

**#EU
GREEN
WEEK**

6 June 2025

EU Green Week Partner Event



The project has received funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement N° 958302

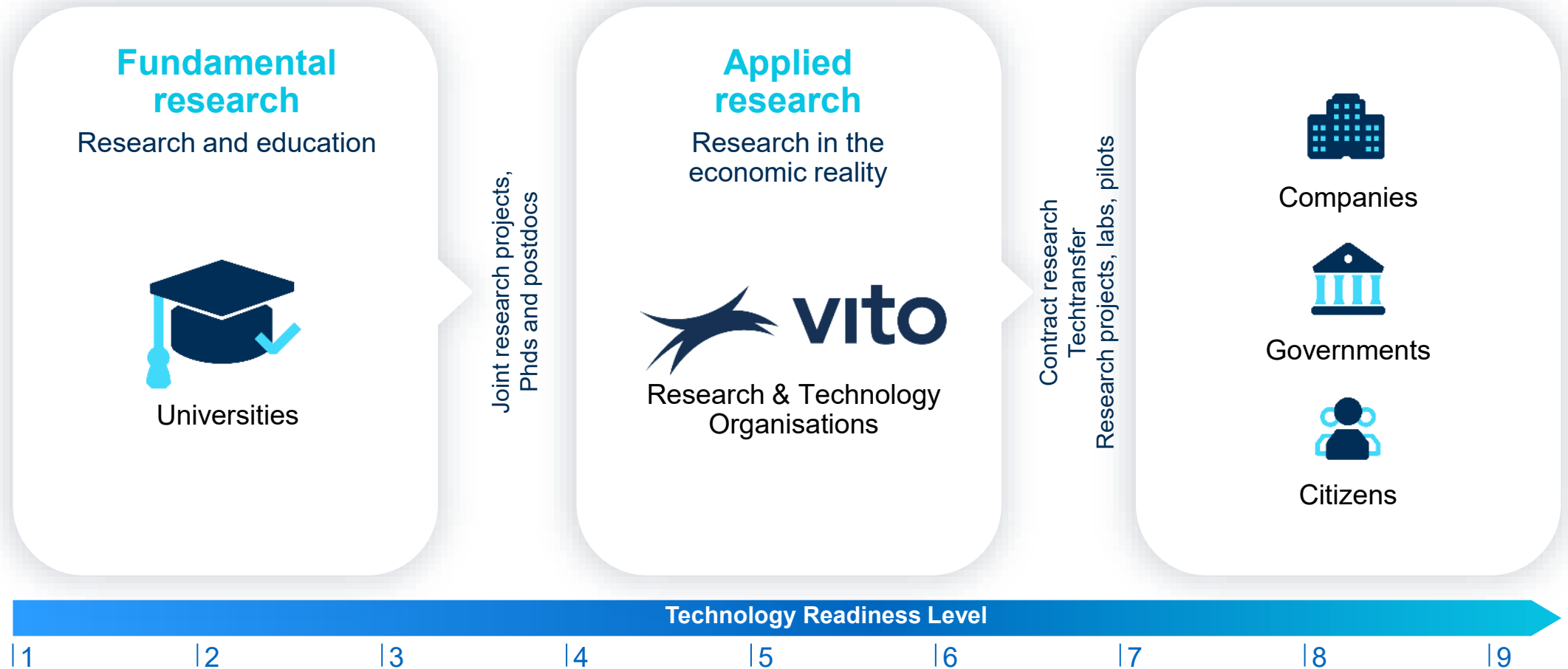
Microwave-assisted leaching of precious metals from end-of-life products

