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TANTALUM-NIOBIUM INTERNATIONAL STUDY CENTER

PRESIDENT'S LETTER

Friends,

June, and the northern summer has finally arrived! The last few months have seen several natural disasters in many parts of the world, from earthquakes, tornados, floods and fires. Our sympathies to any of our members - be it their employees, families, or friends - who may have been impacted.

In April, members of the Executive Committee met, along with our Technical Promotion Officer and Secretary General, to review plans for the Fifty-second General Assembly to be held in Almaty, Kazakhstan, on Monday October 17th. The T.I.C. meeting, technical programme and visits will extend from Sunday October 16th to Wednesday October 19th. The technical programme is taking shape, and as you will see from the list of papers elsewhere in this Bulletin, it promises to be engaging and informative for both the niobium and tantalum industries. Two days of tours for accompanying persons are also being arranged. Complete details and pre-registration forms will be sent to members in July, and we ask that you register as early as possible. We should also inform you that flights to and from Almaty are limited, and you would be well advised to make your travel plans as early as possible.

We wish to thank NAC Kazatomprom and Ulba Metallurgical Plant JSC for hosting the event and for opening their plant for the Wednesday visit. This will be a full day tour, including a return charter flight from Almaty to Ust-Kamenogorsk.

The Committee has also started work on future Assemblies, with plans already well in hand for the 2012 Cape Town meeting which will probably take the form of a Symposium. We are already looking ahead to 2013, with a likely venue in Europe – the location and the host should be announced in October.

Your various Working Groups continue to work hard behind the scenes. Our Technical Promotion Officer is ably representing the T.I.C. at several international forums related to transportation, while several members are involved with various initiatives regarding the mining and trading of minerals in Central Africa. We will receive updates on both these issues at our meeting in Almaty.

Finally, you will also see elsewhere that this is a historic issue of the Bulletin: it will be the very last one published in 'hard copy', as we embrace the internet age and turn to publishing the Bulletin on-line.

Richard Burt
President

CONTENTS

Quarterly Bulletin in electronic format

After 146 issues in paper format, stretching back to the foundation of the association in 1974, the Executive Committee of the T.I.C. has decided that it is time for the quarterly Bulletin to enter the electronic era.

With 1250 paper copies currently being sent around the world each quarter, not only to our member companies but also to over 850 non-members, this change will bring a substantial benefit for the environment and reduce costs.

This issue will therefore be the last on paper.

From September onwards, the nominated delegate of each member company will receive the document by e-mail, in pdf format. Of course, delegates are encouraged to forward the message to their colleagues.

The Bulletin will equally be freely available on our website. New issues will be posted at the end of March, June, September and December. We invite non-members to refer to our website at the end of each quarter.

FIFTY-SECOND GENERAL ASSEMBLY AND TECHNICAL MEETING

The Fifty-second General Assembly meeting of the Tantalum-Niobium International Study Center will be held in Almaty, Kazakhstan, from October 16th to 19th 2011. The meeting will take place at the Rahat Palace Hotel, where a block booking of bedrooms is being held to accommodate the delegates.

On Sunday October 16th, the registration desk will be open from 10a.m. to 1p.m. and 2p.m. to 5p.m. All participants are invited to a Welcome Reception at the hotel from 6p.m. to 8p.m.

The formal General Assembly of the association will be held on Monday October 17th and will be followed by technical presentations for the rest of the morning, then a buffet lunch.

Companies wishing to apply for membership at this General Assembly are reminded that their completed application forms should be returned to the T.I.C. by August 17th 2011. For any further information on becoming a member, please contact the Secretary General on info@tanb.org.

On Monday evening, all participants are invited to a Gala Dinner hosted by NAC Kazatomprom and Ulba Metallurgical Plant JSC, to be held at the Bakhchisaray restaurant. Transfer by bus will be organised.

A second technical session will be held on the morning of Tuesday October 18th, followed by lunch.

The full technical programme is published herebelow.

On Wednesday October 19th, there will be a plant tour to the facility of Ulba Metallurgical Plant JSC. A chartered flight will take the group to Ust-Kamenogorsk, around one and a half hours away from Almaty.

Ulba Metallurgical Plant Joint Stock Company was established on October 29th 1949. The company is one of the world's largest producers of uranium dioxide fuel pellets for nuclear power plants and also manufactures beryllium, tantalum and niobium products.

The uranium production facility has been processing materials for further use in the nuclear industry since 1954.

The tantalum and niobium production facility has a full production cycle from raw material processing to manufacturing of finished products. Production is remarkable for its flexible technology of processing any kind of tantalum and niobium raw materials, including hardly recoverable ones.

The beryllium production facility includes all processing phases from ore concentrate processing to manufacturing of finished products.

Quality and Environment Management Systems are certified by the International Certification Body TÜV Thüringen for compliance with EN ISO 9001:2008 and EN ISO 14001:2004 in all three production areas.

