ISSN 2056-6735 (Online)

The Crucible

Mandatory European Conflict Minerals Legislation?

Avoiding Cracked Castings and Forgings

The magazine of the Minor Metals Trade Association

1st Edition 2015/February www.mmta.co.uk

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Session 1: Trends in minor metals – outlook for materials in aerospace:

"Aerospace material and manufacturing evolution: Current state and future Implications", by **Bill Bihlman, President, Aerolytics LLC, USA**
"The rise of multi-metal aerospace applications", **by Boyd Mueller, Vice President Research and Technology, Alcoa, USA**

Session 2: Minor metals in electronics and new technology:

"An overview of the indium market", by **Malcolm Harrower, Global Sales Manager Compounds, Indium Corp, UK**
"How new applications will impact demand for electronic metals", **by Michael Benson, Business Development Manager, 5N Plus, Canada;**
"CdTe thin film technology overview – achievements and opportunities", by **Jigish Trivedi, Vice President – Technology Integration, First Solar, USA**

"An overview of antimony: Tri-Star Resources' role as a non-Chinese antimony producer and as a future supplier from mine to metal", by **Emin Eyi, Managing Director, Tri-Star Resources, Canada**

MMTA reception at the Hockey Hall of Fame sponsored by 5N Plus

Wednesday 29 April 2015

Session 3: Minor metals in batteries:

"IBM's Battery 500 project – an overview", by **Ho-Cheol Kim, Manager, Energy Research, Master Inventor, IBM Research, USA**
"An overview of batteries: which technology and the how what where of cobalt, lithium and graphite", **by Jon Hkyawy, President & Director, Stormcrow, Canada**

Session 4: Minor metals in alloys:

"The rhenium talk", **by Anthony Lipmann, Managing Director, Lipmann Walton & Co Ltd, UK**
"Tantalum outlook in capacitors", **by Bill Millman, Technical & Quality Director, AVX Corporation, UK**

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INSIDE THIS ISSUE

The MMTA promotes essential elements that add quality, safety and enjoyment to our lives.

The MMTA is the world's leading minor metals industry organisation.

mmta
Minor Metals trade association

Welcome from the Editor

Welcome to the latest edition of the Crucible. We have an excellent programme planned for 2015 and have launched our first quarter's events, with an informal dinner and a plant tour of Aurubis in Hamburg, as well as an extremely informative course on import and export procedures, including incoterms, so if there is anyone in your company who would benefit from a refresher (or an introduction), this course is ideal. We're also looking forward to this year's conference in Toronto, which should be a fantastic event.

Finally, I would like to draw your attention to the piece on developments in the area of conflict minerals Regulation in the EU, which may affect many members. Please do not hesitate to contact me with any concerns or questions, as I will be discussing this with MEPs, and would like to be able to convey Members' thoughts on the matter.

Maria Cox, MMTA

RIP, Michael Edward 'Sam' Quick

14th December 1938 – 9th January 2015

Dozens of traders attended Sam Quick's memorial service on the 23rd January in Chichester. Sam was a very popular trader in refractory metals and was well known in MMTA circles since the founding of the organisation.

Behind Sam's twinkling eyes, loud, infectious laugh and affable manner there was a tough and shrewd operator who developed a highly successful trading technique helped by his amazing ability to form strong and lasting friendships.

Other tributes to Sam, covering his private life and his love of rugby football, are being published elsewhere, but I, as a close friend of his and business partner in the metal business for fifteen years, have been asked to offer this personal account of an exceptional member of the metal trading fraternity.

Every recruit to the business, past and present, gets exceedingly irritated when they are told that once, great 'characters' lifted the trade from grubby commerce into something more glamorous. It was easy to get the impression that all the best traders in the 'old days' wore top hats, sported fresh carnations in their buttonholes, and drank a pint of port every lunchtime. I'm sure none of that was true, but Sam was definitely a great character in the modern era.

He recruited me to join Rudolf Wolff from Henry Gardener in 1970. I wasn't particularly attracted by Wolff's cliquey atmosphere but Sam, as many others found out, was someone I definitely wanted to work with. The MMTA was founded at about this time.

Business in the rarer metals was starting to boom as demand from new technologies in aerospace, electronics and chemicals were transformed by revolutionary innovation. More and more metal markets were breaking free from the straitjacket of the 'producer price', and new markets were opening up, mainly from behind the 'Iron Curtain'. These developments in supply and demand offered the opportunity for a new type of more technically orientated metal business to thrive and allowed for small companies to splinter off from the large traditional traders.

Sam and I, and another Wolff trader, Colin Williams, formed our own company, Wogen

Resources. Unlike me (an inveterate market analyst and speculator) Sam's trading was based on personal relationships. He did business with people he liked, and they tended to be people who were a bit like himself –outgoing, bright, risk-taking, and fun to be with – and from everywhere you could imagine—giant Japanese trading conglomerates, Sheffield foundries and New York scrap merchants. Occasionally I would introduce him to someone I thought he could do business with. After the meeting he would often squeeze up his eyes, beam his trade mark ironic grin, and say, "No heart", – his way of saying he couldn't trust the guy.

While we struggled to do deals in the early years, we all got on very well at Wogen, but eventually we all went our separate ways. Sam left Wogen and I left the trading world altogether. Two other well-known rare metals traders who had also helped to put Wogen on the road to prosperity, John Parker and, later, Nick French, also left the company for pastures new.

Sam was able to continue his trading career by forming alliances with many of his old business partners, mainly because they were also his friends. Sam was no push-over in deals, however. He certainly knew his stuff. His business often involved making numerous Byzantine calculations, linking an alloy's analysis with various processing losses and melting charges and spotting profit opportunities in a whole group of sales possibilities. All too complicated for me, I have to confess.

However busy he was, Sam would ring me up every couple of months throughout the intervening years, and invite me to one of his famous lunches in Shepherd Market in Mayfair to meet old friends and his new business partners. He had more trading successes and I got the firm impression that he much preferred his new trading experiences working with, rather than for, larger companies. He was still putting deals together in his 70s.

One incident stands out as an example of Sam's sense of fun and generosity. He and I were paying a routine visit to Mexico City to meet our agent, a rather slick Spanish matador look-alike. Our agent mentioned, in passing, that he was to visit his new acquisition – a fluorspar mine - the following day. It was located about four hours' drive from the town of Ixmiquilpan about 200 kilometres directly north of Mexico City. Would we like to join him? We said yes and after a mescal-fuelled night in the sleepy Mexican town, we set off in the cool before dawn into the chaparral country dotted with mesquite, tumble-weed and those tall cactuses you see in cowboy films. Sam and I opted to sit in the back of the pick-up truck to avoid being asphyxiated by the smell of our agent's aftershave. It was pretty uncomfortable as the sun turned into a blowlamp and the road petered out into a rubble-strewn track. The dust was choking and the far too common sight of a rattle snake crossing our path did no good at all for our searing hangovers.

At one point we could see a small 'pueblo' in the distance, and we came across three boys obviously on their way to school. Our agent stopped to talk to them. They wanted a lift and asked if we wanted to accommodate them. I wasn't keen. They were none too clean and I was feeling pretty cramped as it was, but Sam was already helping them up beside us and we were soon on our way. Within minutes, Sam, who didn't speak a word of Spanish, had worked out that the children had had real trouble with a sum in their maths homework and was explaining how to do it using drawings and examples in their exercise books. They were all laughing like donkeys at his weird efforts to make himself understood, and you could see that Sam was having the time of his life. Generous, full of life and great fun.

