ANALYTICAL RESOURCES CORE

COLORADO STATE UNIVERSITY

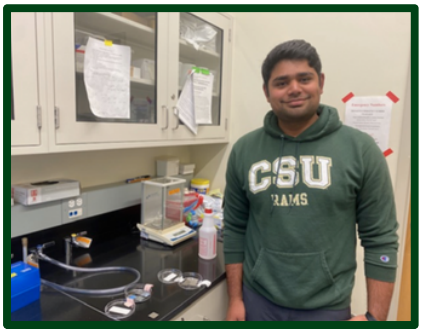
ARC MONTHLY BULLETIN

OCTOBER 2023

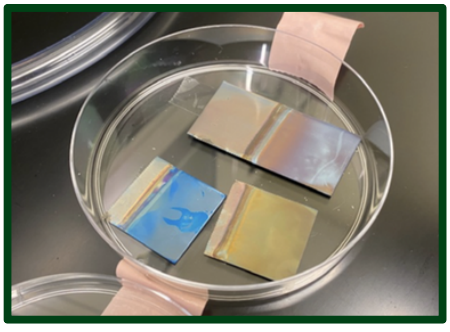
Welcome to the ARC Bulletin, a monthly newsletter to keep you informed about the latest happenings in the ARC. Here you will find information about our team, job opportunities, equipment and facilities, upcoming seminars, and other exciting news!

RESEARCH SPOTLIGHT

This month's research spotlight features Aniruddha Savargaonkar's recent (and first!) publication in the Journal of Biomedical Materials "**Antifouling Behavior of Copper-Modified Titania Nanotube Surfaces**". Savargaonkar is a 3rd year PhD student working in Dr. Ketul Popat's lab within the Mechanical Engineering department. Savargaonkar's work is focused on materials development for orthopedic implants, specifically performing surface modifications on titanium.



Anniruddha with samples in the Popat lab.



Nanotube surfaces as seen by the naked eye.

ARC TRIVIA

Which instrument in the ARC is also called a SQUID?

HTTPS://WWW.RESEARCH.COLOSTATE.EDU/ARC/

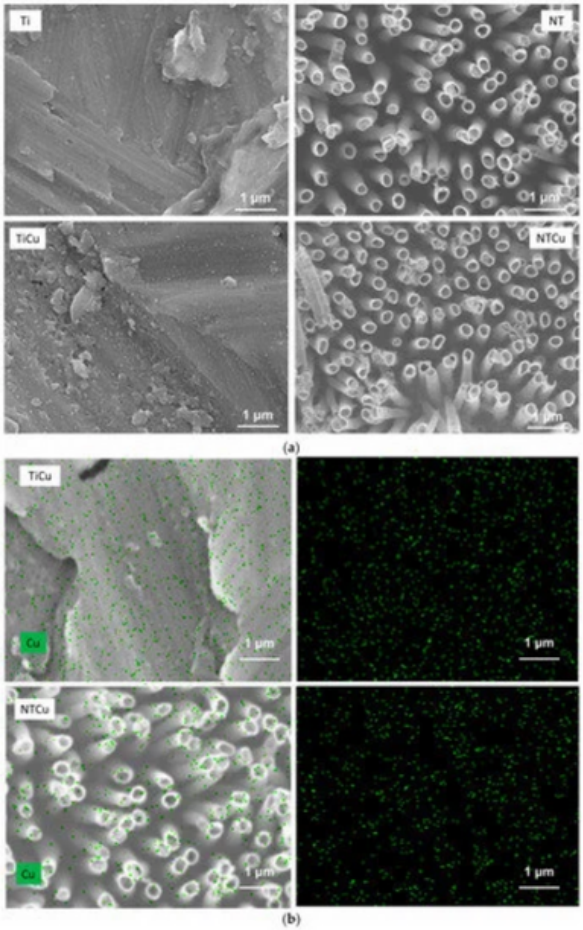
We look forward to featuring more of our users' research.
Want to have your research in the spotlight?
Be sure to cite our RRID (SCR_021758) so that we can find you!

