

The Crucible

Minor Metals—Ready for the Circular Economy

In Conversation with Derek Raphael, Derek Raphael & Co.



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Counterparty Insolvency & Warehouse Fraud

Finishing with a 'bonus' Q & A on Brexit and Commodities

MMTA & Holman Fenwick Willan Breakfast Seminar

26th May—8:30–10:30am, London

We are very pleased to announce that new MMTA Member, Holman Fenwick Willan is holding a breakfast seminar in partnership with the MMTA at its London office.

This event is free to attend

Draft programme:

Registration & Breakfast

Session 1: **Counterparty Insolvency** – a case study on:

- Recent law on retention of title clauses in open account markets;
- Risks and focus areas when buying and claiming under credit insurance policies

Session 2: **Warehouse Fraud** – a case study on:

- Warehouse due diligence best practice;
- Insurance and financing claims if you are subject to a warehouse fraud

Q & A: Brexit and Commodities

Networking

To register for this event please contact admin@mmta.co.uk

Kindly sponsored and hosted by

holman fenwick willan hfw

Announcement from John Price, Trident Traders Ltd, and former MMTA Chairman

John has closed down Trident Traders Ltd as he has decided to retire.

He joined Leigh and Sillavan in 1974 in Macclesfield and then with Martin Tolson formed Trident Traders back in 1982. The company operated for 15 years in Macclesfield and then since 1997 in Bath. John says: "it has been a wonderful roller

coaster ride and I feel privileged to have met and concluded business with so many people around the world. I thank them all and particularly those with whom I have become close personal friends.

My close association with The MMTA remains a very special memory and I am so delighted to see its growth and international success.

Yours most warmly

John Price"

On behalf of the MMTA, we would all like to wish John a long and happy retirement.

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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.



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News from the MMTA's International Minor Metals Conference

The Wider Picture

James Peer, MMTA Chairman, opened the MMTA's recent International Minor Metals Conference in Amsterdam by thanking the event's sponsors: Platinum Sponsor, C Steinweg Group, and Silver Sponsors: Exotech, EAG, Argus Media and the REACH Orphan Substances Consortium. He thanked them all for their support which allows the MMTA to maintain the incredibly high standards of the conference.

James was very pleased to report that this year's conference has the best attendance in the MMTA's history, with 30% more Member companies attending than last year and an increase of 30% in delegates from Asia, which combined with the very strong presence from North America, reflects the truly global reach of the MMTA.

He went on to say that we all know the past year has been one of exceptional turbulence and uncertainty in all commodity markets, and that the world of minor metals has not been unscathed. Whilst it seems that many metals have found their low points, there are still plenty of headwinds that make a rebound in demand risky to bank on.

Some of the key unanswered questions James outlined are:

1. When and if the huge fall in energy prices will translate into increased growth and demand in consumer based economies;
2. When non-oil and gas and mining sector business investment levels will return to their pre financial crisis levels;
3. What the nature and trajectory of growth in China over the coming 5 years will be.

On top of this, James referred to a number of political uncertainties that potentially threaten to restrict the trade flows and patterns that Members of our association thrive on.

1. The consequences of the UK leaving the EU, which through copycat behaviour by other members of the EU could potentially see the unravelling of the European single market;
2. A more protectionist USA, with every candidate in the US Presidential election committed to halting any EU – USA free trade agreement, and serious doubts over whether the Pan Asian – USA trade agreement will be ratified.

However, against all this uncertainty, he pointed to tremendous opportunities for many of the elements that we are all involved in; minor metals are at the heart of technologies that will define the way we live over the coming generations, such as electric and self-drive cars, the continued growth of the aviation sector, advances in renewable energy sources, where technology is moving so rapidly that, in fields such as solar power, they are becoming competitive with fossil fuels without the need for subsidy. And of course, there is our unwavering demand for electronic devices, all of which require increasing volumes of minor metals.

The MMTA Chairman closed by saying that the news from China is not all gloomy; the MMTA's friends from the China Non-Ferrous Metals Association have advised that in 2015 the top 10 non-ferrous metals production of 50 million

tonnes was still outstripped by demand of 52 million tonnes. It is a message that we all need to remember – whilst growth in metal consumption may not be what it was in China over the past 10 years, consumption levels are such that China is still the key engine for metal demand worldwide.

Within the MMTA

As far as Association developments are concerned, Volker Mertens, MMTA Treasurer, stressed the importance to the Board, as fellow MMTA Members, of supporting the industry during this difficult period by absorbing the projected deficit in 2016 and drawing on the reserves of the Association. He confirmed, however, that we will reluctantly have to raise fees for 2017, but by the smallest amount possible. In doing so, he drew Members' attention to the changes that have occurred within the Association over the past 6 years since the last time MMTA membership fees were increased.

Chris Edler, Conference Committee Chair, outlined the work of the Board in identifying ways to maximise the benefit of MMTA membership, and announced that from next year there will be a significantly increased discount for MMTA Members when booking for the conference, in the hope that even more Members will attend the Association's conference, and also to encourage non-member companies to join us as Members of the MMTA.

Donald Lambert, Mediation & Arbitration Committee Chair, gave a short overview of the proposed addition of a short form Arbitration process for smaller disputes. The committee has consulted widely on this, and the draft proposal is included in the Annual Review for 2016. Donald encouraged Members to let him know whether the proposed rules and limits will meet the needs of the industry, prior to us moving forward with them.

Finally, Maria Cox, MMTA General Manager, outlined a mixed picture for MMTA membership. Despite a decrease in renewals at the end of 2015, reasons given reflect the difficult environment, with some businesses being wound up or sold, and others refocussing themselves away from minor metals, whether in the short or longer term. However, the membership rate is still 90%, and on an extremely positive note, we had 11 new Members in 2015, with 4 confirmed new Members in the first quarter of 2016, and another 3 currently being processed. We held productive meetings with prospective new members during the conference, and therefore hope to see more joining the Association as the year progresses.



Conference Topics

Last month, the MMTA and Metal Events welcomed a record number of attendees to the Grand Hotel Krasnapolsky in vibrant Amsterdam for the MMTA's International Minor Metals Conference. An exceptional line-up of speakers was warmly welcomed by delegates interested in hearing specialist insight into the fascinating metals that they work with every day.



Keynote speaker, the chemist and author John Emsley, opened the event with the intriguingly titled presentation 'Elements of surprise: Metals Murder Think Again (MMTA)'. Not one to disappoint, John began by looking at nefarious means to commit murders using minor metals. He also examined the boom in minor metals applications in recent years, concluding that we have truly entered the 'minor metal age'.

