**Met4Tech** – UKRI Interdisciplinary Circular Economy Centre for Technology Metals

*(PI - Prof Frances Wall, Camborne School of Mines, University of Exeter)*
UKRI Interdisciplinary Centre for Technology Metals
(21 Co-Is, 9 PDRAs, 8 PhD Students, 3 man./policy staff, 50+ partners (£1.6 million cash/in-kind)

**Theme 1 – Virtual Data Observatory – Stocks / Flows & Practices**
Li, Co, REE, Te, Se, PGM, In, W, Sn, Ta, Ga, Nb, Sb …

**Theme 2 - CE Principles for Raw materials & new Geo-models**

**Theme 3 - Design, Manufacturing, & Recycling Technologies**

**Theme 4 - Roadmap for a new technology metals circular economy system**

- POLICY & GOVERNANCE
- ENVIRONMENTAL & LCA
- SOCIAL SCIENCES & VALUE CHAINS
- RESPONSIBLE INNOVATION
We need to transform the current linear system for supply/use (take-make-waste) into a new **Technology Metals Circular Economy system and network**.

**Some Areas for collaboration opportunities include:**

- New approaches for the extraction/production of tech metals that reduce waste, energy use, and pollution.
- Ways to retain technology metals for use in strategic applications and in products with longer service life;
- Innovative technology for more efficient recovery and recycling of technology metals from wastes/products at end-of-life; and,
- New industry/business models with more circular approaches to promoting the technology metal values chains in the UK.
<table>
<thead>
<tr>
<th>Metal</th>
<th>Symbol</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antimony</td>
<td>Sb</td>
<td>Alloys, Batteries, semi-conductors</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Co</td>
<td>Batteries, superalloys, catalysts, magnets</td>
</tr>
<tr>
<td>Gallium</td>
<td>Ga</td>
<td>Electronics (circuit boards and optoelectronics)</td>
</tr>
<tr>
<td>Germanium *</td>
<td>Ge</td>
<td>Electronics (IF detectors and thermal imaging)</td>
</tr>
<tr>
<td>Indium</td>
<td>In</td>
<td>Photovoltaics, Batteries, LCDs, phone screens</td>
</tr>
<tr>
<td>Lithium - UK</td>
<td>Li</td>
<td>Batteries</td>
</tr>
<tr>
<td>Niobium</td>
<td>Nb</td>
<td>Super conductor, electronics</td>
</tr>
<tr>
<td>Platinum Group Metals</td>
<td>PGM</td>
<td>Auto catalysts, fuel cells, electronics</td>
</tr>
<tr>
<td>Rare Earth Elements</td>
<td>REE</td>
<td>Magnets (wind turbines, EVs), catalysts, phosphors (low energy lighting), alloys, smartphones</td>
</tr>
<tr>
<td>Selenium *</td>
<td>Se</td>
<td>Electronics, alloys</td>
</tr>
<tr>
<td>Tantalum (3TG)</td>
<td>Ta</td>
<td>Electronics, superalloys</td>
</tr>
<tr>
<td>Tellurium</td>
<td>Te</td>
<td>Alloys, solar cells</td>
</tr>
<tr>
<td>Tin – UK (3TG)</td>
<td>Sn</td>
<td>Solder in all electronics</td>
</tr>
<tr>
<td>Tungsten – UK (3TG)</td>
<td>W</td>
<td>Wear-resistant materials, superalloys, electrical and electronics, catalysts</td>
</tr>
</tbody>
</table>

- All metals shown above are on UKs List of Critical Minerals 2022 (* except for Ge and Se)
- Several of these metals (Li, Sn, W) have mineralisation / mining projects in the UK
- Metals shown as 3TG are on the list of Conflict Minerals
Overall objective:
- To develop a knowledge base for assessing flows and stocks of technology metals across their value chains.
- To form the **UK tech metals CE National Virtual Data Observatory (NVO)**

Key questions addressed in TA1:

- Where (sectors/ applications/ products) are tech metals located in the UK economy?

- What is the tech metals resource potential in UK stocks?

- What is the fate of the UK tech metal stocks reaching the end-of-life stage and the amount of leakage across existing systems?
CE Principles for Raw Materials & new Geo-Models

- Granite-related (Li, Sn, W) mineralisation and related mine waste in Cornwall – **in progress**
- Cobalt deposits mined by large scale mining (LSM) and artisanal and small-scale mining (ASM)
- Carbonatite-related REE mineralisation and mine wastes
- Maximising value of (Te, Bi, W) by-products from gold mining

**Case Studies & Projects:**
Thematic Area 3 (TA3)

Design, Manufacturing & Recycling:
Develop novel separation and recycling techniques for technology metals, linking together chemistry, materials science, AI and robotics.

Fast and selective separation methods:
- Fast delamination techniques
- Changes in physical properties
- Developing selective etchants
- Developing de-bondable adhesives
- Design for recycle and reactor design
Thematic Area 4 (TA4)  
Josh Ignatius, Frank Boons

Developing the technology metals CE Roadmap:  
Agent-Based Model with Policy Evaluation Architecture

We will examine:  
Scenarios, Interventions, and Options

We will conduct:  
Deep Dive / Spark sessions, Constructor Workshops, and User Testing of the Roadmap
Some recent Case Study Examples:

**Joint Case Study**
Met4Tech & CE-Hub
Value chains for Rare Earth Elements (REEs) used in Magnets for Electric Vehicles (motors) and Wind Power (turbine blades)

**Cornwall Case Study with Company partners**
Looking at lithium, tin, tungsten mineralisation and applying new Circular Economy Geo-models (will also be contributed to UN Resource Management System)

**Lithium-Ion Batteries Value Chain**
*Ten challenges for developing a circular economy for Lithium-ion batteries*

**Solvent Extraction / Delamination Research Innovations**
Recovery of tech metals from waste electronic products such as mobile phones, photovoltaic devices, super-magnets, and lithium ion batteries

**Responsible Innovation**
Development of guidelines based on transparent interactive review of activities and ‘learning lessons’ for more circular and sustainable approaches
Many ways to collaborate...

- Data collation & value chains
- CE systems development
- Stakeholder interviews and workshops
- CE principles & technology innovations
- Developing & testing the CE Roadmap
- Providing feedback and ideas

Website: [https://met4tech.org/](https://met4tech.org/)  
Email enquiries: Met4Tech@exeter.ac.uk

**University of Exeter** - Carol Pettit *(senior impact manager)*, Victoria Smyth *(project coordinator)*  
**University of Birmingham** - Sam King *(project manager)*