"I work with two surface modifications, one of which is nanotubes. We grow the nanotubes on them and then deposit copper on the nanotubes," he explains. "Copper is a proven antibacterial, and my aim is to make these orthopedic implants more antibacterial. As of now, around 5 percent of implants fail every year due to bacterial infections. If the implant fails, it can lead to a lot of problems and be painful and costly for the patient."

Savargaonkar's work aims to make the implant material itself antibacterial so that patients will not have to be prescribed long-term antibiotics in order to combat costly and potentially unnecessary infections. Additionally, he hopes to make these implants more compatible with cells so that bone cells can better adhere to the implant. Copper is not a material of interest to many because if you exceed the limit of copper, the implant will turn toxic for the body. Creating the right balance is essential when considering copper as an antibacterial surface coating on implants.

"As the modifications grew, it was difficult for the bacteria to adhere to the material," Savargaonkar states when discussing his findings. "I was concerned about bacterial biofilm formation, which forms a natural polymer on the surface. So, if bacteria cannot adhere to the implant, they cannot grow. If bacteria were able to adhere, they would be killed by the copper."

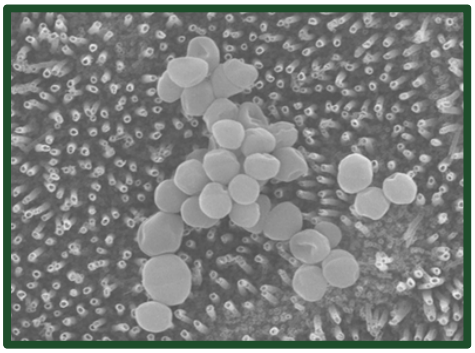
The ARC and especially Dr. Rebecca Miller helped Savargaonkar with his research through the use of X-ray photoelectron spectroscopy (XPS, a technique used to analyze surface chemistry), and scanning electron microscopy (SEM, a high-resolution imaging technique).



Representative SEM images and corresponding EDS mapping of copper for different surfaces.

Savargaonkar used the XPS to check if there was copper on the material's surface and, if so, how much. He also used Energy Dispersive X-ray Spectroscopy (EDS) on the SEM to check if their deposition process was uniform because the topography changes for nanotubes. The SEM was used to image nanotube topography, bacterial growth, morphology, and biofilm formation as impacted by the surface modifications.

Currently, Savargaonkar is working on NIH funded projects utilizing SEM and XPS. The first is a cell project using SEM to visualize the proliferation and differentiation of human STEM cells on the modified titanium surfaces.



SEM image of the surviving bacteria cells on titanium nanotubes. Savargaonka's honorable mention in the ARC 2023 SEM Imaging contest.

For his second project, Savargaonkar is working with porous titanium. Porous titanium differs in modulus compared to sheet titanium; there is a large difference between modulus of the bone and titanium that makes it difficult for the body to accept the material. If a material is porous, the cells can grow from the inside of the material, making it easier for the body to accept it. These porous materials will be useful for knee and hip implants in the future. The new JEOL SEM that will soon be added to the ARC will significantly help with Savargaonkar's future research, due to the higher resolution imaging capabilities as well as the more automated, user-friendly workflows.

Thank you Aniruddha, for speaking with us! We are thrilled to hear how our facilities have aided in advancing your research.

WE CARE ABOUT YOUR SAFETY!

The ARC will be making some changes in the coming months with stricter eye protection requirements aligned with the upcoming CSU IBC Eye Protection Policy, set to take effect on January 1, 2024. Eye protection will be mandatory for every user and visitor throughout all our laboratory spaces, including computer workstations near instruments. Your safety is our utmost priority, and the reinforcement of wearing safety glasses is a proactive step to ensure the protection of your eyes and personal safety in accordance with CSU's safety regulations.

We are excited to share that November is ARC Safety Month, during which we will make eye protection and personal safety a special focus area in our training and communications with users. Safety glasses will soon be readily available at all entrances for those who may forget, but we kindly request that users bring their own whenever possible. Thank you for partnering with us in creating a safer working environment for all, as we continue to care for your eyes and your overall safety here in the ARC!

