

# Chemistry Innovation

Driving Innovation and Value for the UK chemistry-using industries

Knowledge  
Transfer  
Network

Chemistry Innovation

Participant Pitches

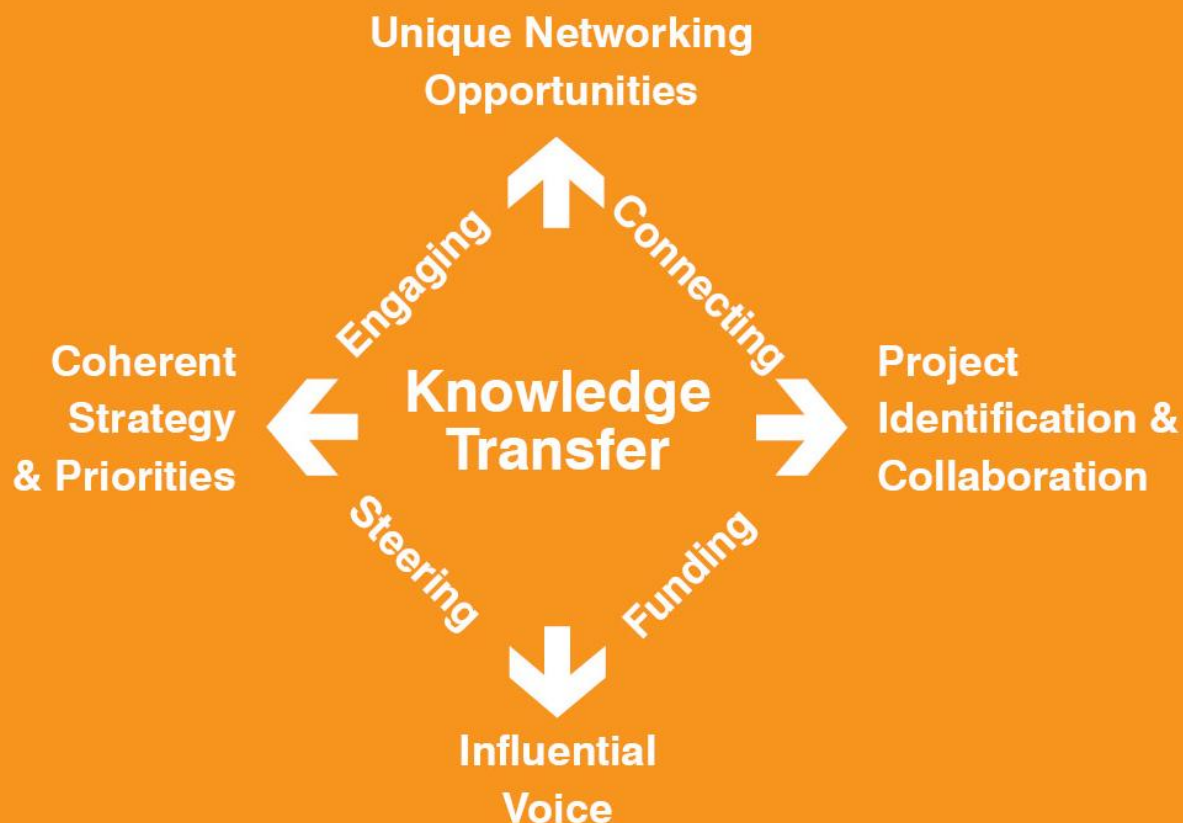
November 2013

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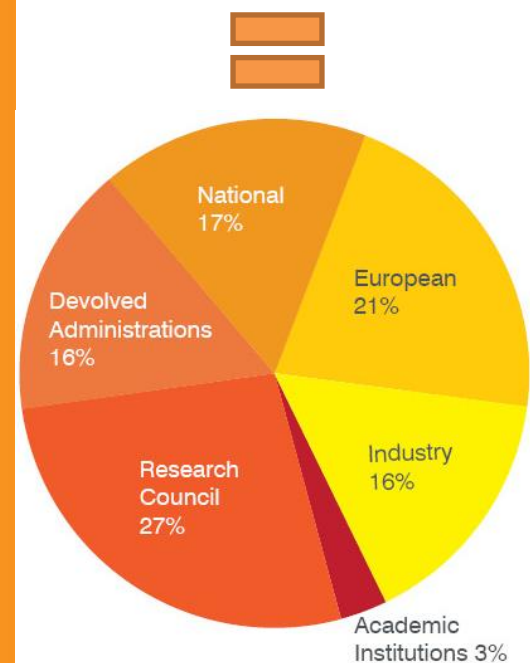
Catherine Joce

Chemistry Innovation KTN

# Chemistry Innovation Knowledge Transfer Network



**200 collaborative projects**



**£220m funding leveraged**

**Value potential of £1.3bn**

# Topic (s) of interest and project idea



## Raw Materials for the 21st Century

The raw materials used as input materials for the production



## Smart Manufacturing Processes

The processes used in the manufacture of chemicals



## Design for Functionality

The efficient design and manufacture of chemical entities, materials and systems which offer desired functionality

- SC5\_12 – 2014/2015: Innovative and sustainable solutions leading to **substitution of raw materials**
- NMK 23 - 2015: Novel materials by design for **substituting critical elements**
- SC5\_19 – 2014/2015: Coordinating and supporting research and innovation in the area of climate action, environment, resource efficiency and raw materials
- WASTE 3 – 2014: Recycling of raw materials from products and buildings
- SC5\_11 – 2014/2015: New solutions for sustainable production of raw materials
- SPIRE 7 - 2015: Recovery technologies for metals and other minerals

# What I have to offer and partners sought

- **Ideal dissemination partner**
- Coordinating the Innovation Network for Substitution of Critical Raw Materials
- Chair UK Materials Security Special Interest Group
- Experienced European project partner (11 projects, 3 as coordinator)



**CRM\_InnoNet**  
Substitution of Critical Raw Materials



**RAMINTECH**

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Christer Forsgren

Stena Metall AB

# Organisation

- A family owned company
- Stena Metal is active in 9 EU-countries
- 250 plants, 4000 employeed, 3.000 Milj € turnover
- WEEE, 9 car shredders, Hazardous waste treatment, Secondary Al smelter, etc.

## Topic (s) of interest and project idea

- Recycled material mostly contain more contaminants (irrelevant material) than virgin material
- Presently “all” design and education is based on characteristics of virgin material
- Develop a new design of products based on recycled material

# What I have to offer and partners sought

- At Chalmers Technical University there are nine PhD students and two full time professors in Industrial Material Recycling. R&D at Stena Recycling International, eight persons.
- What is “clean enough” for recycled Sb used as flame retardants, In in ITO used for LCDs and Nd in magnets.
- Proposed step 1. Recycling of Sb from ash, plastics, industrial waste, etc. that can replace virgin Sb.

