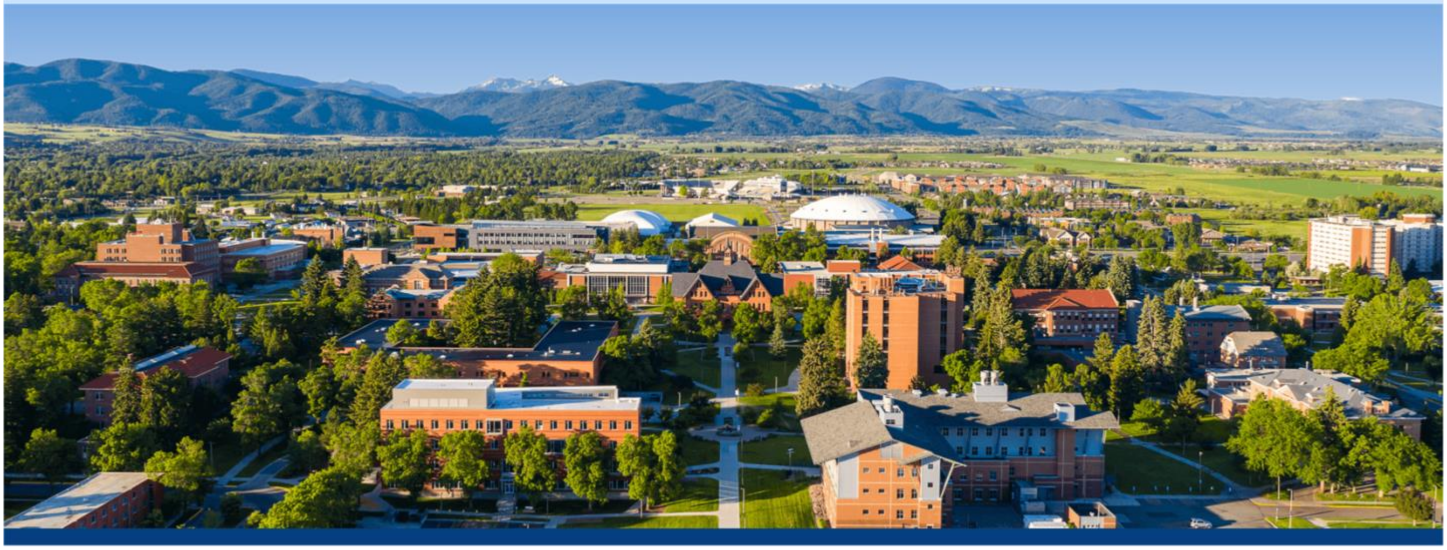
# NNCI REU CONVOCATION 2023

## Abstract Book



Montana State University
Bozeman, Montana
August 5-8, 2023

Hosted by the
Montana Nanotechnology Facility (MONT)

MONTANA STATE UNIVERSITY | Montana Nanotechnology Facility

National Nanotechnology Coordinated Infrastructure

NSF

Welcome and thank you for joining us for the 2023 NNCI REU Convocation!
We are pleased to celebrate the endeavors of the 87 undergraduate researchers participating this year.

The Montana Nanotechnology Facility (MONT) is one of 16 National Science Foundation supported user facility sites at universities across the US. These 16 sites are collectively known as the National Nanotechnology Coordinated Infrastructure (NNCI). With the pooled resources of these 16 multidisciplinary user facilities, the NNCI can aid any user in finding just the right tools and experts needed to further research and innovation and development at the nanoscale.


MONT's facilities include:

The Imaging and Chemical Analysis Lab (ICAL)
The Montana Microfabrication Facility (MMF)
The Center for Biofilm Engineering (CBE)
The Mass Spectrometry Facility
The cryo-EM/TEM Facility
The Sample prepLab

https://nano.montana.edu

## Speaker Bios

*In order of appearance*

**Welcome from MONT Director**

Dr. David Dickensheets, MONT Director, and Professor, Department of Electrical and Computer Engineering, Montana State University

A native of the rural west, Dr. Dickensheets received the BSEE degree from the University of Colorado in 1985 and the MSEE degree from the University of Washington in 1988. From 1988 until 1991 he worked as a design engineer for the Hewlett-Packard Company in its Medical Products Division in Andover, MA, performing low-noise analog circuit design for cardiac ultrasound imagers.

Dr. Dickensheets' research interests include MEMS and MOEMS (acronyms for micro{-opto}-electro-mechanical systems), active and adaptive optics, optical microscopy and spectroscopy of tissues, and the application of microfabrication techniques to develop miniature imaging instruments for biological research, health care and industry.

**Welcome from NNCI Director**

Dr. David Gottfried, Regents Researcher and Senior Assistant Director
Institute for Electronics and Nanotechnology
Georgia Institute of Technology

David Gottfried received a Bachelor of Science in chemistry from the University of Michigan and continued his Ph.D. studies in physical chemistry at Stanford University under a National Science Foundation graduate fellowship. He was a European Molecular Biology Organization post-doctoral fellow at the Weizmann Institute of Science before beginning research and teaching in biophysics at the Albert Einstein College of Medicine. In 1999 he moved to the Georgia Tech Research Institute where he designed and tested optical sensors for chemical and biological agents with food safety, environmental, and homeland security applications. Dr. Gottfried joined the Microelectronics Research Center in 2007, where he was a technical liaison and biomedical domain expert for the NSF-funded National Nanotechnology Infrastructure Network. Beginning in 2012 he served as a member of the Advanced Technology Team in the Institute for Electronics and Nanotechnology (IEN) and then became Senior Assistant Director for IEN Nanotechnology Programs in 2016. He is currently the Director of the Southeastern Nanotechnology Infrastructure Corridor (SENIC), which is a member site of the National Nanotechnology Coordinated Infrastructure (NNCI), and is also Director of the NNCI Coordinating Office. Dr. Gottfried was selected as a Fellow of the American Chemical Society in 2012 and the American Association for the Advancement of Science in 2018. In 2021 he was named a Regents Researcher by the Board of Regents of the University System of Georgia.

**Making Sure What Happens at the REU Doesn't Stay at the REU**

Dr. Quinn Spadola, NNCO Deputy Director

Dr. Quinn Spadola is the Deputy Director of the National Nanotechnology Coordination Office (NNCO). She is motivated by a desire to broaden participation in the STEM workforce. She sees nanotechnology as a powerful tool to engage and excite future STEM professionals as well as to bring together agency representatives, academics, and members of industry to tackle challenges such as climate change and pandemic preparedness. Prior to returning to the NNCO she was Associate Director for Education and Outreach for the National Nanotechnology Coordinated Infrastructure (NNCI), a network of open nanotechnology laboratory user facilities supported by the National Science Foundation, and the Director of Education and Outreach for the NNCI site at the Georgia Institute of Technology. Dr. Spadola began her time at the NNCO as an AAAS Science and Technology Policy Fellow in 2014. After her fellowship, she served as Education and Outreach Coordinator and Technical Advisor to the Director until 2018. She received her Ph.D. in physics from Arizona State University and her MFA in Science and Natural History Filmmaking from Montana State University.

**Brain-on-a-chip technology: Where we are at and what comes next?**
Dr. Anja Kunze, Associate Professor, Electrical and Computer Engineering Department, Montana State University

Dr. Kunze obtained her Ph.D. 2012 in Microsystems and Microelectronics from the École Polytechnique Fédérale de Lausanne (EPFL, Switzerland) and her M.Sc. in Electrical Engineering from the Dresden University of Technology in 2007. From 2012 to 2016, Dr. Kunze worked as a postdoctoral researcher and Assistant Adjunct Professor at the University of California, Los Angeles (UCLA). At MSU, she is heading the Kunze Neuroengineering Lab and teaches courses in bioelectronics and bio-micro- and nanosystems within the Norm Asbjornson College of Engineering. For her research efforts in advancing micro- and nanotechnology to study neurodegenerative diseases and brain tissue engineering, Dr. Kunze received the NSF CAREER award in 2019, the MSU Cox Faculty Award for Creative Scholarship and Teaching, and the Norm Asbjornson College of Engineering Excellent in Research Award in 2023. She is also the co-founder of NanoMagnetic Solutions, Inc., and regularly serves as a reviewer in NIH study sections.

**Tools for effective science communication: Sharing your research beyond an academic audience**
Suzi Taylor, Director of the Science Math Resource Center, Montana State University

Suzi Taylor has a long history of leading outreach programs for Montana State University, including serving as MSU lead for Montana NSF EPSCoR's Track 1 projects, and partnering with faculty on programs funded by NASA, USDA, the Department of Energy and other agencies to create outreach projects that support the citizens of Montana. Suzi has a special interest in reaching youth in Montana's smallest and most rural communities. Her favorite projects have included working with 40 Montana classrooms as they virtually followed an MSU geology expedition to Mount Everest; helping to launch Science Action Clubs all over Montana; and leading a statewide geocaching project tied to the Montana Climate Assessment.

Suzi also serves as co-leader of the Montana Girls STEM Collaborative, a statewide network of adults who collaborate to engage and inspire girls, and serves on the advisory board for The STEM Effect, a National Science Foundation-supported project that examines the long-term impacts of STEM programs for girls.

**2D Materials for Quantum Technologies**
Dr. Nicholas J. Borys, Assistant Professor, Department of Physics, Montana State University
Associate Director, MonArk NSF Quantum Foundry

Borys' research interests include nano-optical imaging and spectroscopy of quantum materials and nanoscale optoelectronic systems and development of devices and technologies for quantum photonics. Nick's personal interests include rock climbing, skiing, mountaineering, cooking, beard growing, and highly addictive TV series.

**Applying for NSF Graduate Fellowships**, and **An International Summer Research Experience in Japan**
Dr. Lynn Rathbun, Laboratory Manager, Cornell Nanoscale Facility

Historical tracking data since 1997 predicts that 75% of you will go to graduate school with 50% of you eventually earning a Ph.D.  We will talk about funding for graduate school (You get PAID!!). In particular, we will talk about the NSF Graduate Fellowship Program, the largest of the national competitive fellowship programs, and the surprising things that determine a winning application. Lastly, I will invite you all to apply for a special NNCI internship next summer at a National Laboratory in Japan.

Dr. Rathbun is the Laboratory Manager at the Cornell Nanoscale Facility. He obtained a B.S. in Physics from The Ohio State University in 1971, an M.S. in Physics from the University of Illinois in 1973, and a Ph.D. in Physics from the University of Illinois in 1979. He has been at CNF (and its predecessors) since 1979. From 2002-2015 he was Program Manager/Asst. Director of the National Nanotechnology Infrastructure Network (NNIN), the predecessor to NNCI. In 1997, under NNUN (the predecessor to NNIN) he originated the concept of a network wide REU program and established the network REU convocation. He has been to almost all REU convocations since then. As part of NSF reporting activities, he has conducted extensive longitudinal tracking of the education and career paths of a large percentage of NNUN/NNIN/NNCI REU participants from 1997-2015.

**Dr. Wataru Nakagawa,** Associate Professor, Department of Electrical and Computer Engineering, Montana State University.
Graduate Panel Host and Moderator

Wataru Nakagawa received his BS degree in physics from Stanford University and his MS and PhD degrees in electrical and computer engineering (applied physics) from the University of California, San Diego, La Jolla, California. He is currently an associate professor in the Department of Electrical and Computer Engineering at Montana State University, Bozeman, Montana. His research interests include near-field optical effects in photonic structures and interdisciplinary applications of nanostructured optical devices.

**Graduate Student Panelists**
**Timothy Campbell**, Graduate Student, Dept. of Earth Sciences, Montana State University
**Zeynep Malkoç**, Graduate Student, Electrical & Computer Engineering, Montana State University
**Joseph Stage**, Graduate Student, Dept. of Physics, Montana State University
**Jordan Baker**, Graduate Student, Electrical & Computer Engineering, Montana State University

**Trevor Huffmaster,** Director of the Blackstone Launchpad, Montana State University
Entrepreneurship and Innovation Panel Host and Moderator

Huffmaster is the director of Blackstone Launchpad, a center for entrepreneurship at Montana State University, and 406 Labs, a business incubator and accelerator at Montana State University. Trevor previously was on the founding team of a physician practice management organization and spent over 15 years in senior IT management and software roles with several leading healthcare organizations, including the Ohio State University Medical Center. BA in Biology from Boston University and a Master of Health Administration (MHA) from The Ohio State University.

**Entrepreneurship and Innovation Panelists**
**Dr. Sarah Lukes,** Founder and CEO, Agile Focus Designs

At Agile Focus Designs, Sarah Lukes is on a mission to bring high-tech imaging advancements to large industries like semiconductors and pharmaceuticals, enabling industry users to use microscopic zoom without moving or damaging samples or the microscope. Her diverse background includes working in orthopedics/radiology, cardiovascular stents, and cryogenics/lidar at the Mayo Clinic, Boston Scientific, and S2 Corporation, respectively. She attained a PhD in electrical engineering at Montana State University with a focus on optical MEMS as an NSF Graduate Research fellow and is currently an Optica traveling lecturer and ambassador.

**Dr. Brock J. LaMeres,** Professor, Electrical & Computer Engineering, Montana State University, Boeing Professor of Engineering Education, Director, Montana Engineering Education Research Center (MEERC)

Brock LaMeres is a professor of electrical & computer engineering at Montana State University. For the past 17 years, Dr. LaMeres' research team has been working on fault-tolerant computer technology for critical applications. LaMeres' team has developed a computer technology called "RadPC" that can operate in the presence of space radiation. RadPC has been tested on high-altitude balloons, sounding rockets, on two small satellites, and three times on the International Space Station. In 2024, RadPC will travel to the surface of the moon for its harshest test yet. Dr. LaMeres founded a spin-out company called Resilient Computing in 2020 to commercialize RadPC. Resilient Computing has been successful at funding its start-up using SBIR/STTR funds and is on track to bring the first commercial version of RadPC to market in 2024 coinciding with its lunar demonstration. LaMeres received his Ph.D. in electrical engineering from the University of Colorado. Prior to coming to MSU, LaMeres worked for Hewlett-Packard for 8 years as a design engineer where he developed test equipment for the computer industry.

**Dr. Matt Hull,** Associate Director for Innovation and Entrepreneurship for the NNCI and Virginia Tech's National Center for Earth and Environmental Nanotechnology (NanoEarth).

Matthew Hull serves as Associate Director for Innovation and Entrepreneurship for the NSF-funded US National Nanotechnology Coordinated Infrastructure (NNCI) and Virginia Tech's National Center for Earth and Environmental Nanotechnology (NanoEarth). He also serves as Research Professor and Director for the Virginia Tech Nanoscale Characterization and Fabrication Laboratory (NCFL) managed by Virginia Tech's Institute for Critical Technology and Applied Science (ICTAS). He received his Ph.D. in Civil and Environmental Engineering from Virginia Tech in 2011 and an M.S. in Biology from Virginia Tech in 2002. He received his B.S. In Environmental Science from Ferrum College in 2000. Hull also served as President and Owner of NanoSafe, Inc., a provider of nanotechnology human and environmental health and safety (EHS) services and nano-enabled sustainability solutions he founded in 2007 and led to a successful exit in 2023, when NanoSafe was acquired by ITA International, LLC.

