HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

ELECTRONICS RESEARCH LABORATORY

SUOMEN AKATEMIA

Program: Critical Materials in Circular Economy of Cities (Romulus) 2022-2025

FUSUMIN - Focused ultrasound for urban mining

How to develop economically viable metal recovery processes for circular economy of electronics?

MOTIVATION

With rare and precious metals (RPMs) in great demand by the modern industries, interest has grown in the recent years in finding new sources of them. Traditional mining - extracting minerals and metals from the crust of the Earth - is becoming increasingly more difficult as resource nodes deplete. Current techniques for RPM circulation by extraction from electronic waste consume a lot of energy and produce harmful pollution from the chemical processing. One promising approach is urban mining - utilizing scrap rich with RPMs, such as printed circuit boards or car catalysts, for "mining", i.e. extraction of RPMs.

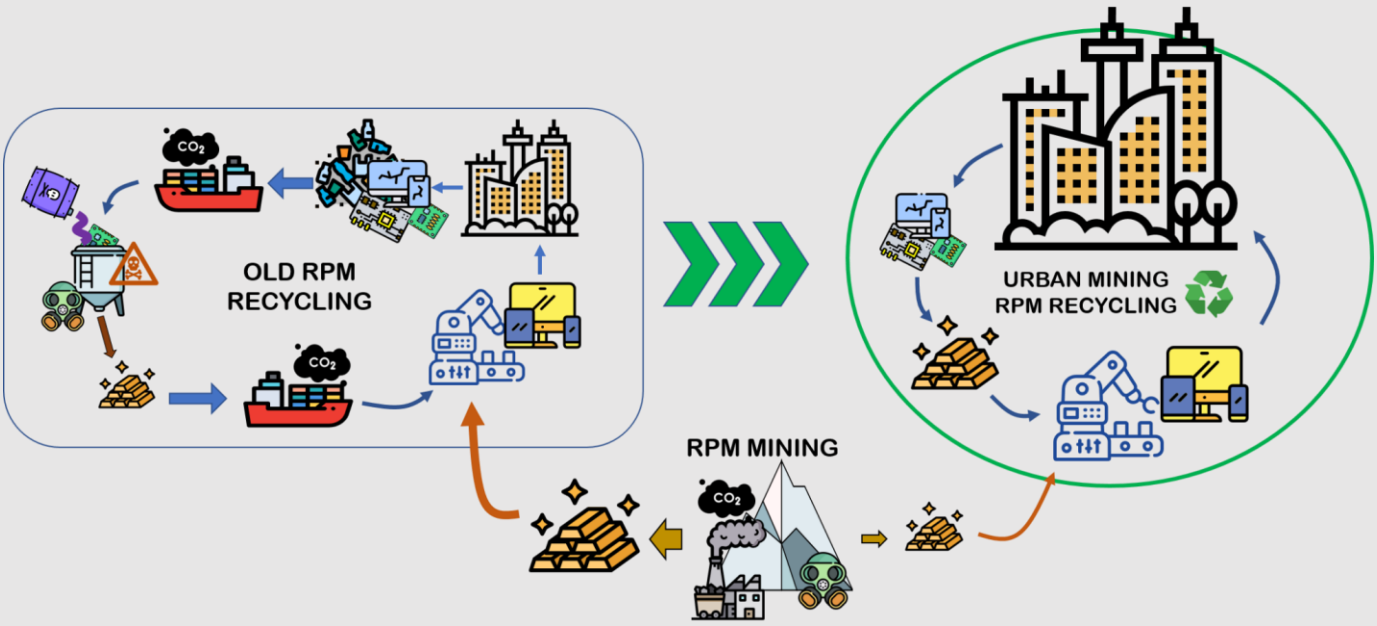

Figure 1. FUSUMIN concept on reducing mining of rare and precious metals, and boosting greener recycling by introducing new urban mining solutions into the circular economy.

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EXECUTION

In this project, we propose to reduce the use of chemicals in RPM extraction by enrichening the material to be refined. We do this by identifying the areas of scrap rich in RPMs by ultrasonic imaging, and utilize a focused ultrasound transducer to extract these areas with high concentrations of the desired metals, which can then be fed to traditional refining. The project will demonstrate the proof-of-concept of automated RPM rich area identification, ultrasonic extraction and scaling up to an industrially and economically viable scale.