Dan Hewak from the University of Southampton followed with 'Current and emerging applications of minor metals in optoelectronic devices'. Chalcogenide Glass devices are used in a myriad of applications from night vision systems in cars to security sensors. They have typical compositions based on: Ga, Ge, Zn, Te, Se, S, Sb and As. Dan talked about his department's challenge of decreasing the thickness of optical fibres, as well as the development of 'chaff', the substance used to confuse radars searching for military aircraft. Minor metals have, for several decades, played a crucial role in optoelectronic devices, and continue to do so. There are also opportunities going into the future to replace some noble metals with minors, as devices move from the research lab to commercial products.

The first session of the day looked at future movers and shakers in the minor metals world. Starting with the extremely topical issue of lithium's use in automotive batteries, Dr Reiner Haus from Dorfner Anzaplan in Germany talked about the recent announcement of the Tesla Model 3. This new model is already breaking records in the auto industry, with 232,000 reservations within 48 hours of launching. To fulfil future battery demand, Tesla is well under way with constructing the world's largest lithium ion battery plant.

However, apart from investing in lithium mining projects, it seemed difficult for new suppliers to enter the Tesla supply chain.

Jim Hickey, Procurement Manager from Magnesium Elektron continued the morning with a fascinating look at the use of magnesium through automotive and aerospace history. Medical applications, too, are an area where magnesium comes into its own, with dissolvable temporary implants now complementing the use of more permanent replacement parts. This is due to magnesium's unique properties and interactions in the body.

'Hafnium supply: Past, present and future' by Alister MacDonald, of new MMTA Member company Alkane Resources, also took a look at zirconium supply. Both metals, as well as a multitude of others, can be found in Alkane's new Australian mining project, the Dubbo Zirconia Project around 400km north of Sydney. Alister went on to examine the supply and demand for these materials

and touched on niobium and rare earth applications as well.

Rounding off the morning's session was Sybrand van der Zwaag, Professor at the Faculty of Aerospace Engineering at the Technical University, Delft in the Netherlands. Sybrand presented an extremely engaging overview of self-healing metallo-ceramics and the minor metals used in them. With the help of some fantastic imagery, which really brought the subject to life, he illustrated thermal and erosion damage caused by sand and volcanic ash in aircraft engines. Self-healing MAX phases (the point when a material becomes a tough metallo-ceramic) based on TiAlC and CrAlC look to be very promising for engine applications, but more work needs to be done on other minor metal based MAX Phases for next generation jet engines.

In a slight change to the format, the afternoon session focused on supply chain management and REACH implementation. A panel of experts presented short introductions to their particular supply chain issues, followed by an interactive Q&A from the audience. Steffen Schmidt from the Tungsten Industry-Conflict Mineral Council began with a look at conflict-free tungsten from mine to consumer. This was followed by 'Cobalt Supply Chain Issues' by David Weight from the Cobalt Development Institute, who explained in detail how the CDI and its Members were taking action on ethical supply and transparency in the cobalt industry. Joining the panel was Candida Owens of Cronimet Central Africa, who has many years' experience in conflict-free tantalum supply.

Wrapping up the afternoon session was Karine van de Velde of the REACH Orphan Substances Consortium based in Belgium. Karine warned the audience about the 2018 REACH deadline urging them

to get started on the registration process for any substances as yet unregistered as soon as possible.

Day two started with a rousing presentation by Markus Moll, a veteran speaker at the conference. Markus looked at alloy steel markets and their outlook, covering alloy engineering steels, stainless steels, tool steels and nickel alloys, as well as the implications for the minor metals chrome and molybdenum as a result of these market developments.

'Tantalum and Niobium myths' followed with David Henderson of Rittenhouse International

Resources. He started with the myth

of niobium being a rare metal, as well as other incorrect assumptions about the future markets of niobium and tantalum. David concluded with a look at how to properly evaluate mining projects and the ever important distinction between resources and reserves.

The final session of the conference was the diagnosis for minor metals post Fanya. Previous attendees of the MMTA's conferences will remember the long discussions on the subject of the Fanya Metal Exchange and its effect on supplies and prices of various minor metals. The Fanya Exchange traded antimony, germanium, gallium, wolfram, indium, silicon, cobalt and bismuth and amassed huge stockpiles of the minor metals. For example, Fanya's indium stockpiles at last count was put at 3,600 tonnes, which compares with annual global consumption in mobile phones, televisions and solar cells of less than half that.

Funsho Ojobuoboh, Consultant at Vital Materials began this session with a look at selenium in infra-red (IR) technology. IR is used in applications such as lasers and windows with minor metals such as germanium (Ge), silicon (Si), gallium arsenide (GaAs), magnesium fluoride (MgF₂), as well as some aluminium alloys. Zinc selenide is one of two major IR materials by the Chemical Vapour Deposition process (the other is ZnS). This is because of its superior IR optical quality making it an excellent IR laser window (due to its low absorption coefficient), but unfortunately it is a soft material and not durable in erosion environment.

Koen t'Hoen from M&R Claushuis spoke about lead and tin residues containing minor metals and the issues surrounding their recovery. He focused in particular on mercury containing residues, including its uses and disposal and the legislative issues surrounding mercury's use.

Wrapping up the conference, Brian O'Neill, from US-based AIM Minor Metals, looked at the indium market since the collapse of the Fanya Exchange, being one of the metals with the largest reported stocks. Brian set the scene with an analysis of supply and consumption, as well as the accuracy of Fanya's figures in the context of current market conditions. Brian concluded that now that Fanya has ceased trading, 'normal' supply dynamics have been restored, but future demand increase for indium will be modest.

We would like to thank all the speakers, sponsors and delegates for making the conference such a success. Until next year!



Drinks reception on board the Het van Wappen, hosted by C Steinweg Group



Eglentine Metal

This advertising board was spotted at Blists Hill Victorian Museum in Shropshire.

Internet research has not shone light on the composition of this metal, so the MMTA is challenging Members to tell us.

What we know so far...

Eglentine filed an American Federal Registration for the Eglentine trade mark in 1905, being used for manufacturing stirrups, bits and other metal parts of a horse's harness.

Some sources suggest it may simply be aluminium—is anyone able to confirm or deny this?

Letter from North America

Dear Members

So, finally, Cruz has thrown in the towel. Kasich too. Donald Trump is now the sole candidate in the race for the Republican nomination. Or is it even a race anymore? Perhaps it still is, otherwise why would Cruz have done what he did? But a race with whom? These are questions some are now asking.