**Mackenna Landis**, Graduate Student, Electrical and Computer Engineering, Montana State University

Mackenna Landis is a PhD candidate in Electrical and Computer Engineering, doing research in the Kunze Neuroengineering Lab. She received a bachelor's degree in Bioengineering Mathematics at Carroll College in 2019 and completed an REU in 2018 at the Institute for Cell Engineering. She currently serves as CEO for NanoMagnetic Solutions, Inc., which was officially founded in 2021 out of the Kunze Lab. In the company, she performs biovalidation research on a variety of projects, including guided neurite outgrowth for neural tissue engineering and spatially patterned cell differentiation. These projects will provide NMS with multiple avenues for marketing their flagship technology to biomedical research labs that want to generate consistent lab-grown tissues to study disease models.

# NNCI REU CONVOCATION 2023 SCHEDULE

## Saturday, August 5th

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| 6-8pm | Welcome Dinner- Inspiration Hall |
| | Norm Asbjornson Building, Inspiration Hall- 2nd Floor |

## Sunday, August 6th

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|---|---|
| 7am-7pm | Yellowstone National Park |
| | Depart from SUB, Grant St. entrance |

## Monday, August 7th

**All Activities are in Norm Asbjornson Hall**

| | | |
|---|---|---|
| 8:00am-8:45am | Breakfast with Speakers | |
| | 8:15am | Welcome, Dr. David Dickensheets, MONT Director |
| | 8:20am | Welcome, Dr. David Gottfried, NNCI Director |
| | 8:25am | Making Sure What Happened at the REU Doesn't Stay at the REU, Dr. Quinn Spadola, NNCO Deputy Director |
| | 8:45am | Move to parallel sessions |

| 9:00am - 10:30am | Parallel A<br>Room 137<br>Moderator: Leslie O'Neill | | Parallel B<br>Room 153<br>Moderator: Kathryn Hollar | | Parallel C<br>Room 149<br>Moderator: Steven Wignall | | |
|---|---|---|---|---|---|---|---|
| 9:00am | A1 Aahan Dwivedi | RTNN @ U N.Carolina | B7 Hannah Stanley | KY Multiscale @ UofL | C13 Cobe Smart | KY Multiscale @ UofL | 9:00am |
| 9:15am | A2 Alejandra Rivera Ramos | KY Multiscale @ UofL | B8 Luke Whitehead | MANTH @ U Penn | C14 Leah Moylan | SDNI @ UC San Diego | 9:15am |
| 9:30am | A3 Macharia Kanyatte | SENIC @ Georgia Tech | B9 Mohammed Sbai | CNS @ Harvard | C15 Paola Berrios | Concord, Virginia Tech, & MSU | 9:30am |
| 9:45am | A4 Vashti Allred | RTNN @ U N.Carolina | B10 Victoria Vinson | MANTH @ U Penn | C16 Kyra Martindale | NNF @ U Nebraska – Lincoln | 9:45am |
| 10:00am | A5 Samantha Musante | KY Multiscale @ UofL | B11 Destiny Kanu | CNS @ Harvard | C17 Jadon Salazar | SDNI @ UC San Diego | 10:00am |
| 10:15am | A6 Alan Valladares | NCI-SW @ ASU | B12 Jordan Mackie | MONT @ Montana State | C18 Edward De La Uz | SHyNE @ Northwestern | 10:15am |

10:30 session finished

| | |
|---|---|
| 10:30 - 10:45am | BREAK |

| 10:45am-12:15pm | Parallel D<br>Room 137<br>Moderator: Ana Sanchez Galiano | | Parallel E<br>Room 153<br>Moderator: Pat Watson | | Parallel F<br>Room 149<br>Moderator: Wataru Nakagawa | | |
|---|---|---|---|---|---|---|---|
| 10:45am | D19 Alondra Ruiz | SENIC @ Georgia Tech | E25 Samantha Averitt | CNF @ Cornell | F31 Jacob Mapa | SDNI @ UC San Diego | 10:45am |
| 11:00am | D20 Luca Caruso | KY Multiscale @ UofL | E26 Zachary Bernheimer | MANTH @ U Penn | F32 Marco Ebeling | CNS @ Harvard | 11:00am |
| 11:15am | D21 Khajana Hart | NCI-SW @ ASU | E27 Amara Taddeo | CNF @ Cornell | F33 Stayce Mockel | MONT @ Montana State | 11:15am |
| 11:30am | D22 Tyler Tanner | SENIC @ Georgia Tech | E28 Hunter Sullivan | RTNN @ NC State | F34 Aimee Toscano | KY Multiscale @ UK | 11:30am |
| 11:45am | D23 Sierra Monreal | NCI-SW @ ASU | E29 Benjamin Alexander | MANTH @ U Penn | F35 Mikayla Jackson | CNS @ Harvard | 11:45am |
| 12:00pm | D24 Erica Guelfi | KY Multiscale @ UofL | E30 Cecelia Barr | RTNN @ Duke | F36 Lilyane Stessman | SDNI @ UC San Diego | 12:00pm |

12:15 session finished

| | | |
|---|---|---|
| 12:15-2pm | Lunch with Speakers | |
| | 12:45pm | Brain-on-a-chip technology: Where we are at and what comes next? Dr. Anja Kunze, Associate Professor in the Electrical and Computer Engineering Dept, MSU |
| | 1:15pm | Tools for Effective Science Communication: Sharing your research beyond an academic audience, Suzi Taylor, Director of the Science Math Resource Center, MSU |
| | 2:00pm | Move to parallel sessions |

| 2:15 - 3:45pm | Parallel G<br>Room 137<br>Moderator: Melanie-Claire Mallison | | Parallel H<br>Room 153<br>Moderator: Emily Moreno-Hernandez | | Parallel I<br>Room 149<br>Moderator: Colin Shaw | | |
|---|---|---|---|---|---|---|---|
| 2:15pm | G37 Kota Aono | NNF @ U Nebraska – Lincolr | H43 Gavin Smith | CNS @ Harvard | I49 Jonathan Sardin | RTNN @ NC State | 2:15pm |
| 2:30pm | G38 Ryan Wozniak | MANTH @ U Penn | H44 Michael Kudlacek | NCI-SW @ ASU | I50 Alana Green | Concord, Virginia Tech, & MSU | 2:30pm |
| 2:45pm | G39 Angel Soto | KY Multiscale @ UofL | H45 Tony Yost | RTNN @ Duke | I51 Lilly Johnson | RTNN @ Duke | 2:45pm |
| 3:00pm | G40 Toko Ogata | CNF @ Cornell | H46 Tanvi Mani Panchumarthy | SHyNE @ Northwestern | I52 Kenndal Williams | SDNI @ UC San Diego | 3:00pm |
| 3:15pm | G41 Evangelina Stefan | KY Multiscale @ UK | H47 Olivia Snapper | CNS @ Harvard | I53 Samuel Dunbar | Concord, Virginia Tech, & MSU | 3:15pm |
| 3:30pm | G42 Naomi Naranjo | CNF @ Cornell | H48 Maggie Yang | SHyNE @ Northwestern | I54 Sara Johnson | MONT @ Montana State | 3:30pm |

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| 3:45 session finished | GROUP PHOTO on STAIRS |
| 4:00pm | Poster session, Norm Asbjornson Hall |
| 5:30pm | Adjourn/ Dinner on own |

## Tuesday, August 8th

8:00am-8:45am Breakfast with Speakers

- 8:15am 2D Materials for Quantum Technologies, Dr. Nicholas Borys, Associate Professor, Physics, MSU
- 8:45am Move to parallel sessions

| 9:00am - 10:30am | Parallel J<br>Room 137<br>Moderator: Ana Sanchez Galiano | | Parallel K<br>Room 153<br>Moderator: Ruari McDonnell | | Parallel L<br>Room 149<br>Moderator: Ashley Martinez | | |
|---|---|---|---|---|---|---|---|
| 9:00am | J55 Paul Bloom | CNF @ Cornell | K61 Alexandra Houseworth | MONT @ Montana State | L67 Chanese Smith | NCI-SW @ ASU | 9:00am |
| 9:15am | J56 Jessica Rutherford | KY Multiscale @ UofL | K62 Aidan Thomas | RTNN @ U N. Carolina | L68 Marina Kartono | SDNI @ UC San Diego | 9:15am |
| 9:30am | J57 Michael Sassa | KY Multiscale @ UofL | K63 Maxim Sokolov | SENIC @ Georgia Tech | L69 James Bautista | KY Multiscale @ UK | 9:30am |
| 9:45am | J58 Alejandro Soledad | CNS @ Harvard | K64 Noé Oberholtzer Hess | MONT @ Montana State | L70 Ololade Oriowo | CNS @ Harvard | 9:45am |
| 10:00am | J59 Audrey Silvernail | RTNN @ NC State | K65 Allison Peng | RTNN @ Duke | L71 Lauren Shackleford | KY Multiscale @ UofL | 10:00am |
| 10:15am | J60 Abria Granger | SENIC @ Georgia Tech | K66 Wyatt Thomas | RTNN @ NC State | L72 Matthew Flores | NCI-SW @ ASU | 10:15am |

10:30 Session finished

10:30 - 10:45am BREAK

| 10:45am-12:00pm | Parallel M<br>Room 137<br>Moderator: Jenna Huttenmaier | | Parallel N<br>Room 153<br>Moderator: Mikkel Thomas | | Parallel P<br>Room 149<br>Moderator: Tirzah Abbott | | |
|---|---|---|---|---|---|---|---|
| 10:45am | M73 Daysanit Rivera-Garcia | NNF @ U Nebraska – Lincoln | N78 Asaalah Muhammad | KY Multiscale @ UK | P83 Avani Marmer | SHyNE @ Northwestern | 10:45am |
| 11:00am | M74 Astrid Dzotcha Kengne | CNF @ Cornell | N79 Melissa Soto | RTNN @ U N.Carolina | P84 Darian Rosales | NCI-SW @ ASU | 11:00am |
| 11:15am | M75 Wren Hoertdoerfer | CNS @ Harvard | N80 Rohan Luthra | SDNI @ UC San Diego | P85 Caroline Kenney | Concord, Virginia Tech, & MSU | 11:15am |
| 11:30am | M76 Ike Zhang | SHyNE @ Northwestern | N81 Bryan Kim | CNF @ Cornell | P86 Riiny Giir | CNS @ Harvard | 11:30am |
| 11:45am | M77 Daniel Harrison | CNF @ Cornell | N82 Julia Stoneburner | SDNI @ UC San Diego | P87 Davis Guarracino | SENIC @ Georgia Tech | 11:45am |

12:00 session finished

12:00-1:15pm Lunch with Speakers

- 12:30pm Applying for NSF Graduate Fellowships, and An International Summer Research Experience in Japan, Dr. Lynn Rathbun, Laboratory Manager at the Cornell Nanoscale Facility

1:15pm Graduate Student Panel, Dr. Wataru Nakagawa, Associate Professor, Electrical and Computer Engineering, MSU, Moderator

- Tim Campbell, Graduate Student, Dept. of Earth Sciences, MSU
- Zeynep Malkoç, Graduate Student, Electrical & Computer Engineering at MSU
- Joseph Stage, Graduate Student, Dept. of Physics, MSU
- Jordan Baker, Graduate Student, Electrical & Computer Engineering at MSU

2:15pm Entrepenureship and Innovation Panel, Trevor Huffmaster, Director, Blackstone Lauchpad, MSU, Moderator

- Dr. Sarah Lukes, Founder, CEO at Agile Focus Designs
- Dr. Brock Lameres, Professor of Electrical & Computer Engineering at MSU with a spin-off company, Resilient Computing
- Dr. Matt Hull, Associate Director for Innovation and Entrepreneurship for the NNCI
- McKenna Landis, Graduate Student, Electrical & Computer Engineering at MSU

3:15pm Facility tours for those interested

4:00pm Adjourn. Thank you!

## Student Abstracts

*Organized by Session*

Parallel A1

Student's name: Aahan Dwivedi
Home institution: University of Florida
NNCI site: RTNN @ University of North Carolina
REU Principal Investigator: James Cahoon: Department of Chemistry, University of North Carolina - Chapel Hill
REU Mentor: Alicia Bryan: Department of Chemistry, University of North Carolina - Chapel Hill
Contact: aahandwivedi30@gmail.com

Title: **Lead Iodide Seeded Chemical Vapor Deposition of Hybrid Perovskites**

Abstract: Organic halide perovskites are a promising class of materials for low-cost solar cells, reaching maximum power conversion efficiencies of over 25% in less than two decades of research. One of the major challenges to overcome for these materials is large-area film fabrication. Chemical vapor deposition (CVD) is a common industrial technique with high tunability and replicability that has shown great promise in creating perovskite films at the scales needed for solar cells. In this exploration, we attempt to deposit and convert an initial lead iodide seed layer into perovskite using CVD. After conducting SEM and UV-Vis analysis of samples synthesized with this approach and comparing it to samples where perovskite is directly grown without the lead iodide seed layer, we find that the addition of the seed layer significantly improves the rate at which perovskite films grow while also improving the quality of the film created.

Parallel A2

Student's name: Alejandra Rivera Ramos
Home institution: University of Puerto Rico - Mayagüez
NNCI site: KY Multiscale @ University of Louisville
REU Principal Investigator: Kevin M. Walsh Ph.D. - University of Louisville
REU Mentor: Thomas J. Roussel, Jr. Ph.D. - University of Louisville
Contact: alejandra.rivera25@upr.edu

Title: **Pushing the Limits of SLA Printed Molds**

Abstract: Polydimethylsiloxane (PDMS) is a widely used silicone-based organic polymer substrate for developing microfluidic platforms. Traditionally, PDMS microchannels are cured in cleanroom generated casting molds to create micro-scale (<100 µm) geometric features. Inexpensive Stereolithography (SLA) desktop printers can generate molds with features in the tens of microns, offering a cheaper and faster alternative. Unfortunately, chemicals in SLA resins inhibit PDMS curing. This project aims to overcome the inhibition issue by exploring various post-processing parameters (washing, UV curing, and baking the molds). PDMS curing was inspected through touch and microscopy, it was observed that uncured PDMS exhibits undesirable tackiness at the surface between PDMS and the SLA mold. The results indicate that optimal PDMS curing involves washing the resin molds in Isopropyl Alcohol (IPA) for 5 minutes, followed by UV curing the resin while submerged in water for 60 minutes, and baking the standard resin molds for two hours at 120˚C. Another effective method involves 1 minute of washing in Acetone, UV curing the resin while submerged in water for 75 minutes, and baking the standard resin molds for one hour at 120˚C. These findings enable cost-effective and efficient PDMS microchannel production using SLA molds.

