Pre-commercial pilot for the efficient recovery of Precious Metals from European end-of-life resources with novel low-cost technologies

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RAW MATERIALS WEEK

BRUSSELS 9-13 DECEMBER 2024

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

Project overview

SPENT AUTOCATALYSTS

WEEE/PCBAs

EoL PV PANELS

CONCENTRATION → **REFINING** → **VALORISATION**

To recover CRM and precious metals **(Pt, Pd, Rh, Au and Ag)** from spent autocatalysts, PCBAs and PV scrap and to valorise them into new products

Grant agreement N: 958302

Coordinator: FUNDACIÓN TECNALIA RESEARCH & INNOVATION, Spain

Consortium: 20 Partners from 9 countries

Duration: 1 May 2021 – 30 April 2025 (48 months)

Project budget: € 12,838,998 (€ 11,210,485 EU contribution)

New Autocatalysts

Electrical components printing

Jewelry

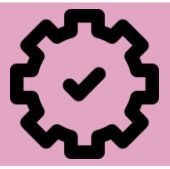
3D printing

Challenges in recycling Precious Metals and PGMs

The **current industrial recycling technologies** such as smelting or hydrometallurgical processes **present several limitations**

CAPEX-OPEX intensive

High Temperature (>1200°C)



Limited efficiency of recovery due to the complex mixture of materials in *end-of-life* products e.g., low-mid grade PCBA (i.e., 20 to 100g Au/t)

High environmental footprint resulting from the use of strong acidic solutions

Adverse impacts on both human health and environment

The *large-scale* nature of the *state-of-the-art* refineries prevents the development of SME-scaled operations

PEACOC Alternative - Objectives

Goal: To demonstrate a first-of-a-kind economically and environmentally-viable pre-commercial metallurgical system for recovering precious metals from a wide variety of abundant *EoL* products in Europe

i) **2 kg PGMs/week** from spent auto-catalysts (containing ~2.5 kg PGMs/t)

ii) **0.5-1 kg Au/week** from Printed Circuit Board Assembly (PCBA) with a focus on low and medium grade PCBA (containing 20-100 g Au/t)

iii) **10 kg Ag/week** from EoL Photovoltaic (PV) panels (containing ~3-10 kg Ag/t

Improve the **precious metals concentration** stage by up to 100 times

Aim at near **zero-waste strategy** by valorizing the recovered precious metals and residues into new functional products

Prove the **PEACOC sustainability** from economic, technical and environmental perspectives

Design and operate a **mobile refining pilot** at pre-commercial scale for producing precious metals

Identify new or un-valorised resources in Europe and neighboring countries

Expand the impact of the PEACOC project by exploring the **replication** of the proposed process to treat **other end-of-life products**

