1. Gold Insight

Tracing Gold-Copper-Zinc with advanced microanalysis

The proposed research will contribute to the Challenge of securing Primary Resources by developing innovative techniques for exploration.

The innovative new techniques will arise from a novel combination of state-of-the-art micro-chemical analysis: trace element mapping and in situ Pb and S isotope analysis as well as trace-element informed geochronology. The technology readiness level of these techniques will be elevated by increasing the speed and throughput of analysis. The tools will be trained on known orogenic gold (Au) exploration targets for which full 3D geological and structural models will be developed and integrated with absolute geochronology. The targets are in active emerging orogenic gold districts in Sweden and Ireland where low environmental-impact extraction is feasible. We have assembled a three-partner consortium from two EU countries with some of the most exciting developments in exploration for Au and with outstanding field resources, analytical facilities, and world-leading expertise.

The outputs of the proposed project will contribute to the implementation of the ERA-MIN2 work programme. It will significantly de-risk exploration in these and other minerals districts and develop an innovation platform for higher participation of EU institutions in the global exploration market. Orogenic gold deposits also often host other precious or base metals, including significant quantities of tellurium and its discovery will help secure the supply of this energy-critical-element (ECE).

OBJECTIVES

This proposal seeks to contribute to the challenge of securing Primary Resources by developing innovative techniques for exploration, thus directly meeting Topic 1 of the ERA-MIN2 call 'addressing new concepts, technologies and improved models to be used in mineral exploration'. The main exploration targets are orogenic gold (Au) deposits in Sweden and Ireland. There is a global exploration demand for Au with mine production projections sharply declining. The targeted type of Au deposits can also be an important source of the energy critical element (ECE) tellurium (Te), for which there is a predicted increase in demand from photovoltaic films. The project will develop novel environmentally responsible techniques for Au and associated Te exploration and discovery thereby addressing the second concern of Topic 1: 'to make significant or demonstrable progress toward the goal of responsible and sustainable development through increasing raw material supply while reducing impacts on the environment'. The advanced targeting methods will discover at the early exploration stage, the recoverable grade of Au, and whether beneficial precious Te is present, and whether the deposit hosts potentially harmful penalty elements

1. To develop a new exploration tool for orogenic Au deposits

2. To construct a 4D model for the two gold districts, by combining 3D structural models with the absolute age relationships between Au deposition, structural events and intrusions of proximal granites, using novel, customised geochronological tools capable of high-precision dating orogenic Au mineralisation

3. To trace the ultimate source of Au and test possible genetic relationships to lower temperature Cu and Zn-Pb deposits in Ireland.

Project Coordinator: Prof Balz Kamber Trinity College Dublin

Partners: Luleå University of Technology, Swedish Museum of Natural History

Geosciences

Start date April 1st 2018, 24 month duration

Total value of the project: €727,550

Total funding to Irish partners from GSI: €176,150

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2. RecEOL (co-funded by EPA)

Recycling of End-of-Life Products (PCB, ASR, LCD)

RecEOL provides evidence that a patented recycling process for waste printed circuit board (PCB), LCDs, batteries and automobile shredder residue (ASR) is economically viable and environmentally sustainable. The project brings together industry and academia to solve the challenges of recycling above wastes while realising the business opportunities in recycling.

PCBs are part of the WEEE (Waste Electrical and Electronic Equipment) stream; one of the fastest growing waste streams in the EU. The best way to increase the recycling rate will be to offer a highly profitable process to provide a financial incentive. PCBs are present in most electronic equipment such as televisions, computers or mobile phones. Hence RecEOL has global potential. The objective and expected outcome of the RecEOL project is to demonstrate (1) the capability of the process to recycle metals including critical (indium) and special (tantalum), (2) that the metal recycling yields are significantly improved over current processes, (3) that the process is economic and environmentally sustainable.

RecEOL is applied research. The aim is to show on the pilot plant scale that the scaled-up commercial plant is economic. Hence, RecEOL must establish the metal yields, the kinetics, the mass balances to find the financial performance of a commercial plant. The technology offers many advantages over current technologies:

1. Yields: over 95% recycling rate of copper, steel and solder exceeding the current rates of 70-80%. Moreover, aluminium, solder and steel is separated and can be recovered.