Will the Republicans (the Grand Old Party – GOP) do what they did to Barry Goldwater in 1964? Probably not. But who knows what they are planning. I, certainly, remain flummoxed by politics here. And I've now voted in a number of elections. Probably best to turn to the BBC to find out what's really going on. Many of my American friends do!

Where do Trump and Clinton stand on trade agreements?

All that said, of passing interest to members may be how Trump and Clinton stand on trade agreements. Back in November last year, Trump said of the Trans-Pacific Partnership (TPP): “*The TPP is a horrible deal... It's a deal that was designed for China to come in, as they always do, through the back door, and totally take advantage of everyone.*”

Clinton, too, appears to be against the deal. In October last year, she was quoted as saying: “*As of today, I am not in favor of what I have learned about it.*” However, at this juncture, I am not sure whether either has come out with a view on the Transatlantic Trade and Investment Partnership with the EU. But, going by Trump's isolationist rhetoric and Clinton's need to keep the unions on side, I'm not sure either of them has all that much reason to look favorably upon it. We'll just have to wait and see – unless the deal is consummated before everything is concluded in November.

As readers of my letters will know, I like to keep an eye out for interesting scientific advances using minor metals. Here are two I found particularly interesting. Unfortunately, because of their nature, they'll probably not lead to a massive increase in demand for the metals involved.

Two-dimensional semi-conductors in electronic and optoelectronic devices

The first was news from the U.S. Energy Department's National Renewable Energy Laboratory (NREL) that it had “*uncovered a way to overcome a principal obstacle in using two-dimensional (2D) semi-conductors in electronic and optoelectronic devices.*”

Seen, as the NREL notes, as promising candidates for next generation devices, 2D semi-conductors, which are only a few atomic layers thick, are made of such metallic compounds as molybdenum di-sulfide (MoS_2), molybdenum di-selenide (MoSe_2), molybdenum di-telluride (MoTe_2), tungsten di-sulfide (WS_2) and tungsten di-selenide (WSe_2). The obstacle (the Schottky barrier between the semi-conductor and metal contact) is actually removed by using a 2D metal, for example, niobium di-sulfide (NbS_2) as the electrode.

Liquid metal particles for heat-free soldering and other applications

The second was contained in news from Iowa State University that scientists there had “*developed liquid metal particles that can be used for heat-free soldering and other applications.*” In this case, the particles are only about the size of red blood cells, i.e. some 10 micrometers in diameter. The scientists proved their concept using “*liquid-metal particles containing Field's metal (an alloy of bismuth, indium and tin) and particles containing an alloy of bismuth and tin.*”

If, indeed, these particles do actually have “*significant implications for manufacturing*”, then it'll be interesting to see whether, down the line, demand for the aforementioned metals is affected positively in any way.

As last month, on that last scientific note, I remain, from a very wet and chilly New York, with best wishes to MMTA members everywhere.

Yours

Tom Butcher, May 4th, 2016 ©2016 Tom Butcher

PS I'm only sad I missed the conference this year. I heard it was great! tb

Minor Metals:

Ready for the Circular Economy

The world's population is growing quickly; people are moving to urban centres, and raw material demand is expected to increase three-fold by 2050.

Government and business need to face these challenges head on to ensure a plentiful supply of resources for all; therefore optimisation is crucial.

Metals will be central to any strategy to make a sustainable future. Minor metals are used in renewable energy technologies, electric vehicles and other sustainable technologies – please visit www.mmta.co.uk/newsletter/sustainable-minor-metals to learn more.

These metals are often described by governments as 'strategic' or 'critical' because of their exceptional characteristics and economic importance; minor metals are part of the innovative solutions which will ensure a sustainable future. In addition, steel, nickel, aluminium and other base metals also rely on minor metals as alloying elements to give them their mechanical properties, deformability, corrosion resistance and other essential performance characteristics.

One solution to the world's raw material challenges is to develop a **circular economy**. The circular economy is a practical method to manage the planet's expanding resource demands.

So what is the Circular Economy?

A circular economy is an alternative to a traditional linear economy ('take-make-dispose') in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life. (WRAP UK)



The circular economy aims to eradicate waste—not just from manufacturing processes, as lean management aspires to do, but systematically, throughout the life cycles and uses of products and their components. Indeed, tight component and product cycles of use and re-use, aided by product design, help define the concept of a circular economy and distinguish it from the linear take-make-dispose economy, which wastes large amounts of embedded materials, energy, and labour. (McKinsey & Company)

Exploration and material extraction costs are rising. This, coupled with growing tensions around geopolitics and supply risk, are contributing to volatile commodity prices. A circular economy could help stabilise some of these issues by decoupling economic growth from resource consumption.

Why are we talking about this now?

The European Commission says that the circular economy offers an opportunity to reinvent the economy, making it more sustainable and competitive, bringing benefits for businesses, industries, and citizens alike. This new plan would, they believe, make Europe's economy cleaner and more competitive, and the Commission is delivering ambitious measures to cut resource use, reduce waste and boost recycling. The Commission has recently adopted (December 2015) an ambitious Circular Economy Package, which includes revised legislative proposals on waste to stimulate Europe's transition towards this circular economy.

The Circular Economy Package consists of an EU Action Plan for the Circular Economy establishing a concrete and ambitious programme, with measures covering the whole cycle: from production and consumption to waste management and the market for secondary raw materials.

The proposed actions will contribute to 'closing the loop' of product lifecycles through greater recycling and re-use, and bring benefits for both the environment and the economy. Within this there will most definitely be business opportunities for those able to demonstrate that their activities support the overall aims of the circular economy.

The most concrete proposal in the revised legislation is on waste. Clear targets have been set for the reduction of waste and to establish an ambitious and credible long-term path for waste management and recycling. Key elements of the revised waste proposal include:

- A common EU target for recycling 65% of municipal waste by 2030;
- A common EU target for recycling 75% of packaging waste by 2030;
- A binding landfill target to reduce landfill to maximum of 10% of all waste by 2030;

- A ban on landfilling of separately collected waste;
- Promotion of economic instruments to discourage landfilling ;
- Simplified and improved definitions and harmonised calculation methods for recycling rates throughout the EU;
- Concrete measures to promote re-use and stimulate industrial symbiosis – turning one industry's by-product into another industry's raw material;
- Economic incentives for producers to put greener products on the market and support recovery and recycling schemes (e.g. for packaging, batteries, electric and electronic equipment, vehicles).