His love of art and his skill at painting represented another dimension to his energetic personality. Much of his work was inspired by the lovely landscapes round his home in West Sussex.

He was drinking with his friends in his local pub a few days before he died so suddenly.

Sam made room for hundreds of friends. And his love and loyalty to his children was the centre-piece of his life. Culturally Sam and I belong in very different worlds, but, for me, he was a metal business character of the very best kind.

Peter Robbins

European Conflict Minerals Legislation – Where is this leading for EU business?

It would be very easy to think that because the EU's proposed conflict minerals regulation has been announced as voluntary, it won't have much of an impact on EU businesses, but this is far from the truth.

As previously reported in the Crucible, the draft regulations were published in early 2014.

'The Commission proposes a draft Regulation setting up an EU system of self-certification for importers of tin, tantalum, tungsten and gold who choose to import responsibly into the Union. Self-certification requires EU importers of these metals and their ores to exercise 'due diligence". Click here to see the full press release.

In early December, and again in January, the MMTA was invited to Brussels to discuss European Conflict Minerals legislation with MEPs and other industry representatives.

From these discussions, including associations and companies in the tin, tantalum, tungsten and gold supply chains, it became apparent that there were many shared questions and concerns regarding the details of the draft regulation, including, importantly, whether these requirements would eventually become mandatory and increase their scope to other minerals and metals.

KEY QUESTIONS TO BE RESOLVED:

1. Is the final legislation going to be voluntary, and how voluntary is voluntary?
2. Who is going to be affected and to what extent?
3. How far will existing conflict free schemes, both voluntary and mandatory, be recognised, and will companies be able to double up on their compliance efforts to minimise administration and cost?
4. What measures will be in place to protect and support SME Importers and allow them to operate on a level footing in the market?
5. What are 'conflict-affected and high-risk areas', who will decide and how frequently?
6. Will this legislation be effective in breaking the link between mining & metals and conflict?
7. What will the impact be on conflict-affected areas?
8. What will the impact be on the competitiveness of EU business?

The draft proposals currently being reviewed, although described as voluntary self-certification, aim to achieve full compliance through market pressure and a process of 'naming and shaming' of non-compliant companies. By inviting companies importing tin, tungsten and tantalum, their ores, and gold into the EU to self-certify as Responsible Importers, the EU aims to use market pressure both downstream and upstream to ultimately achieve full compliance. Those companies not designated 'Responsible Importers' (ie without traceable, conflict-free supply chains), will be deemed non-compliant and will increasingly find their competitiveness threatened by their downstream customers selecting importers who are 'responsible'.

This is how the regulation is planned to work, nevertheless, there are many voices calling for a straightforward mandatory system that relies on enforcement rather than market forces to achieve its goal of breaking the link between the mining & metals sector and conflict.

The MMTA has made a submission to the International Trade Committee drafting the report for the European Parliament on behalf of its Members, as well as to the Development and Foreign Affairs Committees, who are also involved in making submissions in the process, calling for the scheme to be voluntary, and any move to mandatory not to be considered until such time as a thorough evaluation of the scheme has been undertaken, fully assessing the impact not only on conflict-affected areas, but also, crucially, on EU businesses, particularly Small and Medium Sized Enterprises (SMEs).

The onus on the Responsible Importer is to perform due diligence and be able to confirm that they purchase only material from Responsible Smelters & Refiners, who will in turn need to verify that metal bought from conflict-affected or high risk areas is conflict-free. Third party audits will be required to support self-certification. The process envisioned would involve a significant administrative and financial burden for importers of tin, tantalum, tungsten, their ores, and gold into the EU.

In order to be a Responsible Smelter/ Refiner – and the EU recognises that this is the final point at which the origin of material can be traced, so wants to capture 100% of smelters/ refiners globally – the smelter/refiner needs to be able to prove that they source only from conflict-free sources when sourcing from any region defined as conflict-affected or high-risk. There will be a mechanism within the EU scheme to remove a smelter from the 'white list' of Responsible Smelters & Refiners, and if this happens, no Responsible Importer wishing to retain its own status will be able to purchase material from the delisted smelter/refiner.

There remain questions around what will be defined as 'conflict-affected and high-risk areas'. Although it has been requested, the Commission does not wish to define a list detailing the scope of the Regulation. It wishes individual businesses and/or Member State Competent Authorities (as yet to be set up) to use a risk assessment process to define the current conflict-affected and high-risk areas and review and update these on a regular basis, redefining their supply chains as appropriate. There are several concerns with this approach:

Firstly, if global conflicts are too fluid for the Commission to define a list, how will companies with far fewer resources and expertise do so? Will failure to correctly assess a conflict-affected area lead to non-compliance? These questions remain un answered so far, and the proposal has been challenged strongly by the MMTA.

In the current draft of the regulation, Responsible Importers will report to individual Member State Competent Authorities who will gather data, audit and report on compliance or the lack of it. Should the scheme become mandatory—and for those who choose to self-certify, obligations will be mandatory—the Member State Competent Authority will also add to and remove companies from the list of Responsible Importers and Responsible Smelters & Refiners. These Competent Authorities will be able to define conflict-affected and high-risk areas, and it has been suggested that additional confusion, not to mention administrative burden, will be created as each Member State interprets its own definition according to its own priorities. Nevertheless, the Commission fears that at this time, when the nations of Europe are demanding less central control, it would be inappropriate to create a single EU Authority with the power to decide one single list of conflict-affected and high-risk areas and one harmonised system.

INDUSTRY DISCUSSION CONCLUSIONS:

1. Additional mandatory legislation reduces competiveness for those importing into the EU;
2. The EU needs to recognise Dodd-Frank and conflict free smelter initiative participants instead of doubling on administrative and compliance costs;
3. There is a danger that such regulation affects the market and encourages end -users to just skip Africa altogether to avoid the extra paperwork;
4. Leaves too much to national authorities - providing a guide book and leaving it to individual countries to interpret means that the definition of 'conflict-affected and high-risk' may be different from country to country.

Photo courtesy Solutions for Hope

The current (OECD) definition is: areas in a state of armed conflict, fragile post-conflict, as well as areas witnessing weak or non-existent governance and security, such as failed states, and widespread and systematic violations of international law, including human rights abuses.

It is easy to see that this could encompass many more countries than the DRC region.

The MMTA's submission includes amendments to the proposal which would require one list of conflict-affected and high-risk areas to be defined for use across the EU, and only countries agreed internationally to be the cause of most serious international concern would be added, thus avoiding the potential inclusion of every area to which the above definition could potentially be applied. Business needs certainty and uniformity to be able to plan and operate effectively.

Another concern is that it remains unclear to what extent the EU system will recognise and give parity to existing schemes. There are several audited industry voluntary schemes which have already made significant progress in certifying conflict-free smelters globally. There is also a raft of compliance required by Dodd Frank legislation in the US. It would go a long way towards making compliance with the EU conflict minerals scheme manageable if companies could comply once, to one scheme, and have their efforts mutually recognised by the others as equivalent. As yet this is not included in the proposal, but it is one of the amendments the MMTA is seeking, and this approach is shared by many industry bodies.

