Recovering critical raw materials

Minerals such as antimony, germanium and indium are integral to a wide variety of technologies and devices. Researchers in the ION4RAW project are developing new, more sustainable and environmentally-friendly methods to recover critical raw materials and metals from mining sites, as Maria Tripiana explains.

Critical raw materials like cobalt, germanium and platinum group metals are integral to the production of a wide variety of products and technologies, from photo-voltaic panels to mobile phones, and a reliable, sustainable supply is correspondingly important to the European economy. Europe relies to a large extent on imports for its supplies of these materials, but now the European Commission is keen to encourage research into recovery methods designed to make better use of existing primary sources of ores. "The EC is trying to support projects which focus on the recovery of these materials," outlines Maria Tripiana, a division manager at the Spanish computational science research company IDENER. The ION4RAW project, an initiative bringing together 13 partners from eight different countries – including IDENER – is making an important contribution in this respect. "We are working to develop a more efficient and environmentally friendly way of recovering metals from primary sources," explains Tripiana, the project coordinator.

This would represent a significant shift away from many of the hydrometallurgical processes that are currently used to separate metals and recover waste materials, some of which are based on the use of quite toxic, environmentally harmful materials. For example, gold can be extracted by a leaching process called cyanidation, which involves the use of highly toxic cyanide; by contrast Tripiana and her colleagues in the project are working to develop a new, greener approach. "We are looking to find another route," she says.

ION4RAW project

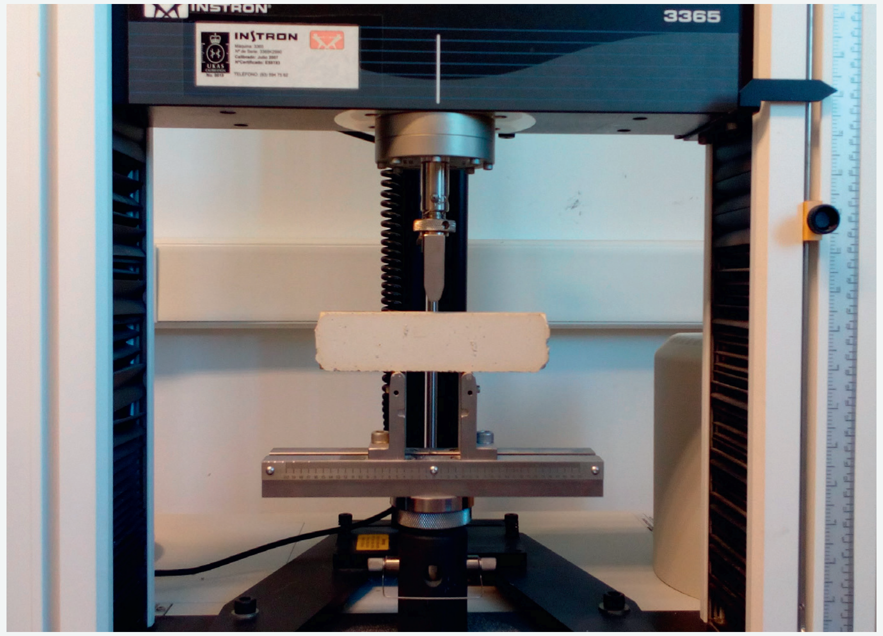
The project is targetting the recovery of several materials on the EUs Critical Raw Materials list published in 2020, including germanium, bismuth and indium, as well as product metals like gold, silver and copper. These materials are commonly found at landfill sites and in mining waste, and Tripiana says the project's mining partners have played an important role in identifying which resources are present at which sites. "We asked some of the mining companies involved in ION4RAW to assess whether the metals that we are interested in were present in their resources. We then started work on characterising the materials and analysing which metals are there," she says.

> We are working to **develop a prototype** of the technology at Tecnalia's facilities. We are also thinking about how the technology can be **integrated within existing mining facilities.**

The process under development in the project has five main steps and is based on the use of innovative deep eutectic solvent ionic liquids; these are green, chemically stable solvents which can be modified and tuned to recover different metals. "There are different formulations of deep eutectic solvents, depending on the metal of interest. We are screening different formulations of deep eutectic solvents," continues Tripiana.