What about the Circular Economy beyond Europe?

China has set up CACE, a government-backed association to encourage circular growth, and an increasing number of initiatives are being developed in the US, where the clear business case for the circular economy is having an impact.

Civil society has been the real driver for the circular economy until recently. The Ellen MacArthur Foundation, the leading organisation behind the circular economy movement, counts companies such as Philips, Renault and Unilever as their Global Partners, pushing their businesses and supply chains towards the circular economic model. With such downstream companies championing the transition to a circular economic model, those within their supply chains will increasingly need to demonstrate they are complying.

How do minor metals fit in to the Circular Economy?

Minor metals are ideally suited to this shift in economic model. Many minor metals have recycling loops of high economic value.

Examples where MMTA Members are leaders in their field include:

- Rhenium and precious metal recovery from spent catalysts
- Tantalum recovery from used capacitors
- Indium metal recovery from ITO and sputtering production waste
- Tungsten recovery from cemented carbide scrap
- Recovery of molybdenum, tungsten and niobium from used sputtering targets
- Recycling of cobalt and titanium based superalloys

It should be noted that metals are infinitely recyclable and can be used again and again, whilst urban mines contain many high value metals, unlocking a new 'reserve.'

The aim of circular economy plans, in particular for metals, is to implement conditions across the metals value chain to secure cost-efficient access to secondary raw materials by region.

Recycling would be prioritised, with the emphasis on recovery of

valuable metals from recyclable waste and end-of-life products. The anticipated benefit of this would be job creation and economic growth resulting from support given to the recycling and downstream industries by government. In addition, recycling materials lowers environmental impacts and the energy intensity of materials' supply.

High volume metals, including aluminium, copper, nickel, zinc and lead, already have high recycling rates, but great potential remains for increased recycling of other metals, including minor metals and other critical raw materials. However, the industry still faces challenges at all stages of the metals value chain, from leakage of waste, to the continued lack of implementation of measures to reduce landfilling in some regions.

The problem with data...

Minor metals are often used as alloying elements in steel, nickel, aluminium and others and they are often poorly reflected in the recycling rate figures of these metals.

It is common for base metal recyclers not to include the percentage of any alloys in the metals they process. This means that reported recycling rates for minor metals can be much lower than what is recycled in reality.

So isn't the circular economy just another way to describe recycling?

The circular economy is much more than recycling. A linear economy makes, uses and then disposes of materials. The circular economy looks at all the options across the chain to use as few resources as possible in the first place, keep resources in circulation for as long as possible, extract the maximum value from them while in use, then recover and regenerate products at the end of service life.

This means designing products for longevity with repairability in mind, so that materials can be easily dismantled and recycled, not to mention the alternative business models that encompass trade-ins, sharing models and service packages.

What about primary production-won't we need mining anymore?

Even if 100% of metals used in the past were to be recycled, this would not meet the material requirements of today. This is due to increased population and demand for consumer goods. Also, due to the expected lifespan of metals in some applications, such as construction, aerospace and automotive, the metals used here cannot be expected to be recycled for at least 30+ years. There will continue to be a demand for primary production.

Tea with the MMTA A

Anthony Lipmann in conversation with Derek Raphael of Derek Raphael & Co.

For this inaugural 'Tea with the MMTA' interview, I am in a state of some anxiety in case my guest, Derek Raphael, might not be a tea drinker. Fortunately, I am not to be disappointed. To my offer of Chinese Green, Jasmine or Ginger & Apple, it is "Builders' tea, no sugar".

The location for our chat is our office in Hampton Court to which Derek has driven from his home in St John's Wood on a slightly drizzly morning before this 77 year-old heads out for the golf course at nearby Coombe Hill.

As one of the stand-out personalities of our trade, Derek has seen more of the ups and downs of metal trading than most, and hence my choice for first interviewee in what I hope will be a series focusing on the people (rather than the technicalities) that lie behind the market. As a keen sportsman - cricketer, golfer, marathon runner (the last one at 65) - I am conscious that I am competing for his time against possibly more exciting activities, so I had better make this good.

Derek, you could say, remains one of the most successful living metal people of the post-war generation. While today's minor metal people might associate Derek Raphael & Co Ltd., with cobalt or molybdenum (both metals in danger of growing out of their minor metal status), his background in metals started mainly with ores, minerals, ferro-alloys, coal and fertilizers. As we stir our teas to the left, I venture to ask Derek first about his family background. After all, how does one become a metal merchant when it is not exactly on most university curricula?

Like many of those who peopled the metal trade of the 20th Century, a Jewish background went with the territory. The Raphael origins go back to Lithuania and *schmutter*. Derek's grandfather, Raphael Oblowitz, a tailor, born in 1880, left Lithuania for Leeds at the age of 20 and went on to South Africa where, by 1907, he became a naturalised British subject of the 'Colony of The Cape of Good Hope'. One of three brothers, they built a thriving department store, famous for Jewish women's fashions, but then, using his first name Raphael, he set up his own wholesale and distribution company called *Raphael Brothers*. So it was that when this company was passed down to Derek's father, the Raphael name was passed on too.

Derek's dad, Maurice, served in the South African Army but was

captured at the defeat of Tobruk, spending three years as a prisoner of war in Italy and Germany. As Derek explains, as a result of being a prisoner of war, in later years 'he always kept a biscuit in his pocket.'

Whether it is a Jewish attribute or not, it was the ability to embrace change that perhaps lay behind the decision which ultimately led to the family moving to Lausanne in the 1960s. In 1948, expecting a depression similar to the one that followed the First World War, Maurice sold the business, but it was not until 1960 that the family moved to Lausanne, with Derek, by now a Bachelor of Commerce from University of Cape Town (UCT), following by hitch-hiking to Europe.

It was a chance meeting via his parents that led to his first job with *Continental Ore Company* in Lausanne. This was the group founded by Henry J Leir that became one of the leading trade houses of the period - simply known as *COC*.

It might interest present owners of MMTA companies to note that interviews to work for the Leir empire were as far from present day corporate practice as it is possible to be - at 21 years old in 1960, Derek was interviewed alongside his mother and father. I ask Derek to explain. Essentially, it was the Jewish way - Leir regarded his employee's background as essential to the character of the person, and by the same token he also took his responsibility as employer seriously, as if acting in the place of a parent. I have personal knowledge of this myself - for when sometime in about 1965 my father was also employed by Leir, my sister and I, eight and seven years old respectively, were ushered into Mr Leir's study overlooking the snow-capped peaks around Crans Montana. My father was asked how he would hedge physical copper cathodes on a wirebar contract and I was offered a stamp for my stamp collection on condition I told Leir what I would pay for it. This was the backcloth to one of the most successful international metals and minerals trading groups of the 20th Century.

