MONOLITHOS

CATALYSTS - RECYCLING - INNOVATION

COMPANY PROFILE

MONOLITHOS in a nutshell

Commercial Achievements:

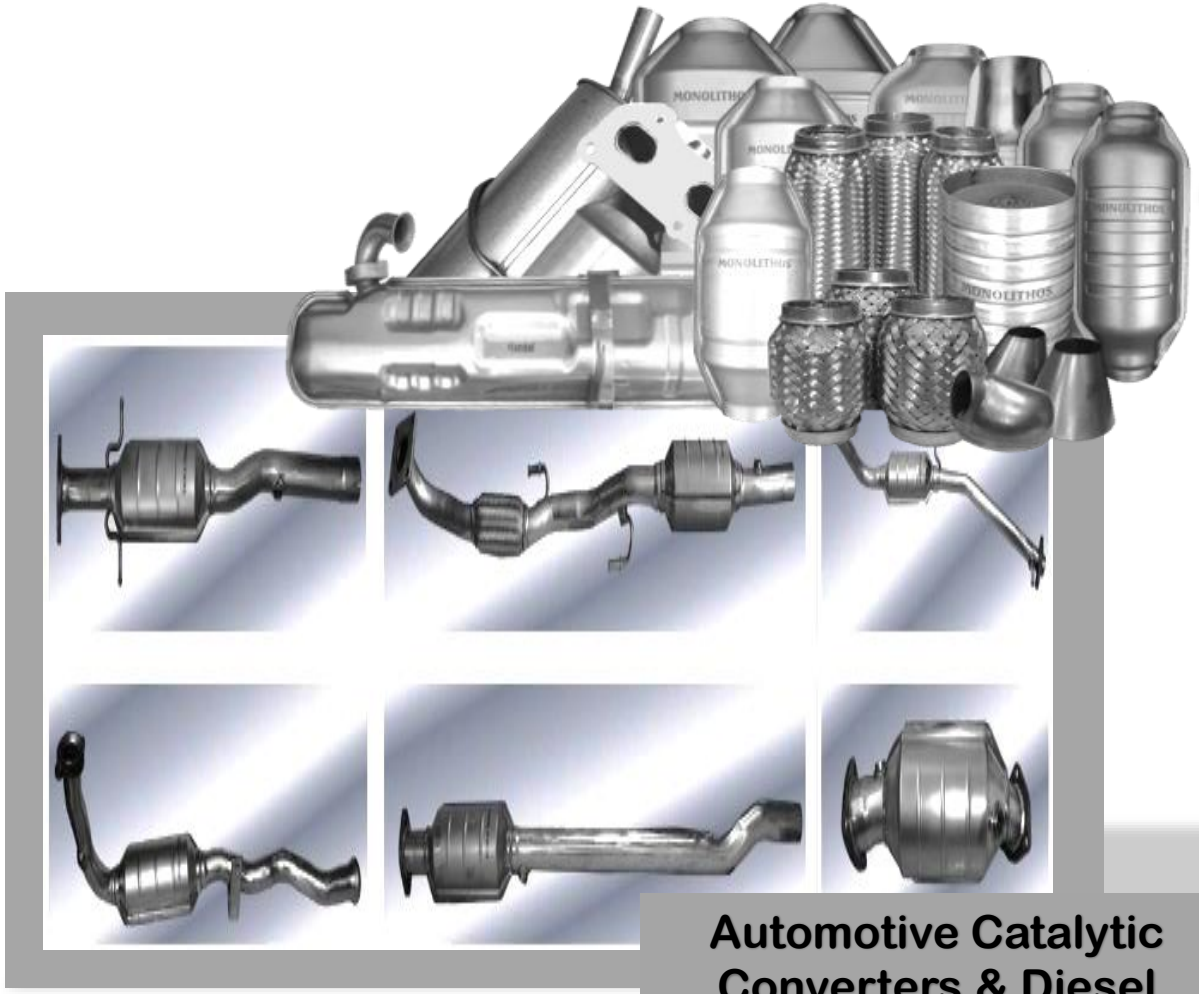
- **3.5m Euros** turnover (2023)
- **33 employees** (15 Ph.D., 5 M.Sc.)
- **2150sqm** industrial and lab facilities in Athens
- Three locations: **Athens**, **Thessaloniki** *(Diavata, 120sqm)*, **Cyprus** *(Psevdas, 130sqm)*
- **Zero** Bank Loans and Open Accounts to Suppliers
- **Fully licensed** operation for the production and recycling of catalytic systems

