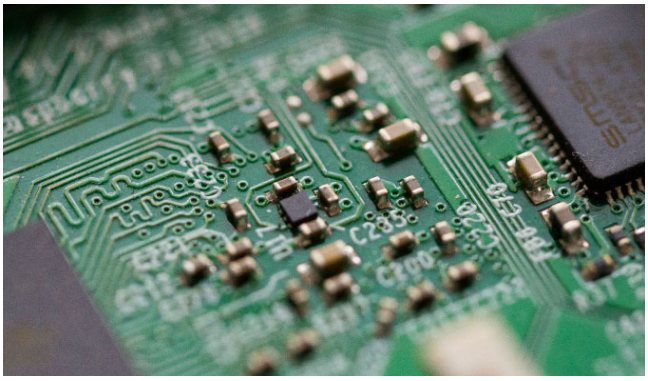
A GAME SYSTEM FOR RECOVERING PRECIOUS METALS FROM E-SCRAP

Gas-assisted microflow solvent extraction can help boost the value of complex material streams from circuit boards.



The computers and electronics we rely on for nearly all aspects of modern life have a heavy end-of-life (EOL) footprint. The world generates some 50 million metric tons of electronic scrap (e-scrap) every year.[1] Very little of that is recycled: The rate is about 15 percent in the United States.[2]

The lack of e-scrap recycling represents a global loss of more than $62 billion in precious metals such as gold and platinum.[3] Recovering these metals requires a cost-effective extraction process that can recover them at high purity.

Researchers at Virginia Polytechnic Institute and State University, working with the resource management firm Phinix, have developed a solution for producing high-purity precious metals from EOL printed circuit boards. The team's gas-assisted microflow extraction (GAME) system provides several advantages over conventional solvent extraction systems, such as shorter residence time and lower extraction cost.

PROJECT DESCRIPTION

Printed circuit boards pose a recycling challenge because of their mixed composition and high concentrations of lower-value base metals such as copper. Conventional methods like acid leaching, where metals are dissolved from the product before being recovered and purified, can be expensive and produce toxic wastewater when the resulting leach solution contains low levels of target metals, as with printed circuit boards. Bulk solvent extraction requires long loading times to accumulate enough desirable material.

In this project, the team collected scrapped laptop and desktop computers at Virginia Tech, studying the elemental compositions of the computers' printed circuit boards. In the first part of the project, various methods, including physical pretreatments, two-stage acid leaching, traditional bulk solvent extraction, stripping, and reduction precipitation, were applied, and systematic experiments were performed to study the optimized conditions. Precious metals, including gold, silver, and palladium, were leached out of the source material.

In the project's second stage, the GAME system was designed, constructed, and used to perform solvent extraction experiments for comparison to traditional methods. The GAME system uses three phases—aqueous, organic, and gas—to separate metals in a confined microchannel efficiently. Organic and gas phases are introduced into a continuous aqueous phase in hollow droplets; in other words, the organic phase is coated on gas bubbles. This method increases the organic phase's surface area, leading to an increase in reaction rate and higher recovery of gold compared to conventional extraction.

[1] United Nations Environment Programme. "UN Report: Time to seize opportunity, tackle challenge of e-waste." January 24, 2019. https://www.unep.org/news-and-stories/press-release/un-report-time-seize-opportunity-tackle-challenge-e-waste. Accessed January 3, 2024

[2] The Global E-Waste Statistics Partnership. Country Sheets: United States of America. 2019. https://globalewaste.org/statistics/country/united-states-of-america/2019/. Accessed January 3, 2024

[3] United Nations Environment Programme

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PROJECT IMPACT

This project has created a processing circuit for precious metal recovery from electronic scrap with high technical and economic viability. Using this method in the electronic scrap recycling industry could recover an estimated 64 metric tons of gold, silver, and palladium. The materials recovered could bring considerable economic benefits while reducing the costs, and carbon emissions associated with producing precious metals from ores.

NEXT STEPS

The researchers published a paper on the techno-economic analysis of this work in 2023. Virginia Tech has licensed this technology exclusively to Phinix, LLC (skdas@phinix.net). Phinix, LLC has applied for a U.S. utility and PCT patent application with Drs. Zhang and Das as co-inventors. Phinix, LLC has initiated and is discussing with potential customers who could implement the technology commercially.

PROJECT PARTNERS

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PUBLICATIONS

Zhang, W., Xiao, Z., Noble, A., and Das, S. Low-Concentration Precious Metal Recovery from Complex Streams Using Gas-Assisted Microflow Solvent Extraction: Final Report for REMADE Project: 19-01-RR-03. May 2023

Deng, S., Xiao, Z., Zhang W., Noble, A., Das, S., Yih, Y. and Sutherland, J.W. "Economic Analysis of Precious Metal Recovery from Electronic Waste Through Gas-Assisted Microflow Extraction." Resources, Conservation and Recycling. March 2023. https://doi.org/10.1016/j.resconrec.2022.106810

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