

PROMETIA
10th Scientific Seminar

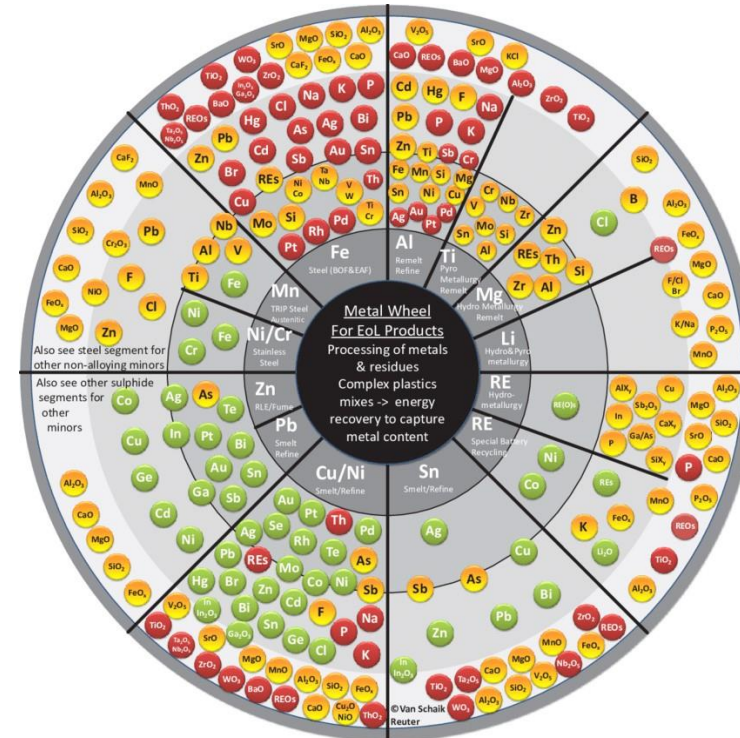
Recycling of man made minerals from the urban mine: challenges and opportunities.

Ir David Bastin

November 2023, Lisboa.

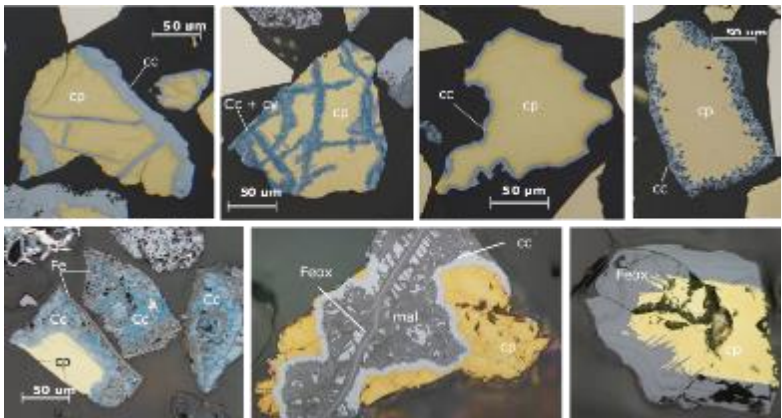
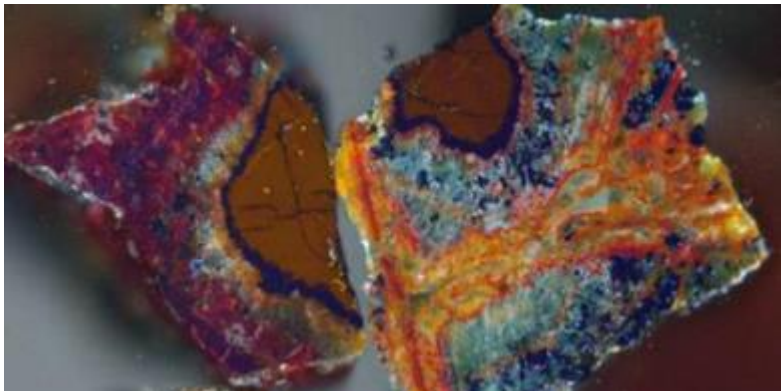


GeMMe
Géoressources, Minéralurgie
& Métallurgie Extractive



The Metal Wheel, Reuter & al., 2013.

Mineral Processing and Extractive metallurgy developed for natural metals paragenesis faced with EOL products containing more and more complex elements associations .



