Recycling of technology metals from electronics
A good opportunity – and a complex challenge
Umicore – a materials technology company

Ø 50% of metal needs from Recycling

14,400 people in ~ 80 industrial sites worldwide, turnover 2012 €: 12.5 Billion (2.4 B excl. metals)
Booming product sales & increasing functionality drive demand for (technology) metals

Drivers:
- growing population (Asia!)
- growing wealth
- technology development & product performance

... next wave: tablet computer:
- 2013 tablets will overpass laptops
- 2015 more tablets than laptops + PC
Massive shift from geological resources to anthropogenic “deposits”

- **Electric & electronic equipment (EEE)**
  Over 40% of world mine production of copper, tin, antimony, indium, ruthenium & rare earths are annually used in EEE

- **Mobile phones & computer**
  account for 4% world mine production of gold and silver and for 20% of palladium & cobalt.

- **Cars**
  > 60% of PGM mine production goes into autocatalysts, increasing significance for electronics (“computer on wheels“) and light metals

- In the last 30 years we extracted > 80% of the REE, PGM, Ga, In, … that have ever been mined

- **Clean energy technologies & other high tech applications** will further accelerate demand for technology metals (precious metals, semiconductors, rare earths, refractory metals, …)
  ➔ without access to these metals no sustainable development in EU
How to avoid clean solutions with dirty feet?

No foreseeable absolute scarcity of metals, but:
• Declining grades & increasing complexity of ores
• Need to mine from greater depths and/or in ecological sensitive areas (artic regions, oceans, rain forest etc.)

⇒ footprint of primary metals production can be high
  • Energy needs & related climate impact
  • Other burden on environment (land, water, biodiversity)

Other supply risks (political, trade restrictions, economical/speculation; regional or company oligopolies, …) and demand surges already today lead to market imbalances & temporary scarcities.

→ critical metals identification for the EU
Recycling & circular economy as key contributors

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

**Urban mining**
- 200 g/t Au, 60 g/t Pd & Cu, Sn, Sb, … in PC motherboards
- 300 g/t Au, 60 g/t Pd … in cell phones

Challenge 1: how to accumulate millions of discarded EoL product into „urban mines“ of a reasonable (= economically viable) size
Recycling of most technology metals still lags way behind …

End-of-Life recycling rates for metals in metallic applications

WEEE: precious metal recycling rates below 15%


New report (April 2013):
Metal Recycling: Opportunities, Limits, Infrastructure

Recycling needs a chain, not a single process  
- system approach is crucial

Example recycling of WEEE  
Recovery of technology metals  
from circuit boards

Collection  
10,000’s

Dismantling  
1000’s

Preprocessing  
100’s

Smelting & refining  
of technology metals (metallurgy)  
3

Number of actors in Europe

Total efficiency is determined by weakest step in the chain  
Make sure that critical fractions reach these plants

Example: 30% x 90% x 60% x 95% = 15%
Challenge 2: relevant products/fractions don‘t reach suitable recycling processes

a) Low collection

⇒ ambitious targets & new business models are required

b) “Deviation” of collected goods

⇒ dubious exports ⇒ low quality "recycling"

⇒ “Tracing & Tracking“, controls & enforcement, stakeholder responsibility, transparency
Technology metals need smart recycling
- mass focused traditional European recycling does not fit

- “Mono-substance” materials without hazards
- Trace elements remain part of alloys/glass

Recycling focus on mass & costs

- “Poly-substance” materials, incl. hazardous elements
- Complex components as part of complex products

Place focus on trace elements & value
Recycling – technical fundamentals
Success factors are product design & technical-organisational set-up of the recycling chain

Product manufacturing ↔ manual/mechanical preprocessing ↔ metallurgical recovery

Challenge 3: How to recover low concentrated technology metals from complex products

Multi-metal recycling with modern technology

- High tech & economies of scale

- **Recovery of 20 metals with innovative metallurgy** from WEEE, catalysts, batteries, smelter by-products etc.: Au, Ag, Pt, Pd, Rh, Ru, Ir, Cu, Pb, Ni, Sn, Bi, Se, Te, Sb, As, In (via versatile multi feed process).
  - Co, REE (via specialised process for battery materials)

- Value of precious metals enables co-recovery of specialty metals (‘paying metals’)

- **High energy efficiency** by smart mix of materials and sophisticated technology

- High metal yields, minimal emissions & final waste

Umicore’s integrated smelter-refinery in Hoboken/Antwerp
Treatment of 350 000 t/a, global customer base

ISO 14001 & 9001, OHSAS 18001
Concluding - Recycling success factors

Recycling prerequisites

1. Technical recyclability as basic requirement
2. Accessibility of relevant component → product design
3. Economic viability intrinsically or externally created
4. Completeness of collection business models, legislation, infrastructure
5. Keeping within recycling chain → transparency of flows
6. Technical-organisational set-up of chain → recycling quality
7. Sufficient recycling capacity

Complex products require a systemic optimisation & interdisciplinary approaches (product development, process engineering, metallurgy, ecology, social & economic sciences)
Focus circular economy
- significant improvements still needed at every step

- Consider recycling in product design
- Develop business models to close the loop
- Recycle production scrap
- Improve range & yields of recovered metals
- Improve efficiency of energy & water use
- Improve collection
- Increase transparency of flows
- Ensure quality recycling
- Go beyond mass recycling (more focus on technology metals)
- Develop innovative technologies to cope with technical recycling challenges

Mining & Recycling are complementary systems!
Thanks for your attention

Umicore – A Materials Technology Company

Energy Materials
- We develop materials which enable the clean production and storage of energy

Catalysis
- We develop technologies to treat automotive emissions

Recycling
- We operate a unique recycling process to deal with complex industrial residues and end-of-life materials

Performance Materials
- We produce a range of essential materials and chemicals based on precious metals and zinc

Contact: christian.hagelueken@eu.umicore.com; www.umicore.com

Technology metals: descriptive expression, comprising most precious and special metals

- crucial for technical functionality based on their often unique physical & chemical properties (conductivity; melting point; density; hardness; catalytic/optical/magnetic properties, …)
- mostly used in low concentrations and a complex substance mix (‘spice metals’)
- Key for “Hi-Tech” and “Clean-Tech”
Efficient production and use of energy will further boost demand for technology metals

Photovoltaic (solar cells)
- Germanium
- Gallium
- Selenium
- Indium
- Silver

Electric vehicles & batteries
- Lithium
- Cobalt
- Nickel
- Copper
- Rare Earth Elements

Light Emitting Diodes (LED)
- Gallium
- Indium
- Germanium
- Silver

Fuel Cells
- Platinum
- Iridium
- Cobalt