UNIVERSITY OF WYOMING

DEPARTMENT OF CHEMISTRY

Spring 2022 Newsletter

Letter from the Department Head

Greetings alumni and friends!

I hope this newsletter finds you and your loved ones safe and healthy. It finally feels like we are coming out of the COVID pandemic. Overall, although the past year has been a very productive one for our faculty, there is general scare that the administration is looking to further downsize the department in view of the financial crunch faced by UW. I will start with some of the exciting news. Our colleagues, John Hoberg and Bruce Parkinson, received a $1.8M grant through the NSF-DMREF program on "Salt Separation membranes based on modifiable 2D COFs". Our junior faculty, Michael Taylor, received the NIH ESI-MIRA outstanding investigator award that was the first of its kind awarded to anyone in Wyoming. This award will fund $1.4M to Mike's laboratory over a 5-year period to pursue his ideas on developing new chemical tools for optically controlled protein modifications. David Anderson received a $500k NSF award to study "Parahydrogen Matrix Isolation Infrared Spectroscopy and Kinetics". Jing Zhou received her $417k NSF grant to pursue "Surface Science Studies of Ni-based Bimetallic Particles Supported on CeO2(111) for Dry Reforming of Methane". Additionally, Brian Leonard and Elliot Hulley were funded by NSF to host a research experience for undergraduates (REU) program in the department through the summer of 2023. Caleb Hill's laboratory received $800k of funding through the NSF-EPSCoR mechanism to continue develop his research program. The Wyoming Inclusive Excellence Team led by Rachel Watson was selected to be one of 15 institutions to be part of a national learning community re-envisioning inclusive collaborations between 2-year and 4-year institutions. Elliot Hulley secured NIH funding to acquire a new X-ray diffractometer that will be installed this summer in collaboration with Navomoney Arulsamy. On the teaching side, Ginka Kubelka was recognized as a Top Professor at the 42nd Annual Cap and Gown Chapter of MortarBoard "Top Prof" celebration. Also, John Hoberg, was one of 29 instructors who received this year's Promoting Intellectual Engagement (PIE) Award. Last year, the department welcomed 9 new graduate students who will be pursuing a doctoral degree in Chemistry. The department now has 39 students enrolled in its graduate program and expects to welcome another 10 students in Fall of 2022. The department is also excited to be preparing to join the new college of Physical Sciences and Engineering that is expected to happen in the summer of 2023.

Now for some challenges ahead. A major decline in the state revenue has forced a 10% reduction in the departmental budget for the upcoming year. Our request for a new faculty hire was turned down hurting our ability to maintain the current teaching and research curriculum. This is particularly unfortunate as we have lost 8 colleagues in just the last 4 years to retirements, resignations and reappointment denials, with only

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UW College of Arts and Sciences Department of Chemistry

three of those positions returned back. The department is currently down to 10 research faculty and 4.25 APLs forcing us to cancel our advanced general chemistry curriculum (CHEM 1050 and 1060) and more recently the trailer sections of the organic chemistry courses (CHEM 2420 and 2440). The faculty shortage is also deeply hurting our graduate curriculum and faculty research. Additionally, the department continues to struggle with the billing and maintenance of several of its major research instruments including the MALDI-MS, XPS and TEM systems due to lack of personnel support.

Edward Clennan retired from the university on August 31, 2021, after a distinguished career of over 42 years at UW with a productive research group, considerable external funding and numerous graduate students. Ed has still been regular at work though since his retirement trying to wrap up his NSF project and publish results from it. He is currently working on an invited review, and continues to serve as the editor of the Journal of Sulfur Chemistry. Caleb Hill resigned from the department to take up a new position at the Baylor University later this summer. We wish him the very best for his career. On a somber note, Dr. Thomas Peter Martin Jr., who was post-doctoral associate in the department and managed the TEM instrument, passed away in March 2022. A plaque is being commissioned to rename the TEM lab the "Thomas Peter Martin Junior Memorial Transmission Electron Microscopy Laboratory".

And finally, a huge Thank You to all our alumni and friends for their generous donations over the years. These funds continue to support our mission of teaching, research and service in impactful ways. Your gifts go toward awards, student travel to meetings and helping students with financial needs among supporting us meet other goals. So please continue to help us out with your generous donations at http://www.uwyo.edu/chemistry/giving.html. Also, please continue to send us your stories and accomplishments by email or otherwise to help celebrate them with our community.

