

# TIC

TANTALUM-NIOBIUM  
INTERNATIONAL STUDY CENTER

## Bulletin N° 182

JULY 2020

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# President's Welcome

Dear Members:

It is my hope this note finds you and your family healthy and safe. As the summer months start in the Northern hemisphere we all hope this nasty pandemic doesn't take advantage of this opportunity with families going on holiday. Here in the US, especially in certain states, we are seeing a resurgence of Covid-19 as people became too relaxed. Please stay safe and vigilant.

With this letter we are trying something different as my letter will be translated into the four languages into which we translate our annual Bulletin Review (Portuguese, Japanese, French and Chinese). I hope you and your colleagues find it beneficial.

The Executive Committee, Roland, Emma, Dave and I have been working very hard on your behalf and I will mention the four main items here: 1) The virtual General Meeting, which required you to vote by email on the accounts, the budget and specific charter items was a success. I appreciate all who took the time to return their ballots so that we could achieve a quorum. As you know, all items were passed successfully, 2) the NORM initiative is moving ahead nicely as we are building the necessary regulatory support to have TRANSSC vote in our favour to review the exemption limits for U-238 and Th-232 which directly impact tantalum ore denial of shipments (see page 24), 3) ITSCI funding has been a major item of discussion over the past few months as revenue from levies has decreased significantly, in part due to Covid-19 and the resulting impact on market demand and shipments. We have been working with RMI and ITSCI to determine how we can lend support to stabilize ITSCI through this tough period (see page 27), and last but not least, 4) while I am not feeling positive about holding our 61st General Assembly in Geneva this October, we continue to prepare on the slight chance it will happen. The membership will be polled on this matter once more during July for one last opportunity to receive your opinion on the matter before the final decision.

As always, I look forward to hearing from you and please stay safe.

Regards,

Dr Daniel Persico, President

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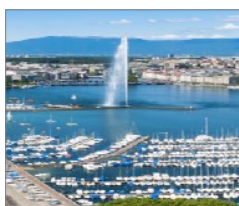
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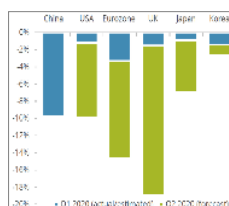
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# 主席致辞



亲爱的会员们，

我希望你收到这封信时你和你的家人都平安和健康。随着北半球踏入夏季，很多家庭也开始放暑假去旅行，我们希望这个令人讨厌的疫症不要趁机肆虐。在美国某些州郡，由于人们开始放松戒备使新型冠状病毒又再在社区爆发。请大家注意安全和保持警惕。

我们刻意把这封信像年刊一样以四种语言翻译（葡萄牙语/日语/法语/中文）。希望您和您的同事都能受益。

执行委员会，罗兰（Roland），艾玛（Emma），戴夫（Dave）和本人一直为您们努力，这里有四个主要事项：1) 虚拟股东大会有赖您们的支持，通过电子邮件对帐目，预算和具体章程都成功投票通过。我感谢所有花时间投票的会员使我们达到法定人数成功通过所有项目；2) 天然放射性物质(NORM)计划进展顺利：我们建立了必要的监管支持，让运输安全标准委员会（TRANSSC）投票支持我们，以降低对U-238和Th-232的拒绝钽矿石装运豁免限制；3) 在过去的几个月中，ITSCI资金一直是讨论的主要议题，因为来自征费收入显著下降，部分原因是新型冠状病毒及其对市场需求和装运的影响。我们一直在与负责任的矿产倡议组织（RMI）和ITSCI合作，以确定如何在这个艰难时期为ITSCI提供支持，最后4) 虽然我对今年10月在日内瓦举行的第61届会议（GA61）并不乐观，但我们仍会继续为这可能性低的会议做好准备。在7月，我们将请各成员进行最后一次投票，希望在最终决定之前听取您对此事的意见。

跟往常一样，我希望能收到您们的反馈。

祝你们平安。

丹尼尔·佩尔西科博士（Daniel Persico），主席

# Lettre du Président



Chers membres,

J'espère que cette note vous trouvera, vous et vos familles, en bonne santé et en sécurité. Alors que les mois d'été commencent dans l'hémisphère Nord, nous espérons tous que cette vilaine pandémie ne profitera pas de cette opportunité, avec les familles qui partent en vacances. Ici aux États-Unis, en particulier dans certains états, nous assistons à une résurgence du Covid-19 car certains ont baissé leurs gardes. Veuillez rester en sécurité et vigilants.

Avec cette édition, nous expérimentons une nouveauté car ma lettre sera traduite dans les quatre langues dans lesquelles nous traduisons notre Revue du Bulletin annuelle (portugais / japonais / français / chinois). J'espère que vous et vos collègues trouvez cela bénéfique.

Le Comité Exécutif, Roland, Emma, Dave et moi continuons à travailler en votre nom et je mentionnerai ici les quatre points principaux: 1) L'assemblée générale virtuelle, qui vous invitait à voter par email sur les comptes, le budget et des amendements des statuts, a été un succès. Merci à tous ceux qui ont pris le temps de retourner leurs bulletins de vote afin que nous puissions atteindre le quorum. Comme vous le savez, tous les éléments ont été délibérés avec succès, 2) l'initiative NORM progresse bien: nous construisons le soutien réglementaire nécessaire pour que TRANSSC vote en notre faveur afin de revoir les limites d'exemption pour U-238 et Th-232 qui ont un impact direct sur les refus de transport de minerai de tantale, 3) Le financement d'ITSCI a été un sujet de discussion majeur au cours des derniers mois, les revenus provenant des prélèvements ayant considérablement diminué, en partie en raison du Covid-19 et de son impact sur la demande du marché et les expéditions. Nous avons travaillé avec RMI et ITSCI pour déterminer comment nous pouvons apporter notre soutien pour stabiliser le programme ITSCI pendant cette période difficile, et enfin et surtout, 4) alors que je ne suis pas optimiste quant à la tenue du GA61 à Genève en octobre, nous continuons à nous préparer au cas où la réunion pourrait se tenir. Les membres seront à nouveau interrogés sur cette question au cours du mois de juillet pour une dernière occasion de recevoir leur avis, avant la décision finale.

Comme toujours, j'ai hâte d'avoir de vos nouvelles et je vous prie de rester en sécurité.

Cordialement,

Dr Daniel Persico, Président

# 社長のあいさつ



メンバー各位

メンバー皆様として皆様の御家族が健康で安全であることを願っています。北半球は夏が始まり、この厄介なパンデミックが家族との休暇の機会をなくすようなことにならないことを祈っています。ここ米国では、特に特定の州では、人々がリラックスしすぎたため、Covid-19の再感染が見られます。

安全と警戒を怠らないでください。

年次のBulletin Reviewを4言語（ポルトガル語/日本語/フランス語/中国語）に翻訳したように、今回も異なった試みをしたく思い、皆様にも有益であると信じております。

執行委員会、ローランド、エンマ、デイブ、私たちはメンバを代表して一生懸命取り組んでおり、ここでは4つの主要な項目について言及します。

- 1) 仮想総会として決算書、予算、およびその他項目について投票していただき、すべて可決しております。
- 2) NORMイニシアチブは順調に進んでいます。私たちは、タンタル鉱石の運送に直接影響するU-238およびTh-232の免除制限を検討するためにTRANSSC投票に賛成するために必要な規制サポートを構築しています。
- 3) Covid-19により市場の需要と出荷の影響が原因で、過去数か月間でITSCIの資金調達が大きな議論的となりました。私たちは、RMIとITSCIと協力して、この厳しい期間を通じてITSCIを安定させるためのサポートをどのように提供できるかを決定してきました。
- 4) 今年の10月にジュネーブでGA61を開催が困難だとは感じながらも、まずかなチャンスを残しつつ、ワークし続けております。

最終決定前に再度メンバー方々に意見をお聞きしたく思います。

ご意見お待ちいたしております。皆様のご健康とご多幸を祈っております。

ダニエル・F・パーシコ、PhD、, 社長

# Boas-vindas do presidente



Caros Membros,

Espero que esta nota encontre vocês e suas famílias com saúde e em segurança. Enquanto os meses de verão começam no hemisfério norte, todos esperamos que essa odiosa pandemia não aproveite tal oportunidade com as famílias que estão saindo de férias. Aqui nos EUA, especialmente em alguns estados, estamos notando um ressurgimento da Covid-19 à medida que as pessoas começam a relaxar demais. Por favor, fiquem seguros e vigilantes.

Com esta carta, estamos tentando algo diferente, uma vez que ela será traduzida para os quatro idiomas para os quais traduzimos nossa Revisão Anual do Boletim (japonês/francês/chinês/português). Espero que vocês e seus colegas achem isso proveitoso.

O Comitê Executivo, Roland, Emma, Dave e eu temos trabalhado muito em nome de vocês, e mencionarei aqui os quatro principais itens: 1) A Reunião Anual Virtual, que requisitou seu voto eletrônico no orçamento e em itens normativos específicos, foi um sucesso. Agradeço a todos que dedicaram seu tempo para enviar seus votos, de modo que pudéssemos alcançar um quorum. Como vocês sabem, todos os itens foram aprovados com êxito; 2) a Iniciativa NORM está progredindo bem, à medida que estamos construindo o apoio regulatório necessário para que o TRANSSC vote a nosso favor no sentido da revisão dos limites de isenção para o U-238 e o Th-232, os quais têm impacto direto nas recusas de embarques de minérios de tântalo; 3) o financiamento do ITSCI tem sido um importante item de discussão nos últimos meses, uma vez que a receita com as taxas diminuiu significativamente, em parte devido à Covid-19 e ao consequente impacto na demanda do mercado e nos embarques. Temos trabalhado com a RMI e o ITSCI para verificar como podemos dar apoio para estabilizar o ITSCI durante esse difícil período; e, por último, mas não menos importante, 4) embora eu não esteja otimista no tocante à realização da GA-61 em Genebra, em outubro deste ano, continuamos a nos preparar para a pequena chance de que isto aconteça. Os membros serão consultados novamente sobre este assunto em julho, para uma última chance de recebermos sua opinião antes da decisão final.

Como sempre, gostaria de ouvir seus comentários e, por favor, fiquem seguros.

Saudações,

Dr. Daniel Persico, Presidente

# The Anders Gustaf Ekeberg Tantalum Prize: Shortlist 2020

## *Recognising excellence in tantalum research and innovation*



The Anders Gustaf Ekeberg Tantalum Prize ('Ekeberg Prize') is awarded annually by the T.I.C. for excellence in tantalum research and innovation and the 2020 shortlist shows that the level of interest in element #73 remains as high as ever\*.

Technology-driven innovations will ensure the long-term future of the tantalum market and with so many potential new or embryonic applications in development there is every reason for optimism in the future.

The Ekeberg Prize was established by the T.I.C. in 2017 to increase awareness of the many unique properties of tantalum products and the applications in which they excel. To date the Ekeberg Prize has been awarded for outstanding work on the subjects of tantalum capacitors (2018, Dr Yuri Freeman) and additive manufacturing (2019, Nicolas Soro et al).

This year, the seven publications on the shortlist show the great versatility of tantalum in a number of cutting edge applications:

- Tantalum recycling by solvent extraction: chloride is better than fluoride
- Tantalum (Ta) and niobium (Nb) containing alloy powders for application in additive manufacturing
- Tantalum bone implants printed by selective electron beam manufacturing (SEBM) and their clinical applications
- Discovery of  $\omega$ -free high-temperature Ti-Ta-X shape memory alloys from first-principles calculations
- Fabrication of porous tantalum and tungsten black coatings for artificial earth satellites
- Remelt processing and microstructure of selective laser melted Ti25Ta
- Tantalum(V) 1,3-propanediolate beta-diketonate solution as a precursor to sol-gel derived, metal oxide thin films

### **About the Ekeberg Prize**

The Ekeberg Prize is named after Dr Anders Gustaf Ekeberg, who discovered tantalum in 1802 while researching mineral chemistry at Uppsala University. Born in 1767, Anders Gustaf Ekeberg was a Swedish scientist, mathematician, and poet. He became a professor at Uppsala University in 1794 and initially made his name by developing advanced analytical techniques and by proposing Swedish names for the common chemical elements according to the principles set out by the "father of modern chemistry" Antoine-Laurent de Lavoisier.

Ekeberg discovered the oxide of tantalum in 1802, isolating it from samples of two different minerals collected from mines in Sweden and Finland. However, it was not an easy process to identify tantalum and according to Ekeberg's friend, the chemist Jacob Berzelius, Ekeberg chose the name 'tantalum' partly to reflect the difficulties that he had experienced in reacting the new element with common acids (and partly out of his passion for ancient Greek literature. Tantalus was a demi-god who killed and cooked his son, Pelops, and as punishment was condemned to stand in a pool of water beneath a fruit tree with low branches, with the fruit ever eluding his grasp, and the water always receding before he could take a drink; see [Bulletin #175](#) for his full story).

The Ekeberg Prize is sponsored by the T.I.C. and is central to its efforts to publicise the many exceptional benefits afforded by this element. The winner will be recognized by the tantalum industry and receive his/her prize medal, made by the Kazakhstan Mint from pure tantalum metal, at the 61st General Assembly in Geneva, Switzerland, in October 2020.

\* Although T.I.C. represents and supports both tantalum and niobium equally, the Ekeberg Prize focuses on tantalum, because CBMM's Charles Hatchett Award ([www.charles-hatchett.com](http://www.charles-hatchett.com)) already superbly recognises niobium published research.

## How the winner will be chosen

The Ekeberg Prize is judged by an independent Panel of Experts who are selected from around the world to provide an impartial assessment on the technical merit of the shortlisted papers. Members of the current T.I.C. Executive Committee and staff cannot sit on the Panel. This year, we are honoured to have on the Panel the following experts (for biographies please visit [www.tanb.org/view/panel-of-experts](http://www.tanb.org/view/panel-of-experts)):

- Richard Burt (Kielsinn Inc., Canada), a former T.I.C. President with considerable industry experience (Chair)
- Professor Elizabeth Dickey, Professor of Materials Science and Engineering at North Carolina State University, USA
- Magnus Ericsson, a consulting professor in mineral economics at Luleå University of Technology, Sweden
- Dr Axel Hoppe, a former T.I.C. President who worked at H.C. Starck for over 30 years, based in Germany
- Dr Nedal Nassar, Chief of the Materials Flow Analysis Section at the National Minerals Information Center, USGS, USA
- Professor Toru Okabe of the Institute of Industrial Science, The University of Tokyo, Japan
- Tomáš Zedníček Ph.D., President of the European Passive Components Institute (EPCI), Czech Republic

The winner of the 2020 Ekeberg Prize will be announced in September 2020.

