KU Leuven as a European Partner in the NSF I/UCRC for RESOURCE RECOVERY & RECYCLING

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Consumer products are increasingly complex

- Ag, Au, Pd... (precious metals)
- Cu, Al, Ni, Sn, Zn, Fe, Bi, Sb, In... (base & special metals)
- Hg, Be, Pb, Cd, As... (metals of concern!)
- halogens (Br, F, Cl...)
- plastics & other organics
- Glass, ceramics

These devices represent a considerable metal stock in society

**Cell phones**:  
1300 Million units x 250 mg Ag ≈ 325 t Ag  
x 24 mg Au ≈ 31 t Au  
x 9 mg Pd ≈ 12 t Pd  
x 9 g Cu ≈ 12,000 t Cu  
x 3.8 g Co² ≈ 4900 t Co

**PC & laptops**:  
300 Million units x 1000 mg Ag ≈ 300 t Ag  
x 220 mg Au ≈ 66 t Au  
x 80 mg Pd ≈ 24 t Pd  
x ≈ 500 g Cu ≈ 150,000 t Cu  
≈140 M batteries² x 65 g Co ≈ 9100 t Co

* based on 2008 sales, Gartner 2.3.2009  
¹ 20 g Li-ion battery  
² Li-ion batteries is used in >90% of laptops

Credit: C. Meskers - Umicore
CR$^3$ Vision

To be the premiere industry-university alliance serving consortium members’ needs, by establishing the needed knowledge base, and by educating future leaders of the industry. We are dedicated to the Sustainable Stewardship of our Earth’s Resources.
CR³ Academic Partners
CR³ member companies
## Current Research Projects

- Development of a Novel Recycling Process for Li-Ion Batteries
- Dezincing of Galvanized Steel
- Fundamental Study of Lithium Ion Battery Recovery
- Magnet Separation Technologies for Recycling
- Metal Recovery via Automated Sortation
- Molten Metal Compositional Sensing to Enhance Scrap Recycling
- Opportunities and Barriers to Resource Recovery and Recycling from Shredder Residue in North America
- Rare-Earth Recovery from Magnets, Catalysts, and other Secondary Resources
- Recovery of Rare Earth Metals from Phosphor Dust of Waste Fluorescent Light Fixtures
- Recovery of Value-Added Products from Red Mud and Foundry Bag House Dust
- Recovery of Zinc and Iron from EAF Duffs Including Hot Stage Slag Engineering and Energy Recovery
- Synthesis of Inorganic Polymers from Metallurgical Residues
KIEM - Kroll Institute for Extractive Metallurgy

Patrick R. Taylor
Director, KIEM
G.S. Ansell
Distinguished Professor of Chemical Metallurgy

EXPERTISE
- Mineral Processing
- Extractive Metallurgy
- Recycling
- Waste Treatment & Minimization
- Thermal Plasma Processing of Materials
- Thermal Plasma Processing of Wastes

Brajendra Mishra
Associate Director
KIEM, Professor of Metallurgical and Materials Engineering

EXPERTISE
- Pyrometallurgy
- Electrochemistry
- Materials synthesis
- Waste Processing
- Recycling
- Molten Salt Processing
- Oxidation
- Reactive & radioactive metals
- Glove box processing

Corby G. Anderson
Harrison Western
Professor of Metallurgical and Materials Engineering

EXPERTISE
- Extractive Metallurgy
- Mineral Processing
- Recycling
- Waste Treatment & Minimization
European Partner
KU Leuven
Leuven, Belgium

K.U.Leuven $CR^3$ steering group

Bart Blanpain  P. Tom Jones  Tom Van Gerven  Karel Van Acker  Koen Binnemans
Research Domains

• Residue valorisation and enhanced landfill mining
  – enhanced landfill mining
  – thermal residues valorisation

• Process and flowsheet intensification
  – metallurgical processing
  – process- en flowsheet design
  – CCS – mineral carbonation (magnetic, ultrasound, microwave)
  – Rare earth elements recycling

• Sustainable materials management
  – Eco-design, materials selection
  – Sustainability indicators and assessment (LCA, MFA, exergy,...)
Timeline

- Official start of I/UCRC CR³ (Jan 2010)
- KU Leuven is CR³ affiliate partner (Jan 2010)
- Contact companies (April-Aug 2010)
- European CR³ Workshop with companies (September 2010)
- Sign-up Members through K.U.Leuven (Sept-Dec 2010)
- KU Leuven site operational and active full partner CR³ (April 2011)
- Start of Leuven projects (Sept 2011)
Mapping and sorting the research interests (May 2011)
Lessons learned

• Leadership and vision are essential

• Research synergy between the academic partners is necessary

• Most CR³ companies enjoy the international approach

• Different research approaches can be very inspirational
Lessons learned

• Institutional frames (overheads, educational programmes, ...) may be confusing

• International travel could be an issue, but most see it as an opportunity

• Equivalent (e.g. European) funding to NSF funding for US partners would be very helpful
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