Best Regards,
Debashis

Graduate Students who received their Ph.D. in the past year:

Dr. Yuqi She
Dr. Andrew Smith
Dr. Travis Morrow
Dr. Kyle Covington
Dr. Valerie Kuehl
Dr. Daniel Harris
Dr. Joshua Hill

In Memoriam of Thomas Peter Martin Jr., Post Doctorate Research Associate

"It is with great sadness that I inform you of the passing of our TEM operator and collaborator Thomas Martin. Tom was a huge asset to the Department and the University for his expertise and devotion to both operating and training users of the TEM as well as collaborating on many research projects."

-Dr. Bruce Parkinson

A plaque is being commissioned to rename the TEM lab the "Thomas Peter Martin Junior Memorial Transmission Electron Microscopy Laboratory"

Chemistry Faculty Member Laura de Sousa Oliveira Receives Training through the Learning Actively Mentoring Program (LAMP)

In 2021, Dr. Oliveira was one of 32 faculty members from UW and Wyoming's Community Colleges accepted into the yearlong LAMP training in active, inclusive pedagogy. In May, Laura attended an immersive summer institute where she was trained in Place-based Education (PBE), Experiential Learning, Problem-based Learning (PBL), Backwards Course Design and Universal Design for Learning. Laura designed an instructional strategy that facilitated freshmen General Chemistry students in writing an original grant proposal! Throughout the semester, Laura supported students in iteratively writing proposal sections. Not only was this an authentic scientific experience for students, but it also allowed them to deeply apply knowledge that most General Chemistry students memorize and forget. Laura will present her final LAMP poster detailing her curriculum design on May 6th (3:30-6pm) in the Active Learning Classroom of the new Science Initiative building!

Large-scale Active Learning Classroom to open in the new Science Initiative Building; Dr. Elliot Hulley will be amongst the first instructors to teach in the room!

The active learning classroom (ALC) in the new Science Initiative Building will enable up to 200 students to engage in team-based, active learning. Using student-centered design features, this room contains 22 round tables that each sit 9 learners. The chairs are color-coded to enable students in particular seats to assume certain tasks. Five projection screens enable displays to be viewed from any location in the room. Students (as well as the instructor) can display on these projection screens. Glass writing boards line the walls. Two additional desks are provided in the south corner for LAMP learning assistants (LAs). An adjacent prep area is equipped with resources that will enable laboratory-style demonstrations including chemical reactions that necessitate a hood. All demonstrations can be recorded live and footage piped to the full classroom. Adjacent storage areas are also provided to enable you to easily utilize any active learning supplies needed. Finally, the room is equipped with a state-of-the-art Constellation sound system that enables students to engage in small-group discussions without being interrupted by the noise of adjacent groups. This sound system also enables instructors to effortlessly 'call back' the large group without straining or yelling and without the use of a microphone! Dr. Elliot Hulley will teach his General Chemistry course in the room and looks forward to finally having a space that enables him to teach using the student-centered pedagogies that he learned in the Learning Actively Mentoring Program (LAMP).

Rachel Watson Leads University of Wyoming's Howard Hughes Medical Institute's Inclusive Excellence Challenge (HHMI IE3)

The Wyoming Inclusive Excellence Team is fortunate to be one of only fifteen institutions nationwide to be part of a national learning community re-envisioning inclusive collaborations between 2-year and 4-year institutions. Phase I of this grant is supporting an Institutional Ethnography to enable us to better understand the way in which our eight Wyoming community colleges and University of Wyoming impact educators daily in ways that affect inclusive excellence. Along with colleagues from Pharmacy (Dr. Reshmi Singh) and Education (Rosemary McBride), Rachel is traveling to every community college to do focus groups and is simultaneously kicking off educator learning communities at a handful of the colleges. Rachel is also an active leader in the national cohort of 15 institutions where she has stepped up to lead book discussions and organize webinars and facilitate community building sessions. During the next six years this national learning community will receive over eight million dollars to support Phase II work including the continued work within the state of Wyoming.

From Research Scientist Dr. Navomoney Arulsamy

Research Scientist Arulsamy managed the departmental X-ray diffractometer and EPR spectrometer and also taught the General Chemistry I and Advanced Inorganic Chemistry courses. The Bruker EMX EPR spectrometer is now equipped with an ER4141 variable temperature unit.