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# Oliver Skipper

## Ceram

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Ketan Patel

DCN Corporation Ltd

# DCN Corp<sup>®</sup> the Organisation



- Micro R&D SME - **founded in 2009**. Founded by Mr Ketan K. Patel (CEO)
- Based on a Proof-of-Principle (PoP) nano 'platform' disruptive technology - contrived during a PhD programme at The University of Manchester (UoM)
- Discovered a novel means for even displacement of nanoparticles (Gold nanoparticles) from dip coating and an associated encapsulation chamber set-up
- PoP dip coating achieved at Standard Temperature and Pressure (STP) via non-clean room conditions
- DCN Corp<sup>®</sup>'s means of dip coating is highly cost-effective and eco-friendly when compared to competitor nano-fabrication methodologies, such as Chemical Vapour Deposition (CVD) and/or Physical Vapour Deposition (PVD)

Please ensure to visit us @ [www.dncorp.com](http://www.dncorp.com)

# Topic(s) of interest & Project idea

## Topic(s) of interest:-

- Finding alternatives or 'substitutes' for components or materials containing 'critical' or scarce elements such as used in electronic devices, lighting, alloys and hard materials
- Recycling of 'technology' metals and other critical materials from end-of-life products

## R&D Project idea:-

- DCN Corp<sup>®</sup> is seeking to provide a reliable means for facilitating the usually spontaneous reaction of Surface-enhanced Raman Scattering (SERS)
- Seeking new R&D partners/commercialization personal to develop a Proof-of-Concept (PoC) for nano-scale coating onto plastic polymers base substrates. Scope for demonstrating a greater degree of nano-homogeneity versus roughened surfaces - e.g. stainless steel

# What I have to offer & Partners sought

## What DCN Corp<sup>®</sup> has to offer:-

- DCN Corp<sup>®</sup>'s nano dip coating methodology will enable for accurate, eco-efficient, simple and scalable coatings. Thus, providing a means for substituting critical/scarce elements
- DCN Corp<sup>®</sup>'s offering would be a strong competitor, because its service providing will be miniaturising a variety of electronic devices by a factor of 1/1000

## R&D/commercial partners sought:-

- DCN Corp<sup>®</sup> is seeking new partners who have an eagerness to adapt the unique capabilities possible from nanotechnology

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Atsufumi Hirohata

University of York



Heusler Alloy Replacement for Iridium

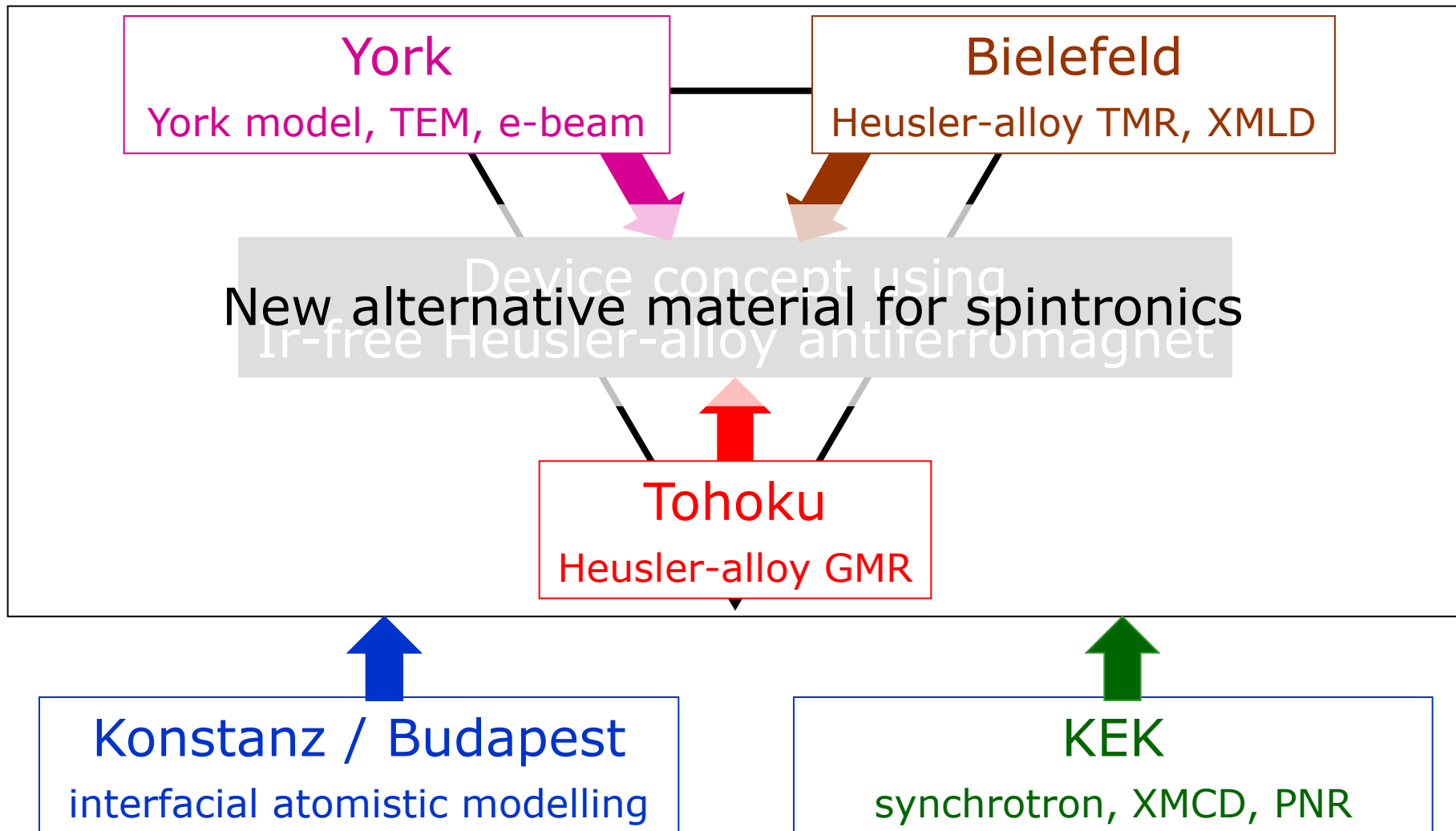
# Topic (s) of interest and project idea