These deep eutectic solvents are comprised of two components, the Lewis and Brønsted acids, which melt at a different temperature to the mixture as a whole. After minerals have been prepared for processing they are dissolved into the deep eutectic solvents, and the resulting solution is comprised of a mix of different metals. "We have a target metal, and there are also other metals," explains Tripiana. The second part of the ION4Raw process is electro-deposition, which Tripiana says takes place in the same reactor as the initial step. "With the deep eutectic solvents, we are going to have a solution with metals. After electro-deposition we then have the metals in a solid form," she outlines. "In the electro-deposition process, the deep eutectic solvent solution is effectively used as an electrolyte solution. There is a cathode and an anode, which are also made of metals - a current is applied, and the metals are deposited in the cathode in a solid form. There are several factors which may affect the electro-deposition process, such as resistance between the liquid and the cathode, and the presence of chemicals which may be produced."

Researchers in the project are working to address these types of technical challenges, which are central to the wider objective of scaling up the technology and demonstrating its effectiveness beyond the laboratory environment. This is an issue which is high on the project's overall agenda. "Scaling up a technology from the laboratory is always a major challenge," acknowledges Tripiana. The technology itself is not yet quite ready for practical application but significant progress has been made, with researchers working to reach technology readiness level (TRL) 5 by the end of the project. "We are working to develop a process prototype of the technology, the reactor, at our partner Tecnalia's facilities. We are also thinking about how the technology can be integrated within existing mining facilities," continues Tripiana. "We have to consider the way that mines currently work, and we also have to consider the fact that mining is a very old industry. They have very well-established procedures, and they have been working in a particular way for a very long time."



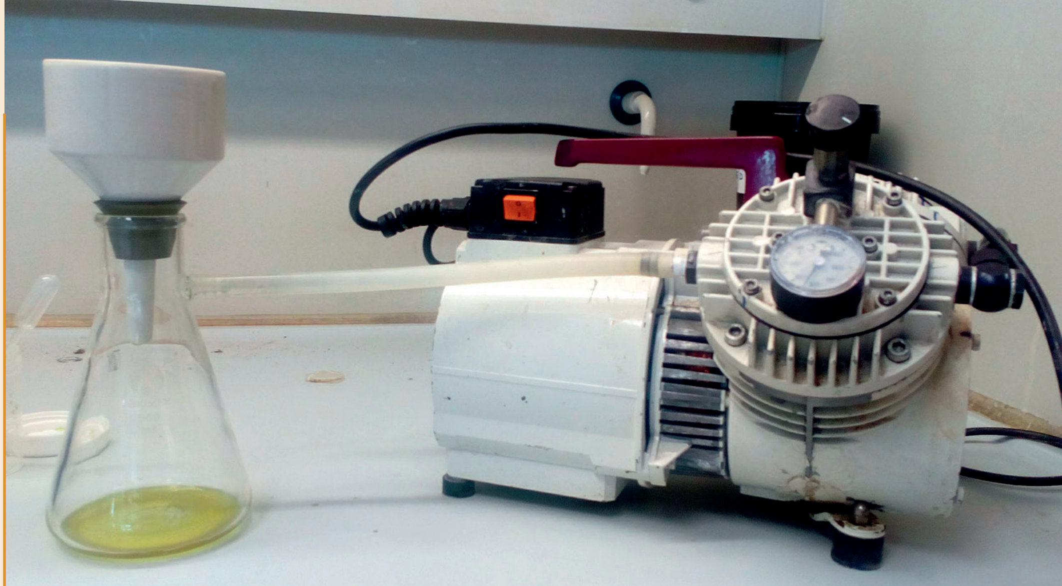
The circular economy of the process was validated in Lurederra technology center by the incorporation of remaining solids in concrete formulations, showing good mechanical properties.

Mining companies

A mining company might not be ready to change these established procedures without clear evidence that an alternative will deliver benefits, so it's important to show that the technology works effectively. While the ION4RAW project itself is set to conclude in November, Tripiana says there is the possibility of a continuation, which could involve bringing the technology closer to practical application. "We could try to focus on reaching a higher TRL, implementing the ION4RAW technology in a mining environment and demonstrating that it works," she outlines. A further area of interest is the possibility of using secondary resources rather than primary resources, yet this would be challenging. "The concentration of these metals is going to be diluted in secondary materials, so it's going to be more difficult to extract them," explains Tripiana. "We could potentially look into applying the ION4RAW technology on secondary resources, but we would expect it to be less efficient."