Wyoming INBRE provided the funding, and we are grateful for their generous support. The low temperature unit allows data acquisition at the liquid N2 temperature (77 K) and at other temperatures expanding the capacity of the spectrometer significantly. Since the installation many samples including short-lived organic free radical intermediates, electrochemically generated mixed-oxidation state species, transition metal complexes and magnetically unique samples have been studied by low temperature EPR data. The X-ray diffractometer also works well, and we continue to measure single crystal diffraction data for various research groups on campus and also an external research group from the University of Montana. We are also happy to report that we will be transitioning to a new Bruker D8 Venture Dual X-ray Diffractometer in the summer. We will continue to operate the older Bruker APEX II diffractometer and are also planning to use it in our teaching.

From the Hoberg Group:

Newly funded grants:
"Salt Separation membranes based on modifiable 2D COFs" is an NSF-DMREF grant funded at $1.8 million. This collaboration involves fellow chemistry faculty Bruce Parkinson, Laura de Sousa Oliveira and Jon Brant in engineering.

Publications in 2021:
Spaulding, V.; Zosel, K. Duong, P. H. H.; Li-Oakey, K. D.; Parkinson, B. A.; Gomez-Gualdron, D. A.; Hoberg, J. O. "A self-assembling, biporous, metal-binding covalent organic framework and its application for gas separation" Mater. Adv. 2021, 2, 3362-3369.

Kuehl, V. A.; Duong, P. H. H.; Sadrieva, D.; Amin, S. A.; She, Y.; Li-Oakey, K. D.; Yarger, J. L.; Parkinson, B. A.; Hoberg, J. O. "Synthesis, Postsynthetic Modifications, and Applications of the First Quinoxaline-Based Covalent Organic Framework" ACS Appl. Mater. Interfaces 2021, 13, 37494. doi.org/10.1021/acsami.1c08854.

Kuehl, V. A.; Wenzel, M. J.; Parkinson, B. A.; Sousa Oliveira, L. de; Hoberg, J. O. "Pitfalls in the Synthesis of Polyimide-Linked Two-Dimensional Covalent Organic Frameworks" J. Mater. Chem. A 2021, 9, 15301–15309.

Brophy, J.; Summerfield, K.; Yin, J.; Kephart, J.; Stecher, J.T.; Adams, J.; Yanase, T.; Brant, J.; Li-Oakey, K.D.; Hoberg, J.O.; Parkinson, B. A. "The influence of disorder in the synthesis, characterization and applications of a modifiable two-dimensional Covalent Organic Framework" Materials 2021, 14, 71.

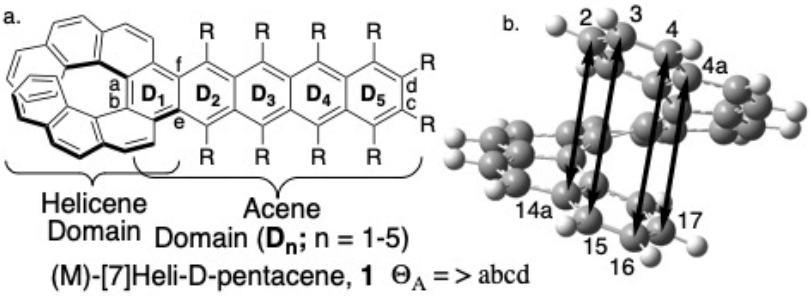
Duong, P. H. H.; Shin, Y. K.; Kuehl, V. A.; Afroz, M. M.; Hoberg, J. O.; Parkinson, B. A.; van Duin, A. C. T.; Li-Oakey, K. D. Molecular Interactions and Layer Stacking Dictate Covalent Organic Framework Effective Pore Size. ACS App Mat Inter 2021, 13, 42164.

Students:
Valerie Kuehl defended her thesis titled "Substituent Modified Covalent Organic Frameworks for Applications in Selective Separations"and received her Ph.D. in May of 2021. She is currently a post doc at Los Alamos National Lab.

Michael Wenzel and Kira Kirkham continue to pursue their PhDs in the Hoberg group focusing on design, synthesis and applications of covalent organic frameworks.

From the Clennan Group:

Ed retired on August 31st 2021. During the 2021-2022 academic year he has been directing the final year of a National Science Foundation Grant to study heli-twisted acenes. This work was done in collaboration with an undergraduate, Ryan Miller. Ed's group had a paper accepted for publication this year entitled, "A Computational Physical Organic Study of a Torque, Lock, and Propagate Approach and Validation with the Synthesis of Configurationally Stable First-Generation Heli-Twisted Acenes." It has now been published online and can be accessed by typing doi:10.1002/ejoc.202101533 into your browser. Ed is also working on an invited review, and he is continuing to work as the editor of the Journal of Sulfur Chemistry.



