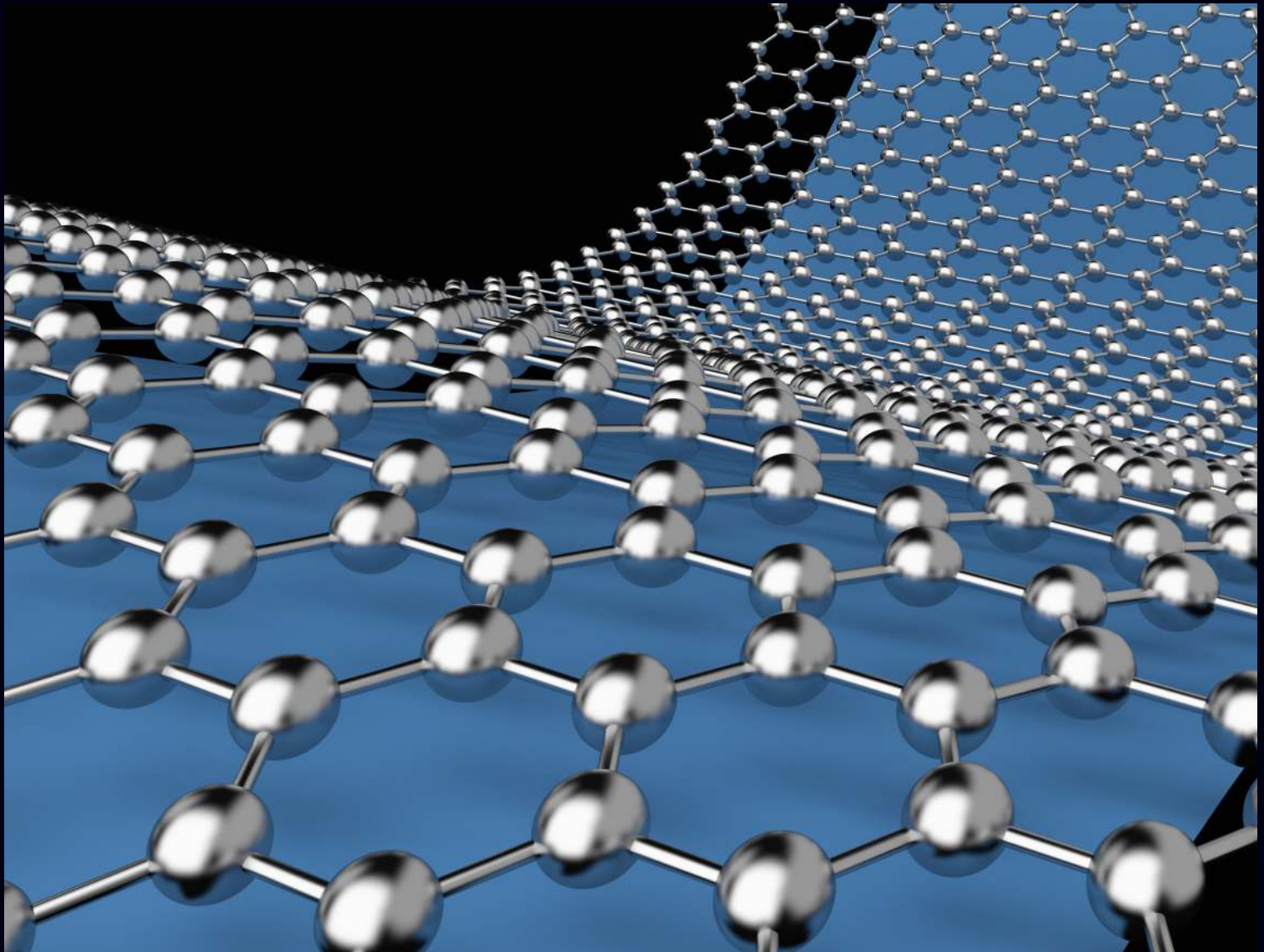


The Crucible

Graphene—Friend or Foe?

Minor metals in nuclear medicine

Chemical registration in the US—TSCA reauthorization



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To register for the conference or for more information please visit www.metalevents.com or www.mmta.co.uk/conference, or alternatively email sales@metalevents.com

MMTA Conference Golf Tournament, hosted by ICD Alloys & Metals LLC



For our first golf tournament, taking place on **Monday 24th April** before the start of the conference, we will be at **the prestigious K Club, previous venue of the Ryder Cup.**

The tournament fee of EUR150 (+ VAT) will include transport by coach from and back to the conference hotel, breakfast on arrival, 18 holes of golf, electric buggy, and lunch

Registered conference delegates wishing to join this event, should contact admin@mmta.co.uk

Speakers for 2017 include:

The MMTA's Popular Science Talk: Laurence Knight, Producer, BBC World Service, and Andrea Sella, Professor of Inorganic Chemistry, University College London, will take a tour around some of the amazing minor metals elements that make up our industry. The BBC World Service has just completed its Elements programme, which took a close look at chemical elements, the basic building blocks of the universe. Where do we get them, what do we use them for and how do they fit into our economy?

