



**TANTALUM-NIOBIUM**

**INTERNATIONAL STUDY CENTER**

**Bulletin N° 171: October 2017**

# How to make tantalum

(the supernova is a clue, see page 9)

Photo: NASA, ESA, NRAO/AUI/NSF and G. Dubner (University of Buenos Aires)

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## President's Letter

Dear Fellow Members and Friends,

As we are starting to see the leaves change to riotous colors here in New England, it's a sign that our next General Assembly will be held in Vancouver shortly. It is also encouraging to see that overall markets for tantalum and niobium appear to be moving in a positive direction.

The T.I.C. has several ongoing initiatives, as highlighted in some of the articles of this issue and in our September monthly update recently distributed to our members. Given recent events, may I once again remind our members about our policy of undertaking proper due diligence globally? Earlier this summer, the DRC government attempted to substantially increase the export tax on coltan and certain other materials, for example. This could increase the risk of attempts to illegally move minerals between mining areas, both within the country and across international borders. As iTSCi recommended, for companies in central Africa, please pay close attention to ensure that all tags are properly applied, copies of documentation are available and complete, weight discrepancies are accounted for, and any unusual appearance or assay information (such as lower levels of Nb<sub>2</sub>O<sub>5</sub>, for example) is investigated and justified. You may find it useful to record methods and results of checks, in case of future incidents that may arise, as well as future audits. Similarly, we know that current conditions in Colombia, for instance, are not favorable for exploiting coltan.

The topic of supply chain regulations is a never ending one and we continue to closely monitor this area. As detailed later in this quarterly Bulletin, the T.I.C. has developed and expanded several ongoing and important relationships in this area. Some of these topics will be addressed in more detail in Vancouver. Following up on her presentation in Penang in 2015, Signe Ratso, Director, European Commission DG Trade, will be giving a talk on the EU's conflict minerals regulations, for example.

Similarly, the Conflict-Free Sourcing Initiative (or CFSI) is transitioning to the Responsible Minerals Initiative (or RMI), which expands their scope of work beyond just conflict minerals. RMI will be looking to improve social and environmental impacts of extraction and processing of raw materials. Note this will include not just 3TG, but other materials such as cobalt and mica. In addition, the 2013 CFSP Audit Protocol for Tin and Tantalum is being replaced by the Responsible Minerals Assurance Process, Tin and Tantalum Standard effective 2018. This revised standard will encompass both conflict minerals and certain human rights issues. The article starting on page 22 of this Bulletin discusses some of these aspects, but there will also be a presentation by our reciprocal associate member, CFSI, in Vancouver.

Your Executive Committee (or ExCom) and T.I.C. staff continue to explore ways to improve your organization. In our September monthly update, for example, we included an online survey for our members - the results of which will be discussed in Vancouver. Similarly, as highlighted in the article starting on page 14 of this issue, we are considering bringing back a regular Tantalum and Niobium Intellectual Property Report.

Finally, may I take this opportunity to thank my fellow ExCom members and T.I.C. staff for all their hard work and efforts over the last year? We will have two ExCom members stepping down in Vancouver- David O'Brock and myself. David's contributions to the organization over his years of service are sincerely appreciated. Personally, as I step down from 6 years on the ExCom and finish my third annual term as President, may I express my gratitude to my fellow members? It has been an honor and a privilege to serve you. I look forward to seeing you in Vancouver.

Sincerely yours,

David Henderson

President



Fall in Vancouver



Dear T.I.C. Members,

By the time you read this edition of the Bulletin I'm sure many of you will be either about to travel to Vancouver or may even have arrived. For our 58th General Assembly we have arranged the most presentations of any meeting since the 53rd General Assembly in Cape Town, South Africa. The T.I.C. team is working flat out and Emma Wickens deserves special mention here for her dedication and indefatigability to keep our flagship event on course.

## 58th General Assembly

The General Assembly is also when we hold our annual general meeting (AGM) and this year at the AGM, after three years at the helm, David Henderson will be stepping down as President and also from the Executive Committee.

David was first elected to the Committee in 2011 and became President in 2014 at the 55th General Assembly in New York, USA. I have worked closely with David since joining the T.I.C. last January, and seen first-hand the considerable time, effort and consideration he puts towards helping the Association. David, thank you.

A General Assembly has too many highlights to list, but one event I am particularly looking forward to this year is the panel discussion on downstream perspectives on minerals due diligence procedures. Our panellists are Per Loof, CEO of KEMET Corporation, Dr Elizabeth Orlando, from the U.S. Department of State, Alicia Chen, program manager for conflict minerals at Dell Inc., and Julie Timon from the European Commission's DG Trade, and their conversation promises to be a treat.



At the General Assembly in Vancouver delegates will be able to vote for the "Most Technical" and "Most Entertaining" papers.

(photo: Vancouver Convention & Visitors Bureau)



Visiting the International Atomic Energy Agency (IAEA), in Vienna, Austria, to attend a NORM transport meeting.

(photo: T.I.C.)

Sponsorship of a General Assembly makes a significant contribution to de-risking the event so, special thanks to our generous sponsors KEMET Electronics Corp., Exotech, Inc., A&R Merchants Inc., and Krome Commodities Ltd. Next year we are planning on holding a Central African General Assembly and already invitations to key regional governments have been sent out. Further details will follow in due course.

## Out and about

Although July and August are traditionally months when the metals industry can be relatively quiet, the T.I.C. team has still managed to collect significant air miles in its tireless quest to promote our elements and members' interests.

This included our Technical Officer, David Knudson, visiting Ulba Metallurgical Plant JSC in Ust-Kamenogorsk, Kazakhstan, and a meeting that I attended of the IAEA's Transport Safety Standards Committee (TRANSSC), looking at NORM transport regulations.

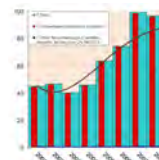
I look forward to meeting many of you in Vancouver.

Best wishes,

Roland Chavasse, Director

## **Statistics workshop at the 58th General Assembly: Tuesday October 17th at 2:30p.m.—4:30p.m.**

During the 58th General Assembly David Knudson, the T.I.C. Technical Officer, will be holding a statistics workshop from 2.30pm to 4.30pm on Tuesday October 17th in the Sechelt meeting room at the Fairmont Waterfront Hotel. The room is located on lobby level close to the plenary area. If you have any questions about the T.I.C. statistics service, how to report your data or what data to report, then please come along.



# The 2017 Critical Raw Materials list for the European Union



In September 2017 the European Union (EU) published its third Critical Raw Materials (CRM) list for the EU<sup>1</sup>. The list of 27 materials includes both niobium and tantalum, unlike the previous list which considered tantalum to be non-critical. The T.I.C. has followed this project closely through its membership of the CRM Alliance ([www.criticalrawmaterials.org](http://www.criticalrawmaterials.org)) and was contacted for information by the British Geological Survey (BGS) and French Geological Survey (BRGM), who respectively coordinated much of the niobium and tantalum research, but the EU's methodology prevents industry stakeholders from proposing a position regarding the inclusion or exclusion of either element<sup>2</sup>.

## The 2017 list

The 27 raw materials listed below are critical for the EU because risks of their supply shortage and impacts on the economy are higher than those of most of the other raw materials. China is the most influential country in terms of global supply of the majority of critical raw materials, although not for niobium, of course.

Antimony	Baryte*	Beryllium	Bismuth*	Borate	Cobalt	Coking coal
Fluorspar	Gallium	Germanium	Hafnium*	Helium*	Heavy rare earths	Indium
Light rare earths	Magnesium	Natural graphite	Natural rubber*	Niobium	Platinum group metals	Phosphate rock
Phosphorus*	Scandium*	Silicon metal	Tantalum*	Tungsten	Vanadium*	

\* = not considered critical on the 2014 list, but added in 2017.

## Development of the CRM list

The EU's initial Raw Materials Initiative was developed in 2008 to tackle the challenges related to what it saw as access to raw materials during a period commonly described as a Chinese-driven commodities 'supercycle', a period of relatively high commodity prices. The first list of 14 critical raw materials was produced by the European Commission in 2011 and included both tantalum and niobium. Although the methodology didn't appear to materially change for the second list, when it was published in 2014 tantalum had been re-categorised as non-critical.

## Purpose of the EU's CRM list

The EU is one of many government bodies around the world that monitor the consumption and supply patterns of raw materials within their territory. For some the purpose is military in nature, but for the EU the primary purpose of the list is economic: to identify the raw materials with a high supply-risk and a high economic importance to which reliable and unhindered access is a concern for European industry and value chains.

The list provides a factual tool for trade, innovation and industrial policy measures to strengthen the competitiveness of European industry in line with the renewed industrial strategy for Europe, for instance by:

- identifying investment needs which can help alleviate Europe's reliance on imports of raw materials;
- guiding support to innovation on raw materials supply under the EU's Horizon 2020 research and innovation programme;
- drawing attention to the importance of critical raw materials for the transition to a low-carbon, resource-efficient and more circular economy.

Although the list is only advisory (and doesn't give exemption to REACH or other EU legislation) the list is expected to encourage the EU member states to incentivise domestic production of critical raw materials through enhancing



recycling activities and when necessary to facilitate the launching of new mining activities. It also allows to better understand how the security of supply of raw materials can be achieved by diversifying sources of supply and through increased substitution away from those materials on the CRM list. It is also used as a supporting element when the EU is negotiating trade agreements, challenging trade-distortive measures, developing research and innovation actions.

### Assessment

The 2017 criticality assessment was carried out for 61 non-energy and non-agricultural raw materials (58 individual materials and 3 material groups: heavy rare earth elements, light rare earth elements, platinum group metals, amounting to 78 materials in total). This is a significant increase in the number of materials assessed compared to 2011 (41 materials) and 2014 (54 materials)<sup>3</sup>.

### Methodology

To support the new CRM list the European Commission published a comprehensive guide to its methodology<sup>4</sup>, a prescriptive document containing the guidelines and the 'ready-to-apply' methodology for the EU criticality assessment. In addition to explaining the main changes to the methodology for the 2017 list, it contains recommendations on how to reorganize and improve the single fact sheets of the assessed raw materials.

Economic importance (EI) and supply risk (SR) remain the two main parameters used to determine the criticality of a raw material, (see figure 1). Economic importance aims at providing insight into the condition of a material for the EU economy in terms of end-use applications and the value added of corresponding EU manufacturing, and is corrected by a substitution index related to technical and cost performance of the substitutes for individual applications. Supply risk reflects the risk of a disruption in the EU supply of the material and is based on the concentration of primary supply from raw material producing countries, considering their governance performance and trade aspects.

Depending on the EU import reliance, consideration is given to the global pattern of production and also from which countries the EU sources its raw materials. Supply risk is measured at the 'bottleneck' stage of the material (extraction or processing) which presents the highest supply risk for the EU. Substitution and recycling are considered risk-reducing measures.

Compared to the methodology used to create the 2011 and 2014 lists, the 2017 methodology gives greater consideration to trade (import reliance and export restrictions) in calculating supply risk, substitution as a factor correcting both economic importance and supply risk, and detailed allocation of raw materials end-uses based on industrial applications to define economic importance.