Mining & Urban Mining

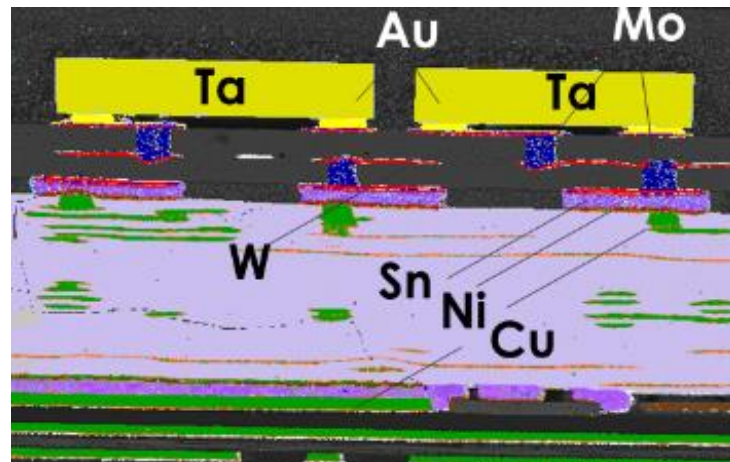
Liberation and Size Reduction

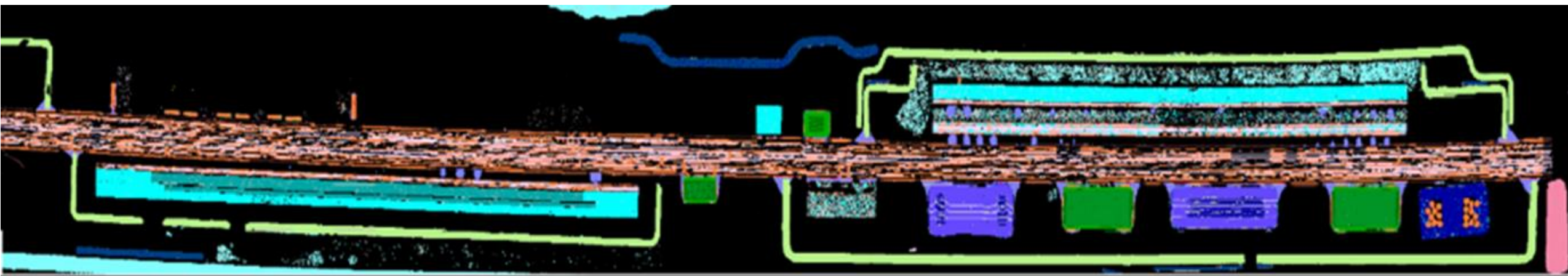


Separation and Concentration



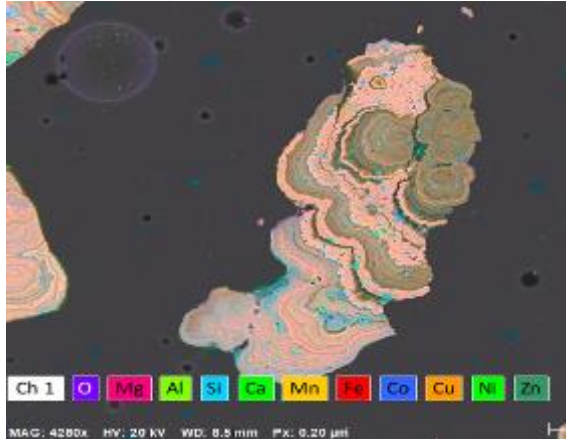
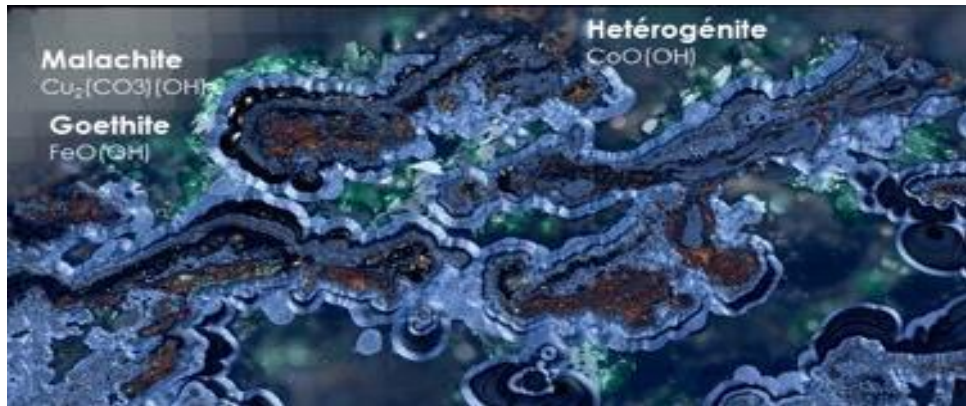
Refining