Interviewing, or being interviewed for reminiscences, is thirsty work, and Derek gets up to make another tea. When I get to the kitchen, he has already boiled the water and is busy re-using the two bags left over from before.

Today's chat, if you like, is about the folklore of the metal trade. Derek was part of a generation whose metal heyday was 1963-1973; a period dominated by four major trading groups - *Philipp Brothers*,

Associated Metals & Minerals (ASOMA), *Hochschild* and finally *COC*.

Derek's early career and my father's middle years crossed at *COC*, so I am interested to know how he thinks those companies differed in the way they were run from the big commodity groups of today.

The answer, when it comes – between sips of tea – is quite surprising. 'First', Derek says, 'communications in those days were nothing like today'. 'Knowledge was not perfect.' In fact, he adds, 'it was totally imperfect!' 'The essence of *COC* was not big positions, not stockholding, but essentially back-to-back business. With 32 offices worldwide this was its strength – those were the communications that enabled the business to channel and serve enquiries. It was all about agency business.' In the case of *COC*, they were agents for iron ore for the Brazilian *CVRD*, ferro-chrome for *Rhodesian Alloys*, pig iron for *Arcor* (later *Samancor*) supplying *Yawata Iron & Steel* in Japan under a ten-year contract, agents of *Duval* for sulphur, ferro-alloys for *Ugine*, and from their own mines in Mexico fluorspar into the USA. The USA was the biggest market and the focus for the organization.

At 21 years old, Derek was sent by Leir to train in the New York office

and assigned to Victor Tosoro in the coal department. Tosoro tells him to write to all the coal companies he can think of to try and get an agency to sell coal to steelworks in Italy. As Derek recounts it, one morning the telephone rings and someone asks to speak to him. No-one has ever phoned in and asked to speak to Derek before. Someone in a thick American accent says 'I am so & so from *Peabody Coal & Coke*' – until recently one of the largest energy companies in USA – and so begins a long-term contract from USA to Italy.

At another time, Derek is sent to Washington to manage the letters of tender for the acquisition of surplus naval vessels (Liberty ships) and later finds himself sent to inspect a stripped U.S. aircraft carrier towering high above the cityscape of Portland, Maine, a huge empty steel shell to be towed to Japan for breaking up.

The stories are flowing thick and fast and, just in case my iPhone is not recording, I am scribbling furiously to get the facts onto paper. It looks as if it is time for our third cup of tea, and I am conscious we are still trapped in the 1960s and have a bit of a way to go. But I have noticed a striking thing proved by this metal man opposite me

and true of metal people, young and old – they rarely forget a deal. Derek surprises himself more than me with his crystal clear memory of names, prices, destinations – and perhaps, if pressed, who knows, the telephone numbers too!

With his New York training under the belt, in 1962 Derek was sent to *Minerais*, *COC*'s subsidiary in Luxembourg, whose main activities were refractories, petcoke and ferro-alloys. There he shared an apartment with another 21 year old, Roger Ehrman, who was in charge of ferro-alloys. *Minerais* were agents for the Czechoslovak FeMo producer marketing to steelworks in Belgium.

Although I know, as most minor metal people do, that moly is the metal with which his name is most associated, I still want to know how it became such a big theme.



Three things, it seems, happened.

The first was that around this time the then *Minerais* boss, Dr Francois Mayer, disappeared into Russia and returned with a consignment of 5mt of FeMo, a source which was new to the market.

The second was that Derek was sent to London – a country he had never lived in but which has since

become his home for the last 55 years. Leir backed young people and gave them responsibility, and Derek thinks that perhaps Leir believed his British South African accent would fit better into the UK than the Mittel-European accents sported by most of his *COC* colleagues. What Derek found upon arrival, though, was that the incumbents had been rather busier trying to sell the business than the metal in the business, and ferro-molybdenum was one of the items they were meant to be selling.

To paint the scene for modern eyes, Derek recounts that in those days there were literally hundreds of foundries and electric furnace steelworks in the UK, all consuming FeMo. In the days before molybdenum oxide was the additive of choice, the only product consumed to add moly to steel was ferro-molybdenum. However, at that time, the production scene was entirely unlike today with a long list of UK home grown producers – *Hi Speed Steels*, *Ferro Alloys Glossop*, *Minworth* and *Murex* – and, in the days before EU harmonization, all protected from foreign competition by a 33% tariff rate!

The third thing that happened was that in 1964 the world's main producer, *Climax*, in the USA went on strike, devastating the supply

of MoS₂ raw material to UK FeMo producers.

Derek saw his opportunity. He had been in touch with a merchant in Liverpool, *H.J.Evans*, who simply could not obtain any FeMo for the foundries he served. With *Climax* on strike, Derek reverted to Luxembourg to see if they could obtain FeMo from overseas and, with Dr Mayer's opening, the way was clear for Russian metal to make its way to Europe.

The shortage of Mo units was so great that, even at 33% duty, the business was obtained at 29 shillings and nine pence per lb Mo while the official market price was 13 shillings. It was not long before Derek was visiting all the steel plants in the UK and his lifelong involvement with the molybdenum market had begun.

What strikes me as I am speaking to Derek is, in some ways, how little has changed; that there is still room for chutzpah, luck, being in the right place at the right time (when someone gets fired or moves on) and, above, all being open to new ideas.

Communications, it is true, have improved no end today – there is no need for a metal merchant to have 32 offices telexing overnight to each other – but there is the same need to field an enquiry in an ever changing world of supply and demand. There is also the same requirement for merchants to trade something about which they may know little, but follow it through into a business. It was moly then; today it might be tantalum ethoxide, niobium-titanium alloy or rhenium heptoxide (but please don't get too excited, these are only examples).

Looking back, the 1960's & 1970s had a geopolitics that has now changed. Then, it was the era of Checkpoint Charlie trade, the need for trading companies to bridge the gap between regimes who could not deal with each other. This might mean navigating between countries who could not pay each other outside bilateral trade limits. If the balance of payments between certain nations was not in favour of the purchaser then a country could not buy direct. In one example, Derek relates, India required Polish sulphur but could not buy it officially, as the bilateral accounts showed no deficit to Poland. This type of trade allowed leeway to the merchant to buy Polish sulphur whose origin would be changed in Rotterdam and then sold to India for cleared dollars.

