Dear Fellow Members and Friends,

As we move into spring, it’s been great to see the cold and snows of winter being replaced by warmer temperatures and green vistas, at least in the northern hemisphere. We’re hopeful that, although early days, with a new design cycle in the capacitor sector and the end of destocking programs in the superalloy sector, for example, we’re seeing similar green shoots sprouting up in tantalum demand.

As always, our customers are demanding value for money and your Executive Committee is strongly aware of this requirement from our members as well. We have been working hard to improve the organization and hopefully the initial results are perceived positively. Of significant impact this last quarter has been the arrival of Roland Chavasse as our first Director. While he has already reached out to many of you, he plans to contact all of you over the next few months. Roland has also made noticeable progress in improving our relations with various key partners, such as iTSCI and ITRI.

It is with some sadness, but also with much appreciation, that we announce two senior members of the Executive Committee will be stepping down at the end of their current term, Dale Gwinnutt and Bill Millman. They both have made substantial contributions to the T.I.C. and their experience, insights, and institutional knowledge will be sorely missed. I would also like to take this opportunity to thank Ulric Schwela for all his efforts on our behalf over the years as T.I.C.’s dedicated Technical Officer and wish him well in his future endeavours. I trust you find his interview to be illuminating (see page 5).

While some of you have already expressed interest in serving on the Executive Committee, we encourage all of you, that would like to see the T.I.C. grow and develop, to consider putting your name forward as a candidate for election at our next General Assembly.

(continued on page 2)
We are only as strong as our members and your efforts and commitment. I would remind you that members of the Executive Committee serve as individuals and not as representatives of their companies.

As you’ll see in a separate article, with the efforts of our Meetings Subteam, ably led by David Gussack, plans are well underway for the meeting in Toulouse and beyond. A highlight this October will obviously be a factory floor visit to Airbus, rather than a privatized version of the standard public visit. As space on the tour is limited, we are negotiating to increase the number of visitors allowed.

Your Supply Chain Subteam has been working on various initiatives and issues over the last several months, ranging from issues with shipment, such as radioactivity, to improving relations with various government entities. At our recent Executive Committee meeting earlier this month, John Crawley volunteered to be its new leader.

The Website Subteam, headed by Dan Persico with great support from Dale Gwinnutt, has done an outstanding job in bringing our new version online. I trust you find this to be a significant improvement and are appreciative of their efforts, as it’s now our intention to disband this subteam and create a new one, focused on marketing - or on the content portion of our message rather than the distribution channel per se. While part of its remit will be to update the content of our website, it will also look more broadly at our overall education and promotion efforts. Ian Margerison of Metalysis has volunteered to lead the new Marketing Subteam.

We’re also seeking to increase involvement of non-Executive Committee members in our subteams and have started to do so. Another subteam the Executive Committee recently decided to establish, for example, was on statistics, as part of our investment in this field (see page 4). While the new Statistics Subteam will be led by Alexey Tsorayev, your thoughts, suggestions, and recommendations on how we can improve in this area would be most welcome please. Please send your ideas, particularly if you would like to serve on such a subteam, to either Alexey or Roland.

Our final subteam is Staffing, headed by Bill Millman. It has been working hard on identifying a suitable replacement for Ulric Schwela in the Technical Officer role. We expect to start interviewing prospective candidates shortly, but are always on the lookout for recommendations and suggestions from our members.

Finally, I would like to call your attention please to the proposed antitrust compliance policy (see page 9 or on the Home section of our revised website). Your comments on this are sought, particularly as it can only be implemented after your vote for approval at the annual general meeting (AGM) held during in our General Assembly in Toulouse. This is to also note that the Executive Committee is also looking at various other issues, which might require membership approval at the AGM, but this process is still very preliminary. Some of these are procedural in nature, such as better delineating the role of the Director, having our notification policies adapt from snail mail to the electronic age, and possibly moving our fiscal year to a calendar year. Once these proposed policies are developed, they will be posted on the website in due course, allowing plenty of time for your review and comments before the General Assembly.

Warm regards,

David R. Henderson
President

Interested in sponsoring the 57th General Assembly?
See page 4 for details.
Toulouse, France: host city of the Fifty-seventh General Assembly

As the venue of the T.I.C.’s Fifty-seventh General Assembly, the city of Toulouse in south-west France offers a visitor everything from medieval monasteries to cutting edge technology at the Airbus plant, via music, gastronomic delights and culture.

The old heart of the city is mostly constructed of brick and a local pink stone, which lends itself to liveliness and has resulted in the city becoming known as La Ville Rose (The Pink City). French southern vigour pulses through narrow streets and there is no missing the uniqueness of France’s fourth-largest city. Today Toulouse is a cosmopolitan melting-pot that’s awash with culture, industry and architecture, not to mention some exceptional French cuisine such as the famous Toulouse sausage (La saucisse de Toulouse) and fine wines from the near-by Fronton and Gaillac regions.