"Developments in aero-engines and material choice", by **Bill Reid, Strategic Sourcing Manager: airfoil castings, forgings and mill products, Pratt & Whitney, USA;**

"Delivering a conflict-free supply chain", by **Carolyn Duran, Director, Global Supply Management, Intel Corp, USA;**

"An update on specialty and stainless markets", by **Markus Moll, Managing Director, SMR GmbH, Austria;**

"Coatings for gas turbine blades", by **Dr Lisa O'Donoghue, University of Limerick, Ireland;**

"Tomtor — an alternative source of supply for scandium and niobium", by **Alexander Malakh, Chairman of the Board, TriArc Mining Ltd;**

"Energy storage and its applications", by **Professor Peter Hall, Chair in Chemical Engineering, The University of Sheffield, UK;**

"Lithium and cobalt supply requirements for batteries", by **Simon Moores, Managing Director, Benchmark Minerals Ltd, UK;**

"Future applications for minor metals: Bi, In, Se, Ge & Ga", by **Dominic Boyle, PPM Pure Metals GmbH, Germany;**

Programme Timings:

Monday 24 April

09:00 Golf Tournament at the K Club – Sponsored by ICD Alloys & Metals Inc

17:00 Registration at The Conrad

18:00-20:00 – Welcome reception for all attendees

Tuesday 25 April

08:45 Registration & Coffee

Welcome remarks

Session 1: 09:00-11:00

11:00-12:00 Coffee

Session 2: 12:00-13:30

13:30-14:15 Luncheon

14:30 MMTA's AGM

Wednesday April 26

Session 3: 09:30-10:45

10:45-11:40 Coffee

Session 5: 11:40-13:00

13:00-14:30 Luncheon and close of conference

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UPCOMING MMTA EVENTS

BOOKINGS WILL CLOSE SOON



The MMTA's 43rd Anniversary Dinner

Tuesday, 1st November, 2016

Lord's Cricket Ground, London

£105 MMTA Members and their guests/

£150 Non-Members/Optional tour £12 (+ VAT)

To Book online, go to www.mmta.co.uk/events

Alternatively, email admin@mmta.co.uk if you prefer to receive an invoice.

The Drinks Reception is kindly hosted by Alex Stewart International



The Main Dinner is kindly hosted by RC Inspection Ltd



MMTA Christmas Lunch,

15th December, London

This year's event at Ironmongers' Hall will begin with networking drinks and carols, and is followed by a festive 4-course lunch including wine. It will be— as always—a great way to end the year with industry colleagues and friends.

MMTA New York Dinner,

19th January, 2017, New York

This year we will be returning to the Cornell Club for networking drinks & canapes, followed by a topical speaker and a 3-course meal.

To register your interest in either of these events, please contact admin@mmta.co.uk

NEW MMTA MEMBER COMPANY — TUNGCO INC.



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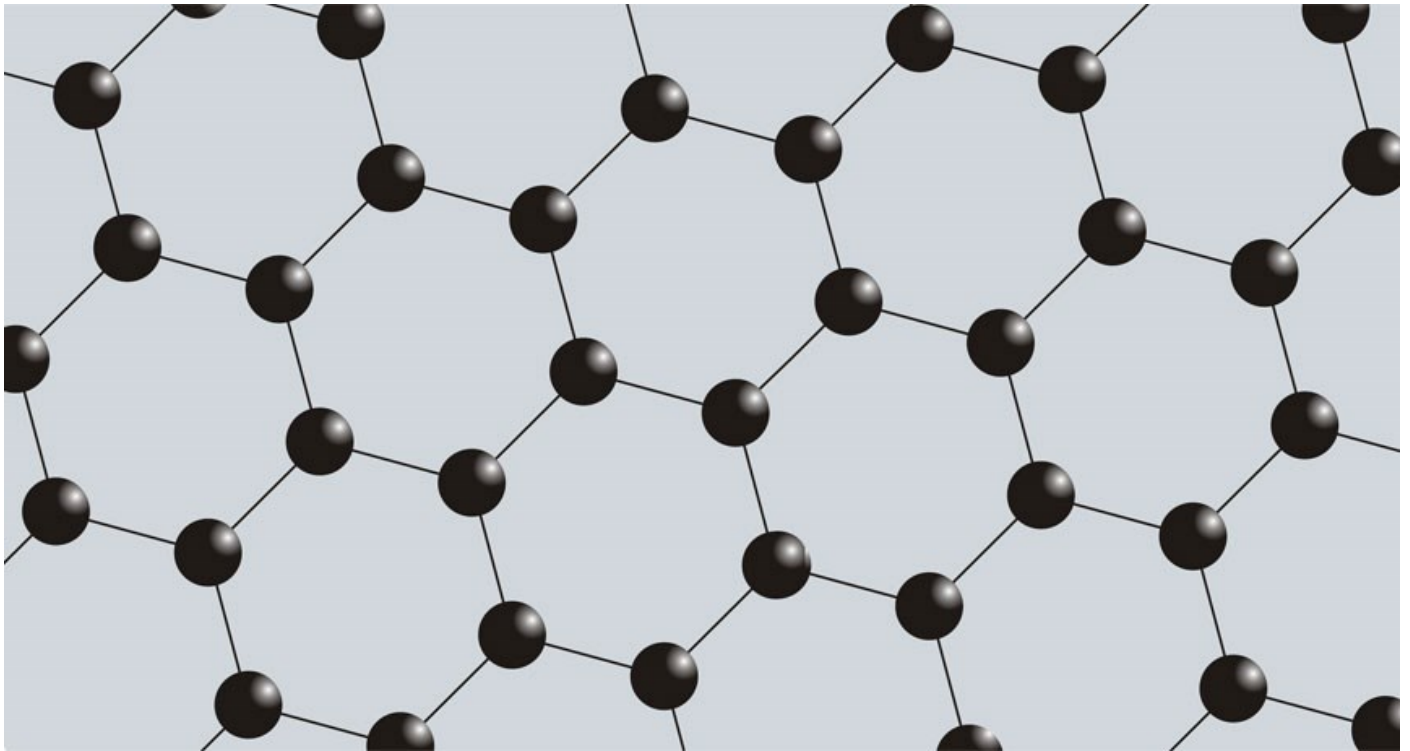
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Graphene: Friend or Foe?