Frantisek Kukurugya, Jeroen Spooren



Turning fundamental research into solutions

Creating value and increased competitiveness for companies and governments



Waste Recycling Technology Team



**AI FOR CIRCULAR
METALS & MINERALS**



**REGENERATIVE
METALLURGY**

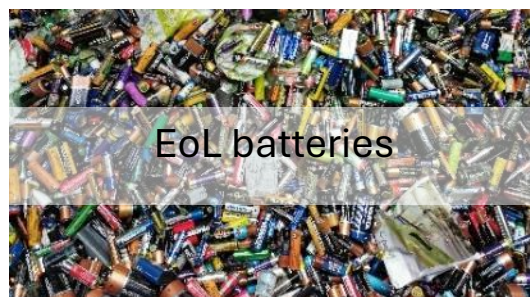


**MINERAL ACTIVATION
AND PRODUCTIZATION**



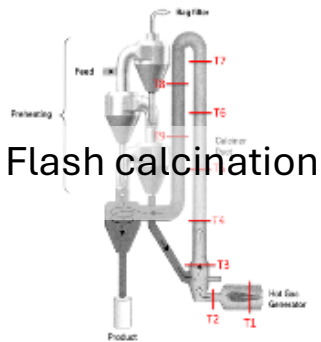
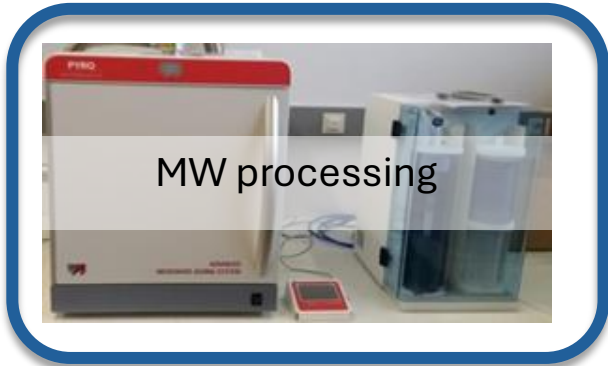
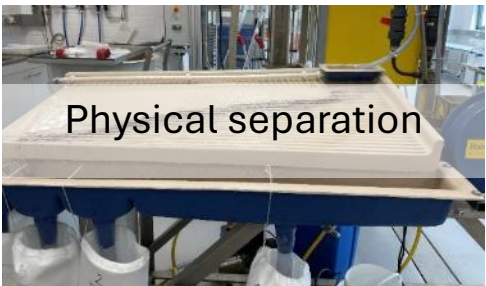
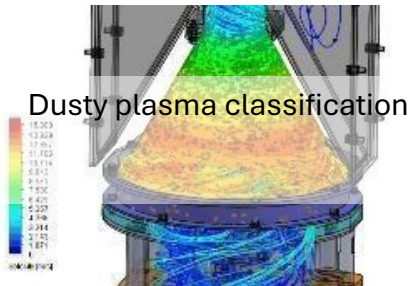
 **vito** vito.be