2. Critical and special metals: for the first time, metals such as indium and tantalum will be recyclable.

3. All PCBs: even low value (TVs; low gold content) PCBs.

4. No shredding: highly energy efficient process.

5. Simple process from established industries: no moving parts, low capital cost.

6. Easy scale up: doubling the salt volume, doubles throughput of the continuous process.

The project is an essential step towards the commercial implementation of the RecEOL process.

OBJECTIVES

Currently not all metals present in WEEE are recycled. But with RecEOL as a pre-processing step prior to metal recycling these otherwise lost metals incl. indium & tantalum can be recycled, while others with improved yields compared to standard methods.

The objective and expected outcome of the project is to demonstrate (1) the capability of the RecEOL process to recycle valuable metals including critical and special metals from PCBs, LCD screens, ASR and lithium-ion batteries (currently hardly any recycling), (2) that all the metal recycling yields are significantly improved over current best technologies, (3) that the process is economically viable for end-users e.g. COR, ALU & MRU, (4) that the process is environmentally sustainable and (5) that the process also results in a viable business for CRL, the inventor and owner of the RecEOL process.

The purpose of the consortium is (1) to provide undisputable scientific evidence that the RecEOL process separates metals into a number of streams enabling subsequent metal refining by existing processes operated by ALU, MRU or others and (2) that the process can be scaled-up to an economic throughput. New metal recycling processes will be developed.

Project Coordinator Dr Maria Jose Sousa Gallagher, University College Cork

Partners: Composite Recycling Ltd, Coolrec BV (COR), Technische Universität Bergakademie Freiberg (TUF), Alumisel (ALU), Muldenhütten Recycling und Umwelttechnik GmbH (MRU)

Start date May 1st 2018, 36 month duration

Total value of the project: €2,479,457

Total funding to Irish partners from GSI: €199,958

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3. Biomimic (co-funded by EPA)

Innovative biotechnological methods for effective mining of secondary material

Metal supply is one of Europe's biggest challenges. The Commission has identified a number of metals as critical for its industry and the employment; meaning that they are essential for high-tech, green and defence applications, while their availability is fluctuating due to politically and economically driven factors. Ironically, metals of a high economic value end-up in low technology applications, being landfilled or in hazardous wastes, posing threat to the environment and health. It is estimated that fly ash from waste-to-energy plants produced annually in Europe, contains metals of the value of 600 million euro. Another promising resource of high-value metals is red mud; a by-product of aluminium industry considered to be hazardous and that has been involved in a couple of environmental incidents.

The reason for not exploiting resources like ashes and red mud is that the metals are present at low concentrations and in complex matrices. With its unique multidisciplinary consortium of problem owning and end-user industries, innovators and researchers BIOMIMIC is aiming to solve the challenge of extracting these metals, while leaving the remaining material free from toxic substances. The project will explore naturally occurring bioprocesses, namely biosulfide precipitation and biosorption. Employing beyond state-of-the-art innovations in microorganism mixtures and reactor design is expected to increase the rate of these typically slow biotechnological methods. The expected impacts of BIOMIMIC include: i) pushing EU to the forefront of sustainable processing technologies, ii) improving competitiveness through creation of added value and new jobs, iii) creating value of raw materials currently landfilled enabling better efficiency of exploitation of raw

materials' resources and iv) increasing the range and yields of recovered raw materials (including water and energy consumption) leading to reduced environmental footprint.

OBJECTIVES

BIOMIMIC develops prototypes that address key problem areas of complex waste processing, including dilute and complex metal mixture, chemical usage and water management. The primary objective of BIOMIMIC is to create and validate new biotechnological metallurgical methods that have the potential to concentrate metals selectively in dilute solutions. It combines commercially available leaching techniques with innovative biotechnological methods for metal recovery. The processes mimic the natural occurring biological processes but use pioneering reactor design and biosorbents and microbial consortia / communities to increase the selective metal recovery, productivity and yield at tough conditions. Besides the technical aspects of process development, the objective is to reduce investment risks by increasing the process knowledge and by performing techno-economic evaluations of the potential process routes. Furthermore, the project will provide an estimation of the ecological impact and possible contribution of BIOMIMIC prototypes to the European supply of target metals. The methods can also be applied on additional low-grade, polymetallic primary and secondary resources such as acid mine drainage and tailings, increasing their impact on resource efficiency in Europe. Objectives include:

- Recover Zn, Iron oxide and further Critical Raw Materials (CRM) targeting 90% recovery and 56% purity as sulfides from complex waste material in municipal solid waste and red mud using leaching and bio reduction and/or biosorption
- Develop a cost and energy effective bioprecipitation prototype with 1) novel reactor designs and 2) microbial consortia of Sulfate Reducing Bacteria (SRB) that combines water and chemical recovery with metal recovery, validated using industrial leachates (TRL 5) and resulting in at least 1 non-disclosure application
- Improve and validate metal recovery, such as Miscanthus Biochar, ashes from sludge incineration and cyanobacterium Synechocystis PCC 6803 of low level metal wastes with high pH and salts including fly ash leachate and residues from the alumina and steel processing industries (TRL 5)
- Reduce the risk of investment by understanding the complexity and nature of Exopolysaccharide Substances (EPS) from a structural perspective; quantifying the responds of relevant variables on SRB behaviour and biosorption mechanism through factorial design and descriptive and technoeconomical models
- Stimulate innovation and achieve a high involvement of stakeholders to increase the commercial readiness level, give feedback to the method development, reduce risks of investment and facilitate dissemination of the result
- Create economic and environmental additional benefits by reducing landfilling costs of fly ash by approx. 80 €/ton
- Produce metadata and assess the benefit of BIOMIMIC prototypes on securing metal demand in EU and thereby facilitating future technology upscaling activities to commercial scale. Write a EITRM application for post-BIOMIMIC upscaling activities by spring 2020
- Improve industrial and public perception of the processes by a dissemination module including giving feedback to the BREF documentation of "Best available technologies" [1], publication of 3 scientific manuscripts, 2 pan European press releases, 1 industrially and publically relevant report, BIOMIMIC short videos and presence on social media channels

Project Coordinator Dr Karin Willquist, Research Institutes of Sweden

Partners: Fraunhofer Institute for Systems and Innovation Research, Flocazur AB, Nordic BioEngineering AB, Purac AB, Aughinish Alumina Ltd, Luleu University of Technology, Fortum Waste Solutions, G.E.O.S. Ingenieurgesellschft mbH, University of Limerick, Geonardo Environmental Technologies

Start date May 1st 2018, 29 month duration

Total value of the project: €1,078,708

Total funding to Irish partners from GSI: €339,500

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4. Scandere (co-funded by EPA)

Scaling up a circular economy business model by new design, leaner remanufacturing, and automated material recycling technologies

Securing the supply of raw materials is one of Europe's biggest challenges. The Commission has identified 30 critical raw materials (CRMs), which are adopted by products in many sectors. Today, most of the products are processed in the "make-sell-use-dispose" paradigm, where original equipment manufacturers (OEMs) intend to sell a higher number of products and lose control of the products after their sales.

The **product-as-a-service (PaaS) model**, which provides OEMs with a **reverse incentive**, is emerging as a promising concept in several sectors and creating a potential for increasing the CRM efficiency by a factor of two or more. However, to raise and upscale the adoption of CRM-efficient PaaS business models, a major challenge is to **holistically address the inter-dependent activities** occurring in different points both temporally and geographically: product design, remanufacturing, and recycling.

Therefore, front runners in European industry and academia, including the need owners and solution providers, will join forces in this project to tackle this challenge taking consumer electrical and electronic equipment as an example.

The major outcomes will showcase three CRM-efficient PaaS offerings with enhanced sustainability as **a European model** to business leaders and policy makers. The major expected impacts are 1) increasing the **CRM efficiency and security** from the EU's interest, 2) **decoupling economic growth and resource use** and 3) improving **innovation capacity** for further enhancing CRM-efficient PaaS business models.

OBJECTIVES

1) Create three demonstrators with improved product **designs**, leaner **remanufacturing**, optimized **recycling** and adapted **regulations** in a CRMefficient PaaS business model from the three pillars of sustainability using indicators with the lifecycle perspective, and

2) **Improve knowledge** for product design, remanufacturing, and recycling including their interplays among them in a whole CRM-efficient PaaS offering.

Project Coordinator: Prof Tomohiko Sakao, Linköping University

Partners: Elektrorecykling S.A., Compliance and Risks, Poznan University of Technology, Katholieke Universiteit Leuven, Institut Polytechnique de Grenoble, BSH Hausgeräte GmbH, Asociatia ECOTIC

Start date May 1st 2022, 36 month duration

Total value of the project: €1,495,494

Total funding to Irish partners from GSI: €144,800