EQUIPTMENT UPDATES

SAXS down for the foreseeable future

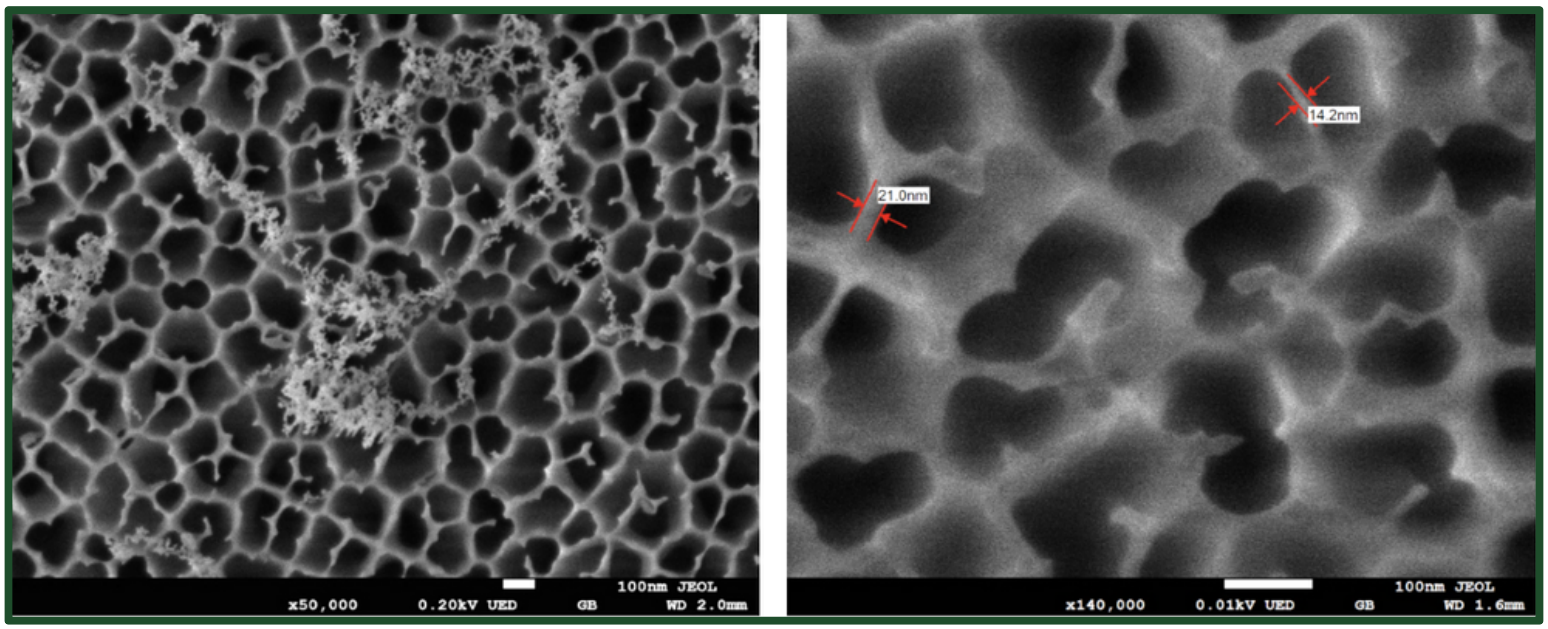
Our Small Angle X-ray Scattering system (SAXS) experienced a problem during the X-ray beam focusing process following a needed replacement of the filament. The ARC is currently out of in-house X-ray expertise and undergoing a search for a new X-ray manager. We are evaluating options for repair but in the meantime, users with urgent needs for SAXS analyses can reach out to our colleagues at CU Boulder and School of Mines. Please contact Alyssa.May@colostate.edu for more details.

A new SEM is coming!

We are thrilled to announce that the ARC will soon have a new state-of-the-art, ultrahigh-resolution field emission scanning electron microscope, the JEOL JSM-IT800(HL)! We anticipate the new SEM will be installed and available during Spring 2024. The new SEM will have a variety of advanced features (EDS, EBSD, STEM, CL, lithography, variable pressure, air-free sample transfer, etc) that will allow researchers to perform more comprehensive micro- and nano-scale imaging and analyses, broadening the scope of research possibilities at CSU, particularly in materials science and engineering, geosciences, biological sciences, agricultural and ecosystem sciences, and veterinary medicine.