R&D portfolio – Alternative resources



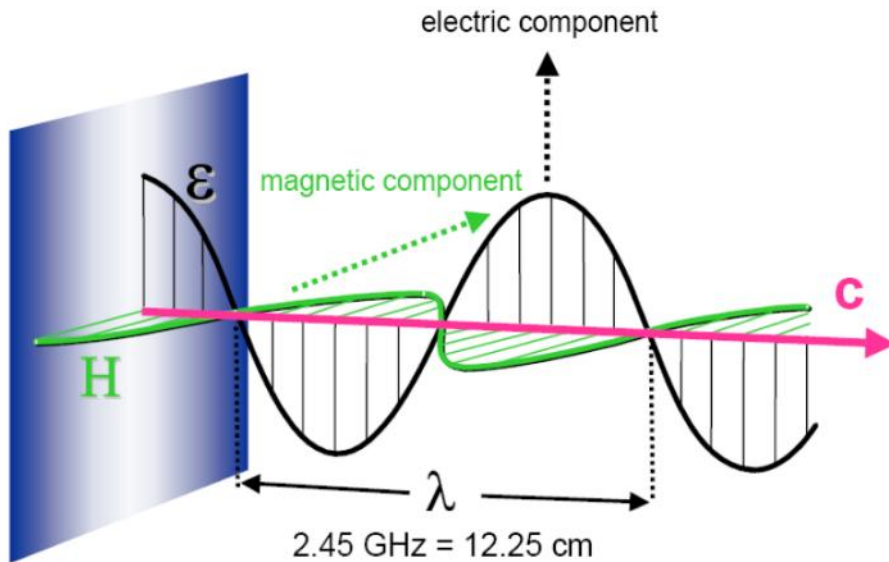
R&D portfolio – Recycling technologies

Characterise-to-Sort



Introduction into MWAL

Electromagnetic radiation

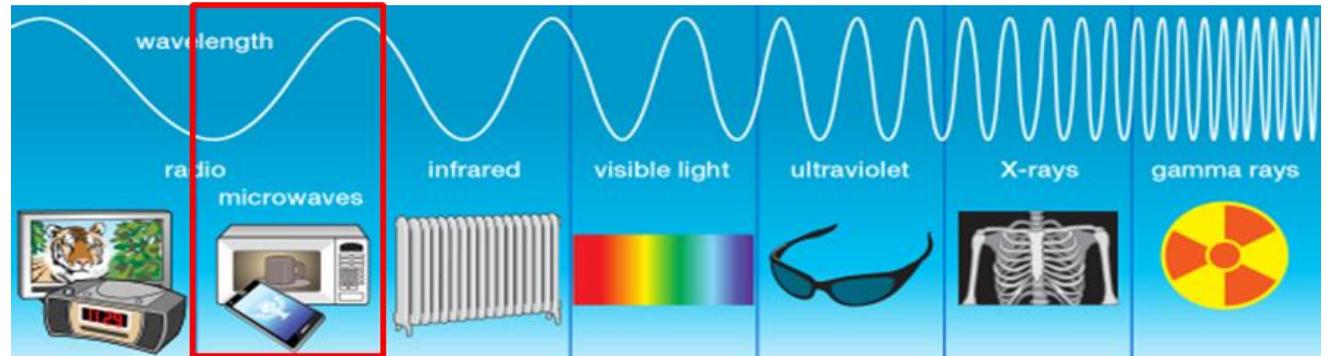


Microwave radiation

High-frequency non-ionizing radiation

Wavelength (λ): 1 meter to 1 millimeter

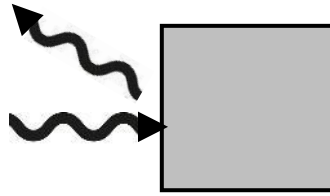
Frequencies (f): 300 MHz (1 m) and 300 GHz (1 mm)



How can be MW radiation applied in hydrometallurgy?

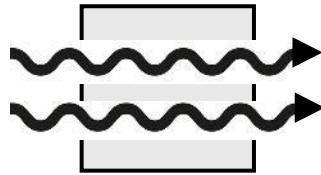
Reflection

- Metals

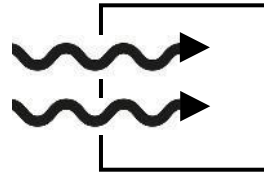


Transmission

- Glass, plastics



Absorption

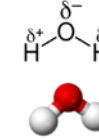


Capability to absorb EM energy and convert it into heat at given frequency and temperature

Loss tangent
$$\tan \delta = \frac{\epsilon''}{\epsilon'}$$



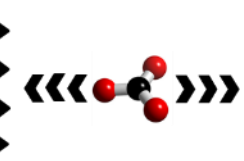
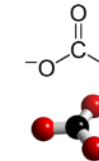
• Dipolar polarization



Reverse of polarity (several millions of times per second)



• Displacement of ions



Displacement of ions induces conductive heat

Advantages of MW heating:

- Fast heating resulting in shorter processing time
- Direct, selective and volumetric heating (inside out)
- Electrification of metallurgical processes



Industrial applications (so far):

- Food processing (tempering, blanching, pasteurization, sterilization, etc.)
- Drying (paper, plastics, ceramics, wood, rubber, etc.)