Scientific Achievements:

- ✓ 5 European **patents**
- ✓ 26 peer-reviewed **scientific publications**
- ✓ 4 **PhDs** partially conducted in MONOLITHOS
- ✓ 2 **Meng Thesis** conducted in MONOLITHOS
- ✓ 32 **Internships** conducted in MONOLITHOS

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

COMMERCIAL ACTIVITIES



Automotive Catalytic Converters & Diesel Particulate Filters (DPFs) Manufacturing

Recycling & Assaying of Platinum Group Metals

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

COMMERCIAL ACTIVITIES

Diesel Particulate Filters (DPFs)
& Selective Catalytic
Reduction Systems (SCRs)
Regeneration

Marine & Stationary
Catalytic Applications

Heavy Duty
Applications

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

IN THE FOREFRONT
of advanced nano-materials and waste valorization

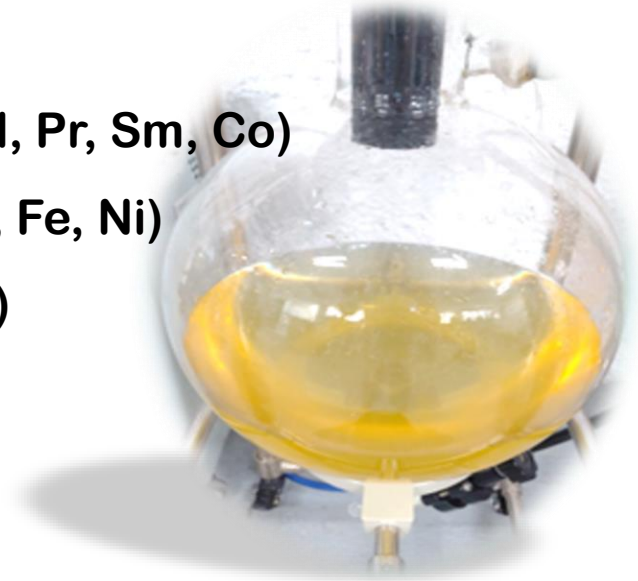
Nano-catalysts development

- LDVs emission control
- HDVs emission control
- Marine emission control
- Electrocatalysts
- Vulcanization catalysts
- Photocatalysts

Critical Raw Materials Recovery

- Three Way Catalysts TWC (Pt, Pd, Rh)
- Diesel Particulate Filter DPF (Pt, Pd)
- Diesel Oxidation Catalysts DOC (Pt, Pd)

- Permanent magnets (Nd, Pr, Sm, Co)
- Electrocatalysts (Pt, Pd, Fe, Ni)
- Batteries (Li, Mn, Ni, Co)
- WEEEs (Cu, Ni, Au)



MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

MONOLITHOS Research and Innovation Projects

Nano-catalysts Development

Emissions Control Catalysts

V·E·R·A

Funded by the European Union

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Programme Under Grant Agreement No. 101056893

CAT4HEAVY

The LIFE CAT4HEAVY project (Grant Agreement no. LIFE17 ENV/GR/000352) has received funding from the LIFE programme of the European Union

Prometheus catalyst

This project has received funding from the European Commission and the European Union's Horizon 2020 Research and Innovation program under Grant Agreement No. 778893

DIAGONAL

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Programme Under Grant Agreement No. 953152

Funded by the European Union

INNOCAT

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement No. 18344

Electrocatalysts

eCO2FUEL

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Programme Under Grant Agreement No. 101037389

Funded by the European Union

Non emission nanocatalysts

GEORIS

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 21107

safevulca

RawMaterials

Co-funded by the European Union

This activity has received funding from the European Institute of Innovation and Technology (EIT), a body of the European Union, under the Horizon 2020, the EU Framework programme for Research an Innovation under Grant Aggreement No. 18145