For visitors new to Toulouse try getting into the swing of the city with breakfast at a café terrace on the Place du Capitole, the sunny central square. Don’t forget to wear good shoes though, because this is a city that is best explored on foot.

From Place du Capitole take Rue du Taur, one of many brick-paved streets that have barely changed in centuries, to the St Sernin Basilica, an imposing Romanesque church housing over 200 ancient Christian relics. Staying with religion, by walking towards the Garonne River one reaches the gothic majesty of the Jacobins’ Monastery.

Art-lovers should visit the Augustins’ Monastery, (www.augustins.org), now an exceptional museum of fine art, or the formidable Hôtel d’Assézat (www.fondation-bemberg.fr), a former woad-merchant’s house that now is home to the remarkable post-Renaissance to post-impressionist collection of Georges Bemberg, an Argentinian plutocrat.

In a city that offers many excellent prospects for lunch the Victor Hugo Market may not look like an obvious choice – the building resembles a concrete bus station from the outside – but once inside the abundance of gastronomic delights on offer is worth the journey. Just outside the market is J’Go, a landmark restaurant serving the finest meats from across the region.

Popular evening venues abound and range from fashionable wine bars like No.5 on Rue de la Bourse, to more leisurely dining rooms such as Monsieur Georges on Place St Georges. A busy stretch of bars and restaurants is also found around the Place St Pierre and along the river.

For the technically-minded the Aeroscopia Museum offers hours of entertainment and interest and will also be host to the T.I.C.’s gala dinner during the General Assembly.

We look forward to seeing you in Toulouse!

(inspired by an article in the Sunday Times, 06 March 2016)
Sponsorship opportunities at the Fifty-seventh General Assembly

Toulouse, France, October 16th to 19th 2016

Sponsorship of the T.I.C.’s General Assemblies is the perfect way to engage with the global leaders in the tantalum and niobium industries in a highly targeted and cost-effective way.

There are several sponsorship opportunities available, including Gold and Silver packages, the cocktail reception, gala dinner and two lunches. If you would like to see your company promoted to all your colleagues, business partners and even competitors, contact the T.I.C. (info@tanb.org) at your earliest convenience for more details.

A new collection process for T.I.C. statistics

T.I.C. statistics are evolving; not only has a new subteam led by Alexey Tsorayev been established by the Executive Committee, but we are also investing in a bespoke highly-secure online database to collect members’ trade data. During the second quarter statistics collection process we will be changing over from the current email-based collection system to collection through the secure online database.

The new system will allow members to directly report their data on an ultra-secure website created by Stratovation Ltd and hosted by Miller Roskell Ltd, the independent chartered accountant who since 2015 collects, aggregates and anonymises members’ data.

As with the current system, the T.I.C. will have no access to an individual member’s confidential statistics.

Miller Roskell Ltd provides the T.I.C. with aggregated, anonymised data that the T.I.C. then forwards to members. Neither the T.I.C. staff nor Executive Committee members will be able to access the members’ data section on the new database.

Full details of the new online statistics collection database, your user-name, password and how to use it to submit your data will be distributed to members soon.

Miller Roskell Ltd is a chartered certified accountant that is 100% independent of the T.I.C. and is in no way related to the T.I.C. member company Roskill Information Services Ltd.

If you have any questions please contact tech@tanb.org.

The T.I.C.’s Director and Technical Officer visiting Miller Roskell Ltd in March 2016 to discuss the secure database collection system.
Ulric Schwela, polyglot and chemist, first arrived at the T.I.C. in 2005 from the international sampling and analysis company (and T.I.C. member company) Alfred H. Knight (AHK). Over the next 11 years he contributed greatly to the T.I.C., particularly regulations connected to naturally occurring radioactive materials (NORM) but also in answering members’ technical questions and working to develop the General Assemblies.

After reading chemistry at university Ulric joined AHK in Operations and then became Technical Manager, ensuring quality samples from around the world were correctly obtained and prepared prior to their chemical analysis. He was further given the role of Radiation Protection Supervisor, leading AHK’s radiation work compliance, and fielding all enquiries and safe handling procedures; apt preparation for dealing with queries about shipments of tantalite under Class 7 regulations.

The T.I.C.’s Technical Officer (TO) is a key member of the executive team and since Ulric’s appointment he has made a considerable contribution to the growth and development of this association. The T.I.C.’s Director, Roland Chavasse, said “Ulric has been a great asset to the T.I.C. and he will be missed by members and staff alike. We wish Ulric all the best for the future and look forward to consulting with his company – Salus Mineralis – on issues concerning the safe transport of naturally radioactive tantalum and niobium minerals” (contact details for Salus Mineralis are given on page 7).