### Niobium and tantalum

Niobium has always been a critical raw material from the EU's point of view, but tantalum is considered to have considerably more secure supply and thus falls in a grey area where sometimes (2011 and 2017) it is listed as critical and sometimes (2014) it is not.

For niobium the EU's factsheet states that "Primary extraction of niobium ores and concentrates does not take place in Europe, nor does the production of ferroniobium. Therefore the EU is entirely reliant on imports of ferroniobium to meet its current demand. Apparent consumption of ferroniobium in Europe (2010 to 2014) was on average about 12,500 tonnes per annum, the majority of which (ca. 86 %) was used in the manufacture of steel".<sup>5</sup>

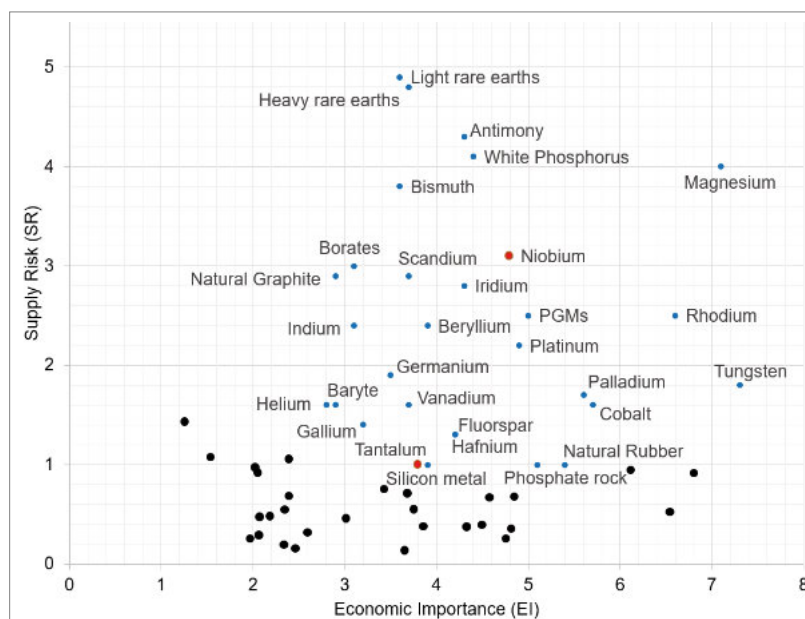


Figure 1: The materials assessed for criticality in 2017 clearly show that those with higher Economic Importance and Supply Risk are those that are considered to be critical. Materials on the new CRM list are blue or red dots<sup>5</sup>, while black dots show non-critical materials. (Data: EU)

The tantalum factsheet, on the other hand, says “With the exception of very small quantities of by-product from kaolin mining in France, there is currently no primary mine production of tantalum in the EU. There are a few processors notably in Estonia (from imported primary ore), Austria, Germany and the UK (mainly from secondary material)”, a far less risky supply situation, from the EU’s perspective (figure 2)<sup>5</sup>.

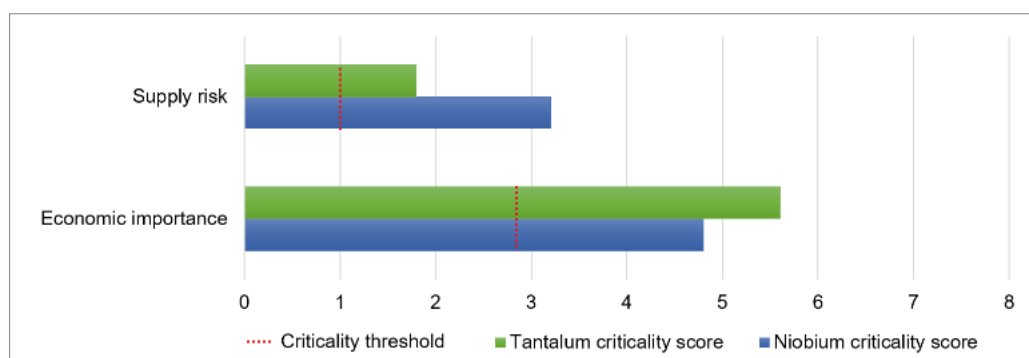


Figure 2: Niobium and tantalum (final scores, after adjustments)

Raw materials, even if not classed as critical, are important for any economy, whether mined domestically or imported from abroad, since they are at the beginning of manufacturing value chains. Their availability may quickly change in line with trade flows or trade policy developments, geopolitical changes or force majeure events. The EU believes that these risks underline a general need of diversification of supply and the increase of recycling rates of all raw materials.

A critical raw materials list can only ever be a subjective and historical judgement call about the interrelationships between raw materials, intermediate products and finished goods, but it can still generate value both for politicians and commodity market watchers. Dispassionate, reasoned assessment of a market by fresh eyes can sometimes offer a new perspective or demystify an opaque corner of the market, offering food for thought to those of us who observe or who are involved in the globalized commodities markets. **TIC**

#### Notes

- 1 The 2017 CRM list is published at <https://ec.europa.eu/transparency/regdoc/rep/1/2017/EN/COM-2017-490-F1-EN-MAIN-PART-1.PDF>
- 2 The methodology uses the following data priority for the calculations: official EU data; Member State authorities’ public data; public data from international organisations and non-EU authorities (e.g. USGS); and only “exceptionally, as a last option, and if duly justified” will they consider trade/industry associations’ public data and expert judgement.
- 3 Note that the full set of rare earth elements was considered as one “material” in the 2011 CRM list.
- 4 <http://publications.europa.eu/en/publication-detail/-/publication/2d43b7e2-66ac-11e7-b2f2-01aa75ed71a1/language-en/format-PDF/source-32064602>. Additional methodology information can be found at <https://publications.europa.eu/en/publication-detail/-/publication/860168b9-78c1-11e7-b2f2-01aa75ed71a1/language-en/format-PDF/source-35948374>.
- 5 Detailed factsheets for many of the elements, including tantalum and niobium are available at <https://publications.europa.eu/en/publication-detail/-/publication/7345e3e8-98fc-11e7-b92d-01aa75ed71a1/language-en>.

## The European Partnership for Responsible Minerals (EPRM)



A new multi-stakeholder partnership has been established to support the implementation of the OECD Due Diligence Guidance in Europe and promote responsible mining practices in Conflict and High Risk Areas (CAHRAs). Called the European Partnership for Responsible Minerals (EPRM) it is managed by the Netherlands Enterprise Agency (NEA). Membership is not confined to EU members and institutions and it is the T.I.C.’s intention to join this partnership, as we joined the Public-Private Alliance for Responsible Minerals Trade (PPA), a U.S.-based multi-stakeholder group which was established following the enactment of section 1502 of the Dodd-Frank Act.

Responsible mineral supply chains require cooperation throughout the chain, from sourcing to the assembly of end products. The OECD Due Diligence Guidance is often a point of departure, but further multi-stakeholder dialogue and cooperation are required to successfully implement it. The EPRM aims to fulfil an important role in facilitating information-sharing and learning, both along the supply chain and across different sectors that make use of 3TG. Large downstream companies rely on the entire chain to meet their responsibility and can play an important role in educating and supporting SME suppliers.

For further information about EPRM please visit <https://europeanpartnership-responsibleminerals.eu/>.



## iTSCi in focus: the Governance Committee



*The iTSCi Programme aims to work within the OECD's framework and to comply with the UN guidelines to create a system that assists companies with traceability, due diligence and audit requirements that arise from purchasing 3T minerals, particularly from the DRC, Burundi, Uganda and Rwanda. The T.I.C. and ITRI sit on the iTSCi Governance Committee; there is also a third (vacant) seat for a tungsten representative.*

One of the roles of the T.I.C.'s Director is to act as the Association's primary representative on the Governance Committee of the iTSCi Programme. This is a role that keeps the T.I.C. intimately involved with supply chain issues and provides a fascinating insight into the complexity and challenges behind running the largest tantalum-tin-tungsten (3T) minerals traceability programme in central Africa. It can, however, be a challenge too, not least because for some 20 hours per month the Executive Committee cannot know what the Director is working on beyond "iTSCi" for reasons of confidentiality and avoiding conflict of interest.

However, this work is not without benefit for the T.I.C.: iTSCi can open doors for the T.I.C., its field agents are exceptionally well informed about regional affairs, and time spent on the Governance Committee receives fair remuneration (for more information see the iTSCi financial breakdown in Bulletin N°170).

### The role of the Governance Committee

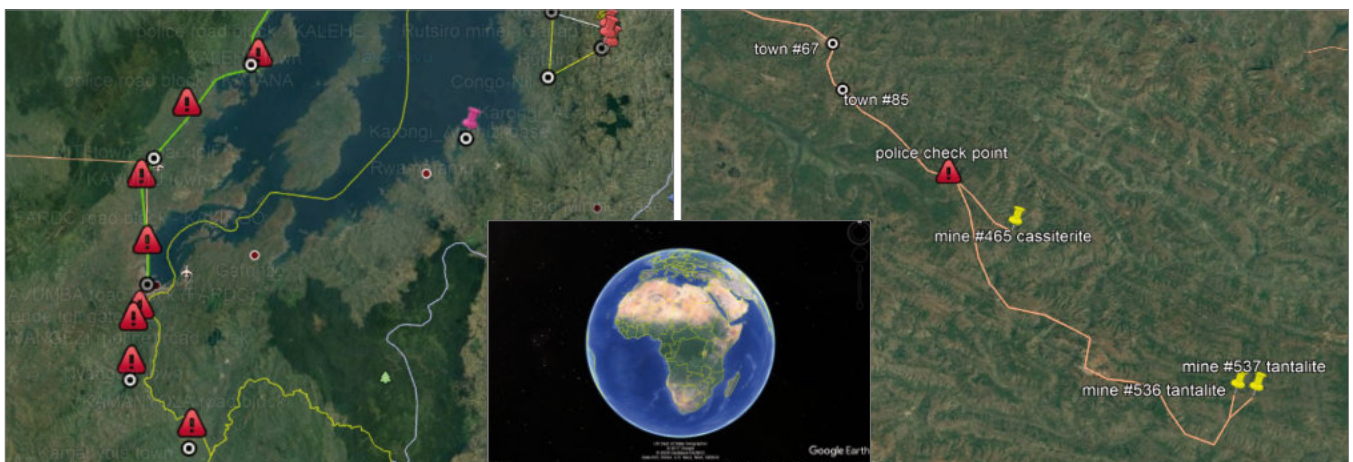
The primary function is as the decision-making body of the Programme and as such it works closely with relevant governments, civil society, the Advisory Panel, field contractors and the iTSCi Secretariat. Among the many tasks three tasks stand out for their importance to the programme or frequency: investigating level 1 incidents (the most serious category, see Bulletin N° 169), financial monitoring and planning (see Bulletin N°170), and overseeing the acceptance of new mines to the programme.

New mines continue to be added to iTSCi steadily, albeit at a slower rate than in the Programme's early years. Once the Governance Committee receives the mine baseline report prepared by a field agent it is time to start checking; researching companies and people involved, comparing the mine's workforce and output to others nearby, following up any relevant incidents, and plotting the coordinates for the mine and its route to market. For the latter Google Earth is a truly invaluable tool, allowing fast visualisation and scalable mapping that gives a rough and ready context to the situation.