Parallel A3
Student's name: Macharia Kanyatte
Home institution: Vanderbilt University
NNCI site: SENIC @ Georgia Tech
REU Principal Investigator: Dr. Billyde Brown
REU Mentor: Harnjoo Kim
Contact: macharia.m.kanyatte@vanderbilt.edu
Title: **High-Throughput Two Photon Lithography for Additively Manufactured Microsupercapacitor (MSC) Electrodes with Pre-defined Pore Structures**
Abstract: In this work, we propose a novel approach to address challenges in 3D Microsupercapacitor (MSC) technologies using High-Throughput Two Photon Lithography (HTTPL) to fabricate MSC electrodes with predefined ordered pore structures. A crucial factor in designing MSC electrodes is maximizing electrochemically active specific surface area, which determines the specific capacitance and contributes to the energy density of the device. Through HTTPL, we create polymeric templates and deposit conformal conductive pseudocapacitive coatings via atomic layer deposition (ALD), precisely controlling geometric specific surface area during additive manufacturing. This enables us to tailor energy storage performance by creating electrodes with patterned 3D pore structures. The performance of the fabricated MSC electrodes is characterized using electrochemical testing, revealing a strong correlation between specific surface area and device performance. Moreover, our work paves the way for large-scale manufacturing of MSC electrodes using HTTPL. Our project aims to develop a mathematical model that relates processing parameters and selected structural dimensions (pore size, pillar area fraction, height, etc.) to measured performance. Such a model would allow for accurate prediction of MSC device performance, facilitating informed device design selection to achieve targeted performance metrics before actual fabrication.

Parallel A4
Student's name: Vashti Allred
Home institution: University of Arizona
NNCI site: RTNN @ University of North Carolina
REU Principal Investigator: Jinsong Huang
REU Mentor: Marise García Batlle
Contact: vallred@arizona.edu
Title: **A New Strategy for Perovskite-Substrate Adhesion in Solar Cells**
Abstract: Perovskite solar cells hold great promise for efficient, cost-effective renewable energy, yet achieving optimal adhesion between the perovskite layer and the substrate remains challenging, impacting device performance and stability.

To address this, we introduced a specially synthesized polymer into the hole transport material (HTM) to enhance interfacial adhesion. Thorough characterization confirmed successful polymer incorporation into the HTM, significantly strengthening the bond between the perovskite and the substrate.

Devices utilizing the modified HTM achieved an impressive 19% power conversion efficiency (PCE). This project highlights the potential of our synthesized polymer as a valuable addition to HTMs, offering improved bonding in perovskite solar cells and paving the way for more stable long-term devices.

Parallel A5
Student's name: Samantha Musante
Home institution: Trinity College
NNCI site: KY Multiscale @ University of Louisville
REU Principal Investigator: Dr. Kevin Walsh, University of Louisville
REU Mentor: Dr. Cindy Harnett, University of Louisville
Contact: sam@musante.org
Title: **Smart Connectors for Cut-and-Seam Manufacturing of Soft Electronics**
Abstract: Interfaces between inorganic and biological systems need to be mechanically compatible with soft surfaces that grow, stretch, and distort over time. This requirement has driven the development of soft photonic and electronic circuits. However, the evolving shape of these circuits poses a problem when connecting circuits together: how can we match up

distorted contacts that may be impossible to align? The problem comes up when connecting circuit pieces into custom 3D structures to cover one-of-a-kind biological shapes. The usual solution to the distortion problem is to create a stiffened connector region that prevents the circuit from deforming, which is good for alignment but doesn't conform to biological surfaces as closely as a soft region does. The goal of this research is to connect signals across thin seams between soft materials without precise alignment at the connections. Our method relies on mm- and smaller scale electrical components inserted into thin adhesive tapes, producing materials with anisotropic electrical conductivity. In this work, we investigate the alignment tolerances in circuits made from thin films and fibers, focusing on sensors that will function after being encapsulated by conformal biocompatible coatings.

Parallel A6

Student's name: Alan Valladares
Home institution: Arizona State University
NNCI site: NCI-SW @ Arizona State University
REU Principal Investigator: Ines Montano - Northern Arizona University
REU Mentor: Alex Hardin - Northern Arizona University
Contact: avallad456@gmail.com

Title: **Simulation of Polymer Chlorosome Nanocomposites using Quantum Computing**

Abstract: Light-harvesting and energy transfer in photosynthesis are often incredibly efficient processes and as such, the role of quantum behavior or means of better understanding that efficiency are being heavily pursued. In this project, we are exploring the potential of quantum simulations to model Polymer Chlorosome Nanocomposites (PCNs), an example of artificial light-harvesting systems. In order to study and simulate PCNs, we first calculate the electronic structures of select molecules through quantum algorithms, such as the Variational Quantum Eigensolver (VQE) and the Subspace-Search Variational Quantum Eigensolver (SSVQE). With Pennylane, an open source software framework for quantum computing and quantum chemistry, we determine both the energy of the ground and excited states of molecular structures constructed using the software application Avogadro. Once the electronic structure is determined, we can then use it as input data to simulate the quantum dynamics of the artificial light-harvesting system. This research effort will advance our understanding of energy transfer in light-harvesting systems and evaluate the potential of PCNs to create photonic materials with emergent properties for applications ranging from artificial photosynthesis to photovoltaics and quantum photonics.

Parallel B7

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Title: **Dielectrophoretic Trapping of Nanoparticles with Carbon Nanofiber Mats**

Abstract: Trapping nanoparticles smaller than 200 nm has posed considerable challenges in current methodologies. However, our research has turned towards using dielectrophoresis (DEP) to accomplish this task. DEP leverages non-uniform electrical fields to effectively trap polarizable particles. In our design, we aim to significantly augment the volume of liquid at an accelerated flow rate of mL/min, as compared to the conventional µL/hour in typical DEP devices. To capture these nanoparticles, it is imperative to generate large field gradients, necessitating the utilization of conductive nanofiber mats that will be separated with an insulative membrane. This design will be securely housed within a 3D printed beaker that can quantify nanoparticle trapping. Initial testing will involve the utilization of 210 nm fluorescent particles in static fluid before using a flow through device. There will be repeated tests at different voltages and AC frequencies. By adopting this methodology, we hope to see our device to be successful in trapping these nanoparticles.

Parallel B8

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Title: **Design and Fabrication of Micro-LED Devices for Implantation and Stimulation in vivo**
Abstract: With recent developments in microfabrication and its use in optogenetics, there becomes a need to create devices small enough to implant in vivo to use for monitoring and researching neurological diseases. These devices are still somewhat simple, as they are hoping to mimic the normal neurological conditions while exposing the brain to new forms of stimulation. With the devices we have created with photolithography, we can stimulate the neurons within the brain using blue light micro-LEDs and observe the changes that occur. These devices' electric capabilities, durability and flexibility are tested to ensure that they are able to form around the brain tissue for maximum transmission. Our devices show that the electronic signals are strong and repeatable, with the amount of blue light being adjustable based on the need. The light output also matches with the wavelength required for stimulation of Channelrhodopsin 2, which allows us to control the ion channels of the neurons. With some modification, these devices will continue to be used for future projects, where implantable devices for both stimulation and recording are possible.

Parallel B9
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Title: **Fabrication of elastomer bistable jumper**
Abstract: A bistable jumper
Multistability—the property of having multiple stable equilibrium configurations—has recently emerged as a powerful platform to design a wide range of smart structures, including shape-reconfigurable architectures, fully elastic and reusable energy-trapping metamaterials, soft swimming robots with preprogrammed directional propulsion, and deployable solar panels for aerospace applications. As part of this project, I focused on bistable spherical caps and identify geometrical configurations leading to an energy barrier that can be overcome upon impact, opening up opportunities for jumping. I casted a variety of shells, characterize their nonlinear behavior upon indentation and verify their ability to jump upon impact on a rigid surface. Further, i characterized the deformation of the shells using the micro-ct available at CNS.

Parallel B10
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Title: **Characterization of Alternative Electrolytic Solutions for Use in Microrobot Self-Assembly Systems**
Abstract: Electroplating is a process used to deposit metals onto surfaces by passing an electric current through an electrolyte solution. It's a technique that can be used to add many properties to materials, such as increased conductivity or corrosion resistance. In addition, it's proven to be a reliable method for the fabrication of self-assembled, high-performance materials. Previous works have shown that electroplating by individual agents in a swarm can be achieved using electronically integrated microrobots. In solution, these devices harvest energy from on-board solar cells to plate metal on their bodies and bond together to form complex, macroscopic structures. This behavior has been demonstrated using a variety of nickel (Ni) plating electrolytes. However, it would be desirable to operate the devices in alternative electrolytes, enabling the deposition of a variety of metals. Here, we have characterized various properties of a copper sulfate ($CuSO_4$) plating solution. Analysis of the solution allowed for an estimation of the overpotential, as well as growth rates of Cu at different voltages. The devices not only plated Cu, but two devices were able to successfully form a junction. These results illustrate that the devices could be used to assemble complex geometries, using an array of metals.

Parallel B11

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Title: **DEVELOPMENT OF IN-SITU HEATING TEM STUDIES**

Abstract: In-situ heating in a Transmission Electron Microscope (TEM) allows high-magnification observation of samples at elevated temperatures, aiding in the analysis of structural and chemical composition changes in materials. For this study, materials such as Gold (Au) embedded in Silicon (Si) and Iron (Fe) embedded in Silicon (Si) were considered. Additionally, we investigated several tools for improving the outcomes of these experiments: a novel software control suite referred to as AXON drift correction; a new, high-speed camera known as a Direct Electron camera; and optimized microscope settings. The resulting analysis showed that AXON drift correction held up over elevated temperature ranges of up to 800C, Scanning-TEM mode showed better contrast than TEM mode for the materials studied, Direct Electron camera was fully integrated into the AXON software, and a sample showed particle formation and rapid movement within, rather than on top. Further studies are warranted.

Parallel B12

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Title: **Establishing an okadaic acid model of progressive neurodegeneration using hTau phosphorylation dynamics for neuroengineering applications**

Abstract: A defining characteristic of Alzheimer's and other Tauopathies is the hyperphosphorylation and aggregation of the microtubule-associated protein Tau. To model Tauopathies in brain cell cultures, okadaic acid (OA) is used to inhibit protein phosphatase 2A, which results in the accumulation of phosphate groups on Tau [1]. Threonine 231 (T231) and Serine 404 (S404) are highly conserved phosphorylation sites in Tauopathic forms of neurodegeneration. We seek to establish a live-cell, time-dependent dementia model that mirrors the progression of the disease state by quantifying the level of phosphorylation of Tau at these sites. After treating hippocampal neurons with 100nM OA for 1 hour and imaging immunostained cells, we found higher rates of phosphorylation and neurite degeneration compared to controls. While both the T231 and S404 sites appear to experience similar levels of phosphorylation at 24 hours, T231 trends toward rapid, consistent phosphorylation, whereas the S404 phosphorylation site shows a more gradual increase in phosphorylation after OA removal. Both sites show clear signs of degeneration at 24 hours. This study establishes a time-dependent model of Tau hyperphosphorylation which can be utilized for the development of biomedical engineering interventions at progressive stages of neurodegeneration, such as mechanical protein manipulation via nanomagnetic forces.

Parallel C13

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Title: **3D-printed Flow Battery Leveraging Advanced Materials and Microscale Featured Electrodes.**

Abstract: Climate change necessitates a transition from fossil fuels to renewable energy sources, prompting the U.S. Department of Energy to actively seek alternative solutions for reducing carbon dioxide emissions. Among the promising technologies, redox flow batteries stand out, as they store electrical energy in liquid electrolytes containing dissolved chemical compounds. These batteries excel in large-scale energy storage, but their high cost and low energy density pose challenges. Vanadium redox flow batteries are commonly employed in this field. Nevertheless, there is a cost-effective

alternative that emerges through additive manufacturing. The emerging technology of 3D-printed flow batteries aims to bridge the gap between scalability and cost in renewable energy. Additive manufacturing enables the utilization of complex geometries and the exploration of different prototypes while maintaining affordability. By leveraging these innovations, our goal is to enhance the viability and affordability of renewable energy storage solutions by developing corrosion-resilient electrodes compatible with harsh electrolyte solutions. In our approach, we employ boron-doped diamond deposition and molybdenum to produce robust and electrically conductive flow battery electrodes with high-surface area features. To facilitate 3D printing with molybdenum, we are utilizing an ultrasonic atomizer to generate metal powder feedstocks. The manifold structure for facilitating flow across the electrodes will also be produced via additive manufacturing using an acid-resistant SLA resin. Flow field patterns will be evaluated using fluid mechanics simulations to determine optimal structure geometries. The overall flow battery design will focus on addressing prior design concerns related to electrolyte cross-contamination, battery lifespan, and compatibility with scaling beyond lab-sized energy storage systems.

Parallel C14

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Title: **Predictors of Right-Ventricular Function in Pulmonary Arterial Hypertension Using Machine Learning**

Abstract: The objective of this research study is to employ supervised and unsupervised learning techniques to evaluate predictors of right-ventricular function in pulmonary arterial hypertension. Since right-ventricular function is used to determine disease severity and outcome, we would like to identify metrics, and relationships between those metrics, that are most informative of changes in right-ventricular function. This will be completed using data collected from rats induced with pulmonary arterial hypertension.

Parallel C15

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Title: **Characterizing Chemical Composition of Plagioclase Microlites within Fault-Generated Pseudotachylites retrieved from the Ikertôq Shear Zone near Sisimiut, Greenland**

Abstract: Pseudotachylites are thin, glassy veins that result from the frictional melting of rocks during seismic or tectonic events. Due to unpredictable thermal conditions within these zones, pseudotachylites often exhibit nonequilibrium processes along with unpredictable lithologies. As a result, it can be difficult to study and classify textures in order to make sense of the physical conditions during primary crystallization. The chemistry of small, tabular microlite crystals can be used to investigate pseudotachylite melt-origin. Plagioclase microlites within the Ikertôq pseudotachylites were analyzed using EDS and WDS in order to construct geochemical plots relevant to understanding temperature conditions present during primary crystallization. Conclusively, we were able to deduce that plagioclase microlites displayed higher amounts of calcium (An37 - An47) and lower amounts of sodium in comparison to the plagioclase clasts within both the pseudotachylite matrix (An30−An31) and tonalitic gneiss host rock (An32-An34). Though all plagioclases displayed an andesitic composition, microlites had a larger compositional range while both the clast and host rock's were limited. Higher [Ca] within microlite proves the pseudotachylite crystallized at higher temperatures around ~1450°C in comparison to the clasts and host rock. These observations are consistent with other quantitative studies and can provide insight on disequilibrium melt behavior.

Parallel C16
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Title: **Additive Manufacturing of Functional Emulsions to Spatially Control Mechanical Properties**
Abstract: Soft, elastic deformable composites enable the development of new materials and structures involving soft robotics and wearable electronics. However, there is a deficiency in techniques to control these composite microstructures. Here we explore how droplets of Field's Metal (FM) embedded in a UV-curable silicone changes the composite microstructures and affects the mechanical properties of the material as a whole. We utilize direct-ink-write (DIW) 3D printing to control droplet shape, orientation, and connectivity throughout a printed part. This includes changing the FM droplet shape from spherical to needle-like structures. This can be used to create materials with stiffness gradients that produce distinct physical properties and mechanical functionalities. In this work, a material with a functional stiffness gradient was fabricated, and its mechanical properties were examined with a mechanical testing machine. The composite material will provide opportunities to route strain around rigid components such as electronic components in wearable electronic devices that are elastically deformable.