As Ulric’s time as the Association’s dedicated Technical Officer draws to an end, we asked him to reflect on his time, trials and triumphs while at the T.I.C.:

**Visits to members**

“The highlights of my times at the T.I.C. have undoubtedly been the many plant visits I have made to member companies. Sometimes visits were part of a T.I.C. conference, others one-off trips, but either way there is no better way to learn about tantalum and niobium than by visiting T.I.C. members.

“My career at the T.I.C. kicked off immediately with visits to AVX in Lanškroun, Czech Republic and H. C. Starck in Goslar, Germany, a perfect introduction to the marvels of tantalum and niobium. At AVX I witnessed capacitor production, from pressing the anodes, to anodising into a rainbow of colours, to the reels of capacitors being produced.

After a memorable evening in the vaults of the mediaeval town hall in Lanškroun I pressed on to H. C. Starck in historic Goslar to witness their complex processing of minerals, including an overnight stay in a city-wall tower. This was a truly unique experience not least due to the help-yourself bar stocked with H. C. Starck’s finest distilled products, but also the atmospheric curved tower walls and the warm welcome provided by the lively Sicilian caretaker.

Over the years memorable visits to members have included:

- A&M Minerals and Metals in London
- Anglo American in São Paulo (SP, Brazil)
- Avon Specialty Metals in Gloucester (UK)

During the gala dinner at 51st General Assembly (2010) in Lake Tahoe, USA.
Every member visit was a rich experience, both for the openness shown by the hosts and for the peerless learning opportunities each one afforded. It was not all one-way and my visits to members also allowed me to explain the full benefits of T.I.C. membership and offer updates on developments from the T.I.C.’s point of view. The greatest reward, however, was building a network of lasting friendships throughout the global T.I.C. community.”

Transport Committee

“The role of the T.I.C.’s TO really took off with transport work-related to the naturally occurring radioactive materials (NORM) that tantalum and niobium minerals can contain. Typically the radiation is caused by thorium (Th) and uranium (U) associated with the mineral matrix and unless the material is treated to remove these elements at the mine it will fall under Class 7 regulations when it is transported.

“The T.I.C. set up a Transport Committee after the Lisbon General Assembly in 2003, and commissioned a transport risk assessment, with the TO reviewing multiple times every detail of the parameters, assumptions, protocols, operations, tests, and not least the final report which was published in April 2007.

“Meeting after meeting followed in Vienna, Austria, beginning in 2006 with the IAEA Coordinated Research Programme (CRP) on the safe transport of NORM. To this the T.I.C. and eight other participants submitted risk assessment reports that were later brought together into the final report, published in 2011 (link).
Sustainable shipping

“Simultaneously in 2006 the T.I.C. redoubled efforts on addressing denial of shipment; joining forces with a number of states and international organisations to form the International Steering Committee on Delay and Denial of Shipment of Radioactive Material focusing on six areas:

1. Awareness – reaching out to other stakeholders
2. Communication – laying out a strategy on what and how to communicate
3. Economic – fact finding and understanding the issue’s economic impact
4. Harmonisation – discussing differences in regulation and any justification
5. Lobbying – using the arguments of the industry’s benefits to society
6. Training – identifying and supporting areas where training was required

The TO also Chaired this committee in 2011, which had grown to over 40 participants from all over the world, reflecting the interest in this topic. By 2013 the committee evolved into the Transport Facilitation Working Group, led by a triumvirate of a state regulator and two from industry, including Ulric. Finally, recent developments in Tanzania show that even today the area of transport continues to have a mixed understanding of Class 7 issues.

Supply Chain

Following the UN Group of Experts of 2008 the T.I.C. took action by forming a Working Group on Tantalum and Niobium Mining, with the remit to address all issues related to artisanal scale mining (ASM). In 2009 the T.I.C. membership approved a formal policy on ASM which requires members to source minerals in a responsible manner. This predated the OECD due diligence guidelines, with Ulric and the then President Richard Burt attending the first such OECD meeting in December 2009. Simultaneously in 2008 the TO reached out to ITRI on the potential for collaboration, resulting in the iTSCi Programme. When Richard retired in 2012 such “supply chain” work was added to the TO’s portfolio.

Statistics: what’s in a number?

“As the first TO to organise the collection of statistics the main challenge was the transition from snail mail to email. The TO’s annual statistics presentation was a permanent fixture in the meeting programme. Another challenge has been interpretation, on one hand the data are strictly limited by the number of T.I.C. members, and on the other hand by demands from members for information. I wish Alexey Tsorayev and the Statistics Subteam well in this perennial quest.”

Farewell for now, and safe transport!