Critical Raw Materials Recovery

Catalysts

Platirus

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Program Under Grant Agreement No. 730224

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 19148

EBRA

PHEIDIAS

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 20220

peacoc

Funded by the European Union

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Programme Under Grant Agreement No. 958302

HydroCAT

European Union

NSRF 2014-2020

Fuels Cells/Electrolyzers

PROMETH2

Funded by the European Union

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862253

This project is supported by the Clean Hydrogen Partnership and its members under Grant Agreement No. 101111784

HERACLES

Funded by the European Union

LYDIA

Co-funded by the European Union

RawMaterials

Funded by the EIT RawMaterials under the Grant Agreement 22019

Batteries

CROCODILE

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No. 776473

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 22020

ReLiFe

RECYCLING LITHIUM FERROPHOSPHATE

ReLi-ion

BATTERY RECYCLING

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 21113

Permanent magnets

UDysCovery

Co-funded by the European Union

RawMaterials

Funded by the EIT RawMaterials under the Grant Agreement 21028

Electronic waste

WEEE NET9

Co-funded by the European Union

RawMaterials

Funded by the EIT RawMaterials under the Grant Agreement 21115

Mining Tailings

EXPOMINE

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Programme Under Grant Agreement No. 873149

Robotics/AI pre-processing

CRUSADE

Funded by the European Union

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Programme Under Grant Agreement No. 101138642

Training

ChemPGM

Funded by the European Union

The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007669

EXP SKILLS-REM

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 21104

3RETURN

ΕΣΠΑ 2014-2020

3D Briefcase of mineral applications

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 19010

HydroMetEC

RawMaterials

Co-funded by the European Union

Funded by the EIT RawMaterials under the Grant Agreement 19033

CO2MPRISE

Funded by the European Union

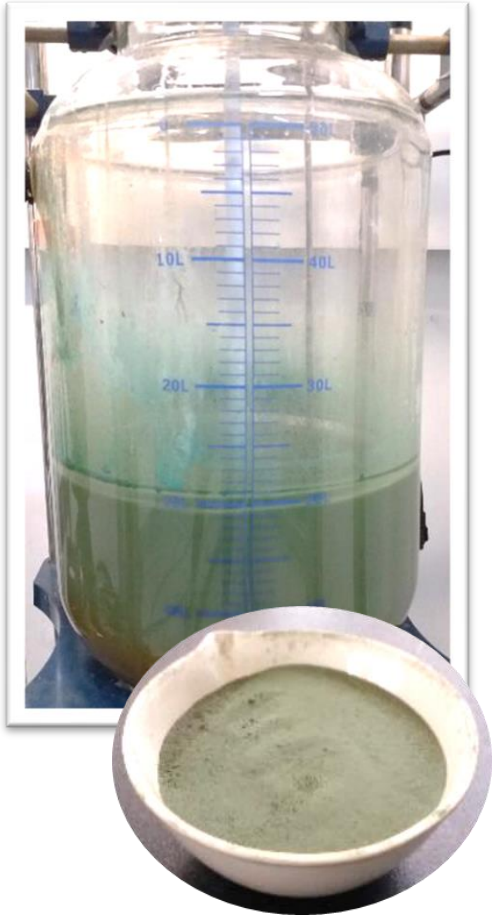
This Project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under the Marie Sklodowska-Curie Grant Agreement No. 734873