Importantly, the MMTA is also seeking that the burdens of this Regulation not fall solely onto importers. Conflict-minerals due diligence impacts the entire supply chain and the burden should be shared, not concentrated on one group. Smelters and refiners, and others, are already complying with audit requirements for other schemes, as well as Dodd Frank requirements, and the compliance efforts already involved in creating the conflict-free smelter lists should be built upon and not simply duplicated, creating additional burden. We have made our support for existing industry schemes known, and strongly support efforts for this work to be recognised as compliant with the new EU scheme.

There are to be 'additional measures' to support SME Importers in their compliance, and all concerned are keen to stress their wish to minimise the burden on this group. The MMTA asked the Commissioner directly what form these additional measures will take and how the Commission will ensure that the compliance burden, which will be onerous even for larger importers, does not effectively exclude smaller importers from the EU market. The MMTA reminded the panel that REACH compliance is not a thing of the past for EU businesses – some only registered for the 2013 deadline and for others 2018 compliance still lays ahead. There is a danger that conflict minerals compliance measures may only succeed in making SMEs (and perhaps the EU market) uncompetitive.

And if you are sighing with relief because you don't handle tin, tantalum, tungsten or gold, don't smile too soon – the draft regulation does not stipulate that at some point in the future, the scheme will not be extended to include additional metals, indeed some parties are actively advocating that the scope should be widened to include all metals and minerals imported into the EU.

Based on the current wording of the draft regulation, secondary/recycled material is not explicitly excluded from the scope of the scheme. We, along with many other industry bodies, are calling for this exclusion to be made explicit, as no attempt to trace the conflict-free or otherwise origin of secondary materials can be effective.

There are also questions around alloys: at what % does an alloy need to be included? The draft regulation is based on 'custom codes', which include alloys and downstream products, so there needs to be some clarity as to where the boundary is. For information, the full Annex of those materials currently within the scope of the regulation is reproduced below:

CN Code	Product Description
2609 00 00	Tin ores and concentrates
2611 00 00	Tungsten ores and concentrates
2615 90 00	Tantalum ores and concentrates
2616 90 00	Gold ores and concentrates
2825 90 40	Tungsten oxides and hydroxides
2849 90 30	Tungsten carbides
2849 90 50	Tantalum carbides
7108	Gold, unwrought or in semi-manufactured forms, or in powder form
8001	Tin, unwrought
8003 00 00	Tin bars, rods, profiles and wires
8007 00	Tin, other articles
8101 10 00	Tungsten, powder
8101 94 00	Tungsten, unwrought, including bars and rods obtained simply by sintering
8101 96 00	Tungsten wire
8101 99	Tungsten bars and rods, other than those obtained simply by sintering, profiles, plates, sheets, strip and foil, and other
8103 20 00	Tantalum, unwrought including bars and rods, obtained simply by sintering; powders
8103 90	Tantalum bars and rods, other than those obtained simply by sintering, profiles, wire, plates, sheets, strip and foil, and other

KEY CONSIDERATIONS FOR LEGISLATORS:

1. That the Dodd-Frank Act could be overturned after the next US election;
2. That there is now an expectation from consumers for transparency in business, as well as there being little faith in politicians and the administration.
3. That there is concern from the industry side about the impact of EU legislation undermining the sustainability of industry conflict minerals projects and affecting co-operation on the ground. It was emphasised that there is already an audited conflict-free smelter list available.

Maria Cox, MMTA

EXISTING INDUSTRY INITIATIVES TO TACKLE THE ISSUE OF CONFLICT MINERALS

Tungsten Industry-Conflict Minerals Council (TI-CMC)

- Provides assurances that Tungsten from compliant companies are conflict free.
- http://www.ti-cmc.org/

World Gold Council (WGC)

- The Conflict Free Gold Standard helps to 'operationalise' the OECD guidelines. To see the standard click here.
- http://www.gold.org/gold-mining/responsible-mining/social

OECD and the due diligence guidance

- Provides a theoretical and voluntary guide to companies, offering a flexible approach to progressive improvement
- http://www.oecd.org/corporate/mne/mining.htm

ICGLR regional certification mechanism

- An intergovernmental organisation of central Africa setting standards for national member states
- http://www.icglr.org/index.php/en/six-tools

CFSP conflict free smelter programme

- Downstream industry system for auditing smelters
- Globally applicable, industry supported and funded
- http://www.conflictfreesourcing.org/conflict-free-smelter-program/

ITSCI traceability and due diligence programme

- Upstream industry system for 3T minerals, currently from central Africa
- Provides extensive information on participating companies including audits
- Globally applicable, industry supported and funded
- https://www.itri.co.uk/index.php?option=com_zoo&task=item&item_id=2192&Itemid=189

CFTI conflict free tin initiative

- Dutch led project cooperation of companies across the supply chain to demonstrate conflict free mineral sourcing from the highest risk area of the DRC
- Utilised ITSCI plus CFSP
- CFTI project no longer active, although conflict free minerals continue to flow

SfH solutions for hope

- US industry led company cooperation to source minerals from lower risk areas of DRC, with a shortened supply chain
- Utilised ITSCI plus CFSP
- http://solutions-network.org/site-solutionsforhope/

CTC certified trading chains

- German BGR led effort to apply extensive standards to mines in the DRC and Rwanda
- Addressing traceability, health and safety, gender and a range of issues
- Implemented at around 10 mine sites
- http://www.bgr.bund.de/EN/Themen/Min_rohstoffe/CTC/Downloads/Vortrag_Steinbach_Kigali.html

AFP analytical fingerprinting

- German BGR led effort to technically fingerprint all minerals from all mines in central Africa
- Could support but not replace traceability
- Database still under development
- http://www.bgr.bund.de/SharedDocs/Newsletter/EN/2011/Anrisse/nl0411_03t_mineralresourceafrica.html

List of initiatives courtesy of ITRI

NEW MMTA MEMBER

Fesil Sales SA

Fesil Sales is a subsidiary branch of the British Columbian global supply chain company MFC Industrial Ltd. Through MFC, the company is now listed on the NY stock exchange as "MIL". FESIL Sales supplies a wide range of raw materials to steel works and foundries around the world and is specialized in Bulk and Noble Ferro alloys, Minor Metals, Pig Iron, Graphite and Carbon commodities, Cored wires and Non-ferrous metals. The Group has three major locations in Luxembourg, Germany and Pittsburgh and has other subsidiaries in India, South Africa, Ukraine and Slovenia.

Contact: Parham Ghazi Saeedi

Email: parham.gs@fesil-sales.com

Website: www.fesil-sales.com

Visit to Less Common Metals

The Executive Team was kindly invited to MMTA member company Less Common Metals (LCM) just before Christmas. Ian Higgins, the Managing Director welcomed us to their site in Ellesmere Port, Cheshire.

LCM produces Rare Earth based alloys, supplying the permanent magnet industry. The company counts some of the world's largest magnet manufacturers as its customers; these are based all around the world including Europe, US, Japan, Taiwan and even into China (which dominates Rare Earth supply) where LCM supply in niche and specialised markets. Many of the magnets produced are subsequently supplied into the automotive sector.

