

T.I.C.

TANTALUM-NIOBIUM INTERNATIONAL STUDY CENTER

PRESIDENT'S LETTER

Dear Members and Friends,

With summer waning and autumn fast approaching this can mean only one thing, the General Assembly and associated technical meeting is not far away. All indications are that this will be a most successful event based on the number of registrants and applicants for new membership.

The site of this year's General Assembly, the historic city of York, in northeast England, looks to be an excellent place to catch up with "old" friends and make new ones. And for the accompanying participants, there is a wealth of things to do and see during the day whether it is going on the prearranged tours or just leisurely strolling the city's cobblestoned streets. I am certain that those of us involved in the meeting will be keenly interested in hearing what our spouses, partners and friends will have seen and experienced during their daily sojourns.

As for the discussions we will have at the General Assembly, the breadth of the technical presentations, the panel session on the progress in the area of Conflict Minerals as well as the market presentation by Dennis Zogbi, President of Paumanok Publications, I am certain there is more than enough technical and market content to keep everyone actively engaged in the meeting. The Executive Committee of the T.I.C. appreciates the time and effort that goes into preparing the presentations and accompanying documentations and thanks in advance all those who have committed in this manner to making this a very successful meeting.

I thank everyone who has worked with me over the last year. I hope you feel that during my term as President I have helped move the T.I.C. forward as a vital and contributing organization in the eyes of the membership and industry. And lest we forget, none of this is possible without the tireless efforts of our Secretary General, Ms Emma Wickens. Thank you Emma.

See you in York.

Regards,

Dr Daniel F. Persico (Dan)
President

CONTENTS

| | |
|-----------------------------------------------------------------|---------------------------|
| President's Letter.....1 | Member company news.....7 |
| Fifty-fourth General Assembly, technical programme/abstracts..2 | Executive Committee.....7 |

FIFTY-FOURTH GENERAL ASSEMBLY

The Fifty-fourth General Assembly will be held in York, England, from October 13th to 16th 2013. The conference will take place at the Royal York Hotel & Events Centre.

On Sunday October 13th, the registration desk will be open from 10a.m. to 1p.m. and 2p.m. to 5p.m. All participants are invited to a Welcome Reception that evening, from 6p.m. to 8p.m.

The formal General Assembly of the association will be held from 8.30a.m. till 9.30a.m. on Monday October 14th, this session is for existing members only. It will be followed by technical presentations until mid-afternoon, with a break for a buffet lunch.

On Monday evening, all participants are invited to a Gala Dinner to be held in the very special setting of the National Railway Museum, just a few steps away from the hotel.

A second technical session will be held on Tuesday October 15th, breaking for a buffet lunch and ending mid-afternoon.

The full technical programme is published herebelow. Papers on subjects related to the Supply Chain will be grouped together and followed by a panel discussion.

On the morning of Wednesday October 16th, delegates will be given the opportunity to visit the facility of Metalysis, located a little over an hour away from York. Lunch will be taken at the Monk Fryston Hall Hotel, a stately manor house dating back to the 12th century. The busses will then continue to the small market town of Masham, where a guided tour of the Theakston Brewery has been arranged.

Tours for accompanying persons are also being arranged for Monday, Tuesday and Wednesday. The first day will focus on the city of York, with its Medieval streets and Georgian avenues, the famous Minster and city walls. Participants will also discover the Jorvik Viking Centre and York's Sweet Story. The second day will take participants a little further afield, aboard a magnificent steam train, to the picturesque village of Goathland. The afternoon will be spent visiting Castle Howard, a beautiful stately home set in spectacular grounds. On Wednesday, accompanying persons will leave York at the end of the morning for Monk Fryston Hall Hotel, where they will take lunch with the delegates who visited Metalysis. They will then continue to Masham for the guided tour of the Theakston Brewery.

TECHNICAL PROGRAMME - ABSTRACTS

The following papers are expected.