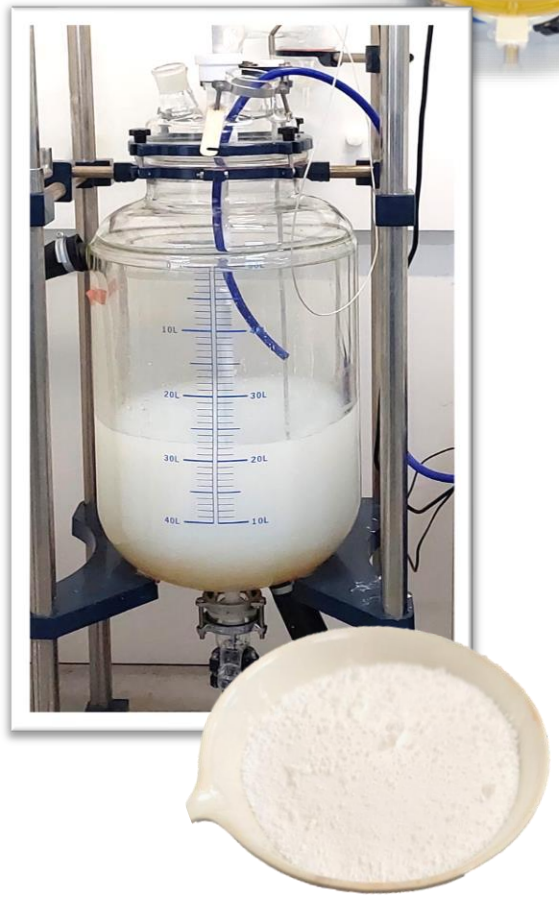
MONOLITHOS

CATALYSTS - RECYCLING - INNOVATION

Nanomaterials Upscaling Expertise

Nano-catalysts development





Electrocatalysts

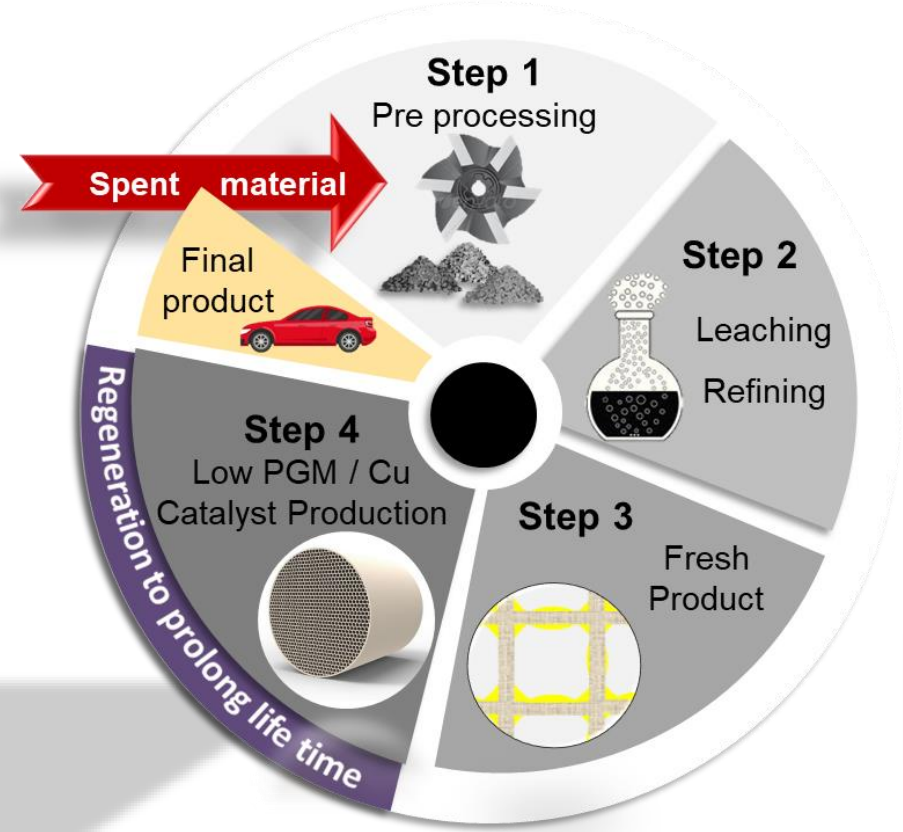
Automotive Catalysts

Photocatalyst

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

FROM PROJECTS TO PRODUCTS Mentality

Critical Raw Materials Recovery



- WEEEs
- Batteries
- Mine wastes
- Electrocatalysts
- Automotive Catalysts
- Permanent magnets

Characterization

Pre-processing

CRM extraction

CRM valorization

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

Zero waste mentality

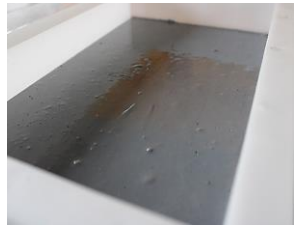
Expertise in geopolymer production
Valorization of mining waste and industrial by-products