Parallel C17
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Title: **Detecting Differences in Operational Stability of Perovskite Solar Cells**
Abstract: Renewable energy is highly sought after for its eco-friendly nature. One option in this avenue is solar energy. While silicon solar cells are currently the most prevalent, research is ongoing in alternative materials and among them is the perovskite solar cell, (PSC). Over time PSCs have reached power efficiencies comparable to silicon solar cells. However, degradation has continued to be an ongoing issue. Hence, perovskites hold great promise, but also areas of needed improvement. Research in PSCs is a time consuming, repetitive process, of implementing additives and exploring various charge transport layers and device architectures. Because of this, efforts are being made to automate the process in the lab. This will permit fabrication and testing of numerous possible combinations at a time. The aim of this project is to help streamline this automatization of PSC fabrication, characterization, and stability testing. In particular, focus is made on the characterization stage. The goal is automatic characterization. In this stage, power efficiency is tested. In summary, perovskite solar cells hold great potential and research is currently made to make them a suitable enterprise. The nature of this endeavor has made automation desirable and has resulted in a developing streamlined process in PSC research.

Parallel C18
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Title: **Mesoscale nanocrystal organization in stony coral tissue loss disease lesions**
Abstract: The arising pathogenic diseases Stony Coral Tissue Loss Disease (SCTLD) requires investigation due to the impact on existing coral reef generating organisms, such as death of entire reefs, and it is paramount to understand direct effects on stony coral. In this study the exoskeletons of both healthy and SCTLD-afflicted Montastraea cavernosa, a common species of stony coral found in the Atlantic Ocean, was characterized using scanning electron microscopy (SEM) in combination with electron backscattering diffraction (EBSD) to complete crystallographic analysis and energy dispersive X-ray spectroscopy (EDS) to understand changes in elemental composition. This study highlights that SCTLD-afflicted

samples indeed impacted the minerals the coral forms. Specifically, there are differences between healthy and SCTLD-afflicted calcium carbonate crystal size and crystal size distribution at centers of calcification (CoC) near locations containing the most recently created mineral. We discovered a difference in inorganic ion impurity content (strontium and magnesium) between both healthy and SCTLD-afflicted coral samples and elucidated differences in crystal defects. This study may further aid in our understanding of SCTLD pathogen impacts on mineralization pathways that stony corals undergo or inform strategies that can be implemented to further improve the lifespan of stony corals.

Parallel D19

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Title: **Design and Development of High Entropy Alloys**

Abstract: High Entropy Alloys (HEAs) are a mixture of four or more metals that have a higher performance in comparison to pure metals. They have better corrosion resistance, higher strength, and better workability. The higher performance is due to the mixture of different materials and the non-uniformity of the mixture. HEAs have a diversity of applications such as aerospace, automotive, and biomedical industries. Finding the perfect process and materials to create and develop high entropy alloys can replace expensive materials or make cheaper materials stronger for its application. HEAs have a wide range of possible compositions and require high-throughput screening techniques to efficiently develop useful compositions. The objective of this research is to develop and design a tunable method that can be controlled and altered to create HEAs. The method used for the design of a HEA is the electrodeposition since the compositions can be adjusted by changing its parameters and it accelerates the process at a lower cost. Through the sequential deposition and annealing of individual layers, we demonstrate a cost-effective and highly tunable method for developing HEA samples with gradient composition.

Parallel D20

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Title: **Bio-inspired Surfaces: Fabricating Shark Skin Using Glancing Angle Deposition (GLAD)**

Abstract: Oftentimes microstructures in nature can be a great source of engineering innovation. Examples include cicada wings, lotus leaves, and firefly wings. This research focuses on the microstructure of shark skin, dermal denticles, which are hydrophobic, drag-reducing, and anti-fouling. These properties are desired in healthcare, medical devices, and marine and industrial environments. Current fabrication techniques for shark skin mimicry include 3D printing, electron beam lithography, slant irradiation, and molding directly from shark skin. However, these methods can be costly, inefficient, and unable to scale down complex features. This research utilized glancing angle deposition (GLAD), a physical vapor deposition process with high incident angles to the substrate. The dermal denticle bases were created with conventional photolithography. These are called line seeds, the only area where deposition occurs, due to a shadowing effect. The first step is to design the line seeds using proper design rules. Four different line seed shapes were created: rectangle, square, curve, and semi-circle. The semi-circle design produced ridge-like features, making it the best. A scanning electron microscope (SEM) was used to characterize the fabricated designs. To show the hydrophobicity of the shark skin mimicries, a water contact angle (WCA) test was conducted.

Parallel D21

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Title: **Polymer Membrane Composites for Intercompartment Cell-Like Communication**
Abstract: Nature and natural phenomena are important for scientists to study complex processes of living systems for applications to improve human lives. Biomimicry has been applied to many different structural and functional conditions that we use today. For example, wind turbines that are modeled after the fins of humpback whales or ventilation systems that are inspired by the organization of termite mounds. Through biomimetics, it is possible to isolate a factor and focus on one aspect of an issue such as in this project where we used pH-dependent Polyacrylic acid(PAA) Polybutadiene(PBD) diblock copolymer, BODIPY fluorophore pigment, and naturally occurring biopolymer alginate to mimic cell membranes and cellular organization for health and energy applications. This research is how we can look at energy transfer within nanocomposites to mimic cellular structure and function. This research can be applied to wound healing, drug delivery, cell transplantation, pharmaceuticals, tissue engineering, etc.

Parallel D22
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Title: **3D Printing Microscale Hemispherical Lenses Using Projection Two Photon Lithography (TPL)**
Abstract: Two photon lithography (TPL) is a nano/microscale additive manufacturing process that allows for 3D printing with features of 100nm. Projection two photon lithography (P-TPL) is a subset of TPL that allows for entire layers of a structure to be printed at a time. This allows for P-TPL to be roughly 1000 times faster than standard TPL without compromising the resolution. One of the things that can be 3D printed with this method are micro-optics. Creating a 40µm diameter hemisphere that had little to no deformities and is easily mass produced was our goal. Settings during the P-TPL process that were altered to make these hemispheres include but are not limited to: how many laser pulses polymerizes a layer, how many layers are printed and the spacing in between them, and how dense a feature on the print is. The best combination of these settings was found to be 10 layers with 2µm spacing in between layers, 1 laser pulse per layer, and having all features inside the structure to be printed.

Parallel D23
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Title: **Boron Nitride and Diamond Electronics**
Abstract: The future calls for integration of diamond-based capacitors for high-power radio frequency (RF) applications. Diamonds' exceptional properties, including thermal conductivity and ultra-wide bandgap, address current semiconductor challenges in research and real-world settings. This study aims to fabricate and characterize metal-boron nitride-diamond capacitors rendering them suitable for harsh conditions. Electrical characteristics were measured using a Cascade probe station and semiconductor/component test system, while varying boron nitride thicknesses will continue to be tested to assess their impact on the breakdown field. By harnessing the unique properties of boron nitride and diamond, this research contributes to the development of reliable electronic devices, engineered to thrive in power transmission, aerospace, and energy systems. The outcomes hold potential to fuel advancements in research and industrial applications.

Parallel D24
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Title: **Fluidic Device for Removal of Extracellular Hemoglobin from Freeze-Dried Blood Products**
Abstract: Hospitals across the nation are constantly in need of new blood supplies due to issues with blood sourcing as well as shelf-life concerns. Recent innovations in the method of freeze-drying blood may be able to overcome these sourcing issues, but this method presents new challenges of its own. The freeze-drying process leads to hemolysis and the release of intracellular hemoglobin into solution. This free hemoglobin is inflammatory and cytotoxic, causing organ damage if not disposed of before transfusion. In light of these issues, we have designed a centrifuge-free device to wash blood samples, separating the free hemoglobin from live red blood cells. This prototype system is run by a syringe pump and consists of coiled millifluidic tubing followed by flow splitters designed through additive manufacturing. This device is able to increase separation of the red blood cells from their washing fluid, increasing the end red blood cell concentration and siphoning off the washing solution containing free hemoglobin. With modification, this system will present a novel method for ensuring the safety of blood for transfusion in areas that lack resources to acquire technology such as a centrifuge, paving the way for use in remote or mobile situations such as military use.

Parallel E25
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Title: **Nanoscribe Advanced Patterning Techniques for Two-Photon 2D and 3D Structures**
Abstract: The CNF's Nanoscribe GT2 is a laser lithography system capable of printing three-dimensional structures with a resolution down to 200 nm using two-photon polymerization (2PP). Whereas traditional 2D direct laser writing (DLW) tools require 3D structures to be built up one layer at a time, the Nanoscribe allows for complex 3D geometries to be fabricated with multiple levels in a single process step. Moreover, due to its high limit of resolution, extending this tool to the fabrication of 2D structures provides users with enhanced flexibility for their process flows. In this work, we explore the Nanoscribe's capabilities in various configurations, with an emphasis placed on process development for both positive and negative spin-coated resists. An alignment strategy is proposed that enables structures to be printed with one-micron accuracy using pre-existing fiducial markers. By investigating the capabilities of this tool, we are also able to gauge its ability to aid in applications such as lift-off and microfluidics, potentially enabling the realization of devices that would be difficult to create using other methods.

Parallel E26
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Title: **Laser Micro-Machining 2D Reflective Materials to Create Ultra-Light Mirrors for Space Applications**
Abstract: Ultra-light materials are critical for creating large scale structures in space, such as telescopes. Larger mirrors for radio telescopes would enable much greater resolution for astronomical observations and dramatically increase our ability to receive data from distant space probes with less powerful broadcasting antennae. Current approaches to creating light mirrors often rely either on polished metal panels or thin sheets which must be held in tension by a relatively heavy frame. Both technologies are difficult to scale up, limited by the mass of the panels or frame required. Thin materials such as metal foils and metalized polymer films are affordable and readily available, making them good candidates for constructing ultra-light mirrors. In this research, we investigated how laser micro-machining can be used to change the bending stiffness and tensile response of these 2D materials through corrugation and Kirigami inspired patterns. We found that Aluminum foil can be bent using only a laser, and that certain patterns of cuts can dramatically increase the elasticity of typically rigid 2D materials.

Parallel E27

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Title: **Nanoimprint Process Optimization for Overlay and Fidelity**

Abstract: Nanoimprint lithography (NIL) has the capabilities of having high resolution, producing features that are sub 10nm and is also cost-effective compared to lithography techniques with same resolution, such as electron-beam lithography. To achieve such benefits, nanoimprinting parameters must be optimized, such as imprint temperature, pressure, polymer physical properties, residual layer thickness, and etch depth of mask, among others. Optimal thermal nanoimprint lithography (T-NIL) guidelines were achieved with polymethyl methacrylate (PMMA), a well-understood electron-beam resist, on Si wafers on the Nanonex NX-2500 with two non-uniform density patterns and a uniform grating pattern. For widest pattern conditions, optimal T-NIL parameters occurred around 250°C with an imprint time of 210 seconds using 50K PMMA.

Parallel E28

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Title: **Developing Spintronic THz Emitter using Hybrid Perovskites**

Abstract: Laser-driven terahertz (THz) sources generate coherent radiation across a wide spectrum, from broad to focused, with single-cycle to multi-cycle pulses. Their natural synchronization with a femtosecond laser enables ultrafast time-resolved spectroscopy, imaging, and communication applications. Our investigation expands previous research comparing materials for THz emitters. We explore hybrid perovskites as spin filters that increase the polarization of the spin current injected from the metal/ferromagnetic devices as improvements to existing technology. Hybrid perovskites offer advantages like being lightweight, easy to manufacture, are defect tolerant, and tunable through tailoring of the chemical composition, nanostructuring and quantum confinement. We compared the results of our perovskite devices against metallic reference samples and found that the addition of hybrid perovskites resulted in measurable THz emissions and increased wavelength via Fast Fourier transformation – showing definition and range of devices using these materials.

Parallel E29

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Title: **Characterization of Synthetic Mucin Using Atomic Force Microscopy**

Abstract: Mucin glycoproteins are essential lubricants in many organisms. We examine the micro-scale tribology of synthetic mucins, which have the advantage of avoiding biological contamination. In particular, atomic force microscopy has been used to measure the relationships between friction, sliding speed, and applied normal force in solutions containing synthetic mucin. Resulting data suggest the adsorption of mucins onto substrates is an essential mechanism in producing their lubricating effect. Moreover, friction is velocity-strengthening, indicating mucin-mucin bonding events do not drive friction. The protocols developed here and resulting findings inform ongoing screening and modeling of synthetic mucins, an essential step in comparison to their biological counterparts.

Parallel E30

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Title: **Investigations of Vibrational Dynamics in Hybrid Perovskite Materials Using High-Resolution Raman Spectroscopy**

Abstract: Perovskites are a promising new technology for solar panels. Hybrid perovskites have organic spacers in between layers, which alters the dimensionality, improving electronic properties such as the conductivity. In this experiment, five newly synthesized hybrid perovskites from the University of Pavia were investigated. Using the organic spacers, phenylethyl ammonium and butyl ammonium, the synthesized crystals included: the 3D double perovskite, Cs2AgBiBr6, the 2D hybrid perovskites (PEA)2CsAgBiBr7, (BA)2CsAgBiBr7 , and the 1D hybrid perovskites (PEA)4AgBiBr and (BA)4AgBiBr8. These are double perovskites, meaning they are made with Ag and Bi as opposed to Pb, the more common element for perovskites. They are important to future development in this field since they are made without lead, a toxic material that is environmentally damaging when the perovskite degrades, which is a common outcome. These crystals were investigated using Raman spectroscopy to analyze their vibrational modes. As a result, it has been determined that they are useful alternatives to their lead-incorporated analogues. They have similar Raman spectra, structures and phase transitions, and degradation properties in ambient conditions or in the presence of a laser. Information on these perovskites was found, leading to a more comprehensive understanding of them and their future applications.

Parallel F31

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Title: **Enzyme-loaded modified porous silicon nanoparticles in polymer scaffolds synthesized via spray nebulization for nerve cell regeneration**

Abstract: The nervous system is vital as the main control center for all functions of the human body and is responsible for maintaining the proper communication between each organ. Said nerve cells have a regenerating ability against minor damage but are mostly imperfect in their nature. This project aims to improve the recovery of neural damage by enhancing the regeneration of injured neurons through the use of porous silicon nanoparticles for the targeted delivery of nerve growth factors. For this drug delivery system, we are investigating the loading of the enzyme BDNF (brain-derived neurotrophic factor) into modified porous silicon nanoparticles (pSiNP). We are planning to trap the loaded pSiNPs in a matrix of polycaprolactone (PCL) polymer scaffolds to form a patch via spray nebulization. We are expecting that the nanofibrous scaffolds that make up the patch will provide additional protection to the enzyme-loaded particles, allowing for a slower payload release (which is desired, instead of having a burst release), and direct cell growth on the damaged neuron. We will first use lysozyme as a model enzyme to load into pSiNPs as it is low-cost and has similar properties to BDNF.

Parallel F32

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Title: **MEMS-driving twisted bilayer photonic crystal**

Abstract: Structured light, created by controlling its phase, radiation, frequency, and polarization, has led to significant advancements in areas such as imaging, sensing, and quantum optics. Photonic crystals, which use periodic nanostructures, are important tools for creating structured light and are compatible with on-chip technology. Bilayer

photonic crystals, which can generate additional degrees of freedom in optical tunability, have recently gained attention. We will discuss our theoretical and experimental studies on several bilayer photonic crystal structures, including their tunable and complex responses. We will also demonstrate the use of microelectromechanical systems (MEMS) for reconfigurability. These developments have applications in telecommunications, adaptive sensing, programmable photonics, and quantum optics and can be scaled to large photonic integrated devices.