Mining & Urban Mining



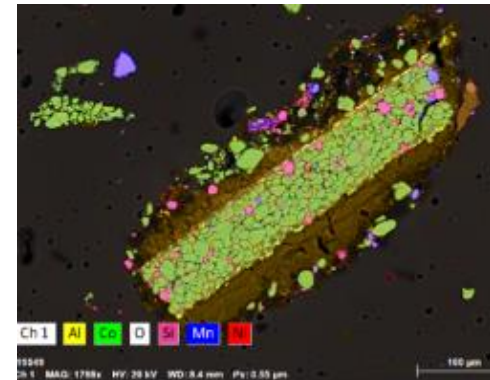
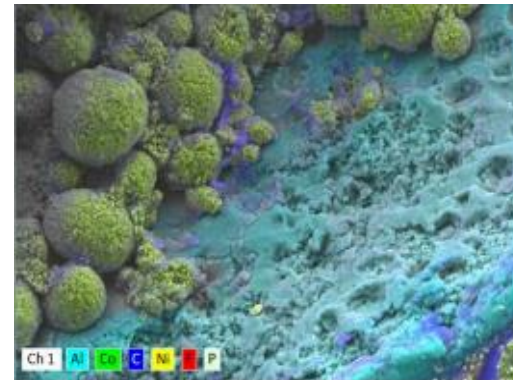
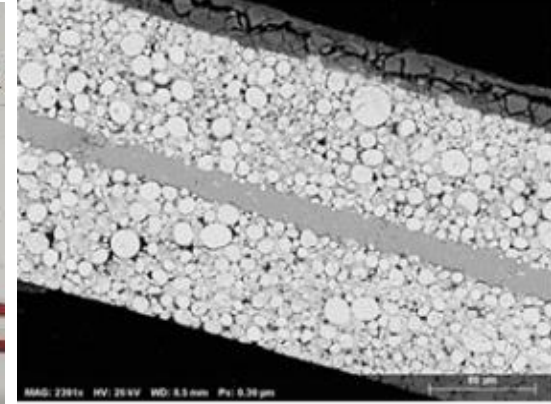
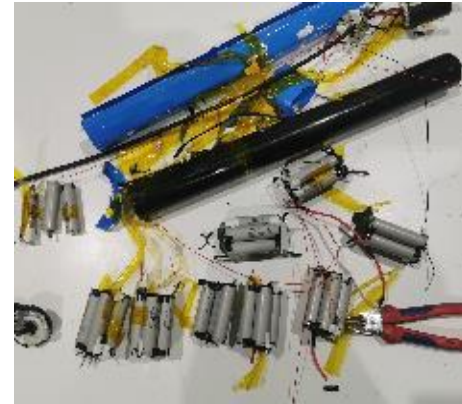