Mine tailings

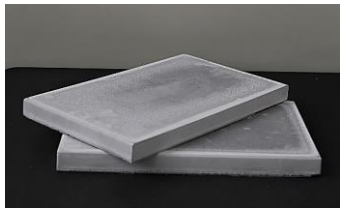
Industrial by-products

Preprocessing

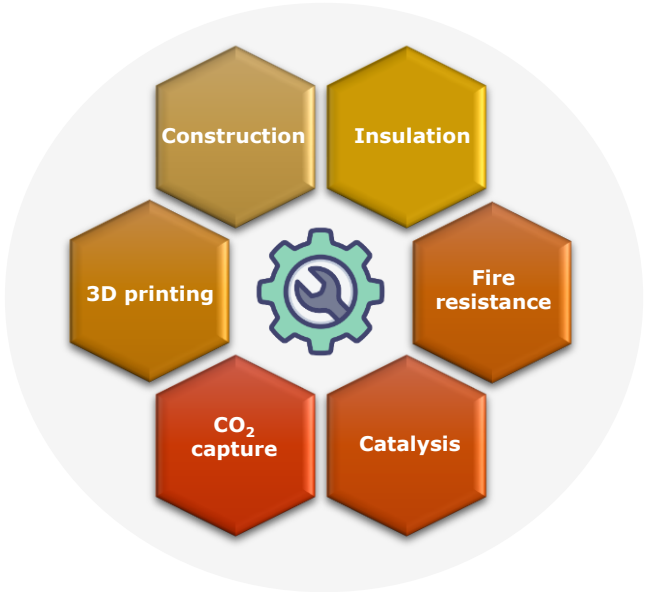
Alkali activation
Mixing



Molding
Curing



Geopolymer Blocks



Low-T production (<80 °C)

Simple and scalable process

Zero cost of feedstock

Low environmental footprint

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

Pilot unit facilities

Chlorine Hydrometallurgy Recycling Unit

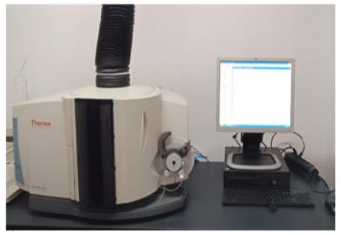
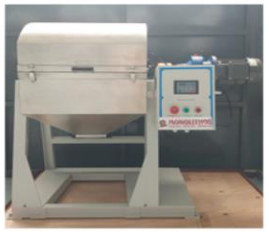
- 1m^3 batch reactor
- Jacketed batch reactor for temperature regulation
- 200L Nutsche filter

Microwave-Assisted Leaching Recycling Unit

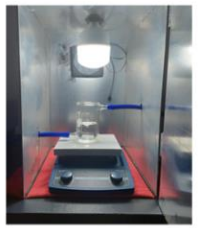
- 7 reactors with 2L capacity each
- Microwave heating with operation under pressure
- 600L settler with continuous filtration

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

HIGH TECH EQUIPMENT
(>3m euros investment since 2017)