Any irregularities are discussed and, if need be, investigated by field agents. Satisfactory mines are approved to join the Programme and receive tags and log books. Soon minerals from that mine can start moving to market in the full confidence that they are fully traceable, auditable and legitimate.



The iTSCi Governance Committee, Roland Chavasse (T.I.C., left) and Kay Nimmo (ITRI, right) meeting with ICGLR Executive Secretary, Ambassador Ambeyi Ligabo.



Left to right: Google Earth maps showing police check points in South Kivu province, DRC; Africa; a typical supply chain drawn from a mine base line report showing three mines, a police check point and two towns along the road to the market.

## 2017 Charles Hatchett Award winners

*The Charles Hatchett Award is an annual award that recognised the best published scientific or technical paper relating to the metallurgy of niobium. It is sponsored by CBMM. In Bulletin N°170 the Award was introduced and here we report on the 2017 award winners whose pioneering research examined the unique role niobium plays in improving the properties of commercial steels.*

The 2017 Charles Hatchett Award has been awarded to a research team led by the Nippon Steel and Sumitomo Corporation of Japan. The winning paper explains how detailed atom probe tomography studies have been used to clarify the mechanism through which niobium improves the high temperature properties of a ferritic stainless steel, widely used for automotive exhaust manifolds. This innovative research has a much broader application to our understanding of the role played by niobium across the full range of commercial steels where niobium is added to enhance their properties.

This Institute of Materials, Minerals and Mining (IOM3) annual Award, now in its 39th year, is sponsored by Companhia Brasileira de Metalurgia e Mineração (CBMM) and makes an important contribution to the company's activities which recognise excellence in research on niobium and its applications. The award winners were presented with their medals at the IOM3 dinner held in London, UK, on July 11th this year.

It has been widely speculated that niobium atoms, in solution, segregate to grain boundaries and dislocations, initially within the gamma matrix, and that such interactions contribute to the retardation of recovery of dislocation sub-structures which then has a subsequent, important impact on the final properties of the transformed steel. This is a mechanism unique to the element niobium.

This work, using the atom probe tomography technique has, for the first time, clearly established that niobium does indeed segregate powerfully to dislocations and the authors have described the phenomenon as the 'Niobium-Cottrell' atmosphere. They have sought to explain its manifestation by suggesting that the size of the niobium atom plays an important role in the segregation of the element to available substitutional sites in the distorted matrix in the vicinity of dislocations. This important observation contributes significantly to our current knowledge of the role which niobium plays in the retardation of recrystallization and thus to its ability to dramatically influence the development of enhanced mechanical properties. This mechanism is of particular importance in the processing of ferritic stainless steel that operates at high temperatures where enhanced thermal fatigue properties are required.

Prior to the medal ceremony, the lead author, Dr Jun Takahashi, presented the winning project to a select group of industry experts and CBMM representatives. This included the company's Chief Technology Officer, Marcos Stuart, who said, "This enhanced learning helps us to understand why niobium is such a unique element and our constantly improving knowledge of its fundamental role in improving high performance steel properties opens up new uses and applications for niobium bearing steels across a range of industries. The atom probe tomography provided visualization of what could previously only be conceptualized".

The award is made annually to the best research paper on the science and technology of niobium and its alloys. Further information about the Charles Hatchett Award, including information about past winners and how to submit your research for consideration, can be found at <http://www.charles-hatchett.com/> or by visiting CBMM's website <http://www.cbmm.com.br/>.



2017 Charles Hatchett Award winners receiving their medals from the Institute of Materials, Minerals and Mining (IOM3). Pictured from left: IOM3 President Martin Cox, Ken Kimura, Kazuto Kawakami and Jun Takahashi (Picture: CBMM)



# How to make tantalum

The original paper for this article was written and presented by James Fife, KEMET Blue Powder Corporation (then Niotan Inc.), in October 2010 as part of the Fifty-first General Assembly in Lake Tahoe, USA. It has not been published previously.

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Many readers of the Bulletin will be familiar with the many physical and chemical processes used to purify and transform the physical properties of tantalum; however, perhaps some may not know how tantalum is made in the first place. The purpose of this paper is to present the story of how tantalum is made.

The subject of this story is tantalum, atomic number 73 in the periodic table of elements. This means that the basic feat of making tantalum is to assemble 73 protons (along with 108 neutrons) into a space the size of an atomic nucleus (radius of about  $145 \times 10^{-17}$  m).

The problem with this task is the positive electric charge on each proton causing a mutual repulsion between all these 73 protons. Consequently, you must do work to bring all 73 protons into this small region against the repulsive force. It must be noted that once the protons are brought into the nucleus they become bound together by the strong nuclear force so no further work is required to maintain the nucleus.



## Energy required

The amount of work required to assemble a single tantalum nucleus can be calculated using the coulomb term from the binding energy equation for the liquid drop model of the nucleus. This states that the work required to overcome the electrostatic repulsion between the protons in a nucleus is given by:

How much work does it take to assemble 73 protons into a Sphere 10,000 times smaller than an atom?

The coulomb term from the binding energy equation  
Giving the answer in millions of electron-volts

$$E_c = \frac{.691 \cdot Z(Z-1)}{A^{\frac{1}{3}}}$$

Evaluated for tantalum (Z=73 and A=181)

$$E_c = 642 \text{ MeV}$$

One mole (181 grams) of tantalum requires

$$Ec = 3.8 \times 10^{26} \text{ MeV}$$

$$E_c = \frac{.691 \cdot Z(Z-1)}{A^{\frac{1}{3}}}$$

where Z is the number of protons in the nucleus and A is the total number of nucleons (neutrons plus protons).

The answer for tantalum is 642 MeV (million electron volts). One mole of tantalum (181 grams) would therefore require about  $3.8 \times 10^{26}$  MeV of work to assemble against the mutual coulombic repulsion of all the ingredients.

Figure 1.

## How much work is this?

Converting to perhaps more familiar terms this much energy would require the detonation of about 15,000 tons of TNT (15 kilotons, see figure 2). And that is how much energy would be required if the process was 100% efficient. Any natural process couldn't be expected to be highly efficient so we should expect the actual energy budget to make one mole of tantalum is practically much more than this.

The staggering amount of energy required to make a handful of tantalum atoms raises the question: what process could have created the circumstance required to assemble a tantalum nucleus?

One possible answer you may consider is the nuclear synthesis that occurs in stars like our sun must be what it takes. Let us examine this hypothesis.



Figure 2. To create one mole (181g) of tantalum requires  $3.8 \times 10^{26}$  MeV of energy. This is equivalent to the energy released by the detonation of 15 kilotons of TNT, approximate to a small atomic bomb.

### Nuclear synthesis in stars<sup>1</sup>

Consider a star like our sun. It would initially be composed mostly of hydrogen. During the formation of the star through the gravitational collapse of a primordial cloud of interstellar gas the temperature rises because of the compression. With compression, the temperature in the core of the gas ball becomes high enough to support the process of nuclear fusion whereby protons bond together (as we described above) and form heavier helium nuclei.

Since the mass of a helium atom is slightly less than the combined masses of the four hydrogen atoms from which it is created, this fusion process, infamous as the hydrogen bomb, releases energy equivalent of the excess mass, which acts to further heat the core and drive the fusion process. The heat given off by the fusion creates pressure, which counteracts the gravitational attraction that would otherwise make the star collapse. The process continues in the core of the star until the hydrogen there is used up.

The core then contracts, since gravitation is no longer opposed by energy production, and both the core and the surrounding material are heated. Hydrogen fusion then begins in surrounding layers. Meanwhile the core becomes hot enough to ignite other fusion reactions, burning helium to form carbon, then burning carbon to form oxygen, magnesium, neon, and finally sulphur and silicon. Again, each of these reactions leads to the release of energy and so far, we seem to be on the right track; with each generation of fusion and gravitational contraction we make ever heavier elements.

The next cycle of fusion combines silicon nuclei to form iron, specifically the common iron isotope  $^{56}\text{Fe}$ , made up of 26 protons and 30 neutrons. The  $^{56}\text{Fe}$  nucleus is the most strongly bound of all nuclei, and further fusion would absorb energy rather than releasing it.

Because ignition of successively heavier fuels took place in the very center of the star while previous fuels continued to burn in the less dense, overlying regions, the interior of the star came to resemble a cosmic onion, with elements layered in order of increasing atomic weight towards the center.

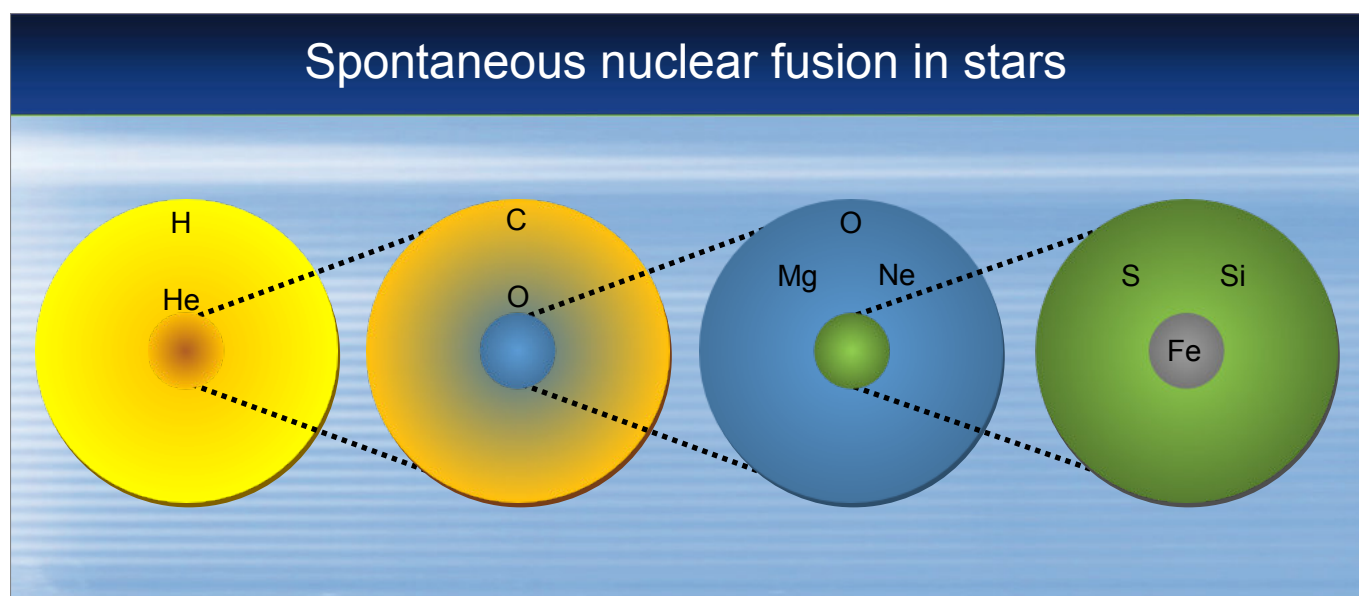


Figure 3. The onion-like structure of a massive star towards the end of its life.

