*Oak Ridge National Laboratory*

# CHEMICAL SEPARATION LICENSING OPPORTUNITIES

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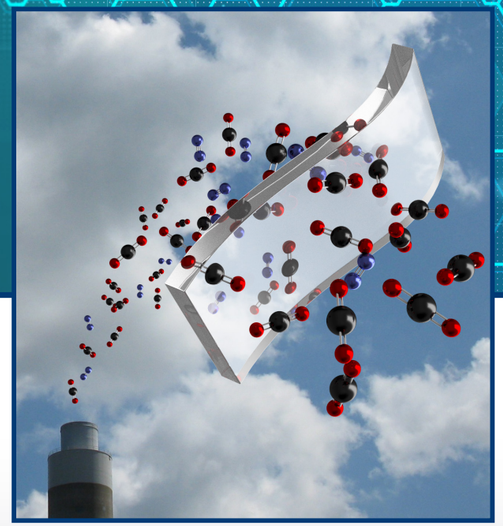
https://chemicalseparationtechnologies.ornl.gov.



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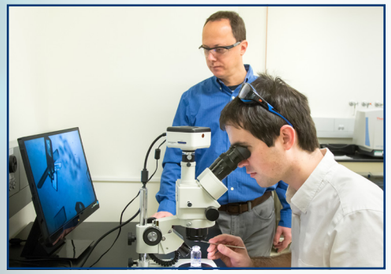
U.S. DEPARTMENT OF ENERGY

OAK RIDGE National Laboratory

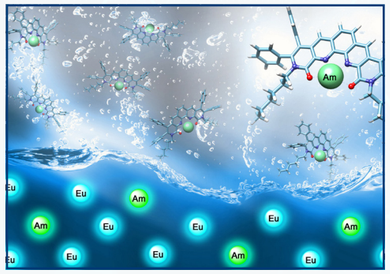
# Chemical Separation Licensing Opportunities at ORNL

ORNL researchers are working with the US Department of Energy (DOE), industry, and academia to develop new fundamental knowledge of separations processes to drive promising chemical separation systems that can be easily adopted by industry. ORNL-developed chemical separation systems offer economical, efficient separation agents that are stable and functional under real-world processing conditions. ORNL's Caustic-Side Solvent Extraction process, which separates >99.99% of the cesium from tank waste, has been used in processing more than 6 million gallons of high-level waste at DOE's Savannah River Site since 2008. These novel approaches involve efficient sorbents, highly selective receptors, polymer membranes, solvent extraction, and selective crystallization that can be applied to wide-ranging industrial needs, including industrial waste streams, industrial contaminate removal, and recovery of critical materials and other commodities. Individuals and organizations can partner with our researchers via Cooperative Research and Development Agreements, Strategic Partnership Projects, or user agreements. For a list of chemical separation technologies available for licensing, please visit https://chemicalseparationtechnologies.ornl.gov.



## Gas Separation

ORNL researchers have developed separation systems to advance negative emissions technologies such as carbon dioxide capture for sustainable energy production. These systems incorporate materials such as ligands for carbon dioxide capture and carbonate precipitation and membranes and nanostructured polymer architectures for gas separations. ORNL-developed technologies offer unique advantages for industrial processes, including greater permeability, high selectivity, recyclability, cost-effectiveness, and easy adoption into current practices. ORNL scientists have created a robust portfolio of sorbents that provide easy capture of gases and recovery of precipitated contaminates while avoiding energy-intensive processes. ORNL research also focuses on novel highly selective and permeable membranes for large-scale separation of carbon dioxide. ORNL's technology portfolio also offers nanostructured architectures such as bead-based polymers and porous membranes that selectively bind and/or transport target molecular species via tailored interactions.