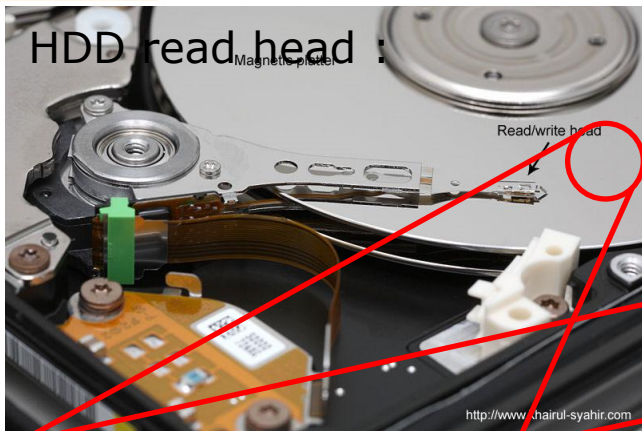
- Melting point :  $> 3,000^{\circ} \text{C}$   
→ **Very stable**
- Almost no applications previously
- World supply :  $\sim 5.8 \text{ t / yr}$   
→ 87 % from South Africa
- 1  $\sim$  2 % in Pt and Rh ore
- **The scarecest element**  
→  $4 \times 10^{-4} \text{ ppm}$   
Comparisons Nd : 33 ppm  
Li : 17 ppm  
Dy : 6.2 ppm  
Pt :  $3.7 \times 10^{-3} \text{ ppm}$   
Au :  $3.1 \times 10^{-3} \text{ ppm}$   
Ru :  $1 \times 10^{-3} \text{ ppm}$

\* <http://www.atheistfrontier.com/people/dmitri-mendeleyev/periodic-table-of-the-elements-for-kids.jpg>

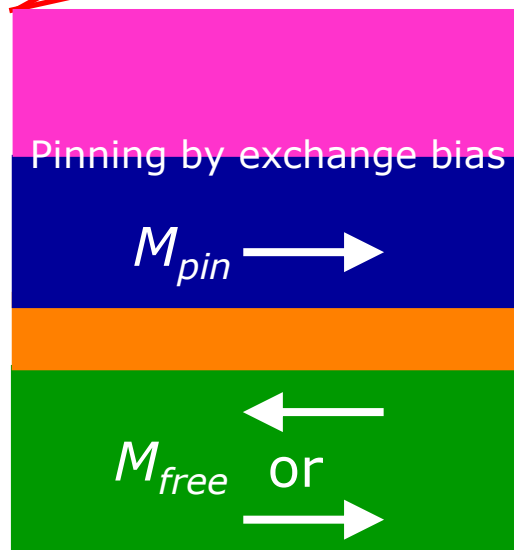
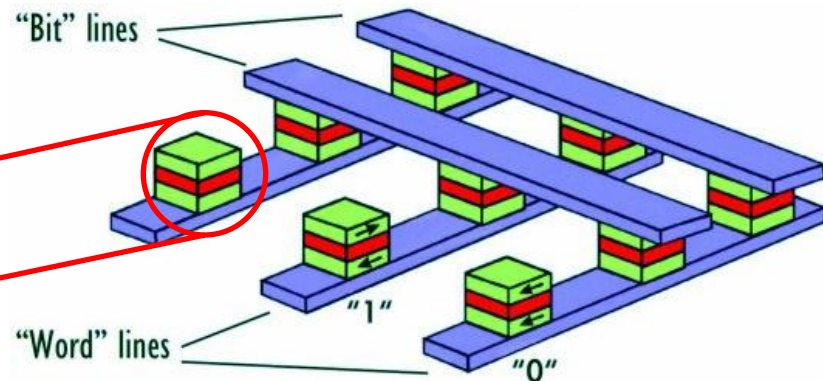
# Organisation



# What I have to offer and partners sought



Magnetic random access memory (MRAM) :



Antiferromagnet  
Pinned ferromagnet  
Non-magnet  
Free ferromagnet

Current → IrMn



- Large exchange bias (> 3.5 kOe)
- Low set temperature (~ 250° C)
- Thin-film form (~ 6 nm)

Replacement with a Heusler alloy

Spin-valve structure

Iakovos Yakoumis

Monolithos Ltd



***Spent  
Ceramic  
Monoliths***



***After-Market  
Catalysts &  
Components***

## Organisation

# MONOLITHOS

### SME

- ❖ 12 people – 3 experienced researchers
- ❖ 3 locations in Greece (Athens, Thessaloniki)
- ❖ 54% exports to Germany

### BUSINESS AREAS:

- Manufacturing of new direct-fit catalytic converters for the aftermarket
- Recycling of spent automotive catalytic converters

# Topic (s) of interest and project idea

## **Participation of PF7 project: NEXTGENCAT** (NMP. 2011.2.2-4)

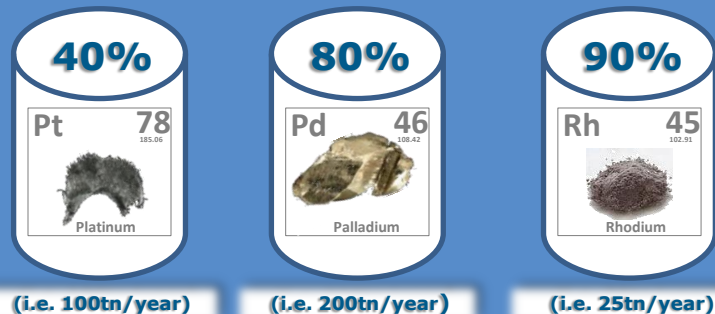
**Development of novel eco-friendly nano-structured automotive catalysts utilizing transition metal nanoparticles (*Cu, Ni, Co, Zn, Fe, etc.*) that can partially replace PGMs (*Pt, Pd, Rh*)**

## **Research Interests**

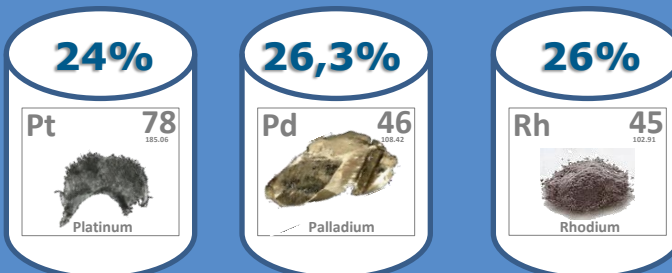
- **Partial or complete replacement of precious metals by transition metals nanoparticles in catalyst wash coat**
- **Development of monoliths utilizing catalysts in their structure (hollow fibers, nanotubes, etc.)**
- **Ageing and activity studies in novel catalysts (e.g. Pd-only catalysts)**
- **Small scale (1-10 tn) recycling facilities for precious metals (*Pt, Pd, Rh*) and rare-earths (REEs), specialized for automotive catalysts**

# What I have to offer and partners sought

## The share of automotive catalysts to world PGM demand:



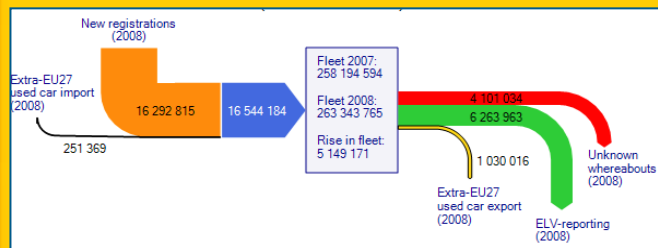
## Recycling Rate of each metal:



**PGM content:**

**Spent Catalytic Monolith vs Primary Ore**  
**2600ppm vs < 10ppm**

## "Lost" PGMs only from ELV passengers cars



- Mean PGM content in spent catalysts: 1,96g
- 8 tns of PGMs are not entering the "formal" recycling path in EU-27 countries per annum
- Estimated PGM value: **172 million Euros**
- Estimated recycling fees: **12 million Euros**

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# John Graves

## Coventry University

# Organisation

- Coventry University Functional Materials Group

John Graves

[j.graves@coventry.ac.uk](mailto:j.graves@coventry.ac.uk)

Tel: 02476 888624

Mobile: 07814584183

[www.coventry.ac.uk/research/research-directory/engineering/functional-materials/](http://www.coventry.ac.uk/research/research-directory/engineering/functional-materials/)

## Topic (s) of interest and project idea

- Substituting Materials in Electronic Devices
  - Indium replacement for transparent conductive layers
- Project idea
  - Non-precious metal catalysts for forming fine line additive circuitry – applications in metal mesh manufacturing
- Recycling of raw materials from products and buildings
- Project idea
  - Faster and more efficient recovery of precious metals

# What I have to offer and partners sought

- Developing functionalised catalysts for forming additive circuitry
- 20 years+ industrial experience in additive and subtractive metallisation technology in the printed circuit board and micro industries
- Excellent industrial contacts
- Expertise in electrochemistry, electrochemical metal recovery, nanotechnology and ultrasound
- Partners sought
  - Companies or research institutes working on metal mesh transparent conductors looking to participate in Horizon 2020
  - Partners with experience of PET film coating technology
  - Companies or research institutes looking to improve recovery of precious metals from products

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James Goddin

Granta Design

# Organisation

- Specialists in:
  - Materials Information Management Software
  - Materials selection, substitution & optimisation
  - Eco Design & Materials Risk Management
    - Environmental impacts (Energy, CO2, Water..)
    - Restricted substances
    - Critical Materials / Conflict minerals
    - Circular economy

## Topic (s) of interest and project idea

- Materials for energy
- Materials for severe operating conditions
- Materials modelling & simulation (ICME)
- Materials substitution
- Nano materials
- Composites
- EU Materials knowledge capture
- Additive manufacturing
- Supply chain materials information management

# What I have to offer and partners sought

## Offered:

- Centralised web based materials information management.
- Extensive materials data.

## Partners Sought:

- Manufacturers & recyclers.
- Companies seeking to reduce materials supply risk.

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# Andrew Bloodworth

## British Geological Survey

# British Geological Survey

- Founded in 1835 to find mineral resources for the Industrial Revolution
- Collected domestic mineral production data since 1853, global mineral data since 1913
- A major GS with a staff of around 650 and a turnover of £46million

## Mineral and metal resource security:

- metallogenesis of critical metals
- global mineral/ metal production, flows and life cycles

# Critical metals: BGS role



- Better understanding of critical metallogenesis
- Better metrics (primary and secondary resources)
- Material flow analysis
- Promote dialogue along/ across supply chains
- Security of supply information and advice into better policy (permitting/ trade/ research)
- Reality check on relative importance of primary and secondary resources
- Promote community understanding of resource consequences of conspicuous consumption

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# Catherine Coates

## Ilika plc

# Organisation



Science-led Materials Discovery

- Ilika Technologies Ltd (AIM: IKA)
- Specialises in use of high throughput (combinatorial) techniques to accelerate the development of novel materials for energy and electronics applications.
- Generally works in joint development projects with large organisations.

## Topic (s) of interest and project idea

- SCS\_12\_2014/15: Substitution of Raw Materials
  - in electronic devices (Reach)
  - In materials used in extreme conditions (superalloys)
- NMK\_2015: Novel Materials by Design
  - eliminating critical element content while enhancing performance (magnets)

# What I have to offer and partners sought

- **Offer:** unique high throughput materials synthesis and testing capability
- **Seek:** Larger organisations and partners from knowledge base with application area expertise.

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Alicia Valero

CIRCE

# Organisation



- CIRCE - Research Centre for Energy Resources and Consumption
- Founded in 1993 with the support of the University of Zaragoza, to create and develop innovative solutions and scientific/technical knowledge and transfer them to the business sector in the field of energy.
- CIRCE's mission is to drive forward improvements in **energy and material efficiency** and to spread the use of **renewable energy** by means of the development of **R+D+i** (Research, Development and Innovation) activities and **formative actions** that respond to the needs of national and international producers, thereby contributing to sustainable development.

# Topics of interest

<p>SC5_13 – 2014/2015: Coordinating and supporting raw materials research and innovation</p>	<p>Networking topic to develop a "raw materials knowledge infrastructure" on (among others):</p> <ul style="list-style-type: none"> <li>- Raw materials research and innovation coordination:, on metals, industrial minerals and aggregates, wood and natural rubber-based materials: developing a long-term vision and roadmap, networking among European Technology Platforms and other industrial and research initiatives.</li> </ul>	<p>Coordination and support action – single stage</p>
<p>SC5_19 – 2014/2015: Coordinating and supporting research and innovation in the area of climate action, environment, resource efficiency and raw materials</p>	<p>Networking topic to (among others) map the EU Member State research and innovation activity on resource efficiency and raw materials: identifying baselines, trends, good practices, opportunities, threats, synergies.</p>	<p>Coordination and support action – single stage</p>

# Project idea + Partners sought

## Project idea

- Comprehensive physical evaluation of the raw material endowment of the Earth and particularly of Europe:
  - Production
  - Reserves/Resources
  - Ore grade trends
  - Forecasted demand and supply
  - Import/Export
  - Stock in use
  - State of recycling/“Urban mining”
  - Physical evaluation

## Partners sought

- Geological surveys
- Research centres/companies working on raw materials.
- Mining and metallurgical companies.
- Bureau of statistical offices (BSOs)

# What I have to offer

- **Thermodynamic Accounting of the Global Depletion of the Mineral Capital on Earth**  
**A Proposal to the United Nations Statistics Division**
- **The System of Environmental-Economic Accounts (SEEA) of the United Nations may well provide such statistical framework -> from SEEA to SETEA**
- A group of **concerned scientists** who attended the JETC Conference held in Brescia, Italy, from July 1-5, 2013, launched an **Appeal to UN and the EU calling for a better preservation of the Earth's resources endowment** and the use of the **laws of thermodynamics for the assessment of energy and material resources** as well as the Planet's dissipation of energy.