Technologies in PEACOC projects

Pre-treatment and concentration

EoL Autocatalysts

MONOLITHOS CATALYSTS - RECYCLING - INNOVATION

Low/medium-grade EoL PCBA

Treee

NOVA LIÈGE université

Roller sorting TUDelft

MDS TUDelft

EoL PV panels

comet traitements

Magnetic sorting TUDelft

GOLD REC

Refining – PEACOC pilot plant

Microwave-Assisted Leaching

vito

ceinnmat Emerging technologies

Gas-diffusion Electrocrystallization

vito

JM

6TMIC Manufacturing solution using advanced engineering

Precious metals

Residues

Valorization

Mechanical Alloying

MBN nanomaterialia

Powder composites

Extrusion

3D HUB GREECE

Filaments for 3D printing

3D printing

ADMATEC Additive Manufacturing Technologies

3D-printed items: jewelry, catalysts and PCBs

Manufacture of autocatalysts and fuel cells

CRF CENTRO RICERCHE FIAT

Ford FORD OTOSAN

MONOLITHOS CATALYSTS - RECYCLING - INNOVATION

vito

Autocatalysts and Hydrogen fuel cells

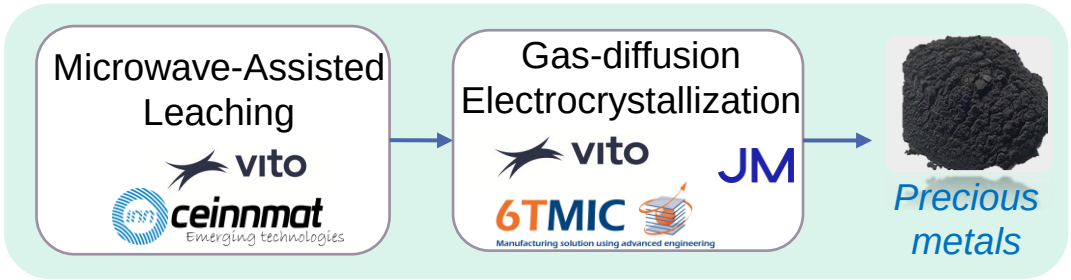
Deep Eutectic Solvent

tecnalia

Single Precious Metals

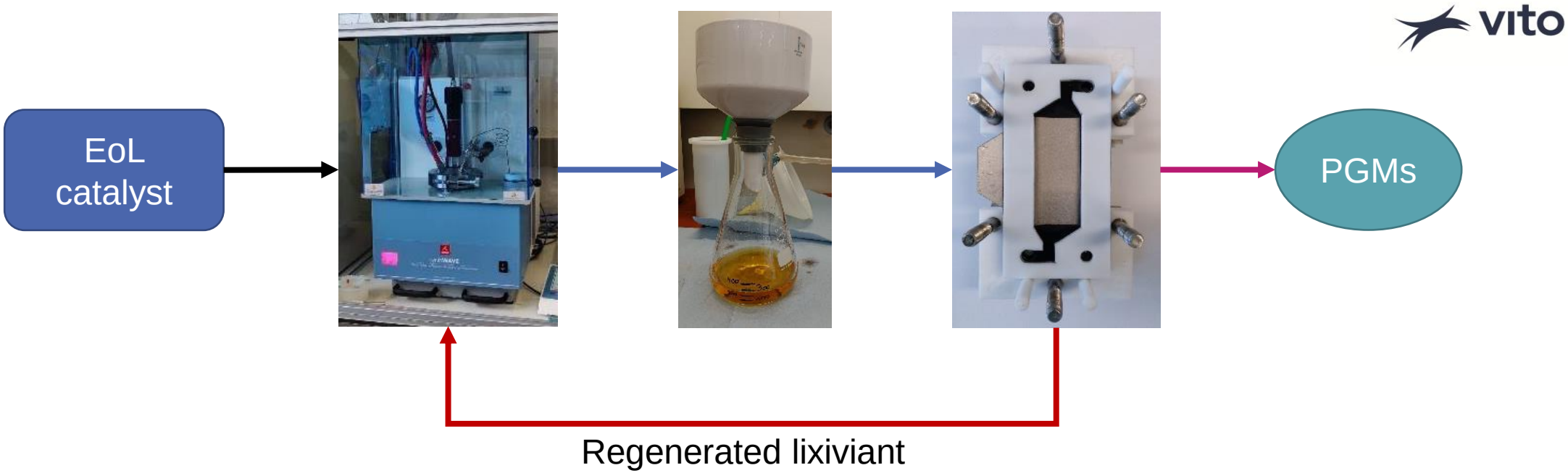
Achievements in the refining stage

Refining – PEACOC pilot plant



- **Microwave-Assisted leaching & GDEx were developed in the EU funded project PLATRUS RIA GA 730224 and selected in the final flowsheet among 11 different technologies investigated based on LCA and LCC assessment.**

- **In PEACOC the processes were integrated and further optimized at laboratory scale for the treatment of spent autocatalysts**



Achievements in the refining stage - MWAL

Refining – PEACOC pilot plant

Microwave-Assisted Leaching (vito, ceinnmat Emerging technologies) → Gas-diffusion Electrocrystallization (vito, 6TMIC Manufacturing solution using advanced engineering, JM) → *Precious metals*

