy (SEM)--Susan Swapp, University of Wyoming

Nanotechnology in STEM

What is Nanotechnology

Why Teach Nanotechnology

How to Teach Nanotechnology

Ethics

Professionalism

Responsible Conduct of Research

Nanoscience in the Earth and Environmental Sciences

Methods

Teaching Ethics and Nanotechnology

Ethics education is an increasingly important component of the pre-professional training of scientists. Funding agencies (NSF, NIH) require training of graduate students in the responsible conduct of research, employers are increasingly expecting their workers to have basic training in ethics, and the public demands the highest standards of ethical conduct by scientists. Yet, few faculty have the requisite training to effectively teach about ethics in their classes, or even informally in mentoring students working in their labs.

This module has been developed to meet the need of introducing ethics education into the STEM curriculum:

- For faculty, resources, case studies, and teaching activities are provided to facilitate instruction in ethics within established geo "core" courses or in a dedicated course on "Ethics and Nanoscience";
- For students, resources are provided to help expand their understanding of ethical situations that may arise in their careers, and to give them the tools they need to appropriately address these issues.
- To start: Take a look at this video on **The Ethics of Nanotechnology**--developed by the Microelectronics Research Center, University of Texas--Austin.

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Goldschmidt Workshop 2018

MONT Workshops & Events

MONT Activities

Nanoscience Topics in the Earth and Environmental Sciences--Ready for Your Classes

Nanoscience topics can be introduced to virtually every class in the Earth and Environmental Sciences curricula. Here is a collection of over 500 references from the literature that have been identified by experts who attended the Goldschmidt 2017 and NanoEarth 2018 workshops. These references are organized in topics that can readily be integrated into existing courses in Mineralogy, Petrology, Geochemistry, Hydrology, Environmental Geology, and many more. This is not meant to be a comprehensive list of resources--the small world of nanoscience turns out to be a very large field of scholarship (drawing from sister disciplines in chemistry, physics, material science, chemical and environmental engineering...). This is a place to start where you'll find easily accessible and reliable references. Unfortunately, copyright limitations do not permit us to post copies of these articles--but you can easily find these in any research library.

For faculty, we encourage you to:

- Introduce units on nanoscience into your existing courses; the nanoscience revolution has as many applications and implications as the plate tectonics revolution 50 years ago! Nanoscience introduces some really exciting new science, and it demonstrates career pathway opportunities for students.
- Aggregate these topics into a new course on nanoscience! There is a great need for a new generation of nanoscience courses in the Earth and Environmental Sciences.
- Create new teaching activities on nanoscience: new lectures based on the literature, class demonstrations, teaching activities and problem sets, laboratory experiments, course-long projects....

Please **Contribute a Resource** at this online form. Please contribute: a) additional references that you use in your own teaching and research; b) course outlines and syllabi; and c) teaching activities you've developed to share with the community.

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Goldschmidt Workshop 2017

NanoEarth Workshop 2018

Goldschmidt Workshop 2018

MONT Workshops & Events

MONT Activities

Nanoparticles in the Earth System: Fluxes, Rates, Transport, Transformation

- Banfield, J. F., and Zhang, H., 2001. Nanoparticles in the environment: Reviews in mineralogy and geochemistry, v. 44, no. 1, p. 1-58.
- Barnard, A. S., and Guo, H., 2012. Nature's Nanostructures, CRC Press.
- Batley, G. E., Kirby, J. K., and McLaughlin, M. J., 2013. Fate and Risks of Nanomaterials in Aquatic and Terrestrial Environments: Accounts of Chemical Research, v. 46, no. 3, p. 854-862.
- Bertsch, P. M., 2014. It's been nano all along!: The occurrence, behaviour, and fate of natural and manufactured nano-minerals/materials in the environment: Australian Clay Minerals Society Conference.
- Graca, B., Zgrundo, A., Zakrzewska, D., Rzodkiewicz, M., and Karczewski, J., 2018. Origin and fate of nanoparticles in marine water--Preliminary results: Chemosphere
- Hendren, C. O., Mesnard, X., Dröge, J., and Wiesner, M. R., 2011. Estimating production data for five engineered nanomaterials as a basis for exposure assessment. ACS Publications.