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## Tantalum recycling by solvent extraction: chloride is better than fluoride

Authors: Luke M. M. Kinsman<sup>1</sup>, Rosa A. M. Crevecoeur<sup>1</sup>, Amrita Singh-Morgan<sup>1</sup>, Bryne T. Ngwenya<sup>2</sup>, Carole A. Morrison<sup>1</sup> and Jason B. Love<sup>1</sup>

Organisations: 1. EaStCHEM School of Chemistry, University of Edinburgh, Edinburgh EH9 3FJ, UK;  
2. School of Geosciences, University of Edinburgh, Edinburgh EH9 3FE, UK;

Full article at: Metals 2020, 10(3), 346;  
<https://doi.org/10.3390/met10030346>

The recycling of tantalum (Ta) is becoming increasingly important due to the criticality of its supply from a 'conflict' mineral. It is used extensively in modern electronics, such as in capacitors, and so electronic waste is a potentially valuable secondary source of this metal. However, the recycling of Ta is difficult, not least because of the challenges of its leaching and subsequent separation from other metals. In this work, we show that Ta(V) halides, such as TaCl<sub>5</sub> and TaF<sub>5</sub>, which can potentially be accessed from Ta metal upon acid halide leaching, can be recovered by solvent extraction using a simple primary amide reagent. The need for high halide concentrations in the aqueous phase implies the formation of the hexahalide salts [TaX<sub>6</sub>]<sup>-</sup> (X = F, Cl) and that an anion-swing mechanism operates. While extraction of the fluorides is poor (up to 45%), excellent extraction under chloride conditions is found (>99%) and presents an alternative route to Ta recycling.

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## Tantalum (Ta) and niobium (Nb) containing alloy powders for application in additive manufacturing

Authors: Ilka Kaczmarek, Markus Weinmann, Melanie Stenzel and Christoph Schnitter

Organisation: TANIOWIS GmbH (H.C. Starck Tantalum and Niobium GmbH), Im Schleeke 78-91, 38642 Goslar, Germany

Full article at: International Journal of Powder Metallurgy, Volume 55, No. 4, 2019  
[https://www.semanticscholar.org/paper/TANTALUM-\(Ta\)-AND-NIOBIUM-\(Nb\)-CONTAINING-ALLOY-FOR-Kaczmarek-Weinmann/8883a4bffa6075046fdb8ace639c9b8c408b4267](https://www.semanticscholar.org/paper/TANTALUM-(Ta)-AND-NIOBIUM-(Nb)-CONTAINING-ALLOY-FOR-Kaczmarek-Weinmann/8883a4bffa6075046fdb8ace639c9b8c408b4267)

Additive manufacturing (AM) opens new opportunities for producing parts with complex geometries and designs that cannot be realized by subtractive machining. While AM enlarges the scope of manufacturing possibilities, the intrinsic properties of the materials applied can limit the range of accessible applications. In this context, Ta and Nb, as well as new Ta- and Nb-based alloy powders, can serve special fields of application; e.g., chemical processing, superconductors, energy, or high-temperature environments. Moreover, additively manufactured Ta/Nb-containing alloys are a promising alternative for optimization of mechanical and biological performance parameters in medical implants. The present paper gives an overview of the development of pure Ta, Nb, and Ta/Nb-containing alloy powders that have been specifically designed for application in AM processes. It is shown how spherical powders of this category are produced, optimized, and AM built in test geometries as well as for selected application-oriented complex parts. Mechanical parameters of built specimens obtained from selected pre-alloyed powders are discussed. Studies on the microstructure, chemical composition, and phase composition of the respective built parts are described and examples of applications provided that can derive future benefit of those materials.

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## Tantalum bone implants printed by selective electron beam manufacturing (SEBM) and their clinical applications

Authors: H.P. Tang<sup>1,4</sup>, K. Yang<sup>1</sup>, L. Jia<sup>1</sup>, W.W. He<sup>2</sup>, L. Yang<sup>3,5</sup> and X.Z. ZHANG<sup>1</sup>

Organisations: 1.—State Key Laboratory of Porous Metal Materials, Northwest Institute for Nonferrous Metal Research, Xi'an 710016, China.  
2.—Xi'an Sailong Metal Materials Co. Ltd, Xi'an 710016, China.  
3.—Army Medical University, Chongqing 400038, China

Full article at: JOM: the journal of the Minerals, Metals & Materials Society 72(3) · January 2020  
<https://link.springer.com/article/10.1007/s11837-020-04016-8>

Tantalum is a refractory metal with a melting point of 2996°C but it offers outstanding biocompatibility for bone implant applications. In this study, the selective electron beam melting (SEBM) process was used for the first time to fabricate both dense and fine lattice tantalum structures. The use of 90-ppm-oxygen Ta powder for SEBM ensured excellent ductility of the as-printed fine Ta lattice implants with strut diameter of just 350 µm. The as-printed dense Ta samples (99.90%) achieved tensile ductility of 45% compared with the minimum requirement of 25% by ISO 13782 and the reported 2% fabricated by SLM using 1800-ppm-oxygen Ta powder. Since 2016, 27 clinical applications have been achieved in China using the custom-designed and SEBM-printed Ta implants by the authors of this study. All these Ta implants (mostly Ta lattice structures) have performed satisfactorily in patients' bodies so far. Three selected clinical applications, Ta lattice hip, fibula and femur implants, are briefly discussed in this article.

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## Discovery of $\omega$ -free high-temperature Ti-Ta-X shape memory alloys from first-principles calculations

Authors: Alberto Ferrari<sup>1</sup>, Alexander Paulsen<sup>2</sup>, Dennis Langenkämper<sup>2</sup>, David Piorunek<sup>2</sup>, Christoph Somsen<sup>2</sup>, Jan Frenzel<sup>2</sup>, Jutta Rogal<sup>1</sup>, Gunther Eggeler<sup>2</sup> and Ralf Drautz<sup>1</sup>

Organisations: 1. Interdisciplinary Centre for Advanced Materials Simulation, Ruhr-Universität Bochum, 44801 Bochum, Germany  
2. Institut für Werkstoffe, Ruhr-Universität Bochum, 44801 Bochum, Germany

Full article at: Phys. Rev. Materials 3, 103605 – Published 21 October 2019  
<https://journals.aps.org/prmaterials/abstract/10.1103/PhysRevMaterials.3.103605>

The rapid degradation of the functional properties of many Ti-based alloys is due to the precipitation of the  $\omega$  phase. In the conventional high-temperature shape memory alloy Ti-Ta, the formation of this phase compromises completely the shape memory effect, and high (>100°C) transformation temperatures cannot be maintained during cycling. A solution to this problem is the addition of other elements to form Ti-Ta-X alloys, which often modifies the transformation temperatures; due to the largely unexplored space of possible compositions, very few elements are known to stabilize the shape memory effect without decreasing the transformation temperatures below 100°C. In this study, we use transparent descriptors derived from first-principles calculations to search for new ternary Ti-Ta-X alloys that combine stability and high temperatures. We suggest four alloys with these properties, namely Ti-Ta-Sb, Ti-Ta-Bi, Ti-Ta-In, and Ti-Ta-Sc. Our predictions for the most promising of these alloys, Ti-Ta-Sc, are subsequently fully validated by experimental investigations, the alloy Ti-Ta-Sc showing no traces of  $\omega$  phase after cycling. Our computational strategy is transferable to other materials and may contribute to suppress  $\omega$  phase formation in a large class of alloys.

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## Fabrication of porous tantalum and tungsten black coatings for artificial earth satellites

Authors: Yu. Zh. Tuleushev<sup>a,b</sup>, V. N. Volodin<sup>a,c</sup>, E. A. Zhakanbaev<sup>a</sup>, E. E. Suslov<sup>a</sup>, and A. S. Kerimshe<sup>a</sup>

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b. National Center of Space Research and Technologies, Almaty, 050000 Kazakhstan  
c. Institute of Metallurgy and Ore Beneficiation, Almaty, 050010 Kazakhstan

Full article at: Technical Physics Letters volume 46, pages 319–322 (2020)  
<https://link.springer.com/article/10.1134%2FS1063785020040148#citeas>

Coatings are fabricated using plasma-ion sputtering and codeposition of ultradispersed Ta and Cd particles and Nb- and Mo-doped W and Cd particles. The fabricated coatings consist of a mixture of crystallized cadmium and the amorphized refractory metals. Subjecting the coatings to thermal annealing in vacuum at 800°C for 1 h results in complete evaporation of cadmium from the coatings and the formation of cellular structures, their light-absorbing capacity depending on doping with Nb and Mo. The Nb-doped tantalum coatings and Nb- and Mo-doped tungsten coatings exhibit the highest light absorption. The electrical resistance of fabricated black coatings is sufficient to drain static charge accumulating due to contact with near-Earth plasma.



## Remelt processing and microstructure of selective laser melted Ti25Ta

Authors: E.G. Brodie<sup>a,b</sup>, A.E. Medvedev<sup>a,c</sup>, J.E. Frith<sup>a</sup>, M.S. Dargusch<sup>d</sup>, H.L. Fraser<sup>a,e</sup> and A. Molotnikov<sup>a,b,c</sup>

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C. RMIT Centre for Additive Manufacturing, RMIT University, Melbourne, Australia  
D. AMPAM, The University of Queensland, Brisbane, QLD, 4072, Australia  
E. Department of Materials Science and Engineering, The Ohio State University, OH, 43210, USA

Full article at: Journal of Alloys and Compounds, Volume 820, 15 April 2020  
<https://www.sciencedirect.com/science/article/abs/pii/S0925838819343282?via%3Dihub>

In this study, elemental powder mixtures of Ti25Ta, an alloy with promise for orthopaedic applications, were processed using Selective Laser Melting (SLM), an emerging manufacturing method for bespoke implants. Material density and homogeneity was investigated as a function of laser scan speed and scanning strategy. Dense (>99.99%), pore free material was obtained at optimised processing parameters and a 'remelt' scan strategy improved melting of the Ta powders, avoiding keyhole formation. Tensile and ultrasonic modulus testing of the SLM Ti25Ta revealed that the processed material had a similar yield strength to SLM commercially pure Ti, namely  $426 \pm 15$  MPa, with a significant reduction of elastic modulus to  $65 \pm 5$  GPa. The remelt scan strategy increased the yield strength to  $545 \pm 9$  MPa, without altering the elastic modulus, however reduced the elongation from  $25 \pm 1$  to  $11 \pm 4\%$ . TEM analysis revealed the microstructure consisted of predominantly hexagonal  $\alpha'$  martensite with a limited amount of orthorhombic  $\alpha''$  martensite formed in the Ta-rich regions near partially melted Ta particles, specifically facilitated by enhanced diffusion occurring during the remelt scan. The composition range for the  $\alpha''$  phase was observed to be approximately 40–50 wt% Ta. Electron back-scattered imaging (BSI) and back scattered diffraction (EBSD) revealed the formation of the prior  $\beta$  grains with close to equiaxed morphology and a slight texture in the  $\alpha'$  martensite. The application of the remelt scan disrupted the prior  $\beta$  grain structure and resulted in randomly oriented  $\alpha'$  laths.

## Tantalum(v) 1,3-propanediolate $\beta$ -diketonate solution as a precursor to sol–gel derived, metal oxide thin films

Authors: Christopher Beale<sup>a,b</sup>, Stefanie Hamacher<sup>a,b</sup>, Alexey Yakushenko<sup>c</sup>, Oumaima Bensaid<sup>a,b</sup>, Sabine Willbold<sup>d</sup>, Guillermo Beltramo<sup>e</sup>, Sören Möller<sup>f</sup>, Heinrich Hartmann<sup>g</sup>, Elmar Neumann<sup>g</sup>, Gregor Mussler<sup>h</sup>, Alexander Shkurmanov<sup>h</sup>, Dirk Mayer<sup>a</sup>, Bernhard Wolfrum<sup>a,i</sup> and Andreas Offenhäusser<sup>a</sup>

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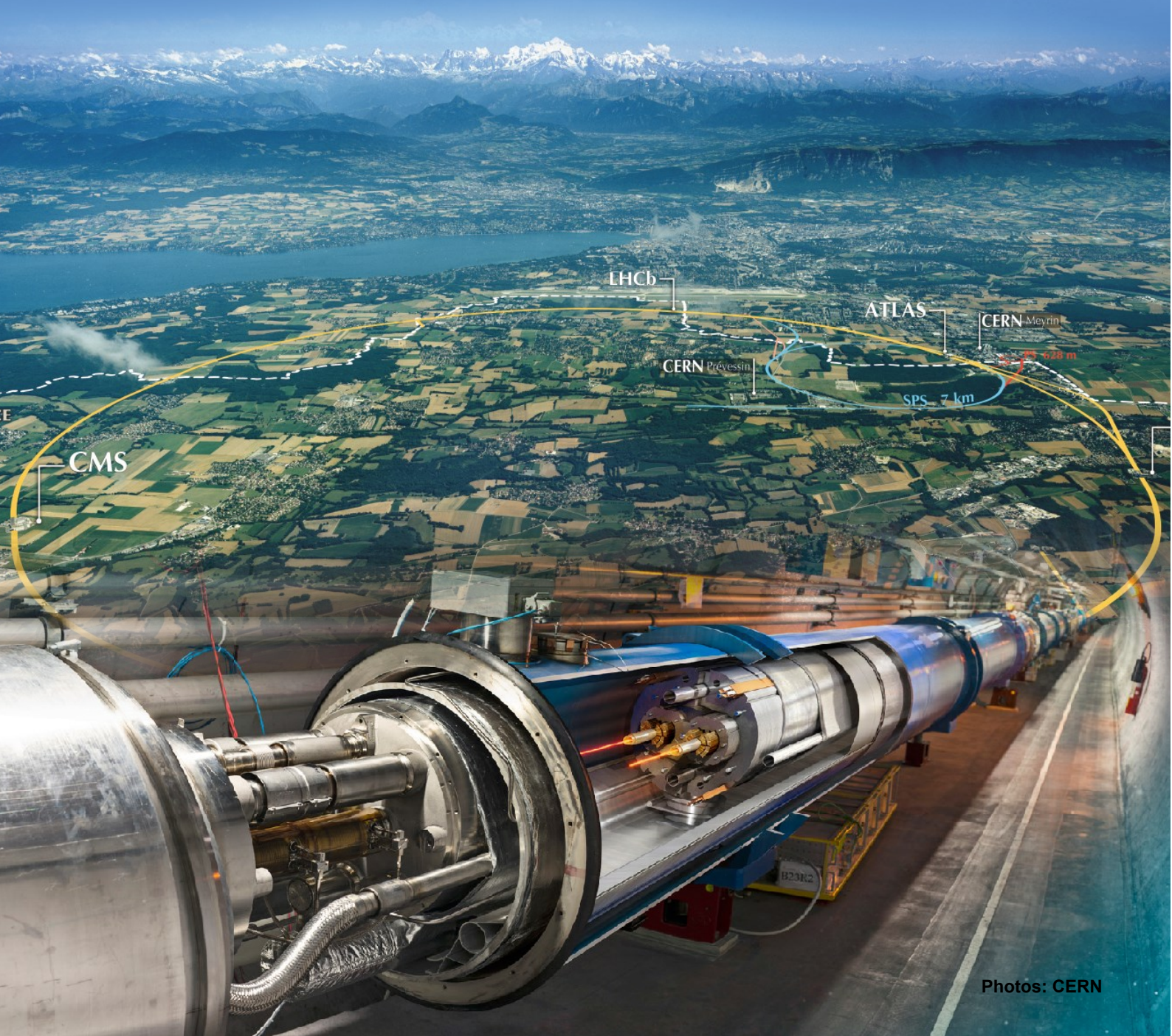
Full article at: RSC Advances 10(23) · April 2020  
[https://www.researchgate.net/publication/340412244\\_Tantalumv\\_13-propanediolate\\_beta-diketonate\\_solution\\_as\\_a\\_precursor\\_to\\_sol-gel\\_derived\\_metal\\_oxide\\_thin\\_films](https://www.researchgate.net/publication/340412244_Tantalumv_13-propanediolate_beta-diketonate_solution_as_a_precursor_to_sol-gel_derived_metal_oxide_thin_films)

Tantalum oxide is ubiquitous in everyday life, from capacitors in electronics to ion conductors for electrochromic windows and electrochemical storage devices. Investigations into sol–gel deposition of tantalum oxide, and its sister niobium oxide, has accelerated since the 1980s and continues to this day. The aim of this study is to synthesize a near UV sensitive, air stable, and low toxicity tantalum sol–gel precursor solution for metal oxide thin films – these attributes promise to reduce manufacturing costs and allow for facile mass production. By utilizing 1D and 2D nuclear magnetic resonance, this study shows that by removing ethanol from the precursor solution at a relatively low temperature and pressure, decomposition of the photosensitive complex can be minimized while obtaining a precursor solution with sufficient stability for storage and processing in the atmosphere. The solution described herein is further modified for inkjet printing, where multiple material characterization techniques demonstrate that the solution can be utilized in low temperature, photochemical solution deposition of tantalum oxide, which is likely amorphous. Tested substrates include amorphous silica, crystalline silicon wafer, and gold/titanium/PET foil. The hope is that these results may spark future investigations into electronic, optical, and biomedical device fabrication with tantalum oxide, and potentially niobium oxide, based films using the proposed synthesis method.