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Derk Bol

Materials innovation  
institute M2i

# Organisation



## Materials innovation institute M2i

- Public Private Partnership for material innovation with industry in drivers seat - Based in the Netherlands
- Over 60 industrial and university partners in NL and abroad
- 100+ research projects running (PhDs, postdocs, engineers)
- Wide materials scope
- Partner of ERA-MIN (ERA-NET on raw materials)

# Topic (s) of interest and project ideas

1. Substitute use of Nb, Co, Cr + other metals in alloyed steels
  - Pre-competitive research on precipitation strengthening in steel
  - Understand underlying mechanisms (quantum mechanical modelling/ simulations + in situ experimental techniques)
  - Gained predictive power leads to commercially viable solutions
  - Acknowledged industrial interest from two major companies
2. Substitute high grade materials by more abundant ones
  - By means of thermo-mechanical processes influencing micro/ nanostructure of materials and hence properties
3. Interested in
  - Research initiatives on metals extraction for recycling
  - Research initiatives on deep sea mining

# What I have to offer and partners sought

## We offer

- Start of consortium for substitution projects
  1. Substitute use of Nb, Co, Cr + other metals in alloyed steels
  2. Substitute high grade materials by more abundant ones
- Funding
  - ERA–MIN joint call early 2014 (mining, recycling, substitution)
  - Dutch partnership programs (open for non Dutch companies)
- Network of industrial and academic partners for
  - Research initiatives on deep sea mining
  - Research initiatives on metals extraction for recycling

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Adrian Murphy

International Synergies Ltd

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Josephine Arendorf

Oakdene Hollins

# Organisation – Oakdene Hollins

Research and consultancy company

Specialising in:

- Materials security
- Environmental Impacts
- Market and technology appraisal
- Policy guidance

# What we have to offer

- Extensive knowledge, contacts and intelligence on CRMs
- European and global level
- Experience of managing large European projects
- Background data gathering to support projects
- Application specific information

Josephine Arendorf

[Josie.arendorf@oakdenehollins.co.uk](mailto:Josie.arendorf@oakdenehollins.co.uk)

[www.oakdenehollins.co.uk](http://www.oakdenehollins.co.uk)

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Anna Utsi

Swerea MEFOS

# Organisation

Swerea MEFOS is an independent research institute, and its business concept is applied research, technical development and consulting in process metallurgy, heating, metalworking, environmental engineering and energy efficiency mainly for the ferrous and non-ferrous industry. Research is carried out in collaborative research projects or in projects on contract basis, financed by individual companies.

Swerea MEFOS is well known worldwide for its unique large scale pilot plant equipment in metallurgy and metalworking and its ability to perform very large research projects. We have approx. 100 employees, 55 of which are research engineers.

Our primary research areas are:

- Project management, operational and applied engineering for major EU and pilot projects
- Metallurgical process technology, including heating and machining, particularly reduction metallurgy, alloys, energy and gasification technology
- Process integration
- Measurement techniques and process analysis
- Computer modelling, simulation and calculations, particularly CFD and FEM technology
- Environmental and residual product technologies

Swerea MEFOS is a part of the Swerea group, which in turn is part of RISE Research Institutes of Sweden.

## Topic (s) of interest and project idea

- Recovery technologies for metals and minerals;
  - PVC Europe, a more efficient recovery and use of V and P from waste and by-products for a more resource efficient Europe. REM from apatite.
- Swerea MEFOS is interested in all type of projects addressing production and processing of metals from primary and secondary resources. Especially process development and substitution for critical materials for Europe (e.g. metallurgical coke) and recycling methods of metals are of interest.

# What I have to offer and partners sought

- Offer
  - Metallurgical process technology
  - Process integration
  - Measurement techniques and process analysis
  - Computer modelling, simulation and calculations
  - Environmental and residual product technologies
  - Large scale pilot plant equipment in metallurgy and metalworking
- Looking for
  - Chemical industry dealing with P and V (users or producers of P or V-based products): material characterization, P-V streams, supply of additional P-V sources
  - Vanadium producers including new actors: Use of semi vanadium products from the PVC processes and optimise of the V-cycle in EU
  - Forest industry: use of P-products from the PVC processes and optimise the P-cycle in EU
  - Rare earths: looking for rare extraction from apatite

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Stuart Brown

Knowledge Centre for  
Materials Chemistry (KCMC)

# Knowledge Centre for Materials Chemistry



- Materials Chemistry Innovation from the UK Knowledge Base partners
- Focus on collaborative R&D with industry
- Themes: **Energy, Health, Sustainability**
- Contact: [stuart.brown@materialschemistry.org](mailto:stuart.brown@materialschemistry.org), Tel: +44 7515 334 817



# Topic (s) of interest and project idea

- **SC5\_11 – 2014/2015: Innovative and sustainable solutions leading to substitution of raw materials**
  - University of Bolton – Prof Guosheng Shao
  - Non-indium based transparent conducting oxides to replace the depleting ITO resources
  - Have UK industrial partner with high-density plasma deposition with well controlled ion energy, suitable for TCO deposition on plastic substrates
  - Room temperature deposition with roll2roll capacity
  - Alternative materials solution for thin film solar cells using sustainable resources
- **Partners sought**
  - End user in Europe for thin film solar cells
  - End user for large-area photonic devices such as touch screens, LED/LCD TV
  - End user for Organic PV or organic photonics

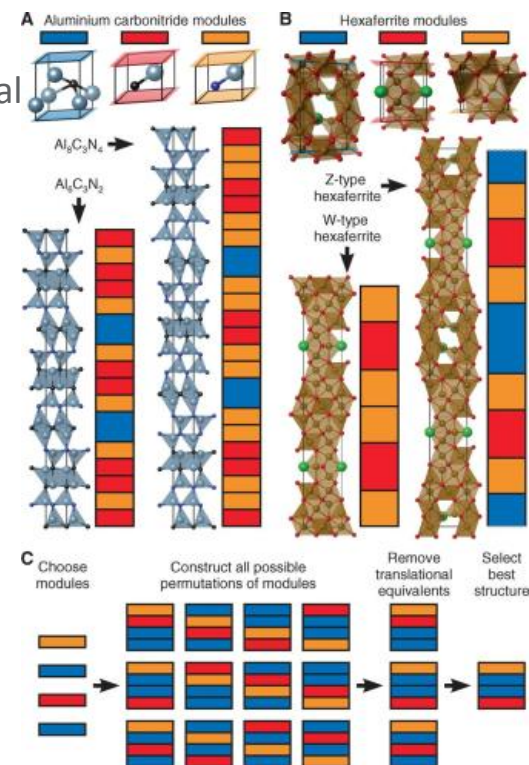
# Topic (s) of interest and project idea

- **NMK 23 - 2015: Novel materials by design for substituting critical elements**