Niobium oxide dielectric for capacitors: study of thermal characteristics and leakage current

by Tak Ohashi, SANYO Electric Co., Ltd

Research and development is currently ongoing for solid electrolytic capacitors with next generation materials, targeting small form factor, large capacitance and low ESR.

Niobium needs less quantity than tantalum to achieve the same CV value, considering the material performance. In addition, niobium is much cheaper than tantalum. These are the reasons why niobium is expected to increase as alternative to tantalum as capacitor material.

However, leakage current of niobium is higher than that of tantalum and niobium capacitor manufacturing is currently struggling due to lower performance than tantalum.

To reveal the cause for thermal characteristics change of niobium oxide dielectric and leakage current mechanism, we conducted some experiments to provide the guideline for material selection/process development. In this paper, capacitor products and materials, thermal characteristics change of niobium oxide dielectric and leakage current occurrence mechanism are described.

The Metalysis flexible manufacturing process - transforming the world of tantalum

by Ian Margerison, Metalysis

Metalysis has developed a transformational manufacturing process based on the FFC Cambridge technology. This offers a unique, environmentally friendly alternative to existing technologies and is particularly suitable for higher value metals including titanium, rare earths and in particular tantalum.

This presentation traces the development of the reduction by electrolysis process from its origins at Cambridge University through to commercialisation by Metalysis. Through a number of development phases and supported by a suite of over 25 patents, the Metalysis process now offers unique opportunities in tantalum and also 'designer' alloy combinations not previously considered possible.

The Metalysis process is both scalable and flexible in being able to deal with a number of metals. There are also potential recycling opportunities opened up for many industries. It is the biggest single development in metals production in sixty years. Metalysis will transform the world of metals.

Picturing the limitations to the CV/g and CV/cc of tantalum capacitors

by James Allen Fife, KEMET Blue Powder Corp.

It is strategically important to the tantalum industry to have an accurate expectation for the technical limitations to tantalum capacitors. One critical question is the amount of micro-farad volts that can be achieved with a given amount of tantalum material. The understanding of this limit is important to commercial decisions about the potential of the tantalum supply to sustain industry into the future.

This presentation explores predictions of sophisticated models of tantalum capacitors that take into consideration the detailed structure of the tantalum particles that make up the anode. The model predicts a large opportunity to further increase the value derived from tantalum reserves; and shows how the increased CV/g capabilities can be achieved through the application of straightforward design of the particle morphology.

New high productive electron beam melting system for bulky refractory metal materials

by Jochen Flinspach, Arno Niebling and Dieter Kaufhold, ALD Vacuumtechnologies GmbH (engineering company of the AMG group)

ALD Vacuumtechnologies GmbH, the engineering company of AMG, is introducing a new electron beam melting system for the consolidation of niobium and tantalum bulk material into easy to handle plates. The material is melted in a crucible system placed on a cart within a vacuum chamber. Evaporated metal is collected on condenser screens inside the chamber. The refined material consolidated to plates is easily accessible and handled by driving the cart outside the melt chamber. The produced plates can be either used directly after cutting into pieces as alloy component or as input material for further refining in additional EB-melting furnaces.

Besides this new system, ALD is a well-known supplier of electron beam melting systems to the tantalum and niobium producers. ALD's products start from laboratory size systems in the 60 kW range to big production systems of >6 MW installed melting power. Own process know-how gained on ALD's in house EB-melting service can be transferred during system start up to new entries into the melting business.

Metal dusts and certain considerations when defining a suitable basis of safety

by Michael Merritt and David Firth, Chilworth Technology Ltd (a DEKRA company)
(presented by Nigel Allen)

Generating a dust cloud explosion is relatively easy, but in practice prevention of an explosion is often more difficult to achieve. When handling metal powders with high ignition sensitivity and strong explosion characteristics coupled with the propensity to form dust clouds during normal processing conditions, it is vital that manufacturers and processors understand the need to control ignition risks and mitigate against explosion effects. The risks of explosion can be further exacerbated through the potential to liberate a highly flammable gas, such as hydrogen, when in contact with water, and in these circumstances process control becomes even more important to the safe operation of the process. The measures taken to reduce these risks are known as the Basis of Safety and are supported by a stringent testing programme to define a safe operating envelope for the process. Based on over a quarter of a century of practical process safety expertise, this paper will discuss how to tailor a testing regime to obtain pertinent data for metal powders with the aim of applying a robust Basis of Safety.