In 1997, the company was incorporated into the National Atomic Company Kazatomprom, a national operator of the Republic of Kazakhstan for export of uranium and uranium compounds, rare metals, nuclear fuel for power plants, special purpose equipment, and dual-use technologies and materials. It is now amongst the leading uranium mining companies in the world.

Sightseeing tours for accompanying persons are also being arranged for Monday and Tuesday. One day, participants will discover central Almaty and the immediate surroundings, with the Kok-Tobe Hill and Medeo Gorge. The other day will take participants a little further afield, to appreciate the history and beautiful scenery of the local countryside.

An invitation will be sent to the nominated delegate of each member company in July. Others who would like to attend should contact the T.I.C. as soon as possible

FIFTY-SECOND GENERAL ASSEMBLY: TECHNICAL PROGRAMME

The following papers are expected (not in running order):

Current trends in the development of production technology for tantalum powders with capacitance of up to 8 kCV
by L.M. Frolova and A.E. Kaynazarova, NAC Kazatomprom, Ulba Metallurgical Plant

NbZr1 alloy used for superconductive joints for radiofrequency superconducting (RFSC) cavities
by Bernd Spaniol, Andreas Uhlendorf, Joachim Rutz, Xenia Singer, Jacek Sekutowicz and Peter Kneisel, W.C. Heraeus

New operating developments at Mibra mine
by Itamar Resende, Companhia Industrial Fluminense

Current situation and prospects for high capacitance tantalum powder
by Zhang Xueqing, Ma Yuezhong, Cheng Yuewei, Wang Zhidao, Luo Guoqing, Lin Fukun and Chen Xueqing, CNMC Ningxia Orient Group

As it was and in our time
by K. A. Stewart and G. T. Ibbs, A.S. Metallurgy (Liverpool)

Development of electron beam melting technology at Ulba Metallurgical Plant JSC
by S.J. Dobrusin and D.V. Popov, NAC Kazatomprom, Ulba Metallurgical Plant

Tantalum market trends in the Far East
by Hiroaki Yoshinaga and Shigeo Nakamura, Advanced Material Japan

Development of a new generation pilot plant for production of tantalum powders utilizing FFC Cambridge process principles
by Ian Margerison, Metalysis

Technology for production of niobium master alloy and high-purity niobium at Ulba Metallurgical Plant JSC
by D.V. Popov, S.J. Dobrusin, A.B. Savichev and G.A. Gaintsev, NAC Kazatomprom, Ulba Metallurgical Plant

T.I.C. statistics and transport update
by Ulric Schwela, Tantalum-Niobium International Study Center

Tantalum market prospects
by A. Bossonogov and A. Tsorayev, NAC Kazatomprom, Ulba Metallurgical Plant

Research on large grain niobium sheet process used in superconducting accelerating cavity
by Xie Weiping, CNMC Ningxia Orient Group

Update on conflict-free supply chain management issues
by William Millman, AVX, and Richard Burt, GraviTa Inc.

Overview of the artisanal mining sector in Eastern DRC: current initiatives on the ground
by John Kanyoni, Mining Chamber, Fédération des Entreprises du Congo

TANTALUM SPUTTERING TARGETS: APPLICATION, ATTRIBUTES AND FUTURE

This article was prepared from the paper by Paul S. Gilman of Praxair Electronics presented at the meeting of the T.I.C. held on the shores of Lake Tahoe, Nevada, U.S.A., in October 2010.

INTRODUCTION

The ability of tantalum to form a thin, protective oxide is the basis for the application of tantalum in electrolytic capacitors.

The first use of tantalum in microelectronics was in the formation of discrete thin film capacitors. Early tantalum depositions utilized evaporation, but by the end of the 1960s physical vapor deposition, i.e. sputtering, was the preferred method of thin film deposition. Physical vapor deposition relies on ionized argon atoms to mechanically knock off metallic atoms from a material source called a target. The target atoms subsequently deposit on the required substrate. In magnetron sputtering, a magnetic field increases ion density by focusing secondary electrons which increases the sputter rate and allows the plasma to be sustained at a lower pressure (see Figure 1). The progression of tantalum usage in microelectronics from discrete components to ink jet printer heads to the importance as a barrier for copper interconnects will be discussed. Also the attributes required in tantalum sputtering targets will be discussed.