- Prof Matt Rosseinsky – University of Liverpool
- Functional material structure prediction coupled with experimental validation capability in one laboratory (*Science* DOI: 10.1126/science.1226558)
- Methodology can be applied to the design of new complex materials:
  - Transparent conducting oxides (E.G. ITO replacement)
  - Lithium conductors (E.G. cobalt replacement)
  - Solid-oxide fuel cell materials (E.G. cobalt replacement)
  - Visible light Photocatalysis (E.G. platinum group metal replacement)
  - Thermoelectrics (e.g. tellurium replacement)

- **Partners Sought**

- Experts in specific fields, e.g. thermoelectrics, SOFC
- Device engineers – to go beyond bulk materials;
- Materials & product manufacturers - To input specific materials property requirements and Scale up materials synthesis;
- End users



# **Electrochemical Recovery of Metals from Wastes & Effluents**

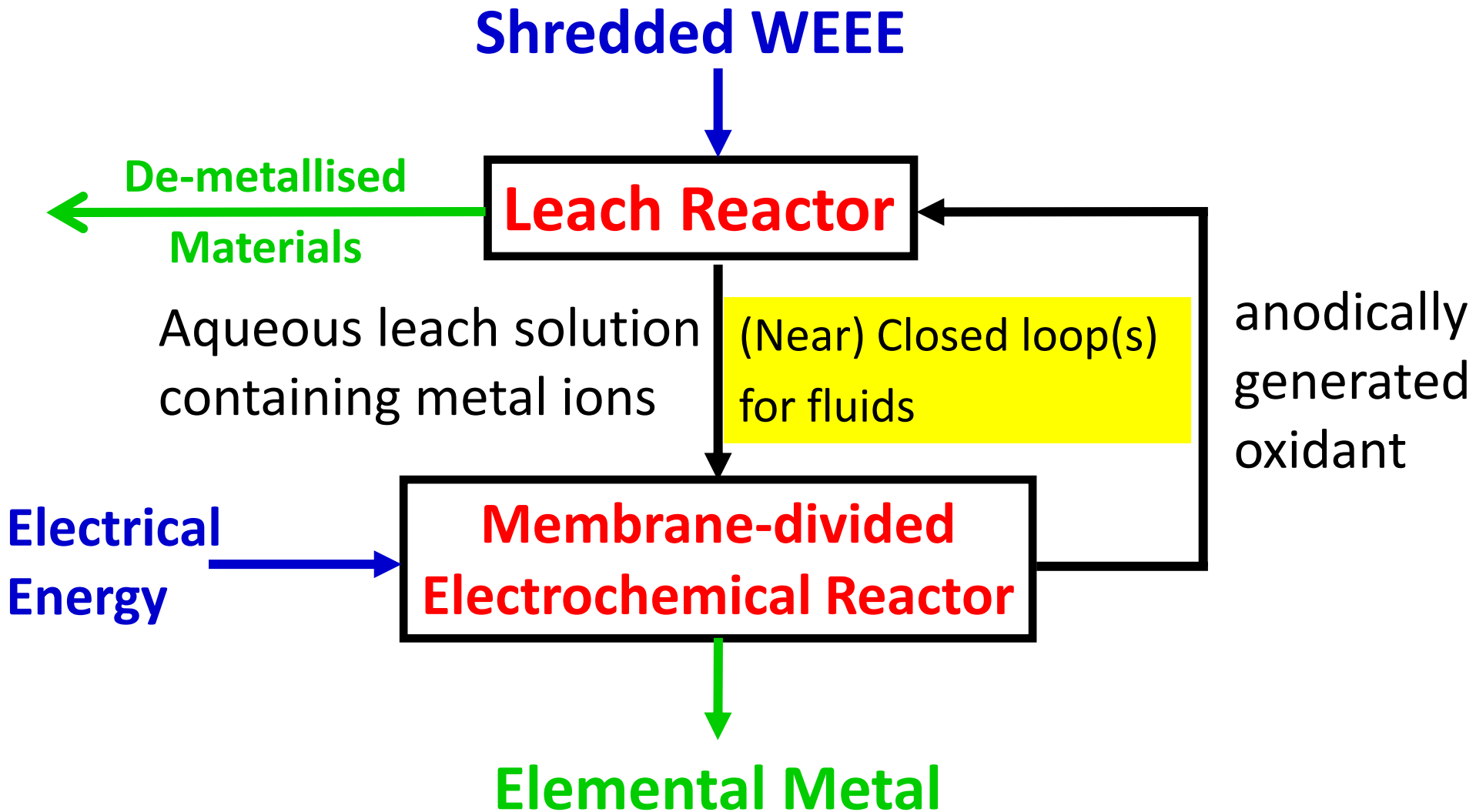
**Geoff Kelsall**

Department of Chemical Engineering, Imperial College London, London SW7 2AZ, UK

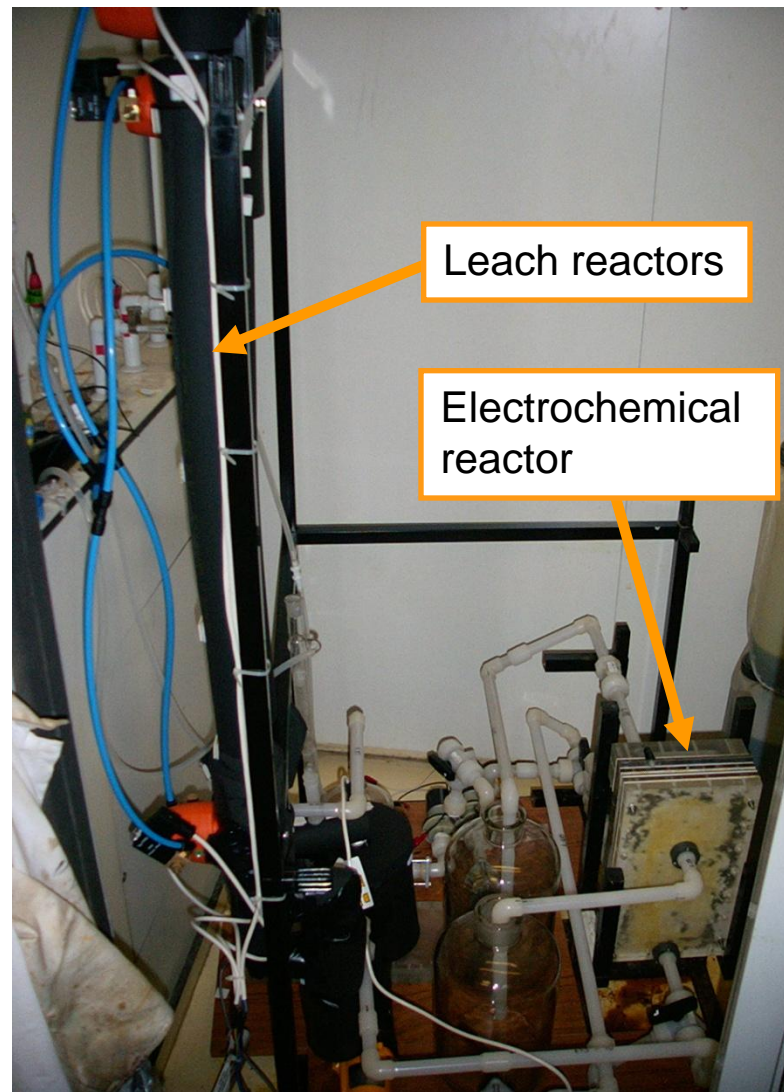
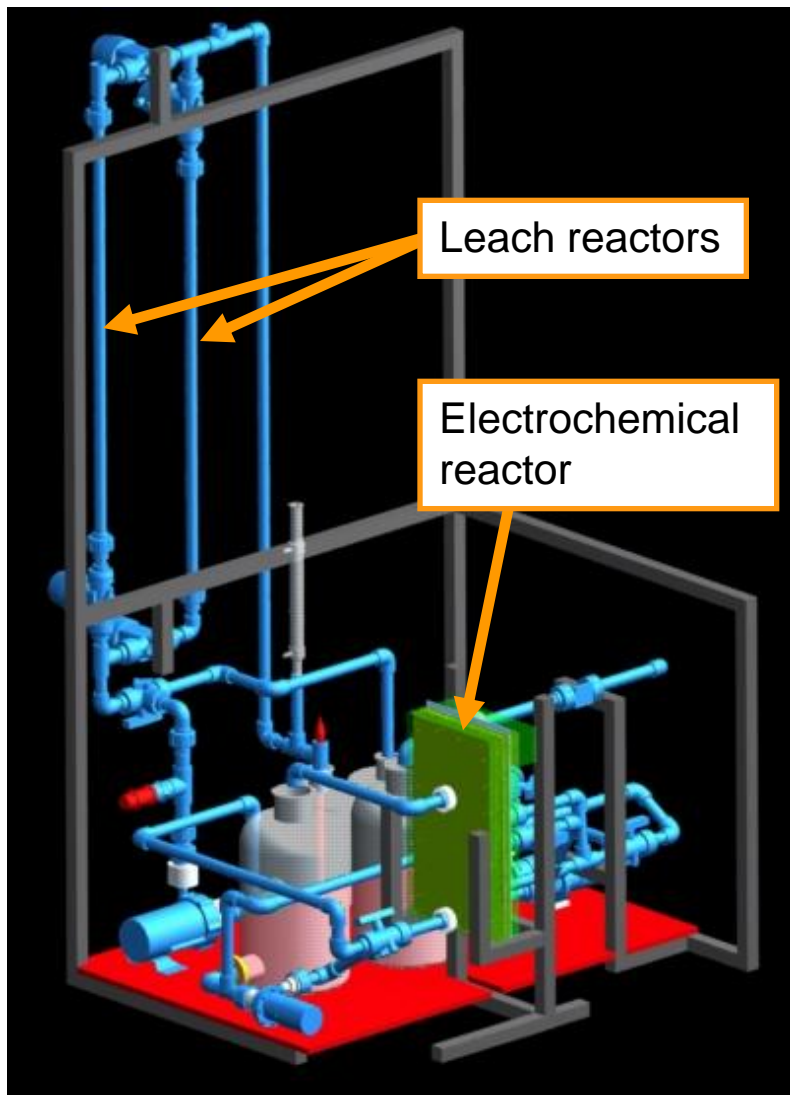
[g.kelsall@imperial.ac.uk](mailto:g.kelsall@imperial.ac.uk)

[www.imperial.ac.uk/electrochemicalengineering](http://www.imperial.ac.uk/electrochemicalengineering)

# Metal Recovery from WEEE by Leaching and Electrowinning

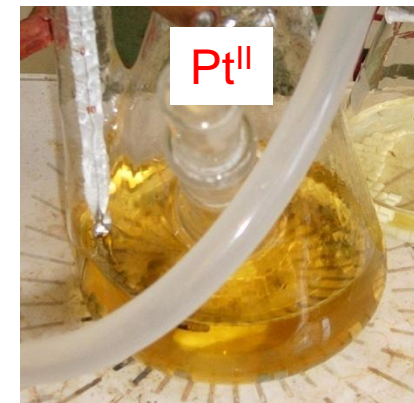
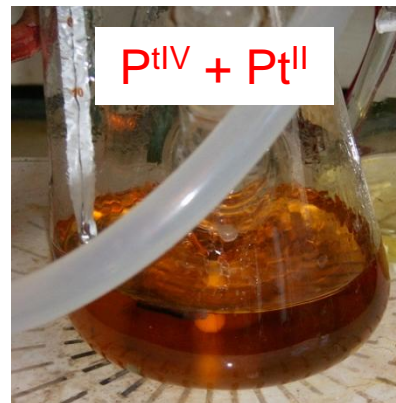
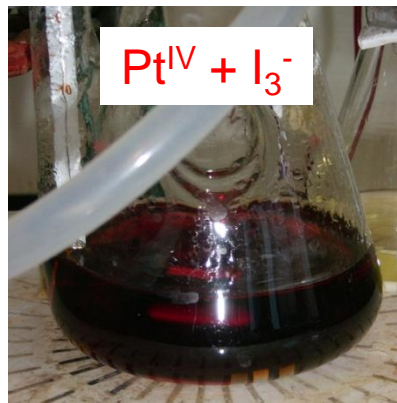
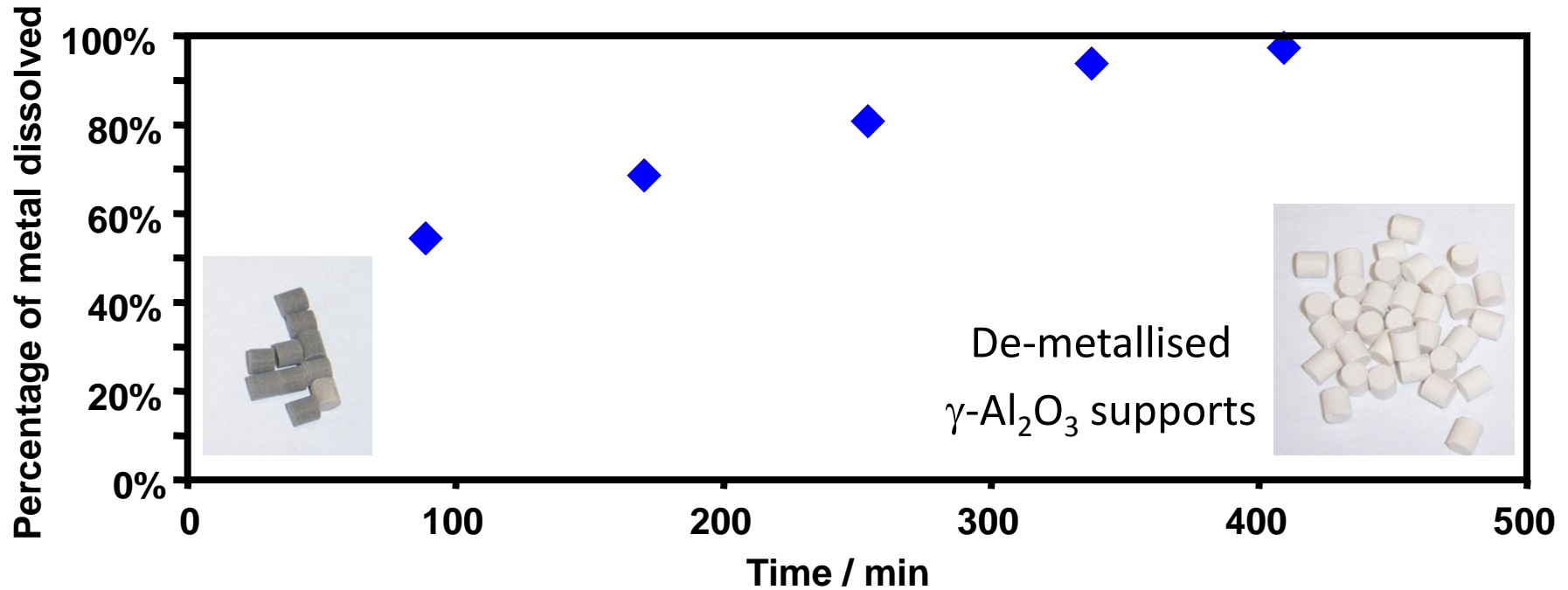