However, as far as finding out how to make tantalum we should look elsewhere; the production of iron marks the end of the line for spontaneous nuclear fusion.

We could feel cheated. After all, we have burned an entire star for perhaps 10 billion years only to end up with some iron. We never got close to making tantalum. Our hypothesis that stellar nuclear fusion was the answer can't work; it's not strong enough. Where can we find the additional energy to get us to 15,000 tons of TNT per mole?

### Type II or core-collapse supernovae<sup>2,3</sup>

Consider a star about 8 times the size of our sun. Because of the larger mass the burning of hydrogen proceeds much faster than in our sun; and the entire hydrogen cycle is complete in about 10 million years. With the loss of energy production in the core, the core collapses and the compression raises the density of the core from 6 g/cc to 1100 g/cc and the temperature is raised from 40 million degrees Kelvin to 190 million degrees igniting other fusion reactions, burning helium to form carbon.

The supply of helium is exhausted in less than a million years and the cycle begins again with the burning of carbon to form neon, magnesium and sodium at 740 million degrees and 240,000 g/cc; next neon is burned at 1.6 billion degrees and 7.4 million g/cc; followed by oxygen at 2.1 billion degrees and 16 million g/cc; and finally, silicon and sulphur burn at 3.4 billion degrees and 50 million g/cc.

The pace of the reactions in the core accelerated with the burning of heavier elements. Whereas the burning of helium lasted nearly a million years, carbon took 12,000 years, neon 12 years, oxygen 4 years and silicon just one week. Imagine that the star has gone through the stages of spontaneous fusion described above and we are at the moment when the fusion of silicon nuclei to form iron first becomes possible at the center of the star.

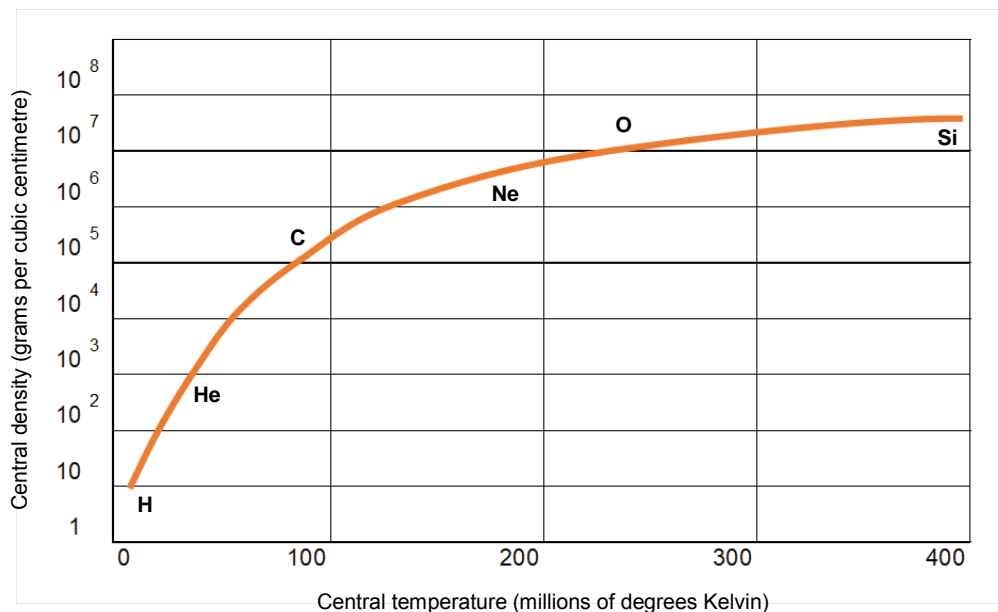
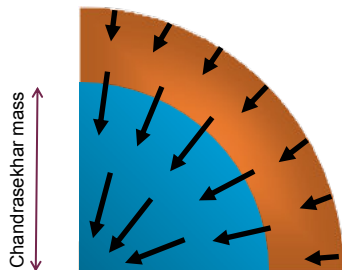


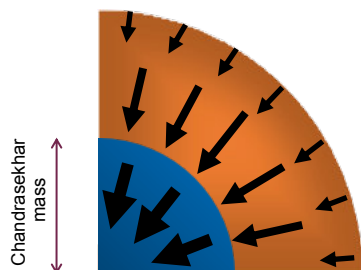
Figure 4. Evolution of a massive star (25 solar masses). The star steadily progresses towards higher temperature and core density. (Bethe and Brown 1985)

When the final fusion reaction begins, a core made up of iron, nickel, chromium, titanium, vanadium, cobalt and manganese begins to form at the center of the star, within a shell of silicon. Fusion continues at the boundary between the iron core and the silicon shell, steadily adding mass to the core. Within the core, however, there is no longer any production of energy by nuclear reactions; the core is an inert sphere under great pressure. It can resist contraction only by electron pressure, which has limits.

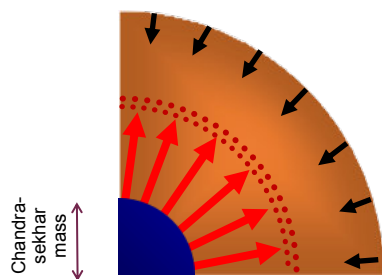




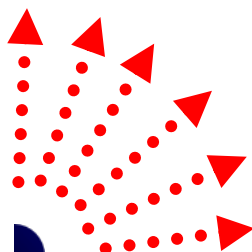
Once the fusion of silicon nuclei begins, it proceeds at an extremely high rate, and the mass of the core reaches what is called the Chandrasekhar limit in about one day. At this mass the repulsion force of electrons is overcome by the attraction force of gravity and the core must collapse.



Once the Chandrasekhar mass has been reached, the pace speeds up still more. In a few tenths of a second the iron core, 1.4 times the mass of the sun and half the size of the earth, collapses into a ball of nuclear matter about 100 kilometres in radius. At this density (400 billion grams per cubic centimetre (g/cc)) matter is so dense that it becomes opaque to neutrinos, which are therefore trapped in the core of the star, heating it still further.



When the centre of the incipient neutron star exceeds the density of an atomic nucleus - 270 trillion g/cc - the inner 40% of the core rebounds as a unit. The outer core, still plunging inward at close to a quarter of the speed of light smashes into the rebounding inner core and rebounds in turn. A shock wave was born (red dots, left). In about a hundredth of a second, it races out through the in-falling matter to the edge of the core. By the time the shock reached the edge of the iron core, the material behind it had no net outward velocity. The shock stalled and becomes an accretion shock, one through which material continuously flows inward.



The core of nuclear matter with a radius of 100 kilometres cools through vast neutrino emission while the inner core collapses further from 100 kilometres to 10-kilometre radius becoming a true neutron star. The power of the neutrino emission exceeds that of the rest of the visible universe.

During the supernova's first 10 seconds, as the star's core implodes to form a neutron star, it radiates as much energy from a central region 20 miles across as all the other stars and galaxies in the rest of the visible universe combined. To put it another way, the energy of that 10-second burst is 100 times more than the sun will radiate in its entire 10-billion-year lifetime.

The total energy burst is 200 to 300 times the energy of the supernova's material explosion and 30,000 times the energy of its total light output. Only a few percent of the neutrinos, interacting with the material just behind the stalled shock for about a second, deposit enough energy to accelerate the shock outward.

By heating and expanding the star and triggering a new flurry of nuclear reactions in its layered interior, the revived shock is responsible for finally achieving the conditions required to make tantalum along with all elements heavier than iron.

The shock takes another two hours, traveling outward at about one fiftieth of the speed of light before any of the light generated finally leaks out of the exploding star. The material of the star is subsequently propelled into space with the nearly complete disruption of the star, leaving behind only the 10-kilometre diameter neutron star.

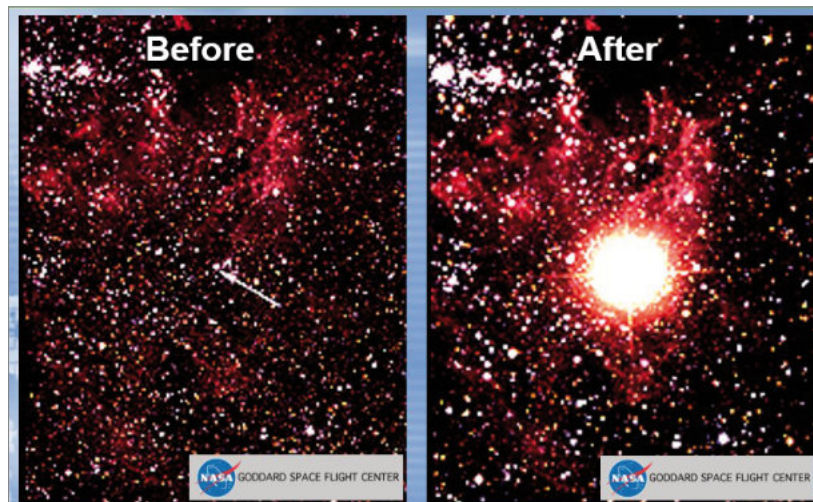


Figure 5. These photographs are of the same part of the sky. The photo on the left was taken on February 22nd 1987 and the photo on the right was taken a few days later as the supernova SN 1987A exploded. (Photo NASA)

The bounty of elements formed in the explosion become dispersed and eventually swept up in the formation of subsequent solar systems such as ours. So, in the end the making of tantalum must be purchased with the sacrifice of an entire star and its associated system of planets. Long after its making, when we find, refine and use tantalum, we then understand that we are truly holding pure star dust.

