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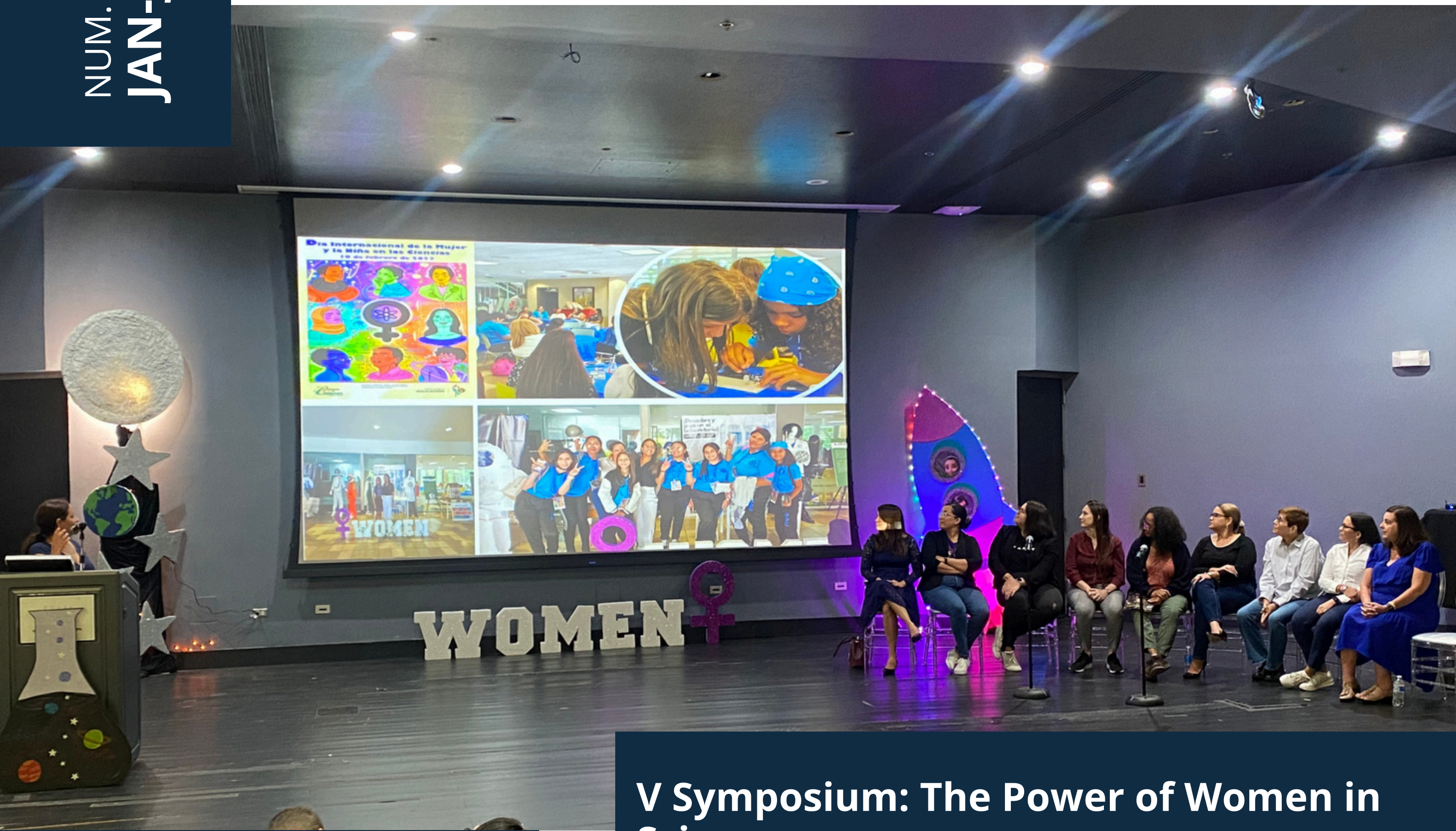
JAN-JUN 2024

The STEM Scene

NEWSLETTER



V Symposium: The Power of Women in Science

The V Symposium, "The Power of Women in Science," took place on March 7-8, 2024, and highlighted the significant contributions of Latino women in STEAM disciplines. The event aimed to inspire students, educators, and the broader community to explore careers in STEM.