“As a summary of the Technical Officer role, the beauty has undoubtedly been the tremendous flexibility of the work and the trust put in the TO, and the interesting variety of challenges that have presented themselves. My key advice to a future Technical Officer will be to keep communicating and keep the network buzzing with the T.I.C. name! It only leaves me to say that it has been a pleasure getting to know so many of you professionally and personally, and I look forward to our paths crossing again in due course.”

Ulric’s company, Salus Mineralis, is a consultancy specialising in the safe transport of Naturally Occurring Radioactive Materials. He can be reached at ulric(at)schwela.com and +44 7753 857878.
The EU’s proposed legislation covering minerals from conflict-affected and high-risk areas has been negotiated between the three main EU institutions for almost a year with little obvious progress. A key question is whether the legislation should be voluntary or mandatory; if mandatory then it could require due diligence risk assessments and reporting for all minerals and metals smelted in or imported to the EU from anywhere in the world.

In May 2015 the European Parliament (the body of elected MEP politicians) voted to agree significant amendments to the proposed EU legislation on minerals and metals from high-risk or conflict-affected areas which had been proposed as voluntary recommendations by the European Commission (the EU’s executive branch) as requested by the European Council (the institution that comprises the EU member states’ governments). The European Parliament demanded a number of amendments, several positive to industry, but critically also that the due diligence procedures become mandatory, rather than voluntary. At a recent conference in Brussels, Belgium, organised by the EICC the T.I.C. was given an update on the situation.

During the last 12 months the European Commission has held two rounds of negotiating between the European Parliament and the European Council to find a way to re-draft the proposed legislation in a way that is acceptable to both organisations, but without success to date. These ‘trialogues’ had been expected to resolve by last December, but a third round of negotiations will commence in May 2016 since EU legislation cannot be passed without agreement from both the European Parliament and European Council.

For T.I.C. members there are a number of points to follow during the aforementioned negotiations. On one hand the proposed EU legislation could usher in a raft of additional bureaucracy for smelters in and importers to the EU; but on the other hand it is possible that the extensive due diligence procedures and conflict-free auditing standards already established within the tantalum industry could satisfy the majority of its requirements.

Positive changes made by the Parliament include a two year transition period, creating an official handbook to guide companies on due diligence best practice, and also a requirement for the Commission to put forward legislative proposals for measures to assist industry and Government in implementing due diligence. However, while both Section 1502 of the USA’s Dodd-Frank law and the proposed EU legislation are based on the OECD Due Diligence Guidance, whereas Dodd-Frank explicitly focuses on the exploitation of 3TG minerals (tin, tantalum, tungsten, and gold) from the DRC and neighbouring countries, the proposed EU legislation does not limit itself geographically or by specifying particular elements. This has led some to fear that the EU legislation could result in mandatory due diligence risk assessments and reporting for all EU smelters and importers of any mineral or metal from anywhere in the world.

To end on a positive note, at the Brussels conference representatives from both the European Parliament and European Commission confirmed that they are aware that the tantalum industry has already demonstrated considerable leadership in due diligence and conflict-free auditing, and that existing industry schemes have a useful contribution to make. Whether existing programmes can be recognised as equivalent to the EU system in order to avoid double auditing and other unnecessary costs is not yet known, but is a subject that the T.I.C. will continue to follow closely both under the umbrella of the iTSCI Programme and in its own right.
On March 8th 2016, representatives of the T.I.C. and ITRI, the tin producers’ trade association, reconfirmed their commitment to the iTSCi Programme (www.itsci.org) by re-signing the service agreement of the iTSCi Governance Committee originally signed on 1st April 2011. The T.I.C. was represented by David Henderson, the T.I.C.’s President, and Roland Chavasse, its Director, while ITRI was represented by David Bishop, its Managing Director.

In a statement Roland Chavasse, who is the T.I.C.’s primary representative on the Governance Committee, said “Although the 2011 agreement has always been valid by re-signing it in 2016 the T.I.C. has reconfirmed its support for the programme and commitment to playing a key role in the future of iTSCi”. Note that the T.I.C. supports all initiatives and programmes that support mineral due diligence processes that are in line with OECD guidelines.

What is the iTSCi Governance Committee?

The Governance Committee makes high level decisions on the direction of the iTSCi Programme, including any improvements or sanctions, suspending mines or companies from membership. The Governance Committee also liaises with representatives from the national Governments in each operating location. The Committee is made up of industry experts from the 3T (tin, tantalum and tungsten) industries who have no commercial or conflicting interests; currently the T.I.C. and ITRI, since seats for the tungsten industry and a qualified expert have not been filled despite the T.I.C. and ITRI’s best efforts.

iTSCi is a joint industry membership programme designed to assist companies with traceability, due diligence and audit requirements on purchases of minerals from high risk areas as recommended in the OECD Due Diligence Guidelines and UN recommendations. iTSCi aims to aid compliance with the US Dodd-Frank Law (but is not in itself a certification system) and complements other initiatives including the EICC-GeSi Conflict-Free Sourcing Initiative (CFSI, www.conflictfreesourcing.org) and the ICGLR Regional Certification Initiative (www.icglr.org).