Stimulating statistics: the goal of rapid reporting of dependable data

by Ulric Schwela, Tantalum-Niobium International Study Center

The timely reporting of statistics for the members has long been a 'raison d'être' of the T.I.C. and this is no less the case today. Efforts continue to overcome difficulties as they arise, including finding new ways to stimulate a small number of members to report their data promptly.

Statistics are collected by the T.I.C. via an independent intermediary to preserve the confidentiality of reporting companies. These are then collated and published to the members every quarter, with four main categories for tantalum and two main categories for niobium:

- Tantalum primary production
- Tantalum processor receipts
- Tantalum processor shipments
- Tantalum capacitor producer receipts
- Niobium primary production
- Niobium processor shipments

Each of these is further sub-divided into anywhere from two to six sub-categories.

The presentation will look at the figures of the past decade to reveal trends, as well as make comparisons between different categories to highlight differences.

A unique Metalysis tantalum product offering for capacitor manufacture

by Ian Mellor, Ian Margerison, Greg Doughty and Lucy Grainger, Metalysis

Through recent development of the Metalysis process and technology, it has been possible not only to produce high quality tantalum powder, but also to produce a product with morphology uniquely suited to the demanding capacitor market requirements.

Tantalum is a high value product traditionally produced by a complex environmentally demanding process. The Metalysis process provides an alternative technology which is both simple and environmentally benign. As well as producing metallurgical grade tantalum, the Metalysis process can also produce electronics and capacitor grade powders. Tantalum is mainly used in capacitors and is the most reliable material in this field.

The presentation describes the development over recent years in tantalum product, purity and morphology. The process benefits are explained and illustrated with product development examples.

The effect of additives to the conductive polymer solution for low-ESR electrolytic capacitors

by Yasuhiro Tomioka, Yasuhisa Sugawara and Koji Sakata, NEC TOKIN Corporation
(presented by Takashi Kono)

NEC TOKIN provides a rich lineup of tantalum solid electrolytic capacitors. We have contributed, in items such as smart phones and tablet PC, to stabilizing the power supply line and to the miniaturization of electronics.

In NEO Capacitor®, we have put conductive polymer into a tantalum capacitor for the first time in the world. It has become a standard product in the field of broadband noise reduction by its excellent noise absorption performance.

For the lower ESR of solid electrolytic capacitors, the higher electric conductivity of conductive polymer is needed.

We considered application of additive agent to the PEDOT/PSS conductive polymer solution in order to improve electric conductivity of the conductive polymer.

We analyzed in this paper mechanisms of conductivity enhancement by additives: inter-molecular electron hopping and inter-particle electron hopping.

By XRD and XPS, we observed high crystallization and homogenization of PEDOT/PSS film that was made from PEDOT/PSS conductive polymer solution with additive agent. From the results, inter-molecular electron hopping and inter-particle electron hopping were suggested as effective factors of conductivity enhancement by additives.

Study of the morphology and electrical properties of tantalum powders prepared by electro-deoxidation method

by Li Jun-Yi, Zheng Ai-Guo, Wang Dong-Xin and Luo Wen, Ningxia Orient Tantalum Industry Co. Ltd
(presented by Guo Hong)

The features of the production and the relationship between the Ta₂O₅ and Ta powder have been obtained in the production of tantalum by electro-deoxidation preparation. The pentoxide changes to other oxides of tantalum during the electrolysis. These other oxides of tantalum are not stable, they combine with other metal ions in solution to form an interphase with tantalum. When the oxygen content in the interphase reduces to a level, the interphase results in 200-400 nm particles of tantalum which then form a single stranded cellular polymer. The microstructure of Ta powder and Ta₂O₅ powder is the same. In studying the electrical properties of the tantalum powder after different electrolysis times, the longer the time the greater the electrical capacity. The calculated current efficiency of the process is low and to achieve industrial application the efficiency must be increased.