This year's focus was on space exploration and featured notable leaders and specialists in this field.

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FEATURED CONTENT

- **What our PR-SPRInT fellows are doing**
- **Science in action: research and community engagement activities**
- **Where are our fellows now**

Posters presentations at the symposium

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NO.1

EDITORIAL

KICKING OFF OUR FIRST EDITION

We are excited to present the first edition of our newsletter, where we aim to highlight the recent achievements of our program. Thanks to the dedication of our team and the support of our community, we have made significant progress that motivates us to keep moving forward.

In this issue, we are highlighting activities from January to June 2024 aimed at promoting the growth and development of our program. These activities include the initial release of research summaries from some of our PR-SPRInT fellows and their mentors. This showcases our work and contributions in line with NASA guidelines and goals related to the development of life support systems and batteries.

In the education and outreach area, our main goal is to engage the community with science and inspire students to pursue higher education in STEM fields. Notable events include training workshops, informational talks, school visits, and space-themed conferences. These activities have helped us strengthen our community connections and reach more people interested in our program.

We are pleased to showcase our work to the educational community and the public. We believe that our efforts in research and education will significantly contribute to the development of future NASA missions and will have a crucial role in preparing a new generation of explorers.

WHAT OUR PR-SPRINT FELLOWS ARE DOING

Here are some exciting updates on our fellow's research projects as participants in PR-SPRInT program

MIGUEL A. SEPÚLVEDA PAGÁN

As a third-year master's student in Chemical Engineering at the University of Puerto Rico, I am researching the development and testing of Ni/CeO2 catalysts for converting CO2 to methane under the guidance of Dr. Yomaira Pagan Torres.

The project is centered on how tuning oxygen vacancies in Ni/CeO2 could affect CO2 methanation. The research being developed in Dr. Pagan's lab focuses on making efficient NASA Artemis missions by optimizing In-Situ Resource Utilization processes where CO2 could be captured and converted by highly active Ni/CeO2 catalysts into energy carrier compounds like methane.

As Methane is a valuable propellant, scientists at the ISS care about increasing methane production.
However, because of the limited available energy in the ISS, catalysts developed for CO2 conversion must operate at low reaction temperatures (<573 K). Ni-supported particles on metal oxides (i.e., CeO2) have been shown to result in the formation of metal-oxide interfaces with active sites that facilitate adsorption and activation towards the formation of methane at low reaction temperatures (<573K). Furthermore, tailoring metal oxides with rare-earth metals has been shown to alter the density of oxygen vacancies resulting from charge imbalances in host metal oxides, which lead to enhanced CO2 activation sites.

Previous results in Dr. Pagan's lab have reported that the activity of Ni/ CeO2 with enhanced metal/oxide interface sites exhibits a methane selectivity of 99% at CO2 conversions >80%. Also, it is the kinetic and catalyst characterization that have been performed (diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS), X-ray diffraction (XRD), Raman spectroscopy, and hydrogen temperature program reduction) demonstrate plausible

(continue on next page)

surface intermediates and reaction pathways by which CO_2 methanation is facilitated at low reaction temperatures <573 K.

One of the major interests in this research is to be able to have higher control for tuning active sites for CO_2 methanation and to propose highly active catalysts that could perform excellently under low inputs of energy while simultaneously being selective towards a desired product.

While this is a major goal, it is important to me to give my absolute best during this research experience and provide robust data that could provoke an impact in the world of catalysis. It is also valuable for me to motivate younger generations of students to work selflessly and give their absolute best, which is something I truly admire from my mentors.

DEVELOPING HIGH-SAFETY, FAST-CHARGING, AND LOW-TEMPERATURE BATTERIES FOR NASA EXPLORATION MISSIONS

Lithium-ion batteries (LIBs) have become the dominant battery technology in various applications, including electronics, electric tools, and electric vehicles. They have also been explored as power sources for NASA's outer space missions. However, LIBs face several challenges that are difficult to overcome. Firstly, their use of flammable carbonates as electrolytes raises safety concerns, particularly in extreme or abusive conditions. Secondly, the graphite anode in LIBs cannot support rapid charging, leading to the growth of lithium dendrites. Consequently, current LIBs typically require 1-10 hours to reach full charge. Lastly, LIBs struggle to perform well at low temperatures due to electrolyte freezing, which severely hampers ion migration and conduction. To better serve NASA's missions, the development of a battery system with high safety, fast-charging capability, and excellent performance in low temperatures is necessary.