Multi-stakeholder participation and expertise in the iTSCi Programme
Dear T.I.C. Members,

The T.I.C., as a broad industry association, is fully committed to ensuring that all of its activities are carried out in full compliance with all applicable laws. This is essential for the operation of the T.I.C. but it is also directly to the benefit of its Members. The T.I.C. over the years has set up a number of procedures and policies designed to implement this important principle. As part of what is a continuing exercise, the Executive Committee of the T.I.C. has now proposed the "Antitrust Compliance Policy" to members, a copy of which is attached hereto and is also available on the Association’s website.

The T.I.C. will submit this Antitrust Compliance Policy at the annual general meeting (AGM) held during the Fifty-seventh General Assembly to be held in October 2016 in Toulouse, France, for its formal approval.

As you probably know, antitrust (also called competition) laws have become a significant body of law. Violations thereof are likely to result in major fines, and may in the USA also lead to criminal sanctions, including imprisonment.

The T.I.C.’s Antitrust Compliance Policy will provide you with a summary description of the main rules, as well as a number of useful practical recommendations to ensure compliance with these rules.

On behalf of the Executive Committee, we therefore strongly encourage you to review carefully and familiarize yourselves with this Policy. We wanted to keep the Policy to a relatively short document, with only the essential aspects and recommendations, but compliance with this Policy is an essential part of the T.I.C.’s values.

Thank you for your cooperation,

Luc Houben
Outside Legal Counsel to the T.I.C.

Purpose, Scope and Implementation

The T.I.C. is fully committed to ensuring that all of its activities are carried out in full compliance with all applicable antitrust legislation. Failure to comply with this Policy may result in the association and/or its members violating antitrust legislation and being subject to the imposition of substantial fines or even criminal penalties for individuals.

All T.I.C. employees, consultants and elected representatives of the T.I.C. are under an obligation to conduct all business dealings in accordance with any applicable antitrust legislation. The employees, T.I.C. consultants and elected representatives must sign a written undertaking to the effect that they have read and understood the Policy and that they agree to adhere to that Policy in the conduct of their business activities.

Members are to ensure that any of their employees involved in T.I.C. activities and all those carrying out activities within the association on behalf of members are fully informed about the T.I.C.’s Policy. Applicant members will be asked to sign a statement to the effect that they have read and understood the T.I.C.’s Policy and that they will adhere to that Policy if admitted.
T.I.C. activities.

Information concerning the Policy will be available on the T.I.C.’s website. All meeting agendas will be sent in advance of the meeting, and they will contain a statement to the following effect: “This meeting will be conducted in full compliance with the T.I.C.’s Antitrust Compliance Policy”.

All chairpersons will be required to remind group members of the contents of the T.I.C.’s Policy on a regular basis. Minutes of the meetings will be distributed to the participants within a reasonable time after the meetings.

Escalation of concerns.

All employees, consultants and members and their representatives are required to report any possible breaches of the Policy. Generally all actual or potential breaches should immediately be reported to the T.I.C.’s legal counsel. The contact information is as follows:

Jones Day
Attention: Luc Houben
4 Rue de la Régence,
(Regentschapsstraat 4)
1000 Brussels, Belgium
(email: lhouben@jonesday.com)
(web: www.jonesday.com/brussels/)

Basic Concepts of Antitrust Law

What is antitrust law?

As an international organization, the activities of the T.I.C. may be subject to a variety of antitrust legislations. Most antitrust laws apply as long as the agreement or behaviour concerned has effects within the country or region governed by those laws. Although the scope and content of antitrust legislation may vary from country to country generally speaking two types of behaviour will be affected.

Firstly, anticompetitive agreements (so-called cartels) between competitors which, for example, seek to share markets, fix prices or otherwise affect competition. Secondly, situations where companies in a dominant position on a given market seek to behave in a way which constitutes an abuse of that position. The former types of practices are of particular relevance for the T.I.C.

What are cartel agreements?

Where employees of different companies ‘enter into agreements’ or any other form of understanding that may ‘affect competition’ on the market these agreements potentially infringe antitrust law. Under some antitrust legislation it is not even necessary for the agreement to have an actual negative effect on competition.

The form of the agreement entered into is not relevant. Even unwritten agreements may be considered illegal. For example, the existence of an anti-competitive agreement may be inferred from surrounding circumstances. The key criterion for the application of antitrust law is that the agreement has either the aim of affecting competition or has that effect.
Types of anti-competitive agreements:

- **Price fixing**: A price fixing agreement between (potential) competitors, whether verbal or in writing, is prohibited. The prohibition covers direct and indirect price fixing such as agreements on surcharges, rebates, discounts, incoterms, etc.