Application in metal extraction limited to a mean to digest solid samples prior to a chemical analysis (e.g. ICP, AAS)

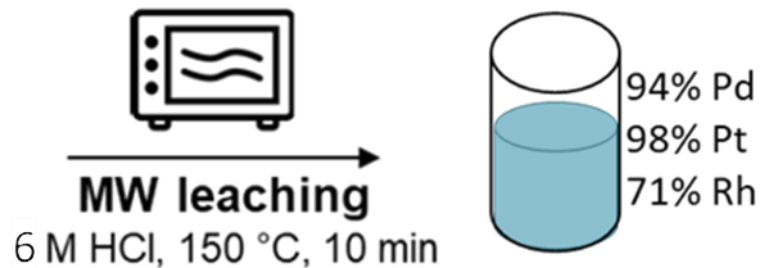


Platirus

TRL 3 – 5

2016 - 2021

Grant Agreement n° 730224



Challenges:

- Reduction of the HCl concentration
- (Re)cycling of leachate
- Scaling up of MW assisted leaching



TRL 5 – 7

2021 - 2026

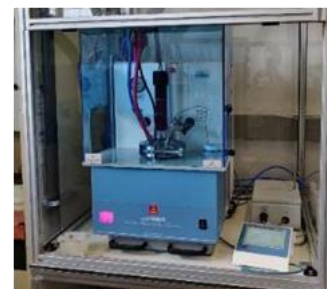
Grant Agreement n° 958302

Optimization of the MWAL