Graphene: Image Source: [MPFIZ/WIKIMEDIA COMMONS](#)

By **Tom Butcher**, Independent Consultant

Introduction

Graphene has been around now for some 12 years. For those in the minor metals industry, should it be seen as a friend or a foe – a substitute or complementary? This short piece will look at graphene: what it is and just some of what it does. And how it may be regarded by those involved in minor metals.

What is Graphene?

First isolated in 2004 by two professors, Andre Geim and Kostya Novoselov, from the University of Manchester in England, graphene is the first two-dimensional material known to man. (For this achievement the two of them were, deservedly, awarded the Nobel Prize for Physics in 2010.)

In stark contrast to most materials that are made up of a 3D structure of atoms, graphene consists of just a single, 2D, layer of carbon atoms that forms a honeycomb (hexagonal lattice) structure. The graphite, used, for example, in pencils, is made out of millions of layers of graphene.

Some Amazing Properties

As a consequence, graphene displays some truly amazing characteristics, many of them seemingly contradictory or paradoxical:

- It is 200 times stronger than steel;
- It is immensely tough, but ultra-light;
- It is incredibly flexible and can be stretched;
- It is the world's thinnest material – one million times thinner than a human hair;
- It is transparent;
- It can act as a perfect barrier – it is impermeable even to helium; and,
- It is a superb conductor (indeed, the world's most conductive).

And as research into the material continues, the list above will soon probably only constitute a small sub-set of the advantages it offers.

Three Applications

One of the most interesting areas of potential use for graphene is in electronics. A number of uses have already been identified and are under development. Here are three:

Touch Screens

Exploiting graphene's properties of being transparent, tough, flexible, and a stunning conductor, it should be possible to produce touch screens that are not only flexible (and perhaps foldable), but also thin and strong – physical electronic newspapers, anyone?

As such, graphene may soon start to give indium (in ITO) a run for its money; whilst ITO may be a good conductor, it remains brittle.

At the end of 2015, researchers at GRAFOL (a European project aiming at roll-to-roll production of graphene films on silicon wafers) announced that they had been able to demonstrate a cost-effective production tool that could make large sheets of graphene on an industrial scale. They believe that graphene could substitute for ITO electrodes in OLEDs. They have, in addition, shown that it may be possible to “*integrate graphene in silicon photonics platforms, as well as flexible thin-film solar cells with transparent electrodes (like perovskite PVs, for example).*”

But we certainly shouldn't be in hurry to give up on ITO in this context. If Chinese researchers at the Ocean University of China in Qingdao are successful in their research, graphene may, on occasion, usefully complement, rather than just substitute for, the indium in PV cells. That occasion is when it rains! Observing that the water in raindrops is not pure, but contains salts that separate into negative and positive ions, they have been experimenting with adding a layer of graphene to dye-sensitized solar cells and using it to generate electricity by separating the positively-charged ions. Initial results have been promising.

And as this wasn't inventive enough, researchers in the UK have created a material based on graphene that has proved very effective at absorbing both ambient heat and light.

Batteries

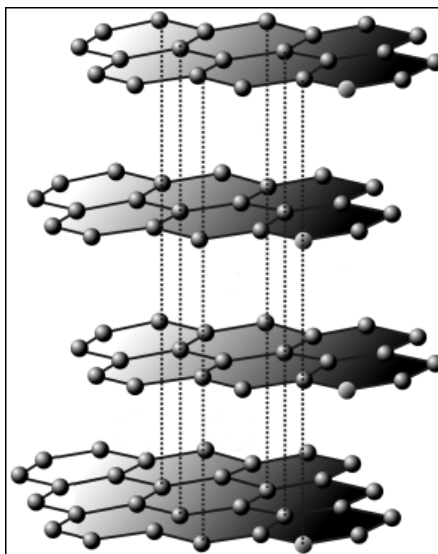
Another area in which scientists have great hope for graphene is in batteries. The current generation of batteries works on the principal of storing energy in controlled chemical reactions. These batteries are usually named after different chemicals and/or metals you find inside them: Alkaline-manganese, zinc-carbon, nickel metal hydride (NiMH), nickel cadmium (Ni-Cd), silver-zinc (Ag-Zn), nickel-hydrogen (NiH₂) and lead acid (Pb-acid).

And then, of course, there are the many different lithium-based batteries, some of which, apart from lithium itself, also contain different minor metals. These include: lithium iron disulfide (Li-FeS₂), lithium-thionyl chloride (LiSOCl₂ or LTC), lithium sulfur dioxide (LiSO₂), lithium manganese oxide LiMn₂O₄ or LMO amongst others. And those that contain more minor metals: Lithium cobalt oxide – LiCoC₂ (LCO), lithium nickel manganese – LiNiMnCoO₂ (NMC), lithium iron phosphate – LiFePo₄ (LFP), lithium nickel cobalt aluminium oxide – LiNiCoAlO₂ (NCA), and lithium titanate – Li₂TiO₃ (LTO).

Much of the competition in the battery world currently revolves around which of the lithium technologies is going to prevail in the world of electric vehicles. Will it be the cheapest, “pouch cell”, battery – LFP? Or the cylindrical battery – NCA – the most expensive? Or the cylindrical NMC battery?

Whilst it is probably not safe yet to open a book on the winner in the battle of the batteries, it is safe to say that for whoever wins, graphene could help increase battery lifespan significantly.

The anodes of lithium batteries currently use 99.99% purity graphite. It is expensive and its production process is wasteful. It is here that graphene comes in. Initial research has shown that anodes made of graphene can hold energy very much better than those made of graphite. In addition, it appears that charge time can be shortened significantly, perhaps to one tenth of the time it takes to charge a traditional lithium-ion battery. Add to this better



longevity, and the prospect for major performance improvements looks quite exciting.