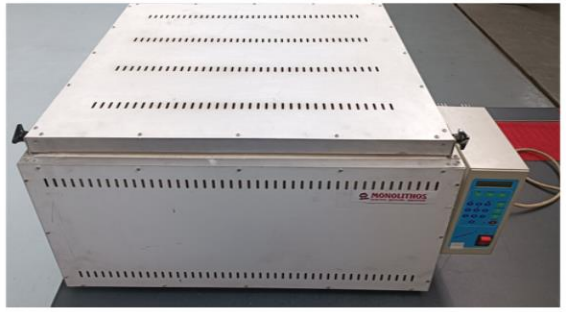








Fully equipped analytical lab












MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

INVESTMENT in knowledge

>30 peer reviewed Publications

1. E Zagoraiou, S Krishan, A Siriwardana, AM Moschovi, I Yakoumis Performance of Stainless-Steel Bipolar Plates (SS-BPPs) in Polymer Electrolyte Membrane Water Electrolyser (PEMWE): A Comprehensive Review, Compounds 4 (2), 252-267, 2024
2. High-Degree Oxidative Desulfurization of a Commercial Marine Fuel Using Deep Eutectic Solvents and Their Recycling Process
3. O. Thoda, A.M.M. Moschovi, K.M.. Sakkas, E. Polyzou, I. Yakoumis, “Highly Active under VIS Light M/TiO2 Photocatalysts Prepared by Single-Step Synthesis”, Appl. Sci. 2023, 13(11), 6858
4. ML Grilli, AE Slobozeanu, C Larosa, D Paneva, I Yakoumis,” Platinum Group Metals: Green Recovery from Spent Auto-Catalysts and Reuse in New Catalysts-A Review”, Crystals 13 (4), 550, 2023
5. A Soto Beobide, AM Moschovi, GN Mathioudakis, M Kourtelesis, ZG Lada, “High Catalytic Efficiency of a Nanosized Copper-Based Catalyst for Automotives: A Physicochemical Characterization”, Molecules 27 (21), 7402, 2023
6. S Papagianni, AM Moschovi, K, “M Sakkas, M Chalaris, I Yakoumis, “Preprocessing and Leaching Methods for Extraction of REE from Permanent Magnets: A Scoping Review”, AppliedChem 2 (4), 14, 2023
7. C Papadopoulos, M Kourtelesis, AM Moschovi, KM Sakkas, I Yakoumis, “Selected Techniques for Cutting SOx Emissions in Maritime Industry, Technologies 10 (5), 99
8. D Salazar, I Yakoumis, ML Grilli, “Substitution and Recycling of Critical Raw Materials in Optoelectronic, Magnetic and Energy Devices III, physica status solidi (a) 219 (15), 2200259
9. S Spathariotis, KM Sakkas, E Polyzou, I Yakoumis, “Recycling of platinum group metals from energy storage devices: a techno-economical business plan analysis, Open Research Europe 2, 92, 2022
10. Papagianni S., et. al., " Platinum Recovered from Automotive Heavy-Duty Diesel Engine Exhaust Systems in Hydrometallurgical Operation ", Metals (2022), 12(1), 31 2. “,
11. Papadopoulou H., et al., "DES-Based Solution for Regenerating Diesel Particulate Filters of Euro V/VI Diesel Vehicles", Materials Proceedings (2021): 5, 107.
12. Moschovi, A. M., et al. "First of its kind automotive catalyst prepared by recycled PGMs-catalytic performance." Catalysts 11.8 (2021): 942.
13. Yakoumis, I., et al. "Recovery of platinum group metals from spent automotive catalysts: A review." Cleaner Engineering and Technology (2021): 100112.
14. Yakoumis, I., et al. "PROMETHEUS: A Copper-Based Polymetallic Catalyst for Automotive Applications. Part II: Catalytic Efficiency an Endurance as Compared with Original Catalysts." Materials 14.9 (2021): 2226.
15. Yakoumis, I. "PROMETHEUS: A Copper-Based Polymetallic Catalyst for Automotive Applications. Part I: Synthesis and Characterization." Materials 14.3 (2021): 622.
16. Moschovi, A. M., et al. "Recycling of Critical Raw Materials from Hydrogen Chemical Storage Stacks (PEMWE), Membrane Electrode Assemblies (MEA) and Electrocatalysts." IOP Conference Series: Materials Science and Engineering. Vol. 1024. No. 1. IOP Publishing, (2021).
17. Giovanna, N., et al. "Platinum Group Metals Recovery Using Secondary Raw Materials (PLATIRUS): Project Overview with a Focus on Processing Spent Autocatalyst." Johnson Matthey Technology Review (2021).
18. Betsi-Argyropoulou, I. I., et al. "Towards Ammonia Free Retrofitting of Heavy-Duty Vehicles to Meet Euro VI Standards." Vehicle and Automotive Engineering. Springer, Singapore, (2020).
19. Yakoumis, I., et al. "Single-step hydrometallurgical method for the platinum group metals leaching from commercial spent automotive catalysts." Journal of Sustainable Metallurgy 6.2 (2020): 259-268.
20. Gutiérrez, A., et al. "Insights into carbon nanotubes and fullerenes in molten alkali carbonates." The Journal of Physical Chemistry C 123.15 (2019): 9909-9918.
21. Gutiérrez, A., et al. "Theoretical study on molten alkali carbonate interfaces." Langmuir 34.43 (2018): 13065- 13076.
22. Moschovi, A. M., et al. "An integrated circular economy model for decoupling Europe from Platinum Group Metals supply risk in the automotive sector." 2018 IEEE International Conference on Environment and Electrical Engineering and 2018 IEEE Industrial and Commercial Power Systems Europe (EEEIC/I&CPS Europe). IEEE, (2018).
23. Yakoumis, I., et al. "Real life experimental determination of platinum group metals content in automotive catalytic converters." IOP Conference Series: Materials Science and Engineering. Vol. 329. No. 1. IOP Publishing, (2018).
24. Yakoumis, I., et al. "Tubular C/Cu decorated γ-alumina membranes for NO abatement." Journal of Membrane Science 515 (2016): 134-143.
25. Kolliopoulos, G., et al. "Behavior of platinum group metals during their pyrometallurgical recovery from spent automotive catalysts." Open Access Lib. J 1 (2014): 1-9.