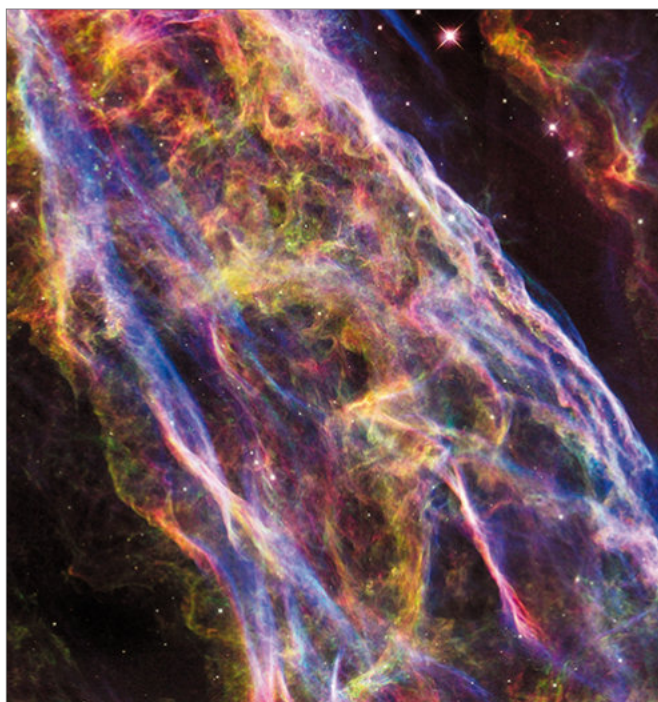


Figure 6. The Veil Nebula is the remains of a supernova 2,100 light years away that exploded some 8,000 years ago. (Photo: NASA)

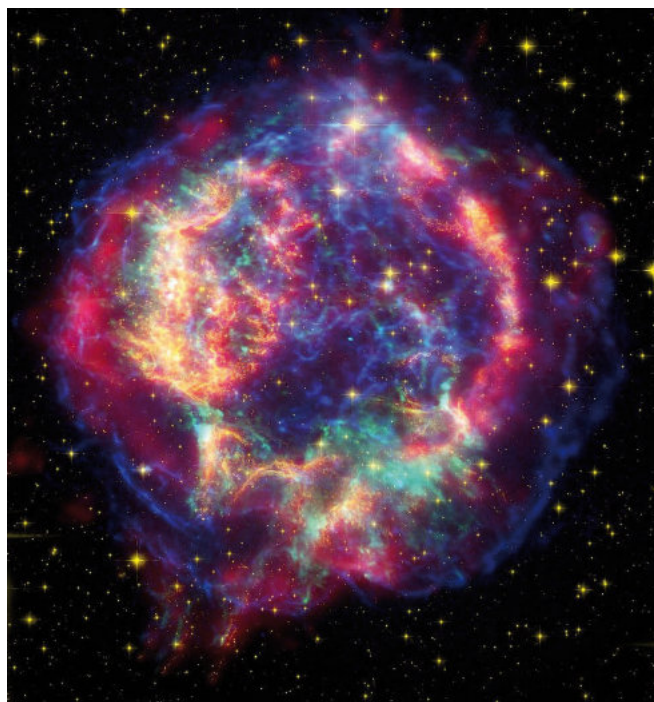


Figure 7. Supernova remnant Cassiopeia A, 10,000 light years away, which exploded 350 years ago. (Photo: NASA)

#### Notes

1 - *How a Supernova Explodes* by Hans Bethe and Gerald Brown, Scientific American, May 1985 <http://www.cenbg.in2p3.fr/heberge/EcoleJoliotCurie/coursannee/transparents/SN%20-%20Bethe%20e%20Brown.pdf>.

2 - *The Great Supernova of 1987* by Stan Woosley and Tom Weaver, Scientific American, August 1989 <http://www.cenbg.in2p3.fr/heberge/EcoleJoliotCurie/coursannee/transparents/SN%201987A.pdf> and *How a Supernova Explodes* by Hans Bethe and Gerald Brown, Scientific American, May 1985 <http://www.cenbg.in2p3.fr/heberge/EcoleJoliotCurie/coursannee/transparents/SN%20-%20Bethe%20e%20Brown.pdf>.

3 - A supernova happens where there is a change in the core, or center, of a star. A change can occur in two different ways, with both resulting in a supernova. A type Ia supernova happens in binary star systems. Binary stars are two stars that orbit the same point. One of the stars, a carbon-oxygen white dwarf, steals matter from its companion star. Eventually, the white dwarf accumulates too much matter. Having too much matter causes the star to explode, resulting in a supernova. A type II supernova occurs at the end of a single star's lifetime. As the star runs out of nuclear fuel, some of its mass flows into its core. Eventually, the core is so heavy that it cannot withstand its own gravitational force. The core collapses, which results in the giant explosion of a supernova. Our sun is a single star, but it does not have enough mass to become a supernova. <https://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-a-supernova.html>

# Tantalum and niobium intellectual property report

In the years 2000 through to 2007 the T.I.C. published monthly reports of patents and papers that were relevant to the tantalum and niobium industries. The reports were written by Mr Peter Evison and when he retired in 2007 the service stopped. Following feedback on this subject from T.I.C. members, the Executive Committee is considering restarting this service. Over the last decade there have been considerable advances to internet-hosted patent databases and this article is an example of what bibliographic data is available from the European Patent Office (EPO, <https://www.epo.org/>) and how such a report may look.

## Note about collection and classification

These patents and papers were chosen because they contain “tantalum” and/or “niobium” in either the title or the abstract. Some may be more relevant than others due to the practice by those filing patents of listing other materials which were not tested to demonstrate the patent but are examples of potential substitutes. In the electronic version of this newsletter the publication numbers are hyperlinks to the patent record held by the EPO.

When a European patent application is published together with the search report, it is known as an A1 document. When this application is published without the search report, it is an A2 document. The search report is then published later as an A3 document. When the patent is granted, it is published as a B document.

Title	Publication number	Applicant(s)	Publication date
<b>TANTALUM</b>			
Single stage reprocessing of spent nuclear fuel	<a href="#">GB2545934 (A)</a>	IAN RICHARD SCOTT [GB]	2017-07-05
Tantalum compounds preparing method thereof precursor composition for film deposition	<a href="#">KR20170077833 (A)</a>	YUPI CHEMICAL CO LTD	2017-07-06
Composite electronic component and board having the same	<a href="#">US2017196092 (A1)</a>	SAMSUNG ELECTRO-MECHANICS CO LTD [KR]	2017-07-06
Ultra-thin doped noble metal films for optoelectronics and photonics applications	<a href="#">US2017200526 (A1)</a>	UNIV MICHIGAN REGENTS [US]	2017-07-13
High-temperature surface ionization source	<a href="#">RU2625728 (C1)</a>	RUSSIAN FEDERATION ON THE NAME OF WHICH THE STATE CORPORATION FOR ATOMIC ENERGY [RU]	2017-07-18
Compressor vane or blade for engine	<a href="#">US2017204871 (A1)</a>	IHI CORP [JP], HITACHI METALS LTD [JP]	2017-07-20
Low profile flat wet electrolytic tantalum capacitor	<a href="#">US2017207031 (A1)</a>	VISHAY SPRAGUE INC [US]	2017-07-20
Method of fabricating tantalum nitride barrier layer and semiconductor device thereof	<a href="#">US2017207316 (A1)</a>	TAIWAN SEMICONDUCTOR MFG CO LTD [TW]	2017-07-20
Dental implant	<a href="#">EP3195825 (A1)</a>	UNIV DO MINHO [PT]	2017-07-26
Metallized plastic article and method for selectively metallizing a surface	<a href="#">US2017211186 (A1)</a>	BYD CO LTD [CN]	2017-07-27
Optical element and method for producing the same	<a href="#">US2017212278 (A1)</a>	CANON KK [JP]	2017-07-27
Semiconductor device fabrication using etch stop layer	<a href="#">US2017213732 (A1)</a>	ASM IP HOLDING BV [NL]	2017-07-27
Elastic device	<a href="#">US2017210616 (A1)</a>	HEWLETT-PACKARD DEV COMPANY L P [US]	2017-07-27
Exhaust gas-purifying catalyst	<a href="#">US2017209854 (A1)</a>	CATALER CORP [JP]	2017-07-27
Method for producing an interconnection comprising a via extending through a substrate	<a href="#">WO2017125336 (A1)</a>	KOBUS SAS [FR]	2017-07-27
Tantalum sputtering target, and production method therefor	<a href="#">SG11201704463V (A)</a>	JX NIPPON MINING & METALS CORP [JP]	2017-07-28
Titanium-zirconium-tantalum-silver bio-alloy for orthopaedic implants	<a href="#">RO132031 (A2)</a>	INSULATING PHYSICAL CHEMISTRY ILIE MURGULESCU [RO], R & D CONSULTANCY AND SERVICES SRL [RO]	2017-07-28
Capacitor having multiple anodes housed in a stacked casing	<a href="#">US9721730 (B1)</a>	GREATBATCH LTD [US]	2017-08-01
Low cobalt hard facing alloy	<a href="#">GB2546808 (A)</a>	ROLLS ROYCE PLC [GB]	2017-08-02



Title	Publication number	Applicant(s)	Publication date
Wear resistant coating	<a href="#">US2017218492 (A1)</a>	HEWLETT- PACKARD DEV COMPANY L P [US]	2017-08-03
Infrared-reflecting film	<a href="#">US2017219750 (A1)</a>	NITTO DENKO CORP [JP]	2017-08-03
Electrode, preparation method therefor, and uses thereof	<a href="#">EP3202956 (A1)</a>	CHINA NAT FOODPURIFICATION TECH (BEIJING) CO LTD [CN]	2017-08-09
Tantalum powder and process for preparing the same, and sintered anode prepared from the tantalum powder	<a href="#">US2017226616 (A1)</a>	NINGXIA ORIENT TANTALUM IND CO LTD [CN]	2017-08-10
Electrical antifuse having airgap or solid core	<a href="#">US9735103 (B1)</a>	IBM [US]	2017-08-15
Method and apparatus for avoiding erosion in a high pressure die casting shot sleeve for use with low iron aluminum silicon alloys	<a href="#">US9731348 (B1)</a>	BRUNSWICK CORP [US]	2017-08-15
A composite material with enhanced mechanical properties and a method to fabricate the same	<a href="#">WO2017138888 (A1)</a>	UNIV NANYANG TECH [SG], SINGAPORE HEALTH SERV PTE LTD [SG]	2017-08-17
Non-noble metal based electro-catalyst compositions for proton exchange membrane based water electrolysis and methods of making	<a href="#">US2017233879 (A1)</a>	UNIV OF PITTSBURGH - OF THE COMMONWEALTH SYSTEM OF HIGHER EDUCATION [US]	2017-08-17
Semiconductor element cleaning solution that suppresses damage to tantalum-containing materials, and cleaning method using same	<a href="#">US2017233687 (A1)</a>	mitsubishi gas chemical co [JP]	2017-08-17
Composite tantalum powder and process for preparing the same and capacitor anode prepared from the tantalum	<a href="#">US2017232509 (A1)</a>	NINGXIA ORIENT TANTALUM IND CO LTD [CN], NAT ENG RES CENTER FOR SPECIAL METAL MAT OF TANTALUM AND NIOBIUM [CN]	2017-08-17

## NIOBIUM

Method of manufacturing pure niobium plate end-group components for superconducting high frequency accelerator cavity	<a href="#">US2017113259 (A1)</a>	SHINOHARA PRESS SERVICE CO LTD [JP]	2017-04-27
Treatment of a mixed metal oxide catalyst containing molybdenum, vanadium, niobium and tellurium	<a href="#">US2017136447 (A1)</a>	SHELL OIL CO [US]	2017-05-18
Process for manufacturing a titanium niobium zirconium (tnz) beta-alloy	<a href="#">WO2017137671 (A1)</a>	DJEMAI ABDELMADJID [FR]	2017-05-26
Niobium-based ceramic materials with reduced terahertz absorption	<a href="#">RO131868 (A2)</a>	NATIONAL RESEARCH AND DEVELOPMENT FACILITY FOR MATERIAL (INCDFM) [RO]	2017-05-30
Methods of forming thin film and integrated circuit device using niobium compound	<a href="#">KR20170063092 (A)</a>	SAMSUNG ELECTRONICS CO LTD [KR]; AIR LIQUIDE [FR]	2017-06-08
Niobium oxide sintered compact sputtering target comprising sintered compact and method for manufacturing niobium oxide sintered compact	<a href="#">KR20170066475 (A)</a>	JX NIPPON MINING & METALS CORP [JP]	2017-06-14
Manufacturing method of tantalum coating layers sputtering target material and niobium coating layers	<a href="#">KR20170073390 (A)</a>	ANDONG NAT UNIV INDUSTRY-ACADEMIC COOP FOUND [KR]	2017-06-28
Niobium-based alloy	<a href="#">RU2625203 (C1)</a>	SHCHEPOCHKINA YULIYA ALEKSEEVNA [RU]	2017-07-12
High-wear-resistance automobile shaft component powder metallurgy material	<a href="#">KR20170087867 (A)</a>	CBMM SA [BR]	2017-07-31
Pin shaft surface niobium permeating strengthening technology	<a href="#">CN106282910 (A)</a>	HANGZHOU SFR TECH CO LTD [CN]	2017-08-17

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# Development of polymer tantalum capacitors with high reliability and high rated voltage

*Paper written and presented by Kazuhiro Koike, TOKIN Corporation (then NEC TOKIN Corporation\*), on October 18th 2016, as part of the Fifty-seventh General Assembly in Toulouse, France.*

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## Abstract

With the advancements of technology in the fields of IT infrastructure and automotive electronics, the opportunities for high reliability and high rated voltage capacitors have been expanding. Tantalum capacitors have gained favour from these market opportunities due to their high capacitance per unit volume and stable electrical characteristics.