Liberation and Size Reduction



Separation and Concentration

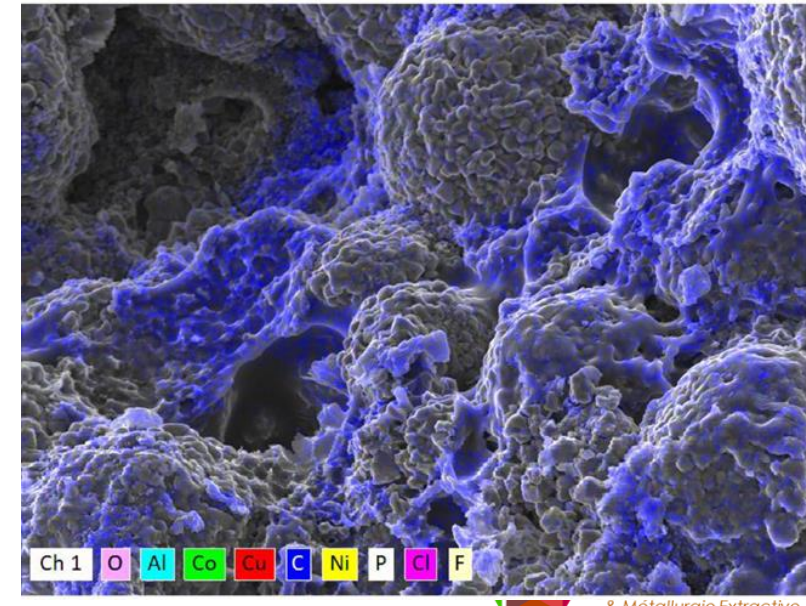
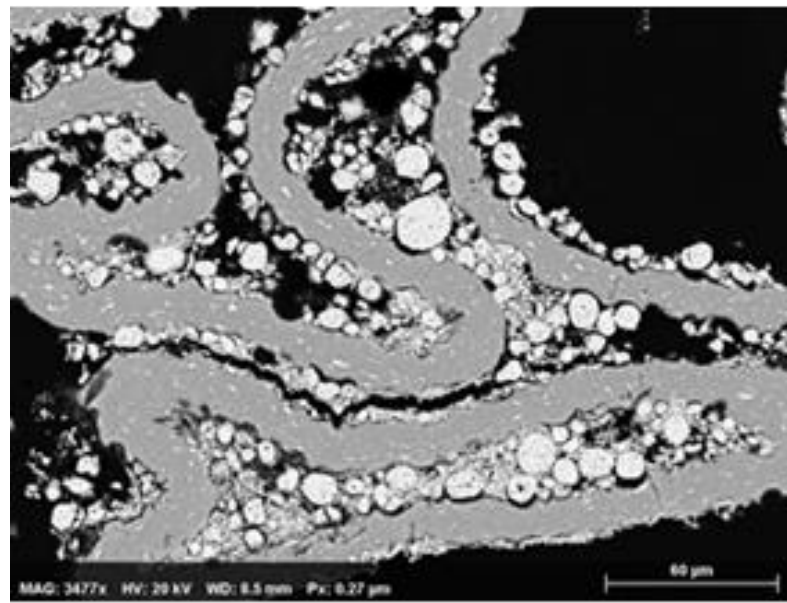
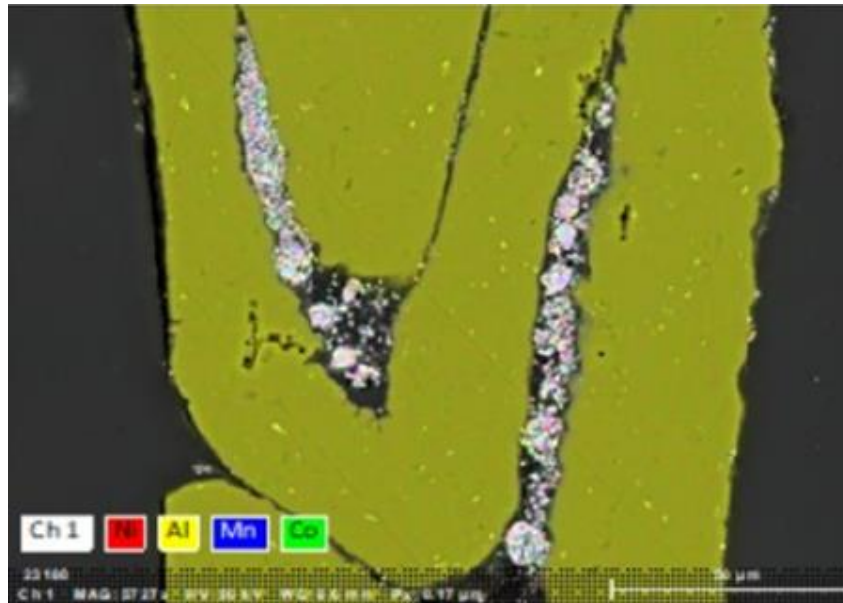