Another aspect of geopolitics was the building of stockpiles – the Russians were at it, so were the Japanese, the Americans, the French and the British. Being a supplier to a stockpile was a lucrative business led by the *American Commodity Credit Corp*; and there were examples of companies actually installing plant and

equipment purely on the basis of supplying the stockpiles. [It is perhaps one of the ironies of our era that the profit from stockpiles in the last 20 years has all been the other way – with merchants regarding the stockpiles as nothing more than an urban mine to be plundered as needed. It is a history that the Chinese unfortunately have not yet learnt from, as the SRB announces purchases of everything from copper to indium.]

By the 1970s, *COC* had been sold and Derek took the big step of going on his own; and I am old enough to recall his astonishing offices within one of the Nash buildings at Cornwall Terrace that made a statement of where *Derek Raphael and Co.* was heading. This was a mixed era, at first highly successful. 1974 was a great year. Suddenly *DRC* was beginning to look a little bit like *COC* – there were offices all over the world – there were five offices in USA alone, bulk ferro-alloys to move around, finance available, notably in *DRC's* case from the *Australia & New Zealand Banking Group* who wanted to be in the commodity finance field. But by the 1980s success had bred hubris and this was to come in the form of coal. As Derek says, "If a banker says, 'I will not finance this' you should think twice." The Monongahela dockyard, in the area of Pittsburgh, was to become his temporary nemesis. 'We don't finance stockpiles of coal', the bank had said, but *DRC* went along and did it. What happened was that the coal price fell and the longer the coal remained stored in the open, the more it degenerated, ground down by traffic, wind, rain and the elements. In simple terms it was a disaster, but such disasters maketh the metal merchant. His empire retracted and *DRC* secured the ability to take over the U.S. debts in the UK and pay them back out of future profit – he was able to fight another day.

The latter period is one of re-growth. Companies, *DRC* learnt, did not have to have an office in every capital to appear well-dressed, it was about the ideas, the conversions, the relationships and understanding a sector of the market. Derek Raphael has been a serially profitable metal merchant, he has done it more than once – as he says he can measure out his life in moly booms – 1963-64, 1979, 1993-94, 2003-04 – and he retains one of the best reputations in the business. Today, his son, Andrew runs the company that bears his name, and Derek is free to play as much golf and cricket as his body can take...and drink as much tea as is safe and, thus, tell us a little bit about what it was to be a 20th Century metal merchant.

Anthony Lipmann, of Lipmann Walton & Co, was interviewing **Derek Raphael**, of Derek Raphael & Co.

Liquidmetal

As the proud owner of my very own personalised Liquidmetal USB stick, made back in 2008, I was thrilled to hear this extraordinary material mentioned at the MMTA's recent conference. Liquidmetal, a name straight out of the *Terminator* films, is, however, unlikely to be used to make the time travelling cyborgs of the movies. (See over for more on these)

My USB stick dates back to my undergraduate placement year for a well-known car manufacturer, where I was working on a project to make small, complex components directly out of metal rather than making plastic components and then coating the exposed surfaces with zinc and chrome. At that time, the most well-known uses of this material were in golf clubs, baseball bats and other sporting equipment. Unfortunately, Liquidmetal had some well publicised issues with impact brittleness and some rather impressive failures after a certain number of hits. These public failures resulted in the business going into substantial debt.

Since then, the consumer electronics market has been the main growth area for Liquidmetal. For example the SanDisk Cruzer Titanium USB drives, with the slide-out connector, is not made of titanium, but rather Liquidmetal. This type of small, complex part is ideally suited to this metal, an alloy of zirconium, titanium, copper, nickel, and aluminium.

As mentioned, the driver for my own research project was the processing characteristics of this metal, the key quality that makes it interesting to materials engineers looking to design innovative metal parts and to fabricate them more simply than with traditional metalworking technologies.

The positive characteristics of Liquidmetal:

- Exceptional dimensional control and repeatability
- Excellent corrosion resistance
- Brilliant surface finish
- High strength
- High elastic limit
- High hardness, scratch & wear resistance
- Non-magnetic
- Complex shapes that can be moulded

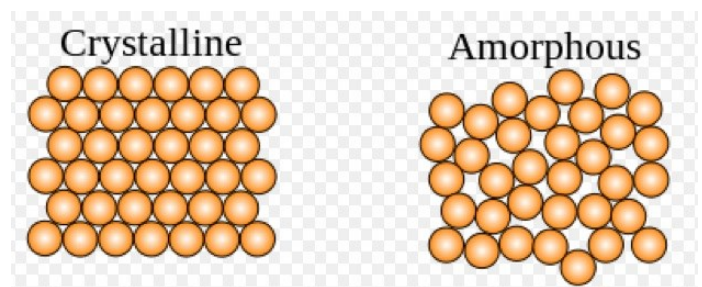
However, it looks like there will soon only be one company using Liquidmetal in its electronic parts: Apple. Rumour has it that, as well as the iPhone 7 having a longer battery life, potentially a water-resistant cover and the elimination of antenna lines, the chassis may be made of Liquidmetal. A very small quantity of

Liquidmetal will be used in place of the aluminium currently used in older phones to achieve the same degree of strength but with less weight, keeping the iPhone 7 thin and light.

Apple has gone to the effort of purchasing the rights to Liquidmetal, so it cannot be used by others in the consumer electronics industry, so it seems likely that they have big plans for the material. It is important to note that Apple will be able to license the material to other industries and applications.

Why is Liquidmetal different from other metals?

When conventional metal alloys cool from their molten state to a solid, atoms naturally form a crystalline structure consisting of many small crystalline grains (see diagram below). The specific ratio of elements slows crystallization. When cooled quickly enough, the alloy solidifies in an amorphous (glass-like) state, precluding crystallization. As a result, the alloy retains the extremely dense amorphous atomic structure that characterizes glass and gives Liquidmetal alloys their mechanical and chemical properties. Perhaps a more appropriate description of Liquidmetal is bulk metallic glass.



As well as its positive forming characteristics, there are some negatives too. There is the impact brittleness we have already touched upon, but there is also a gradual loss of integrity at high temperatures rather than a set melting temperature. Liquidmetal is far from the only bulk metallic glass, with any number of alloys processed in the correct way being able to form an amorphous structure. The key is to cool the alloy extremely quickly.

