UChicago, Argonne, and Fermilab present

LICENSE TO INNOVATE

a showcase to ID your next IP

SEPARATIONS TECHNOLOGY

A message from Juan de Pablo, Executive Vice President for Science, Innovation, National Laboratories, and Global Initiatives, the University of Chicago.

Hello,

Today's showcase combines the deep intellectual property strengths of three institutions: the University of Chicago and two U.S. Department of Energy national laboratories, Argonne National Laboratory and Fermi National Accelerator Laboratory.

In the breakthrough technologies showcased here, you'll see the results of many years of research and development by scientists at all three institutions.

The event today also showcases the results of hard work behind the scenes over the past several years by leaders across our institutions who joined forces to share best practices and innovate through the UChicago Joint Task Force Initiative (JTFI).

Launched in 2018, this unique initiative helps Argonne and Fermilab achieve mission success by opening channels of frequent communication and collaboration across institutions. It has led to the creation of several committees, strategic initiatives, and training opportunities that provide critical support for the national laboratories.

Part of the JTFI, the Technology Transfer Task Force explores operational synergies with Argonne and Fermilab. This task force's work led to the launch of this technology showcase. Previously, the task force played a key role in creating leadership development programs for staff in the national laboratories through the Polsky Center for Entrepreneurship and Innovation. With increased interest and engagement, these programs quickly expanded to multiple cohorts over just a few short years, and have inspired staff to apply entrepreneurial thinking to projects at the labs.

We hope this inaugural technology showcase will follow in the JTFI tradition as the first of many such celebrations of our combined strengths and the power of collaboration.

Thank you for tuning in.

Juan J. de Pablo

Juan de Pablo

ABOUT THIS PARTNERSHIP

The University of Chicago pursues the nation's most important science goals and fosters innovation, technology development, and economic progress through its stewardship of Argonne (through UChicago Argonne, LLC) and Fermilab (through Fermi Research Alliance, LLC) on behalf of the Department of Energy.

The University of Chicago is a leading academic and research institution that has driven new ways of thinking since its founding in 1890. As an intellectual destination, the University draws scholars and students from around the world to its campuses and centers around the globe. The University provides a distinctive educational experience and research environment, empowering individuals to challenge conventional thinking and pursue field-defining research that produces new understanding and breakthroughs with global impact.

Argonne National Laboratory seeks solutions to pressing national problems in science and technology. The nation's first national laboratory, Argonne conducts leading-edge basic and applied scientific research in virtually every scientific discipline. Argonne researchers work closely with researchers from hundreds of companies, universities, and federal, state and municipal agencies to help them solve their specific problems, advance America's scientific leadership and prepare the nation for a better future.

Fermi National Accelerator Laboratory is a Department of Energy national laboratory dedicated to particle physics research. Fermilab supports work by scientists, from across the country and the globe, who seek to further our understanding of matter, energy, space and time. At Fermilab, a robust scientific program pursues answers to key questions about the laws of nature and the cosmos.

WHY SEPARATIONS TECHNOLOGY?

Separation processes are critical across several industries, such as hydrogen, biofuels, pharmaceuticals, and water.

The high cost and energy intensity of product separations, purification, and recovery is a significant challenge. Advances in separation technologies are needed to reduce energy use, harmful emissions, and overall process costs. Some examples of innovative technologies developed include novel strategies for lithium extraction, supersonic beam diffraction for isotopic separations, and functionalized coatings of filtration membranes.