Refining





The challenge of liberating ductile and brittle materials binded by polymers



High Voltage Pulse Fragmentation

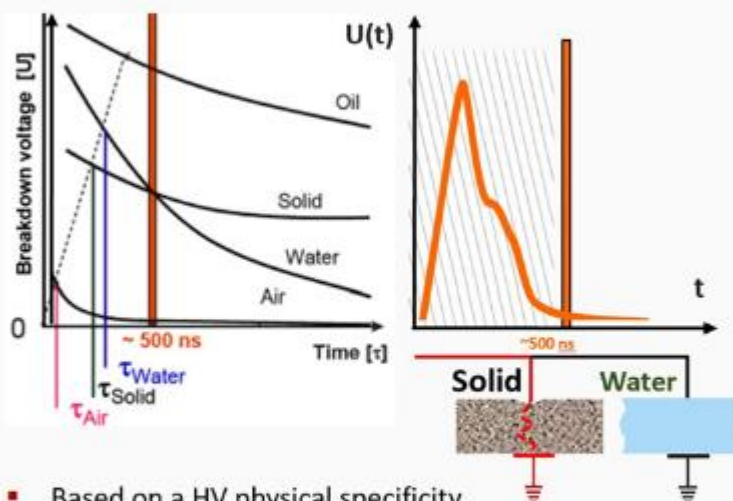


High Voltage Fragmentation



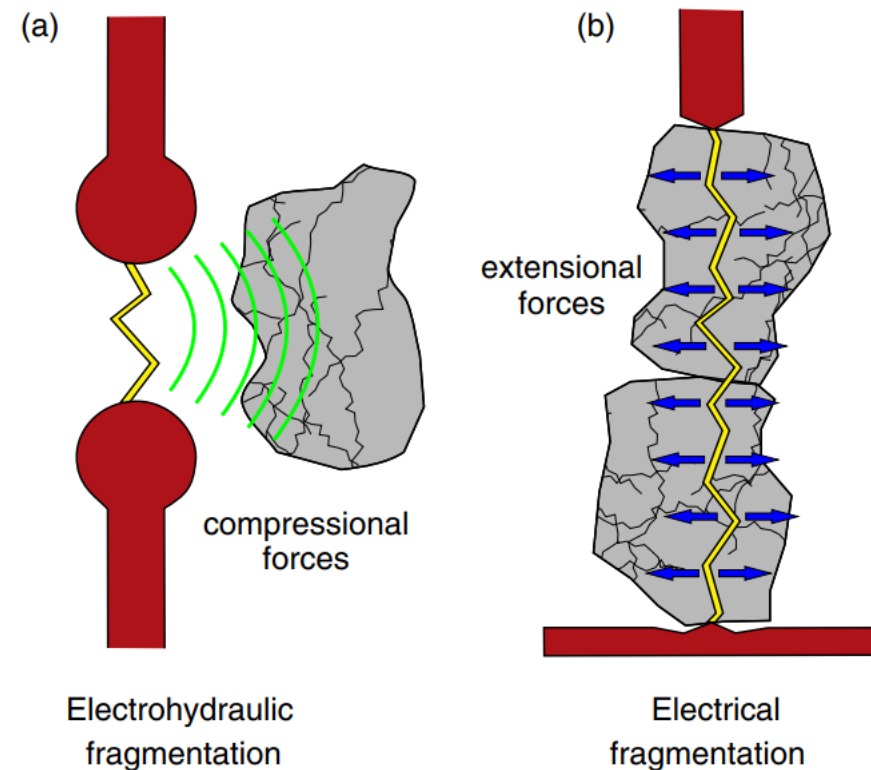
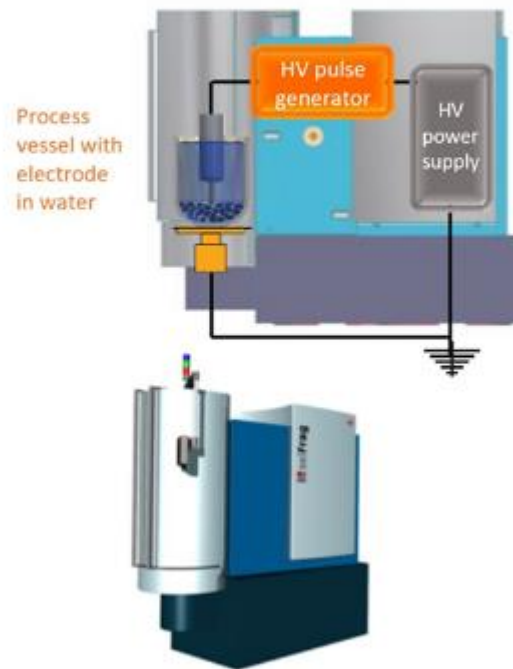
How does HV fragmentation work?

HV pulse power technology



- Based on a HV physical specificity
- At short pulse rise time solid more conductive than water
- Discharge occurs through solid, causing strong internal shockwaves resulting in selective breakage

Industrialized and patented



Recoveries and Entrainment in Blackmass Concentrates

Elements	BM 1	BM 2 Attrition	BM 2 Granulator	BM 2 EDF	Total Flowsheet 1 Attrition	Total Flowsheet 2 Granulator	Total Flowsheet 3 EDF
Ni	84.5 %	17.5 %	34.1 %	91.2 %	87.2 %	89.8 %	98.6 %
Co	87.8 %	18.3 %	42.0 %	89.1 %	90.0 %	92.9 %	98.7 %
Mn	87.3 %	22.4 %	39.3 %	84.9 %	90.1 %	92.3 %	98.1 %
Li	81.6 %	15.9 %	26.2 %	83.8 %	84.5 %	86.4 %	97.0 %
Cu	3.3 %	0.5 %	0.5 %	39.2 %	3.8 %	3.8 %	41.2 %
Al	14.5 %	0.8 %	0.8 %	27.8 %	15.2 %	15.2 %	38.3 %

Wet Attrition

5 % Solids
360 rpm
1 h

Granulator

Horizontal Single Shaft
600 rpm
3 mm closing grid

Electric Fragmentation

160 kV
3 Hz
300 pulses



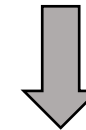
Material after Electric Fragmentation.

The challenge of recovering Cu from WEEE fine shredder residues and dusts. The [Cu⁰ – Al⁰ – Organics] System.

- Leaching of metallic copper
- Al and H₂ generation
- Al precipitation in filtrable form