Our proposed research project aims to develop a battery system with high safety, fast charging capabilities, and low-temperature operation. This battery will use an innovative metal anode that has not been reported before. Our preliminary data indicates that this metal anode has a significantly higher capacity (>600 mAh g_{-1}) compared to conventional graphite anodes and metal oxide cathodes. It is important to note that this new metal anode is compatible with aqueous electrolytes, ensuring enhanced battery safety as water is non-flammable.

Additionally, our initial findings indicate that this battery has the potential to support fast charging, as it demonstrates impressive performance even at high currents (10 mA cm^{-2}). Furthermore, we have discovered that the aqueous electrolyte remains unfrozen even at -10 ℃, enabling efficient operation at low temperatures. To further improve the performance of this battery system, we propose focusing on the following key aspects:

1) Metal anode performance characterization. We will conduct long-term testing of symmetrical metal-metal cells to evaluate their operational stability. Additionally, we will investigate plating/stripping efficiency at various current densities and explore different electrolyte formulas and additives to enhance their properties.

2) Developing high-capacity cathode materials. We aim to synthesize cathode materials with a high capacity ranging from 200 to 400 mAh g^{-1}. Materials such as MnO2, V2O5, and polymers have demonstrated this capacity level in the aqueous Zn metal batteries field. We will focus on synthesizing and applying these materials to our new battery systems.

3) Full-cell battery assembly and systematic battery performance testing. Assembly of full-cell batteries and systematic performance testing: We will assemble full cells utilizing the metal anode, aqueous electrolytes, and the newly developed cathode materials. Comprehensive testing will evaluate capacity, energy density, and cycling performance.

Furthermore, we will examine their performance at high current densities (5-20 C) to assess their fast-charging capabilities.

Additionally, we will investigate battery response to different temperatures (-10, -20, -30, and -40 ℃) to understand their performance under varied environmental conditions.

Research Team and Expertise

As a second-year Ph.D. student in the chemistry department at UPR, I have research experience in supercapacitors and batteries, with a few publications. My mentor, Dr. Xianyong Wu, has over 10 years of battery research experience designing new materials, electrolytes, and battery mechanisms. He has published more than 40 papers in high-impact journals, such as Nat. Energy, J. Am. Chem. Soc., Angew. Chem. Int. Ed., Adv. Materials, etc., with a citation number of >5,400 and an H-index of 32. He has extensive experience with aqueous batteries, non-aqueous batteries, and solid-state batteries.

"Every great advance in science has issued from a new audacity of imagination"

-- John Dewey

HIGHLY SENSITIVE AND SELECTIVE GAS SENSORS BASED ON COBALT/PALLADIUM -2 PHTHALOCYANINES AND MULTI WALLED CARBON NANOTUBES

I am a PhD candidate in the chemistry graduate program at the University of Puerto Rico, Rio Piedras campus. I am currently in my 4th year of graduate school and my research advisor is Dr. Dalice Piñero Cruz.

The purpose of my research is to develop gas sensors that are highly effective in the detection of toxic gases present in the environment. Environmental air pollution is a problem that can result in danger to respiratory health. Exposure to toxic gases (NO_2, NH_3, etc.) can result in non-reversible pulmonary diseases and/or even death. Metal phthalocyanines (CoPc, PdPc) are known to have gas-sensing capabilities on their thin-film nanostructure. The development of MPc nanowires has shown better performance than thin films in terms of sensitivity and rapid response when exposed to the target gas NH_3.

A limitation of the MPc is the low conductivity of the material which can result in an inability to detect some gases. Multi-walled carbon nanotubes (MWCNTs) are a highly conductive material. Incorporating MPc into the MWCNTs surface can enhance the performance of the sensor to obtain detection and selectivity provided by the nature of the MPc.

The purpose of this project is to create MPc-based nanowires using physical vapor deposition (PVD) and MPc-MWCNTs hybrids thin films for the development of highly sensitive and selective gas sensors towards NO_2 and NH_3. Gas sensors can be used in diverse fields that involve environmental monitoring, industrial safety, and NASA space exploration. In terms of the alignment of my project and the NASA missions, gas sensors have applications in human health, life support and habitation systems.