3 g per experiment

Up-scaling

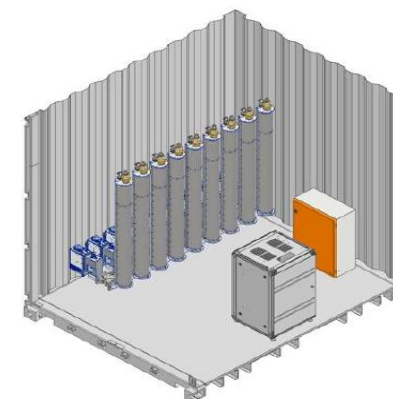


50 g per experiment



Up-scaling

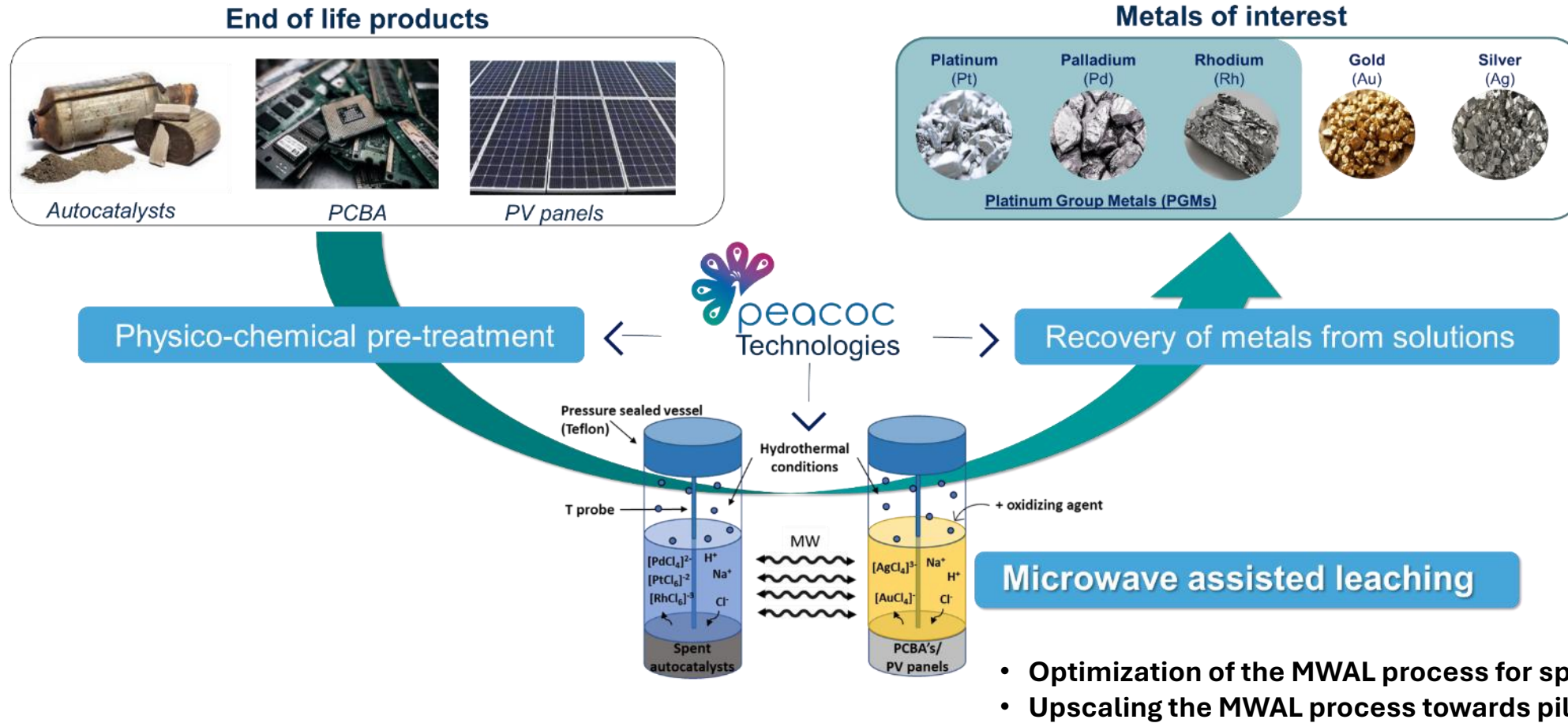
Pilot scale installation



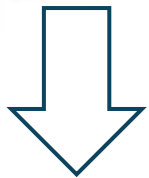
5-10 kg per hour



MWAL position within H2020 PEACOC



Optimization of the MWAL



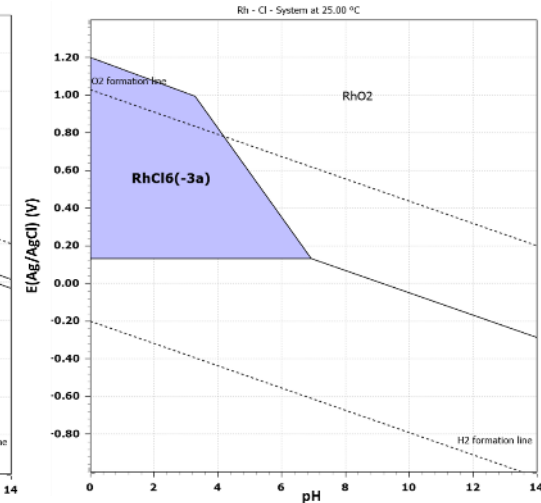
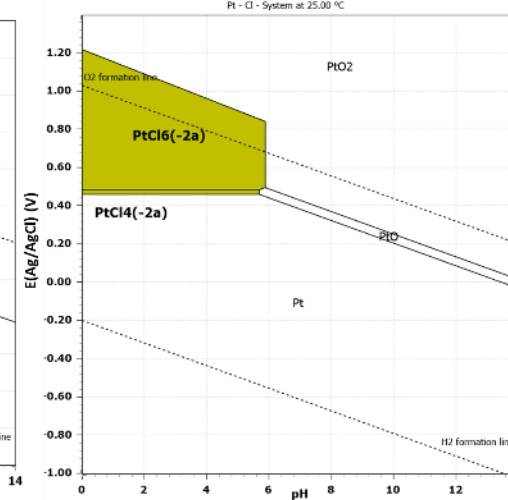
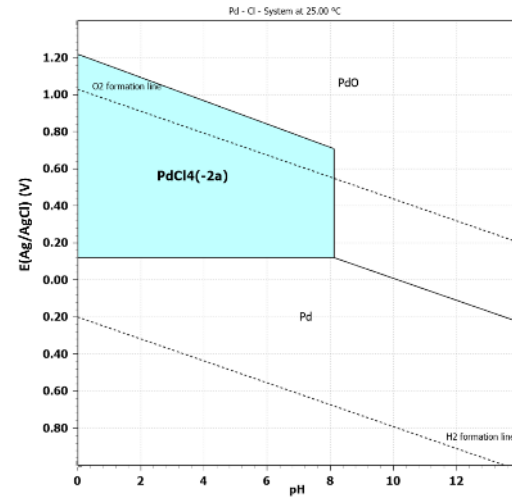
Crushed to < 2 mm