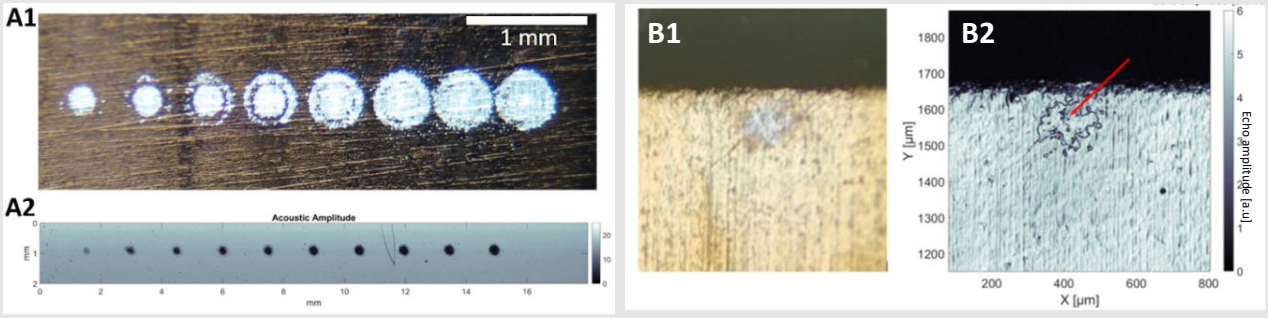

Figure 2. A) Preliminary data of coating removal using ultrasound: (A1) localized extraction of a coating phantom (black ink on aluminum). (A2) Localized extraction of aluminum from a solid sample surface (increasing acoustic amplitude from left to right increases the extraction volume). B: Proof-of-concept of FUSUMIN extraction of a gold plated connector on a PCB. (B1) Microsope photo showing localized extraction of gold (white area). (B2) An ultrasound microscope image of the same area.

IMPACT

We foresee that the technique developed in this project could make urban mining significantly more environmentally friendly, thus making it a viable source of RPMs in our world plagued with climate change. Our vision is a paradigm shift providing technology for cleaner future where RPM is recycled inside or near cities where the actual devices are manufactured and used instead in massive centers where all waste is first collected from around the world. This will have a global environmental and direct local societal impact on developing countries by both reducing the amount of new RPM mined from their natural resources as well as dumping of used RPM back to them in a form of electrical waste.

Scientifically the impact comes from advancements in understanding the interaction of the localized cavitation generated by the ultrasound related to the material extraction, ultrasonic imaging of rough surfaces and RPM identification from these images. This is the first time a localized material extraction is utilized to decrease the chemical usage in RPM recycling. The technique has potential also beyond urban mining e.g. in biological sciences (identification and extraction of e.g. cancerous cells for analysis).

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RESEARCH GROUP

The research group, lead by Professor Ari Salmi, is a strong group of physicist in Electronics Research Laboratory in the Department of Physics at the University of Helsinki. The group is composed of ultrasound post-doctoral researchers and fresh young Ph.D. students assisted by motivated undergraduates eager to learn more every day. The expertises of group members range from advanced electronics design and FEM-modelling of ultrasonic physics to development of industry applications of ultrasound driven instrumentation.

Prof. Ari Salmi, Ph.D – Project PI

Professor Salmi has 17 years of experience in innovation and research related to industrially relevant topics. He has published 88 peer-reviewed journal papers and conference papers and has filed for 14 patents. He also has filed over 20 invention disclosures to the University of Helsinki. Specifically, related to ultrasound industry application, he has broad experience in developing imaging and actuation solutions. Prof. Salmi co-leads the Electronics Research Laboratory with Professor Edward Haeggström.

ELECTRONICS RESEARCH LABORATORY

Electronics Research Laboratory is the leading ultrasound physics laboratory in Finland focusing on harnessing state-of-the-art physics research for industry applications. The laboratory's scope of research applications spans over multi-disciplinary fields from steel industry through pharma & medical to food. Among fundamental academic physics research, the laboratory has a strong track record in providing R&D projects for industry by developing and implementing instrumentation solutions to most demanding industry applications. Beyond academia, more than 6 companies have been span-out from the laboratory´s research having impact of the economic welfare of Finnish society.