How tantalum competes in global markets

by Dennis Zogbi, Paumanok Publications, Inc.

An in-depth look at the competition to attain tantalum metal among industries, and how effectively tantalum competes with other technologies and is expected to compete over the next five years.

Tantalum plays a key role in the electronics and industrial landscape - from sputtering targets and capacitors in the electronics industry, to superalloys for aerospace, specialty products for the medical and chemical based industries and cemented carbides for machine tools. This presentation, while focusing mainly on electronic applications for tantalum, with emphasis upon capacitors, will look at the tantalum industry as a whole and the increasing competition among industries for the metal.

The presentation will also compare the tantalum electronics supply chain in comparison to the supply chain for other capacitor raw materials, competition between capacitor types, and the market drivers that will impact the demand for tantalum versus other dielectric materials over the next five years. In addition, a look at the broader industrial markets where tantalum is used and the trends and drivers that will likely impact demand for tantalum in those markets will also be discussed.

Optimizing volumetric efficiency of tantalum anodes by controlling anode micro-structure

by James Allen Fife, KEMET Blue Powder Corp.

One of the most important attributes of any capacitor is the volumetric efficiency: the quantifiable value of the functionality of the capacitor relative to a characteristic volume of the device. The ongoing miniaturization of electronics is enabled by the continual improvement to the volumetric efficiency of tantalum capacitors.

This paper explores the theoretical limitations to volumetric efficiency that can be achieved with tantalum capacitors made of porous pellet anodes and shows that the net volumetric efficiency of the anodes themselves can be analyzed in terms of several factors that have the effect of reducing the yield of CV/cc. By identifying and clearly understanding these inefficiency factors it is anticipated that researchers will find methods to control these factors to significantly increase the volumetric efficiency of tantalum anodes above the levels that are achieved today, thus, enabling new opportunities for further miniaturization of electronic devices.

Taboca - moving forward and getting into upper gears

by Ian Gordon Hall Dun and Jorge Diaz, Mineração Taboca S.A.

The Pitinga mine, located in the Amazon state of Brazil, has vast resources of tin, niobium and tantalum in a low grade matrix which has been a challenge for many years to produce with efficiency, due to separation issues of the valuable minerals.

In recent years, Taboca has invested to develop a new process to produce a bulk concentrate by gravity, composed of SnO_2 , $(\text{Nb,Ta})_2\text{O}_5$, ZrSiO_4 and Fe_2O_3 but, due to the rare partial paramagnetic properties of the cassiterite and the zircon present in the Pitinga ore, conventional magnetic upgrading routes have not given the expected results for recoveries and concentrates quality.

In 2011, Taboca developed in the laboratory a flotation route for the $(\text{Nb,Ta})_2\text{O}_5$ minerals from the tin flotation tails thus avoiding whatever interference from the paramagnetic properties of the other minerals and this development led to the installation of a pilot circuit, installed in July 2012 and operating at 5tph, in a continuous 24 hour operation.

The current capacity of the gravity plant is a ROM feed of 800tph which results in approximately 25.000 t/month of a gravity pre-concentrate with 3,5% Sn and 2,5% $(\text{Nb,Ta})_2\text{O}_5$ contained, which is fed into a tin flotation circuit, producing a 50% grade tin concentrate. The $(\text{Nb,Ta})_2\text{O}_5$ minerals report to the Sn flotation tails and these tails feed the new $(\text{Nb,Ta})_2\text{O}_5$ pilot flotation circuit.