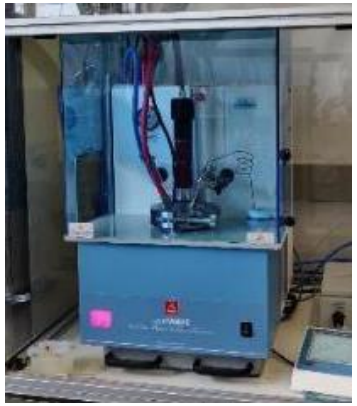
MWAL unit

Optimisation of the MWAL process in the laboratory

vito

FlexiWave system able to process 3 g per batch

SynthWave system able to process 50 g per batch



Upscaling the MWAL process

ceinnmat Emerging technologies

FIGLE SOLO system of CEINNMAT for automatic operation

FIGLE ORCHESTRA of CEINNMAT system for fully continuous operation

Achievements in the refining stage - MWAL

Refining – PEACOC pilot plant

Microwave-Assisted Leaching (vito, ceinnmat Emerging technologies)

→ Gas-diffusion Electrocrystallization (vito, JM, 6TMIC Manufacturing solution using advanced engineering)

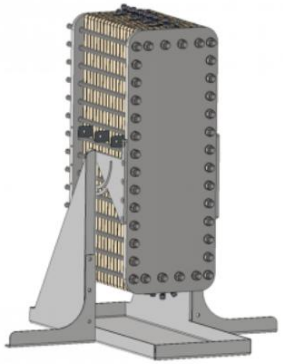
→ 

Precious metals

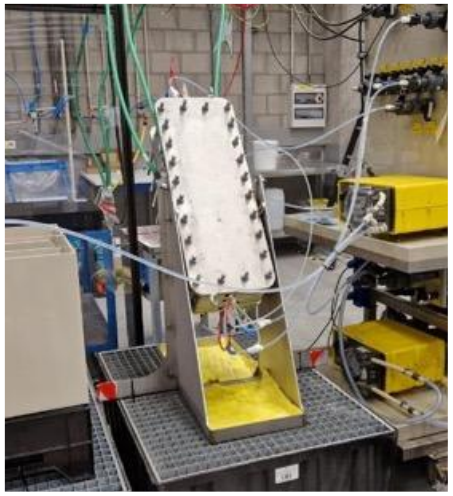
GDEx unit

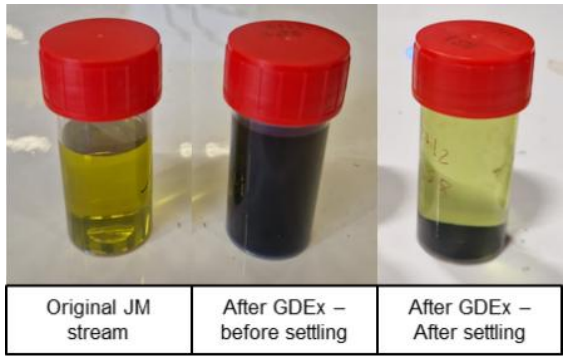
vito

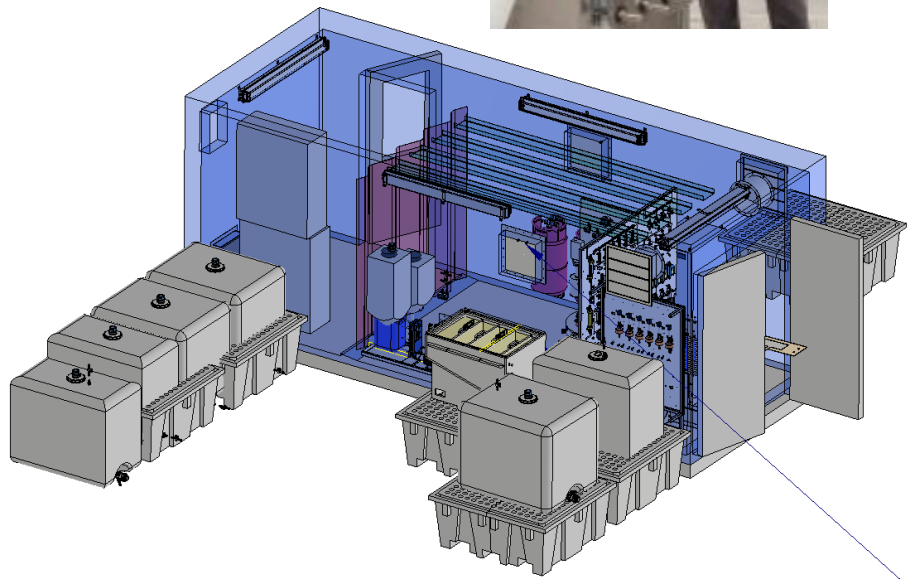
<u>6-cell stack</u> being up-scaled



<u>2-cell stack</u> treating real industrial solution from JM