Acid Pressure Leaching



Al Purification



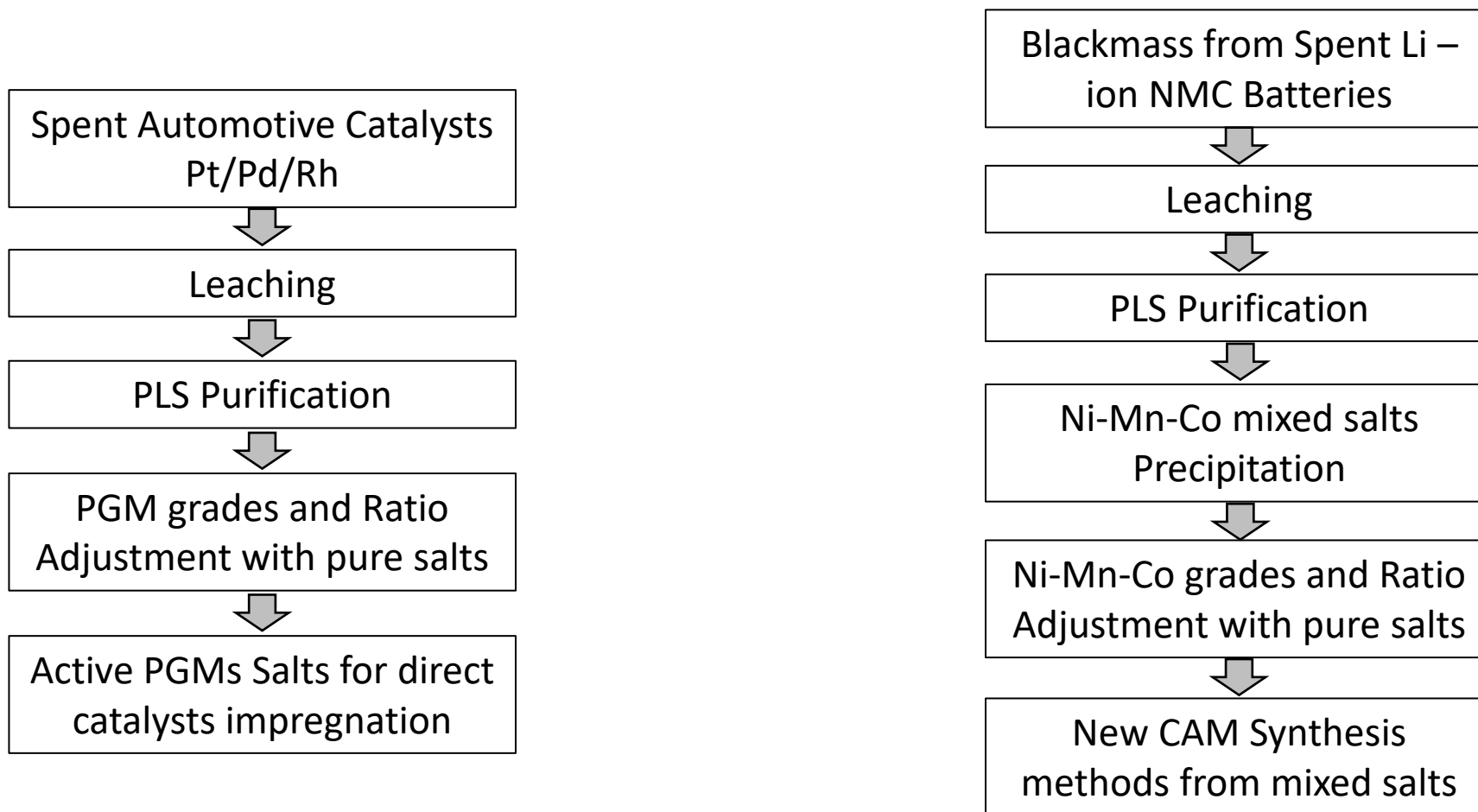
SX



Cu EW

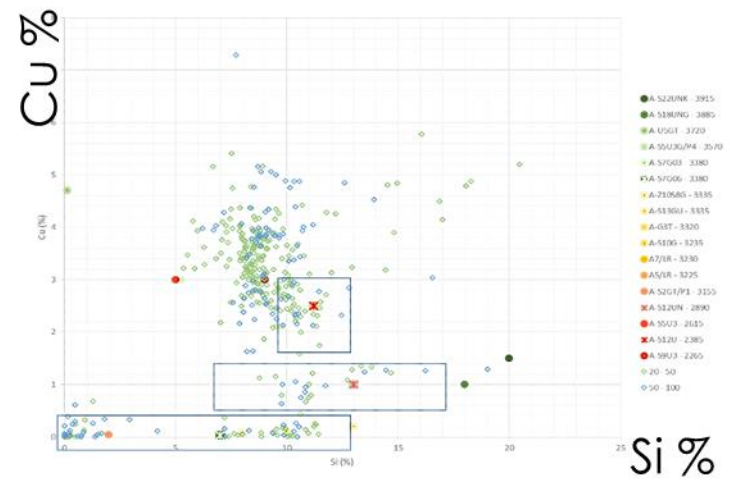
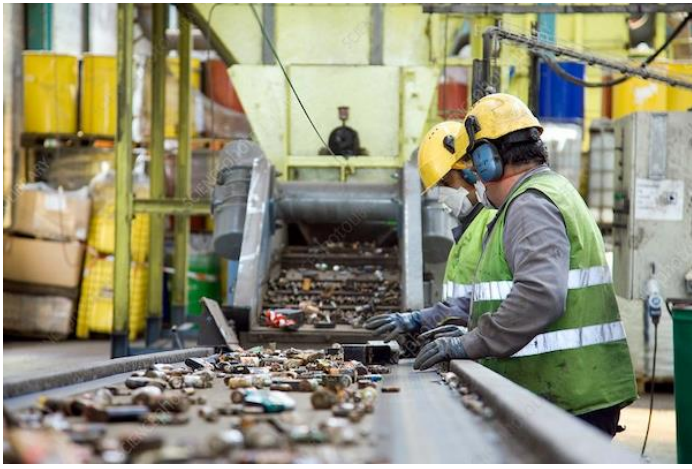
BIOLIX: 14.8 M€ Investment, production of 1500 t/y of copper cathodes, 20 jobs created (yearly metal value > 6 M€).