1700 mg/kg Pd
943 mg/kg Pt
272 mg/kg Rh

Cordierite ($(\text{Mg,Fe})_2\text{Al}_4\text{Si}_5\text{O}_{18}$)
Tayheranite (ZrO_2)
Cerianite (CeO_2)
Corundum (Al_2O_3)

Chloride based leaching system



Objectives:

- Optimize the leaching system:
 - by reducing HCl concentration
 - by replacing Cl^- from HCl by alternative source (NaCl)
- Optimize addition of oxidizing agent
- Optimizing reaction temperature and time
- Optimize liquid to solid (L/S) ratio

Optimization of the MWAL at lab scale

Leaching system optimization

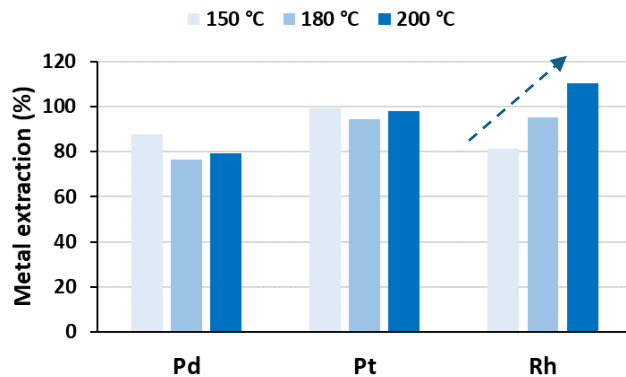


6 M HCl

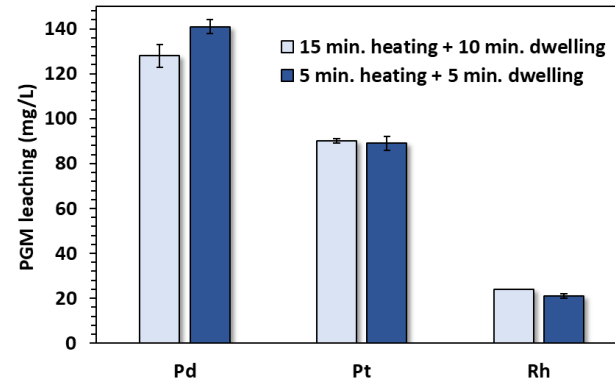


1.5 M HCl + 1.5 M NaCl

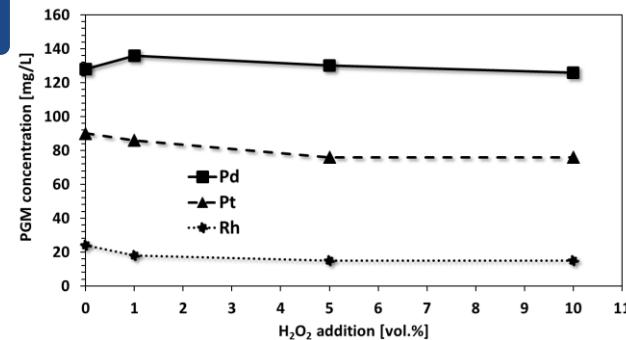
Effect of temperature



Effect of leaching time



Effect of oxidizing agent



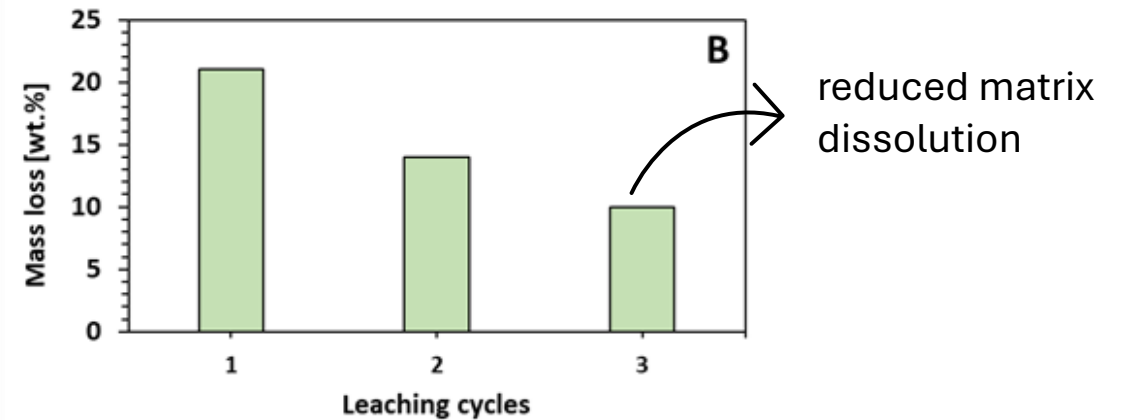
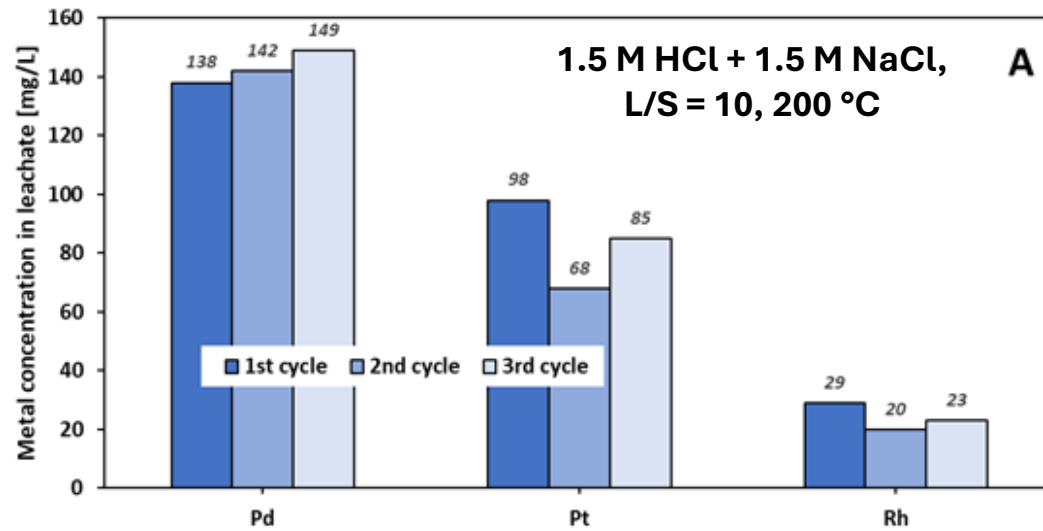
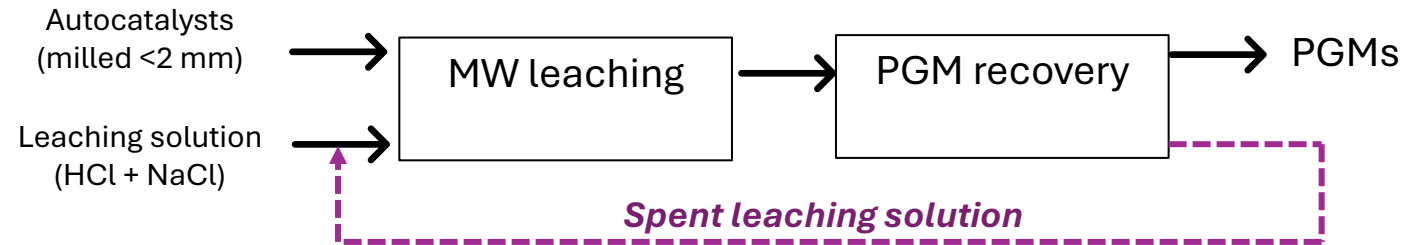
(Laboratory) Upscaling