Achievements in the refining stage

Refining – PEACOC pilot plant

Microwave-Assisted Leaching (vito, ceinnmat Emerging technologies)

→ Gas-diffusion Electrocrystallization (vito, JM, 6TMIC Manufacturing solution using advanced engineering)

→ *Precious metals*

→ **GDEx unit** (vito)

→ **MWAL unit** (ceinnmat Emerging technologies)

Filtration unit (6TMIC Manufacturing solution using advanced engineering)

Achievements in the pre-concentration stage - PVscrap

Pre-treatment and concentration - PCBAs

Low/medium-grade EoL PCBA

Treee

NOVA – LIÈGE université

Roller sorting – TU Delft

MDS – TU Delft

Au (ppm)	Ag (ppm)
40	400

NOVA

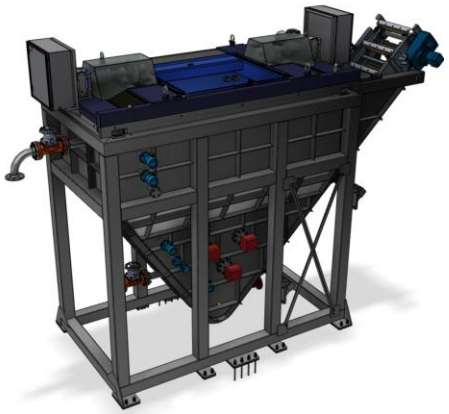
Depopulated PBCAs

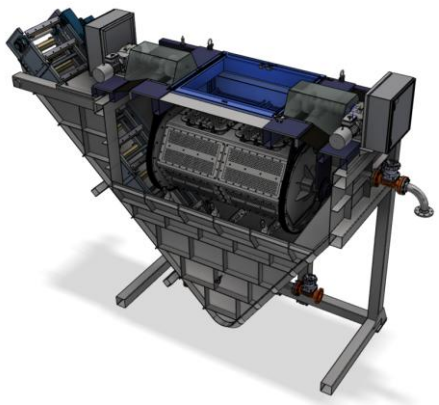
Concentrates (Sn, Cu, PMs)

Electronic components

NOVA prototype

LIÈGE université





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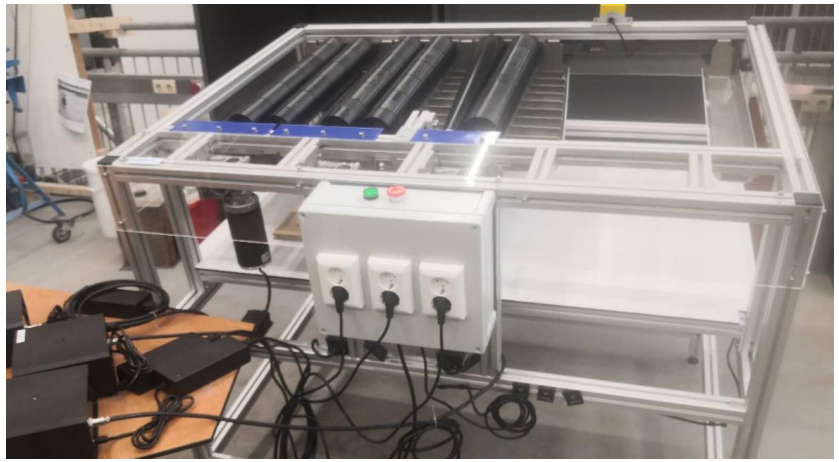
Roller sorting