What makes Liquidmetal special compared to other amorphous alloys is that it is easier to make. To simplify, it doesn't need to be cooled as quickly as other similar materials, meaning the process is cheaper and easier, and greater quantities can be produced.

What is Liquidmetal like?

From the images, Liquidmetal looks very much like a regular metal, and more the colour of steel than aluminium. Look closely and you will see polished areas which could be used to make the whole part shiny if required. In USB form,



If you were to bend a thin piece of Liquidmetal, it would feel more flexible than steel or aluminium, but will reach a point where it suddenly becomes very difficult to deform further.

Experiments with Liquidmetal

This material does lend itself well to exciting experiments!

NASA are generally quite keen on Liquidmetal, having used it in several projects, as well as publishing a report following experimentation on the material.

In one experiment, three marble-sized balls made of steel were dropped from the same height into their own glass tubes. Each tube had a different type of metal plate at the bottom: steel, titanium, and Liquidmetal. Once each ball was dropped, they were left to bounce. The balls hitting the steel and titanium plates bounced for 20 to 25 seconds. The ball hitting the Liquidmetal plate bounced for 1 minute and 21 seconds! During the experiment, this was also the only ball that bounced right out of its tube.

In another experiment (not performed by NASA!), a Porsche was driven over a Liquidmetal component causing no damage.

Commercial use



It seems that although technically a very interesting material, Liquidmetal's main uses (ignoring its golf club application that actually did offer mechanical advantages before the shattering moment) have been as 'premium' or 'luxury' additions to a product, similar to the use of the word 'titanium' in many unnecessary products (which often don't even contain any titanium).

The incredibly expensive luxury phone brand Vertu, was at one time made of Liquidmetal. (The price is mostly due to the 24hr concierge service included)

Current iPhone Application

So what essential and critical part is currently made of Liquidmetal on the iPhone? Yes, the SIM card ejector pin.



It seems an unusual choice, but it does prove that there is a factory somewhere with the ability to make millions of Liquidmetal components, making the iPhone 7 rumours about Liquidmetal having a more prominent use both more credible and practically achievable.

In an ideal materials world, Liquidmetal would be used as a hard, non-deforming, non-corroding and generally scratch resistant case.

Plastics are flexible but not strong, and while metals are much stronger than plastics, they're not as flexible. Liquidmetal alloys can provide a more durable casing than plastic, which is much more resistant to dents, nicks, scratches and breakage.

Liquidmetal is useful anywhere you could imagine an extremely hard, somewhat flexible, easily mouldable component to be useful. It is conceivable that Apple will soon also be in business with the military, aerospace companies, and deep-sea drilling companies, as they have the ability to now license this material out to these types of industries (all of which have used or researched Liquidmetal in the past).

Liquid metal in the Terminator Films...

Not to be confused with the branded Liquidmetal alloy!

In the *Terminator 2* storyline, the T-1000 cyborg is made of liquid metal. T-1000 is a more advanced Terminator than the first film, and is composed entirely of a 'mimetic polyalloy', rendering it capable of rapid shapeshifting, near-perfect mimicry and rapid recovery from damage. Furthermore, it can use its ability to quickly liquify and assume forms in innovative and surprising ways, including fitting through narrow openings, morphing its arms into solid metal tools or bladed weapons, walking through prison bars, and flattening itself and capable of imitating the pattern and texture of the ground to hide or ambush targets.

The polyalloy cannot function unless it is programmed with specific instructions or controlled. The mimetic polyalloy can harden as solid as any steel.

Vulnerabilities

The mimetic polyalloy can be destroyed by the following factors:

Heat

Temperatures in excess of 1535 degrees Celsius, such as those needed to smelt iron, could permanently alter the bonding processes of the mimetic polyalloy. The molten iron (or any other element) could then mix with



T-1000 melting in molten steel.

the elements of the alloy and physically alter its molecular structure, thus rendering it inoperative. High temperatures added with collision damage, such as a crashing helicopter, can also destroy the mimetic polyalloy.

Freezing

When a T-1000 is exposed to liquid nitrogen, it freezes its morphing processes long enough for an enemy to shatter it with a single gunshot. The effect is only temporary; heat can thaw the scattered fragments and the T-1000 is able to reform itself.

Magnetic Fields

A T-X can be temporarily incapacitated by charging up a particle accelerator and triggering a magnetic field. The mimetic polyalloy is pulled from the metallic endoskeleton by the magnetic field.



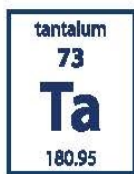
T-X being incapacitated by a magnetic field.

Tamara Alliot, MMTA

Source: Wikipedia

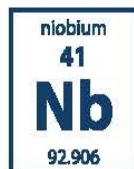


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A Very Brief History of Swordmaking

The sword is a weapon full of imagery – of great armies and knights – but it also parallels the metallurgical developments that made its use possible.

Its invention, the date of which is still disputed, grew from the lengthening of daggers. These shorter weapons were originally made from copper, which although readily available is a relatively soft metal unsuited to anything other than a short stabbing weapon.

The creation of the longer, sharp-edged, swinging and cutting weapon could not occur without the development of a harder metal. For that reason, its first appearance is thought to be between the 17th – 16th century BC in the Black Sea region. This period would later become known as the Bronze Age.

By adding tin to the copper, a harder alloy (bronze) could be created, which advanced the development of the sword; even though ancient swordsmiths may not have understood all the alloy's properties, there is evidence that they were able to vary the composition to create different effects depending on their battle priorities. For example, early Chinese swordsmiths preferred to use a higher percentage of tin (circa 20%) to create a harder, though more brittle, sword, whereas other regions used a lower percentage of tin (circa 10%) for a sword less likely to break in battle, although more likely to bend.

It was not until the Iron Age (12th – 13th century BC), however, that longer, sturdier swords could be developed.

By smelting raw iron (iron ore) using extreme heat and coal to bind the oxygen in the iron ore, swordsmiths were able to produce swords of almost pure iron with carbon dioxide as a by-product.

Smelting was first made possible through the use of bloomeries, now superseded by the blast furnace. At the time, iron's high melting point meant that swordsmiths could only produce a porous iron mass called a bloom, which then had to be hammered out over several cycles of heating and cooling in order to produce a sword. It must be said, however, that these iron swords were only slightly better in terms of strength and hardness than the bronze swords before them, but iron was very widely available, and the process

was far simpler than that of producing a bronze sword, allowing for larger scale production and bigger, sword-carrying armies, with predictable consequences.

