Recycling of complex waste streams: a Umicore perspective

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Urbanization is on the rise
Global Sustainable Development Goals
A Right? Inconvenient Truth?

Increasing sustainable solutions
Complexity trend

Based on: Achzet et al., Materials critical to the energy industry, Augsburg, 2011
Taking on the global challenges
…and the UN sustainable development goals
Introducing Umicore

A global materials technology and recycling group

One of three global leaders in emission control catalysts for light-duty and heavy-duty vehicles and for all fuel types

A leading supplier of key materials for rechargeable batteries used in portable electronics and hybrid & electric cars

The world's leading recycler of complex waste streams containing precious and other valuable metals
Our foundations have not changed
The supporting megatrends have amplified

Unique business model
Supportive megatrends
Industry leader in sustainability

metals
chemistry material science metallurgy
material solutions
application know-how

more stringent emission control
resource scarcity
electrification of the automobile

recycling
Benefits and challenges of urban mining

**Primary mining**
- ~ 5 g/t Au in ore
- Similar for PGMs

**Urban mining**
- 200 g/t Au, 80 g/t Pd & Cu, Sn, Sb, … in PC motherboards
- 300 g/t Au, 100 g/t Pd … in cell phones
- 2,000 g/t PGM in automotive catalysts

Low grade, high volume, fixed location

High grade, millions of units, global dissemination

Challenge: how to accumulate millions of discarded EoL product into “urban mines” of a reasonable (= economically viable) size
Unique position in recycling

**SHORT LOOP**
Recycling services for customer production scrap and residues

**LONG LOOP**
Unique technologies for treating complex residues and by-products
Megatrends have amplified
Resource scarcity continues to play a role

- Finite quantities of mineral resources
- Spotlight has moved from rare earths to cobalt and lithium
On the road towards clean mobility
Material perspective – (urban) mine to wheel
Integration in the value chain Li-Ion batteries

Umicore occupies a unique position in the value chain guaranteeing high speed to market, supply security, and responsiveness to customer needs.
Umicore Battery Recycling Capabilities

Powerful technology available in Hoboken & Olen, Belgium at (pilot) industrial scale for high efficiency metals extraction & refining

**Capacity 7,000 mt/yr**
- ± 250 mio mobile phone batteries
- ± 200,000 HEV’s
- ± 35,000 EV’s

**Recycled products**
- Alloy: Cu – Co – Ni
- Slag : for Li-Ion: lithium concentrate
  - for NiMH: rare earth concentrate
- Flue dust: controlled separation of F

**Eco-efficient**
- Close-to-zero waste
- Advanced gas cleaning
- Energy of battery used to obtain high temperature (electrolyte, metals, plastics)
Refining @ UPMR
The principles of urban mining

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Refining @ UPMR
Closing the materials loop

Mines → Complex mining concentrates & residues → Smelters & refiners → Smelting & refining residues → Industry → Complex production scrap → Consumers → Complex end-of-life materials

Industrial by-products | Recyclables
Refining @ UPMR
Industrial by-products

WET
- e.g. lead sulphate
- e.g. electrolysis slimes
- e.g. hydroxide

LUMPY/METALLIC
- e.g. drosses
- e.g. mattes
- e.g. slags
- e.g. impure bullion

DUSTY/FREE-FLOWING
- e.g. fine drosses
- e.g. complex concentrate
- e.g. flue dust

PGM
- e.g. filter cake

Precious Metals
- & many more
Refining @ UPMR

Recyclables

- **Electronic Scrap**
  - Au, Ag, Pd, Cu...
  - e.g. mobile phones, printed circuit boards

- **Spent Automotive Catalysts**
  - Pt, Pd, Rh...
  - end-of-life car catalysts

- **Spent Industrial Catalysts**
  - Pt, Pd, Rh...
  - industrial catalysts from oil refining & petrochemical industry

- **Other precious metal bearing materials**
  - Ag, In, Se...
  - e.g. fuel cells, photographic residues
Refining @ UPMR
Raw materials flow

- Arrival of raw materials
- Primary sample
- Final preparation of primary sample
- Laboratory
- Assay exchange
- Released for processing
- Smelter
- Loss of identity
Refining @ UPMR
Our process in a nutshell

Recyclables

Collector metals

Industrial by-products

17 different metals
Refining @ UPMR
Our unique metallurgical flowsheet

- Raw materials
  - Sampling and assaying
  - Sulphuric acid plant
    - SO$_2$
    - Ni-speiss
      - Ni, As
    - Precious metals refinery
      - PM-residues
      - Cu
      - Ag, Au, Pt, Pd, Rh, Ir, Ru
      - Se residue
      - In, Se, Te
      - In-Te-residue
      - Special metals refinery
      - Pb, Bi, Sb, Sn
    - Aggregate
  - Lead refinery
    - Pb-bullion
    - Pb-slag
    - Cu bullion
    - Cu matte
  - Blast furnace
  - Smelter
Refining @ UPMR
Precious metals operations

**SMELTER**
- Unique application of ISASMELT technology
- Precious metals concentrated in copper bullion

**LEACHING & ELECTROWINNING**
- Highly flexible technology
- Copper leaching to collect precious metals residue
- Production of pure copper cathodes

**PRECIOUS METALS REFINERY**
- Both classical and unique processes used
- Incorporating pyro- and hydro-metallurgy
- Production of high purity metals
Refining @ UPMR
Base metals operations

BLAST FURNACE
• Production of lead bullion
• Construction aggregate to construction industry in three grain sizes: Umirock, Betogrind, Betozand

LEAD REFINERY
• Refining of lead bullion
• Production of 99.99% lead, LME-registered brand
• A major European lead producer

SPECIAL METALS REFINERY
• Refining side-stream materials from the lead and precious metals refineries
• Production of high purity metals
Refining @ UPMR

Products

Precious metals
- Ag (Silver)
- Au (Gold)
- Pt (Platinum)
- Pd (Palladium)
- Rh (Rhodium)
- Ru (Ruthenium)
- Ir (Iridium)

Minor metals
- Te (Tellurium)
- Se (Selenium)
- In (Indium)
- As (Arsenic)
- Bi (Bismuth)
- Sb (Antimony)
- Sn (Tin)

Base metals
- Pb (Lead)
- Cu (Copper)
- Ni (Nickel)

Other products
- Aggre-gates
- H₂SO₄
IF OUR PIONEERING APPROACH CAN MAKE US A LEADER IN SUSTAINABILITY

IMAGINE WHAT YOU COULD DO?

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materials for a better life