ELSEVIER

MDPI

MONOLITHOS

CATALYSTS - RECYCLING - INNOVATION

PATENTS as an Asset

5 Patents

I. Yakoumis, A. Polyzou, A.M. Sofianou, E. Zagoraiou, S. Papagianni, A.M. Moschovi, 2021, *«Recovery of CRMs from electrochemical stack devices via hydrometallurgical process» (EL 245-0004386313)*

II. Yakoumis, A.M. Moschovi, K.M. Sakkas, 2020, *«Method, device and process for the abatement of SO2 emissions in internal combustion engines » (EP3939690)*

III. Yakoumis, 2019, *«Copper based catalysts for engine exhaust gas stream treatment» (EP3569309A1)*

IV. Yakoumis, S. Souentie, 2019, *«Device and process for the treatment of engine flue gases with high oxygen excess» (EP3542887A8)*

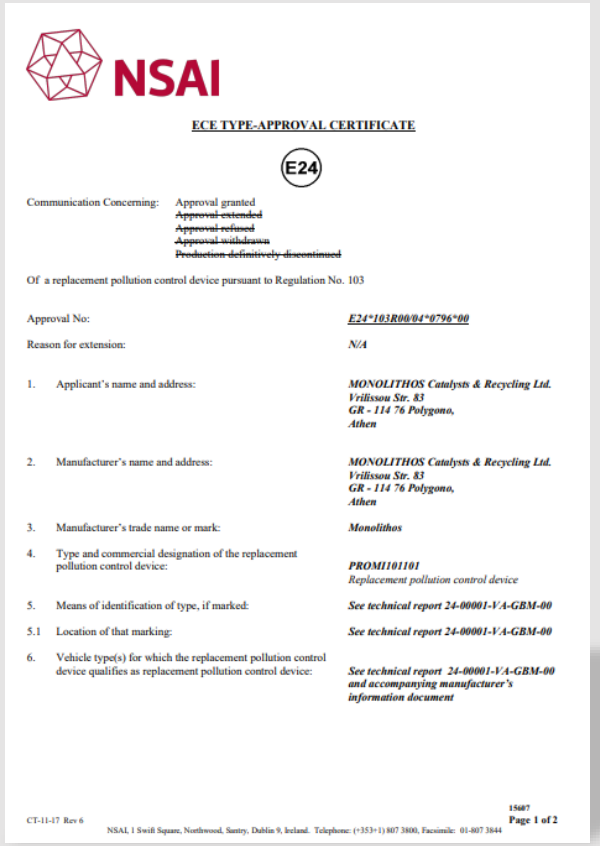
V. Yakoumis, A. Polyzou, A.M. Sofianou, E. Zagoraiou, A.M. Moschovi, 2024, *«Process for recovering and reusing electrodes, electrocatalysts, metals and polymer electrolyte from polymer electrolyte-electrodes assembly of electrochemical devices» (Application No 0000002899)*