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AGENDA

11:00 – 11:25 // Welcome and Keynote

11:30 – 12:15 // Panel Discussion

12:15 – 12:45 // Break – Lunch

12:45 – 2:00 // Pitches and Q&A

- **Chong Liu:** Novel Strategies for Lithium Extraction
- **Steven Sibener:** Heterogeneous Isotope Enrichment and Separation Using Supersonic Molecular Beams
- **Yuepeng Zhang:** Electrodialysis Membrane for Selective Recovery of Critical Materials from Unconventional Water
- **Meltem Urgun Demirtas:** Ion Exchange Polymers, Membranes, and Ionomers
- **Jeff Elam:** Advanced Lithography
- **Sujit Bidhar:** Compact Scalable Nanofiber Mass Production Using Electrospinning

SPEAKERS

KEYNOTE SPEAKER

Juan de Pablo

Executive Vice President for Science, Innovation, National Laboratories, and Global Initiatives; Liew Family Professor in Molecular Engineering; Senior Scientist at Argonne National Laboratory

As the Executive Vice President for Science, Innovation, National Laboratories, and Global Initiatives, Juan de Pablo helps drive and support the expanding reach of the University's science, technology, and innovation efforts, along with their connection to policy and industry. He identifies and shapes emerging strategic scientific and technological initiatives, and provides oversight of entrepreneurship and innovation activities at the University's Polsky Center for Entrepreneurship and Innovation. He also works with faculty, deans, and administrators to build global academic partnerships and international research collaborations while overseeing the University's international centers.

PANEL MODERATOR

Chris Heckle

Director, Materials Manufacturing Innovation Center, Argonne National Laboratory

Chris Heckle is the Director of the Materials Manufacturing Innovation Center at Argonne National Laboratory. She is a globally recognized research and development leader who came to Argonne from Corning Incorporated, where she served as Research Director for Inorganic Materials Research and Asia Research Labs. She is a materials informatics champion who over a 25-year career has facilitated technology innovation across business units for multiple industries, generating hundreds of millions of dollars in revenue. Her experience includes creating a manufacturing platform that opened new market opportunities for Corning in energy storage, as well as a demonstrated record of translating megatrends into technical thrusts and accelerating product timelines through the introduction and adoption of new tools.

SPEAKERS

PANELIST

Andrea Course

Digital Innovation Program Manager, Shell

Andrea Course works as a Digital Innovation Program Manager for Shell, leading a global team of senior technology advisors to develop digital innovation themes, digital strategies, technology roadmaps, and opportunity funnels. Previously, she worked as Principal for Shell Ventures where she invested in innovative start and scale-up companies focusing in the areas of digitalization, ML, AI, robotics, and decarbonization. Currently, she sits on the boards of Innowatts (Digital Energy Platform), and Mirico (Gas Measuring Systems) and she is part of the LPAC at HTX Venture Fund. She has more than 15 years of experience in the energy sector as both a technical SME and an investor.

PANELIST

Gavin Dillingham

Executive Advisor, Federal Affairs, SLB

With over 15 years of experience in clean energy research and policy, Dillingham is currently an Executive Advisor, Federal Affairs at SLB, a provider of technology and solutions for the energy industry. In this role, he supports the development and implementation of federal and state strategy and engagement efforts to advance SLB's decarbonization solutions across North America. Dillingham is a certified climate change professional with expertise in electric power system resilience and greenhouse gas mitigation policies and programs. He has led interdisciplinary research teams, technology commercialization efforts, and fundraising and business development activities for clean energy and climate projects and has directed multiple U.S. Department of Energy program.

PANELIST

Ignasi Palou-Rivera

Executive Director and CTO, RAPID Manufacturing Institute at American Institute of Chemical Engineers (AIChE)

Ignasi Palou-Rivera is the Executive Director and Chief Technology Officer of the RAPID Manufacturing Institute, as well as the President of the U.S. Manufacturing Innovation Council (an independent non-profit connecting the Manufacturing USA institutes) and the Chair of the Manufacturing USA Council. Ignasi's professional career, of over 25 years, spans the areas of chemical process development, process modeling and optimization, refinery planning and scheduling, process technology valuation, and commercialization, covering techno-economic, life-cycle, sustainability analysis, and tech-to-market activities, as well as R&D management.