Over time, swordsmiths discovered that by adding charcoal (carbon) during the iron smelting process, and by quenching to increase hardness,

then tempering to take away the brittleness, they could make far harder and resilient swords which did not lose their shape. The process was, however, not easy to control and it took centuries before the smiths learned to create the new alloy – steel – in any consistent way. The result was swords of vastly varying quality; indeed into the early Middle Ages, some swords were still being made from iron. It was centuries before the true properties of steel were understood.



Video: 'Liquid Fire' to Metal Sword in minutes,

A History of Ancient Britain—Ep4, BBC2 <https://www.youtube.com/watch?v=eEWluyeNp2k>

Sources: Gonzalez, R A brief history of the ancient science of sword making <http://io9.gizmodo.com/5831683/a-brief-history-of-the-ancient-science-of-sword-making>



The Japanese Samurai Sword

It is said that the Japanese master swordsmith, Masamune, accidentally knocked some powder he'd been using as an asthma medication into the molten metal he was preparing for one of his swords. Despite considering abandoning the melt, he decided to continue and finish the blade. What he did not know was that the grey powder was molybdenum, and the Katana Samurai blade that resulted was not only harder and sharper than anything that had been seen before, but also far more flexible. It was said to be able to slice through a human body from collar bone to hip in a single stroke.

Masamune's accident led to a revolution in steelmaking and to Japan's dominance of the global weapons' industry, a status they did not relinquish until the introduction of flintlock muskets almost 300 years later.

Japanese swordsmithing is a traditional smelting process using several layered steels with different carbon concentrations to strengthen the blade and cause the blade to curve due to the different densities of the layers of steel within it.

The blade is then polished for up to three weeks leaving the hamon – the distinct line down the sides of the blade – with a matte finish along the blunt edge.

Video: Samurai Swordmaking, Portland Art Museum
<https://www.youtube.com/watch?v=2WkWNDDrQ04>

Sources: Energy & Capital <http://www.energyandcapital.com/articles/investing-in-molybdenum/1136>

Wikipedia https://en.wikipedia.org/wiki/Japanese_swordsmithing













Hagane (Hard Steel)	Kawagane (Medium Steel)	Shigane (Soft Steel)
		
Maru 	Kobuse 	Honsanmai 
Shihozume 	Makuri 	Wariha Tetsu 
Orikaeshi Sanmai 	Gomai 	Soshu Kitae 
Maru	not laminated; poorest method	
Honsanmai	most common lamination method	
Kobuse	method used on swords from WW2 period	
Soshu Kitae	seven layers method; used by famous sword smith, Masamune	

Image Author: By loulasedna - loulasedna, CC BY-SA 3.0,

Maria Cox, MMTA



IN BRIEF

FAME is a transnational research and innovation project to identify economically viable, technology to exploit European ore deposits that are often relatively small in tonnage terms. Technologies will be optimised to enable the efficient and sustainable exploitation of the relatively small mineral deposits common in Europe.

This project specifically addresses three different primary ore types: skarn, greisen and pegmatite. These ores carry significant potential for the extraction of Critical Raw Materials. Although these ore types are complex mineralogically and have variable metal grades, they are of great strategic

significance in relation to the overall resource balance of the EU.

As part of the project, a group of industry partners visited Kokkola/Kaustinen in Central Ostrobothnia in Western Finland. The region comprises a cluster of resource, research and manufacturing on ore-based chemicals, especially in energy storage.

The lithium spodumene deposits found in Central Ostrobothnia are the most significant in Europe. The FAME project's Finnish industrial partner, Keliber Oy, is currently searching for and developing suitable ore deposits in the region.

The growing global importance of lithium and other metals such as cobalt, manganese, zinc and nickel for the battery industry has been the driving force for this project to link industry with education, including the recycling of metal chemicals and study of the waste streams, as well as developing business operations linked to them.

The focus group visited Oulu University's Research group of Applied Chemistry at Kokkola University Consortium, which has long-term experience of chemical processes related to metal battery chemical production and recycling, and is working with local business on the recycling of lithium-ion batteries, as well as alkaline battery recycling.

[FAME Project Team](#)

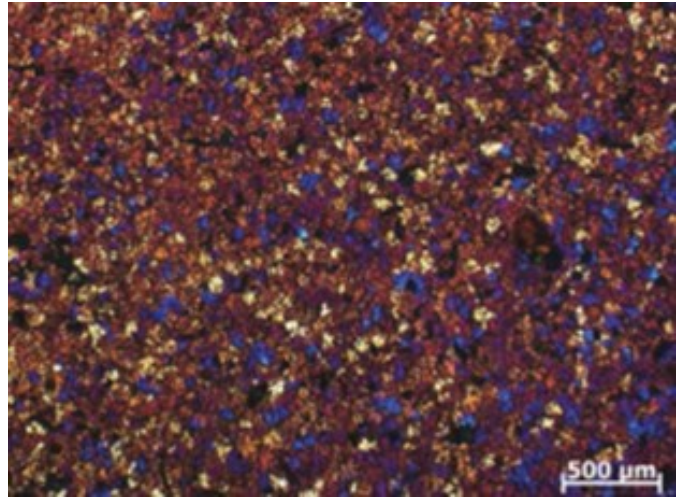


Ever since the Fukushima disaster of 2011, Japan has been searching for alternative energy sources to replace nuclear power, and with a decline in participation in the sport of golf in Japan, developers are beginning to look for innovative uses for abandoned golf courses. This former course, once it goes live, will aim to generate enough power for over 30,000 households.

Source: Japan has finally figured out what to do with its abandoned golf courses, Ariel Schwartz, Business Insider, 16 July, 2015

Potential aerospace applications

for new niobium-base master alloy in magnesium-aluminium and aluminium-silicon alloys



Scientists at Brunel University, London have discovered that a patented niobium-base master alloy improves grain refinement in aluminium-containing magnesium alloys. That isn't all — it also offers 'significant advantages' over titanium in aluminium-silicon alloys.

The research team at the Brunel Centres for Advanced Solidification Techniques saw significant improvements in both tensile strength and ductility when the niobium master alloy was added.

The team anticipates that their findings could lead to changes in aerospace applications, where a possible end to over-engineering

of cast components could lead to weight savings of up to 30% without loss of strength or ductility.

The team also anticipates that the new master alloy could enable excess aluminium-silicon alloy melts to be simply recycled back into the process on site, rather than having to be sent off site.

Sources:

www.brunel.ac.uk

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