Parallel F33

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Title: **Super-Resolution Imaging of Cells Using a Lensless Raspberry Pi Camera**

Abstract: "Widefield light microscopy is widely used in biological cell imaging, however this technique is limited by the small field-of-view (FOV) displayed as magnification is increased. This work describes adapting a Raspberry Pi camera sensor with an order of magnitude larger FOV for lensless shadow-imaging of microspheres and cells. The pixel size limited resolution is increased by combining multiple low-resolution sub-pixel shifted images with a super-resolution algorithm. These sub-pixel shifts are achieved by a moving light source which produces shadow shifts that are smaller than the sensor's pixels. A theoretical model to determine the required light source movement based on sensor-cell-light source interaction was developed and used to design multiple device iterations. Additionally, the camera was incorporated into a 3D printed flow-cell as a proof-of-principle application. The device and algorithm were used to visualize 3 um and 10 um polystyrene beads and 6 um baker's yeast cells on both an unpackaged and packaged sensor. An obvious improvement was observed in the image quality of the super resolved image compared to the low resolution images. In combination with the theoretical models, the concept has potential for use in other imaging applications such as mechanical characterization of living cells."

Parallel F34

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Title: **Skyrmions in Graphene Quantum Hall Systems**

Abstract:
Quantum Hall Systems (QHS) describe the quantum effects that smaller classical hall systems do not deal with. In these 2-dimensional electron fields (QHS) , we see quantum hall ferromagnets (QHFM) – sets of electron in which all spins face the same direction. When we add a strong magnetic field, thus, inducing a current, those QHFMs become excited forming quasi-particles of a set of electrons' spin configuration – a Skyrmion. In traditional Quantum Hall Systems, there is only one Landau Level (LL), or one state, that the Skyrmion can exist in. However, in Graphene - monolayer Carbon - because of the high symmetry of the structure itself a Skyrmion can exist in two LLs. When in these two systems, QHS and Graphene QHS, the Skyrmion will take on a a specific form as it is topologically stable due to the energy barrier between the edge of the skyrmion and its surrounding thin film environment. In this project, we attempt to determine this stable configuration, where the Skyrmion has the lowest energy, using an algorithm called the "Metropolis Algorithm". The identification of these configurations will allow for the ability to adapt Skyrmions to be used as bits in fields such as Quantum Computing.

Parallel F35

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Title: **Development of Novel Hydrogels for Tissue Healing**
Abstract: Adhesion to wet tissue surfaces using Alginate-Acrylamide tough adhesive hydrogels has demonstrated a wide range of applications and excellent mechanical performance and biocompatibility. While these materials have shown great promise, they are typically formulated as a preformed hydrogel patch and liquid bridging layer to promote their attachment to tissue which makes their application in laparoscopic surgeries more challenging. However, extensive studies have revealed their susceptibility to issues such as cytotoxicity and limited ability to accommodate the dynamic movements of tissues. Tough adhesive hydrogels can stick to wet and moving tissue surfaces, but they have non-degradable components, prompting the exploration of degradable materials that exhibit material toughness comparable to that of native biological tissue. Therefore, this study aimed to optimize the adhesion performance of the injectable gels to the tissue, explore how mesenchymal stem cells (MSCs) interact with the gels while promoting chondrogenic differentiation, and tune the degradation. Our main goal was to create an injectable hydrogel adhesive that is degradable and suitable for repairing cartilage, as currently, no approved sealants are available. We hypothesized that the tough adhesive hydrogels would possess the desired qualities once they had been thoroughly tested, such as mechanical toughness, adhesion, and degradation to utilize them for tissue replacements and drug release systems.

Parallel F36
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Title: **A protease-based theranostic as a tool to understand and inhibit calpain in brain injury**
Abstract: Following traumatic brain injury (TBI), increases in intracellular calcium activate the calcium-dependent protease, calpain. Calpain is activated in neurons and endothelial cells, resulting in neurodegeneration and blood-brain barrier dysregulation. Calpastatin is a calpain-inhibiting protein that could act as a prospective therapeutic against calpain. Customary methods of measuring calpain activity only allow for bulk analysis and lack regional visualization capabilities within the brain. Recently, we have developed a theranostic that includes a calpain-specific activity-based nanosensor and a calpastatin peptide as a tool to measure calpain and calpastatin dynamics in the brain. We synthesized PEG-CS1, PEG-CS1-calpastatin, and PEG-CS1-scramble conjugates. Both the PEG-CS1 and the Scramble-PEG-CS1 show an increase in sensor activation over time, as measured by fluorescence. This follow the hypothesis that calpain-1 was uninhibited by the conjugates and able to cleave. The PEG-CS1-calpastatin showed no sensor activation. indicating that calpain-1 was inhibited by the calpastatin. In a preliminary experiment, conjugates were injected in a mouse controlled cortical impact model and we observed calpastatin inhibits calpain activation in neurons and endothelial cells. We will investigate the interaction between calpain and calpastatin in these cells within the hippocampus and the cerebral cortex to quantify the therapeutic potential of calpastatin regionally in the brain.

Parallel G37
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Title: **Reconstructed Dermal Layers for Skin Regeneration using 3D Biofabrication**
Abstract: Skin is the largest organ in the human body and has a complex structure. This complex three-dimensional (3D) microstructure cannot be reproduced by conventional monolayer (2D) culture. A previous work showed promising results with fibrin-based 3D culture to stimulate proliferation and differentiation of skin epithelial cells. This work aims to reconstruct skin dermal layers to further and better mimic the structure of human skins using this technology. We used 3D printing technology to fabricate chambers for the 3D culture method using biocompatible PDMS. Then we did 3D culturing Human dermal fibroblasts (HDF) for 2-weeks and evaluated them by imaging and mechanical properties measurement. We also attempted to co-culture HDF and human umbilical vein endothelial cells (HUVECs) by taking

advantage of the chamber structure. The results showed that HDF was successfully embedded with fibrin matrix in the PDMS chamber and adapted to the 3D microenvironment and proliferated within 2-week observation window. This can be shown by changes of imaging and mechanical properties. Also, Vascularization in the dermal layer was achieved by co-culturing HDF and HUVEC. The skin model reconstructed in this work is more suitable for skin disease models and for drug test in vitro.

Parallel G38

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Title: **Fabrication and Characterization of Surfaces with Spatially-Modulated Adhesion and Friction**

Abstract: Interest in rapidly variable friction and adhesion has grown significantly in the fields of haptics and robotics in the past few decades due to its applicability in cases such as in-hand robotic manipulation and immersive human interaction. Previous research has examined the changes in friction and adhesion of surface contacts through various methods such as electroadhesion, ultrasonic vibration, and shape memory polymers (SMPs). However, there has been a lack of microscale and nanoscale modulation of these SMPs via thermal stimulation. This research attempts to characterize the effects of thermal stimulation on the friction and adhesion of SMPs, while also detailing the fabrication of a microheater array that can perform this spatial modulation of a thermal input to an SMP. Currently, a nanofabrication method has been designed and utilized to create a microheater array that can spatially modulate the temperature of the SMP. Further characterization is being conducted to determine the extent of the microheater array's effects on the mechanical properties of an SMP.

Parallel G39

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Title: **Simulation of a bistable buckling beam using Lorentz force.**

Abstract: "ICs advanced with CMOS (FLASH) but have limitations. Emerging memories offer speed and power benefits.
This research focuses on the simulation of a mechanical memory non-volatile cell using a bistable buckle beam structure.
The goal of this research is to determine how much Lorentz force is required to actuate the beam and determine the switching time.

The proposed memory cell achieves two stable positions through Lorentz force actuation. By applying a current to the beam, it can be actuated in both upward and downward positions. Simulations were conducted using the software CoventorWare. However, due to limitations in simulating the magnetic field, only mechanical simulations were performed. Despite this limitation, critical parameters such as the magnetic field, pressure, and area, current were successfully determined.

The actuation threshold for the beam was established by applying a constant pressure of 11 kPa (equivalent to 5.5 mA current). Through transient mechanical simulations spanning 400 ns, the switching time of the device was determined to be 100 ns.

In conclusion, it was found that a current of 5.5 mA is sufficient for actuating the beam, the beam's actuation time of 100 ns outperforms conventional flash memory significantly, making it a faster and more energy-efficient alternative."

Parallel G40

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Title: **Electrical Characterization of Dielectric Films**
Abstract: The characteristics of dielectric thin films have been studied to improve the performance and sizing of semiconductor devices, especially Metal–Oxide–Semiconductor Field Effect Transistors (MOSFETs). The MOSFET switches the current flow by inversion on the semiconductor surface as applied voltage across the MOS capacitor. The MOS capacitor is the heart of the MOSFET, because the operation and characterization are dependent on this inversion. MOS capacitors, consisting of an aluminum electrode, a dielectric film of various materials, and a n-type silicon substrate body, were made by a simple process: 30-50 nm dielectric film (silicon dioxide, aluminum oxide, zirconium dioxide) was formed on the n-type silicon wafer, then 200 nm of aluminum was deposited through a shadow mask. Various tools were used to deposit dielectric films, including High-Density Plasma Chemical Vapor Deposition (HDP-CVD), evaporators, thermal oxidation, and Atomic Layer Deposition (ALD). The fabricated devices were evaluated by measuring and analyzing Capacitance-Voltage (C-V) characteristics at some frequency. The minimum voltage required to create an inversion layer, called threshold voltage, is one of the most important parameters that can be given from the C-V curve. We compared the differences in deposition tools and materials, then discussed which is the best to fabricate MOS capacitors. Parallel

G41
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Title: **Crystal Growth of Ce2Ge2Mg**
Abstract: A quantum spin liquid (QSL) is a phase of matter that is formed from antiferromagnetic interactions of magnetic spins in a material; it is a superposition of all possible spin singlet configurations. It is predicted that a Shastry-Sutherland Lattice (SSL), where magnetic ions sit in orthogonal pairs, can host QSLs. Ce2Ge2Mg is a material where magnetic Ce ions sit on a SSL. We wanted to make Ce2Ge2Mg by the flux method for crystal growth where Mg is the flux, and then study this material to see how the SSL can be related to QSLs. Crystal material was made through the flux method, but they were not the desired material Ce2Ge2Mg.

Parallel G42
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Title: **Wafer-Scale Fabrication of Single-Domain Magnetic Nanostructures**
Abstract: Single-domain magnets are critical to the development of untethered micromachines, and to achieve single-domain behavior, these magnets must have a width of under 100 nanometers. We have developed a process to fabricate these magnets utilizing Deep Ultraviolet (DUV) lithography as a more accessible alternative to the current time and cost-consuming electron beam lithography process. Through precise etching of chromium on quartz photomasks, we can produce phase-shift photomasks with a 180-degree phase-shift, allowing for greater pitch density and depth of focus. Further improvements to the feature width in photoresist can be made by optimizing parameters on the ASML DUV Stepper. Our process successfully produced features with a range of widths under the 100 nm threshold. Additionally, we characterized the necessary conditions to achieve pitches ranging from 400 to 300 nm and to have control over the spacing between features.

Parallel H43

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Title: **Probing the impact of nanofabrication on transport properties of thin-film lithium niobate device interfaces**

Abstract: While bulk Lithium Niobate (LN) has been a widely used and studied material platform for photonic devices for decades, its electrical properties as a thin film remain understudied. In this project we investigated the electrical properties of the LN-metal electrode interface to understand how each of our nanofabrication processing steps impact electro-optic device performance. To characterize our devices, we took 2-probe current-voltage measurements using a semiconductor device analyzer. By modeling the equivalent circuit, we extracted information about the resistance, surface and bulk conductivity, and the Schottky barrier of our samples. Our initial findings confirm expectations that chemical and physical etches tend to increase surface conductivity while annealing decreases the observed current. Combined with electro-optic response measurements taken on LN photonic devices in our group, we are able to point to specific interface properties that positively or negatively impact device performance. These measurements, combined with techniques to measure material defect densities, will provide key insight into the structure-processing-property relationships of nanofabricated electro-optic devices in thin-film Lithium Niobate.

Parallel H44

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Title: **"'In-Situ' Gallium Etching of Bulk Gallium Oxide Substrates"**

Abstract: Ultra-wide bandgap semiconductors have many advantages in power electronics for use in high power-switching applications and energy conservation in power systems. Materials with large bandgaps typically have difficulties associated with their use, which can be overcome through the study and observation of various material properties. Gallium oxide (Ga2O¬3) is an up-and-coming semiconductor material being investigated for its potential superior performance in comparison to the most frequently used materials. Typically, this material is doped with silicon impurities to improve conduction within the material, however, having the appropriate concentration is important for proper use of the material. The etching process used with gallium oxide does not affect the silicon, so we determined what happened to these atoms post-etch. We believed that the dopant atoms built up on the surfaces after undergoing 'in-situ' gallium etching. This was investigated through the fabrication of Schottky diodes, which are metal-semiconductor contacts, that allow for various material parameters to be determined. We will discuss this fabrication process and interpret the results, providing meaning and insight for future research.

Parallel H45

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Title: **Computational Analysis of Hybrid Perovskites**

Abstract: Due to their extreme versatility and varied applicability hybrid perovskites are of particular interest to the materials science community. An effective method of analyzing these structures is density functional theory, which is capable of measuring complex interactions and properties within chosen molecular systems. The optimal combination of exchange correlations and dispersion corrections within density functional theory for hybrid perovskite compositions is

not currently known, but its discovery is the aim of this project. The computations performed during the course of this project used a number of different exchange correlations in conjunction with dispersion corrections and measured their effect on perovskite compositions to gain a better understanding of their impact on geometry. Despite this, in the ten weeks of data collection, no clear conclusion could be drawn regarding the proficiency of the density functionals regarding their predictions of perovskite geometry. However, all tested density functionals and dispersion corrections successfully performed calculations that provided useful information and near accurate predictions of experimental compositions geometry.

Parallel H46

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Title: **Characterizing Phase Transitions and Thermal Responses in DNA-coated Gold Nanoparticles**

Abstract: For colloidal materials in liquids, solvent composition influences the conformations and aggregation of macromolecules. Such factors strongly affect the material properties of DNA-functionalized gold nanoparticles (DNA-AuNPs), which either remain dispersed or aggregate into colloidal crystals, depending on the salt concentration in the solution. Furthermore, these colloidal crystals exhibit a phase transition from face-centered cubic to (FCC) to body-centered cubic (BCC) structures, as the salinity of the surrounding solution increases as well as differing thermal expansion properties at variable salt concentrations. In this study, we report on various properties of these nanoparticles that have not been well characterized previously.

Similar to previous studies, the DNA-AuNPs exhibit FCC structures at low salts and BCC structures at high salts. The transition concentration was determined, and notably, the structure at these concentrations does not seem to be a mixture of FCC and BCC. Rather the particles seem to pass through a distorted intermediate phase. Thermal properties of the nanoparticles are also quite notable, and the nanoparticles seem to exhibit positive thermal expansion at low salt concentrations and negative thermal expansion at high salt concentrations, meaning the system overall exhibits switchable thermal expansion properties. This work has implications for the design of stimuli-responsive nanotechnologies.