RESEARCHERS

Chong Liu

Neubauer Family Assistant Professor of Molecular Engineering, Pritzker School of Molecular Engineering, Univeristy of Chicago

Improved Electrochemical Li Extraction from Seawater and Other Dilute Li Sources Using Mixed Li and Na Layered Oxides

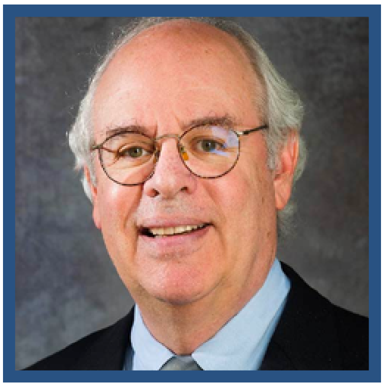
Inventors at the University of Chicago have demonstrated that the use of a new material from the layered cobalt oxide family can deliver highly selective Lithium extraction through material structural design. A core-shell structured $(NaLi)_{1-x}CoO_2$ material was synthesized using a core Li-phase ($Li_{0.94}CoO_2$), a shell Na-phase ($Na_{0.51}CoO_2$), and a transition intermediate phase through Na ion-exchange of the parent $Li_{1-x}CoO_2$ material.

The developed electrochemical extraction process works by extracting (electrochemical intercalation) Li from a dilute Li solution and recovering (electrochemical deintercalation) Li in a fresh solution. The core Li-phase limits layer expansion and prevents Na intercalation/promotes high Li selectivity, and the shell Na-phase/intermediate phase maintains electrode stability from further Na-ion exchange.

Pre-Seeding Lithium in 1D Olivine Hosts for Li Extraction

This technology utilizes the 1D olivine compound $FePO_4$ as a host material to control Li selectivity by manipulating the intercalation pathway. Results showed that Li and Na phase separate in $FePO_4$. This phase separation can be utilized to increase Na intercalation energy barrier through the creation of partially filled 1D Li channels by a non-equilibrium solid solution Li seeding process. Li seeding into the host $FePO_4$ material is achieved through electrochemical/chemical processes.

RESEARCHERS



THE UNIVERSITY OF CHICAGO

Steven Sibener

Carl William Eisendrath Distinguished Service Professor, Department of Chemistry, University of Chicago

Heterogeneous Isotope Enrichment and Separation Using Supersonic Molecular Beams

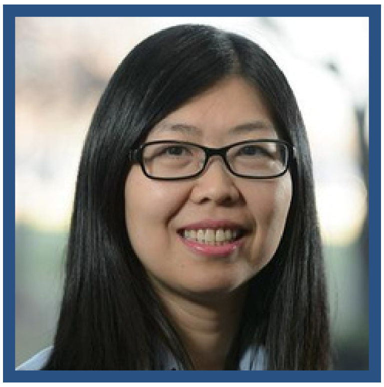
Present isotope separation methods utilize laser beams, centrifugation, and diffusion to exploit subtle differences in physical properties. However, these methods are relatively inefficient and require multiple successive steps to achieve the desired enrichment.

The angle at which molecules elastically scatter from a crystalline surface is dependent on both the velocity and angle of the incident beam. Based on this, the inventors devised an isotopic separation scheme in which a supersonic beam with a specific velocity and velocity distribution is directed at a crystalline substance. The different isotopes composing the beam scatter at different angles from the crystal surface, which allows for the isotopes to be separated and collected.

The invention is a system for the highly efficient separation of isotopes below 50AMU based on supersonic beam diffraction. The system consists of an ultra-high vacuum (UHV) scattering apparatus and an adjustable mass spectrometer detector and collector.

In small-scale proof of concept experiments, the inventors evaluated the separation of an isotopic mixture consisting of 20Ne and 22Ne. The method yielded an enrichment ratio of 3.50+/- 0.30 with respect to 22Ne and the measured diffraction pattern of the isotopes matched to the computationally predicted diffraction pattern.

RESEARCHERS



Yuepeng Zhang

Group Leader, Nanocomposite Materials and Membrane Manufacturing, Argonne

Electrodialysis Membrane for Selective Recovery of Critical Materials from Unconventional Water

Lithium can be collected from geothermal brines, lithium-containing ores, salt lakes, Li clays, and processed battery-recycled solutions. These Li resources contain competing ions such as Na+, K+, and Mg2+, making it challenging to obtain high-purity Li. Current lithium extraction techniques that use pressure-driven membranes are energy-intensive and have low Li selectivity, and adsorption methods that show relatively high Li selectivity require pretreatment and regeneration.