Show More

The global budget for naturally occurring inorganic nanoparticles

Continents: 10^{12} g yr⁻¹

Cone Shelves: 10^{12} g yr⁻¹

Open Oceans: 10^{12} g yr⁻¹

All numbers in Tg = 10^{12} g

All italicized numbers are fluxes (Tg yr⁻¹)

Show caption

A Teaching “Primer” on Nanoscience for Earth Scientists

Hosted at Carleton College Science Education Resource Center (SERC)

- Review article in *Science* to reintroduce nanoscience to Earth scientists
- Companion website developed to demonstrate “what”, “why” and “how” to teach nanoscience, includes
 - Analytical methods, Ethics
 - >500 vetted references on Nanoscience topics in E. Sci., ready to introduce into existing courses
- Webinar to National Association of Geoscience Teachers (NAGT)
- Participant survey and focus group usability study of website use in progress with SERC Assessment Team

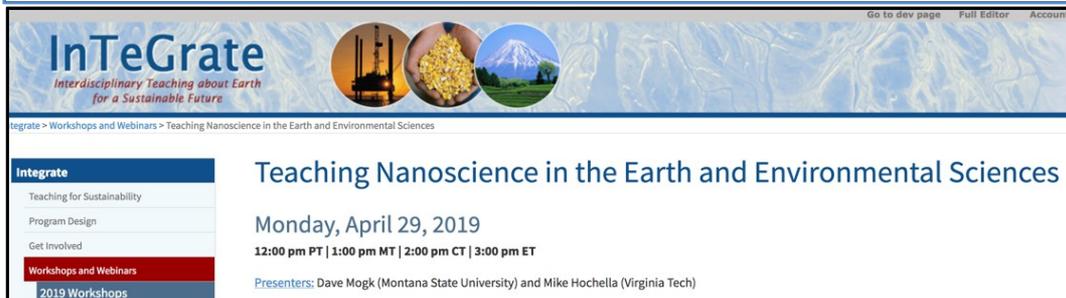
REVIEW SUMMARY

Hochella *et al.*, *Science* **363**, 1414 (2019) 29 March 2019

EARTH SYSTEM

Natural, incidental, and engineered nanomaterials and their impacts on the Earth system

Michael F. Hochella Jr.*, David W. Mogk, James Ranville, Irving C. Allen, George W. Luther, Linsey C. Marr, B. Peter McGrail, Mitsu Murayama, Nikolla P. Qafoku, Kevin M. Rosso, Nita Sahai, Paul A. Schroeder, Peter Vikesland, Paul Westerhoff, Yi Yang



InTeGrate
 Interdisciplinary Teaching about Earth
 for a Sustainable Future

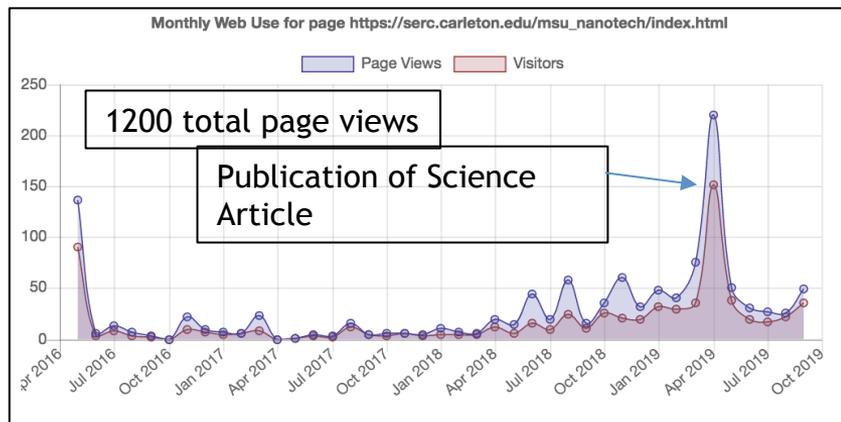
tegrate > Workshops and Webinars > Teaching Nanoscience in the Earth and Environmental Sciences

Integrate
 Teaching for Sustainability
 Program Design
 Get Involved
Workshops and Webinars
 2019 Workshops

