Improved method for isotope enrichment could secure a vital global commodity

June 29 2014

This is a still frame from an artist's animated rendering of the MAGIS Device (magnetically activated and guided isotope separation). To begin the MAGIS process, unpurified ore is vaporized and enters an optical pumping region where a one-watt laser (red beam) tuned to a specific wavelength magnetizes only the particles of the desired isotope so that they are repelled by a magnetic field. The magnetized and unmagnetized particles enter a curved tunnel lined with permanent magnets, called a wave guide. The particles must follow the curve to make it to the collector at the end, but can only do so if repelled by the magnetic field. Since only the particles of one isotope are magnetized (blue dots), only those particles make the trip and end up in the collector. The MAGIS method was developed by Mark Raizen, Tom Mazur and Bruce Klappauf. The full animation can be viewed below. Credit: © Marianna Grenadier, College of Natural Sciences, The University of Texas at Austin.

Researchers at The University of Texas at Austin have devised a new method for enriching a group of the world's most expensive chemical commodities, stable isotopes, which are vital to medical imaging and nuclear power, as reported this week in the journal *Nature Physics*. For many isotopes, the new method is cheaper than existing methods. For others, it is more environmentally friendly.

A less expensive, domestic source of stable isotopes could ensure continuation of current applications while opening up opportunities for new medical therapies and fundamental scientific research.

Chemical elements often exist in nature as a blend of different variants called isotopes. To be useful in most applications, a single isotope has to be enriched, or separated out from the rest.

A combination of factors has created a looming shortage of some of the world's most expensive but useful stable isotopes.

Last year, the Government Accountability Office released a report warning that there may soon be a shortage of lithium-7, a critical component of many nuclear power reactors. Production of lithium-7 was banned in the U.S. because of environmental concerns, and it's unclear whether the current sources, in China and Russia, will continue meeting global demand.

One of the major sources of molybdenum-99, essential for medical imaging in tens of millions of heart, kidney and breast procedures each year, is an aging nuclear reactor in Canada that's expected to cease operations in 2016. Other valuable isotopes are produced by Cold War era machines known as calutrons operating in Russia. Their extreme age, high operating costs and regional concentration further threaten global supply.

"Isotopes are among the most expensive commodities on Earth," says Mark Raizen, professor of physics in The University of Texas at Austin's College of Natural Sciences and author on the study. "One ounce of a stable isotope that needs the calutron to separate it can run around $3 million. That's roughly 2,000 times the price of gold. And that has held back certain medical therapies."

Unlike the calutron, which requires huge amounts of energy to maintain a magnetic field with electromagnets, the new method for enriching stable isotopes, called MAGIS (magnetically activated and guided isotope separation), needs little energy due to its use of low-powered lasers and permanent magnets. It also has less potential for environmental effects than the chemical process used in producing lithium-7, which has been linked to mercury contamination.

View an animation of the MAGIS device in action and read more about how it works below:

Nuclear medicine in particular could benefit from the new method, the researchers say. Many stable isotopes are precursors to the short-lived radioisotopes used in medical imaging, cancer therapies and nutritional diagnostics.

The new method also has the potential to enhance our national security. The researchers used the method to enrich lithium-7, crucial to the operation of most nuclear reactors. The U.S. depends on the supply of lithium-7 from Russia and China, and a disruption could cause the shutdown of reactors. Other isotopes can be used to detect dangerous nuclear materials arriving at U.S. ports.

Raizen's co-authors on the paper are Tom Mazur, a Ph.D. student at the university; and Bruce Klappauf, a software developer at Enthought and a former senior research scientist at UT Austin.

Now, Raizen's top goal is getting this technology out of the lab and into the world. The MAGIS invention has been issued a U.S. patent, which is owned by The University of Texas at Austin, with Raizen and Klappauf as inventors.

Raizen plans to create a nonprofit foundation to license the technology.

"I believe this is world-changing in a way that is unique among all the projects that I have done. And I do feel passionately about it," said Raizen. "There are many potential uses of isotopes that we don't even know yet. But they've been held back because the price has been so high, or it's been unavailable. That will be one of the missions of the foundation—to explore and develop isotopes to benefit humanity."

Some critics have raised concerns about the potential for terrorists or rogue states to use MAGIS to enrich uranium for nuclear weapons. Raizen believes these concerns are unfounded given uranium's unique chemical characteristics. Read an online debate between Raizen and Francis Slakey, a physicist and associate director of public affairs for the American Physical Society here: http://www.aps.org/publications/apsnews/201301/backpage.cfm.

More information: Demonstration of magnetically activated and guided isotope separation, *Nature Physics*, DOI: 10.1038/nphys3013

Provided by University of Texas at Austin

June 29) retrieved 27 April 2024 from https://phys.org/news/2014-06-method-isotope-enrichment-vital-global.html