# Upgrading CERN with Nb<sub>3</sub>Sn magnets

## *Taming the superconductors of tomorrow*

The imminent deployment of accelerator magnets based on the superconductor Nb<sub>3</sub>Sn for the High-Luminosity Large Hadron Collider (HL-LHC) at CERN serves as a springboard to future accelerator magnets for fundamental exploration. Here Luca Bottura Ph.D., head of the CERN magnets, superconductors and cryostats group, explains why.



*Paper written by Luca Bottura, head of the CERN magnets, superconductors and cryostats group. Before joining CERN in 1995, he was part of the conceptual and engineering design team for ITER. He has worked on the magnets for the LHC and now undertakes R&D for high-field future accelerator magnets. This article first appeared in the May/June 2020 CERN COURIER (<https://cerncourier.com/>) and all views and opinions in this article are those of the author and not the T.I.C.*

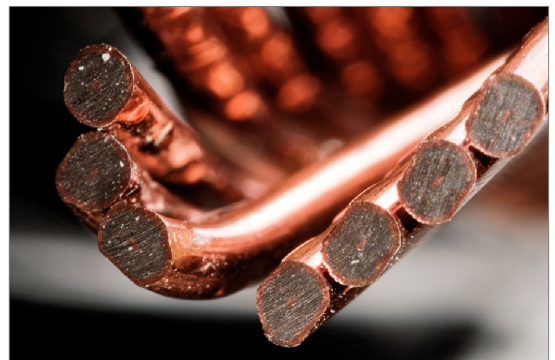
## Introduction

The steady increase in the energy of colliders during the past 40 years, which has fuelled some of the greatest discoveries in particle physics, was possible thanks to progress in superconducting materials and accelerator magnets.

The highest particle energies have been reached by proton–proton colliders, where beams of high-rigidity travelling on a piecewise circular trajectory require magnetic fields largely in excess of those that can be produced using resistive electromagnets.

Starting from the Tevatron in 1983, through HERA in 1991, RHIC in 2000 and finally the (Large Hadron Collider) LHC in 2008, all large-scale hadron colliders were built using superconducting magnets. Large superconducting magnets for detectors are just as important to high-energy physics experiments as beamline magnets are to particle accelerators.

In fact, detector magnets are where superconductivity took its stronghold, right from the infancy of the technology in the 1960s, with major installations such as the large bubble-chamber solenoid at Argonne National Laboratory, followed by the giant BEBC solenoid at CERN, which held the record for the highest stored energy for many years. A long line of superconducting magnets has provided the magnetic fields for detectors of all large-scale high-energy physics colliders, with the most recent and largest realisation being the LHC experiments, Compact Muon Solenoid (CMS) and ATLAS.



A Nb<sub>3</sub>Sn Rutherford cable, showing the single strands and the glass-fibre insulation, partially unwrapped. Photos: M Brice/CERN



One of the 11 T niobium-tin dipoles for the HL-LHC, pictured at CERN's Large Magnet Facility in January 2020. Photo: M Rayner/CERN

## Optimisation

All past accelerator and detector magnets had one thing in common: they were built using composite Nb–Ti/Cu wires and cables. Nb–Ti is a ductile alloy with a critical field of 14.5 T and critical temperature of 9.2 K, made from almost equal parts of the two constituents. It was discovered to be superconducting in 1962 and its performance, quality and cost have been optimised over more than half a century of research, development and large-scale industrial production. Indeed, it is unlikely that the performance of the LHC dipole magnets, operated so far at 7.7 T and expected to reach nominal conditions at 8.33 T, can be surpassed using the same superconducting material, or any foreseeable improvement of this alloy.

And yet, approved projects and studies for future circular machines are all calling for the development of superconducting magnets that produce fields beyond those produced for the LHC. These include the High-Luminosity LHC (HL-LHC), which is currently taking shape, and the Future Circular Collider design study (FCC), both at CERN, together with studies and programmes outside Europe, such as the Super proton–proton Collider in China (SppC) or the past studies of a Very Large Hadron Collider at Fermilab and the US–DOE Muon Accelerator Program.

This requires that we turn to other superconducting materials and novel magnet technology.

## The HL-LHC springboard

To reach its main objective, to increase the levelled LHC luminosity at ATLAS and CMS, and the integrated luminosity by a factor of 10, the HL-LHC requires very large-aperture quadrupoles, with field levels at the coil in the range of 12 T in the interaction regions. These quadrupoles, currently being built and tested at CERN and Fermilab, are the main fruit of the 10-year US-DOE LHC Accelerator Research Program (US-LARP) – a joint venture between CERN, Brookhaven National Laboratory, Fermilab and Lawrence Berkeley National Laboratory.

In addition, the increased beam intensity calls for collimators to be inserted in locations within the LHC “dispersion suppressor”, the portion of the accelerator where the regular magnet lattice is modified to ensure that off-momentum particles are centered in the interaction points. To gain the required space, standard arc dipoles will be substituted by dipoles of shorter length and higher field, approximately 11 T.

As described earlier, such fields require the use of new materials. For the HL-LHC, the material of choice is the intermetallic compound of niobium and tin  $\text{Nb}_3\text{Sn}$ , which was discovered in 1954.  $\text{Nb}_3\text{Sn}$  has a critical field of about 30 T and a critical temperature of about 18 K, outperforming Nb–Ti by a factor of two. Though discovered before Nb–Ti, and exhibiting better performance,  $\text{Nb}_3\text{Sn}$  has not been used for accelerator magnets so far because in its final form it is brittle and cannot withstand large stress and strain without special precautions.

### *“The HL-LHC is the springboard to the future of high-field accelerator magnets”*

In fact,  $\text{Nb}_3\text{Sn}$  was one of the candidate materials considered for the LHC in the late 1980s and mid 1990s. Already at that time it was demonstrated that accelerator magnets could be built with  $\text{Nb}_3\text{Sn}$ , but it was also clear that the technology was complex, with a number of critical steps, and not ripe for large-scale production. A good 20 years of progress in basic material performance, cable development, magnet engineering and industrial process control was necessary to reach the present state, during which time the success of the production of  $\text{Nb}_3\text{Sn}$  for the ITER fusion experiment has given confidence in the credibility of this material for large-scale applications. As a result, magnet experts are now convinced that  $\text{Nb}_3\text{Sn}$  technology is sufficiently mature to satisfy the challenging field levels required by the HL-LHC.



Power couple  $\text{Nb}_3\text{Sn}$  11 T dipoles for the HL-LHC undergoing tests at CERN's SM18 facility in February. Photo: CERN-PHOTO-202002-038-5

### A difficult recipe

The present manufacturing recipe for  $\text{Nb}_3\text{Sn}$  accelerator magnets consists of winding the magnet coil with glass-fibre insulated cables made of multi-filamentary wires that contain Nb and Sn precursors in a Cu matrix.

In this form the cables can be handled and plastically deformed without breakage. The coils then undergo heat treatment, typically at a temperature of around 650 °C, during which the precursor elements react chemically and form the desired  $\text{Nb}_3\text{Sn}$  superconducting phase.

At this stage, the reacted coil is extremely fragile and needs to be protected from any mechanical action.

This is done by injecting a polymer, which fills the interstitial spaces among cables, and is subsequently cured to become a matrix of hardened plastic providing cohesion and support to the cables.

The above process, though conceptually simple, has a number of technical difficulties that call for top-of-the-line engineering and production control. To give some examples, the texture of the electrical insulation, consisting of a few tenths of mm of glass fibre, needs to be able to withstand the high-temperature heat-treatment step, but also retain dielectric and mechanical properties at liquid-helium temperatures 1000 °C lower.

## A very short history of superconducting magnets

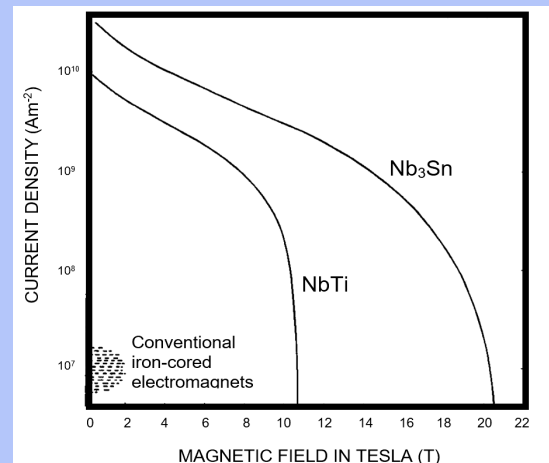
Superconductivity was first identified in 1911, but for many years remained a laboratory curiosity while metallurgical and manufacturing technology struggled to catch up. The first niobium-based superconductor discovered was niobium-tin ( $\text{Nb}_3\text{Sn}$ ) by Bell Telephone Laboratories in 1954 and this prompted many others to be developed, including niobium-titanium in 1962.

Although initially disregarded, in time NbTi alloys emerged to become the most widely used. NbTi is relatively inexpensive, has excellent mechanical properties and produces reliable, stable and extremely uniform magnetic fields. NbTi made it possible to fabricate magnets that reliably generated magnetic fields of up to 10.5 T (Tesla) with unprecedented efficiency and economy.

Today NbTi is the commercial 'work horse' of superconducting magnets, especially for magnetic resonance imaging (MRI) machines (see Bulletin #170).

When the Large Hadron Collider (LHC) was first constructed NbTi superconducting magnets were chosen. LHC used a total of 1232 dipole and 400 quadrupole magnets wound with copper stabilized NbTi Rutherford cables as well as many other magnets. In total some 8000 NbTi superconducting magnets were installed in the LHC tunnel, utilizing a total of 1200 tons of NbTi/Cu conductor manufactured by eight companies.

Niobium-based superconducting magnet technology has already fueled some of the greatest discoveries in high-energy physics and their contribution to science and to the world can only increase once the High-Luminosity upgrade (HL-LHC) is operational.



The critical current densities at 4.2 K of NbTi,  $\text{Nb}_3\text{Sn}$  and conventional iron-cored electromagnets (chart: Martin N. Wilson. CERN, 1996)

The superconducting wire also changes its dimensions by a few percent, which is orders of magnitude larger than the dimensional accuracy requested for field quality and therefore must be predicted and accommodated for by appropriate magnet and tooling design.

The finished coil, even if it is made solid by the polymer cast, still remains stress and strain sensitive. The level of stress that can be tolerated without breakage can be up to 150 MPa, to be compared to the electromagnetic stress of optimised magnets operating at 12 T that can reach levels in the range of 100 MPa. This does not leave much headroom for engineering margins and manufacturing tolerances.

Finally, protecting high-field magnets from quenches, with their large stored energy, requires that the protection system has a very fast reaction – three times faster than at the LHC – and excellent noise rejection to avoid false trips related to flux jumps in the large  $\text{Nb}_3\text{Sn}$  filaments.



A Rutherford cabling machine is used to assemble the high-performance cables, made from state-of-the-art  $\text{Nb}_3\text{Sn}$  conductor, for the LHC High Luminosity upgrade. (Photo: Max Brice/CERN)

### The next jump

The CERN magnet group, in collaboration with the US-DOE laboratories participating in the LHC Accelerator Upgrade Project, is in the process of addressing these and other challenges, finding solutions suitable for a magnet production on the scale required for the HL-LHC.

A total of six 11 T dipoles (each about 6 m long) and 20 inner triplet quadrupoles (up to 7.5 m long) are in production at CERN and in the US, and the first magnets have been tested (see "Power couple" image on the previous page).

And yet, it is clear that we are not ready to extrapolate such production on a much larger scale, i.e. to the thousands of magnets required for a possible future hadron collider such as FCC-hh.

This is exactly why the HL-LHC is so critical to the development of high-field magnets for future accelerators: not only will it be the first demonstration of Nb<sub>3</sub>Sn magnets in operation, steering and colliding beams, but by building it on a scale that can be managed at the laboratory level we have a unique opportunity to identify all the areas of necessary development, and the open technology issues, to allow the next jump. Beyond its prime physics objective, the HL-LHC is therefore the springboard to the future of high-field accelerator magnets.

### Climb to higher peak fields

For future circular colliders, the target dipole field has been set at 16 T for FCC-hh, allowing proton–proton collisions at an energy of 100 TeV, while China’s proposed pp collider (SppC) aims at a 12 T dipole field, to be followed by a 20 T dipole. Are these field levels realistic? And based on which technology?

Looking at the dipole fields produced by Nb<sub>3</sub>Sn development magnets during the past 40 years (see figure 1), fields up to 16 T have been achieved in R&D demonstrators, suggesting that the FCC target can be reached. In 2018 “FRESKA2” – a large-aperture (100 mm) dipole developed over the past decade through a collaboration between CERN and CEA-Saclay in the framework of the European Union project EuCARD – attained a record field of 14.6 T at 1.9 K (13.9 T at 4.5 K).

Another very recent result, obtained in June 2019, is the successful test at Fermilab by the US Magnet Development Programme (MDP) of a “cos-theta” dipole with an aperture of 60 mm called MDPCT1 (see “Cos-theta 1” image right), which reached a field of 14.1 T at 4.5 K.