Man made minerals and the opportunities to shorten the recycling routes.



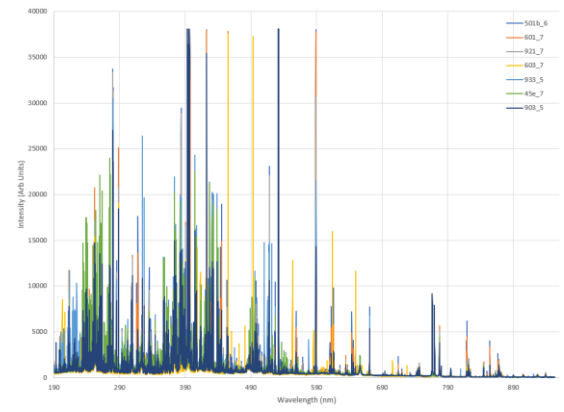
Close the gap between Recyclers/Metallurgists and Material Science Actors.

Increasing the sorted scraps qualities.
Keeping the value of alloying elements and shortening remelting operations
Going beyond the human eyes.



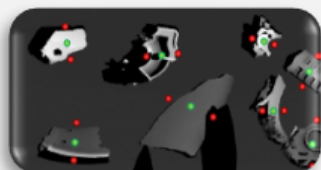
Compositions of Al alloys from a Zorba stream

LIBS Laser Induced Spectroscopy



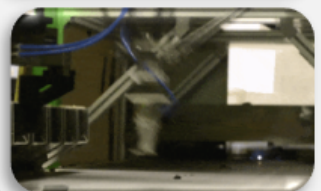
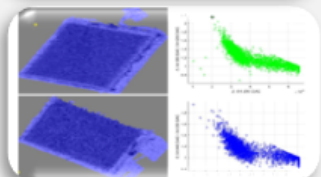
PICKIT

The PICKIT Concept and Technology



Multi-Sensors Hub

- 3D Imaging
- UV-VIS Hyperspectral Imaging
- X-Ray Transmission (XRT)
- Laser Induced Breakdown Spectroscopy (LIBS)

