WORKING TOWARDS A SECOND LIFE FOR CRITICAL RAW MATERIALS IN GERMANY

Each year millions of tonnes of waste electrical and electronic equipment (WEEE) is generated in the EU, but only 30% is reported as properly collected and recycled. The Critical Raw Materials (CRM) Closed Loop Recovery Project aims to increase the recovery of target materials by 5% by 2020 and by 20% by 2030.

With this in mind the project has invested in trials exploring novel ways of boosting the collection and recovery of CRMs from household WEEE.

Held across the UK, Italy, Germany and the Czech Republic, the collection trials mechanisms included retailer take-back schemes; re-use containers at household waste recycling centres, business collections, university drop-off hubs, school collections and other collection events.

PROMOTING RECOVERY IN GERMANY

RecyclingBörse (also known as 'AKR'), based in North Rhine-Westphalia in Germany, collects and re-markets used products in its own second-hand shops across the region and also runs a certified WEEE recycling facility.

AKR is an independent and not-for-profit organisation, with a mission to promote re-use. It also has the capability to test and evaluate collected WEEE items according to technical and market criteria.

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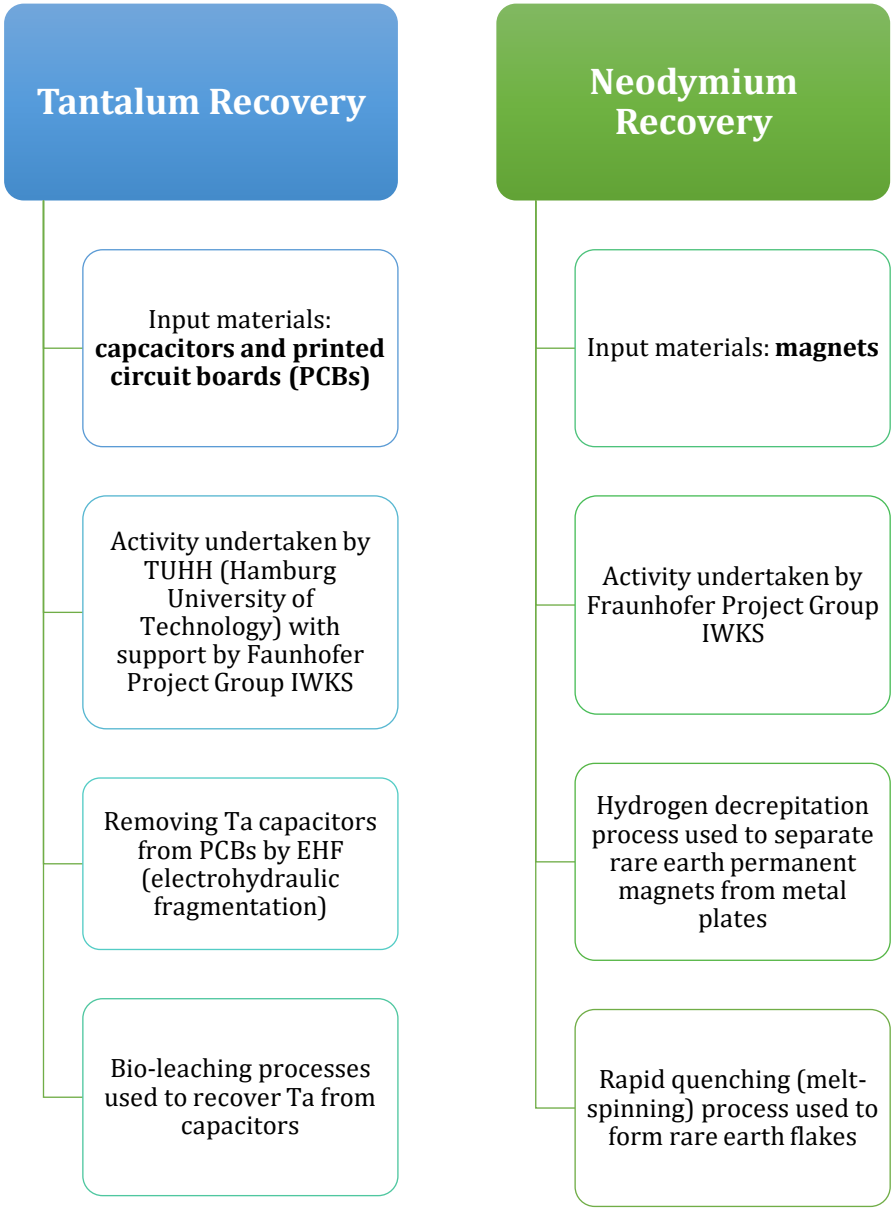
METHODOLOGY

This trial was focussed on the recovery of tantalum (Ta), commonly used in the electronics industry for capacitors and high power resistors, and neodymium (Nd), commonly used as an alloy within magnets and within everyday household items, such PCs, laptops and smartphones.