In recent years, ceramic capacitors and aluminium capacitors with high reliability and high rated voltage have been released, also in response to expanding market needs. However, these capacitors have certain negative aspects in their electrical characteristics which can limit their applicability.

Ceramic capacitors have acoustic noise issues when under AC bias. In addition, their capacitance can be reduced depending on applied voltage and ambient temperature conditions. Aluminium capacitors have limitations in their ability to be miniaturized.

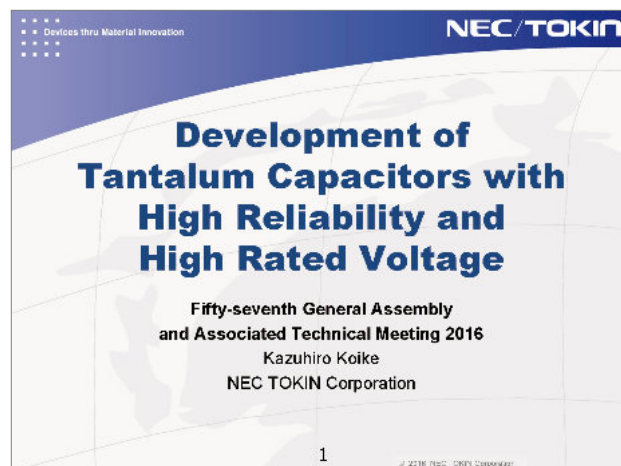
We will report on our activity and results towards the development of tantalum capacitors with high reliability and high rated voltage. We have been developing unique technologies and application techniques of tantalum powder for developing high voltage tantalum capacitors.

Key to the development of these high voltage and high reliability tantalum capacitors are the tantalum capacitor powders used in the manufacture of the capacitors. In our report, we will show our development roadmap for tantalum capacitors with high reliability and high rated voltage, and make an explanation of the future prospects for these products. We will refer to some of our applied technologies and present our specific requirements to the tantalum capacitor powder manufacturers.

## 1. NEC TOKIN NeoCapacitor

NEC TOKIN has two Research and Development centres in Japan, one in Sendai, Miyagi Prefecture, in the northeast of Japan and the other in Toyama, Toyama Prefecture, in the northwest of Japan. Tantalum capacitor production is in Thailand. [Figure 1-1]

NEC TOKIN started manufacturing tantalum capacitors in 1955 [Figure 1-2]. We started to produce dip type tantalum capacitors from 1970 and chip type from 1981. In 1994, NEC TOKIN released conductive polymer capacitors, trademarked as “NeoCapacitor”. This conductive polymer technology was expanded to the aluminium capacitor trademarked as Proadlizer and to the tantalum substrate package series (G/PS).



\* Since this paper was given at the Fifty-seventh General Assembly NEC TOKIN Corporation has changed its name to TOKIN Corporation following its full acquisition by KEMET Electronics Corporation. The slides and text here are as they were presented at the Fifty-seventh General Assembly.



Figure 1-1

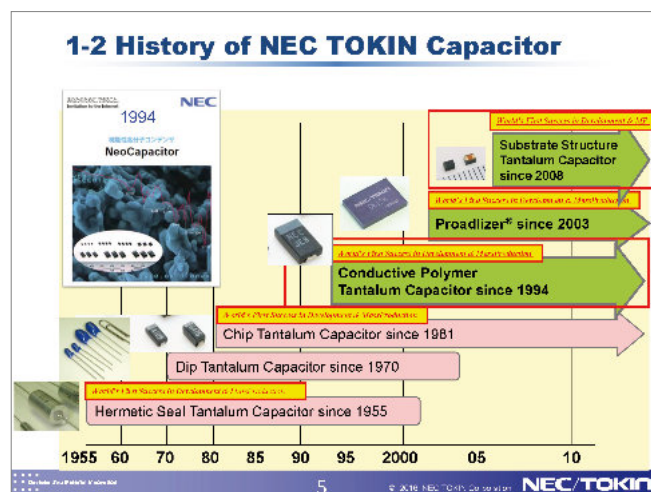


Figure 1-2

The conductive polymer is formed on tantalum pentoxide. The conductivity of the conductive polymer is about 100 times greater than that of manganese dioxide; therefore, the ESR of the tantalum capacitor is significantly decreased [Figure 1-3]. Today NeoCapacitor technology can be found in notebook-PCs, tablets and other mobile devices.

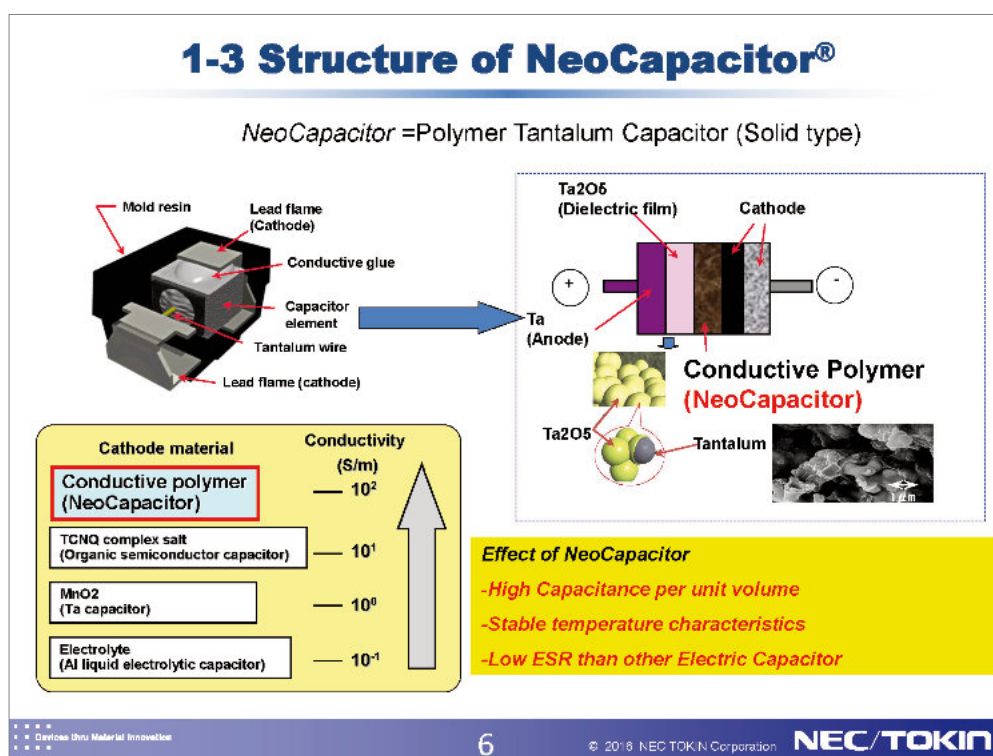


Figure 1-3

## 2. Market Trend

Figure 2-1 shows the latest consumer market trends. These days there is considerable increasing demand for high reliability capacitors and other devices in the IT infrastructure and automotive markets. The IT infrastructure market has witnessed a shift from current wireless networks to HetNet, and the automotive market is seeing expansion from car navigation to a variety of other applications such as ADAS, eCall, telematics and back-up monitoring cameras. To respond to these broadening markets, NEC TOKIN developed a product roadmap of high reliability and high rated voltage capacitors and has continued to drive these efforts. [Figure 2-2]



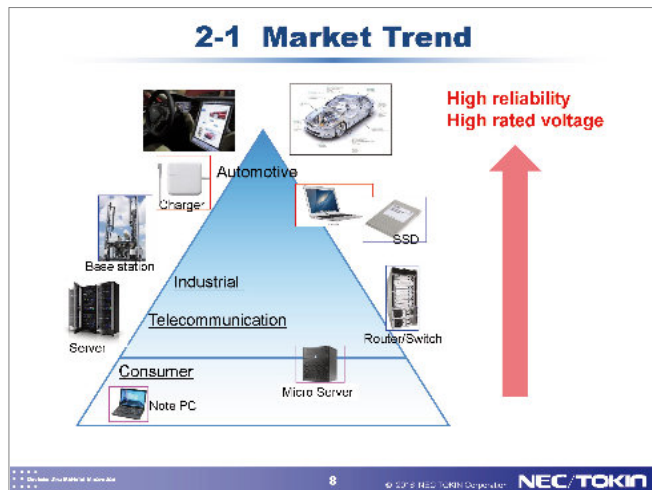


Figure 2-1

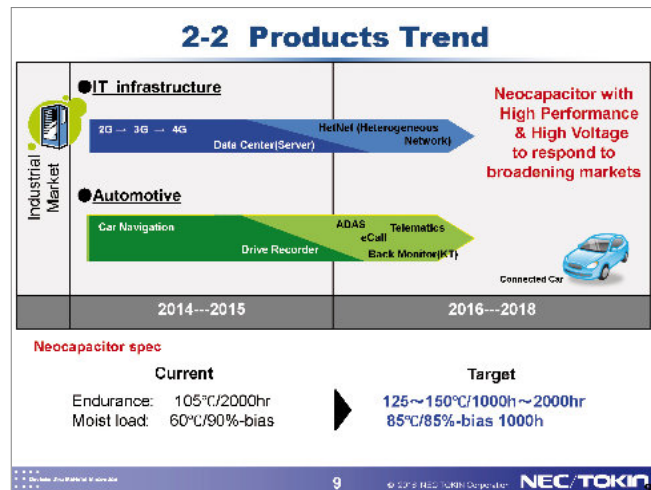


Figure 2-2

### 3. NEC TOKIN Strategy

One of our targets is to develop high reliability series for all the different product structures in our current line-up. For example, for the PS/L, the traditional structure, PS/H and PS/U; for F/PS, the face-down structure, F/PU; and for G/PS, the substrate structure, G/PU. The “H” means high-quality which focuses on high temperature (125°C) applications for the industrial market, and “U” means ultra-high quality, which focuses on high temperature (125°C) and high humidity (85°C 85%RH) applications for the automotive market. In addition, we are working to expand our line-up of high voltage products targeting rated voltages up to 100V. [Figure 3-1]