LCM products are made to clients' specifications and include complex alloys and other specialised products with tight compositional tolerances and controlled microstructures. Since 2008, LCM has been a wholly owned subsidiary of Great Western Minerals Group. The group has developed a 'mine to market' model establishing a fully integrated supply chain of rare earth alloys.

After the company presentation, including its history and products as well as Health and Safety rules, we were able to discuss with Ian and his colleagues David Murthy and Chris Hall the concept of criticality of metals in the EU and the dominance of China in the Rare Earth supply chain.

As you are aware from previous Crucible articles, Rare Earths are classed as critical and/or strategic in many jurisdictions due to their unique technical properties and the dominance of China in their supply, which leaves the material exposed to price fluctuations, as seen in the past.

Building an integrated supply chain of rare earths outside China helps to reduce risk of supply chain disruptions. Having sustainable supply of Rare Earth allows their exceptional technical properties to be fully utilised rather than focusing on trying to substitute them out of products, which is sometimes detrimental to product performance.

Environmental performance and traceability are very important considerations for end users, and a fully integrated supply chain allows end-users to have confidence in the origin and standards of their material.

During the afternoon we toured the 6,200m^2 building which employs 29 permanent members of staff. There is an on-site analytical lab with products tested and made to customer specifications. The facilities have ISO 9001-2008 and ISO 14001 certification.

One of the pieces of equipment we learnt about during the tour was the 600kg Strip casting melter, which was installed in 2012 when the business moved to its current premises. This equipment produces a uniform fine grain structure and minimises the formation of alpha-iron formation which is preferable for magnet makers. A water cooled rotating copper wheel rapidly chills the molten material which turns it into flakes, with the size of flakes depending on the wheel speed.

We would like to thank Ian and the LCM staff for such an informative and enjoyable visit.

Tamara Alliot, MMTA

Magnetocaloric Alloys

During our discussions at LCM, the subject of **magnetocaloric alloys** came into conversation, a fascinating property of some Rare Earth alloys.

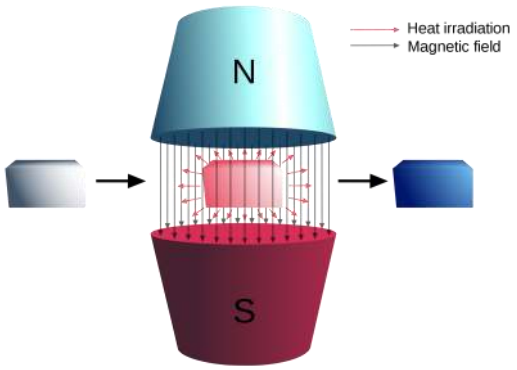
A magnetocaloric alloy is one that changes temperature when in a magnetic field.

Praseodymium alloyed with nickel (PrNi) has such a strong magnetocaloric effect that it has allowed scientists to approach to within one milliKelvin (one thousandth of a degree) of absolute zero.

Here is a video of the process for those reading online:

https://www.youtube.com/watch?v=xVhAvp17xJ8

Magnetic cooling can provide a new solution for refrigeration, reducing energy consumption and eliminating the use of hazardous coolants which also reduces issues with recycling. The diagram below shows a Gadolinium alloy heating up inside the magnetic field and losing thermal energy to the environment, therefore exiting the field cooler than when it entered.



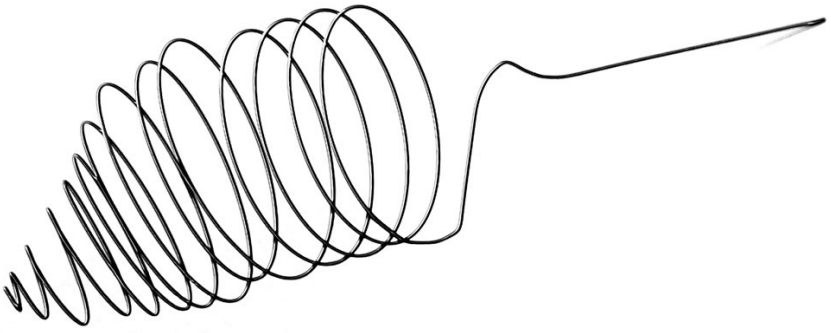
Shape Memory Alloys

In the world of smart phones, smart watches and even smart central heating, why not take a look at smart alloys? In particular shape memory alloys (SMAs). SMAs 'remember' their original shape after being exposed to temperature or electromagnetic fields. SMAs can change 'shape, stiffness, position, natural frequency and other mechanical characteristics.'[1]

SMAs include nickel-titanium alloys, with this group's generic name being Nitinol*, copper-aluminium-nickel, copper-zinc-aluminium, and iron- manganese-silicon alloys.

Nitinol was found to be a SMA back in 1961 and it 'remembers' its shape with structural changes on an atomic level.

Dr. Frederick E. Wang, an expert in crystal physics, found that Nitinol has phase changes while still a solid. Nitinol is in the martensite phase while under the transition temperature (which varies depending on the composition of the alloy). In this phase Nitinol can be bent into different shapes. By heating the metal (to around 500c) while it is bent, which fixes the 'parent' shape, the metal is then in the austenite phase where the atoms are arranged very regularly and compactly. Above the transition temperature, Nitinol reverts from the martensite to the austenite phase which changes it back into its parent shape. [2]



There are many interesting applications of Nitinol in military, safety and robotics with the medical sector taking a leading role: tweezers, orthodontic wires, and glasses frames that can be bent and then return to their original shape on warming. The last application sounds of particular use for everyday life, as long as the glass remains intact!

Other miscellaneous applications of shape memory alloys include use in household appliances and in clothing, from deep fat fryers to bra underwires.

*stands for Nickel Titanium Naval Ordnance Laboratory

References:

[1]Rogers, Craig. "Intelligent Materials." Scientific American Sept. 1995: 154-157.

[2] http://web.stanford.edu/~richlin1/sma/sma.html

NEW MMTA MEMBER

Interalloys Trading & Business Consulting GmbH

Interalloys, founded in 1993 is a privately funded commodity trading company specializing in the purchase, sale and distribution of Steel Making Raw Materials and Non Ferrous products to a global customer base.

Interalloys continue to add to their expanding portfolio of offtake and distribution agreements. Working hand-in-hand with mine owners we provide a route to market; logistics, capital and marketing.

Our Steel Raw Materials and base metals concentrate business provides both mining and consuming customers with a complete pit to furnace supply solution. We search for high quality emerging producers who need a partner to provide them with their route to market; logistics, capital and a global customer base.

Headquartered in Europe and with satellite operations worldwide, Interalloys provides global coverage with local know-how to ensure the best cultural and strategic fit to our suppliers and customers.