ΟΡΓΑΝΙΣΜΟΣ ΒΙΟΜΗΧΑΝΙΚΗΣ ΙΔΙΟΚΤΗΣΙΑΣ

Europäisches Patentamt
European Patent Office
Office européen des brevets

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

ISO 9001:2015 Certification & EURO VI homologated catalyst



NSAI

ECE TYPE-APPROVAL CERTIFICATE

E24

Communication Concerning: Approval granted
~~Approval extended~~
~~Approval refused~~
~~Approval withdrawn~~
~~Production definitively discontinued~~

Of a replacement pollution control device pursuant to Regulation No. 103

Approval No:		*E24*103R00/04*0796*00*
Reason for extension:		*N/A*
1.	Applicant's name and address:	*MONOLITHOS Catalysts & Recycling Ltd. Vrilissou Str. 83 GR - 114 76 Polygono, Athen*
2.	Manufacturer's name and address:	*MONOLITHOS Catalysts & Recycling Ltd. Vrilissou Str. 83 GR - 114 76 Polygono, Athen*
3.	Manufacturer's trade name or mark:	*Monolithos*
4.	Type and commercial designation of the replacement pollution control device:	*PROMI1101101 Replacement pollution control device*
5.	Means of identification of type, if marked:	*See technical report 24-00001-VA-GBM-00*
5.1	Location of that marking:	*See technical report 24-00001-VA-GBM-00*
6.	Vehicle type(s) for which the replacement pollution control device qualifies as replacement pollution control device:	*See technical report 24-00001-VA-GBM-00 and accompanying manufacturer's information document*

CT-11-17 Rev 6

15687
Page 1 of 2

NSAI, 1 Swift Square, Northwood, Santry, Dublin 9, Ireland. Telephone: (+353+1) 807 3800, Facsimile: 01-807 3644

- ✓ **MONOLITHOS is ISO 9001:2015 Certified for the "Production of Automotive Catalytic Converters".**
- ✓ **Prometheus is the 1st ever Cu-based homologated emission control catalyst applicable for Euro6b cases.**
- ✓ **Prometheus has been developed and certified as a novel and disruptive commercial product only 3 years after the finalization of MONOLITHOS 1st European R&I Project (SME Instrument Prometheus).**

CERTIFICATE

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

The Organization:

MONOLITHOS Ltd

Legal address: 83, Vrilissou Str., P.C. 11476, Polygono

Production Site: 5-7, Anonimou Str., P.C. 10442, Ak. Platonos Athens, Greece

implements a management system that meets the requirements of the standard:

ISO 9001:2015
Quality Management System

Scope of Certification:

Production of automotive catalytic converters.

Certificate Code: AV621/2775Q

Initial Certification:	29.11.2023
Certification Decision:	29.11.2023
Certificate Issue:	1/29.11.2023
Certificate Expiry:	28.11.2024

The certification was carried out in accordance with the AVRV's Terms and Conditions for Certification and remains in force following regular surveillance audits.

On behalf of AVRV

Nikolaos G. Tzachristas
Managing Director

IAF ESYD Certification MS Certificate Nr 692

AVRV Inspection, Assessment and Certification A.E
18, Ag Thoma Str. 15004, Spata Attiki
www.avrv.gr, e. info@avrv.gr
t. +30 2106047411, f.+30 2106046507

This certificate remains the property of AVRV, may be withdrawn when the AVRV's Terms and Conditions for Certification are not met and relates to the aforementioned period of the current certification cycle, expired on 28.11.2026.
The validity of the certificate can be confirmed at www.avrv.gr.

Pg 1 of 1

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

AWARDS - Universal Recycling Excellence

MONOLITHOS has been announced
ClimateTech Category Winner
of the Tech Rocketship Awards 2022
by the UK Department of International Trade.
For the development and operation of the recycling process.

Dr. Anastasia - Maria Moschovi
(Head of MONOLITHOS R&I Department)
was **declared** the
Woman in Energy Award Winner
at EUSEW Awards 2023.
For the development and operation of the recycling process for CRMs recycling.

MONOLITHOS
CATALYSTS - RECYCLING - INNOVATION

MONOLITHOS

CATALYSTS - RECYCLING - INNOVATION

Thank You
For Your Attention

www.innovation.monolithos.gr

info@monolithos-catalysts.gr