- **Market sharing**: Agreements between (potential) competitors involving the allocation or sharing of markets are also prohibited. This may for example cover agreements allocating specific customer segments, territories or product types.

- **Quantity fixing**: An agreement between competitors whereby they agree on quantities or volumes to be produced, sold, transported or otherwise placed on the market is prohibited.

- **Information exchange**: More recently antitrust enforcers have considered that the mere exchange of competitively sensitive information between competitors can amount to a cartel. This covers information on prices, quantities, markets and commercial strategies. This is the case even if the information to be exchanged could be obtained elsewhere, for example, an exchange of information relating to tariffs. Within the context of the activities of the T.I.C. it is not permitted to disclose business information which a company would normally regard as confidential.

**Managing meetings, conference calls and other T.I.C. activities.**

Whenever a T.I.C. employee or a person chairing a T.I.C. meeting or activity identifies a potential risk he or she shall be entitled to suspend the meeting and request that participants do not engage in the potentially harmful conversation or exchange.

**Document creation & storage.**

When writing/composing/editing any document, for example, an email, a memo, a set of guidelines, the following advice applies:

- Pay specific attention to the language used. This is particularly important when sending emails. The casual feel of such correspondence often gives rise to ill-considered statements. Before sending an email consider whether you would object to your boss or a regulatory or antitrust authority reading it. If you would, do not send it.

- Seek legal advice as to the document’s contents should the document have actual or possible antitrust implications.

- Retain a master copy or version of the authoritative document for as long as needed to meet legal or other requirements.

- Pursuant to applicable legislation there may be a legal requirement to keep certain documents for certain periods. All documents are to be retained for at least the minimum period specified in that legislation.

- If there is a prospect of litigation or investigation by a regulatory or antitrust body all document destruction is to be suspended immediately. This requirement applies to all records or documents relating to the matter in question however unimportant or irrelevant they may appear to be.

**What should be done in the event of an investigation?**

Under most antitrust laws, authorities have the power to request information and to inspect the premises of a company. The T.I.C. will assist authorities in the conduct of any investigation. However difficulties may arise should employees or representatives or members take it upon themselves to respond to requests for information from such authorities without first obtaining legal advice. Such persons may not have a complete overview of all the relevant information in the area concerned. Moreover, certain documents may be privileged or confidential. Should a T.I.C. consultant or a member receive a request for information, of if there are any specific questions regarding antitrust issues relating to the T.I.C., we encourage these parties to contact T.I.C.’s legal counsel.
Paper written by J. Petrzílek, M. Biler, J. Navratil, M. Uher of AVX Czech Republic s.r.o., and presented by William Millman on October 27th 2015, as part of the Fifty-sixth General Assembly held in Penang, Malaysia.

J. Petrzílek, M. Biler, J. Navratil, M. Uher
AVX Czech Republic s.r.o., Dvorakova 328, 563 01 Lanskroun, Czech Republic
Tel.: +420 465 358 111, Fax: +420 465 358 701, e-mail: jan.petrzilek@eur.avx.com

Abstract

Tantalum capacitors are passive components well known for their stability of parameters over a range of conditions. This makes them the best choice for special high reliability systems. Conditions can comprise high temperatures, humidity, mechanical shock and vibrations, thermal shocks and current surges. Over this range of operational conditions, high energy, low DCL and low ESR might be demanded. This article will discuss challenges and reliability evaluation of SMD hermetically sealed tantalum capacitors with conductive polymer cathode that are stable up to 150°C, can be rated up to 100V and exhibit super low DCL and single digit ESR.

Introduction

Tantalum capacitors are widely used mostly for their stability, reliability and volumetric efficiency. Since the anode and dielectric materials are always the same – tantalum and tantalum pentoxide, based on cathode material, several types of capacitors can be distinguished.

A specific category is formed by tantalum capacitors with a liquid electrolyte. In this case, the dielectric is contacted by a liquid with ionic conductivity, for example diluted sulfuric acid. Such capacitors are still popular in applications where high energies and high energy densities are required and until recently, they were the only tantalum capacitors capable of high voltage (100V and higher) ratings. Their other major advantages are high capacitance recovery (most of the dielectric is contacted) even if the anode is large, high temperature capability (200°C), surge robustness, self-repairing feature (liquid electrolyte serves as source of oxygen and oxidizes potentially damaged spots of dielectric). But the same feature is responsible for deterioration mechanisms – crystals grow under voltage, especially at voltages that are close to breakdown voltage of the electrolyte. Crystals of dielectric are responsible for DCL increase and this is progressively growing with temperature.