Notes:

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The bio-leaching trials for Ta are classed as very early-stage, as it is a metal which cannot be leached even by aqua regia, and there is almost no existing literature for Ta bio-leaching. As the bio-leaching process does not require or produce highly toxic or highly corrosive chemicals, the downstream processes, including the metal-removing from liquid phase and waste water treatment, would cause much lower environmental impacts.

LINK BETWEEN COLLECTION AND RECOVERY TRIALS

The below table demonstrates the overall recovery potential of Ta and Nd based on the collection and recovery trials. The trial activities listed are described within the AKR collection case study.[1] *Note: The recovery trials were focused on good accessibility and identifiability of Ta and Nd containing components. Therefore, only the number of PCs and laptops are taken into consideration*.

NUMBER OF COLLECTED ITEMS WITH PRINCIPAL TANTALUM AND NEODYMIUM POTENTIAL					
WEEE Item	**Collection Trial Activity**				
	Re-use Olympics Schools	**Re-Bag**	**Re-Box**	**Total**	**Recovery Potential**
PC	32	Zero	Zero	**32**	Ta, Nd
Laptop	4	Zero	Zero	**4**	Ta, Nd
Mobile phone	36	20	1	**57**	Ta, Nd
Smartphone	30	3	Zero	**33**	Ta, Nd
Tablet	11	3	Zero	**14**	Ta

TRIAL RESULTS

[1] http://www.criticalrawmaterialrecovery.eu/three-ways-to-get-great-weee-recycling-results

- The recovery potential per unit (laptop or PC), depending on the length of the leaching process, is promising. This is especially the case, given that the industry standard for extraction of Ta in the current treatment of PCBs in a smelter route is zero.

Length of leaching process	Leaching ratio	Tantalum recovery potential
70 days	13.74%	0.0011g
15 days	5.31%	0.0004g

Table 2: Ta recovery potential per unit (PC or laptop).

- The recovery potential of Nd from magnets is also positive. For a single Hard Disk Drive (HDD) with a 10.1g magnet of the Voice Coil Motor (VCM), 0.65g of Nd is recoverable. The recovered amount of Nd during the trial also determined the technical recovery potential of magnet flakes that are directly usable in a magnet production. Since there is no practical process existing in Europe, this figure is an important footnote that could stimulate further technological advances towards the removal of VCM magnets from HDDs.

LESSONS LEARNT

Commercial

- With regard to the recovery of Nd from HDDs, there is currently no recycling process implemented in Europe for magnet recycling/recovery. Thus, the commercial viability can be evaluated only roughly by comparison with the estimated costs of the production and pricing of magnets imported from China. Currently, the assumed price of magnets from China is about 60€/kg. Based on indicative assessments of the recovery trials for this project, the cost of producing 1kg magnet material from used magnets from HDDs is about 15€, with current price levels of 95€/kg for virgin Nd oxide.

- The current lack of economically viable recycling processes highlights the importance of keeping collection costs low to improve the overall economic viability of the process.

- The analysis of the trials showed that even though the operational costs of bio-leaching are considerably higher than the cost of traditional recovery processes and conventional mining, more metal can be extracted using bio-leaching, especially from low-grade material (e.g. copper). Conventional mining can extract 60% to 65% from an ore/material, whereas 90% to 95% can be extracted using bio-leaching. The same results are expected for Ta and other CRMs.

Recovery Process

- **The recovered material can be directly used** for new magnet processing, without further purification of melting processes (as it is already a ready-to-use form).
- **Manual dismantling took time and effort**. It would be useful (and possible) to develop an automatic dismantling system for HDDs.
- **The recovered amount of Nd during the trial determined the technical recovery potential of magnet flakes that are directly usable in magnet production**. This is an important development, as there aren't any practical processes existing in Europe.
- **Further (future) work would be useful** in a number of areas:
  - To investigate the potential of setting-up economically feasible magnet production in Europe by incorporating significant flows of secondary magnets from sources such as HDDs and electric motors.
  - To develop an economically viable dismantling process to remove the VCM magnets from HDDs.

BUSINESS BENEFITS

- This trial supports a 2017 recommendation by the German Environment Agency

(UBA). Namely, that future treatment regulations should include a Ta requirement that magnets from HDDs should be separated and added to a recovery process.

- The Ta recovery by bio-leaching shows a high potential for new innovative research, especially considering that there appears to be no existing literature on this specific problem.

- Bio-leaching (compared to conventional acid leaching) has a low environmental impact and avoids the use of hazardous substances. This therefore suggests opportunities to implement this technology in new markets, or for use by organisations that have restrictions in handling hazardous liquids.

- This CRM Recovery Project trial has tested and demonstrated a number of repeatable, lab-scale (but scalable) processes for the recovery of CRMs from WEEE items.

- The trial has also successfully demonstrated the important link between WEEE collection and CRM recovery, which can serve to increase the latter.

- The learnings and outcomes of this trial have provided valuable input into the EU-wide policy and infrastructure recommendations that will be published shortly, and which could be applied in a commercial setting to increase the recovery of CRM-rich components from data-bearing devices.

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