In February this year, the CERN magnet group set a new Nb<sub>3</sub>Sn record with an enhanced racetrack model coil (eRMC), developed in the framework of the FCC study. The setup, which consists of two racetrack coils assembled without mid-plane gap (see “racetrack” image on next page), produced a 16.36 T central field at 1.9 K and a 16.5 T peak field on the coil, which is the highest ever reached for a magnet of this configuration. The magnet was also tested at 4.5 K and reached a field of about 16.3 T. These results send a positive signal for the feasibility of next-generation hadron colliders.

A field of 16 T seems to be the upper limit that can be reached with a Nb<sub>3</sub>Sn accelerator magnet. Indeed, though the conductor performance can still be improved, as demonstrated by recent results obtained at the National High Magnetic Field Laboratory (NHMFL), Ohio State University and Fermilab within the scope of the US-MDP, this is the point at which the material itself will run out of steam. As for any other superconductor, the critical current density drops as the field grows, requiring an increasing amount of material to carry a given current.

The effect becomes dramatic when approaching a significant fraction of the critical field. Akin to Nb–Ti in the region of 8 T, a further field increase with Nb<sub>3</sub>Sn beyond 16 T would require an exceedingly large coil and an impractical amount of conductor.

### ***Nb<sub>3</sub>Sn is technically the low-temperature superconductor with the highest performance***

Reaching the ultimate performance of Nb<sub>3</sub>Sn, which will be situated between the present 12 T and the expected maximum of 16 T, still requires much work. The technology issues identified by the ongoing work on the HL-LHC magnets are exacerbated by the increase in field, electromagnetic force and stored energy.

Innovative industrial solutions will be needed, and the conductor itself brought to a level of maturity comparable to Nb–Ti in terms of performance, quality and cost. This work is the core of the ongoing FCC magnet-development program that CERN is pursuing in collaboration with laboratories, universities and industries worldwide.

As the limit of Nb<sub>3</sub>Sn comes into view, we see history repeating itself: the only way to push beyond it to higher fields will be to resort to new materials. Since Nb<sub>3</sub>Sn is technically the low-temperature superconductor (LTS) with the highest performance, this will require a shift to high-temperature superconductors.



The MDP “cos-theta 1” dipole accelerator magnet at Fermilab, which achieved a field of 14.1 T (the highest ever achieved for such a device at an operational temperature of 4.5 K) in 2019.

Photo: Fermilab

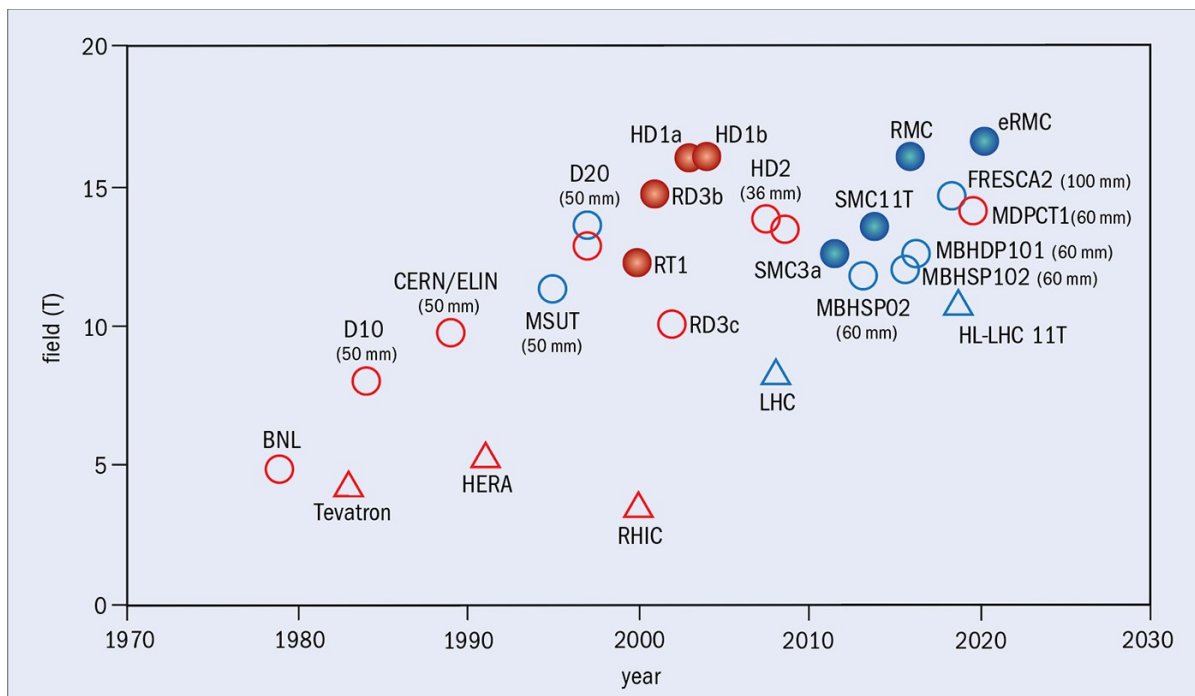


Figure 1: Record fields attained with Nb<sub>3</sub>Sn dipole magnets of various configurations and dimensions, and either at liquid (4.2 K, red) or superfluid (1.9 K, blue) helium temperature. Solid symbols are short (< 1 m) demonstrator “racetracks” with no bore, while open symbols are short models and long magnets with bore. For comparison, superconducting colliders past and present are shown as triangles. Credit: CERN

High-temperature superconductivity (HTS), discovered in 1986, is of great relevance in the quest for high fields. When operated at low temperature (the same liquid-helium range as LTS), HTS materials have exceedingly large critical fields in the range of 100 T and above.

And yet, only recently has the material and magnet engineering reached the point where HTS materials can generate magnetic fields in excess of LTS ones. The first user applications coming to fruition are ultra-high-field NMR magnets, as recently delivered by Bruker Biospin, and the intense magnetic fields required by materials science, for example the 32 T all-superconducting user facility built at NHMFL.

As for their application in accelerator magnets, the potential of HTS to make a quantum leap is enormous. But it is also clear that the tough challenges that needed to be solved for Nb<sub>3</sub>Sn will escalate to a formidable level in HTS accelerator magnets. The magnetic force scales with the square of the field produced by the magnet, and for HTS the problem will no longer be whether the material can carry the super-currents, but rather how to manage stresses approaching structural material limits. Stored energy has the same square-dependence on the field, and quench detection and protection in large HTS magnets are still a spectacular challenge.

In fact, HTS magnet engineering will probably differ so much from the LTS paradigm that it is fair to say that we do not yet know whether we have identified all the issues that need to be solved. HTS is the most exciting class of material to work with; the new world for brave explorers. But it is still too early to count on practical applications, not least because the production cost for this rather complex class of ceramic materials is about two orders of magnitude higher than that of good-old Nb–Ti.

It is thus logical to expect the near future to be based mainly on Nb<sub>3</sub>Sn. With the first demonstration to come imminently in the LHC, we need to consolidate the technology and bring it to the maturity necessary on a large-scale production.



A Nb<sub>3</sub>Sn demonstrator racetrack dipole magnet with no bore developed at CERN in the framework of the Future Circular Collider study, which reached a record peak field of 16.5 T in February. Photo: J Perez/CERN

This may likely take place in steps – exploring 12 T territory first, while seeking the solutions to the challenges of ultimate Nb<sub>3</sub>Sn performance towards 16 T – and could take as long as a decade. For China's SppC, iron-based HTS has been suggested as a route to 20 T dipoles. This technology study is interesting from the point of view of the material, but the magnet technology for iron-based superconductors is still rather far away.

Meanwhile, nurtured by novel ideas and innovative solutions, HTS could grow from the present state of a material of great potential to its first applications. The LHC already uses HTS tapes (based on Bi-2223) for the superconducting part of the current leads. The HL-LHC will go further, by pioneering the use of MgB<sub>2</sub> to transport the large currents required to power the new magnets over considerable distances (thereby shielding power converters and making maintenance much easier). The grand challenges posed by HTS will likely require a revolution rather than an evolution of magnet technology, and significant technology advancement leading to large-scale application in accelerators can only be imagined on the 25-year horizon.

### Road to the future

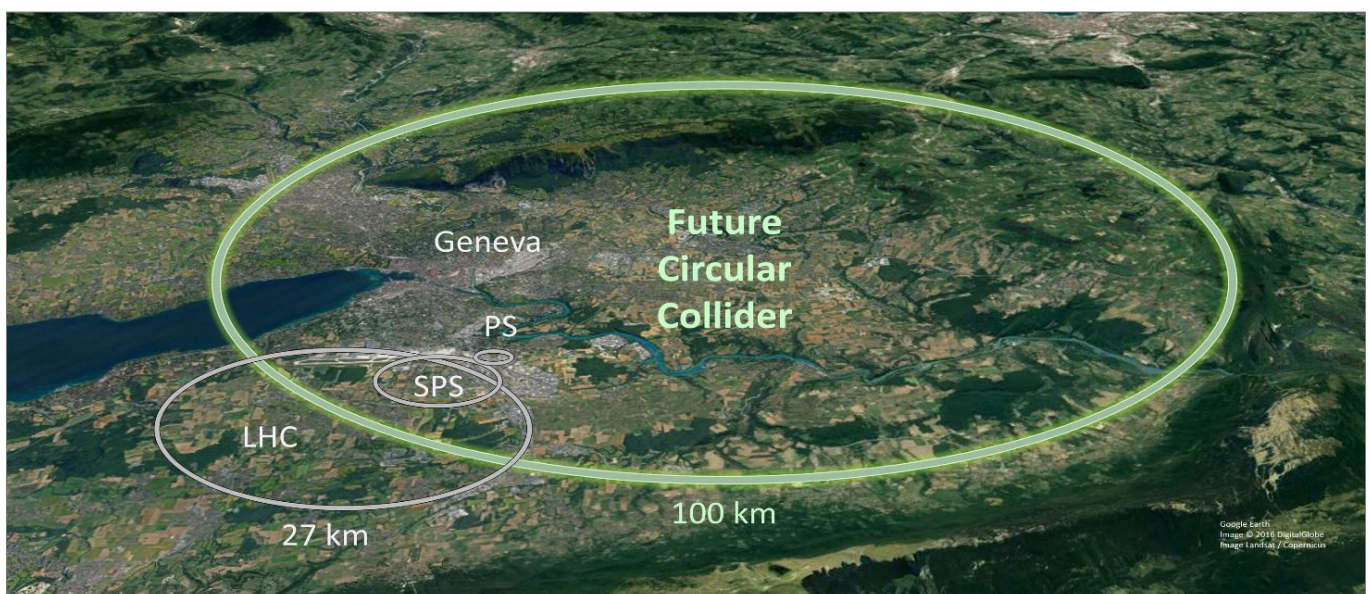
There are two important messages to retain from this rather simplified perspective on high-field magnets for accelerators. Firstly, given the long lead times of this technology, and even in times of uncertainty, it is important to maintain a healthy and ambitious programme so that the next step in technology is at hand when critical decisions on the accelerators of the future are due. The second message is that with such long development cycles and very specific technology, it is not realistic to rely on the private sector to advance and sustain the specific demands of HEP. In fact, the business model of high-energy physics is very peculiar, involving long investment times followed by short production bursts, and not sustainable by present industry standards. So, without taking the place of industry, it is crucial to secure critical know-how and infrastructure within the field to meet development needs and ensure the long-term future of our accelerators, present and to come.

## What next for CERN?

On June 19th the CERN Council unanimously endorsed the idea of building a newer, larger circular supercollider, dubbed the Future Circular Collider (FCC). The move is the first step toward building a 100 TeV 100-kilometer (62 mile) circumference collider around Geneva. The new collider is scheduled to be operational by 2040 and the final cost is expected to be around €21 billion (US\$23.5 billion).

The proposed new collider would be used for further research into the Higgs boson as well as research into topics like the nature of dark matter. "Such a machine would produce copious amounts of Higgs bosons in a very clean environment, would make dramatic progress in mapping the diverse interactions of the Higgs boson with other particles and would form an essential part of a rich research program, allowing measurements of extremely high precision", according to a statement by CERN.

The next step will be a technical and financial feasibility study for the new collider.



Location of the proposed FCC under Geneva, on the border of France and Switzerland (Images: Google Earth, CERN)



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# 61st General Assembly: Technical Programme Abstracts

The 61st General Assembly is scheduled to be held in Geneva, Switzerland, from October 11th to 14th 2020.

**Please note that, while we sincerely hope this event will be able to take place, at time of publication this cannot be guaranteed due to uncertainties caused by the Covid-19 global pandemic. The Executive Committee asks for your understanding as it continues to monitor the situation closely. A final decision will be taken by early August. Please look out for further updates in due course.**

Full details, including how to book tickets, sponsors and general information about the event will be circulated and made available at [www.tanb.org](http://www.tanb.org) in due course.



Photo: Shutterstock

**The following papers are expected. The announced presenter is the first author listed, unless otherwise specified. Please note that this list is subject to change.**

## **Environmental stability of tantalum-polymer capacitors**

by Dr Yuri Freeman and Dr Philip Lessner

KEMET Electronics Corporation

Capacitance stability over a broad range of frequencies and temperatures is one of the major advantages of polymer tantalum (Ta) capacitors in comparison to Wet and MnO<sub>2</sub> Tantalum capacitors. However, several recent publications showed some changes of the capacitance and other AC and DC characteristics of Polymer Ta capacitors with temperature and humidity. A research project was performed by KEMET Electronics in cooperation with the Clemson University and North Carolina State University to understand the nature of these changes in electrical characteristics of polymer tantalum capacitors with the change in environmental parameters and develop technological principles to address these changes. We present the most important scientific and practical results of this mutual industry-academia research project.

## **The tech hardware market and the electronics supply chain**

by Renzo DeMeo

Prismark

The tech hardware industry is worth over \$2 trillion and supports modern infrastructure and a significant part of the consumer lifestyle. This presentation will describe the hardware electronics market and its historical growth to where it is today. It will define the various segments from mobile phones to automotive. It will also review the supporting supply chain from components to materials. Lastly, we will provide a short term and long-term outlook, highlighting some of the significant technical, structural, and market-related trends affecting the industry, including disruptions and opportunities from the Covid-19 pandemic.

## **Effect of tantalum-niobium composite carbides preparation process on its physical properties**

by Bai Zhangjun, Mu Dong, Huang Yunkong, Xie Weiping, Wang Qiang. Presented by Jiang Bin.

Ningxia Orient Tantalum Industry Co. Ltd

In this paper, the influence of raw material category, sintering process and grinding process on the properties of tantalum-niobium composite carbide powder is discussed, and the physical characteristics of tantalum-niobium carbides are analyzed. In the meantime, Fisher average particle size, particle size distribution, apparent density, porosity and morphology of carbides are analyzed to determine comprehensive influence of various factors on the product quality. The results show that the particle size of the raw material has a great influence on the particle size of the product, showing the particle heredity rule. The porosity and apparent density of carbide products are also related to the particle size of the raw material. The smaller the particle size of the raw material, the smaller the porosity, while the apparent density tends to increase. However, the "arch bridge" formed between the agglomerated particles is destroyed due to the airflow pulverization of carbides with the same raw materials, the apparent density increases when the average particle size decreases.