High DCL induces electrolysis of the electrolyte and produces hydrogen that can cause mechanical damage of the capacitor case. Prevailing failure mode is thus leakage of the electrolyte and capacitance drop. The other drawback of this type of capacitor comes from limited conductivity of the electrolyte – capacitance drops with increased frequency and as well with decreasing temperature.

Tantalum capacitors with solid electrolytes use electronically conductive materials – manganese dioxide or intrinsically conductive polymers to contact the dielectric. Manganese dioxide as a cathode material gives high mechanical, thermal and electrical stability, as well as self-healing capability. They can work up to 230°C, usually are SMD [1, 2].

The drawbacks are potentially a dangerous failure mode (tantalum can vigorously react with manganese dioxide when ignited and lead to burning) and has relatively high resistivity of the cathode (resulting in higher ESR). Also their maximal rated voltages are 63V because of the above some point, greater thickness of dielectric does not increase further breakdown voltage of this type of capacitors [3].
The latest cathode materials used are conductive polymers. Polypyrrole or PEDT are the most frequently used compounds. They reduce the drawbacks of manganese dioxide cathode – polymers do not have enough oxygen in their molecules to support tantalum burning and their higher conductivity allows ESR reduction. They also allow self healing and are mostly available as SMD. Special pre-polymerized types of conductive polymer allow to increase BDV [3-5] and lower DCL so that nowadays there are capacitors available rated up to 125V [6]. Major drawbacks of conductive polymer cathode are connected with chemical instability of such material. Polymers are prone to oxidative degradation at elevated temperatures and such processes are accelerated in presence of oxygen, this limits also their ratings to 85 - 125°C. High levels of humidity can also induce chemical degradation [7,8]. These mechanisms lead to ESR increase and capacitance drop. Both types of capacitors using solid electrolyte have common issues with capacitance recovery – not 100% of dielectric is contacted and this can lead to capacitance changes with humidity, especially in case of conductive polymer.

Since capacitance is directly proportional to the surface of contacted dielectric and inversely proportional to dielectric thickness, capacitor designers try to minimize dielectric thickness in order to achieve high capacitance and thus high energy densities. But at the same time, such dielectric thickness must assure stability of electrical parameters under conditions given mostly by required voltage and temperature. Such stabilities depend to some extent on dielectric quality, but also on cathode material. If we compare the applied voltage on each unit of dielectric thickness, there are extremes such as 0.5-0.6V per 1 nm for low temperature pulsing wet tantalums for medical application on one side and less than 0.1V per 1 nm for manganese dioxide based capacitors for 230°C on the other side.

This article will concentrate on capacitors for high operating voltages, namely 100V. For such voltages choices of cathode materials are limited to wet electrolyte or pre-polymerized conductive polymer. Based on above mentioned list of advantages and drawbacks, it would be polymer that can give us better temperature stability, extended frequency range and lower ESR. Also the wear out mechanisms leading potentially to leakage of aggressive electrolyte are not present here. Major drawbacks of polymer cathode connected with its lower chemical stability can be significantly reduced by hermetic sealing [1, 2]. The already low ESR of high voltage polymer capacitors can be further reduced by parallel connection of multiple capacitors inside the hermetic case.

**Experimental Details**

Pressed tantalum pellets with embedded tantalum wire were sintered, anodized and coated by conductive polymer. Polymeric material based on PEDT-PSS dispersion was used for both internal and external impregnation using a dipping and drying process. The external cathode layer was then coated by dipping into graphite and silver. Special screening and ageing procedures have been applied and assembled into packages that allowed later hermetic sealing under inert atmosphere. Three types of hermetic cases were used: ceramic package CTC21D that holds two capacitors, TO3 metal case that holds up to ten anodes and customized low profile case holding up to 40 anodes (Figure 1).

**Results and Discussion**

Using multiple capacitors in one hermetic case requires prescreening before assembly. A special procedure based on statistical screening [9] and voltage overexertion is applied on each capacitor. The principle is to remove any part that is not capable to withstand 90% of voltage applied during dielectric formation. In addition to this, DCL is
measured at 90% of forming voltage and parts with leakage from tails of distributions are as well are removed. Distribution of leakage measured before assembly at 90% of formation voltage is presented on Figure 2.

![Figure 2: DCL distribution of anodes before assembly](image)

Capacitors prepared in a ceramic case with nominal capacitance 22uF and rated voltage 100V have been tested under life conditions 85°C/100V, 125°C/67V and 150°C/50V. Results of capacitance and ESR are presented on Figure 3. No significant changes of capacitance is observed, small increase of ESR is visible during the first periods of life at 125 or 150°C. Based on these encouraging results, trials with more parallel capacitors in one case have been performed.