Roller Sorter TU Delft



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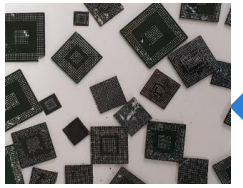


CPUs

Au (ppm)	Ag (ppm)
1320	1740

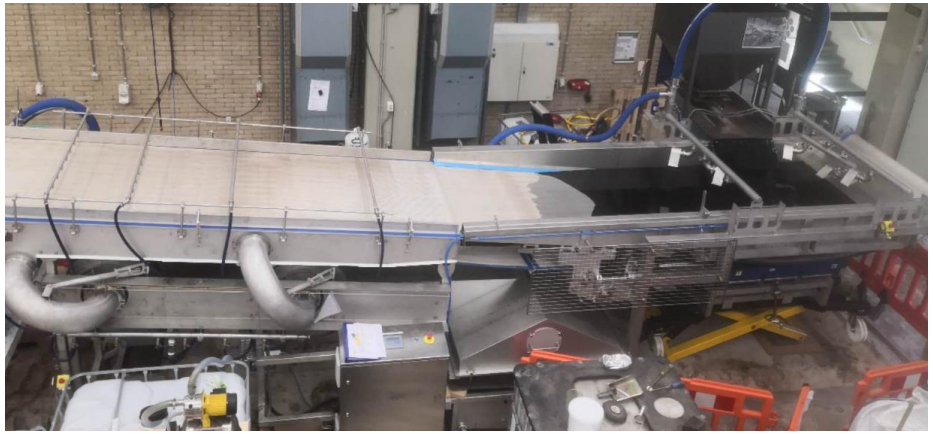
IC chips

Au (ppm)	Ag (ppm)
420	980

MLCC

Au (ppm)	Ag (ppm)
3	10300

MDS pilot — TU Delft



Achievements in the pre-concentration stage - PVscrap

Pre-treatment and concentration – PV scrap

EoL PV panels

comet traitements

Magnetic sorting

TU Delft

GOLD REC

PV scrap

Ag (%)	1.4
Cu (%)	35.3
Fe (%)	19.0
Sn (%)	1.6

Ref	Ag%	Cu%	Fe%	Sn%
1	1.36	6.8	12.7	1.3
2	4.8	22.8	6.8	1.4
3	0.03	0.6	48.2	1
4	5.38	24.9	12.8	2.1
5	0.02	7.3	52.6	4.5
6	0.28	2.9	5.9	0.9
7	0.37	23.6	13.9	1.9
8	0.29	43.4	3.5	3.9
9	0.72	22.1	179.42	1.7

Magnetic sorting

GOLDREC

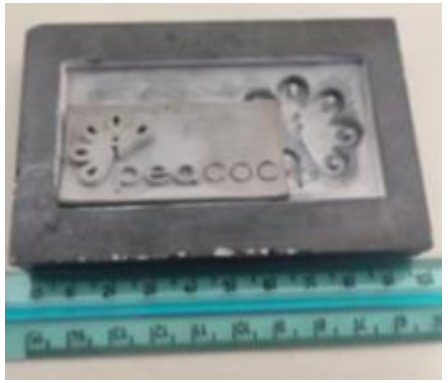
In progress…

To remove Fe and Cu and upconcentrate Ag content

Valorisation of recovered PMs and residual matrices

- **MONOLITHOS has successfully produced new automotive catalysts using recycled PGMs.** The new autocatalyst has achieved the same conversion performance than commercial ones.