The image below, taken on a JSM-IT800(HL), is of an Anapore membrane filter taken at ultra-low (0.01 kV) accelerating voltage. Features as small as 14 nm can be identified, as shown.

We'd like to thank the CSU Office of the Vice President for Research for prioritizing its funding as an advancement of CSU research.



TD Tube Conditioning Unit

NEW!

We recently acquired a MARKES TC-20 standalone thermal desorption (TD) tube conditioning unit for conditioning up to 20 TD sorbent tubes. These tubes are used by CSU researchers to collect volatiles in environmental or atmospheric samples prior to analysis by GCMS. Previously, users had to condition these tubes on the ARC's GCMS using helium, a process that would take up to 50 hours for 20 tubes and utilize significant amounts of helium. The new TC-20 unit operates independently from the GCMS, uses nitrogen gas instead of helium and takes just 2½ hours to condition 20 tubes. All this will result in cost, time and helium savings and increased availability on the GCMS for actual analyses. Contact Paul.Mathews@colostate.edu for more information.

What is thermal desorption GCMS?

Thermal desorption gas chromatography-mass spectrometry (TD-GCMS) is a powerful analytical technique that facilitates the identification and quantification of volatile and semi-volatile compounds in a wide range of samples. It works by heating a sample to release and separate its volatile components, which are then analyzed by gas chromatography to separate the compounds based on their chemical properties and a mass spectrometer to identify them by their mass and fragmentation patterns. TD-GCMS finds extensive application in environmental research for assessing air and water quality, in food science to analyze flavor compounds, in forensic investigations for detecting trace substances, and in pharmaceutical research for drug analysis. This versatile technique supports a broad spectrum of research ranging from environmental monitoring to material characterization.

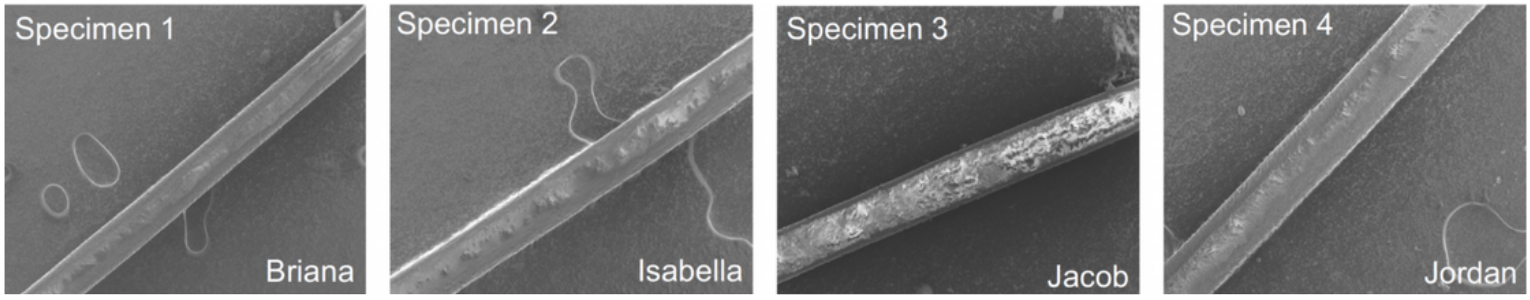
ARC TRIVIA ANSWER

Our magnetic properties measurement system (MPMS), which is basically a SQUID (Superconducting Quantum Interference Device) Magnetometer. It is used to measure very weak magnetic fields in materials with extremely high sensitivity.