Argonne's novel hybrid membrane enables highly selective and continuous Li extraction without absorbent regeneration and exhibits higher permselectivity and a longer service time than the state-of-the-art. Compared with the traditional liquid extraction method, the membrane technology is compact, modular, and easy to standardize. Argonne's novel membrane facilitates a higher yield and a better cost performance because it enables the ion extraction process to be continuous.

Meltem Urgun Demirtas

Group Leader, Bioprocesses and Reactive Separations, Argonne

Ion Exchange Polymers, Membranes, and Ionomers

Argonne's novel ion exchange materials represent a class of new green membranes for CO2 capture and conversion to facilitate the transition to a decarbonized economy. Ion-conducting membranes and ionomers are critical components for many applications including fuel cells, water/CO2 electrolysis, flow batteries, and water desalination.

Current state-of-the-art proton and anion exchange membranes (PEM and AEM) are still not sufficient in conductivity, mechanical stability, and long-term durability. Some of the widely commercially available ion exchange membranes also have environmental concerns that have limited their wide application.

Argonne's technical advance is a novel cross-linkable nonfluorinated polymer with low cost, high ion conductivity, and long-term stability with great potential for use as membranes and ionomers in electrochemical applications.

RESEARCHERS

Jeff Elam

Senior Chemist and Group Leader, Functionalized Coatings, Argonne

Advanced Membrane Functionalization

The performance of membranes is determined in large part by the surface properties of the material, especially along the pore walls. Commercial membranes are manufactured from a relatively limited set of polymer materials, which provide a limited set of interfacial properties. Most of these polymers are hydrophobic, which makes them prone to fouling, especially in challenging separations such as oil/water. Fouling of membranes during industrial separations necessitates periodic cleaning with sparging or harsh chemicals (many of which degrade the structural integrity of the membrane), and ultimately replacement of the membranes. Most approaches to coating membranes to endow them with fouling resistance result in pore blockage due to non-conformal deposition.

Argonne uses conformal interface modification techniques such as atomic layer deposition (ALD) to modify the membrane surface properties without constricting the pores. Using these techniques, we can transform existing commercial polymer membranes into hydrophilic ones that passively resist the attachment of foulants, enabling substantially extended operational lifetime between cleanings as well as easier cleaning. For even more challenging fouling environments, ALD coatings can be rendered catalytically active so that reactive oxygen species can be formed at the pore walls in operando, degrading and detaching any foulants that may adhere.

ALD also has the ability to create gradient coatings along the pore lengths, producing so-called Janus membranes with different properties on their two sides. These membranes can exhibit transport properties impossible to achieve using traditional membranes, such as unidirectional transport of ions.

RESEARCHERS

Fermilab

Sujit Bidhar

Engineer, R&D, Fermilab

Compact Scalable Nanofiber Mass Production Using Electrospinning

Conventional electrospinning units use sophisticated power supply units, which are bulky systems with high input voltage and power outputs running into hundreds of watts. In contrast, the Compact Nanofiber Electrospinner system can be operated with a 9V battery, like the average Duracell battery, as well as a 12V DC adapter, like the ones used by laptop computers.

The system is a versatile unit employing a syringe-needled spinneret, which produces material analogous to the thread of a spider for nanofiber prototyping. It can produce a variety of ceramic and metallic nanofibers and be fitted with a needle-less helical spinneret for mass production. The system produces thicker nanofiber mats using a specially designed corona ionizer.

The device has applications in research labs and educational institutes; air and water filtration; textiles and wound dressing.

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Argonne NATIONAL LABORATORY

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Fermilab

The mission of the Office of Partnerships and Technology Transfer (OPTT) is to transfer technologies developed at Fermilab to private sector partners in order to enhance the nation's economic competitiveness. For more information, visit **partnerships.fnal.gov** or email **optt@fnal.gov**.

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