- **MBN has demonstrated an alternative process to make feedstock power for additive manufacturing using residual matrices from the PEACOC process.**



Valorisation of recovered PMs and residual matrices

- **The MDS process by TUDelft has been patented,** as an innovative method of separating scrap particles, and particle separation assembly

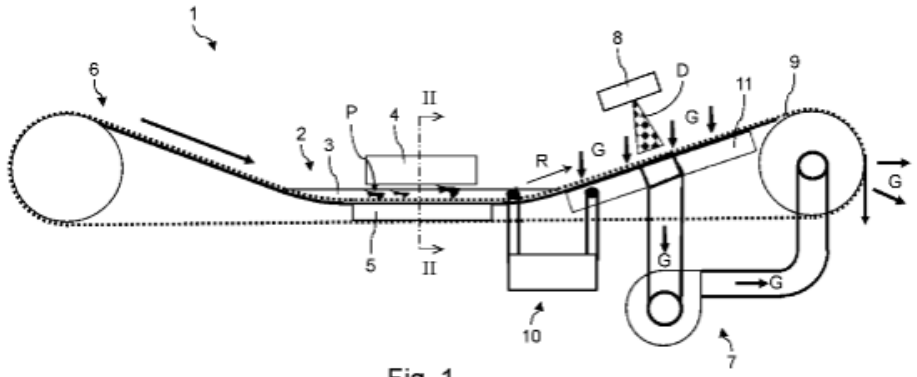
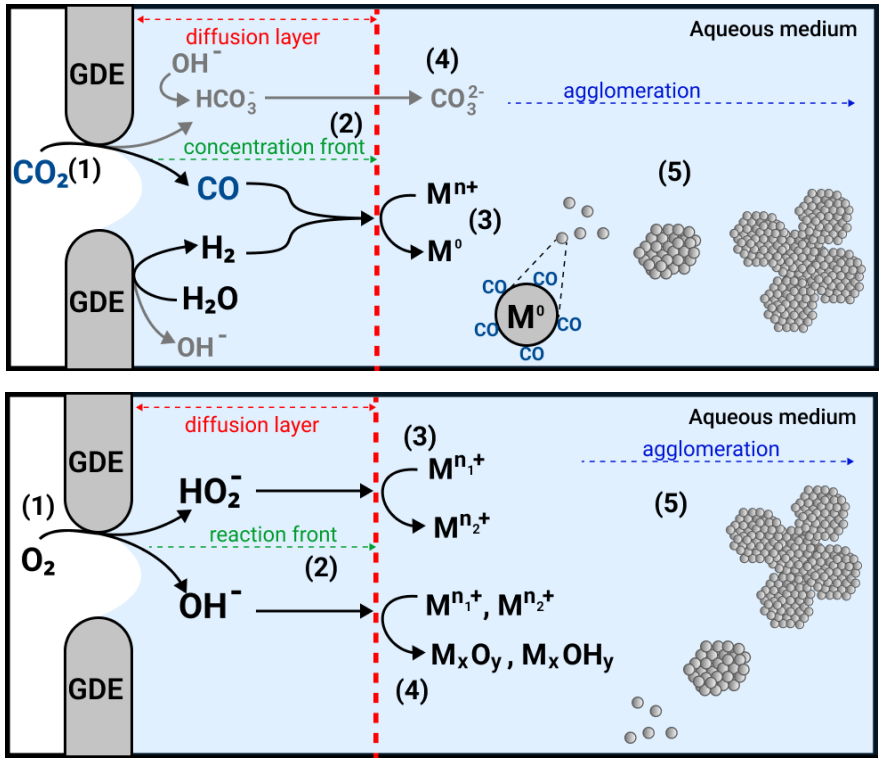


Fig. 1

- **The GDEx process for the precipitation of PGMs developed by VITO has been patented. Also, a patent of the MWAL process has been filed**



Valorisation of recovered PMs and residual matrices

- **TECNALIA has submitted two patents from two different processes**

1. Process for the selective recovery of PGMs from spent autocatalysts. A product containing 67% of Pd, 27 % of Pt and 1% Rh is obtained (95% purity).
2. Process for the selective recovery of PGMs from spent autocatalysts. A product containing 70% of Pd, 8 % of Pt and 4% Rh is obtained (82% purity).

PEACOC project

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