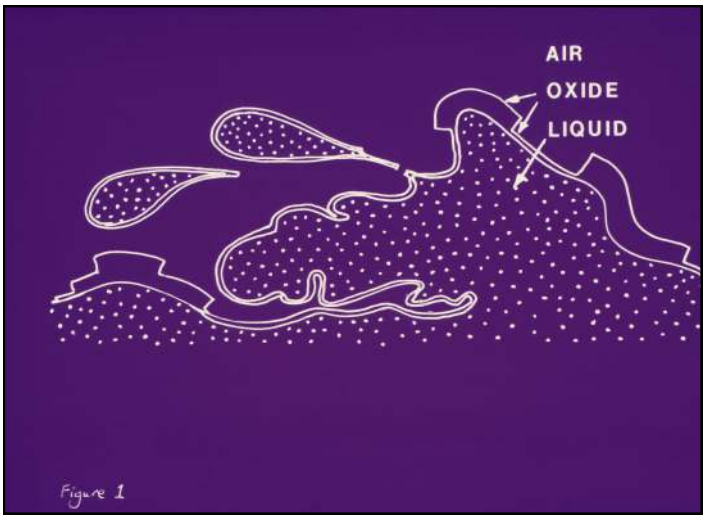
Contact : Emilie Janson
Email : info@interalloys.co.uk
Phone : +44(0)20 7002 5357
Website: www.interalloys.co.uk

INTERALLOYS

Cracked Liquid Metals Make Cracked Castings and Cracked Forgings

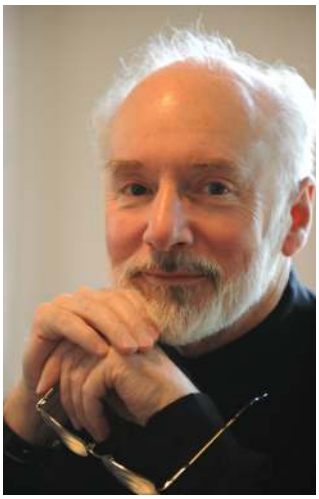
John Campbell, Emeritus Professor of Casting Technology, Department of Metallurgy and Materials, University of Birmingham, UK

When liquid metals are poured, this innocent action separates the liquid into splashes and droplets, and each new surface becomes instantly coated with an oxide film, making the surface of the splashes and droplets effectively 'dry'. In coming together again the dry surface films meet up with other dry surface films, forming double films. The double films are submerged in the liquid metal and float around, remaining in suspension. Depending on the metal or its impurities, the films are often Al_2O_3 or similar highly stable ceramic. The double ceramic films cannot bond across their dry central interface, so they act as cracks in the liquid. Turbulent pouring fills the liquid metal with cracks. The cracks are frozen into the cast metal, filling many of our engineering metals with cracks.



For the past 6000 years the presence of these bifilm cracks in metals has been overlooked. They have remained undetected and unsuspected because they are often only a few molecules thick. However, they can form large and serious cracks, some the size of newspapers. More often they are one or more millimetres across. However, they are often present in huge numbers.

The presence of dense populations of bifilm cracks in our liquid metals explains practically all of our problems with cast materials: the formation of gas porosity becomes easy as a result of the gas in solution precipitating into and expanding the bifilm into a bubble. Shrinkage porosity is similarly explained by the reduced pressure in the liquid sucking the bifilms apart to grow a pore. Hot tears and cracks are simply explained: they *are* the bifilms; I always cure hot tearing by improving the filling system design for the casting - the hot tear disappears like magic!



The presence of the cracks in castings and ingots explains their variable and sometimes unreliable properties. In addition, they survive significant plastic working during forging, rolling and extrusion, leading to cracking effects of many kinds, such as forging cracks, edge cracking during rolling, and crocodile cracks during extrusion.

For the metallurgists and those interested in the technical details among us, it seems probable that every crack in every metal is started by a bifilm (the only exception to this may be the formation of ratcheting cracks from slip planes in a fatigue condition). This radical view is the outcome of molecular dynamics studies which appear to find that no viable lattice mechanisms to initiate cracks exist. This is contrary to traditional thinking which has assumed such mechanisms, for instance, as wedge cracks from dislocation pile-ups at inclusions. In other words, cracks should not be able to initiate in metals. It seems probable that the bifilm is the only crack initiating mechanism. Possibly therefore, as dislocations are the explanation for plasticity, bifilms are the explanation for the initiation of cracks.

Bifilms also seem to be involved in the initiation of corrosion pits and intergranular corrosion, because, if the bifilm contacts the surface of the metal, liquid corrodants can enter the metal by capillary attraction. The attack is further concentrated because of the inter-metallics and other phases which preferentially precipitate on the outer wetted interfaces of the bifilm, creating efficient corrosion couples. Stress corrosion cracking and hydrogen embrittlement might also eventually be found to involve bifilms, explaining the previous baffling and intractable behaviour of these phenomena.

It is welcome news that some casting operations in the world are now tackling the problem, reducing bifilm populations in their cast material with encouraging and sometimes dramatic benefits to properties.

Elongations to failure in Al alloys are improved by at least 10 or 20 times, inclusions and cracking in steel castings are reduced by a factor between 10 and 1000 times, and there is evidence that creep life of Ni superalloys is extended by at least 10 times. There are reasons to suspect these benefits are only the start. Furthermore, these effects are expected to be universal in metals which form stable oxides, or which contain alloys or impurities which form stable oxides. This includes most of our engineering metals; whereas the oxidation-resistant metals such as gold are in principle free of bifilm problems, the addition of only minute traces of impurity elements ensure the presence of these defects.

The engineering techniques required to make a start on this problem, to achieve a mere order of magnitude benefit, are easily implemented in current foundries at negligible cost, merely by following techniques already well developed and documented. These techniques involve the pouring of metals without the introduction and entrainment of air into the melt. (Interestingly, vacuum melting and casting is of little use at this time because industrial vacuums used for melting and casting are not sufficiently good: so far as the liquid metal and its reactivity are concerned, current vacuums are equivalent merely to dilute air.) The channels which convey the liquid metal into the mold have to be designed with great care to avoid the ingress of air at any point. This is relatively easily attained by following simple rules. An Al alloy foundry making parts up to 2000 kg and a steel foundry producing castings up to 3000 kg are using these techniques to produce extraordinarily perfect castings. I have used the same techniques to demonstrate a uniquely defect-free 50,000 kg steel casting.

For the future, there is every reason to believe that there is much more to be gained from total elimination of bifilms, which, in principle, appears to be attainable with current technology. Foundries are now being conceived in which the pouring of liquid metals is completely avoided at every stage: the metal either flows horizontally or travels uphill, against gravity, never downwards. Naturally, such new ventures require substantial funds, but are no more costly than traditional casting processes. Also, of course, they tend to be highly environmentally beneficial, especially since they tend only to make castings, not scrap. Foundries which are on the drawing board, being built, or currently working, eliminating pouring and employing counter-gravity filling of molds include an Al alloy foundry making precision castings weighing only 10g, an Al alloy foundry making automotive wheels, and a bronze foundry making 4000 kg propeller blades for ships. A steel foundry to make castings up to 500 kg is at the concept stage.

These are exciting times. The discovery of the bifilm, and the development of techniques to reduce or eliminate it promise a new era of metallurgy and engineering. It will be a revolution!

Further reading by the author

"Complete Casting Handbook" Elsevier 2011

"Stop Pouring; Start Casting" The Hoyte Lecture; American Foundry Society 2012.

MMTA Event

LAST FEW REMAINING PLACES!

Aurubis Plant Visit and Evening in Hamburg 19th—20th March 2015

The MMTA will be joining members of the German Metal Traders Association (VDM) minor metals group to visit Aurubis in Hamburg on March 20th.