## **Tantalum capacitors support to medical lung ventilators and telecom 5G infrastructure challenges**

by Tomas Zednicek Ph.D.

European Passive Components Institute (EPCI)

2020 was the year of the pandemic that impacted the lives of most people on Earth. Medical infrastructure was highly overloaded with shortage of critical medical equipment namely lung ventilators with tantalum capacitors onboard. Thus, tantalum capacitors have been on the list of critical supply chain brought to attention of the local governments. The presentation will provide a brief overview of tantalum capacitor applications in lung ventilators and its function. The pandemic situation delayed implementation of 5G telecom infrastructure to 2021 and the second part of the presentation will discuss challenges for tantalum capacitors there. We are just entering the high speed 5G communication era that will enable instantaneous connectivity to billions of devices. SMART cities will offer connections to cloud servers with faster data content transfer to users (such as movie streaming) and low latency applications (such as vehicle collision avoidance systems). Simply, 5G will provide the speed, low latency and connectivity to enable a new generation of applications, services and business opportunities that have not been seen before. Is there a place for tantalum capacitors in the base station hardware designs?

## **Cost sharing and value of implementing supply chain due diligence**

by Rashad Abelson

OECD

On-going discussions in multi-stakeholder forums have raised important questions on the perceived imbalance of how due diligence costs and benefits are distributed along the supply chain. Governments, private sector representatives, and civil society organisations participating in the OECD Responsible Minerals Implementation Programme have been involved in discussions between 2018 and 2020, with a view to encourage stakeholders to devise innovative solutions to address this potential imbalance. The OECD Secretariat is currently drafting a position paper to inform discussion on this topic by giving stakeholders a better understanding of how the costs of due diligence are currently distributed and how they can potentially be differently distributed across the supply chain, appropriately recognizing the value and benefits of due diligence. The objective of this work is to identify research questions to close gaps in information and advance the discussion with a view to finding avenues for a resolution.

## **T.I.C. 2020 annual statistics presentation**

by David Knudson

Tantalum-Niobium International Study Center (T.I.C.)

This presentation will provide a comprehensive statistical report on collected T.I.C. member data for calendar years 2010 through 2019 along with up to date publicly sourced international trade data on tantalum and niobium raw materials and products. Also covered will be the collection practices of publicly available international trade data and the methodology for its integration with T.I.C. member collected trade data. Each quarter the T.I.C. administers the collection of anonymous statistics data from its members by an independent intermediary (Miller Roskell Ltd, a chartered accountant). This data is then verified and certified by Miller Roskell Ltd and provided to

the T.I.C. The data is then collated and presented in report form to our members, also on a quarterly schedule. The categories for data collected are tantalum and niobium raw materials, mining production and trading receipts, tantalum receipts by processors, and tantalum and niobium product shipments by processors.

### **Shipping NORM material: complex shipments in a complicated world**

by Kevin Loyens

TAM International LP

Shipping NORM material that contains traces of uranium or thorium can be very challenging and intimidating due to the complicated and often restrictive regulations that apply. Once cargo is categorized as “IMO Cass 7” the framework for transportation significantly changes. Not only do different regulations apply in different jurisdictions. These regulations change regularly and are sometimes interpreted and applied differently in different parts of the world. Different paperwork is required, transport options are more limited and there will be implications on insurance, safety and security policies and many other items in the day-to-day management of a company’s supply chain. In this everchanging environment, it is important for companies to understand the how and why of proper classification of NORM material. Properly complying with the regulations will impact the packaging that is used, labeling requirements and how transport of the cargo is organized. TAM International is a Canadian company with a global network that is specialized in handling, packaging and worldwide transport of radioactive materials. With more than 16 years of experience in the nuclear, mining and rare earth industries, TAM is well positioned to provide an overview of best practices and dos and don’ts. Properly understanding the regulatory, transport and handling framework of NORM will enable companies to implement a proper strategy for managing these materials throughout their supply chain.

### **EU H2020 project TARANTULA: recovery of tungsten, niobium and tantalum occurring as by-products in mining and processing waste streams**

by Amal Siriwardana. Presented by Dr Nader Akil

EU H2020 project TARANTULA, grant agreement # 821159

The extraordinary properties of refractory metals, the unlikeliness of their future substitution and their use in booming industries will sustain a high EU demand for tungsten (W), niobium (Nb) and tantalum (Ta). Despite all three being classified as Critical Raw Materials (CRM) by the European Commission (EC), fractions of these indispensable metals are dissipated as by-products in mining waste streams as well as process scrap. To stimulate their recovery from such complex, low-grade resources, TARANTULA (H2020 - GA: 821159) will develop a suite of cost-effective, scalable and eco-friendly – bio-, hydro-, iono-, solvo-, pyro- and electro-metallurgical – processes with high selectivity and recovery rates. These novel technologies, each representing an alternative for one or more process steps of state-of-the-art processing lines, will form new routes towards market-ready metals, metal oxides and metal carbides. Flexibility will be the cornerstone of the overall process flowsheet to enable recovery of all three elements (W, Nb, Ta), thereby minimising the CAPEX required for future processing installations. Following systematic research and innovation activities at lab scale, the envisioned technologies will be brought to TRL3-5 and, based on performance, validated at prototype level by experienced industrial partners. In parallel, future by-product recovery will be supported by carrying out a comprehensive identification and assessment of existing un/underexploited secondary sources of W, Nb and Ta.

### **Meeting market expectations of minerals due diligence – an update on the Responsible Minerals Assurance Process (RMAP) and the Responsible Minerals Initiative (RMI)**

by Catherine Tyson and Leah Butler

Responsible Minerals Initiative

Over the past several years, market expectations for due diligence for responsible mineral supply chains have evolved as companies deepen their understanding of due diligence and the regulatory imperative for meeting these expectations has grown. Working together, the RMI and its stakeholders, including the T.I.C., continue to develop programs and tools to meet the expectations of actors along mineral supply chains and satisfy regulatory demands. In this paper and presentation, the RMI will address the current status and progress of smelter due diligence in the tantalum sector, updates to RMI’s programs, new RMI program and tool offerings, the status of the RMAP’s application for recognition by the European Commission, update on challenges to minerals due diligence in the wake of Covid-19, and opportunities for future collaboration with the tantalum industry.

## **NORM: a fresh look at an old problem**

by Ulric Schwela<sup>1</sup>, Dr Daniel Persico<sup>2</sup>, Christian Cymorek<sup>3</sup> and Roland Chavasse<sup>4</sup>

1 - Salus Mineralis Ltd, 2 - KEMET Electronics Corporation, 3 - TANIOBIS GmbH, 4 - T.I.C.

The level of interest in NORM and denial of shipment (DoS) at the International Atomic Energy Agency (IAEA) has been increasing steadily in recent years, as shipping lines have consolidated and transporting NORM and Class 7 (radioactive) cargos has become more and more difficult. In 2018, Germany made a proposal at the International Maritime Organisation (IMO) conference to increase the NORM cut-off from 10 Bq/g to 30 Bq/g for tantalite. The IMO asked the IAEA for advice on the issue and late last year the IAEA created a new 'NORM exemption group', of which T.I.C. is a member, to examine this issue and draft a reply to the IMO. However, it quickly became apparent that this question could not be examined in isolation and while examining the broader context of NORM transport it became clear that the IAEA's two core standards - the Basic Safety Standard (GSR part 3) and the transport regulations (SSR-6 and guidance SSG-26) - are not aligned. The NORM exemption group is currently working to create a "context paper" (a white paper) that will be presented to the IAEA TRANSSC-41 meeting in November 2020. It is expected that this context paper will recommend aligning SSR-6 with the senior regulation, GSR Part 3, a result which is likely to lead to an increase in the NORM exemption level. This presentation will discuss the alignment issue, how alignment of SSR-6 and GSR part 3 could change the NORM exemption level, and bring GA61 delegates fully up to speed with this important project.

## **Development of novel spherical multinary alloy powders containing tantalum and niobium for optimization of intrinsic material properties in additive manufacturing (AM)**

by Dr Markus Weinmann, Dr Christoph Schnitter and Dr Melanie Stenzel

TANIOBIS GmbH

The high degree of freedom for geometric designs opened by additive processes is often seen as a main driver for improvement of components but design optimization alone is not enough to achieve highest component performance. Intrinsic material properties also play a vital role to fit parameters to specific requirements of applications. This is especially relevant for applications in which inappropriate material properties may cause fatal failure. The present paper gives an overview of the development and optimization of refractory metal-based spherical multinary alloy powders with variable composition for biomedical applications. It will be shown how alloy powders based on titanium, tantalum and niobium (Ti/Nb/Ta) applied in laser powder bed fusion (L-PBF) can offer improved biocompatibility and optimized mechanical values compared to conventionally applied implant materials. It will be further shown how those findings can be transferred to the development of multinary and high entropy alloys.

## **Quantitative assessment of tantalum consumption in the United States from 2002 to 2018**

by Dr Abraham Padilla and Dr Nedal Nassar

U.S. Geological Survey

Tantalum has received considerable attention in recent years largely due to its increasing use in modern electronics and the high risks associated with its supply chain. In 2018, approximately 80% of the world's supply of tantalum originated from countries in Africa, with nearly 40% thought to originate in the DRC alone. The United States (U.S.), a leading consumer of tantalum materials, has been entirely reliant on imports for its supply of primary tantalum since the 1950s. However, properly quantifying total U.S. tantalum consumption is problematic because two of the most important intermediate forms of tantalum ( $Ta_2O_5$  and  $K_2TaF_7$ ) do not have unique tariff codes and thus a significant part of tantalum material trade is not documented. Furthermore, tantalum incorporated in semi-finished and finished goods is not tracked as tantalum. As a result, estimates of consumption only capture a fraction of the total volume of tantalum consumed in any given year. In this study, we perform a material flow analysis (MFA) to quantify the total volume of tantalum consumed in the U.S. from 2002 through 2018. Our results indicate that U.S. tantalum consumption may be significantly higher, and up to twice as much at times, than previously estimated. Interestingly, our estimates show that some years U.S. tantalum demand has exceeded the volume of primary tantalum produced globally according to U.S. Geological Survey estimates. This suggests that either a significant volume of global primary tantalum production is not accounted for, the volume of secondary (recycled) tantalum available is significantly underestimated, or both. Lastly, the detailed MFA results allow us to quantify the volume of tantalum in-use as well as the quantity that may potentially be available for recycling in any given year, thereby providing valuable insight to both industry and policymakers.

## ITSCI response to Covid-19: challenges, adaptations and lessons-learned

by Mickaël Daudin<sup>1</sup> and Roper Cleland<sup>2</sup> (both presenting)

1 - Pact, 2 - International Tin Association (ITA)

Covid is having a direct impact on the livelihoods of ASM communities through market and logistic challenges. Moreover, reduced circumstances and virus control measures are likely to drive instability and erode basic rights in the region, making ITSCI's work all the more critical. For example, school closure increases risk of children at mines and significant reduction in mineral earnings can stimulate return to criminal behavior and armed groups. Reduced budgets have inevitably resulted in fewer field visits leading to new challenges in data collection, whilst government measures have impacted the extensive stakeholder engagement activities needed to achieve incident resolution. Therefore, ITSCI through its implementing partner Pact is continuing essential field activities such as incident reporting and mitigation, and support to upstream actors in maintaining responsible business and sufficient resilience for economic recovery. This means ensuring that we can get back to pre-Covid levels of activity as the minimum for sustainable activities and OECD alignment. Additionally, we have taken due care with virus control measures to safeguard our own teams and the people we interact with; and sought to leverage our networks, infrastructure, expertise and trust with ASM communities to provide Covid health advice and support wherever possible. This paper outlines some of the challenges we have faced during the Covid crisis, our measures to adjust and adapt, and our learning from the experience.

### The role of niobium at CERN

by Bernardo Bordini and Amalia Ballarino

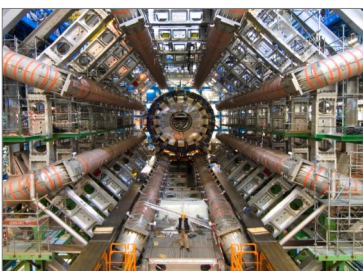
CERN

Due to its superconducting properties niobium (Nb) is a key material for the Large Hadron Collider (LHC), the largest particle accelerator at CERN. The LHC contains 1200 tonnes of high quality Nb-Ti cables distributed in almost 10,000 superconducting magnets cooled by 130 tonnes of helium at 1.9 and 4.2 K. These cables are constituted by composite wires, smaller than 1 mm in diameter, where thousands of Nb-Ti filaments are embedded in high purity copper matrix (Nb-Ti weight ratio about 40%). With the LHC, where the nominal operating field of the dipoles is 8.33 T at 1.9 K, Nb-Ti has most likely reached its physical limits in terms of the maximum magnetic field that can be produced with sufficient operating margins. Because of that, for the High Luminosity upgrade of the LHC (HL-LHC), which is foreseen for 2025 and is mainly aiming in replacing the present quadrupole Nb-Ti magnets of the interaction regions with more powerful magnets, CERN, in collaboration with the US HL-LHC Accelerator Upgrade Project (AUP), has developed and is producing 11-12 T accelerator magnets based on the Nb<sub>3</sub>Sn superconductor. For this project CERN procured about 30 tons of state of the art Nb<sub>3</sub>Sn wires and a similar amount was procured by the US AUP. Furthermore, for the Future Circular Collider design study CERN is considering a 100 km accelerator based on 16 T Nb<sub>3</sub>Sn accelerator magnets requiring about 6000 tons of Nb<sub>3</sub>Sn wires (and 3000 tons of Nb-Ti). In this paper we discuss the present and future role of Nb for CERN and the High Energy Physics community at large.

TIC

## T.I.C.'s 61st General Assembly

planned to be held in Geneva, Switzerland, on October 11th-14th  
includes a field trip to CERN



At time of publication this cannot be guaranteed due to uncertainties caused by the Covid-19 global pandemic. The Executive Committee asks for your understanding as it continues to monitor the situation closely. Please look out for further updates in due course.



Images: CERN

Full details, including the booking form, will be published on [www.TaNb.org](http://www.TaNb.org).