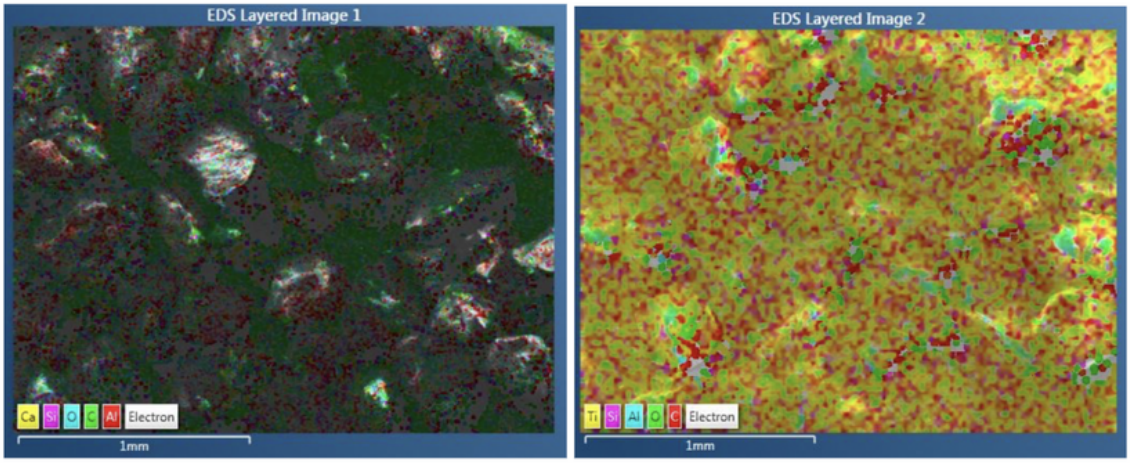
LATEST EDUCATIONAL OFFERINGS

USING SEM IN CHEM333 “FORENSICS CHEMISTRY”

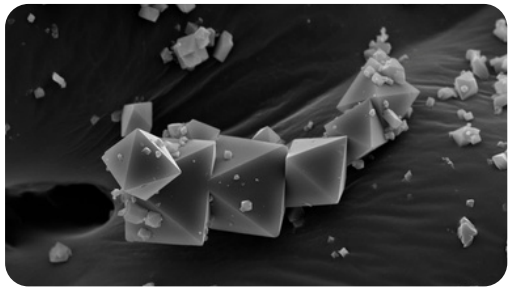
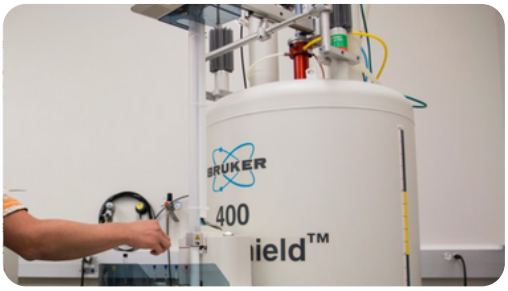
CHEM333, Forensic Chemistry, was developed to provide undergraduate students the opportunity to explore analytical techniques used in solving crimes. The course is taught by Dr. Carlos Olivo Delgado. It is a central requirement for the new concentration in forensic chemistry in the Chemistry bachelor’s degree and was first offered in Fall of 2022. Real-life applications along with fundamental chemical principles are combined in helping students develop critical thinking skills and problem-solving methods essential for a job in forensics. “The ARC has been an exceptional partner in providing access to cutting-edge instruments” says Delgado “like the Scanning Electron Microscope (SEM), allowing the students to explore in detail the defining characteristics of physical evidence like paint chip, hair, and soil. Students also benefit from Energy Dispersive X-ray Spectroscopy (EDS), which in combination with SEM, provides elemental information that helps match the sample composition with its source.”



SEM images of hair from different students showing structural differences



EDS map of two different paint chips showing widely different chemical compositions

ARC FALL & SPRING SEMINAR SERIES

Hosted by the Analytical Resources Core
Office of the Vice President of Research

ANALYTICAL RESOURCES CORE
COLORADO STATE UNIVERSITY

Learn about the ARC's latest developments and newly added technologies available to CSU researchers and regional companies. This year the ARC experts themselves will present the technologies, analytical services, and educational resources each of their labs have to offer. Join us as we delve into a diverse array of scientific instruments and methodologies, enabling you to harness the full potential of our facilities.