Parallel H47

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Title: **Rationale design of anti-biofouling superelastic stent**

Abstract: Medical devices implanted in the body must withstand the foreign body response, risking bacterial infection, blood clotting, or device malfunction. To address these challenges, we propose a drug-eluting stent incorporating a slippery liquid-infused porous surface (SLIPS) onto a TiNi stent. This alloy's unique superelastic properties enables it to deform during surgery, while promptly returning to its original shape after deployment. Such manipulability makes this an ideal candidate for medical devices that may be inserted via minimally invasive techniques in various applications such as brain aneurysms, heart stents, and more.

The coating comprises a multilayer nanoparticle system, creating a highly porous matrix. Subsequently, the pores are infused with a biocompatible lubricant, allowing it to repel various pathogens, microorganisms, and cellular debris. Our work demonstrates the conformal adherence of the SLIPS coating on TiNi substrates, showcases extreme omniphobic repellency, and mechanical stability under various loading conditions. The system proposed has a range of applications to reduce infection risk post-surgery, increase the patency of the device, and improve conduit flow. Moreover, the TiNi-SLIPS

coated devices can be drug-loadable allowing for a plethora of treatments to be administered such as antibiotics, anti-inflammatory drugs, or even cancer treatment small molecules.

Parallel H48

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Title: **New sorbent platforms for humidity-swing direct air capture**

Abstract: Global warming dramatically impacts our ecosystems and communities, impacting water and food resources, human health, and the environment. This work aims to investigate various materials that can be used for carbon capture via moisture-swing processes. By using humidity changes to facilitate carbon dioxide (CO2) release, the process avoids the need for drastic temperature changes and significant amounts of energy. Our goal is to find new materials that are more efficient, cost-effective, and synergistic with other types of CO2 capture and conversion. Here, we test various novel moisture-driven CO2 sorbents, which selectively capture CO2 under dry conditions and release it under wet conditions. The tuning of humidity promotes the at-will adsorption and desorption of CO2, allowing for the repeated use of the sorbent material over multiple cycles. We use microscopy and spectrometry techniques to characterize our synthesized materials. This study presents new sorbent platforms that exhibit moisture-swing effects, allowing further investigation and comparison with other materials for the purpose of large-scale carbon capture.

Parallel I49

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Title: **Fast Pump-Probe Data Acquisition Using Voice-Coil Actuators**

Abstract: "Hybrid-perovskites have garnered tremendous attention due to their immense potential in solar cells and optoelectronic devices. Recently, new quantum emission properties, namely superfluorescence have been reported on these materials. To study the characteristics of this emission, pump-probe techniques need to be utilized. Current techniques, however, are slow and time-consuming, making it difficult to gather a significant amount of data. This is because time delay adjustments between pump-probe pulses are made using slow mechanical delay stages where each data point is taken by waiting for the movement of the stage. To address this issue, we present a high-speed oscillating device designed to introduce a variable delay between optical pulses, essential for conducting precise optical investigations to study superfluorescence. The device guarantees firm locking of mounted optics equipment, preventing unintended rotations, and offering accurate delay adjustments. This enables real-time study of the effects of laser irradiation on hybrid-perovskites, resulting in a deeper understanding of their superfluorescence emission behavior. A comparative study with traditional methods showcases the device's enhanced capabilities, offering faster data collection. This groundbreaking development opens new avenues for exploring ultrafast dynamics and light-matter interactions, ultimately advancing optical research, and propelling the future of hybrid-perovskite-based technologies."

Parallel I50

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Title: **Barite in amygdules and veins in pseudotachylite from the Iktertôq shear zone, western Greenland**

Abstract: Pseudotachylite is a dark, aphanitic rock that forms due to high-velocity frictional sliding on the surface on faults during earthquakes. Pseudotachylite from western Greenland includes barite $BaSO_4$ in amygdules and veins. Since barite is not present in the host rock, and Ba is present only in trace quantities (<2700 ppm), the objective of this study was to determine the source of barite in the pseudotachylite. A XRD and SEM/FE-SEM with EDS were used to examine the chemistry of both the host rock gneiss and pseudotachylite, using NNCI facilities at Montana State and Virginia Tech; whole-rock XRF data was available from previous work, and EPMA was used at Concord University. An average of 796 ppm of Ba has been found in pseudotachylite samples compared to 1083 ppm in gneiss samples, according to previous XRF data. The atomic weight of barite in pseudotachylite amygdules was determined to be 55% of the ideal atomic weight on average, producing a chemical formula of $Ba_{0.55}S_{0.55}O_{2.20}$. Barium is a trace element in feldspar of the host rock, suggesting that it is at least one source of barium in the pseudotachylite.

Parallel I51

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Title: **Characterization of Hybrid Thin-Films Deposited by Resonant Infrared Matrix-Assisted Pulsed Laser Evaporation (RIR-MAPLE)**

Abstract: "Hybrid perovskite materials combine organic and inorganic semiconductor strengths. Using RIR-Maple, we aimed to achieve a vertically oriented passivation layer for a hybrid perovskite active region with Phenylethylene lead Iodide $(PEA)_2PbI_4$. This structure enhances energy conduction, charge transfer, and collection in solar cells. Phosphonic acids (PAs) serve as interfacial modifiers, altering the substrate surface to facilitate the desired orientation. Characterization efforts focused on RIR-MAPLE deposition onto PA-treated substrates, exploring the relationship between the technique and phosphonic acid presence. These characterizations provide valuable data on the RIR-MAPLE deposition technique. Though a significant amount of data was gathered on the connection between RIR-MAPLE and PA's presence, it did not yield a definitive answer regarding the induction of vertical oriented growth. Nonetheless, no adverse side effects from PA treatment were observed. "

Parallel I52

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Title: **Formulate ECM-Targeting Peptides as a Prophylaxis for the Treatment of TBI**

Abstract: Traumatic brain injury (TBI) is termed a ‘silent epidemic,’ annually affecting 85 million people worldwide. It is a leading cause of mortality and morbidity in children, teens, and active adults. TBI can lead to acute and potentially long-term neurological impairments. Despite the prevalence and associated complications, there are no effective treatments for TBI due to poor pharmacokinetics. Following primary injury, the blood brain barrier (BBB) is transiently dysregulated, allowing for passive accumulation of nanomaterials in the injured brain. However, these materials are rapidly cleared. The brain extracellular matrix (ECM) provides structural support and modulates intercellular communication in the brain. Following TBI, dynamic changes occur to the ECM, such as the upregulation of tenascin-C, which can therefore be leveraged as a specific target for TBI. CAQK, a short-length peptide, has been shown to target tenascin-C and has therapeutic properties which promote better histological outcomes after TBI. But this peptide has low retention and subsequent clearance from the body. For this reason, this project aims to synthesize a nanoformulation to target the ECM, increase the peptide blood half-life, and potentially form a prophylactic treatment. The targeting efficacy of this TBI prophylaxis will be evaluated through fluorescent microscopy neuroimaging.

Parallel I53

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Title: **Mineralogy of Carbonate Amygdules in Pseudotachylyte from the Ikertôq Shear Zone, Greenland**

Abstract: This study aims to increase understanding of pseudotachylytes from the Ikertôq Shear Zone, Greenland by documenting mineralogy of 10 micrometer, spheroidal amygdules. Pseudotachylyte is a solidified frictional melt generated by earthquakes during sliding and comminution along fault surfaces. One characteristic feature of pseudotachylytes are amygdules, a vesicle that is later filled with multiple mineral phases from mineral-rich fluid and vapor phases. This study will further explore the amygdules' mineralogy and work to identify the mineral phases in them. To characterize the mineralogy, we used NNCI facilities (EDS with FE-SEM, SEM, and EPMA, as well as EBSD with SEM, and petrographic microscopes) at Virginia Tech, Concord University, and Montana State to map amygdule chemical composition, determine mineral phases, and image morphology. Amygdules seem to overprint other features in the pseudotachylyte. The majority of amygdules are magnesium and iron rich carbonates such as calcite, dolomite, ankerite, and siderite with localized grains of quartz and iron sulfide on the rims. This shows that carbonate-rich fluid and vapor phases diffused through the pseudotachylyte depositing these phases in open vesicles.

Parallel I54

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Title: **Characterization of Evoked Signal Propagation Patterns in Nano-directed Neuritie Networks**

Abstract: Neurons grown in vitro are commonly used to accelerate testing of neuronal systems. A central detriment of neuronal cultures arises from the lack of native brain structure, instead exhibiting random wiring. To alleviate these issues, patterning of in vitro neuronal tissue allows for guided circuits that can replicate brain regions. Magnetic nanoparticle technologies have shown the ability to guide neuronal projections, thus we hypothesize this method can be used to structure the functional network of neurons in vitro. To test this hypothesis, we incubated magnetic nanoparticles to in vitro cortical neuron cultures for 24 hours and grew the cultures with a uniform and non-uniform magnetic field for 10 days over a microelectrode array. Cultures grown within the uniform magnetic field presented an increase in neuronal spikes detected over a microelectrode array, with respect to the uninfluenced growth of control cultures. In contrast, cultures grown in the nonuniform magnetic field exhibited a decrease in signaling events respective to uncontrolled growth. We expect that magnetic field direction and magnitude play an essential role in growth, which results in these shifts in activity. We expect this technology can provide optimized in vitro growth for neuronal testing.

Parallel J55

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Title: **Electrical Interconnects Based on Delafossite Thin Films**

Abstract: The dramatic increase in the resistivity of 3-dimensional metal interconnects with decreasing dimensions presents a significant bottleneck for further downscaling of integrated circuits. This rise in resistivity is due to increased interface electron scattering as the interconnect dimensions approach their electron mean free path. Metallic delafossite oxides, specifically $PtCoO2$ and $PdCoO2$, are an alternative solution due to their Quasi-2D nature which mitigates interface electron scattering due to a 2D Fermi surface. Synthesis of high-quality, single-crystal delafossite thin films has been

previously demonstrated by Molecular Beam Epitaxy (MBE). However, the challenge remains to demonstrate similarly high-quality growth with a back-end-of-the-line (BEOL) synthesis technique such as atomic layer deposition (ALD).
To realize the high-quality, single-crystal ALD synthesis of PtCoO2, we need to develop a ternary ALD process consisting of PtO and CoxOy binary cycles with overlapping processing conditions. In this study, we will present on the development of the CoxOy binary cycles under favorable conditions for ternary PtCoO2 growth. We optimized CoxOy growth with respect to temperature, Co-pulse length, O3 exposure time, purging conditions, adhesion layer, and the number of cycles. We characterized the growth with ellipsometry, and resistivity measurements.

Parallel J56

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Title: **Laser-Driven Microrobots for Microscale Manipulation**

Abstract: As the concept of micro-factories has developed, a need to address how to transport microscale materials efficiently and reliably between two points has risen. In this study, we propose a new approach to realize the transport of microscopic objects utilizing a silicon microrobot smaller than 1 mm called Serpenbot. Serpenbot is a laser-driven MEMS robot designed to operate in dry environments. Its design consists of 2 serpentine-like actuators in tandem with its legs, which drive the robot when irradiated by laser light. The propulsion generated is based on opto-thermal-mechanical coupling. The steering control is executed by selective irradiation of the actuators. Serpenbot's locomotion is observed with a custom automated system that enables pulse laser irradiation control, tracking of the robot, monitoring, and recording its behavior. As a part of our project, we have focused on the Serpenbot's motion characteristics and their dependence on the laser parameters, which involved driving the microrobot at different linear velocities along trajectories of various shapes – circular, rectangular, etc. The instantaneous velocity typically ranges from 10~110 microns per second. In the next phase, we investigated different methods for transporting microscale objects of different shapes and sizes with the help of Serpenbot.

Parallel J57

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Title: **Michael Sassa**

Abstract: When it comes to manufacturing involving custom die-level packaging, traditional wire bonding can be significantly challenging. In this study, we propose an alternative low-cost packaging method utilizing inkjet and aerosol printing to produce functional successful interconnects on custom packages: silicon dies assembled on PCB. Our approach involves manufacturing the multilayer structure with insulating and conducting layer, printed using inkjet and aerosol jet techniques, respectively. First, we conducted characterization of the UV adhesive deposition, with the help of Nordson EFD Pico Pulse inkjet printer, in order to obtain the optimal parameters necessary for the fabrication of an insulating layer with a width of around 600 microns. The silver conducting layer is printed using OPTOMEC Decathlon aerosol jet printer, which forms structures with features as small as 20 microns with high precision on surfaces with more complex geometries. After the fabrication, our structures were tested for conductivity. Based on our results, we plan to optimize the manufacturing process to ensure the successful realization of the proposed packaging method. In the future, our approach could be efficiently utilized to connect various electronic components on complex substrates, including traditional and flexible PCBs.

Parallel J58
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Title: **Characterization and Growth of GeO2 Thin Films Via Solid Phase Epitaxy**
Abstract: Quartz is commonly used in crystal oscillators to stabilize the frequency of carrier waves sent and received by radio transmitters and receivers. GeO2 is a viable alternative as it can be crystallized into a quartz structure while also exhibiting improved piezoelectric properties. GeO2 thin films were grown via solid phase epitaxy on X, Y, and Z cut quartz substrates using reactive DC sputtering followed by annealing. The X-ray diffraction peaks from the X and Y cut films indicate epitaxial growth of GeO2 while the Z cut suggests the formation of additional phases in its structure. Surface morphology features and roughness were measured using Atomic Force Microscopy on a 2-micron scan window for each sample. Both the X and Y cut films exhibit a higher piezoelectric response than their respective base substrates, as evidenced by the sensitivity in deformation when subject to an applied voltage. These results highlight the potential of GeO2 as a promising material in the development of high-frequency components within the telecommunication industry. Further research is required to optimize the growth conditions of GeO2 thin films on Y and Z-cut quartz and to better understand how crystal orientation influences the piezoelectric response of the films.

Parallel J59
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Title: **Direct On-Chip Printing of Hybrid Perovskite Single Crystals for Photodetection Devices**
Abstract: Hybrid perovskites have unique semiconductor properties, such as a tunable band gap and light detection, that are valuable in optoelectronic devices. The use of single crystals in such applications increases uniformity and reduces defects during growth, unlike the commonly used perovskite thin films. A time-efficient, high-quality, and precise method for making hybrid perovskite single crystals is shown and optimized here. Three compositions of hybrid perovskites; MAPbBr3, MAPbCl3, and CsPbBr3 are printed directly on patterned substrates using a cosolvent evaporation strategy at room temperature within minutes. Each solution is engineered to give the highest yield of single crystals by optimizing the ratio of solvents. The crystals are then tested with a probe to measure the current-voltage characteristics of each composition in the dark and with a yellow light. This is used to measure the quality of the crystals as photodetection devices for visible light. In measuring current in the light and reading no current in the dark, these crystals act as semiconductors in preliminary photodetection devices. This result opens up the opportunity for the testing of a wide range of compositions and the incorporation of these crystals and production methods for a real photodetector device.