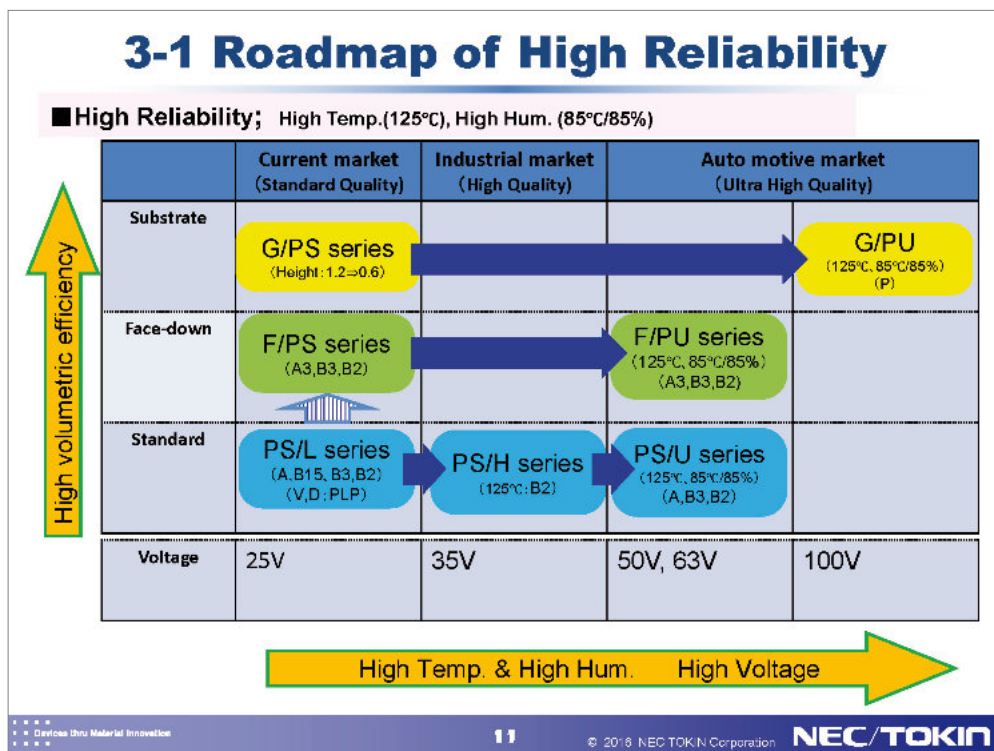


Figure 3-1









We have compared NeoCapacitor with other capacitors at a rated voltage of 25 V. Can type aluminium capacitors are taller and wider, compared with NeoCapacitor. Chip type aluminium capacitors are equal in height but occupy a larger footprint than NeoCapacitor. Multilayer ceramic capacitors (MLCC) are very competitive in footprint and height but have less capacitance when compared with NeoCapacitor. Therefore, Neocapacitor is the best solution when requiring the combination of high reliability, high voltage and miniaturization. [Figure 3-2]

## 3-2 Comparison of Other Capacitor

NeoCapacitor has high Capacitance per unit volume.

Best solution for the combination of  
high reliability, high rated voltage and miniaturization

Rated voltage : 25V

	Tantalum Polymer Chip (Neocapacitor)	Aluminum Polymer Can	Aluminum Polymer Chip	Ceramic Chip
Side View				
Top View				
Case Volume	19.6 mm <sup>3</sup>	145 mm <sup>3</sup>	62.8 mm <sup>3</sup>	21.6 mm <sup>3</sup>
Capacitance	15 uF	33 uF	33 uF	10uF
Cap / Volume	0.77 uF/mm <sup>3</sup>	0.23 uF/mm <sup>3</sup>	0.53 uF/mm <sup>3</sup>	0.46 uF/mm <sup>3</sup>

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Figure 3-2

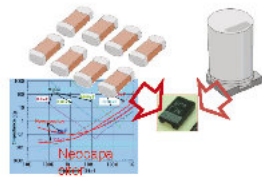
Polymer tantalum capacitors have advantages, compared with MLCC and aluminium capacitors in the following aspects: [Figure3-3]

- NeoCapacitor is small and has high capacitance; therefore delivering superior volumetric efficiency to either MLCCs or aluminium capacitors.  
Customers need many MLCC and big aluminium can case, however we will be able to replace those by one small tantalum capacitor.
- MLCCs have a piezoelectric effect; therefore producing acoustic noise once an electric signal is applied. This acoustic noise will be a problem for the customer. NeoCapacitor do not have any piezoelectric effect and therefore do not have acoustic noise problems.
- MLCCs can lose considerable capacitance once voltage is applied. This reduction in capacitance will be problem if the customer requires stable capacitance at the application voltage.
- MLCC can lose significant capacitance at the temperature extremes (high and low temperatures) because of the properties of certain ceramics. NeoCapacitor delivers a stable capacitance over a wide temperature range.

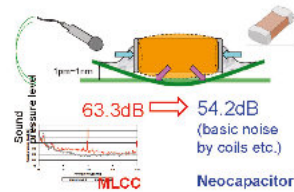
Therefore, smaller and low profile NeoCapacitor can compete effectively against MLCCs.

### 3-3 Advantages of Tantalum Capacitors

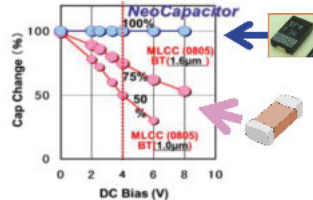
#### ① High capacitance in small volume



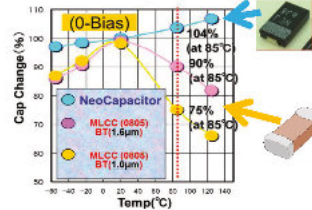
#### ② Without acoustic noise



#### ③ Stable capacitance with DC Bias



#### ④ Stable capacitance over a wide temperature range



Smaller NeoCapacitor can compete against MLCC

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Figure 3-3

#### 4. NEC TOKIN Technologies

Here we will comment on the requirements of each physical component found in the tantalum capacitor needed to achieve high reliability and high voltage. For the element, we need high stability to heat and moisture, durability to mechanical stress and high withstanding voltage. For the moulding resin, we require low mechanical stress on the tantalum element and high moisture resistance. For the lead frame, high adhesion to the moulding resin is a must. [Figure 4-1]

### 4-1 Key Technology

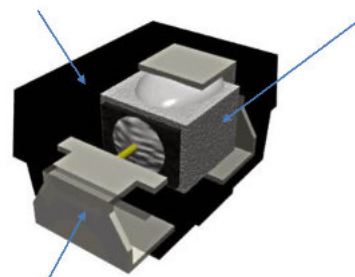
Key function of components for capacitor with high reliability and high rated voltage

#### Molding resin

- Low mechanical stress to element
- High moisture resistance

#### Element

- High stability to heat and moisture
- High durability to mechanical stress
- High withstanding voltage



#### Lead frame

- High adhesion to molding resin

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Figure 4-1



With our technologies for high temperature, we have dramatically improved the ESR property in load life test at 125°C. [Figure 4-2]

Our technologies for high humidity have delivered an outstanding improvement on leakage current in moist load test at 85°C 85%RH. [Figure 4-3]

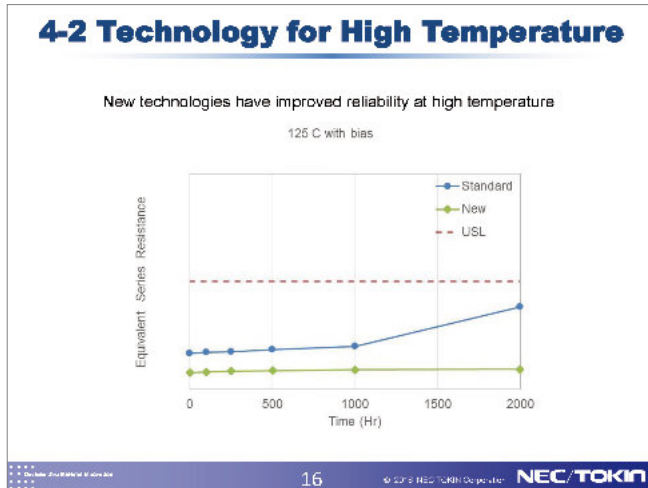


Figure 4-2

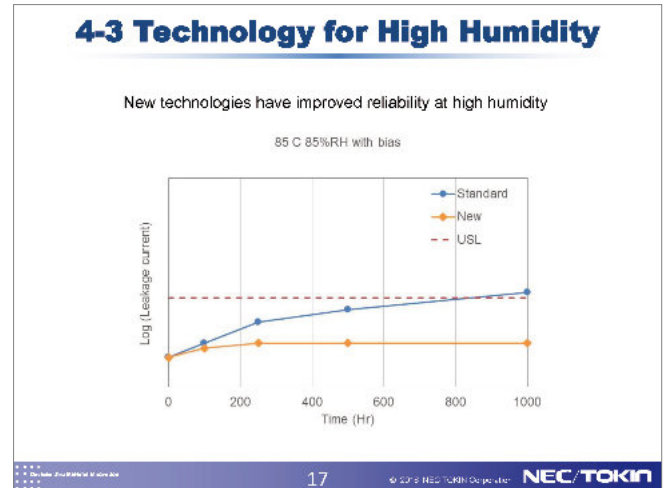


Figure 4-3

Tantalum powder with low deviation of connection area is very important for development of high rated voltage parts. This characteristic can deliver an improvement in the connection of the tantalum core in the element and help maintain the ESR and capacitance even with the thick dielectric layer required to achieve a high withstanding voltage. [Figure 4-4]

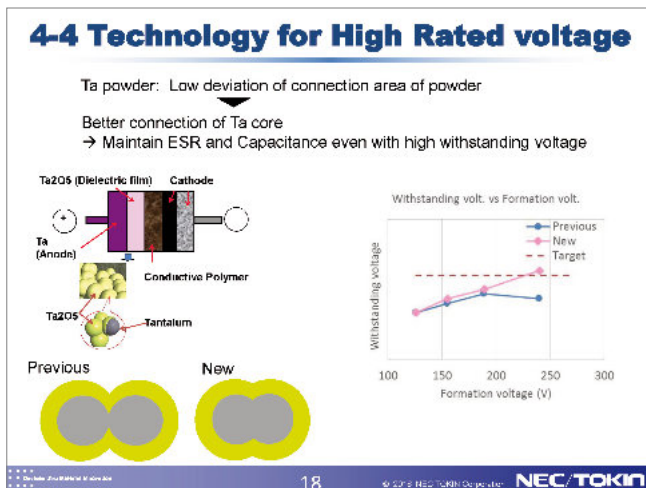


Figure 4-4

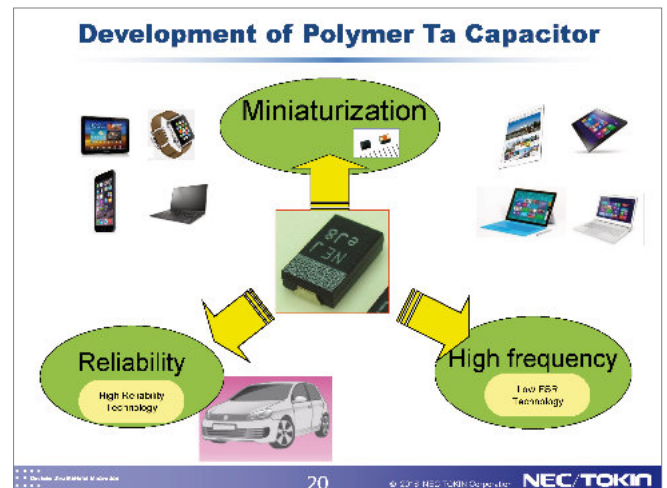


Figure 5-1

## 5. Summary

This presentation has been primarily focused on high reliability and high voltage; however, there is considerable market potential, for example, in the field of miniaturization or high frequency. We have been continuing efforts in parallel to develop products to respond to these market needs and have made considerable progress against these goals. [Figure 5-1]