Teaching Nanoscience in the Earth and Environmental Sciences
 Monday, April 29, 2019
 12:00 pm PT | 1:00 pm MT | 2:00 pm CT | 3:00 pm ET
 Presenters: Dave Mogk (Montana State University) and Mike Hochella (Virginia Tech)

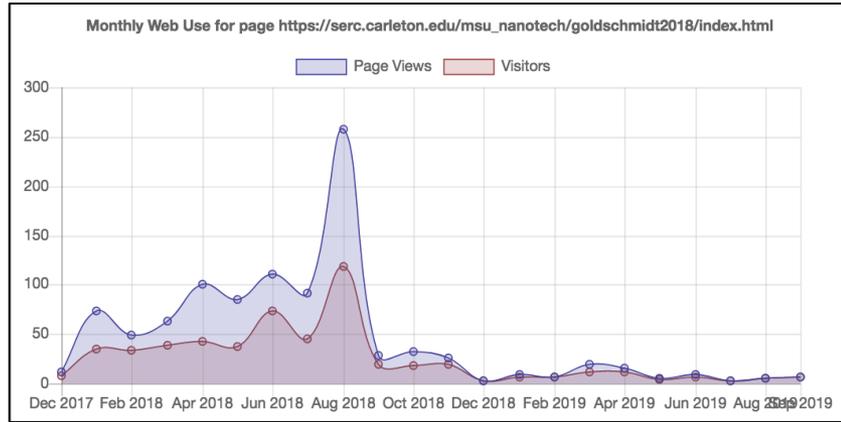
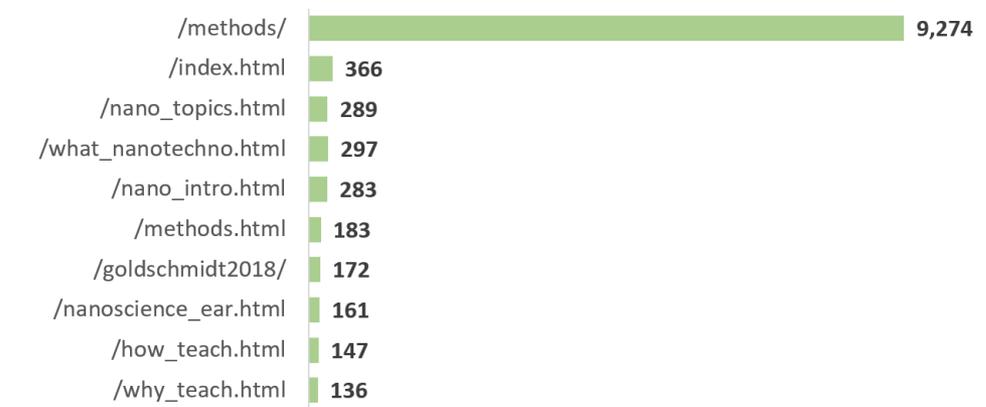
Google Analytics for Teaching Nanoscience Webpages

- Website in development, 2016-present
- Formally launched with publication of Science review article, April 2019
- Advertised on numerous Earth and Environmental Science listservs (Mineralogical Society of America)
- Presentation at 2019 Earth Educators' Rendezvous (National Association of Geoscience Teachers)
- User Pop-Up Survey is in progress
- Usability study with focus user groups is in progress



Metrics for Index page of the Teaching Nanoscience web module

Top 10 most unique pageviews from 3/1/19 to 10/20/19



Metrics for webpages supporting 2018 Goldschmidt Workshop

Pop-up Assessment for Teaching Nanoscience Webpages

Nanoscience Pop-Up User Survey

STEM

biology

technology

nanotechnology

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Workshops

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shop 2018

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Up User

Have a minute to help us out? Help us understand who is using this site.
Not interested? Just use the 'Close' button in the corner.

Choose the single option that seems like the best match for your visit today.