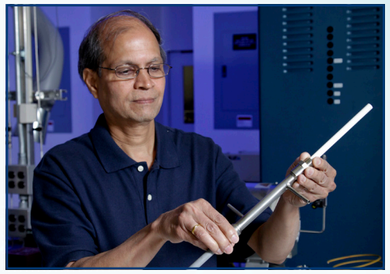



## Extraction Systems

Researchers at ORNL are working to provide solutions for clean water and for waste management of industrial systems. Combining expertise in chemical synthesis with the Laboratory's leading-edge experimental and computational capabilities, scientists create novel systems with superior selectivity, backed by predictive modeling and analysis. Selective and efficient extraction systems are designed using cost-effective materials that are often recyclable. These systems can be designed to control ion binding in liquid–liquid extraction and crystallization of desired products. Some are developed as selective molecular traps that separate specific molecules from mixtures of similar species. ORNL's separation technologies portfolio also includes anion-binding motifs based on new guanidinium, urea, and calixpyrrole platforms, and when combined with cation-binding groups, the structures form high-order assemblies with high selectivity. Research and development focused on ionic liquids has led to novel liquid separation systems with unique physical properties. These technologies offer process safety advantages compared to typical solvents and can be tailor-made for specific industrial applications compared to typical solvents.

## Capture Systems for Industrial Processes

Research at ORNL focuses on the grand challenge of clean water, particularly on the development of technologies to support desalination of drinking water and treatment of water from industrial processes. Capture systems developed at ORNL target a variety of contaminants and commodities in water sources such as seawater or industrial waste streams. The Laboratory's extensive technology portfolio ranges from high-capacity sorbents, such as the HiCap adsorbent material designed to extract uranium from seawater, to carbon-based composites, such as mesoporous carbon materials or tire-derived carbon black composites designed to extract minerals, metal ions, or specific compounds from industrial waste streams.



## Critical Materials Recovery

Critical materials—also called rare earth elements—are important to the development of a multitude of products; however, these materials must first be purified from their natural source. The most difficult aspect of purification is separating the materials from each other, which is costly and time consuming. Current processes are inefficient and repetitive and use potentially harmful acids and organic compounds in large quantities. ORNL researchers are focused on developing new chemical separation technologies with high efficiency, low cost, and low environmental impact. These separation systems can also isolate rare earth elements from untapped new sources and recycled materials, providing new supply chains. ORNL researchers also focus on near-critical materials such as lithium salts. Novel separation systems isolate lithium in large quantities from brines, opening new supply lines to meet increasing demands for lithium-ion batteries especially for use in electric vehicles, smart phones, and other portable electronics.

***For a list of technologies available for licensing please visit https://chemicalseparationtechnologies.ornl.gov.***

## *Licensing Success Story: Purolite® Corporation*

Purolite® Corporation, a leading manufacturer of ion exchange, catalyst, adsorbent, and specialty high performance resins, has a comprehensive line of single-use and regenerable resins for perchlorate removal. ORNL exclusively licensed to Purolite® a resin-based separation system that removes perchlorate and breaks it down into harmless chloride and water. The company's commercially available resins have the advantage of being recharged so they can be used many times, resulting in process costs of up to 80 percent less than conventional methods. The company offers the ORNL-patented perchlorate selective resins as Purolite A530E and Purolite A520E. Purolite A530E is a hydrophobic anion resin that offers one of the highest selectivities for perchlorate and pertechnetate.


## *Licensing Success Story: U.S. Rare Earths Inc.*

ORNL licensed to US Rare Earths Inc. a membrane solvent extraction system invented by researchers at ORNL and Idaho National Laboratory who are members of DOE's Critical Materials Institute. The recycling of critical materials from electronic waste has been limited by processing technologies that are inefficient, costly, and environmentally hazardous. The licensed system offers a simplified process eliminating many of these barriers. Because it involves a single-step process, the system recovers rare earth elements from scrap magnets in a more environmentally friendly manner and has the potential to be more cost-effective than conventional approaches. Through its licensing agreements with ORNL, US Rare Earths Inc. will use the technology to recover rare earth elements from electronics and from its mining claims in the United States.

*"Based on conversations around our mutual commitment to US sustainability, we agreed that the recycling of electronic waste will provide a competitive source of neodymium, dysprosium, and praseodymium for growing the clean tech sector including electric vehicles,"* said Kevin Cassidy, CEO for US Rare Earths Inc.