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Rather than with a traditional graphite anode where lithium ions accumulate around its outer surface, with a graphene anode, the lithium ions can pass through the graphene sheets. This leads to both easy extraction and an optimal storage area.

It appears, too, that performance can be improved even further with the addition of vanadium oxide to the cathode, with experimental batteries so adapted recharging in 20 seconds and, even after 1,000 cycles, retaining 90% capacity.

Finally, researchers are also looking at the use of graphene in supercapacitors. As mentioned above, the current generation of lithium-ion, and, indeed, other traditional batteries, store energy by means of a controlled chemical, or electrochemical, reaction. Capacitors store energy by means of a static charge. They are charged by applying a voltage differential between their positive and negative plates.

Supercapacitors or EDLCs (electric double-layer capacitors), as the name suggests, have very high capacitance, or ability to store a great deal of energy. Because of the relatively greater surface area it can offer, graphene is already being used as a substitute for the activated carbon that is currently used in supercapacitors. This higher surface area leads not only to considerable improvements in charge storage, but also, because it is so light, it could lead to significant reductions in weight – useful in both airplanes and automobiles. And because graphene is so resilient, supercapacitors' longevity could also see huge improvements.

So in the context of both batteries and supercapacitors, graphene should, perhaps, not be seen as a foe, but a friend offering a helping hand in making improvements.

Continues over

Semiconductors

With both its conductivity and thinness, graphene is an ideal candidate to become a semiconductor. Unfortunately, it normally lacks a bandgap, a *sine qua non* of semiconductors. However, various ways are already being devised to introduce one. It is, variously, being doped, fabricated in the shape of ribbons, grown in certain ways with certain other materials, and having its “wrinkles” manipulated through “graphene engineering”. If any one or all of these proves successful, we could find ourselves using graphene semiconductors. It appears that graphene chips have already been proven to be much faster than silicon ones.

Conclusion

Whilst it is still early days, the potential of graphene in so many applications is already becoming evident. But it is going to take a long time to nurture, grow and realize that potential, turning visions for its use into reality. Much of what it appears it is currently being made to do is improve upon technology that we already have, for example, being used to improve radically the performance of batteries and capacitors. I have seen little about it replacing, out and out, other materials and, in particular, individual minor metals: lithium batteries look set to be using lithium for some time yet.

We should, therefore, treat it, for the time being anyway, very much as a friend. Yes, it may, at some stage, become a foe, but probably only in certain applications. If we think of just how new (relatively)

some of the most significant uses (for example, LEDs) are for some minor metals, in contrast graphene really is only in its infancy.

And then, as always, there are bound to be instances where uses will be found for a minor metal that will still further enhance performance already improved by graphene. You only have to look at the use of vanadium in cathodes mentioned above for an example.

So, on the whole, I think we should answer Friend, not Foe.

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In Brief

BMW Unveils Plans to Use New & Used Electric Vehicle Batteries for Homes & Businesses

BMW plans to turn new and used electric vehicle batteries into a system that can store energy for homes and businesses.

The product—recently unveiled in Montreal, marks the company’s entry into the energy storage market, following similar moves by competitors, Daimler and Tesla.

BMW differentiates itself from its rivals by using an electric vehicle battery, as opposed to companies like Tesla which developed the Powerwall, a battery specifically designed just for commercial and residential use.

Overall, however, BMW’s product has the same goals, namely the storage of energy produced during the day from solar panels and a backup source of power in the event of failure of the power grid.

As well as using new BMW i3 batteries, the systems can also use electric vehicle batteries that are too old to use in a car, but still have enough life to be used in other ways. These will be introduced, the company says, as they begin to become available.

According to Fortune magazine, “that could be a while. BMW’s all-electric car has only been produced for a couple of years, with global sales topping 47,000, according to BMW’s [2015 annual report](#). The warranty on most electric car batteries, including the BMW i3, is eight years.”

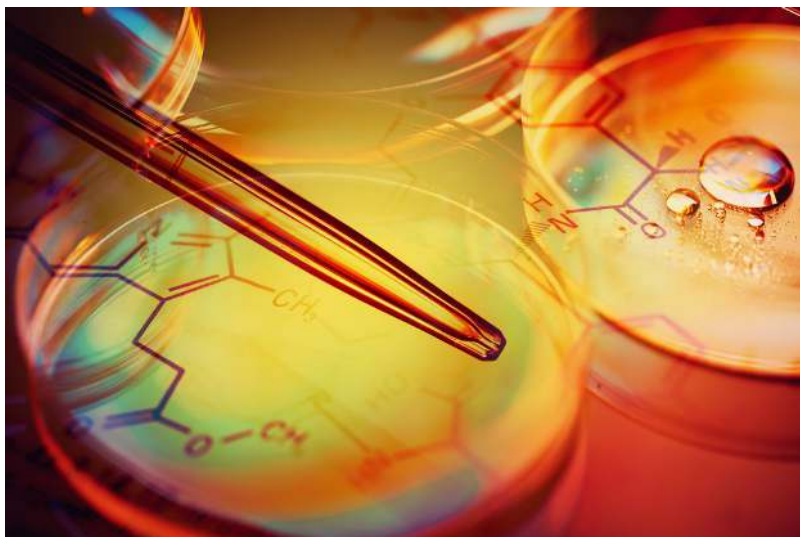
Although details are yet to emerge, BMW’s systems are equipped with car batteries that have 22 or 33-kilowatt-hours of capacity. The typical U.S. household uses between 15 and 30 kWh of energy daily for appliances and entertainment devices, which means the battery stores enough energy to meet that household’s needs for a 24-hour period, BMW says. The unit can also be used to charge an electric car.