In the future, I see myself contributing to diverse research fields. Continuous discovery and pursuit of novel technologies are pivotal to solving current issues in numerous fields that affect healthy human living, space exploration, and upcoming generations. My curiosity in science started after a teacher asked the group if they knew there were "metals" in the rivers. Starting to develop questions that were only possible to answer if I understood the chemistry behind it took me on a journey on which new questions would continue to evolve in my mind until I decided to pursue further studies in the field. Curiosity was the beginning of everything.

REMOVAL OF MONOMERIC SILOXANES FROM WATER USING ZEOLITIC-BASED ADSORBENTS

I'm from Barranquilla, Colombia and I'm currently pursuing my doctoral studies in Chemical Engineering at the University of Puerto Rico in Mayagüez Campus. I'm conducting research in the Nanoporous Synthesis and Adsorption Laboratory (NSSAL) under the mentorship of Dr. Arturo Hernandez Maldonado.

Monomeric siloxanes are a source of concern for water quality due to their high solubility and associated health risks, including reproductive and carcinogenic effects. This project proposes the use of defective pure silica zeolites to remove monomethylsilanetriol (MMST), dimethylsilanediol (DMSD), and trimethylsilanol (TMS) from water. Pure silica zeolites are highly hydrophobic, which offers an advantage in water remediation by reducing competition between the target contaminants and water molecules. Moreover, the presence of silanol groups as defective sites within the structure enhances the adsorption capabilities of pure silica zeolites, making them highly promising candidates for siloxane removal.

Various highly faulted pure silica zeolites with distinct structures and varying degrees of faults will be synthesized under hydrothermal and autogenous conditions and fully characterized by X-ray diffraction (XRD), nitrogen porosimetry, thermogravimetric analysis (TGA), zeta potential measurements, and water contact angle measurements.

Significance. Siloxanes, characterized by their unique oxygen-silicon structure with attached organic radicals, find broad applications across industries and medicine. However, they also present significant environmental and health concerns due to their stability and adverse effects on living organisms. Monomeric siloxanes pose a significant challenge for environmental media, especially aqueous systems, due to their high solubility, not only in open environments but also in closed ones, such as the International Space Station (ISS).

This work's contribution to the scientific field is significant. While many studies have focused on removing siloxanes in the gaseous phase, there has been limited attention on their removal from water. Given their hydrophilic nature, removing monomeric siloxanes from water is a considerable challenge. Therefore, studying the interaction mechanisms between these contaminants and adsorbents will enable the design of materials with high capacity and selectivity for monomeric siloxanes.

Future goals. The future goals of this project would be to conduct dynamic analyses of pure silica zeolites with high adsorption capacity for monomeric siloxanes. Additionally, exploring the development of new materials with structural defects is also an area I wish to delve into.

In my academic and professional pursuits, my main aim is to complete my research on adsorption successfully. Additionally, I actively seek opportunities to collaborate with respected researchers and engage in interdisciplinary projects. This approach is in line with my overarching goal of contributing significantly to the scientific community by applying my skills to address real-world challenges in the fields of industry and environmental issues related to adsorption.

Fun fact. In my research and experiences within the field of Chemical Engineering, I've witnessed the incredible potential for scientific exploration to drive positive change in the world. Whether it's developing sustainable technologies like adsorption and searching for solutions to environmental issues, the possibilities are boundless. These experiences have reinforced my belief in the power of higher education in science to make a meaningful impact on our society and our planet.

SCIENCE IN ACTION

PR-SPRInT program's Education and Outreach component is committed to bringing science to the schools and the community, as well as motivating the new generations to pursue higher education studies in STEM fields. Our program seeks to empower students with the understanding that everyone can make meaningful contributions to the advancement of science and humanity, and that the realm of science is open to all.