The event will include:

- Informal drinks and dinner at **BLOCKBRÄU** (www.block-braeu.de) in the harbour area of Hamburg from **7pm on Thursday 19th March**
- A **presentation and tour of the Aurubis plant** from **10am—12.30 on March 20th** followed by a light lunch.

Hamburg is the Aurubis HQ, as well as the largest production site, employing over 2000 employees producing cathodes, wire rod, continuous cast shapes, precious metals and specialty products from primary ore concentrates and secondary raw materials. Established in 1866, the Aurubis plant is one of the most modern and environmentally friendly copper smelters in the world.

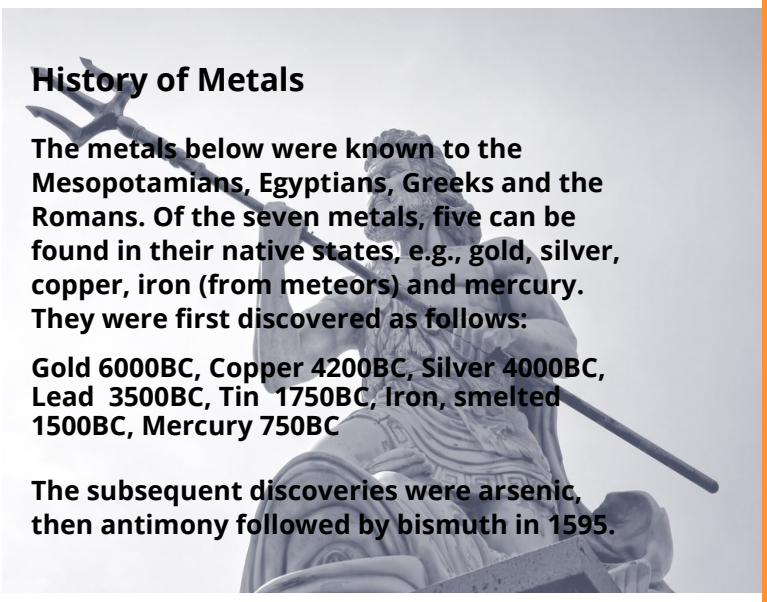
Numbers for this event are limited, so don't delay in booking your place. **The cost of this event is £40 for MMTA Members.**

Go to the MMTA website to book.

The Metal from Atlantis

The Ancient Greeks spoke of a metal that could be found in the mythical city of Atlantis, and earlier this month this metal known as orichalcum has been found off the coast of Sicily where a ship sank around 2600 years ago.

39 ingots at around 300mm in length of the metal were found on the sea floor around 300m from Gela in southern Sicily. The composition of orichalcum is widely debated, but with most agreeing on it being 'brass-like'. The ingots discovered have been analysed and are found to be of the following composition: 75-80 percent copper, 15-20 percent zinc and small percentages of nickel, lead and iron.



History of Metals

The metals below were known to the Mesopotamians, Egyptians, Greeks and the Romans. Of the seven metals, five can be found in their native states, e.g., gold, silver, copper, iron (from meteors) and mercury. They were first discovered as follows:

Gold 6000BC, Copper 4200BC, Silver 4000BC, Lead 3500BC, Tin 1750BC, Iron, smelted 1500BC, Mercury 750BC

The subsequent discoveries were arsenic, then antimony followed by bismuth in 1595.

The process for making the metal in ancient times was to react of zinc ore *, charcoal and copper metal in a crucible.

Information on orichalcum comes from ancient texts and a few artefacts. According to the ancient Greeks, it was invented by Cadmus, a Greek-Phoenician mythological character. The Greek philosopher Plato made orichalcum a legendary metal when he mentioned it in the Critias dialogue.

Plato described Atlantis as flashing "with the red light of orichalcum," he wrote that the metal was mined in the mythical island and was used to cover the interior of Poseidon's temple. In ancient times this metal was comparable to gold in value.

Enrico Mattievich, a retired physics professor, has written a book "Journey to the Mythological Inferno" in which he states that the ancient Greeks had discovered a metallic alloy "with fire-like reflections" similar to Plato's description. A set of metallic jaguars matching this description exists, but these turned out to be made of 9 percent copper, 76 percent gold and 15 percent silver ,meaning that Mattievish believes that the ingots found recently are actually lumps of lantone metal rather than the orichalcum of myth.

*Centuries before zinc was discovered in the metallic form, its ores were used for making brass and zinc compounds and also for healing wounds and sore eyes.

Tamara Alliot, MMTA

Argus acquires MetalPrices.com

Argus Media has bought MetalPrices.com, one of the world's largest providers of metals market information. The acquisition will further increase the range of Argus intelligence available to the metals sector following the acquisition of Metal-Pages.com in May 2014.

MetalPrices publishes nearly 300 metals price assessments each week, including futures prices and other exchange data, third-party market price assessments from around the world and proprietary price assessments which are trusted for indexation and market analysis, especially in North American ferrous and non-ferrous secondary metal markets.

Argus Media chairman and chief executive Adrian Binks said: "MetalPrices is a natural fit for Argus' expanding energy and commodities portfolio. In recent years we have increased our metals coverage to include iron ore, coking coal and metallurgical coke services as well as coverage of the ferro-alloy, minor metals and rare earth markets through our purchase of Metal-Pages.com. This acquisition complements this and extends Argus' global coverage of metals markets."

MetalPrices.com president Marc Dulin said: "We are delighted to become part of Argus. The MetalPrices service will go from strength to strength with the benefit of Argus' international reputation, technical resources and global editorial team, which we are all excited to join."

Matt Bidwell , Head of Marketing – Metal-Pages, Argus Media

LETTER FROM NORTH AMERICA

Dear Members

Rather than dwell on just how horrible the markets have been since I last wrote you, I thought I'd have a quick look back over 2014 and see what might be noted for going forward into 2015.

The Russia/Ukraine situation still remains very fluid, with Russia looking like heading into full-blown recession and Ukraine in desperate need of being propped up financially. And who knows if there may not be more sanctions. If so, then potential concerns about the supply of not only of potash and refractory magnesia, but also cobalt, nickel, niobium, titanium, tungsten and vanadium may become real.

Thinking about tungsten brings to mind China. Back on August 7th, the country lost its appeal to the WTO against an earlier adverse decision over export quotas on rare earths, tungsten and moly. However, by the end of the year, whilst quotas for moly and tungsten had been lifted, it took a little longer for the same to occur for rare earths. However, it appears, export taxes on all of them look set to continue, at least for the time being, and so supplies to the rest of the world will continue to be restricted.

So, the price of oil has fallen 46% over the course of the year, the slide starting midsummer and accelerating from September on. What sort of effect is this going to have on the market for alternative energy solutions, in particular solar and wind, and the likes of neodymium, selenium, gallium, cadmium and tellurium? Have either, or both, solutions reached critical mass?

The latest release (on December 9th) from the U.S. national solar trade body, the Solar Energy Industries Association® (SEIA), may show "[t]*he U.S. installed 1,354 megawatts MW of solar photovoltaics PV in the third quarter of 2014, to total 16.1 gigawatts (GW) installed PV capacity, with another 1.4 GW of concentrating solar power (CSP) capacity, enough to power 3.5 million homes.*" And that the quarter was "*the second largest quarter in history for solar growth*", with both the SEIA and GTM Research predicting "*another record-breaking year for 2014, with total installed capacity reaching three times the size of the market just three years ago.*" But one wonders, following the fourth quarter's oil price woes, just whether these predictions will actually come true.