Specific areas of research have included how to manage the flow of electricity between solar panels, the home and the battery, as well as optimising the use of stored energy. The company has also undertaken projects in conjunction with academia to explore the use of used electric vehicle batteries with a view to creating a separate grid. As electric vehicle use increases, companies are also keen to fully understand the impact of home charging on the energy grid, so that the cost of owning an electric vehicle can be reduced.

Source: Adapted from Fortune <http://fortune.com/2016/06/22/bmw-energy-storage/>

Toxic Substances Control Act (TSCA) Reauthorization:

How Will You Explain the Impact of the New Law to Your CEO?



Chemical registration in the U.S. just got more complicated and expensive.

President Obama recently signed into law the new Frank Lautenberg Chemical Safety Act of 2015 (CSA), which replaces the Toxic Substances Control Act (TSCA) of 1976. The requirements under this law become in effect immediately.

What does this mean for your company?

- **Possible business disruption** likely due to holds on recently submitted and future pre-manufacturing notifications (PMN) for new chemicals and reporting significant new uses for existing chemicals (SNURs);
- **Additional cost** due to expensive laboratory animal and environmental testing for existing and new chemicals;
- **Restrictions on product use** if EPA concludes the uses are unsafe;
- **Additional hurdles to retain confidentiality** of business information (CBI);
- **An increase in fines and criminal penalties for non-compliance;** and
- **Other impacts** depending on your product portfolio.

What to do now?

- **Know the law** by having your legal department and compliance organization study the new requirements or hire experts that can explain these changes to you;
- **Evaluate the impact on your company** by comparing the new requirements to your existing TSCA program, evaluating the status of current and future registrations;
- **Assess the level of hazard and exposure information** that is currently in-place for your products and define data gaps; and
- **Develop an implementation plan** to coincide with implementation dates of the new CSA.

Points to consider when explaining these new requirements to company management:

- **Notify senior management of the new requirements**, which can be provided jointly by your legal and compliance departments and the corporate risk management department...seek help from consultants as needed;
- **Express the impact in business terms as you know them today**, such as factors that will impact time to market, growth and cost of compliance; e.g.,
 - The length of time for registrations under CSA is undetermined and could slow new product launch
 - The cost of additional testing needs to be rationalized with profitability
 - Use restrictions would exclude markets
 - CBI may not be retained as confidential
- **Highlight the penalties for non-compliance;**
- **Provide a high-level plan and path forward;** and
- **Communicate progress regularly.**

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Minor Metals in Nuclear Medicine

By **Dr K. Dessai**, Independent Consultant in Metals, Mining and Energy

Minor metals are used in the commonly-known applications of aerospace, automotive and energy generation, to name a few, and they have also been extensively utilised in medicine and dentistry. In biomedical applications for example, titanium is commonly used as an implant material in dentistry and orthopaedics. A less well-known branch of medicine—nuclear medicine—has also been using minor metals for a number of decades. In this application, it is the radioactive properties of minor metals are utilised, in the form of radioisotopes.

Many chemical elements have a number of isotopes, which have the same atomic number—representing the number of protons – but a different number of neutrons, which results in different masses. The number of electrons is equal to the number of protons for an element in a neutral state, and it is the number of electrons which determines the chemistry of the element or atom.

Radioactive isotopes (or radioisotopes) are atoms which are generally unstable in nature and must therefore be produced artificially. The number of neutrons and protons in a radioisotope will differ from the same element in its naturally occurring state. For example, strontium has a naturally occurring mass number of 88, while it also has radioisotopes Sr-82 and Sr-90. Thus this difference in mass number leads to differing physical and chemical properties, which consequently each have differing applications.

A nucleus of a radioisotope is unstable, as it is composed of an undesirable number of neutrons and protons. For this reason, it will undergo radioactive decay through the emission of an alpha, beta and/or gamma radiation to become a more stable atom. In nuclear medicine, radioisotopes are used within the body, differing from the traditional uses of radiation in medicine, such as X-rays, which are generated externally and passed through the body to form an image.

Radioisotopes are used in two ways in medicine: in diagnostics and in treatment. While a greater proportion are used in diagnosing illness and disease, their growing uses in the treatment of cancers are wide-ranging, especially in the form of radiotherapy. This is because rapidly dividing cells are extremely sensitive to radiation. The ability to target the type of radiation (alpha, beta and/or gamma emissions) from a close proximity to specific cells, tissues,



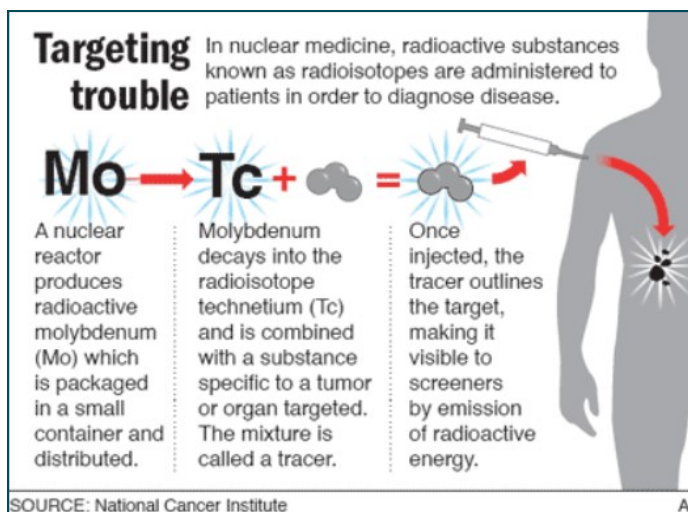
Image Source: Oak Ridge National Laboratory

organs or regions of the body makes the technique a particularly advantageous treatment.