The $(\text{Nb,Ta})_2\text{O}_5$ pilot circuit has capacity to produce 150 tons of $(\text{Nb,Ta})_2\text{O}_5$ concentrate per month with about 35% $(\text{Nb,Ta})_2\text{O}_5$ contained and process recovery of 65%. At the moment, studies are being undertaken to transform the pilot operation into a full scale industrial operation, resulting in a much larger production of $(\text{Nb,Ta})_2\text{O}_5$ concentrate and consequently a much larger FeNbTa alloy production for our customers.

Ferro-niobium in cored wire

by Rainer Hackstein and José Luis Carmona, Global Metwire Injection S.L.
(both presenting)

What is cored wire?

How is cored wire produced?

Where and why is cored wire used?

The use of ferro-niobium in cored wire and the advantages.

The presentation will give an overall view of cored wire production and what is needed.

It will show the two main applications in steel making.

It will give a schematic view of a typical cored wire installation in a steel plant.

The presentation will highlight the specific advantages of ferro-niobium in cored wire compared to the usage of ferro-niobium in lumpy form.

The presentation will show the environmental advantages of ferro-niobium in cored wire versus the standard ferro-niobium application in lumpy form.

It will highlight the better standard deviation of ferro-niobium cored wire through a higher yield and more precise addition.

It will give other advantages and possible future developments.

Novel high voltage tantalum powder for new applications

by Christoph Schnitter, Marcel Hagymási, Helmut Haas and Holger Brumm, H.C. Starck GmbH

New electronic applications in the fields of flat panel displays, telecommunications, automotive as well as medical devices need high voltage tantalum capacitors with increasing energy densities. To meet the requirements for making these new

devices, suitable tantalum powders have to fulfill different demands on pore size distribution, primary particle size and homogeneity, chemical purity and physical properties like good flowability in order to ensure high capacitance, open pore structure for infiltration as well as electrical and mechanical stability. To follow these market needs, H.C. Starck is continuously developing new tantalum powders with a focus on formation voltages in the range of 60-300 V.

The tantalum powders obtained by the Mg reduction process of H.C. Starck provide a unique combination of high purity and excellent macro- and microstructural homogeneity. In the past, these powders were mainly used for low forming voltages up to 60 V and high capacitance ranges. The extension to higher voltage applications was limited since bigger pores >400 nm could not be generated with the existing process route. By using a new advanced production process it is now possible to overcome this limitation thus allowing production of such tantalum powders with mean pore sizes >1 µm combined with an improved microstructural homogeneity for high voltage applications. This enables to extend the formation voltage range of Mg reduced powder from 60 V up to 200 V while keeping maximum capacitance and excellent leakage currents. The properties of these new tantalum powders will be compared to those of existing high voltage powders in order to show the improved pore structure and particle homogeneity as well as the resulting capacitance behaviour.

Conflict free mineral supply chains: from planning to action

by Tyler Gillard, OECD

The tantalum supply chain: strengthening transparent traceability

by Ulric Schwela, Tantalum-Niobium International Study Center

Spurred by a 2008 report by a United Nations Group of Experts, in 2009 the T.I.C. embarked on efforts to improve the transparency of the tantalum supply chain. The focus was on minerals obtained by artisanal scale mining and a working group was set up to examine the avenues that the association could pursue. It soon became evident that the most effective outcome that would address the goal of transparency would stem from co-operation with the tin industry. This was achieved by supporting the nascent ITRI Tin Supply Chain Initiative (iTSCi) which began a pilot programme at selected mine sites in the Kivu provinces of the DRC in 2010.

While the DRC mining ban of September 2010 also ended the iTSCi pilot programme, the iTSCi programme re-started in Rwanda, where it exists nationwide. It subsequently expanded back into the DRC where it covers all of Katanga, part of Maniema and a pilot mine site in South Kivu. Along with more mines covered, all other aspects of the programme continue to grow in size and scope. A pilot trial of electronic data recording began in April 2013, with a view to extending it to those areas where the infrastructure will support it.