Finally, if you are still thinking of gifts for clients, or need an excellent reference book, and primer for newcomers to the business, then you need look no further than the British Geological Survey's excellent **Critical Metals Handbook**, published by Wiley earlier this year and with a fine chapter therein on rhenium by MMTA member Anthony Lipmann. (No, no contributor receives *any* royalties!)

I remain, from a chilly New York, with, once again, best wishes for a very happy and successful 2015 to MMTA members everywhere.

Tom Butcher, December 31st, 2014 Hard Assets Investor

Import Processes & Procedures Course

26-27th March, MMTA Office, London

Over the years, over 200 representatives have benefitted from this course, which covers

Incoterms—Customs Formalities— Methods of Shipment— Cargo Insurance—Documentation—Methods of Payment.

As in recent years, we will be joined by members of the International Steel Trade Association. Jon Walden MBE (Crown Agents) will again be the course presenter. This is a 2-day course.

Testimonial from previous attendee:

"Excellent course, Jon Walden is a great trainer"

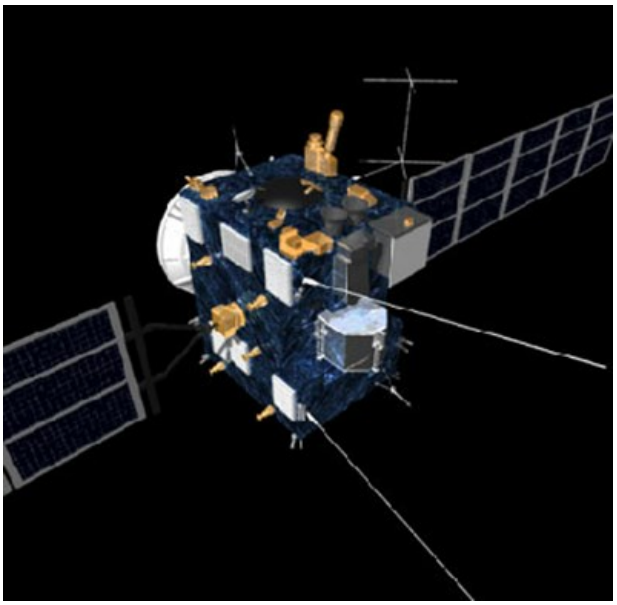
Click here to book or contact the MMTA Executive.

The cost will be £395 + VAT (where applicable), including a copy of INCOTERMS 2010

Beryllium Helps European Space Agency Mission Soft-Land its Philae Probe on Comet

By BeST | Published: November 18, 2014

Beryllium helps the European Space Agency (ESA) Rosetta mission soft-land its Philae probe on comet 67P/Churyumov-Gerasimenko on November 12th, 2014 – the first time in history that such an extraordinary feat has been achieved.



Beryllium was used in multiple applications fitted in multiple locations of both the Rosetta satellite and the Philae Probe vehicle. Prominent examples include the following:

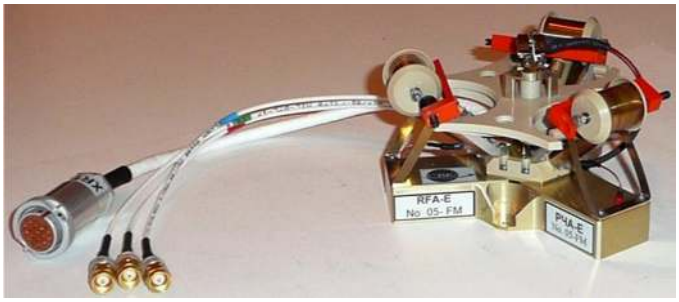
Connector terminals: For the entire 10-year length of its epic journey to rendezvous with the comet, Rosetta and Philae depended upon the reliability of copper beryllium connector terminals of its electrical and electronic connectors. The reliability has been proven in every satellite and space probe launched by the EU and USA.

Radio transmission antennae: The mission used a novel tubular boom antenna design, developed in Poland by Marta Tokarz, Jerzy Grygorczuk, Stanisław Jarzynka and Henryk Gut of the Space Research Center of the Polish Academy of Sciences (CBK PAN)

Philae Lander: Harpoon Penetrator and Components

http://www.esmats.eu/amspapers/pastpapers/pdfs/2014/tokarz.pdf

CBK PAN developed a miniature 6-mm diameter tubular boom antenna, made of copper beryllium 2% alloy strip, which was more compact and lighter than the stainless steel versions used before (it weighs 8g per 1m, while the previous booms weigh 50g – 100g per 1m respectively). This remarkable weight saving was made possible by the unique combination of strength, rigidity and stress relaxation resistance at launch and space temperatures provided by beryllium alloys.



A typical set of 3 Orthogonal Satellite Antennae:

Note the coiled copper beryllium strip, which has been pre-formed into an arced profile (like a flexible tape measure) that will subsequently form the circular profile antennae. Also, note the circular connectors which are fitted with copper beryllium terminals to provide high reliability connections even when subjected to the forces and vibration of launch, coupled with the extreme cold of space.

Schematic illustration of antenna deployment mechanism:

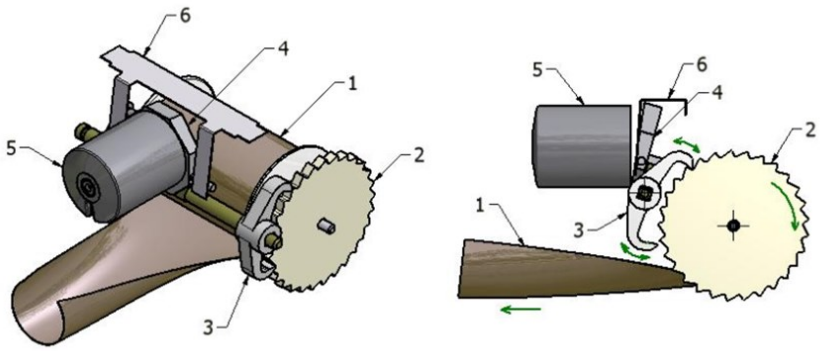
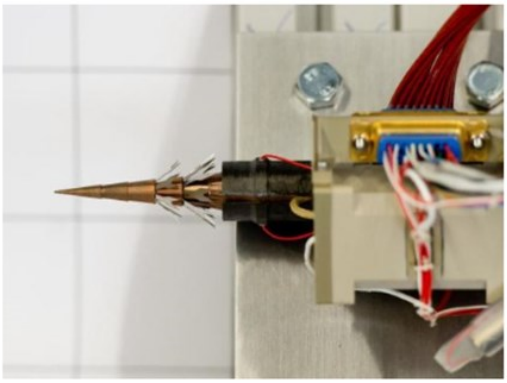
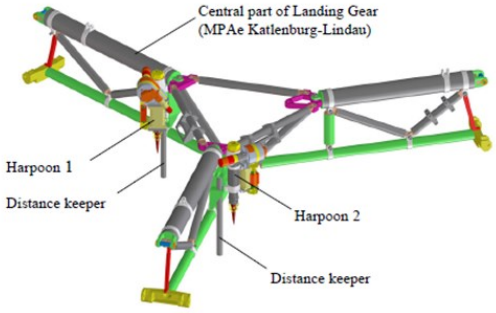


Figure 6. Modified escapement mechanism for MAB deployment: (left) isometric view, (right) side view; 1 – tubular boom stored on the reel, 2 – escape wheel, 3 – detent, 4 – armature, 5 – electromagnet, 6 – return spring

Philae Lander – Penetrator and anchor system "Harpoon":





[Beryllium Science & Technology Association]

NEW MMTA MEMBER

RJR Alloys Inc

RJR Alloys Inc, based in Greenville PA, USA, specializes in the supply of air and vacuum alloy revert, air and vacuum master alloys, pure metals, recycling solutions, and metallurgical consulting. Utilizing a global supply base, we are able to supply hard to source materials in lots both large and small. We also offer a full range of scrap recycling services with a focus on Rhenium and creative solutions to maximize the value of our clients' waste streams. And for over 25 years, we have been assisting melt shops, foundries, and manufacturers with reducing raw material costs and process improvement.