In nuclear medicine, the use of radioisotopes which emit ionizing radiation must be carefully measured and managed so as to diagnose or treat only the required areas for a specific period of time—enough to obtain the necessary information or undertake a particular treatment. Minimum radiation exposure helps to reduce any unwanted side effects or damage to other healthy organs and tissue. Any radiation exposure to treatment providers or the general public also needs to be considered and maintained within safe limits.

Radioisotopes can also be selected based on their decay properties, typically measured using 'Half-life'. The 'Half-life' is the time required for half of the quantity of radioactive isotope to decay, and is measured in minutes (mins), days and years. This means that they survive for long enough to effect the treatment, but decay quickly enough to minimise negative effects from radiation.

Radioisotopes are generally produced in one of two ways: in nuclear reactors, as the products of the fission process through the addition of neutrons, or in cyclotrons, through neutron-depletion by the addition of protons. The largest proportion of the world's supply of radioisotopes or radionuclides have been produced by two reactors; one in the Netherlands at the Petten Nuclear Reactor and one in Canada at Chalk River Laboratories.



Diagnostic radioisotopes are typically those which emit gamma radiation, which is detected externally by a gamma camera. In this application the radioisotope attached to a carrier is taken internally; intravenously or orally. An example of this is Technetium-99m, for which the parent element is the minor metal Molybdenum-99. Mo-99 (half-life 66 hours) is one of the essential radioisotopes required in the production of other species for use in diagnostics.

It is produced during the fission of Uranium-235 in the Chalk River reactor by neutron irradiation of the nuclear fuel.

Another minor metal, Thallium-201 (half-life 73 hours) is used in cardiology for diagnosing coronary heart conditions, as well as detecting the location of low-grade lymphomas. In diagnostic applications, the radioisotope must have a half-life short enough for it to decay away quickly after required imaging has been completed in order to minimise the radiation dose received by the patient.

In therapeutic applications, beta emitting radioisotopes are typically used which can also have some gamma emission.

These are used to treat a wide range of cancers through weakening or destroying tumour cells, for example, Yttrium-90 (half-life 64 hours) is used for non-Hodgkin's lymphoma and liver cancer. Holmium-166 (half-life 26 hours) is being developed for the diagnosis and treatment of liver tumours. There are also other therapeutic applications of minor metal radioisotopes for example, in the use of palliative care and pain relief from cancers and arthritis. Rhenium-186 (half-life 3.8 days) provides pain relief for bone cancer, Samarium-153 (half-life 47 hours) for secondary cancers lodged in bone, and Strontium-89 (half-life 50 days) for prostate and bone cancer. Erbium-169 (half-life 9.4 days) is used to provide pain relief from arthritis of synovial joints.

Another application of minor metals in medicine is their use in sterilisation of equipment. Traditionally, heating has been used for this purpose, however, for equipment such as gloves, syringes, clothing and instruments which would be damaged by this process, Cobalt-60 which is an energetic gamma emitter and has a half-life of 5.27 years, is the main radioisotope used.

A newer area of radioisotope application is in targeted alpha-therapy to treat cancers where alpha radiation emitters such as Bismuth-212 (half-life 1 hour) and Bismuth-213 (half-life 46 mins)

are utilised to provide a higher energy treatment at close range to the cancer cells. This type of therapy is used particularly for melanoma, breast and ovarian cancers. Table 1 below summarises some of the minor metals used in nuclear medicine.

Table 1. Minor metal radioisotopes used in nuclear medicine

Minor metal radioisotopes directly used		
Bismuth-212 & Bismuth-213	Cobalt-57 & Cobalt-60	Rhenium-186 & Rhenium-188
Chromium-51	Dysprosium-165	Holmium-166
Gallium-67 & Gallium-68	Ytterbium-169 & Ytterbium-177	Thallium-201
Indium-111	Iridium-192	Strontium-89
Samarium-153	Selenium-75	
Minor metal radioisotopes as parent species		
Germanium-68 (for Ga-68)	Molybdenum-99 (for Tc-99m)	Strontium-82 (for Rb-82)

The use of minor metals in nuclear medicine as key radiopharmaceuticals or as parent elements has been wide and varied, and new applications continue to be developed. With the versatility they offer, in terms of radioactive decay, energy quantity, half-life and distance, radioisotopes will have a healthy future in diagnostics and therapy. In particular, their use in the treatment of cancers will only increase, given the many and varied forms of the disease, and the need to treat specific areas without damaging healthy tissue until such time as cures are developed.

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Was Napoleon killed by wallpaper?

By **Maria Cox**, MMTA

Ever since the defeated French emperor, Napoleon Bonaparte's death in 1821, on the island of St. Helena, where he lived in exile for nearly six years, there has been speculation as to the cause.

Theories of British assassination plots could be less realistic than one of the most everyday substances in the 19th Century home—the wallpaper.

But why the wallpaper? During the first half of the 19th Century, many changes were happening in the home, and in the 1850's oil lamps replaced candles as the main source of domestic light, providing greater light levels. As a result, the fashion for interior decoration changed. With greater illumination, darker shades became fashionable—with green being a great favourite, for example Scheele's Green and Schweinfurt Green. Described by Jessica Haslam in *Deadly Décor* as an 'accidental killer', Grace Elliot, a historical blogger, states that it was estimated that in 1858 there were 100 million squares miles of green wallpaper in Britain alone, not to mention various other home furnishings using shades of green.

Scheele's green (copper arsenite) was discovered in 1778 by Karl Scheele, a Swedish chemist. Like the IKEA home furnishings of today, it was cheap and vibrant in colour and became extremely popular in the manufacture of a wide range of home goods in homes of all levels of wealth.

