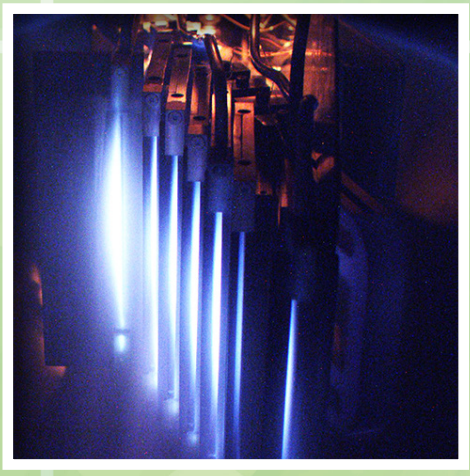


# ENRICHED STABLE ISOTOPES

Isotope Program

U.S. Department of Energy

U.S. DEPARTMENT OF ENERGY | Office of Science

# Restoring Domestic Stable Isotope Production

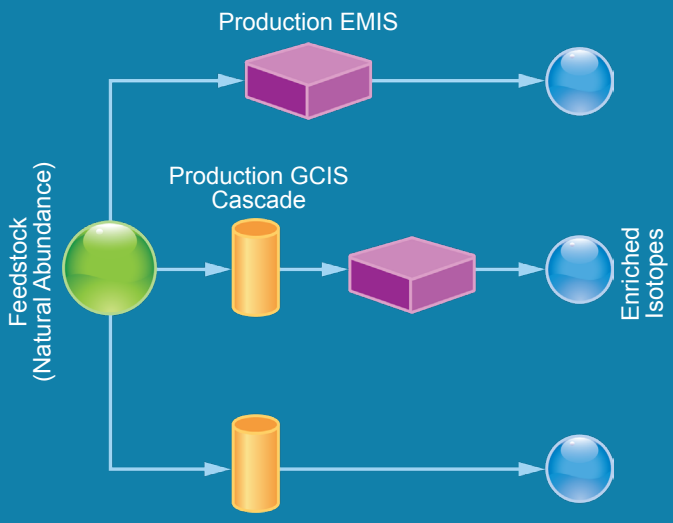
For the first time in 20 years, the United States has an operating stable isotope enrichment capability. The new Enriched Stable Isotope Prototype Plant (ESIPP), funded by the U.S. Department of Energy Isotope Program (DOE IP) and located at DOE's Oak Ridge National Laboratory (ORNL), takes an integrated approach to enriched stable isotope production by incorporating both electromagnetic separation and gas centrifuge technology. As a result, a wide range of enriched stable isotopes is now attainable domestically for basic research, medical, national security, and industrial applications.

*Electromagnetic Isotope Separator (EMIS) at ORNL*

The DOE IP, managed by the Office of Science for Nuclear Physics, began investing in the development of modernized stable isotope enrichment technology in 2009 in response to a growing market demand and a diminishing supply. Development of an electromagnetic isotope separator (EMIS) as part of this effort was first commissioned in 2012, and an upgrade for even higher throughput was completed in 2016. The EMIS technology was transitioned to production operations in 2017, and in early 2018 the first batch of a highly enriched isotope was produced and delivered.

Theoretically, the EMIS system can separate almost any element on the periodic table into individual isotopes. The first step toward separation is to vaporize the element into the gas phase and convert it into an ion beam. The beam is then channeled through a magnetic field, causing ions of different mass-to-charge ratios to bend through different trajectories. The separated ion beams are then focused into separate collection pockets, from which the isotopes are recovered and chemically processed to maximize purity.

Currently, ESIPP can produce research quantities of enriched stable isotopes and is being upgraded to increase the throughput to kilogram quantities for various isotopes. The scalable design of ESIPP can accommodate additional EMIS and gas centrifuge machines, depending on future isotope demand and funding opportunities.

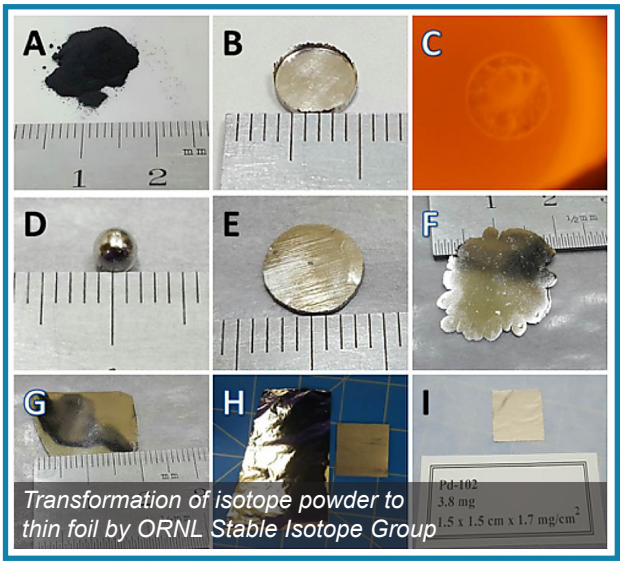



## Integrated Approach

Although EMIS can achieve high enrichment for most elements, its throughput is limited (i.e., milligrams to tens of grams annually). Applications requiring both high-enrichment and high-throughput isotope separation are better served by ESIPP's gas centrifuge technology, currently capable of producing several tens of grams annually, depending on the isotope. An ongoing expansion project is expected to increase annual production capacity to kilogram levels. This cascade of gas centrifuges is also an effective way to pre-enrich target isotopes for use as EMIS feedstock.

## Large Inventory Available for Dispensing

The DOE IP owns about 250 stable isotopes spanning 59 elements available through the National Isotope Development Center catalog (www.isotopes.gov). The majority of these isotopes were obtained through electromagnetic separation in Manhattan Project-era calutrons. These isotopes have served as feedstock for countless research efforts and applications, and they range in value from less than one dollar to tens of thousands of dollars per milligram. Isotopes are dispensed in inventory form (generally powders) to fill customer orders unless an alternative physical or chemical form is requested, and a lease program is also available for isotopes used in nondestructive research. The dispensing of stable isotopes is managed under an ISO 9001:2015 registered quality management system, helping to ensure consistently high-quality products to customers.



*Transformation of isotope powder to thin foil by ORNL Stable Isotope Group*

## Tailored Solutions

Many custom-order chemical and materials processing services are available from the ORNL Stable Isotope Group to help address customer needs efficiently and cost effectively. Current capabilities include:

- Inorganic chemical synthesis, metallurgical, ceramic, and high-vacuum processing
- Pyrochemical conversion
- Arc melting, casting, alloying, and drop casting
- Pulse arc welding
- Hot and cold rolling of metal foils
- Inert processing of reactive metals
- Wire casting, rolling, and swaging
- Metal and ceramic powder consolidation
- Vanadium-encapsulated neutron dosimeters
- High-vacuum evaporation
- Diamond abrasive wire sawing
- Ion beam and plasma sputtering
- Target customization
- High purity transfer of enriched gases

**Front Cover Captions:** From top: magnesium-25 metal produced by reduction/distillation of magnesium oxide, used as a target for high-resolution nuclear cross-section measurements; ruthenium isotope beams separated in ORNL's Electromagnetic Isotope Separator; stable isotope inventory housed at ORNL

**Photo Credits:** All images courtesy of Oak Ridge National Laboratory

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