# Metal Recovery Process Circuit



# Example of Pt Leaching Kinetics with $I_3^-$

4 M KI, 95 °C, 2.043 g fresh 0.31% Pt on  $\gamma$  - alumina, final pH 5.5, 0.5 mM  $I_3^-$  fed in 3 batches



# SoS Minerals- Security of Supply of Mineral Resources Launch and Brokerage Event, 18th February 2013



Name: Reimar Seltmann, Robin Armstrong, Richard Herrington & associated team  
 Email: [rs@nhm.ac.uk](mailto:rs@nhm.ac.uk)  
 Affiliation: Natural History Museum / Working Group of Critical Metals (WGCM IAGOD)  
 Position & interests: Research Leader in Ore Deposits

## Expertise / activity / challenges

### EXPERTISE

- Research leaders: R Seltmann, R Herrington, R Armstrong, C Stanley
- Team currently involved in 5 NERC SoS projects (In, REE, Se-Te, Co, Li)
- Currently recruiting new 3-year PDRA in field of 'Critical Elements'
- Strong industrial links and international cooperation (GAIN network)
- World class, mineral, ore and rock collections and analytical laboratories
- Home of CERCAMS research network accessing CIS
- Joint LODE initiative with IC RSM – new LA-ICPMS analytical facility

### ACTIVITY

- Element cycling of Li, Nd, HREE, In, Nb in key rare-metal granite systems
- Critical elements (CE) in orthomagmatic systems (Co, Te, Se, PGE)
- CE mineral residence research – Sc, Li, Co, REE
- Ore deposits with CE related to weathering – Co, Sc, Ga, HREE
- Mineralogy of ore processing problems – Co, Sc, REE

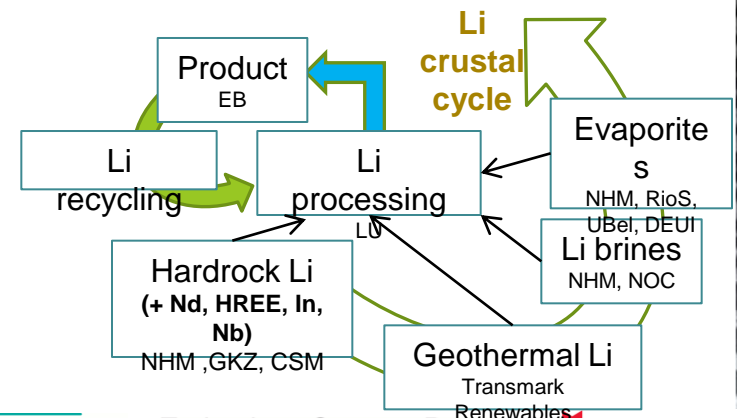
### CHALLENGES

- Analysis of difficult (e.g. light) CE
- Mineral chemistry of CE resident phases
- Geochemical cycles of CE in (mantle), crustal and surface systems
- Prediction of CE mineral sinks in geological systems
- Identifying CE in wastes and developing recovery processes

## Outcomes of interest in SoS Minerals

### Newly developing project 'ELI' (European Lithium)

- Currently 7 partners
- UK, Netherlands, Turkey, Germany, Serbia, Finland
- Downstream partners sought
- Target 'Horizon 2020' for large-scale project
- Build UK based expertise under SoS prior to 'Horizon 2020'



## Environmental dispersion

- Identification of CRM pathways and sinks
- The soil environment and interactions with biosphere

## Extraction / processing / recovery

- Use of geometallurgy to optimise co-product recovery
- Co-recovery of CRM from non-traditional ores
- Novel methods for bioprocessing

## Depositional environments

- Volcanogenic massive sulphides
- The epithermal environment
- Granite related polymetallic veins
- The pegmatite-skarn environments

## Agents

- High-T aqueous mobility
- Fluid inclusion studies

## Pathways

- Melt-mineral partitioning (experimental)
- Melt-fluid and mineral-fluid partitioning (experimental)

## Sources

- CE during mantle metasomatism
- Mantle melting and the oceanic crust
- Volcanic arc environments
- Granite environment

## CE measurement

- Analysis of CE (for example Indium in bulk in presence of tin via isotope dilution)
- Development of protocols for spot analysis (LA-ICP-MS, PIXE, SIMS)

GAIN –

Geobiotechnological Applications for processing Industrial Nonsulfidic raw materials

# Innovative technology for skarn ore processing including Geobiotechnology



**Innovation:** new technologies for selective grinding (e.g. along grain boundaries)

## *Application of Pre-Sorting:*

- to produce pre-concentrates and certain amounts of rich concentrates
- rejection of gangue material



## Technologies:

- X-ray sorting
- XFA sorting
- infrared sorting
- optical sorting

## *Application of new methods of finest grain flotation*

- ultrasonic technology
- optimizing flotation reagents
- bioagglomeration flotation
- biocoagulation

## *Geobiotechnology:*

- bioleaching of sulphides focusing on strategic metals (e.g. Indium)
- reductive leaching of cassiterite
- leaching of scheelite
- leaching of ore matrix like silicates for a better liberation of ore minerals

Development and application of Geobiotechnology for a better recovery of metals from mining residues and mine waters to minimize pollution and to support the “green mining”-strategy