In 'Deadly Décor', Haslam explains that "suspicions regarding the safety of such arsenic wallpaper date back as far as 1839, when Leopold Gmelin, a famous German chemist, noted that damp rooms with green wallpaper often possessed a mouse-like odour, which he attributed to the production of dimethyl arsenic acid within the wallpaper. He reported his concerns in *Karslsruher Zeitung*, a German daily paper of the time, warning the population against applying papers containing Scheele's green pigments to the walls of their homes.



Image: Napoleon Bonaparte—American Museum of Natural History



Image: Toxic Green Room—Death on the Walls

Paper manufacturers, including William Morris, disputed the growing body of evidence, and the government, which enjoyed the tax revenue such industrialised home expenditure brought with it, remained very silent on this growing public health scare. However, it slowly became clear that not only arsenic dust from inferior wallpapers, but also arsenic fumes—released due to warm, damp conditions—were leading to breathing difficulties and in some cases death.

The problem was made worse by the fact that the sick were commonly confined to darkened rooms with the windows and doors closed to keep the patient warm and prevent chills from the cold air. So anyone complaining of headaches, fatigue, chest complaints and nausea (symptoms of arsenic poisoning) would be enclosed in their green bedroom to recover.

The first major cases—4 children in Limehouse, a poor area of London—were initially diagnosed as diphtheria. But the supposed infection did not spread, which confused doctors. Haslam explains that "it was not until Henry Letheby, a public health officer at the time, discovered that the children's bedroom had recently been papered with green wallpaper that the true cause of death was discovered.

His examination of the paper found that it contained three grains per square foot of arsenic; a lethal dose”.

Anyway, back to Napoleon: he could have been exposed to the poison through the toxic fumes given off by wallpaper at Longwood, his prison home on St Helena.

A sample of the paper had been secured by a visitor to the site in the 1820s and tucked into a family scrapbook. It surfaced in Norfolk, England, in the 1980s and, when tested by British scientists in the 1990s, was found to contain arsenic.

According to the American Museum of Natural History, “other evidence suggests that Napoleon’s exposure to arsenic was likely life-long. In 2008, an Italian team widened the inquiry by testing not only strands of Napoleon’s hair from four points in his life—including his boyhood, his exile, the day of his death, and the day after—but that of his son, Napoleon II, and his wife, Empress Josephine. All samples were found to have similarly high arsenic levels, roughly 100 times that of living people whose hair was included in the analysis for comparison.”

So, although not proven, death by wallpaper is definitely a viable theory in the death of the former Emperor!



Image: Longwood, Napoleon’s prison home, AMNH

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Science News

Artificial Leaf Solar Cells

Researchers have developed a new type of solar cell that is capable of transforming carbon dioxide into usable hydrocarbon fuel using only sunlight as energy.

Compared with conventional solar cells that convert sunlight into electricity to be stored in batteries, the new solar cells cheaply and efficiently convert carbon dioxide in the atmosphere directly into usable fuel.

The new device works much like trees and plants that capture and convert carbon dioxide into

sugars to store them as energy. Unlike plants that use catalysts to produce sugar, the researchers used nanoflake tungsten diselenide catalyst to convert carbon dioxide into carbon monoxide.

A solar farm of these so-called artificial leaves can also positively impact global warming by removing significant amounts of the green house gas carbon dioxide in the atmosphere.

Source: Adapted from <http://www.techtimes.com/articles/171975/20160731/artificial-leaf-new-solar-cell-uses-carbon-dioxide-and-sunlight-to-produce-hydrocarbon-fuel.htm>

Lutetium Has Potential in a New Generation of Computing Devices

By **James Walsh**, MMTA

Scientists have developed a new material that has the potential to lead to a new generation of computing devices, by packing in more power while at the same time consuming a fraction of the energy compared to today's devices.

The work was undertaken by researchers at the US Department of Energy's Lawrence Berkley National Laboratory and Cornell University, N.Y.

The new material "sandwiches" together individual layers of atoms to produce a thin film with magnetic polarity that can be flipped between positive and negative with small pulses of electricity. The benefit of this property is that it can be turned into 0's and 1's, or binary which underpins computing devices. This could open the door to ultralow-power microprocessors, storage devices, and next generation electronics.

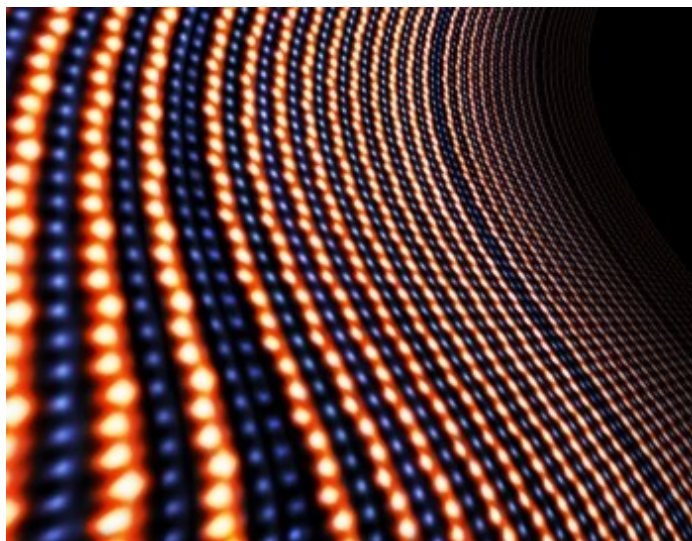
The new material uses lutetium iron oxide (LuFeO_3), a robust ferroelectric but not strongly magnetic, created in thin films consisting of alternating layers of lutetium oxide and iron oxide. To make the material unique, they added one extra monolayer of iron oxide every 10 atomic repeats (layers). This extra addition dramatically changed the material's properties and a strongly ferromagnetic layer was produced near room temperature.