Additional optimization and data gathering

- Liquid-to-solid ration (5-10)
- Mass loss
- Data regarding temperature and pressure
- Energy consumption
- **Leachate recycling**

Optimization of the MWAL at lab scale



Additional literature sources:

Minerals Engineering 146 (2020) 106153



Contents lists available at ScienceDirect

Minerals Engineering

journal homepage: www.elsevier.com/locate/mineng



Combined microwave assisted roasting and leaching to recover platinum group metals from spent automotive catalysts



Jeroen Spooren (Ph.D.)^a, Thomas Abo Atia (Ph.D.)

^a Waste Recycling Technologies, Sustainable Materials Management, Flemish Institute for Technological Research, VITO N.V., Boeretang 200, 2400 Mol, Belgium



Chemical Engineering & Processing: Process Intensification 164 (2021) 108378



Contents lists available at ScienceDirect

Chemical Engineering and Processing - Process Intensification

journal homepage: www.elsevier.com/locate/cep



Fast microwave leaching of platinum, rhodium and cerium from spent non-milled autocatalyst monolith



Thomas Abo Atia^{a,*}, Jeroen Spooren

^a Waste Recycling Technologies, Flemish Institute for Technological Research, VITO N.V., Boeretang 200, 2400 Mol, Belgium



Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec



Microwave chloride leaching of valuable elements from spent automotive catalysts: Understanding the role of hydrogen peroxide



Thomas Abo Atia^{a,1}, Wendy Wouters^a, Giuseppe Monforte^b, Jeroen Spooren^{a,*}

^a Waste Recycling Technologies, Flemish Institute for Technological Research, VITO N.V., Boeretang 200, 2400 Mol, Belgium

^b CNR-ITAE, Istituto per le Tecnologie Avanzate "Nicola Giordano", via S. Lucia sopra Consola, 5, 98126 Messina, Italy

<https://doi.org/10.1595/205651321X16057842276133>

Johnson Matthey Technol. Rev., 2021, **65**, (1), 127–1

**JOHNSON MATTHEY
TECHNOLOGY REVIEW**

www.technology.matthey.com

Platinum Group Metals Recovery Using Secondary Raw Materials (PLATIRUS): Project Overview with a Focus on Processing Spent Autocatalyst

2025



Cleaner Engineering and Technology
Volume 24, February 2025, 100868



Microwave-assisted chloride leaching for efficient recovery of platinum group metals from spent automotive catalysts: An approach for chemical reagent reduction

Frantisek Kukurugya^a, Wendy Wouters, Jeroen Spooren

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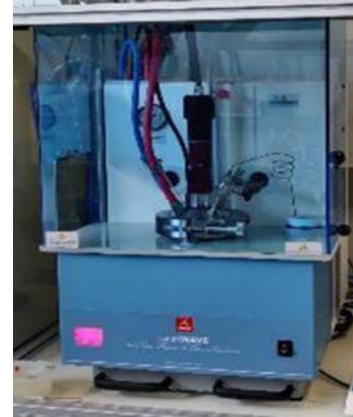
<https://doi.org/10.1016/j.clet.2024.100868>

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Upscaling of the MWAL process



Amount of sample treated	3 – 5 g / batch	30 – 50 g / batch	150 – 300 g / batch	5 – 10 kg / hour (continuous)
Laboratory scale TRL 4	Upscaling TRL 5 – 6		Pilot scale TRL 7	



Conclusion

- MWAL demonstrates **strong potential for sustainable, efficient metal recovery**
- **Fast, direct, selective, and volumetric heating** via microwaves proves viable for hydrometallurgy.
- **Upscaling MWAL technology** from lab-scale to pilot-scale (TRL7) is a key **technological milestone**
- The PEACOC project illustrates the **value of collaborative research** in driving circular economy innovation
- **Application of MWAL** technology with **other streams** to recover **critical raw materials**

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fero.kukurugya@vito.be
jeroen.spooren@vito.be



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Thank you for your attention