Parallel J60
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Title: **Material Characterization of Reused Pipette Tips**
Abstract: Pipette tips are plastic cone shaped lab consumables typically attached to pipettes for measuring liquid. Pipette tips are utilized as single use items, which contributes to plastic waste. A single scientific lab produces about 5.5 million tons of plastic waste yearly. Our solution for this problem is the reuse of pipette tips via a washing process. During the washing process there is a possibility that the silicon coating inside the pipette tip can degrade due to UV light, heat, and sonication. To understand the extent of the degradation, the silicon coating needs to be exposed through a deconstruction

process. Contact angle goniometer and Raman Spectroscopy were used to test the differences of hydrophobicity and chemical composition between washed and new pipette tips. These experiments will characterize material and verify degradation to the silicon coating. Due to the challenges of the necessary deconstruction method, variations between sample pipette tips both washed and new created inconsistencies within Raman Spectroscopy. Material characterization of pipette tips relies on the deconstruction method required to expose the inner surface. Future work aims to solidify a uniformed procedure to better produce reliable data.

Parallel K61

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Title: **Surface Texturing of Solar Cells**

Abstract: Light reflectance poses a problem for maximizing solar cell efficiency by reducing photon absorption within the silicon, thus decreasing power output. Several techniques have been developed on a commercial scale to solve this problem, including creating anti-reflective coatings and surface texturing of silicon. This project focused on adapting large scale methods of surface texturing to the process steps of EELE 508, a weeklong lab based solar cell fabrication course. Experimentation focused on developing a fast and effective texturing process to meet the constraints of this class through maskless wet etching of (100) oriented silicon wafers to create nanoscale pyramid-like structures on the wafer surface. The two etchants used were Potassium Hydroxide (KOH) and Tetramethylammonium Hydroxide (TMAH). Many parameters of the etching solutions were varied, including time, temperature and etchant concentration. Finally, an effective process was developed using TMAH that can consistently produce uniformly textured silicon wafers with reflectance less than 5% for use in small scale solar cell fabrication.

Parallel K62

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Title: **Machine Learning as an Efficient Tool for Simulating Potential Energy and HOMO-LUMO Band Gap of 2D Hybrid Perovskite Materials**

Abstract: ""Density Functional Theory (DFT) is a highly accurate computational method for simulating hybrid organic-inorganic perovskite materials (HOIPs), but it demands significant computational resources for longer simulations. To address this limitation, machine learning could provide a faster and more efficient method to simulate larger systems with minimal compromise on accuracy. In this study, we train a deep neural-network potential with DeepMD [1] infrastructure. Subsequently, we transfer the learned potential to perform molecular dynamics using Lammps [2] with 8 times replication and a longer timescale. The obtained output is then used as an input to train a surrogate model for predicting the frontier orbital energy levels and the HOMO-LUMO gap. Additionally, we examine the interdependence of different structural features that affect the band gap. These methods enable the analysis of a larger system with a longer simulation time than is feasible with DFT."

[1] https://doi.org/10.48550/arXiv.1712.03641
[2] A. Stukowski, Modelling. Simul. Mater. Sci. Eng. 18, 015012 (2010)"

Parallel K63

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Title: **Solar Cell Saunas: Low temperature atomic layer deposition of alumina onto perovskite solar cells**
Abstract: Perovskite solar cells (PSCs) have shown promise over the last decade, rising in power conversion efficiency (PCE) from 6 to over 26%, comparable with traditional silicon cells. Despite their low cost, straightforward manufacture process, PSCs have failed to reach the general market due to their sensitivity to heat, humidity, and light. We investigated the low temperature atomic layer deposition (ALD) of aluminum oxide to attenuate PSC degradation. We developed the ability to deposit on cells at 70C. We evaluated two reference cells, a 200 cycle ALD cell, and a 400 cycle ALD cell. The treated cells saw a respective 2.5% and 1.5% decrease in PCE after the treatment. They showed comparable stability under maximum power point tracking in 65C, 60% humidity, under 1 sun illumination, outperforming the reference cells within 5 hours. The treated cells maintained up to 70% performance after 72h. Atomic layer deposition of alumina is effective in increasing perovskite solar cell stability, and could be critical to the technology's wide scale adoption.

Parallel K64

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Title: **Effects of Annealing on Copper Surface and Corrosion**
Abstract: "Corrosion incurs an annual cost of US $2.5 trillion globally, affecting diverse industries and consumer applications. Copper and copper-based metals contribute 5-10% to this expense. Addressing this challenge presents opportunities for substantial cost savings through corrosion prevention. This study focuses on the potential of annealing Cu coupons to slow down their corrosion. Annealing relieves strain in the crystal lattice introduced by metallurgical processes and produces new grains and grain boundaries. This reduced strain is hypothesized to result in lower corrosion rates of copper. Copper coupons were finely polished before being annealed and ultimately exposed to a corrosive environment composed of sodium pyruvate solution, chosen for its known corrosive properties and relevance to microbially influenced corrosion. Before and after each step, well defined areas on the coupons were analyzed with a variety of techniques that I was trained on, including optical microscopy, scanning electron microscopy(SEM), electron backscatter diffraction(EBSD), atomic force microscopy(AFM), energy dispersive x-ray spectroscopy(EDS), and time of flight mass spectrometry (ToF-SIMS). Experimental observations suggest that the annealed coupon exhibited lower corrosion compared to the unannealed coupon. This finding supports the hypothesis that annealing reduces copper's susceptibility to corrosion."

Parallel K65

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Title: **Exploring P-Type Molecular Doping of Hybrid Perovskites Using Mo(tfdCOCF3)3**
Abstract: Halide perovskite semiconductors are under rigorous study for their potential as a low-cost semiconductor alternative to current commercial photovoltaic technology in thin film optoelectronic devices. Introducing impurities in the lattice through electrical doping creates tunable physical and chemical properties and may impact the long-term stability of the perovskites. In this work, we demonstrate p-doping of MAPbI3 films using the molecular dopant Mo(tfdCOCF3). Film deposition for the MAPbI3 (MA = CH3NH3+) perovskite system is first optimized by varying the preparation of spin-cast MAPbI3 films using mole ratios of 1:1 and 1.05:1 between MAI and PbI2, preparing the films with and without chlorobenzene antisolvent treatment deposited from 3s to 60s, and by annealing at 90°C-120°C for 5-20 min.

Powder X-ray diffraction (PXRD), optical microscopy, and scanning electron microscopy (SEM) results characterize the film morphology, showing significant variation in film uniformity and proving the importance of the antisolvent approach and annealing in optimizing film performance. Hall measurements on preliminary Hall bar devices created using the optimized perovskite film with and without the Mo(tfdCOCF3)3 dopant show generally inconsistent signals, underlining the need for further work in optimizing Hall bar device fabrication.

Parallel K66

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Title: **Annealing Temperature Dependency of Doped P3HT Conductivity**

Abstract: The performance optimization of conducting polymers is crucial for their widespread use in organic electronic devices, mainly having applications in organic field effect transistors. In this study, we investigate the effects of annealing temperature on sample conductivity with different layer compositions. The system is composed of P3HT (Poly(3-hexylthiophene)) doped with F4TCNQ (2,3,5,6-Tetrafluoro-7,7,8,8-tetracyanoquinodimenthane), a strong electron-accepting p-dopant with a deep LUMO level. To understand the impact of annealing temperature, the samples are systematically left to soak at 60, 80, 100, and 120 °C for ten minutes. Atomic force microscopy results show that the annealing temperature significantly alters the morphological structure of each sample, improving or degrading the crystalline structure of the P3HT. Furthermore, we find that the optical absorption and electrical conductivity can be greatly enhanced by the proper annealing conditions. This study illustrates the importance of device fabrication parameters, which is ever important if conducting polymers are to be a contender against silicon in current electronic devices.

Parallel L67

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Title: **Measurement of Thin Film Stress for 2D and 3D Metal Halide Perovskites**

Abstract: The comprehension of perovskite degradation and stress responses under real-world conditions is crucial for designing efficient and stable photovoltaic devices. To achieve this, testing was done in an in-situ stress testing system, enabling the assessment of sample stress under operational conditions, including cycles of sunlight exposure as well as a heat-only source. The immediate stress response provides meaningful observations into the factors that directly contribute to perovskite solar cell degradation. In this experiment, testing and characterization are conducted on 2D and 3D metal halide perovskites. The findings reveal that degradation-inducing stress is primarily due to heat.

Parallel L68

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Title: **The Role of Countercations on the Assembly of Preyssler-type Polyoxometalate**

Abstract: Polyoxometalate (POM) is early transition metals oxide that is mainly composed of V, Nb, Ta, Mo, or W. POM can be used as a building block to make functional frameworks. The POM can be assembled into an extended structure using anionic POM and the cationic metals as bridging cations. The presence of non-bridging potassium cation has a significant impact on the assembly of Preyssler-typed POM [NaP5W30O110]14- with silver bridging ion. Different silver

bridged Preyssler framework are formed based on the amount of potassium ion in the solution. These compounds will be prepared by varying the potassium to silver ratio when the Preyssler cluster is present. The rate of formation of these different compounds will be monitored by observing the time required to form crystals. The different crystal compounds will be characterized using Powder X-Ray Diffraction (PXRD) and Infrared Spectroscopy (IR).

Parallel L69

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Title: **Analyzing Twisted Bilayer Graphene Using Scanning Microscopy**

Abstract: Graphene is a 2-D nano-materials with hexagonal lattices that have shown results in possibly being used in atomically thin transistors and sensors and other nano-electronic devices. To evaluate the surface potential for these materials, it is necessary to use microscopy through electrostatic force microscopy (EFM) and atomic force microscopy (AFM). These methods will allow for faster scanning rates, accurate surface morphology measurements, high stability, and precision up to 100 nm from the surface. We will utilize these methods to evaluate twisted graphene on boron nitride.

Parallel L70

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Title: **Dispersion of Boron Nitride Nano Tubes (BNNTs) in Organic Solvents**

Abstract: Boron nitride nanotubes (BNNTs) have garnered considerable attention due to their remarkable properties which have led to an increase in studies over the years. Similar to carbon nanotubes (CNTs), BNNTs have distinctive structural, mechanical, and electric characteristics, but unlike CNTs which are conductive or semiconductive based on their chirality, BNNTS have insulating qualities which allow them to have a variety of applications from aerospace to biomedical applications. However, because of their chemical structure BNNTs are hydrophobic and insoluble, presenting a challenge for the fabrication of macroscopic materials. To fully exploit their unique properties, several purification methods are necessary to eliminate impurities and obtain pure BNNTs. This research focuses on dispersing BNNT fibers in four solvents (Ethanol, Hexane, Isopropyl Alcohol, Methane) and three surfactant solutions (Alconox solution, Sodium Dodecyl sulfate solution, and Triton X-100 solution), each at different concentrations of 10μg/mL, 100μg/mL, and 1mg/mL. The solvents were compared based on the quantity and quality of dispersed BNNTs, as quantified by SEM, AFM, and Raman spectroscopy. All seven solvents resulted in the dispersion of individualized tubes or small bundles of BNNTs but at varied quantities. Future work consists of optimizing the dispersions employing temperature, deposition techniques, and other solvents.

Parallel L71

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Title: **Structure-Property Relationships for Material Extrusion 3D-Printing of Stainless-Steel for Orthopedic Applications**

Abstract: "Conventional methods for manufacturing orthopedic implants cannot replicate human bone's structural and mechanical properties. The mismatch of these properties stresses the implant area, which can cause inflammation and stability loss during implant integration. This project aims to use material extrusion 3D-printing of 316L stainless steel to create 25, 50, and 100% infilled test coupons, and their designs had a solid fill on the circumference while having porosity on the inside. This style of infill pattern and its variation was performed to mimic a bone structure and hypothesize that such structures can enable designing structures with mechanical properties similar to that of human bone. This structure design and process combination was performed to break the current pattern of structure-property-manufacturing tradeoff in implant design. In order to compare the mechanical properties of the 3D-printed stainless-steel parts to human bone, the flexural and tensile strength of sample parts of various infill densities were measured using three-point bend and tensile testing. As a case study, a human femur bone model was designed and 3D-printed to identify the feasibility of the material extrusion 3D-printing process to print such structures. "

Parallel L72

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Title: **Synthesizing Novel Polysulfones For Light Mediated Catalyst Delivery**

Abstract: Few efficient methods are available for the energy recovery of polybutadiene-containing materials, and even fewer that involve chemical depolymerization as a means of recycling. As depolymerizing agents for polybutadiene do exist, the controlled release of such catalysts must be coupled with materials with multifaceted properties, such as high glass transition temperatures, high rigidity, as well as an effective catalyst delivery method. A most prospective candidate for this task are polysulfone segmented block copolymers with hard and soft segments that induce nanoscale phase separation. Polysulfone-containing block copolymers demonstrate promising rigidity and morphological behavior when containing polyester segments. The addition of photocleavable monomers including cyclobutanedianhydride-aminophenol-imide (CBDA-AP-I), provides an advantage for a low-energy input (in the form of UV light) in order to initiate controlled release of a depolymerizing Grubbs catalyst. The nucleophilic aromatic substitution of 4,4'-dichlorodiphenyl sulfone (DCDPS) using Bisphenol-A (BPA) and CBDA-AP-I as monomers synthesizes an excellent precursor polysulfone. Subsequent ring opening of ethylene carbonate activates the polysulfone for melt transesterification. Dimethyl adipate and polyethylene glycol (PEG) serve as a flexible polyester soft segment that results in rapid release of the depolymerization catalyst when photocleaved.

Parallel M73

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Title: **Exploring the Role of Antioxidant Nanoparticles as a Potential Therapeutic Agent in the Battle Against Oxidative Stress and Astrocytic Damage in Traumatic Brain Injury**

Abstract: Traumatic brain injury (TBI) is a leading cause of injury related morbidity and mortality. Following impact, biochemical changes including oxidative stress, contribute to a spread of secondary damage. Currently, there are no clinically approved therapeutics for treating this secondary injury, however, nanoparticles (NPs) may have potential as a therapeutic strategy. Indeed, NPs have been shown to accumulate in the injured brain and can be designed to combat harmful oxidants, including reactive oxygen species (ROS) and lipid peroxidation products (LPOx). Therefore, our project goal focused on evaluating the therapeutic efficacy of neuroprotective copolymers (NPCs) in alleviating secondary damage. We utilized a controlled cortical impact (CCI) model to examine acute biochemical changes following impact. Immediately post-CCI, NPCs were injected intravenously (8 mg/kg) and brains from 8-week-old male C57BL/6J mice

(N=3/group) were harvested at 1, 3, and 7 days post injury. Samples were prepared for Western blot to examine markers associated with astrocyte damage and antioxidant defense, including glial acidic fibrillary protein (GFAP) breakdown product (GBDP) and peroxiredoxin 6 (PXRD6). Our preliminary results suggest NPCs may acutely reduce GBDP and PRDX6 expression following impact. Future work will examine the individual roles of ROS and LPOx on GBDP and PRDX6 to improve therapeutic efficacy.