Recently two issues have incorrectly been perceived by some observers as having an impact on the programme. One is stolen tags, which amount to a trifling quantity and which are readily identified by reference to the iTSCi database, thus the tags are of no value. The other issue has been the much publicised theft of minerals from an east African port, whose identification by buyers depends entirely on them conducting appropriate due diligence and has no connection with iTSCi.

An update will also be provided on the outreach efforts by EICC/GeSI and the OECD, as well as related activities.

Conflict Minerals

What EICC members need to know about conflict minerals, from a responsibility perspective as well as for reporting requirements. Issues addressed range from covered minerals and countries, to reporting requirements and due diligence guidance.

by Michael Rohwer, EICC and Mike Loch, Motorola Solutions

This 'Reasonable Practices' white paper is intended as a practical guide for downstream companies that have reporting obligations about conflict minerals that may be used in their supply chains. This paper may also be helpful for suppliers to better understand their customer's expectations and requirements. This paper is not a set of rules or a method for compliance with existing legislation. Rather, this paper seeks to provide clear explanations and practical tips for companies about how to understand the source of minerals in their supply chains and how that understanding can contribute to their required reporting.

Field update on the iTSCi system

by Karen Hayes, Pact

Since 2010, Pact has worked with T.I.C. and ITRI to support the field implementation of the iTSCi system for due diligence and traceability of the '3Ts'. The iTSCi system is a comprehensive, upstream, in-region response to the requirements of Section 1502 of the Dodd-Frank Act, the Security and Exchange Commission Rules on conflict minerals, and the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. The system is implemented in partnership with Governments in the region and includes a range of components including mine assessments, a bag-and-tag tracking system, a community-monitored system to record violations of the system, an international database, due diligence of member companies, risk assessments and audits. iTSCi covers minerals from the mine to the smelter where they then enter the Conflict-Free Smelter process. The system has grown dramatically from the 2010 pilots with now over 700 conflict-free sources of coltan (columbo-tantalite), cassiterite (tin) and wolfram (tungsten) identified and incorporated. This rapid growth has

brought both opportunities as well as challenges. This presentation will reflect on progress, obstacles and lessons learned in the different contexts of the Democratic Republic of Congo, Rwanda and Burundi where now some 40 000 artisanal miners depend on the system as the means to get the minerals to the international market.

MEMBER COMPANY NEWS

We would like to remind you that articles concerning T.I.C. members or the industry in general are posted regularly on the T.I.C. website in the section entitled '[News](#)'.

CHANGES IN MEMBER CONTACT DETAILS

King-Tan Tantalum Industry Ltd

Mr Wu Zhihai has been designated as new delegate to the T.I.C. for the company King-Tan Tantalum Industry Ltd. He can be reached on tanb@king-tan.com.

Riffenhouse International Resources LLC

Riffenhouse International Resources LLC has changed address and contact numbers. New details are: P.O. Box 3714, Concord, NH03302, U.S.A., tel: +1 603 715 5700, fax: +1 603 715 2783.

EXECUTIVE COMMITTEE

According to the Charter of the T.I.C., the Executive Committee may consist of between two and eleven people, plus the President. The Executive Committee is drawn from the membership and committee members may be, but need not also be, the delegates of member companies. The Executive Committee composition is approved by the T.I.C. members at each General Assembly, and it currently consists of (in alphabetical order):

- Jiang Binjiangb_nniec@otic.com.cn
- John Crawleyjcrawley@rmmc.com.hk
- José Isildo de Vargas.....isildo@cbmm.com.br
- Alan Ewartadewart@alance.co.uk
- Alex Gagarinulba.gagarin@gmail.com
- David Henderson.....dhenderson@riffenhouseir.com
- Ian Margerison.....ian.margerison@metalysis.com
- William Millman.....william.millman@eur.avx.com
- Yasukazu Mutoyasukazu.muto@hcstarck.com
- Hiroya Nishimoto.....nishimoto.hiroya@jp.panasonic.com
- Daniel Persico (President)danielpersico@rc.jp.nec.com
- Itamar Resendeiresende@lsm.co.uk