![Figure 3: Capacitance and ESR changes over time of life tests for TCH 22uF/100V](image)
Forty capacitors in parallel in a customized low profile hermetic case gave a final module with a nominal capacitance of 400uF at 100V. Figures 4, 5 show capacitances and ESR dependency on frequency and temperature. Figure 6 shows DCL measured at temperature range from -55 to 150°C. The module was then successfully tested for mechanical stability by shock and vibration, temperature shock (500x -55 to 125°C) and repeated surge. The module with such parameters (high energy, low DCL and super low ESR) could be suitable for high power high ripple current applications.
To further push the ripple current capability, modules assembled using 10 capacitors in TO3 metal case were prepared. TO3 case is commonly used for high power electronic components because of its ability to dissipate heat. Modules prepared in a TO3 case have nominal capacitance 100uF at 100V, ESR value 9mOhm. Figure 7 shows its ripple current capability. Measurement was carried out at 105°C, 10V DC voltage, AC frequency 20kHz. Current applied on TO3 100uF capacitor up to 15A RMS or 20A RMS on a low profile 400uF part does not lead to temperature increase greater than 20°C.
Conclusions

A new category of high voltage, super low ESR high power components based on tantalum polymer capacitor were presented. The most advanced technologies give a single capacitor capable of withstanding high temperatures up to 150°C.

The application of statistical methods based on measurement before assembly and burn-in leads to removal of flyers and thus gives the possibility to make extensive matrixes of parallel connected units. Very low ESR makes these devices ideal for high ripple current applications. Hermetic sealing gives protection and assures stable electrical parameters even under hard conditions including high humidity.

References


Member company news

Who would you recommend for T.I.C. membership?

Changes in member contact details

Minerals Resources International AG

Mr John Crawley has become the delegate to the T.I.C. for Minerals Resources International AG, in the place of Mr Girish Malik. The company can be contacted on sales@mrinternational.ch.

Mr Crawley also remains the T.I.C. delegate for Refractory Metals Mining Co. Ltd.

Yichun Jinyang New Materials Co. Ltd

Yichun Jinyang New Materials Co. Ltd has announced a new website: www.ycjinyang.cn

Resignations from membership

The following company has resigned from the Association since issue 164 of the Bulletin was released: Tinco Investments Ltd.
Members of the Executive Committee of the T.I.C.

The Executive Committee is drawn from the membership and committee members may be, but need not also be, the delegates of member companies. The current Executive Committee that was approved by the T.I.C. members at the Fifty-sixth General Assembly consists of (in alphabetical order of member’s surname):

Conor Broughton  conor@amgroup.uk.com
John Crawley  jcrawley@rmmc.com.hk
David Gussack  david@exotech.com
Dale Gwinnutt  dalegwinnutt@elitematerial.com
David Henderson (President)  dhenderson@rittenhouseir.com
Marc Hüppeler  marc.hueppeler@hcstarck.com
Jiang Bin  jiangb_nniec@otic.com.cn
William Millman  bill.millman@avx.com
David O’Brock  david.obrock@molycorp.com
Candida Owens  candida.owens@btinternet.com
Daniel Persico  danielpersico-rc@ nec-tokin.com
Alexey Tsorayev  tsorayeva@ulba.kz

Of these twelve, Mr David Henderson was re-elected as President of the T.I.C. until October 2016.

We are always looking for enthusiastic T.I.C. members to join our range of subteams. If you are interested in doing so and have a couple of hours each month spare, please don’t hesitate to contact director@tanb.org.

And finally… iTSCI’s Yves Bawa wins popular vote for conflict mineral leaders

In the popular vote for the 2016 Top 100 Conflict Minerals Influence Leader Mr Yves Bawa, iTSCI’s implementing manager and Pact Regional Program Director, has been voted as the most influential leader with 448 votes. Kay Nimmo, ITRI’s Sustainability and Regulatory Affairs Manager and manager of the iTSCI Secretariat, came second in the popular vote with 361 votes, followed by Michael Loch of Responsible Trade with 276 votes. Online voting closed on March 16th, after which time a second round of internal voting by the list organiser appears to have taken place.

The success of Mr Bawa and Ms Nimmo in the popular vote is a reflection of iTSCI’s work and commitment to finding solutions to reduce the links between minerals and conflict financing in the African Great Lakes region since 2011. The iTSCI Programme helps more than 300 upstream companies and around 1,500 mine areas in 4 countries (Burundi, DRC, Rwanda and Uganda).

Yves Bawa is the Burundi-based Pact Country Director for Democratic Republic of Congo (DRC), Rwanda and Burundi and the Pact Regional Program Director for the implementation of the iTSCI Programme, a due diligence and mineral traceability system in the region for conflict-free mining. Not only does Mr Bawa play a leading role in the implementation of the iTSCI program in Africa’s Great Lakes region and related projects to strengthen governance, security, social development and conflict reduction in the mining sector, but he has over ten years of experience as a project manager in DRC.