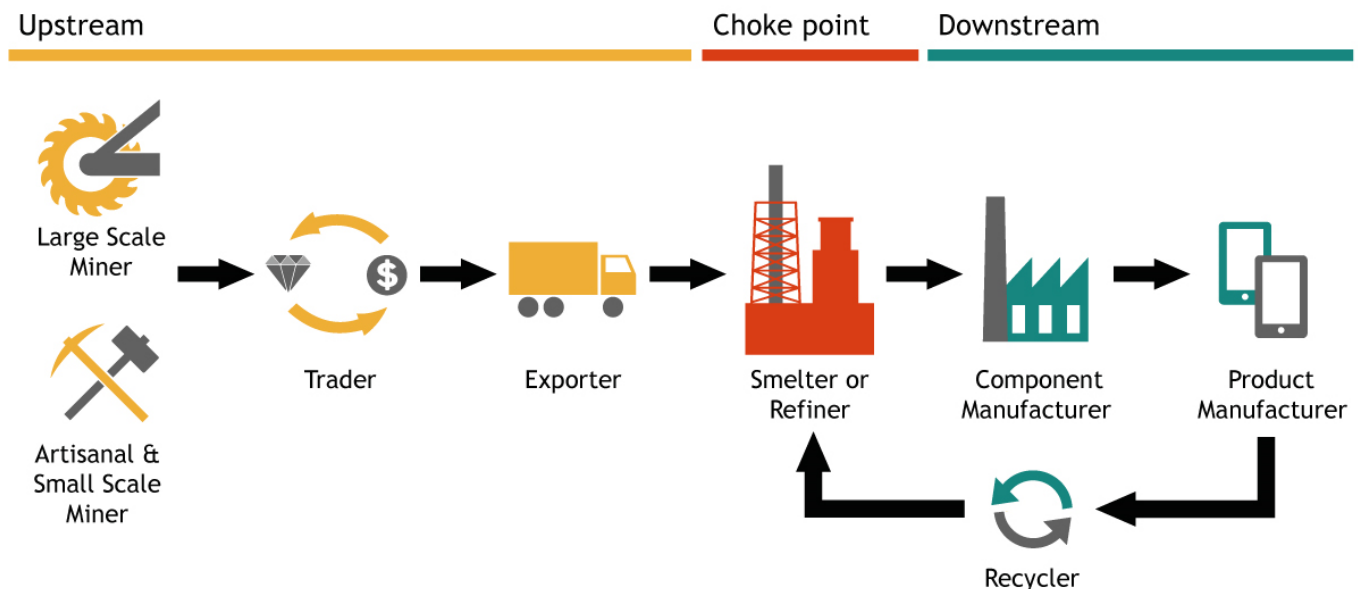
# EPRM launches “Due Diligence Hub” website



<https://europeanpartnership-responsibleminerals.eu/duediligencehub>

The EPRM (European Partnership for Responsible Minerals) has launched the [Due Diligence Hub](#) to assist industry with supply chain due diligence. The new website provides easy access to existing information and tools aggregated from a wide range of websites and sources, all under one roof and targeted to specific business needs. This will make it easier to conduct due diligence in your supply chain as it will become even more important once the [EU Conflict Mineral Regulation 2017/821](#) comes into force.

The EU regulation requires all importers to the EU of tantalum, tungsten, tin and gold (“3TG”) over 1000 kg per year to register their company and undertake due diligence on their supply chain from January 1st 2021.



## Introducing the Due Diligence Hub

With the Due Diligence Hub, the EPRM wants to support supply chain actors to improve their due diligence practices. It is the only portal that provides this wealth of information, allowing users to easily search for content that corresponds to their business requirements. Given the ever-evolving nature of the mineral sector, the EPRM will regularly review its support to supply chain actors, as well as consider opportunities to expand its scope in the future.

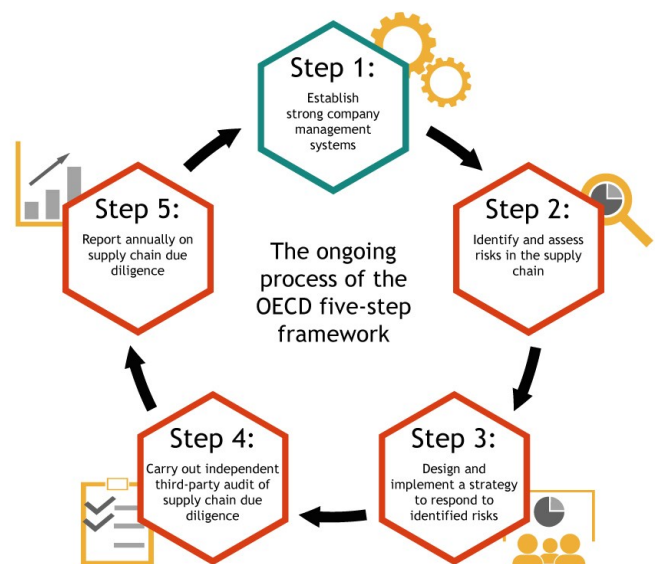
At the Due Diligence Hub you will find:

- A step-by-step guide to conducting due diligence
- 139 international standards and guides classified by minerals and supply chain tier
- 16 case studies demonstrating how other companies undertake due diligence, to share best practice

The EPRM is a multi-stakeholder partnership established with the goal to create better social and economic conditions for mine workers and local mining communities, by increasing the number of mines that adopt responsible mining practices in conflict and high-risk areas (CAHRAs).

The T.I.C. has been a member of EPRM since 2017 and has actively participated in developing the Due Diligence Hub.

The Due Diligence Hub is free to use thanks to the generosity of EPRM members and donors.



# Interview: Mr Tiberio Cabianca, Public Health England and chair of TRANSSC's NORM Exemption Group

Regular readers of the Bulletin will know that the T.I.C. invests a lot of time with regard to the Naturally Occurring Radioactive Material (NORM) exemption level (the 2007 transport risk assessment and participation in TRANSSC<sup>1</sup> since 2008, and more recently with the initiative to raise the exemption level to 30 Bq/g as reported in [Bulletin #180](#)).

Recently TRANSSC established a new working group to examine this issue, headed by Mr Tiberio Cabianca. Mr Cabianca has over 25 years' experience in radiological assessment modelling, 5 years as a member of IAEA's Waste Safety Section of the Division of Radiation, Transport and Waste Safety. He is the current chair of the IAEA's Modelling and Data for Radiological Impact Assessments (MODARIA) II programme and a member of the UK delegation at the Transport Safety Standards Committee (TRANSSC).



On Monday June 29th Mr Cabianca (**TC**) was interviewed by T.I.C. Director, Roland Chavasse (**RC**), and Ulric Schwela (**US**) of Salus Mineralis Ltd (who is helping the Association on NORM issues). We asked him about the work being done by the new 'NORM exemption group' to review the exemption levels for the transport of NORM, including, of course, tantalum-containing raw materials.

**RC:** Thank you for making time to talk with us today. Could you tell us what is the NORM exemption group and what it is currently working on?

**TC:** It is important to understand the role of the IAEA and how it works, and to appreciate that the transport regulations cannot be changed for one specific material (i.e. an exemption for tantalum minerals alone is not possible). The NORM exemption group has been set up recently to look at the exemption regulations that apply to the transport of NORM. It is part of TRANSSC's Technical Transport Expert Group (TTEG) on Radiation Protection (RP), which has the task to answer requests of a technical nature put forward to the Safety Committee in relation to the IAEA transport regulations.

With regard to the original request to look at the exemption level for tantalum raw materials, it is important to understand that the IAEA does not wish to create specific exemptions for different materials, as it may open the door to a long list of exemptions for specific products.

The current NORM exemption group is as a result of how TRANSSC operates: until recently TRANSSC would have brought together an ad hoc group of volunteers to look at an issue and a response would have taken several years, but now there is a system of using Technical Transport Expert Groups (TTEG), made up of technical experts, which helps streamline things a great deal. TTEGs could become structured more formally, but overall, they are good, useful, and still evolving.

Furthermore, the Chair of TRANSSC, Mr Paul Hinrichsen, has given me the impression that he is also keen to support this work. Mr Hinrichsen first brought the IMO question about NORM<sup>2</sup> to my attention, as chair of the Radiation Protection (RP) TTEG in early October 2019, because he believes the issue is more relevant to the RP-TTEG, which has the right expertise to calculate values for radionuclides.

**RC:** It sounds like the IMO's NORM exemption question arrived at just the right time.

**US:** Regarding the original IMO question, how has your work evolved since last October?

**TC:** When I was first contacted by Mr Hinrichsen about the proposal to IMO, I started explaining the differences in the exemption provisions between the 'new Basic Safety Standards' (General Safety Requirements Part 3 (GSR Part 3)) and the transport regulations (Safety Standards Series 6 (SSR-6)). [GSR Part 3 is one of the core IAEA regulations which other IAEA regulations should be consistent with].

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1 - TRANSSC: Transport Safety Standards Committee of the International Atomic Energy Agency, the committee responsible for reviewing and revising the regulations for the transport of radioactive material.

2 - In 2018, Germany made a proposal at the International Maritime Organisation (IMO) Sub-Committee on Carriage of Cargoes and Containers (CCC) to increase the NORM cut-off from 10 Bq/g to 30 Bq/g, resulting in IMO asking IAEA for advice. IAEA delegated the decision to the Transport Safety Standards Committee (TRANSSC).



Most TRANSSC members are not aware that there are so many differences and that some parts of the exemption regulations or provisions don't fit together, and now this is being recognised.

This means that instead of tackling "tantalum NORM" narrowly we will be looking at the subject in a more comprehensive way.

**RC:** Harmonization of the regulations covering NORM would be an important achievement. What are the next steps?

**TC:** The NORM exemption group will write a summary note to TRANSSC, suggesting that we run specific calculations to come up with new values for exemption of NORM, in line with the higher dose criterion given in GSR Part 3. The original proposal to the IMO now appears to have been overtaken by the study into the exemption of NORM.

**US:** What did you find when preparing the note? Did you find any new surprises?

**TC:** We were aware of most of the inconsistencies, but we also found some new ones. There is a particular clause in GSR Part 3 relevant to NORM which is not applied to transport of radioactive material in bulk and I believe that it should apply. The transport regulations are unique and written in a different way because they deal with a particular activity that has specific requirements, and it is useful that we are able to carry out a comprehensive review.

We also found inconsistencies in the guidance that comes with the transport regulations (SSG-26), probably due to being written by different people at different times.

**US:** Could you recap briefly how the numbers in the transport regulations came about in the first place?

**TC:** Current exemption values in the IAEA regulations date back to the mid 1990s and were first published in the 1996 edition of the IAEA Basic Safety Standards. With the 1996 edition of the IAEA transport regulations, it was decided to go from a general value for exemption [70 Bq/g], to radionuclide specific values in line with the BSS. In preparation for this, a study was published with calculations for transport scenarios, however the values in the IAEA BSS were adopted as the transport figures were broadly similar. This was done with good intentions, to ensure consistency between the two sets of regulations, and to make operations easier.

**US:** Has any country implemented the BSS as they are?

**TC:** In some countries they are implemented as such, but in general there are differences between national regulations and the IAEA BSS because the IAEA BSS in general are not legally binding, but represent an international framework for regulations. It is a different question for the IAEA transport regulations which are incorporated in the UN Model Regulations for the transport of dangerous goods. Regarding exemption values many countries have produced their own exemption values which are different from those in the IAEA BSS.

**RC:** What does the NORM exemption group hope to do about harmonisation and alignment, and is it more straightforward to change the GSR Part 3 or SSR-6?

**TC:** SSR-6 is by far the easier of the two to revise; the revision is done by TRANSSC with few external stakeholders, following the UN system of two-yearly review cycles. By contrast, GSR Part 3, which was published in 2014, replaced the previous BSS published in 1996, so there were 18 years between the two. The process itself to create GSR Part 3 took about eight years and was driven by the International Commission for Radiological Protection (ICRP) recommendations published in 2007. There is no plan to change the ICRP recommendations any time soon.

**US:** What are the other challenges when trying to achieve harmonisation between GSR Part 3 and SSR-6?



The T.I.C. team at TRANSSC in October 2019 (from left): Roland Chavasse (T.I.C. Director), Christian Cymorek (TANIOBIS GmbH) & Ulric Schwela (Salus Mineralis Ltd) (photo: T.I.C.)

**TC:** : The main challenge is to come up with exemption values all TRANSSC members agree with. Transport of radioactive material is a global business and therefore we need consistency between how countries use the regulations and a single set of exemption values. In theory ad hoc exemption values for transport can be agreed between 2-3 countries, or within larger groups of countries, like the EU, but for practical reasons it is preferable to have a single set of exemption values in the IAEA regulations.

**RC:** What plans have you for TRANSSC 41, scheduled for November 2020, and beyond?

**TC:** At TRANSSC 41 I will present a note with the rationale for the need to calculate new exemption values for NORM and ask TRANSSC members to give the green light for this. I expect TRANSSC members to broadly be in support following the preliminary discussions that have taken place. To come up with transport specific values for NORM we will develop a method, a procedure to estimate the exposure of different people involved in the transport of NORM. It will be a simple, idealised model, for both workers and other people, based on relevant information, robust enough to give confidence that people are not unduly exposed.

This way of working is not new and has been done in radiation protection many times. We will review work done in the past, collect data from different studies including the NORM CRP report, and any information T.I.C. members can provide on working practices, and put together transport specific exposure scenarios. How is their material transported, what is the geometry, distances, how long for, and so forth?

**US:** We are after all looking at transport of materials above 10 Bq/g, and facilities should be regulated anyway for material above 1 Bq/g, therefore if a facility isn't already following those regulations, no amount of transport regulation is going to change this.



The safe transport of NORM is essential to human life and health and the environment, and also to industry.

**TC:** The NORM exemption group will meet in November at TRANSSC 41. I expect that the calculations will be done by members of the A1/A2 group which I chair. These experts are familiar with the methods to calculate exemption values and I have worked with them for a number of years and I trust them. A lot of the preliminary work will be to discuss the general types of scenarios we will need to develop for the calculations. Fortunately there are a limited number of radionuclides for NORM, so I expect that it can be done relatively quickly. I think that it would be really useful for the T.I.C. delegation to be there too because we need input from people who have good knowledge of how these materials are transported to develop realistic scenarios.

**US:** So, the calculation work will start after TRANSSC 41?

**TC:** Yes, I think that the calculations can be done pretty quickly after we have agreed the scenarios. I expect that we will have new numbers by June 2021, at least preliminary numbers. It may be that the new numbers need refining over the Summer, so that by November 2021 [TRANSSC 43] we will have the final numbers or something very similar.

The whole purpose of the exemption group is ultimately to calculate new values for all naturally occurring radionuclides which will be less restrictive than the current ones. But that will not be the end of the work. For the new numbers to be included in an updated SSR-6 a proposal to change the actual wording of the regulation needs to be put forward to TRANSSC. These proposals must follow a fixed review cycle set by the IAEA and can be rather complex, but it is manageable.

**US:** Is there anything else you'd like to mention about this project?

**TC:** I believe that we have a good chance to get things done relatively quickly because the RP-TTEG is already in place and we can access the right expertise to do the calculations in a relatively short time. The key for T.I.C is to follow closely the IAEA approval process to make sure that the values are included in the regulations. For example I think that it will be very useful for T.I.C. to send a representative to the Technical Meetings that the IAEA would typically convene to review all the proposals for change, to clarify the intention of the proposal if necessary, so that the proposal doesn't get delayed unnecessarily.