Main Contact: Rocky Russo
Email: rocky@rjralloysinc.com
Phone: +1 724 985 4200
Website: http://www.rjralloys.com

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mmta
Minor Metals Trade Association

Click here to book the MMTA meeting room.

Professor Lenny Koh, BEng (Hons), PhD, FRSA, is a Chair Professor in Operations Management, Founders and Directors of the Logistics and Supply Chain Management (LSCM) Research Centre at the Management School, the Faculty's Centre for Energy, Environment and Sustainability (CEES) & the Advanced Resource Efficiency Centre (AREC) of The University of Sheffield, UK. She has been an Associate Dean for 5 years. She is also the co-founder of Supply Chain Management and Information Systems (SCMIS) Consortium, a global network of leading academic and practitioners driving research and knowledge exchange on supply chain and information systems. A world-leading mind recognised amongst FRSs and Nobel Laureates within the University, Professor Koh is a Senior Chair Professor and an internationally renowned and established authority in supply chain especially on low carbon and sustainability, with high H-index (World number 2) and high research income generation in her discipline internationally. She is a Cross-Cutting Chief of a 2022 Futures initiative for advancing supply chain resource sustainability, with a new translational model for connecting invention/basic science at lower TRL to higher TRL.

AREC
Creating the Supply Chain of the Future.

AREC—a centre for supply chain excellence supported and steered by industry

51 industry and academic experts gathered in the Advanced Manufacturing Research Centre (AMRC) in July 2014, exploring supply chain challenges during a half-day workshop that also introduced the Advanced Resource Efficiency Centre (AREC).

AREC is a facility planned by the University of Sheffield to bring together a number of existing research centres with new, dedicated people, facilities and equipment to enable collaborative work between academia and industry to create the supply chain of the future.

The brainchild of Professor Lenny Koh, AREC has been ten years in the making. It has been designed to build on the model successfully executed by the AMRC in the manufacturing space that brings together industry partners, relevant academic departments and funding to create innovative research and commercial opportunities.

Political institutions understand the risks to critical resources and the importance of supply chains

To achieve sustainability objectives industry cannot work in isolation. There is a need for collaborative planning and development that sees industry, regulators, Government and academia working together to establish and promote sustainable innovations.

The UK Government is already committed to providing support to the UK's 4.8 million Small and Medium Sized Businesses (SMEs), developing an environment in which small companies can flourish (HM Treasury 2011).

However it is not just SMEs that require support. Large firms require support to understand unsustainable processes within their supply chains. The European Commission's 2011 report "A Resource Efficient Europe" highlights the importance of understanding the risks to resources such as rare earths; energy; and water (Commission of the European Union 2011). The complex nature of supply chains, and the scale and spread across which they operate requires co-operation at local, regional, national, and international levels.

The 2012 "Resource Security Action Plan" from the Department for Business, Innovation and Skills (BIS) states: "Government's objective is to bring better resource use criteria into the mainstream, so they are routinely included in the range of minimum and best practice product standards"

The long-term vision to achieve this objective is set out, stating:

"The Government is putting innovation and research at the heart of its growth agenda through greater investment and increased collaboration".

Getting it right

We know from extensive research and partner feedback that there are several capabilities that businesses want including:

- Better use of evidence based decision-making and mathematical modelling.
- Making a step change or breakthrough in the capability of supply chains to meet future needs.
- Creating a comprehensively budgeted approach to the real value of resources.
- Innovation through collaboration.

- Moving beyond silos and using inter-disciplinary approaches to generate innovation

The future is not about a supply chain competing against another supply chain. The future is about a resource sustainable supply chain competing against another resource sustainable supply chain. A more effective and efficient use of resources will lead to a more sustainable future. AREC will focus on the supply chain that delivers material and resources to manufacturers, developing tools, methods and processes to map and improve the management of supply chains.

AREC is leading in thematic areas where the University of Sheffield has deep expertise

The University of Sheffield has a number of departments, facilities, and respected and experienced academics in key areas including

- Advanced materials and manufacturing
- Energy and nuclear
- Water
- Agritech/food.

AREC has a very strong track record working with Engineering and understanding industry needs. AREC partners with industry leaders such as Rolls-Royce, TATA Steel, Sheffield Forgemasters, Panalpina, and important bodies such as the Minor Metals Trade Association, The Institute of Materials, Minerals and Mining, Innovate UK KTN. AREC collaborates in materials and manufacturing R&D across a number of departments, notably Materials Science & Engineering, Mechanical Engineering, Chemical & Biological Engineering and Electrical & Electronic Engineering. The broad and interdisciplinary nature of our work is enriched by collaborations with science departments such as Chemistry and Physics & Astronomy delivering the highest quality fundamental research, whilst development at higher technology readiness levels includes the participation of the Advanced Manufacturing Research Centre with Boeing, Mercury Centre, Nano Sorby Centre and the Logistics and Supply Chain Management Research Centre.

Getting involved with AREC

AREC offers a number of benefits to partners, including access to innovation, funding, facilities and world class modelling capabilities. In particular, AREC can help reduce the costs of innovating and enhancing capability through leveraging the University's experience in obtaining matched funding, where the private sector, University and government funding bodies all contribute to project opportunities that have a clear business case and investment rationale, and are expected to create innovation and commercial opportunities.

Partners that join AREC will begin to design project opportunities to address their sectoral challenges and priorities, build partnerships with the University and other firms and agree collaborative business models.

For more information, visit www.sheffield.ac.uk/arec and contact **Professor Lenny Koh** on S.C.L.Koh@sheffield.ac.uk

NEW MMTA MEMBER

GMH Stachow-Metall GmbH

GMH Stachow-Metall GmbH is a family-owned business involved in the international trade of non-ferrous & minor metals, owned and managed by Friederike Stachow.

For the past 25 years GMH Stachow-Metall has focused on non-ferrous scraps, residues and raw materials from tin, zinc, lead. The increasing demand for precious, rare and minor metals over the last years has changed the business of GMH. Over the years, another successful story began and we expanded our known focus into the minor metals business.

Since 1989, reliability and expertise have made GMH Stachow-Metall GmbH an internationally acknowledged partner for customers worldwide, particularly when it's a case of procuring special materials or finding suitable uses for special scrap and residues.

Contact : Friederike Stachow
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