The focus in the project at this stage however is on primary resources from mining sites, part of the wider goal of moving towards a circular economy, in

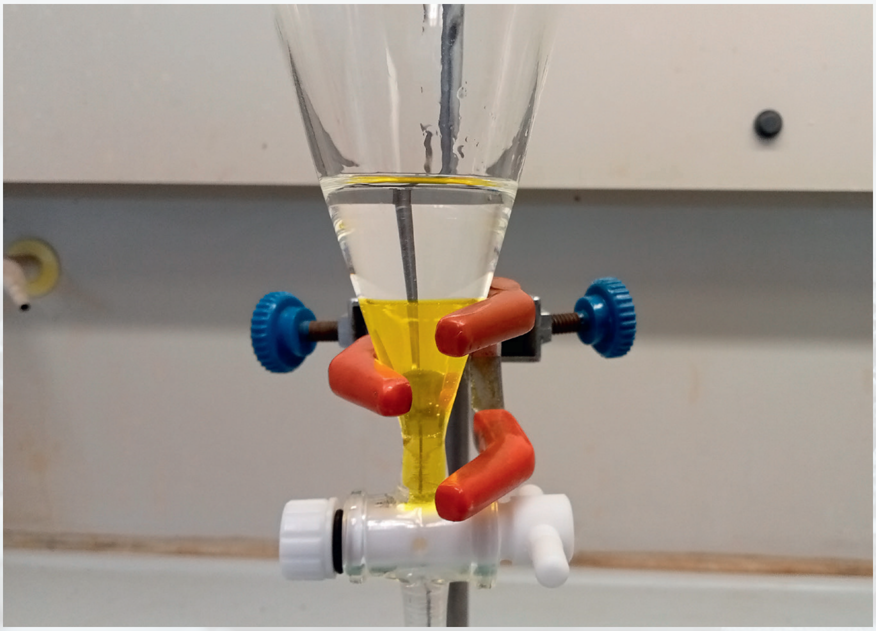
Chemical recovery routes developed in Lurederra technology center based on extraction/precipitation have succeeded in the recovery of some target elements.



Chemical recovery routes developed in Lurederra technology center
based on extraction/precipitation have succeeded in the recovery of some target elements.

which existing materials are used for as long as possible. This is very much in line with the general push towards minimising waste and reducing Europe's dependence on supplies of critical raw materials from abroad, which in some cases have been disrupted over recent years. "We are trying to get these materials from our own resources in Europe, and to develop a process with a very small amount of waste," stresses Tripiana. A second metal recovery stage can be applied in the process to recover any metals that may not have been recovered initially, while the deep eutectic solvents themselves can also be reused, further underlining the environmentally-friendly nature of the project's work. "We are also working on the qualification of the deep eutectic solvents, so that they can be used again," continues Tripiana. "The deep eutectic solvents will be recovered and cleaned, so they can be used over several cycles."

This work is targeted at specific minerals and by-products, yet there are many more materials beyond those targeted by ION4RAW on the EC list. The 2020 edition lists 30 critical raw materials, with four new additions from the 2017 edition, all of which have been identified as being important to the European economy, with a risk of supplies being disrupted. "The EC make an assessment of how difficult it is to get these metals in Europe and give them a criticality factor," outlines Tripiana. While the project is not looking to apply this technology in recovering other materials, Tripiana says there is interest in exploring its flexibility. "We have a lot of different formulations of deep eutectic solvents, and the process can be adapted to a specific feedstock," she says. "The idea is to find the proper deep eutectic solvent for the process. That is the key in terms of the flexibility of the ION4RAW technology."



ION4RAW

Ionometallurgy of primary sources for an enhanced raw materials recovery

Project Objectives

The European Commission identified 30 critical raw materials in a 2020 list. These materials are all essential to the European economy, with the Commission looking to ensure a reliable, sustainable supply to power industry.

The ION4RAW project aims to develop a new, environmentally-friendly means of recovering mineral by-products from waste materials, tapping into currently under-utilised resources from landfills and mining sites.

The project's work brings together researchers from several different disciplines, including metallurgy, process and chemical engineering, and electrochemistry. This research will both enhance the sustainability of the mining industry, and contribute to the goal of establishing a circular economy where resources are re-used.

Project Funding

This project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 815748.

Project Partners

https://ion4raw.eu/project-partners/

Contact Details

María Tripiana
Industrial Process Applications
Division manager / Project Manager
IDENER
Early Ovington 24-8
41300 La Rinconada
Seville, Spain
T: +0034 954460278
E: contact@ion4raw.eu
: https://twitter.com/ION4RAW_EU
W: https://ion4raw.eu/
W: www.idener.es

Maria Tripiana

Maria Tripiana is Division Manager of the Chemical Applications Department in IDENER, a role in which she coordinates and manages several H2020-funded projects. She holds an MSc in Chemical Engineering (industrial intensification) from the University of Seville (2012) and an MBA from ISNIB (2020).

ION4RAW

idener
SCIENTIFIC COMPUTING

European Commission | Horizon 2020 European Union funding for Research & Innovation