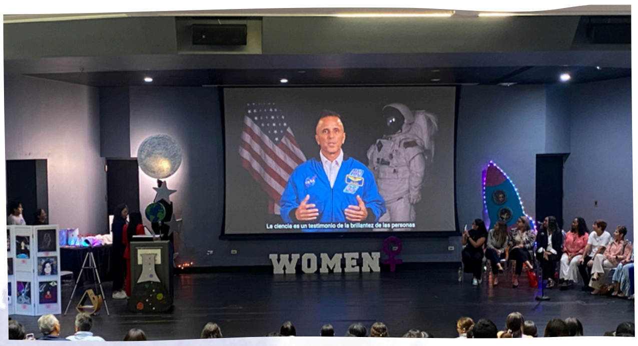
SCHOOL VISITS

Recently, we visited middle and high schools in Carolina and Aguas Buenas, in Puerto Rico, where we performed scientific demonstrations for the students. During these activities, the students can interact directly with the experiments we present and hear about what motivated our PR-SPRInT fellows to pursue higher education in Science fields. Our visits aim to inspire students to continue their higher education in STEM fields and bring them closer to the world of science.

From the education and outreach area, our mission is to inspire and prepare the new generation of explorers.

COMMUNITY ENGAGEMENT

V SYMPOSIUM
THE POWER OF WOMEN IN SCIENCE



On March 7-8, 2024, the V Symposium, "The Power of Women in Science," was celebrated at the University of Puerto Rico, Rio Piedras campus, showcasing the significant contributions of women, particularly Latino women, in the STEM disciplines.

This event brings together notable female scientists specializing in different areas of STEM. It also aims to connect attendees with the world of sciences, inspiring students to pursue careers in STEM and helping educators, researchers, and the wider community to identify academic and professional opportunities in these areas.

Each year, we host this symposium to honor the accomplishments of women and girls in science. Our goal is to motivate young Puerto Rican women to pursue careers in STEM by providing opportunities for them to present their research and projects as students. Additionally, they can engage with respected professionals from various scientific fields.

The theme for the 5th edition of our event was space exploration. Astronaut Joseph Acabá delivered the opening message through a pre-recorded video. We were honored to have special guests, including leaders from NASA and other agencies, as well as academics who have enhanced Puerto Rico's reputation in the field. Noteworthy attendees were NASA scientists Marla Perez-Davis and Dionne Hernandez, Monsi Roman, Yajaira Sierra, Olga Gonzalez, Roxana Gonzalez, and Ivonne Deliz, along with contributors from our university including Mayra Lebron, Carmen Pantoja, Yomaira Pagan, Desiree Cotto, and Liz M. Diaz Vazquez.

These prominent women shared their personal and professional experiences with the attendees, serving as a source of inspiration and motivation for the upcoming generations. This was also an opportunity to acknowledge the trajectory and contributions of our UPR professor, the astrophysicist Dr. Carmen Pantoja.

The agenda included other activities such as workshops on various topics like rover construction, cosmetic chemistry, 3D printing, and more.

There was also a poster exhibition and a fashion show where participants could demonstrate their creativity by either impersonating their favorite scientist or proposing innovative smart clothing designs for space missions.

During the two-day event, there were approximately 735 attendees, including students, teachers, and the general public. In addition, around 3000 people participated in the symposium through online streaming.

This event, like every year, combines learning, fun, and creativity in a setting dedicated to exploring the world of science.

CAREER MILESTONES

WHERE ARE OUR FELLOWS NOW

JOSE RUIZ-ARCE

LANGLEY RESEARCH CENTER, VIRGINA
Intern - Summer 2024

KIMBERLY MELENDEZ

UNIVERSITY OF ILLINOIS
Intern - Summer 2024

DIEGO COSTOSO

Brookhaven Lab MSI CONNECT
Intern - Summer 2024

Since our program started, 19 fellows have had the opportunity to participate in summer internships at NASA centers and other institutions. Some have been able to extend their stay during the semester.

TRAINING

At PR-SPRInT, we prioritize the wellness and professional development of our fellows. This is why we carefully organize and search for top-tier human resources and facilitators to provide training activities aimed at enhancing both personal and professional skills. These are the topics we covered in our latest workshops:

PROFESSIONAL AND PERSONAL DEVELOPMENT

- Time management
- Building successful mentoring relationships

RESEARCH SKILLS AND TOOLS

- XRD analysis
- Computational chemistry
- FabLab workshops:
  - 3D printing
  - Laser cutting
  - Digital drawing using Rhino 3D software

OUR TEAM

PR-SPRInT is a platform and shared space for researchers, students, and teachers to build a community that inspires the next generation of explorers.

Our vision is to create a community that engages and supports the next generation of explorers by serving as a platform and shared space for researchers, students, and teachers.

PR-SPRInT

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