From the Leonard Group:

2021 has been another exciting year for the Leonard research group. The group welcomed Farjana Zhimi, John Samuel, and A K M Manjur Hossain as our newest graduate students. They join current graduate students Joseph McBride and undergraduates Claire Duffee and Kim Sukle. Andrew Smith defended his PhD in November of 2021 and took a postdoc position at Sandia National Labs in Albuquerque NM. Daniel Harris also defended his PhD in December of 2021 and is currently working at Millipore Sigma in Laramie. The group is still working on metal carbide materials, but we have also branched out into two dimensional layered compounds including a collaboration with Jifa Tian in physics on WS2 and a recently funded project working on intercalation chemistry of metal oxyhalide compounds with collaborations in chemistry, engineering, and physics.

The group was quite active last year going to several conferences. Dr Leonard and Andrew Smith attended the national ACS meeting giving presentations about mixed anionic materials and their intercalation. Dr Leonard was invited to a Materials Science and Technology conference in Columbus OH where he presented his work on complex metal carbide materials. Dr Leonard also published a chapter in the Inorganic and Bioinorganic Encyclopedia this year focusing on water splitting catalysis of metal carbide compounds.

In addition to research projects, Dr Leoanrd and Elliott Hulley were funded by NSF to host a research experience for undergraduates (REU) program at UW focusing on bringing in community college students to spend the summer conducting chemistry research.

In 2021, we brought in 1 faculty member and 8 undergraduate students to spend 10 weeks in the department working with various faculty member. This program is funded for 3 years and will continue through the summer of 2023.

Aside from his duties at UW, he also continues to serve as an Advisory Board Member for the journal Materials Research Express. He currently serves as the Councilor for the WY section of the ACS and is on the national ACS Local Section Activity Committee.

From the Zhou Group:

Zhou's group has three graduate students (Tasnim Ara, Daniel Braedt, and Jintao Miao). In the past year, her group continued the research effort on the growth of Ni catalysts dispersed over Ce1-xTixO2-δ (x: 0-0.5) mixed-oxide supports and the understanding of their activity and stability in the CO2-hydrocarbons reforming processes. One of the reactions of interest is the dry reforming of methane (DRM), which utilizes two abundantly available greenhouse gases to produce industrially important syngas that can be further utilized for the production of fuels and value-added chemicals. The project has been supported by Wyoming Carbon Engineering Initiative, the School of Energy Resources at UW.

The research results were reported in three patents ("Modular Reaction Control Systems for Live Monitoring of Long-term and/or Multi-channel Reactions", "Ceria-supported Metal Catalysts and Processes",

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and "Dry Reforming Methane Using Ceria-supported Metal Catalysts and Hydrocarbon Mixture Feedstocks"), two manuscripts ("Infrared Reflection Absorption Spectroscopy and Temperature-programmed Desorption Studies of CO Adsorption on Ni/CeO2(111) Thin Films: The Role of the Ceria Support" and "Growth, Sintering, and Chemical States of Co Supported on Reducible CeO2(111) Thin Films: the Effects of the Metal Coverage and the Nature of the Support"), as well as three presentations at ACS and AVS meetings. This spring, the group was excited to receive a NSF grant (Project title: Surface Science Studies of Ni-based Bimetallic Particles Supported on CeO2(111) for Dry Reforming of Methane; Award period: July 1, 2022-June 30, 2025; Award amount: $416,976). The project aims to gain a fundamental understanding of the effect of the second metal (e.g. Rh and Co) on the catalytic performance of Ni-based bimetallic particles in DRM.

Congratulations to Dr. Ginka Kubelka, winner of Top Professor at the 42nd Annual Cap and Gown Chapter of MortarBoard "Top Prof" celebration.

This honors a distinguished faculty members for their significant contributions to our university, and the inspiration they gift in educating our students.

"'Top Prof' is an event that our members value greatly, as it allows students to recognize the faculty who have had an impact on their lives," says Christine Wade, an associate professor in the UW Department of Family and Consumer Sciences and the adviser to the UW chapter. "Faculty are always honored to be recognized as a 'Top Prof,' because this is a student-driven selection process."

Congratulations to John Hoberg, one of "twenty-nine University of Wyoming instructors who inspire excitement, inquiry and autonomy in first-year courses are this year's Promoting Intellectual Engagement (PIE) Award recipients."