Date	Presenter	Topic
September 6	Karolien Denef	Overview of the Analytical Resources Core
October 4	Corey Broeckling	Mass spectrometry-based metabolomics
November 1	Jackie Chaparro	Inductively coupled plasma mass spectrometry and ionomics applications
December 6	Roy Geiss	Electron microscopy
January 10	Linxing Yao	Targeted quantitative analysis
February 7	Gustavo Diaz	Metaproteomics – who is doing what in microbial communities
March 6	Claudia Boot	Self service mass spec offerings in the ARC
April 3	Indrani Bhowmick	Materials analysis techniques
May 1	Alyssa Winter May	MALDI mass spectrometry and macromolecular analysis
June 5	Rebecca Miller	Surface analysis techniques
July 3	Michele Mailhot	Nuclear Magnetic Resonance (NMR)
August 7	TBD	X-ray diffraction and scattering techniques

First Wednesday of the month | 2-3 pm

www.research.colostate.edu/arc/arc-seminar-series/

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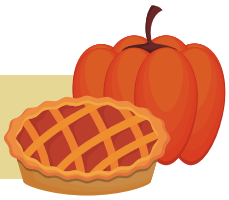
ON THE CALENDAR



NOV 1

Inductively Coupled Plasma Mass Spectrometry and Ionomics. By Dr. Jacqueline Chaparro, ARC Research Scientist

ICP-MS (Inductively coupled plasma – mass spectrometry) is used to quantify the elemental composition in a sample. This seminar will provide an overview of the methods used and developed by ARC to prepare and analyze samples to quantify elements. Dr. Chaparro will highlight some of the work that has been done using ICP-MS at ARC.

DEC 6

Electron Microscopy and the new JEOL IT800(HL) SEM. By Dr. Roy Geiss, ARC Research Scientist

This seminar will review basic electron beam specimen interactions, and how they are used in materials analysis within both Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM). Dr. Geiss will delve into his recent TEM service projects and touch on some emerging avenues that promise to broaden the ARC's TEM application spectrum. Finally, Dr. Geiss will provide an overview of the advanced capabilities of the new JEOL IT800(HL) SEM that will be available to users in late spring 2024.

WE NEED YOUR FEEDBACK ON iLAB!

We have an opportunity to provide feedback on iLab functionality to the development team at iLab on November 16. iLab is especially interested in the user experience so we would love to hear from you!

Please Give us your thoughts by clicking the link or scanning the QR code below. Thank you! https://forms.office.com/r/XeV3V1xJ1g

SCAN ME!

THANK YOU FOR CITING US USING OUR RRID!

Check out recent publications using the ARC:

Üngör Ö, Sanchez S, Ozvat TM, Zadrozny J. Asymmetry-Enhanced 59 Co NMR Thermometry in Co (III) Complexes. Inorganic Chemistry Frontiers. 2023. https://pubs.rsc.org/en/content/articlehtml/2023/qi/d3qi01641b

Zhao Y, Rettner EM, Harry KL, Hu Z, Miscall J, Rorrer NA, Miyake GM. Chemically recyclable polyolefin-like multiblock polymers. Science. 2023 Oct 20;382(6668):310-4.https://www.science.org/doi/10.1126/science.adh3353

Puffer KO, Corbin DA, Miyake GM. Impact of Alkyl Core Substitution Kinetics in Diaryl Dihydrophenazine Photoredox Catalysts on Properties and Performance in O-ATRP. ACS Catalysis. 2023 Oct 18;13:14042-51. https://doi.org/10.1021/acscatal.3c04060

Lustig DR, Buz E, Mulvey JT, Patterson JP, Kittilstved KR, Sambur JB. Characterizing the Ligand Shell Morphology of PEG-Coated ZnO Nanocrystals Using FRET Spectroscopy. The Journal of Physical Chemistry B. 2023 Oct 6. https://doi.org/10.1021/acs.jpcb.3c04900

Shakouri M, Teymouri M, Vaddey NP, Zhang C, Ksaibati K, Kuinkel MS, Liu P. Enhancing physiochemical properties and reactivity of landfilled fly ash through thermo-mechanical beneficiation. Cement and Concrete Composites. 2023 Oct 3:105310. https://doi.org/10.1016/j.cemconcomp.2023.105310

Yourdkhani M, Dojan C, Ziaee M, Radosevich S. Additive Manufacturing of Carbon Fiber-Reinforced Thermoset Composites via In-Situ Thermal Curing. https://www.researchsquare.com/article/rs-3397066/v1

https://www.linkedin.com/company/analytical-resources-core/

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