Parallel M74

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Title: **Etching of Topological Metals for Interconnect**

Abstract: On-chip interconnects are electrical wiring systems that connects transistors and other components in an integrated circuit. Copper (Cu) has been our main interconnect since 1997. Over the years, the dimensions of Cu interconnects have decreased for better computing performance, and finally Cu has reached its limitations where under 15 nm of the interconnect width, signal delays and larger energy consumptions are significant due to the high resistivity of Cu interconnects stemming from surface and grain boundary scattering of electrons. In contrast, topological metals, especially molybdonem phosphite (MoP), have shown promise as our next interconnect metals owing to their topological surface states that are resistant to scattering. We convert molybdenum sulfide (MoS2) flakes to MoP by chemical vapor deposition and use electron beam and etching to create narrow nanoribbons. Four point probe measurements show the resistivity to be ___ microohm-cm, demonstrating the viability of MoP as future interconnects.

Parallel M75

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Title: **Flexible Liquid Encapsulation Platform for Preventing Hydrogel Dehydration**

Abstract: Hydrogels are water-swollen crosslinked polymer networks that exhibit as a gel-like material with biocompatibility and tunable viscoelasticity. They are widely used in various applications, including biomedicine, biomedical devices, and the food industry. However, the utility of hydrogels is limited by their susceptibility to dehydrate in ambient air. To address this, we develop a liquid encapsulation platform inspired by dehydration-resistant waxy monkey tree frogs, which in dry, hot seasons secretes an oily fluid that seals the channels and defects on their skin preventing the loss of water from the body. To mimic this, we encapsulate hydrogel scaffolds with a fluorous-based, hydrophobic polymer scaffold infused with a hydrophobic oil. The liquid encapsulation method extends the initial 60 minutes of the hydrogels observed weight loss to over 360 minutes, this is over 600% improvement. This significant improvement is due to the combination effects of small pore size of the encapsulating polymer scaffold and the extremely low diffusion of water in the hydrophobic oil, leading to the exceptionally low water transmission in the encapsulation layer. The liquid encapsulation platform presented here demonstrates tremendous potential in providing dehydration-resistant hydrogels, enabling the utility use of hydrogels in various emerging application scenarios, such as bioelectronics and soft robotics.

Parallel M76

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Title: **Handheld interface for MOSFET-embedded μ-cantilevers for biomolecular sensing applications**

Abstract: To fulfill the need for accurate, rapid, point-of-care disease screening, a nanomechanical biosensor using antibody-functionalized microcantilevers and a handheld interface to collect data from microcantilevers was developed. First, biosensors were created by functionalizing gold-coated microcantilevers with SARS-CoV-2 S1 antibodies or HIV p24 antibodies using EDC/NHS chemistry. Functionalized microcantilevers were tested on samples containing the corresponding antigen in varying concentrations and a control while recording probe deflection using fluid-AFM. The SARS-CoV-2 and HIV biosensors successfully detected the corresponding antigens, with antigen-spiked samples causing deflection over an order of magnitude greater than controls. In testing the anti-S1 functionalized microcantilever, 1ng/mL and 100ng/mL S1 antigen samples caused 7.5nm and 31.8nm of deflection, respectively, while the control caused 0.5nm. When testing the anti-p24 functionalized microcantilever, 100pg/mL and 100ng/mL p24 antigen caused 16.8nm and 51.6nm of deflection, respectively, while the control caused 1.3nm of deflection. Second, a handheld device was designed to collect data microcantilever-biosensors for disease screening in healthcare settings. The first prototype uses MOSFET-embedded cantilevers for electrical deflection measurement and is currently undergoing testing.

Parallel M77

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Title: **A Systematic Study of How Different Phases of Niobium Nitride ($Nb_xN$) React to Xenon Difluoride ($XeF_2$) Undercut Etch**

Abstract: The superconducting niobium nitride (NbN) was successfully integrated epitaxially with the III-nitride heterostructures (AlN, GaN, etc.) recently. This new technology opens the possibilities for epitaxial metal/semiconductor Schottky diodes, epitaxial gate junctions for III-nitride transistors as well as all-epitaxial bulk acoustic wave resonators. The metallic epitaxial NbN also offers a way to be selectively etched chemically, which allows the lift-off of the epilayers or devices. The NbN system is complex and presents various phases (i.e., beta, delta, epsilon, and gamma). Here in this work, by taking advantage of the high crystalline quality niobium nitride ($Nb_xN$) films grown by Molecular-Beam Epitaxy (MBE), we propose to do a conclusive study to understand the xenon difluoride ($XeF_2$) undercut etch characteristics of different phases of niobium nitride ($Nb_xN$). This study identifies the prerequisite conditions for the epilayer lift-off with a sacrificial layer of $Nb_xN$.

Parallel N78

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Title: **Growth of Ce2Ge2Mg**

Abstract: Quantum spin liquids (QSL's) are defined as a phase of matter and a superposition of all possible configurations of spin singlets. It is formed from anti-ferromagnetic spin interactions in a specific medium. Shastry-Sutherland Lattice's (SSL) are anticipated as hosts to QSL's. One way this can be analyzed is through the medium of a crystal material called Ce2Ge2Mg, where the Ce ions sit on an SSL. Over a span of two weeks, attempts at the growth of Ce2Ge2Mg through the Flux Method has been attempted. The main goal was to achieve a 2:2:1 ratio of Ce, Ge and Mg, respectively. Results demonstrate a failure at receiving the ideal ratio, however, crystal material was successfully acquired. Through the act of adjusting the initial ratios of the three materials, more samples can be made to acquire Ce2Ge2Mg in order to confirm the relationship between the SSL and QSL's.

Parallel N79

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Title: **Uncovering Ruddlesden-Popper Phase and Dion-Jacobson Phase 2D Organic-Inorganic Hybrid Perovskite Charge Transport**

Abstract: 3D perovskites are promising semiconductors used for optoelectronic device applications such as solar cells and LEDs, however exposure to moisture and environmental factors lead to poor structural stability. The use of 2D organic-inorganic hybrid perovskites and tetrazines in the 2D perovskites could show increased structural stability and potential energy transfer through smaller band gaps, often affected by lattice and solubility constraints. Ruddlesden-Popper phase perovskites have been observed to allow for charge transport, but Dion-Jacobson phase perovskites could allow for smaller band gaps and favored stability because of its decreased interlayer distance from its lack of intermolecular forces. This study shows the creation of Ruddlesden-Popper phase and Dion-Jacobson phase iodide and bromide based perovskites thin films by spin coating and methods used to grow single crystals. Characterization of thin films was completed using XRD and UV-vis absorption to view the phase and showed results surrounding possible 1D perovskite creations and double phases. This work provides data to be further analyzed for resolving crystal structure and indicates key differences between Ruddlesden-Popper phase and Dion-Jacobson phase perovskites.

Parallel N80

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Title: **Programmable stimuli-responsive shape morphing hydrogel actuators via 3D printing**

Abstract: Shape-morphing polymeric materials have garnered enduring attention across various research fields due to their significant potential in the realm of soft actuators, smart robotics and deployable devices. The crosslinked poly(N-isopropylacrylamide) (PNIPAM) is one of the most widely used stimuli-responsive hydrogels with temperature-dependent volumetric changes. Although immense studies have been reported using the crosslinked PNIPAM hydrogels, their isotropic volume changes limit their shape transformation and practical applications. In this work, 3D printed bilayer actuators comprising PNIPAM and polyacrylamide hydrogels are presented. Upon controlling the swelling and deswelling behaviors of PNIPAM by the crosslinking density and incorporation with functional additives, the actuators achieve programmable complex 3D shape transformations through temperature changes and light exposure. This approach could lead to advances in various research fields in hydrogel-based systems.

Parallel N81

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Title: **Investigation of Pd-Au Alloys for Sensing and Actuation**

Abstract: Microrobots rely on actuation and sensing as two key functions to navigate their environment. Chemomechanical actuation leverages gaseous fuels such as hydrogen to drive mechanical movement, while liquid crystals perpendicularly anchored on metal surfaces reorient to a planar surface alignment in response to hydrogen. Here, we study sputter-deposited thin films of palladium for actuation on the micron scale and liquid crystal responsive sensors. Through a photolithographic process, we fabricate a palladium-titanium bimorph hinge between two $SiO_2$ panels, one fixed while the other free to rotate, as a working microactuator device. By exposing the microhinge to gaseous hydrogen,

hydrogen diffuses into the palladium bulk and induces a phase transition from a hydrogen-poor α phase to a hydrogen rich β phase (in which the lattice parameter increases from 3.89 Å to 4.03 Å), bringing about a volumetric expansion that drives actuator bending. To promote faster actuation, we also introduce gold to create a palladium-gold alloy hinge, for the palladium-gold-hydride system facilitates a second-order phase transition with an alloy composition of 15-20% gold. Furthermore, our study reveals that sputter-deposited palladium induces surface anisotropy, observed via a preferential azimuthal direction of the liquid crystals when planarly aligned by hydrogen.

Parallel N82

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Title: **Stability and Protein Adsorption of Lipid-Coated Porous Silicon Nanoparticles**

Abstract: Porous silicon nanoparticles (PSiNP) themselves are not stable in many biologically relevant solutions such as PBS, which is commonly used in cell culture and animal studies. Bare porous silicon nanoparticles tend to adsorb proteins in vivo which decreases their blood circulation time and their ability to reach the targeted location. This is an important limitation in biological applications of PSiNP such as drug delivery. Coating the porous silicon nanoparticles in lipids could make them more stable in biologically relevant solutions. Further, increasing the ratio of PEG-lipid could decrease the amount of protein adsorbed onto the nanoparticles. This is investigated by coating the porous silicon nanoparticles with different lipid compositions. These compositions contain different ratios of DSPE-PEG:DSPC or DSPE-PEG:DMPC. DSPE-PEG referring to 1,2-distearoyl-sn-glycero-3-phosphoethanolamine-poly(ethylene glycol), DSPC referring to 1,2-distearoyl-sn-glycero-3-phosphocholine, and DMPC referring to 1,2-dimyristoyl-sn-glycero-3-phosphocholine with two saturated carbon chains of lengths 18, 18, and 14, respectively. Nanoparticles will be prepared via thin-film hydration. Particle size and zeta potential will be characterized using dynamic light scattering. Nanoparticles will be tested in different biological solutions at 37°C: PBS, DMEM, DMEM supplemented with 10% FBS, and pure FBS. Protein adsorption of each formulation will be quantified via BCA assay.

Parallel P83

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Title: **In Situ X-Ray Diffraction during Material Synthesis for Compound Discovery**

Abstract: This project analyzes the reaction of cesium tantalum sulfide with lithium iodide and how it can lead to the creation of novel compounds through ion exchange. To achieve this, a series of ion replacement reactions were performed and systematically examined using advanced x-ray diffraction techniques.

Variable temperature x-ray diffraction (VT-PXRD) was used to track X-ray diffraction in situ throughout a reaction process, leading to the identification of three possible metastable intermediate compounds. Following in-situ analysis, these compounds were isolated using conventional solid-state synthesis methods at distinct temperatures revealed by VT-PXRD. Powder X-ray Diffraction (PXRD) was then employed to comprehensively characterize the synthesized products.
While these compounds were crystallographically distinct from each other and the reactants, further testing is needed to confirm their composition and properties. This investigation paves the way for a deeper understanding of solid-state reactions and offers promising prospects for the creation of innovative materials with diverse applications.

Parallel P84

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Title: **Synthesis of Linear Carbon Chains Using Catalytic Methods**
Abstract: The objective of this research project is to develop a reliable method for synthesizing one-dimensional linear carbon chains, also known as carbynes, which will produce milligram quantities of this nanomaterial. Gold particles are deposited on a silicon substrate as a catalyst, followed by two rounds of exposure to microwave radiation in an ethanol solution. Carbynes are characterized using Raman Microscopy and Transmission Electron Microscopy techniques.
Preliminary findings demonstrate the successful synthesis of carbyne using this approach. The developed method shows promise for producing carbyne in a systematic and efficient manner. The results of this study have significant implications for nanomaterials and carbon-based materials research, offering potential advancements in these areas.
This systematic approach enables the synthesis of one-dimensional linear carbon chains and offers valuable insights into their unique properties. The anticipated impact of this research lies in the potential applications of carbyne in Carbon-based nano-electronics, energy storage, molecular wires, increasing tensile strength of other materials, and catalysis.

Parallel P85
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Title: **Establishing primary cooling phases of pseudotachylite through the examination of microlitic textures from the Ikertôq shear zone in Greenland**
Abstract: Pseudotachyiltes are fault rocks formed by friction melting during earthquakes. They appear as thin dark veins intersecting the host rock along fault planes. Microlitic textures of differing morphologies can be observed within the pseudotachylite veins. The origin of these textures might be from the primary crystalization of the pseudotachytite melt, or devitrification of the fault glass after cooling. In this study, we utilized SEM analysis at Virginia Tech and Montana State and EPMA at Concord University to characterize and categorize the microlitic and spherulitic textures to establish cross-cutting relationships and reconstruct the crystallite cooling phases within the pseudotachylites. We observed that the microlitic textures were directly related to the vein morphology. The margins of the veins were predominantly cryptocrystalline to microcrystalline; textures became increasingly larger and more complex towards the centers. Crystalites nucleated around survivor clasts within the pseudotachylite matrix, but not around minerals infilling amygdules. Based on the correlation between crystal growth and vein morphology, we conclude that the crystallite structures grew during the primary cooling of the pseudotachylite as opposed to devitrification in which we would expect homogeneous crystal growth across the vein.

Parallel P86
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Title: **Mobius Strip and the Anatomy of the heart. Art -> Science**
Abstract: "This summer, we focused on the Möbius strip and its relation to the anatomy of the heart, specifically the myocardial band's 180 twist. The Möbius strip is a fascinating mathematical concept that has found applications in various fields, including art, design, and architecture. It is a one-sided surface with only one edge and one side, formed by twisting a strip of paper or other material and joining its ends. We also explored the contraction and calcium propagation on the cardiac tissues. The mechanism and contraction events of cardiac tissues involve the release of calcium ions, which triggers muscle contraction. Understanding this process and how it relates to the Möbius strip's twisting properties can provide insights into the functioning of the heart. In addition, we cultured cells on the surface of the 3D printed mobius strip from Fiber Infused Gel (FIG) ink which provides proper cell alignment during cell culturing. We also investigated how calcium

propagation occurs on the Möbius strip through a 3D printed scaffold. The Möbius strip's 180 twist, similar to the twist of the myocardial band, was studied to understand its implications for cell contraction and calcium propagation. The idea was to bridge the gap between the artistry of the Möbius strip and the scientific understanding of cardiac muscle contraction. Cardiac muscles undergo coordinated contraction through calcium-induced calcium release conducted through aligned cardiac tissues."

Parallel P87

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Title: **Residue Formation in Dry-Develop Poly(aldehyde) Photoresist**

Abstract: The decomposition of metastable polyaldehydes with a photoacid generator can be used to design dry-develop photoresists, where the exposed film depolymerizes into small molecules to allow the development of lithographic features via controlled vaporization. This eliminates the cost, stiction, and environmental concerns associated with liquid developers used in industry today. The challenge with this resist platform is the formation of non-volatile residue after dry-development. In this research, various photoacid generators were screened and their concentrations varied to study their influence on residue formation after photopatterning with a UV direct-write lithography tool. Photoacid generators Irgacure 103 and Irgacure 121 were found to have desirable qualities with regards to residue formation, and contrast curves are presented to show their performance when incorporated into the resist formulation. These results open the way for future work in quantitative residue analysis, an important step towards advancing the use of dry-develop polyaldehyde photoresists.