2021-2022 Undergraduate Awards

Outstanding Freshman Award:	**Kent Henry**
Outstanding Sophomore Award:	**Brynn McKenna**
Outstanding Junior Award:	**Emma Muller**
Outstanding Senior Award:	**Leah Passafiume**

Hach Memorial:	**Ansel Visser, Max Seibold, Risa Pilon**
Heady Scholarship:	**Stratton Kohr**
Arthur Gray Janssen Award:	**Adriauna Pendergrass, Brynn McKenna**
Raulins Undergraduate Research Prize:	**Jennifer Gehred, Aaron Hardee**
Asplund Academic Excellence Prize:	**Emma Muller**
Walter F. and Barry D. Gasdek Scholarship:	**Devin Lloyd**
Edgar Bailey Smith Chemistry Scholarship:	**Cailin Brugger, Claire Duffee**

Undergraduate Award in Analytical Chemistry:	**Gideon Buchanan**
Undergraduate Award in Inorganic Chemistry:	**Kelsey Johns**
Undergraduate Award in Organic Chemistry:	**Emma Muller**
Undergraduate Award in Physical Chemistry:	**Madalyn Montgomery**

UW Team Receives NSF Award to Study New Membrane Materials for Water Purification, Desalinization

The global disruption produced by climate change will place further stress on the world's freshwater supplies due to higher temperatures, changing rainfall patterns and increases in human population, according to John Hoberg. This is expected to result in half of the world's population facing freshwater shortages by 2030.

A research team at the University of Wyoming received a National Science Foundation (NSF) grant to investigate new membrane materials for purification and desalinization of water. The four-year research grant award, in the amount of nearly $1.77 million, is for a project titled "Salt Separation Membranes Based on Modifiable Two-Dimensional Covalent Organic Frameworks." The grant begins Oct. 1 and continues through Sept. 30, 2025.

The research group is composed of Hoberg, a professor in UW's Department of Chemistry; Bruce Parkinson, a UW School of Energy Resources professor of chemistry; Laura de Sousa Oliveira, a UW assistant professor of chemistry; Jonathan Brant, a professor in the UW Department of Civil and Architectural Engineering; and Zachary Gray, co-founder of WYONANO LLC, a company based in Sheridan.

"Since only about 3 percent of all water on Earth is suitable for human consumption and the oceans contain 97 percent of the Earth's water, energy-efficient desalinization, or salt-separation technologies, is crucial for maintaining society's quality of life," Hoberg says. "Reverse osmosis is currently the most employed and reliable method for water desalinization. However, improvements in process efficiency are needed to make it a more sustainable treatment option."

The improvements Hoberg mentions center on the physical and chemical characteristics of the membranes themselves to address issues related to salt selectivity, water permeability and chemical tolerance. The project's researchers are working to produce new generations of membranes materials that are more stable, selective and energy efficient than current reverse osmosis membranes. These membrane materials can be modified for other water purification applications, such as the removal of specific contaminants.

"The new membrane materials will be based on two-dimensional, covalent organic frameworks -- 2D polymers with a defined but modifiable pore structure that can be synthesized with a high degree of order," Hoberg explains. "Furthermore, the project researchers have developed synthetic strategies for putting a wide variety of functional groups in the pores. The 2D flake-like nature of the materials makes them naturally suited for semipermeable membrane applications."

The project's focus will be on putting charged functional groups in the pores and changing the pore sizes to make ion-selective membranes that reject either anions or cations with a specific size threshold initially focusing on desalinization. Anions are atoms with a negative charge, while cations are atoms that bear a positive electric charge.

To guide the synthesis of the new membrane materials and optimize their performance for a particular separation, the team will use a feedback loop between the organic synthesis of the membrane, membrane performance testing, and computational modeling and machine learning.

Hoberg says the research aligns with the goals of the NSF's Designing Materials to Revolutionize and Engineer Our Future Materials Genome Initiative to accelerate materials discovery and development by building the fundamental knowledge base needed to advance the design and development of materials with desirable properties and functionality.

This research would likely not have gotten off the ground without initial seed funding of $200,000 provided by SER three years ago, Hoberg says. The seed funding led to the project receiving $3 million in grants from the U.S. Department of Energy, a Small Business Technology Transfer grant through WYONANO, and now NSF.

A UW research team recently received a $1.77 million NSF grant to investigate new membrane materials for purification and desalinization of water. Team members, from left, are Jonathan Brant, a professor of civil and architectural engineering; John Hoberg, a professor of chemistry; Laura de Sousa Oliveira, an assistant professor of chemistry; and Bruce Parkinson, a School of Energy Resources professor of chemistry. (Emily Fretland Photo)

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