Darrell Schlom, a materials science and engineering professor at Cornell University, describes the process as "spray painting individual atoms of iron, lutetium and oxygen to build up the new atomic structure, exhibiting the stronger magnetic properties."

Electronics are the fastest growing consumer of energy worldwide, currently consuming around 5% of global energy production. This is projected to grow to 40-50% by 2030 at the current pace if there are no major advances in the field that lead lower energy consumption.

Researchers have increasingly sought alternatives to semiconductor-based electronics over the past decade as the increases in speed and density of microprocessors come at the expense of greater demands on electricity and hotter circuits. This is why room-temperature multiferroics are a hotly pursued goal as they require much less power to read and write data than today's semiconductors. Those properties could make possible, devices that require only brief pulses of electricity instead of the constant stream needed for current electronics, using an estimated 100 times less energy.

Although a viable multiferroic device like this is likely to be several years off, this achievement brings the field closer to its goal of creating devices that continue the computing industry's speed



Lutetium facts

Lutetium is a silvery white metal that appears at the far end of the lanthanoid group of the periodic table.

It has the highest atomic weight, density and melting point ($1663^{\circ}\text{C}/3025^{\circ}\text{F}$) of the rare earth elements (REEs).

Its name is derived from the Latin for Paris – Lutetia—and it was discovered in 1907 by Georges Urbain in Paris, France and independently by Charles James in New Hampshire, USA.

It is sourced as a by-product of yttrium, among other REEs in very small quantities, recovered by ion-exchange with great difficulty.

Because lutetium is difficult to produce, it is expensive, and hence there are few commercial uses. However, it is used for niche applications such as dating meteorites, and as a radionuclide in cancer treatment. It is also used as a catalyst for cracking hydrocarbons in oil refineries.

improvements while consuming less power and also proving Moore's Law once again.

A paper on the work was published in the September 22nd issue of Nature

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Update on EU Silicon Duties

By **Ines Van Lierde**, EuroAlliages

EU duties on silicon originating in the People's Republic of China have been renewed this year for an additional 5 years, as detailed in the [Commission Implementing Regulation 2016/1077](#) of 1 July 2016. The regulation imposes also that the extension of the measures to imports consigned from the Republic of Korea and from Taiwan is maintained, to capture EU imports originating in China via these routes.

The duty imposed is 16,8%, compared with 139% in the US and more than 200% in Canada. For this reason, the EU duty is much more

easily absorbable by the exporter.

The first duties on Silicon were imposed in 1990, and the EU has felt the need to renew these ever since because of the continuing low price of imports emanating from China.

Moreover, overcapacity, which touches many sectors, is further deflating the price of many metals, including silicon. For example, China has the capacity to produce more than twice the world's demand for silicon each year, and due to the slowdown in its own economy, looks to export this material, to overcome this overcapacity.

For more information regarding silicon duties, please contact EuroAlliages: <http://www.euroalliages.com/>

Plastination

By **Gina Evangelidis**,
MMTA

The technique founded by Gunther Von Hagens in 1978, allows biological specimens to be prepared for research, teaching and demonstration purposes.

My most recent encounter with plastination took place at New Scientist Live where the Royal Veterinary College were exhibiting some of the specimens used by their students. These piqued my interest as did the silicone standard plastination process.

There are five steps to this process: fixing, dehydration, forced impregnation, positioning and curing.

Fixing, or embalming as we may more commonly know it, prevents the specimen from decaying and is the backbone of all the work that follows. This prepares the specimen to be placed in a bath of either acetone or alcohol at temperatures between -15 °C to 25 °C. At this temperature, the fat and bodily fluids are removed from the specimen, preparing it for impregnation.

Impregnation takes place by placing the specimen in bath of silicone and vaporising the acetone. By now, the specimen can be positioned as desired and cured to harden. This final process ensures that it is able to be used in future without the requirement for special storage or handling procedures—particularly useful for educational establishments and students.

The key benefit of plastination is that it gives a real, tangible understanding of the anatomy, and thus enriches and enhances students' studies. Of course, this is not the only way it is used – macabre artistic sculptures are created through the use of plastination, and whilst somewhat uncomfortable, the use of this process in modern day teaching and medicine far outweighs this.



Silicon or Silicone?

- Silicon is a naturally occurring chemical element, whereas silicone is a synthetic substance.
- Silicon is the 14th element on the periodic table. It's a metalloid, meaning it has properties of both metals and non-metals, and is the second most abundant element in the Earth's crust, after oxygen.
- Silicon readily bonds with oxygen and is rarely found in nature in its pure form. When silicon and oxygen mix with reactive metals, the result is a class of minerals called silicates, which includes granite, feldspar and mica.
- Elemental silicon is a major player in modern electronics because it's an ideal semiconductor of electricity. When heated into a molten state, silicon can be formed into semi-conductive wafers, to serve as the base for integrated circuits.
- Silicone, by contrast, is a synthetic polymer made up of silicon, oxygen and other elements, most typically carbon and hydrogen.
- Silicone is generally a liquid or a flexible, rubberlike plastic, and has a number of useful properties, such as low toxicity and high heat resistance. It also provides good electrical insulation.
- In the medical field, silicone can be found in implants, catheters, contact lenses, bandages and a variety of other things, including personal care items, such as shampoos, shaving cream and sex toys.
- Due to its high heat resistance, silicone makes up a lot of kitchenware, such as oven mitts, tongs and pan handles; silicone's non-stick properties also make it useful for cookware coatings. Additionally, the material's heat resistance and slipperiness make it an ideal lubricant for automotive parts.
- And, like silicon, silicone is important in electronics — it's used to make casings that can shield sensitive devices from electrical shocks and other hazards.

Source: **Joseph Castro**, @livescience

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