**RC:** Mr Cabianca, thank you very much for your time today. Please keep us informed and let us know if there is anything we can do to help the NORM exemption group in its work going forward. **TIC**

# ITSCI: a decade of success



Supply chain due diligence and mineral traceability are concepts of the utmost importance to the tantalum industry, ensuring that any conflict-related risks are managed and dealt with. The ITSCI Programme plays a critical role in this regard, working within the OECD's *Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas* ('Guidance') framework to assist companies with traceability, due diligence and audit requirements that arise from purchasing tantalum, tin and tungsten (3T) minerals, from the DRC, Burundi, Uganda and Rwanda. By the end of 2019 ITSCI covered over 2000 mines, giving gainful employment to around 80,000 miners, and supplying over 2000 tonnes of tin, tantalum and tungsten minerals per month; it has come a long way in the last decade.

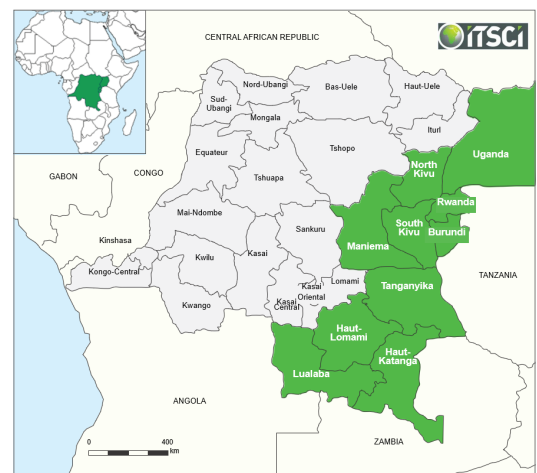
## The early years

During the mid-2000s there was growing awareness of conflict-related issues in the Democratic Republic of the Congo (DRC) through the work of the U.N. Panel of Experts and civil society. In response several upstream initiatives were started, including in the tantalum and tin industries, to establish conflict-free mineral supply chains from central Africa.

The most successful of those initiatives has been ITSCI, which can trace its origins back to 2009 when the International Tin Association established a working group, while simultaneously the T.I.C. established a policy on artisanal and small-scale mining (ASM). The following year ITA ran a small pilot in eastern DRC and in 2011 ITSCI became formalised when ITA and T.I.C. joined forces, creating a partnership which has lasted to this day.

Simultaneously, downstream, the Electronic Industry Citizenship Coalition (EICC, now the Responsible Business Alliance) and the Global e-Sustainability Initiative (GeSI) created the Conflict Free Sourcing Initiative (CFSI, since renamed the Responsible Minerals Initiative) to provide resources and tools to help businesses obtain conflict-free minerals, notably through auditing smelters and refiners. With ITSCI and CFSI/RMI in place it became possible for a factory to purchase 3T materials, confident that any conflict-related risks on the ground were being reported and managed.

In 2010 due diligence and mineral traceability were normalised by the first publication of the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas ('Guidance') and passing of the US Dodd-Frank (Section 1502), which required US companies to "disclose annually whether any of those minerals originated in the Democratic Republic of the Congo or an adjoining country". The latter, de facto, giving the Guidance teeth.



Map showing where ITSCI operates in 2020



ITSCI field officers training miners in due diligence, Numbi, South Kivu, DRC. In 2019 over 5,500 people attended ITSCI training events in central Africa (Photo: ITSCI).

## ITSCI reaches maturity

Today central Africa provides legitimate and ethical 3T minerals from across four central African countries. Furthermore, ITSCI is the only industry initiative with standards 100% aligned with the OECD Guidance.

ITSCI's operational territory covers an area similar in size to Germany, the US state of California or China's Sichuan province, but with considerably more challenging logistics. And yet it works because it has the buy-in from the governments, businesses and communities who host it.

### The OECD has assessed ITSCI and confirmed that it is 100% aligned with its Guidance.

ITSCI works inclusively with national and local governments and has clear roles for government officials. It has agreements with the governments of Burundi, the DRC, and Rwanda, as well as with the ICGLR. Its work is always carried out in partnership with governments and in co-operation with local partners as this contributes to better long term governance, stability and more opportunities for investment and growth.

ITSCI tracks 1.3 million business transactions a year and offers 3T miners a legitimate route to market. ITSCI enables mineral exports valued at around US\$380 million per year, activity which not only provides jobs for thousands of miners, but also creates significant mine tax revenue for governments. ITSCI facilitated 3T exports are some of the most important foreign exchange earnings for Burundi and Rwanda.

The communities that host mines also play an important role. Many improvements in the field are brought about through a continuous incident reporting and mitigation process managed by the field teams who play a key role in



ITSCI works closely with key regional partners. Here the ITSCI Governance Committee, Roland Chavasse (T.I.C.) and Kay Nimmo (ITA, right) meet with the Executive Secretary of the ICGLR, Ambassador Ambeyi Ligabo.

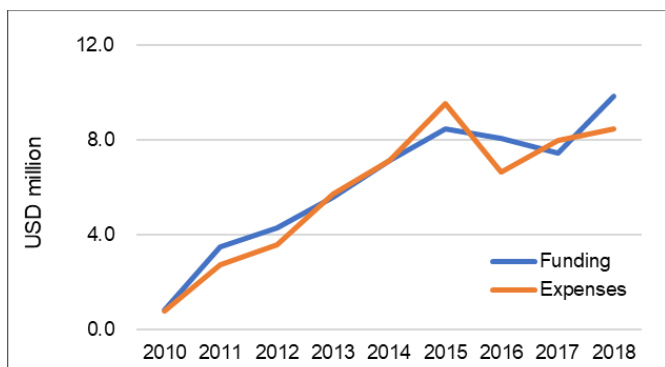


Figure 1: ITSCI funding and expenses since 2010

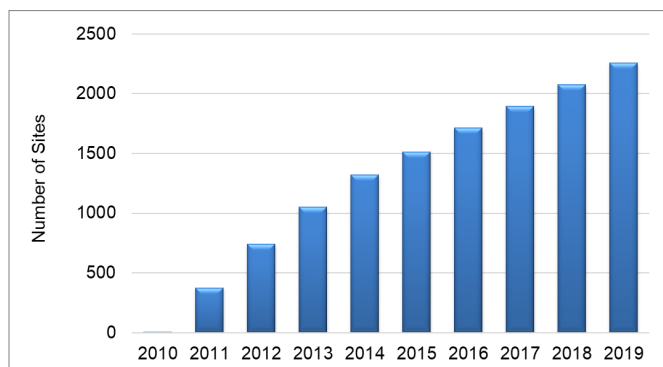


Figure 2: Growth in the number of active mine sites



Community engagement and involvement is crucial to a successful traceability program (photo: Pact)

Financially, ITSCI is self-funded and not-for-profit. Levies on mineral production meet around 90% of annual expenses, with the balance largely from annual membership subscriptions.

The significant majority of annual expenses occur in-region, such as mine visits, training and incident investigations.

Running a lean and efficient program requires continuous mining to generate levy revenue, which normally is not an issue, especially in an expanding program, but then Covid-19 happened.

## Covid-19 in central Africa: OECD issues call to action on 3T supply chains

There can be no doubt that 2020 will be remembered for many years as the year Covid-19 disrupted the global economy. No countries or industries have avoided the disruption caused by attempts to contain and minimise the effects of this terrible pandemic. The supply chains for minerals, especially from the relatively labour intensive 3T mines in central Africa, are no exception and face many challenges.

The OECD recognizes this and has issued a [Call to Action for Responsible Mineral Supply Chains](#).

In it the OECD states that it is “deeply concerned that gains made over the past 10 years in supply chain due diligence could be lost” and calls for immediate and concerted action “to safeguard gains related to due diligence in supply chains in alignment with the OECD [Guidance]”. It goes on to discuss ASM 3T and gold mining, before adding that “responsible artisanal mining communities are vital – recovery will only work if we do not have to re-start [traceability programs] from zero”.

ITSCI creates many positive impacts such as:

- Improved governance and formalisation
- Increased formal tax revenues
- Fair international prices for minerals
- Unique statistics on artisanal mining
- Opportunities to address safety
- Economic multiplier effects in the community

*“The Covid-19 crisis will be a litmus test for responsible businesses. The leaders will distinguish themselves by supporting suppliers and the most vulnerable in their supply chain for a fairer and more resilient recovery. ... Urgent steps are necessary to safeguard hard won gains in mineral supply chain and support artisanal mining communities from the potentially devastating impacts of the Covid-19 crisis.”* — Tyler Gillard, Head of Sector Projects, OECD Centre for Responsible Business Conduct.



Distribution of ITSCI's Covid-19 leaflets (photo: Pact)

The T.I.C. shares the OECD's concerns due to the importance of central African tantalum minerals. We are working closely with the OECD, RMI and other key stakeholders to help them to raise donor funding so that supply chain programs such as ITSCI can survive the current pandemic. While ITSCI continues to report risks in the supply chain under these circumstances, budget cuts have resulted in a decreased level of field effort – restricting the ability to work with stakeholders to resolve risks. Reduced level of effort by ITSCI teams will add to the due diligence burden on smelters. Further, unresolved issues threaten to increase reputational risks for downstream companies. Over 70 NGOs and civil society organisations have also raised the alarm.



ITSCI enables mineral exports which provide jobs for tens of thousands of miners (photo: Pact)

An ITSCI-RMI campaign for financial support has been launched and both organisations are asking stakeholders and downstream industry that wish to support ITSCI's operations during this challenging time to pledge their support.

Over the last decade, ITSCI has provided vital information and support to smelters undergoing RMI RMAP audits and played a key role in reducing risk of conflict for the tantalum industry.

The risk that ITSCI does not continue post-Covid-19 would mean potentially wiping-out years of investment and progress in the social structure in Central Africa.

For further information about the RMI-ITSCI fundraising effort or to learn about the ways you can donate please visit <http://www.responsiblemineralsinitiative.org/about/rba-foundation-rmi-funds/itsci/>, thank you. **TIC**

# A view on the impact of Covid-19 on the mining sector

*The Covid-19 pandemic has had a devastating effect on many personal lives and on the global economy. The mining sector is far from immune to this disruption. Here Roskill Information Services Limited offers its view on some of the implications of the current crisis for the metals and mining sector. This article is a summary of an essay available in full at <https://roskill.com/>. All views and opinions in this article are those of Roskill and not the T.I.C.*

# Roskill

The Covid-19 pandemic has highlighted a number of vulnerabilities in the world economy and is likely to cause or accelerate a range of macroeconomic and microeconomic changes. At the macro level, the rate of growth in different economies, levels of debt, inflation and interest rates have changed. At a micro level, a shift to “working from home” during the crisis may never fully reverse with implications for the design and use of urban areas and the layout of office space as well as demand for transportation. The uptake of online and remote services, including retail, healthcare and education may have fundamentally been accelerated.

The current crisis also raises multiple questions for mining companies and consumers of metals about their previous assumptions over the outlook for metals markets and the robustness of their production or procurement and other strategies. Amongst these, Roskill would highlight:

- **Reinforcement of conservative investment strategies and balance sheet management.** An overarching lesson from the past about commodity markets is that they are highly mean reverting, and that rather than extrapolating short term trends it is usually advisable “to be an optimist when prices are low and a pessimist when prices are high”. Whilst getting into a situation where balance sheet constraints drive operating and investment decisions is probably inevitable in the mining sector at points in the cycle given the capital intensity of building new supply, being able to minimise these and profit from turning points has, time and again, been shown to be an important driver of achieving above-average long run industry returns. Enablers of this for producers include:

- \* Continuous focus on cost management and maintaining or improving the position of assets on the cost curve through the cycle.
- \* Improving access to funding through more cautious debt management and planning, more flexible distributions of cash flows and ensuring a robust return on investments.
- \* Maintaining a focus on long-term strategic objectives whilst developing organisational agility and flexibility to respond to short-term crises.

- **Impacts on demand trends.** Demand for metals is being impacted in the short term by disruptions to the economy and effects on employment and incomes. Under Roskill’s lower “Prolonged Recession” case, global GDP would remain permanently below its pre-Covid-19 trend so some of this would persist. The pattern of future use of metals will also be affected by more microeconomic or behavioural changes triggered by the current crisis, such as shifts in the use of transportation. Should the aerospace sector not fully recover, as outlined in a previous Roskill White Paper, there will be a permanent downwards shift in titanium metal and rhenium demand. In the short term, producers should adjust their supply accordingly. Longer term though, demand for most metals is expected to continue to rise.

- **Electric vehicles (EVs) and the green economy.** Roskill does not think that the trend towards electrification and growth in EVs has fundamentally changed because of Covid-19. In the short to medium term, lower oil prices and a loss of profits by the auto sector to fund the development of EVs may delay the process, especially as some governments are likely to pause environmental regulations and focus on preserving current jobs in the near term. However, the crisis has eased concerns over raw materials supply constraints and lowered EV raw material prices, which will improve the economics of manufacturing EVs compared to conventional vehicles. There also seems to be an increased willingness by governments to take on more long term debt to invest, including towards a “green agenda”. These factors reinforce Roskill’s expectation of a positive outlook for EV raw materials demand over the longer run.

- **Lower energy prices.** Oil and gas prices have been hard hit by the Covid-19 crisis due to the combination of its effect on demand (which is especially focused on transportation) and as international collaboration on managing the supply of oil has fragmented. These factors are related since lower prices caused by the first have been a trigger for the second effect. Roskill’s assumption is that the price of oil will gradually move back up as supply adjustments take place, but the structural price of oil may have permanently moved down – particularly if the previous points on the development of the “green economy” prove to be correct. This will affect the longer run demand outlook for those metals that are especially dependent on use in the oil and gas sector, such as

molybdenum and niobium. Lower energy prices will also benefit those more energy-intensive, usually lower grade, mining operations.

- **Supply chains and deglobalisation.** The Covid-19 pandemic has accentuated tensions between countries and magnified what were already growing concerns over the vulnerability of the supply chains of many goods and services to disruptions. There are inevitable trade-offs between trying to minimise costs and relying on extended supply chains, but these pressures are driving trade towards a more federated and less global structure. In addition, we are seeing a trend towards increased traceability across all metals, not just 3TG. Upstream and downstream integration is also more likely. Separately, governments and government agencies – including the US Department of Defense and the European Commission – are increasingly looking at how they can support the development and supply of critical raw materials such as tantalum and niobium.

- **Operational resilience.** As a consequence of increased supply chain risks, firms may decide they need to build more redundancy into their operating assets. For mining assets that may involve higher levels of inventories and spares, a greater use of automation, procurement through a wider range of suppliers, increased biosecurity controls and increased ownership or direct control of logistics networks. This will inevitably have consequences for costs and prices.

- **Lower interest rates and industry cost of capital.** Survey data suggest that mining companies in general are investing on the basis of a real industry cost of capital of around 8%, and often apply hurdle rates well above this level. This assumes a historical real rate of interest of around 2% and an industry “beta” that is well above other parts of the economy. Both of these assumptions may no longer hold given; US long 10-year government bond yields are negative and since 2015 the mining index has followed global equities. The valuation of mining assets is highly geared to its cost of capital and lowering the rate of return would significantly increase the value of mining assets.