# CFSI's revised Tin and Tantalum Standard

*The Conflict-Free Sourcing Initiative (CFSI) has released its revised Responsible Minerals Assurance Process, Tin and Tantalum Standard. The Standard replaces the CFSP Audit Protocol for Tin and Tantalum of 2013, and goes into effect on June 1st 2018. Announcing the release Leah Butler, CFSI Program Director, said "CFSI greatly appreciates the participation of the T.I.C. and its members in the revision process. We look forward to continue working with the T.I.C. as a critical partner in improving due diligence and assurance in the tantalum supply chain", a sentiment the T.I.C. shares.*



## Introduction

The Responsible Minerals Assurance Process (formerly the Conflict Free Smelter Program (CFSP)) was established to cultivate transparent mineral supply chains and sustainable corporate engagement in the mineral sector with a view to preventing the extraction and trade of minerals from becoming a source of conflict, human rights abuses, and insecurity. It was developed as a specific, practical framework to consistently audit the operations and practices of tin and tantalum smelters, the point at which mineral is converted into a generic metallic powder, product or compound.

The Standard follows guidance provided by the UN Group of Experts and the OECD's Due Diligence Guidance<sup>1</sup>. The OECD Guidance provides a working framework for companies to approach conformance with the due diligence requirements outlined in existing or upcoming legislative initiatives.



Tagging bags of minerals is often the start of a long mineral traceability programme in which each downstream entity adds another layer of data.

(photo: K. Hayes)

## Key improvements in the revised Tin and Tantalum Standard

The revision process brings the Standard in closer alignment with the OECD Guidance and ISO management systems. It also utilizes a global scope for the identification of Conflict-Affected and High-Risk Areas (CAHRAs), and includes a simplification of risk categories from the previous Level 1 to 3 system into low-risk or high-risk sourcing.

Additionally, the Standard now explicitly references both conflict-related risks and other serious human rights abuses contained in the OECD Guidance's Annex II risks. To align with ISO management systems, the Standard now includes requirements for document control and the internal performance monitoring of due diligence management systems.

The revised Standard reduces the former focus on a transactional review, instead concentrating on smelters' management systems. As a result, the standard includes enhanced requirements for know your counter-party (KYC) processes, fewer requirements for chain of custody documentation for low-risk sources, and consolidated data points for high-risk sources, aligning with the OECD Guidance recommendations.

The Standard also includes updated sampling methodology, decreasing the number of samples for secondary material. Lastly, the Standard allows for smelters to use alternate systems for reporting transactions and conducting the mass balance and clarifies the definition of companies in scope.

## What has stayed the same?

The procedural components of the audit remain the same. The auditors will review a smelter's management system to ensure it is robust and allows for the appropriate risk-based due diligence in the mineral supply chain.

The audit frequency continues to be annual, excepting those smelters on a three-year audit cycle. The general audit process remains the same, as does the on-site audit procedure. Materials in scope include both primary and secondary materials, whether mined, purchased, tolled, or otherwise obtained.

As with the previous version, origin determination is not required for secondary materials, legacy materials, or assay samples; however, KYC requirements are in place for all counterparties regardless of material type.

## Impacts on smelters

The new Standard provides more flexibility in smelters' due diligence approaches, in line with the OECD Guidance. Requirements are less prescriptive, allowing for due diligence systems that are proportional to the size, complexity, and risk-profile of a company and its sourcing practices. Smelters should identify sourcing from CAHRAs as part of their due diligence management systems and proceed to evaluate the presence of OECD red flags in their supply chains. Risk assessment and management are required for smelters with high-risk supply chains.

To enhance audit preparations, smelters will be asked to provide more information on their management systems prior to the on-site audit. This will allow for better preparation of both the smelter and the auditor, resulting in a more efficient and informed on-site audit process. After the smelters' first audit under the new Standard, audits will focus on the maintenance of their due diligence management systems, reducing the audit burden over the long-term.

## What happens next?

The remainder of 2017 and first half of 2018 will be a transitional year for smelters. CFSI will provide extensive training and resources to ensure that all smelters understand the changes, and are adequately prepared for their first audit under the revised Standard. Smelters wishing to have their audit under the revised Standard prior to June 1st 2018 are welcome to do so by notifying Hillary Amster, [hamster@eiccoalition.org](mailto:hamster@eiccoalition.org).

Further information concerning the CFSI's new Standard is available at <http://www.conflictreesourcing.org/protocol-development/audit-protocols/> and will also be the subject of a presentation by Hillary Amster called "Advancing responsible sourcing through the CFSI" to be given on October 17th as part of the T.I.C.'s 58th General Assembly in Vancouver, Canada.

1 - The OECD's Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas Third Edition is available at <http://www.oecd.org/daf/inv/mne/mining.htm>

## Member company and T.I.C. updates

Since the last edition of this newsletter the following changes have been made to delegate contact details:

- **Alfred H. Knight International Ltd** has moved office to Pegasus House, Kings Business Park, Prescot, Knowsley, L34 1PJ, United Kingdom. The general phone number is now +44 (0) 151 481 5850.
- **Chemaf sarl** has moved office to 36 Avenue des Roches, Lubumbashi, Democratic Republic of Congo.
- **Cronimet Central Africa AG**: Ms Candida Owens has a new email address [owens.candida@cronimet.ch](mailto:owens.candida@cronimet.ch).
- **ECO White Comercio de Sucatas Ltda** has changed its name to **EcoWhite Trading Ltda** but contact details have not changed.
- **Guangdong Zhiyuan New Material Co. Ltd**: The nominated delegate has changed from Ms Belinda Huang to Mr Wu Lijue. Mr Wu can be contacted at [lijuewu@zhiyuanm.com](mailto:lijuewu@zhiyuanm.com). The company also has a new website <http://www.zhiyuanm.com>.
- **Imerys Ceramics France**: Mr Pierre Sierak has replaced Mr Dominique Duhamet as the nominated delegate. He can be reached at [pierre.sierak@imerys.com](mailto:pierre.sierak@imerys.com).
- **Jiujiang Jinxin Non-ferrous Metals Co. Ltd**: Mr Janny Jiang has a new email address [janny@jiujiangjx.com](mailto:janny@jiujiangjx.com).
- **Metalysis Ltd**: The contact address is now Materials Discovery Centre, Unit 4 R-Evolution@TheAMP, Brindley Way, Catcliffe, Rotherham S60 5FS, United Kingdom.
- **Neometals Ltd** has a new office address at Level 3, 1292 Hay St, West Perth WA 6005, Australia.
- **Vishay**: The contact person is now David Tkach. He can be contacted at [David.Tkach@vishay.com](mailto:David.Tkach@vishay.com). The nominated delegate remains Mr Yehuda Hogeg.



## Members of the Executive Committee of the T.I.C. 2016-2017

The Executive Committee is drawn from the membership and committee members may be, but need not also be, the delegates to the T.I.C. of member companies. The Executive Committee named here was approved by the T.I.C. members at the Fifty-seventh General Assembly and consists of (alphabetical by surname):

Conor Broughton	<a href="mailto:conor@amgroup.uk.com">conor@amgroup.uk.com</a>
John Crawley	<a href="mailto:jcrawley@rmmc.com.hk">jcrawley@rmmc.com.hk</a>
David Gussack	<a href="mailto:david@exotech.com">david@exotech.com</a>
David Henderson (President)	<a href="mailto:dhenderson@rittenhouseir.com">dhenderson@rittenhouseir.com</a>
Marc Huppeler	<a href="mailto:marc.hueppeler@hcstarck.com">marc.hueppeler@hcstarck.com</a>
Jiang Bin	<a href="mailto:jiangb_nniec@otic.com.cn">jiangb_nniec@otic.com.cn</a>
Kokoro Katayama	<a href="mailto:kokoro@raremetal.co.jp">kokoro@raremetal.co.jp</a>
Raveentiran Krishnan	<a href="mailto:raveentiran@msmelt.com">raveentiran@msmelt.com</a>
David O'Brock	<a href="mailto:david.obrock@gmail.com">david.obrock@gmail.com</a>
Candida Owens	<a href="mailto:owens.candida@cronimet.ch">owens.candida@cronimet.ch</a>
Daniel Persico	<a href="mailto:danielpersico-rc@tokin.com">danielpersico-rc@tokin.com</a>
Alexey Tsorayev	<a href="mailto:tsorayevaa@ulba.kz">tsorayevaa@ulba.kz</a>

Of these twelve, Mr David Henderson was re-elected to be President of the T.I.C. until October 2017. The next elections will take place at the annual general meeting (AGM) to be held on Monday October 16th 2017 in Vancouver, Canada. Mr Henderson and Mr O'Brock have announced their intention not to stand again for election.

The T.I.C. currently has the following subteams (chaired by): Marketing (Daniel Persico), Meetings (David Gussack), Statistics (Alexey Tsorayev) and Supply Chain (John Crawley).

We are always looking for enthusiastic T.I.C. members to join the Executive Committee and our subteams. If you are interested in doing so, please contact [director@tanb.org](mailto:director@tanb.org).

## And finally... for the T.I.C. member who has it all: Niobium shoes

For many years niobium and tantalum have been used to create beautiful jewellery and sculpture. However, until recently, 'niobium' was not a word normally associated with fashionable clothing or shoes.

This has changed with the recent launch of the Niobium by New Balance. Described as a modern mid-top sneaker that will "elevate your casual style", the shoe is made from suede leather and neoprene materials, paired with a water-resistant lining for "all-day comfort". Furthermore, the manufacturer points out that the side zip makes it easy to slip on in the morning and "kick off when the day is over". The Niobium is available in black, grey and beige.

Among sneaker enthusiasts the Niobium has been well received and initial reviews say that it is as comfortable as it is stylish. As one fan posted on Sneaker Freaker<sup>1</sup>, a website dedicated to sneakers, "If that [Niobium sneaker] doesn't get you amped up for adventure, then there's nothing we can do for you!"

New Balance made no comment to our suggestion that they develop a matching range of "Tantalum" sneakers (similar to the Niobium but heavier and more expensive).



The New Balance Niobium: Men's Outdoor Sport Style Sneakers  
retailing for USD 159.99 at <http://www.newbalance.com> (photo: New Balance)

1 - <https://www.sneakerfreaker.com/>