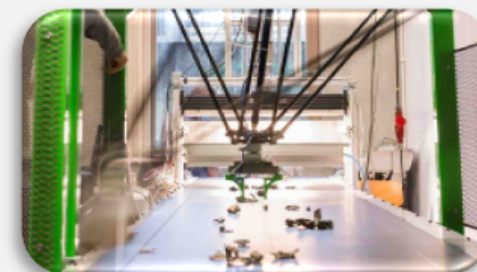


Artificial Intelligence



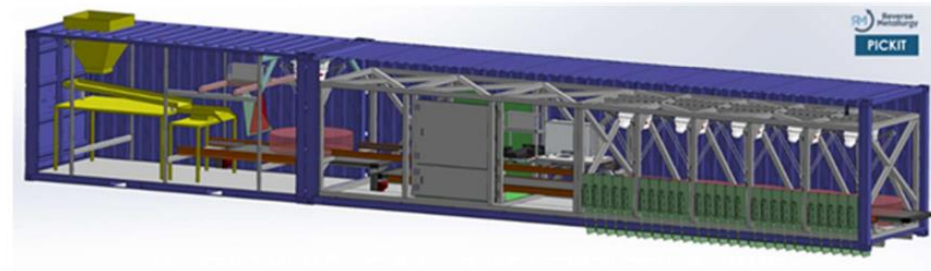
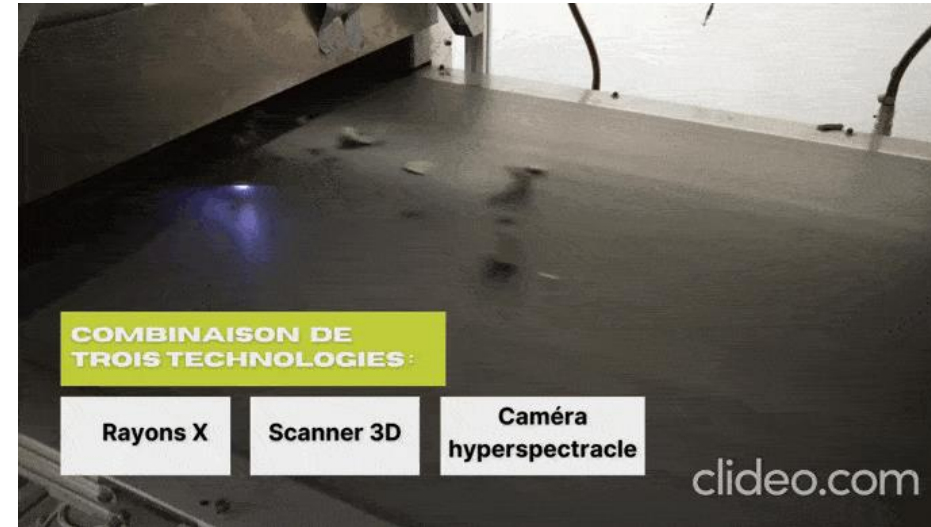
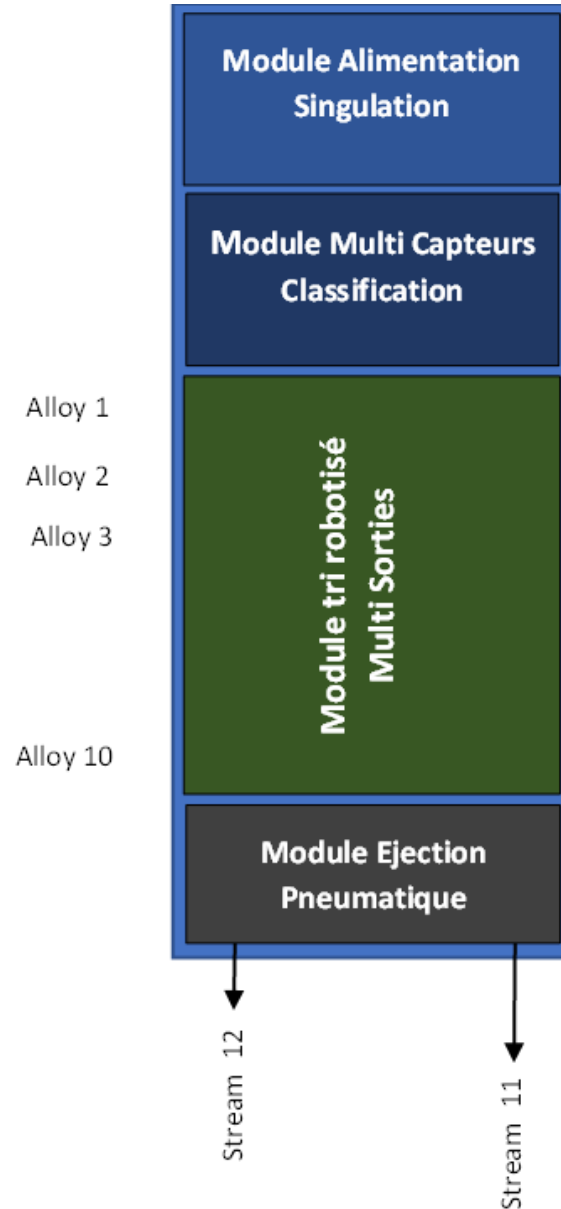
Deep and Machine Learning

Ultra-fast **Robotic Sorting** platform combined with high capacity **Pneumatic Ejection**.



Single Pass Multi-Class Sorting

PICKIT Project





PICKIT – MULTIPICK: 9.4 M€ Investment – 20 000 t/an de Zorba (Metal value> 30M€/y) – 15 jobs created.

- A better evaluation of the resources and reserves of the urban mine. Support projects quantifying what will never be recycled.
- Make the difference between true recycling and downcycling.
- Close the gap between metallurgy, materials science and products designers.
- **Design for Recycling vs Designed from Recycled.**
- **No sustainable urban mines without primary mining.**
- Stop using slogans like Zero Waste, 100 % recycled and carbon neutral.
- We have to think in terms of systems.



*Mini means 600kg
in 1960*

*Mini SE means 1440 kg
in 2021*





1970



2020

Incandescent



12-20 lm/W

Tungsten
Glass,...

Halogene



18-25 lm/W

Tungsten
Iodine, Bromine, ...
Glass,...

Fluo-compact



60-80 lm/W

Tungsten
Mercury, Rare Earths, ... Glass,
Plastics,...

LED



25-140 lm/W

Gallium
Indium, Cerium, Yttrium,
Copper, Silver, Silicium, ...
Plastics, ...

Engineering the circular economy of minerals and metals



- 25+ Research Staff
- 3 M€ annual turnover



Université de Liège hosts the GeMMe, a Research Unit specialized in georesources, mineral engineering and extractive metallurgy.

The GeMMe contributes to the development of innovative processes for the efficient management of mineral and metallic resources while providing unparalleled upscaling experience in urban ore characterization and processing (with a focus on innovative sorting techniques and hydrometallurgy) derived from a long research tradition in primary ores mining and processing.