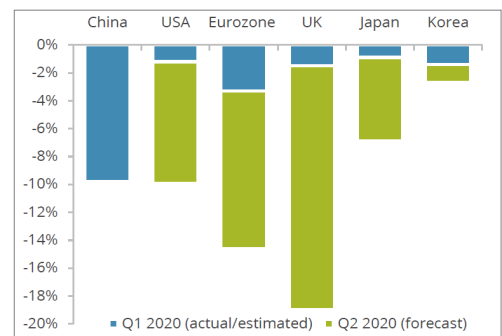
- **Taxation and political risk.** A counterweight to a lower cost of capital may be higher taxation of the mining sector as governments look to raise revenues to close fiscal deficits and repay debts incurred as a result of Covid-19. Mining assets often prove to be a tempting target for such taxes due to their fixed geographical nature. At the extreme this can result in the full nationalisation of assets. Heightened risk of this, and also the supply chain risks already discussed, mean that country risk premia may increase in some jurisdictions. More investment in the mining sector as a result may move back to more perceived stable countries. This may benefit, for example, the development of nickel and lithium projects in Australia over other investments.

## Conclusions

The effects of the Covid-19 crisis are leading to a multi-decade record contraction in global GDP. Industrial production is also being severely impacted, but it is likely to hold up better relative to GDP than in previous downturns. Changes are, so far, more comparable in scale to the 2008-9 global financial crisis (GFC). Although it depends somewhat on being able to control the Covid-19 virus, as a counterpart to the sharp decline in GDP and industrial production, Roskill expects the recovery to be much sharper and more “V-shaped” than in previous downturns such as the GFC. Whilst there is general pessimism about the economic outlook, Roskill is still optimistic that demand for most metals will eventually recover back to pre-Covid-19 levels. That recovery will likely be quicker for those materials which are more China-centric.

Compared to its state in 2008, the mining sector today is also structurally much better positioned to weather the current crisis and the resilience of metals prices and mining equities to the downturn has, so far, been remarkable. Roskill’s index of all metals prices remains 25% above its previous cyclical lows and it is only modestly down for the year-to-date. This resilience partly reflects falls in price that had already taken place in 2019 and as supply adjustments in several markets have offset the effects of lower demand. There may, though, be some general price weakness in the next two quarters as supply disruptions are resolved and as some later inventory destocking is possible.

Roskill’s views on the fundamentals of the metals markets it covers have not fundamentally changed as a result of the Covid-19 pandemic. The current crisis has, though, exposed the vulnerability of some supply chains and accelerated risks of deglobalisation. For the mining sector this highlights the need to improve operational resilience. Increased traceability, and more preferred access or partnership arrangements, along with changes in the cost of capital, energy input prices and political risk, may push up industry margins and shift the location of growth in metals supply back more towards developed regions.



Cumulative quarterly falls in GDP (% q-o-q) (credit: Roskill)

# Tantalum and niobium intellectual property update

This information is taken from the European Patent Office ([www.epo.org](http://www.epo.org)) and similar institutions. Patents listed here were chosen because of their apparent relevance to tantalum and/or niobium. Some may be more relevant than others. Note that European patent applications that are published with a search report are 'A1', while those without a search report are 'A2'. When a patent is granted, it is published as a B document. Disclaimer: This document is for general information only and no liability whatsoever is accepted. The T.I.C. makes no claim as to the accuracy or completeness of the information herein.

Title	Applicant(s)	Publication date
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## TANTALUM

Tantalum-silicon alloy sputtering target material and preparation method thereof CN110952064 (A)	KONFOONG MATERIALS INT CO LTD	2020-04-03
Inner wall treatment method of tantalum capacitor shell CN110957138 (A)	HUNAN HUARAN ELECTRONIC TECH CO LTD	2020-04-03
Tantalum capacitor shell CN110957139 (A)	HUNAN HUARAN ELECTRONIC TECH CO LTD	2020-04-03
Low-oxygen spherical tantalum powder and preparation method thereof CN110947976 (A)	BEIJING AMC POWDERS METALLURGY TECH CO LTD	2020-04-03
Tantalum sputtering target US2020131622 (A1)	JX NIPPON MINING & METALS CORP [JP]	2020-04-30
Manufacturing method of tantalum wire KR20200046897 (A)	KOREA INST IND TECH [KR]	2020-05-07
Solid electrolytic capacitor for a tantalum embedded microchip WO2020106406 (A1)	AVX CORP [US]	2020-05-28
Tantalum capacitor KR20200060010 (A)	SAMSUNG ELECTRO MECH [KR]	2020-05-29
Semiconductor element cleaning solution that suppresses damage to tantalum-containing materials... IL252099 (A)	MITSUBISHI GAS CHEMICAL CO [JP], TOSHIYUKI OIE [JP], KENJI SHIMADA [JP]	2020-05-31
Method of manufacturing tantalum carbide material US2020198980 (A1)	SHOWA DENKO KK [JP]	2020-06-25
Tantalum carbide coating material EP3670450 (A1)	JO DONG WAN [KR]	2020-06-24

## NIOBIUM

Preparation method for niobium-containing cast iron-based motor shell CN110952029 (A)	ANHUI XUANLIDA MOTOR CO LTD	2020-04-03
Niobium and vanadium-doped titanium tantalate-based photocatalyst, preparation method therefor and use thereof WO2020073298 (A1)	NANTONG TEXTILE & SILK INDUSTRIAL TECH RESEARCH INSTITUTE [CN], UNIV SOOCHOW [CN]	2020-04-16
Porous electrochromic niobium oxide films and methods of making and use thereof WO2020076798 (A1)	UNIV TEXAS [US]	2020-04-16
Electroplating of niobium titanium US2020136223 (A1)	IBM [US]	2020-04-30
Niobium tin alloy and method for its preparation EP3650568 (A1)	SPANIOL BERND [DE]	2020-05-13
Niobium-containing austenitic stainless steel and method for manufacturing same WO2020101101 (A1)	KOREA ADVANCED INST SCI & TECH [KR]	2020-05-22
Method of joining a niobium titanium alloy by using an active solder US2020164452 (A1)	OXFORD INSTRUMENTS NANOTECHNOLOGY TOOLS LTD [GB]	2020-05-28
Niobium-molybdenum alloy compensating balance spring for a watch or clock movement EP3663867 (A1)	CARTIER INT AG [CH]	2020-06-10
Spherical niobium alloy powder, products containing the same, and methods of making the same WO2020123265 (A1)	GLOBAL ADVANCED METALS USA INC [US]	2020-06-18
Niobium coated sleeves for joining nickel titanium shape memory components for guidewires US2020197669 (A1)	MEDPLATE LIFESCIENCES CORP [US]	2020-06-25



## Diary of industry events

- T.I.C.'s 61st General Assembly and AGM in Geneva, Switzerland, October 11th to 14th 2020
- International Conference on Managing NORM in Industry, Vienna, Austria, October 19th to 23rd 2020
- RMI (virtual) conference, October 27th to 28th 2020
- IAEA's 41st TRANSSC meeting in Vienna, Austria, November 2nd to 6th 2020
- Electronica, Munich, Germany, November 10th to 13th 2020
- FORMNEXT, Frankfurt, Germany, November 10th to 13th 2020
- Tarantula (Month 18), venue tbc, December 15th to 16th 2020
- Argus Metals Week, London, UK, February 2021
- MMTA International Minor Metal Conference, Charleston, South Carolina, USA, April (tbc) 2021

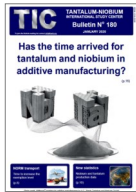

\* correct at time of print

## Member company updates

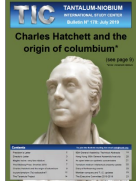
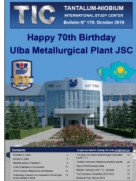
### Changes in member contact details

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

- **ATI Specialty Alloys & Components** has a new delegate, Mr Aresh Toumadje, who can be reached on [Aresh.Toumadje@ATImetals.com](mailto:Aresh.Toumadje@ATImetals.com).
- **EcoWhite Trading Ltda** has a new delegate, Ms Natalia Ramos, who can be reached on [gerencia@ecowhite.com.br](mailto:gerencia@ecowhite.com.br).
- **Guangdong Rising Rare Metals-EO Materials Ltd** has a new email address for the delegate, Mr Zeng Guozhong, [zh\\_ctns@126.com](mailto:zh_ctns@126.com).
- **H.C. Starck Tantalum and Niobium GmbH** has changed its name to **TANIOBIS GmbH**. The email of the delegate, Ms Silvana Fehling, is now [silvana.fehling@taniobis.com](mailto:silvana.fehling@taniobis.com) and the company website has changed to [www.taniobis.com](http://www.taniobis.com).
- **MTU Aero Engines AG** has a new delegate, Mr Dominik Pitz, who can be reached on [dominik.pitz@mtu.de](mailto:dominik.pitz@mtu.de).
- **Plansee SE** has a new delegate, Ms Sandra Horninger, who can be reached on [sandra.horninger@plansee.com](mailto:sandra.horninger@plansee.com).
- **Solikamsk Magnesium Works** has a new delegate, Ms Yuliya Chistyakova, who can be reached on [chistyakova@smw.ru](mailto:chistyakova@smw.ru).



## Join our mailing list to receive the Bulletin by email each quarter



Our mission with the Bulletin is to provide the global tantalum and niobium community with news, information and updates on our work. We hope you enjoy reading it! Recipients will also receive messages about the T.I.C. and our General Assemblies.

Email [info@tanb.org](mailto:info@tanb.org) to join our mailing list and keep up to date with the T.I.C.

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The T.I.C. is an international, non-profit association founded in 1974 under Belgian law that represents around 90 members from over 30 countries involved with all aspects of the tantalum and niobium industry. The T.I.C. is managed by an Executive Committee elected from the membership and representing all segments of the industry. Corporate membership costs EUR 2750 per calendar year and full details of benefits are available at [www.TaNb.org](http://www.TaNb.org)

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# Director's Notes

London, UK

Dear T.I.C. Members,

I hope that you and your family are staying well during these challenging times.

First the good news, fortunately, it seems that members of our tantalum-niobium community have largely been spared the worst impact of the pandemic. In recent weeks I have been talking to many members and stakeholders to understand their views regarding our potential conference this year, and I'm very pleased to report that only one person I've talked with has had Covid-19 and thankfully he has made a full recovery.

Unfortunately however, economically our industry still faces big challenges due to Covid-19; from the mineral traceability programs in central Africa facing significant challenges (see ITSCI article, page 27), to the tough business conditions many members are facing. Clearly there is still some way to go before we get back to 'normal'.

## How does Covid-19 impact the T.I.C.?

The biggest potential impact of Covid-19 on the T.I.C. concerns our General Assembly. This industry is one that places a lot of value in holding face-to-face meetings, but the lack of international travel and health concerns of holding large meetings calls into question whether a meaningful event can be held at present.

If in August the Executive Committee decides that our event cannot take place this year and it decides to roll it to 2021 - as so many other industry events have already done - it will leave a significant hole in our finances. Without the surplus from our General Assembly we will face tough questions, and be forced to consider reducing costs wherever possible and finding new ways to add value.

## A virtual meeting?

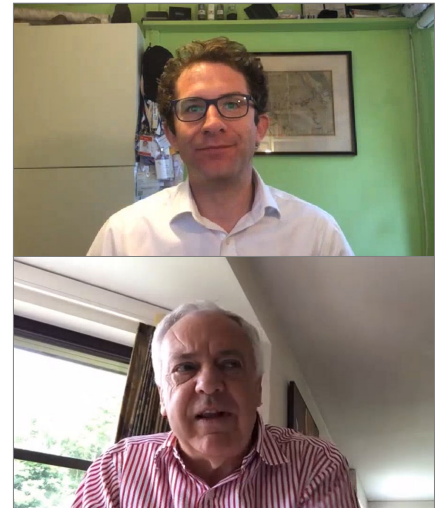
If it is decided that the in-person General Assembly cannot happen this year then we may decide to create a virtual meeting. It could include many of the same features as our traditional event, including plenary presentations, awarding the Ekeberg Prize and offering sponsorship opportunities, and while the gala dinner may lack sparkle at least you could avoid the strange hangers-on who loiter in the lobby and, perhaps most importantly, you would avoid the risk of taking long flights cocooned in protective masks, gloves and face-shields.

It is just an idea, but considering how much the T.I.C. has developed and evolved since 2015, anything is possible. Watch this space...

Please look after yourselves and others,

Best wishes,

Roland Chavasse, Director



Luc Houben, T.I.C.'s legal counsel, and I chat on Zoom. Virtual meetings have rapidly become the new business environment (Photos: T.I.C.)

## Tantalum octopus wanted. Can you help?

In [Bulletin #181](#) we discussed the interference colours that are created from thin films of tantalum and niobium oxide, including the work of artist and goldsmith James Brent Ward. Following up on the positive feedback he's received, he has asked the T.I.C.'s community for help in finding a commercial partner able to create complex shapes in tantalum for his latest project, a tantalum octopus.

James has sent T.I.C. some wax octopus moulds, each about 4 cm long. Potential manufacturing techniques could include powder-bed additive manufacturing, machining, or casting in silver before being coated in tantalum by sputtering. Casting has been trialled but a high oxygen content caused brittleness. Note that the design can be adjusted to aid production.

If you would like to know more, to receive a wax octopus or be introduced to James directly, then please contact [director@tanb.org](mailto:director@tanb.org).



On July 1<sup>st</sup>, 2020, H.C. Starck Tantalum and Niobium became

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# TANI OBIS

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Save the dates



# T.I.C.'s 61st General Assembly

(conference and AGM) is scheduled to take place in

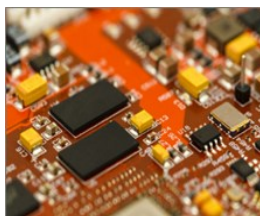
# Geneva, Switzerland

October 11th - 14th 2020

Non-members are welcome to attend this event. The T.I.C. General Assembly attracts industry leaders from around the world. Full details will be made available online at [www.tanb.org](http://www.tanb.org).

**At time of publication this event cannot be guaranteed due to uncertainties caused by the Covid-19 global pandemic. The Executive Committee asks for your understanding as it continues to monitor the situation closely. A final decision will be taken by early August. Please look out for further updates in due course.**

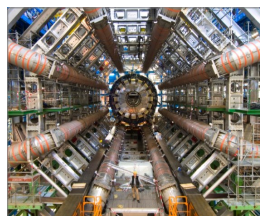
Our 2020 conference will explore issues such as:



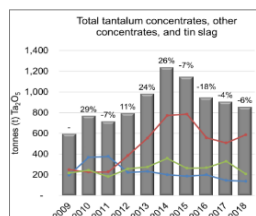
Capacitors



Superalloys



Superconductors



Statistics



And much more!

All questions about the General Assembly should be sent to Emma Wickens at [info@tanb.org](mailto:info@tanb.org). Full details will be published on [www.TaNb.org](http://www.TaNb.org) and in future editions of the Bulletin.

The 61st General Assembly will include the award ceremony for the 2020 Anders Gustaf Ekeberg Tantalum Prize, the annual award for excellence in tantalum research and innovation.



This year our field trip will be to CERN, one of the world's leading centres for scientific research (and a major user of niobium in superconducting magnets!).