1. What brings you to the site?

Other

2. How experienced are you with nanoscience topics?

3. Which of the following best describes you?

Other

4. How did you hear about the site?

Other

5. How do you imagine using the site to support future teaching and/or research?

Optional:

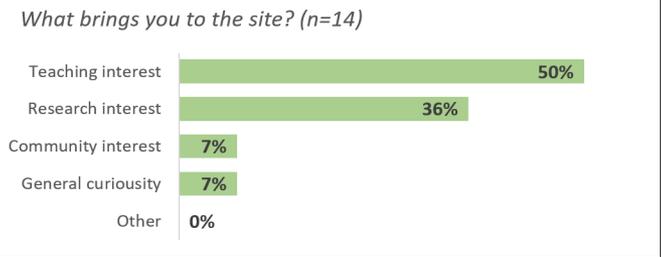
I am interested in receiving email updates about other developments from the Nanoscience project.

I am willing to answer some follow-up questions or to be interviewed.

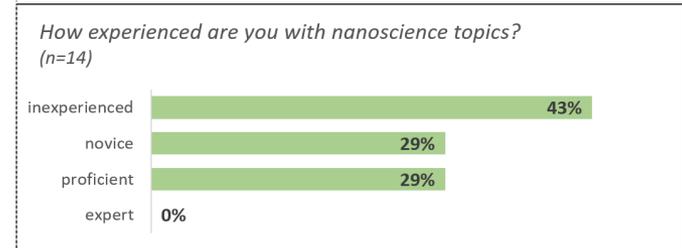
If you checked one or more boxes above, please provide your email address.

mogk@montana.edu

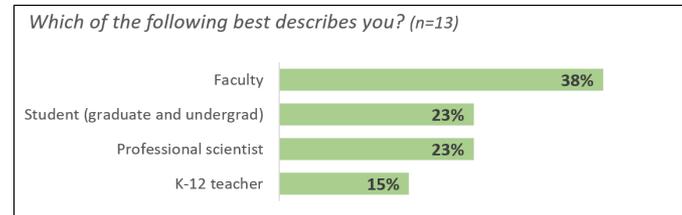
Audience



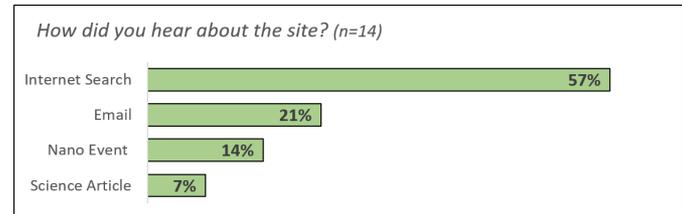
Nanoscience Experience



Professional Status



Connections



NNCI Cooperative Network Activities

Network-Wide

- Participation in **subcommittees** (New Equipment and Research, Entrepreneurship, Assessment and Evaluation) and **working groups** (Microscopy, SEI and Education), resulting in shared reports and best practices
- Attendance at **REU convocation** and **NNCI annual conference**
- Participation in **Nano Day** activities

Multi-Site

- Staffing across the network:
 - Dr. Phil Himmer joined **nano@Stanford**
 - Dr. Andrew Lingley joined **MONT** from **NNI**
- User project support and staff technical interactions with **SDNI**, **MINIC**, **nano@Stanford** and **CNS**
- Working with **SENIC**, leveraging their expertise and investment in facility management software
- Workshop organization and co-authored Science paper with **NanoEarth**
- Hosted Karl F. Böhringer of **NNI** / UW for seminar



On Behalf of the Network

- Planning for visit to DC to **meet with congressional staff** – Summer or Fall 2019

Highlights from MONT/NNCI in first 4 years

- Continue to show significant facility enhancement; **excellent leveraging of NSF funds** to grow State/Private investment in facility
- Continue to see **growth in number of users**; good gender and academic diversity
- Strong **Regional Workforce Development**, with ~100 students using facilities, another ~100 taking courses that rely on access to MONT
- Strong **Education & Outreach portfolio**, locally and on the web in partnership with Carleton College's SERC; Partnership with NanoEarth is elevating "nano" awareness in Geosciences
- Growing impact relative to **on-campus research**: new directions, **increased productivity, high-impact funding** (multiple CAREER awards)
- Growing impact for external researchers and the **economy in the northern Rocky Mountain Region**: new companies and jobs, new Federal funding (10 active SBIR Phase I and Phase II awards), new private funding; **MONT companies are finding success**