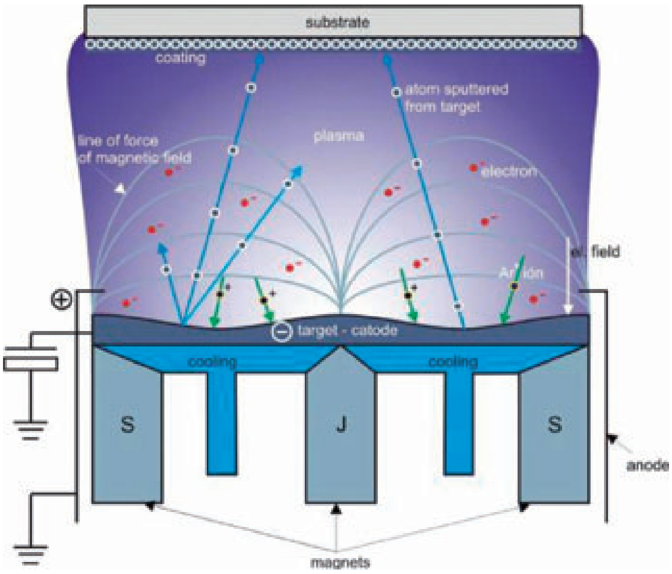


Figure 1: Magnetron sputtering: ionized Ar (+) atoms mechanically knock target atoms off. The target atoms deposit on the substrate. The applied magnetic field increases ion density by focusing the secondary electrons.

THERMAL INK JET PRINTER HEADS

Thermal ink jet printer heads, which were introduced around 1980, are manufactured using thin film integrated circuit manufacturing, providing a boost in the use of tantalum and tantalum based sputtering targets. Utilizing integrated circuit manufacturing technologies, a thin film resistor is used to rapidly heat a thin film layer of ink at a power density of approximately 1.28E9 watts/m^2. A minuscule fraction of ink is vaporized to form an expanding bubble that ejects a droplet of ink (see Figure 2). The resistor of choice is TaAl. Since the high temperature ink tends to cavitate parts of the device, a tantalum anti-cavitation film is used to protect the device from the ink.

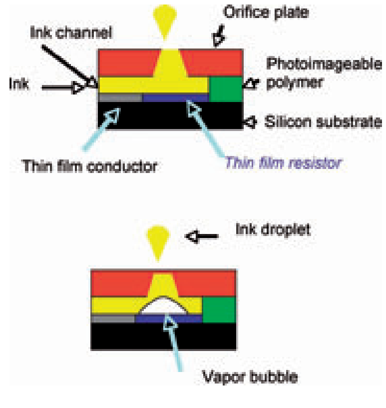


Figure 2: Thermal ink jet printer head (from HP)

COPPER METALLIZATION

A big jump in the use of tantalum thin films in leading edge IC manufacturing occurred with the introduction of copper metallization. The techniques of photoresist masking and plasma etching cannot be used to pattern copper because copper does not form the volatile compounds required for low temperature plasma etching. Typically a Damascene process is used in copper where the underlying silicon oxide insulating layer is patterned with open trenches where the conductor should be (see Figure 3). A barrier film must completely isolate the copper while providing high conductivity. If the barrier film is excessively thick, the high conductivity benefit of the copper interconnects is lost.

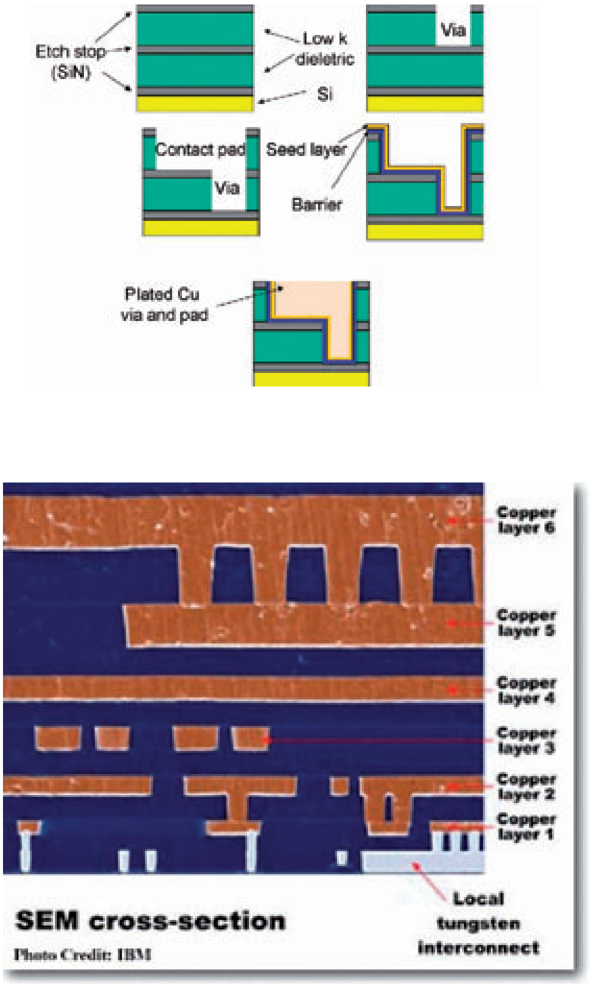


Figure 3: Copper metallization using a Damascene process where the underlying silicon oxide insulating layer is patterned with open trenches where the conductor should be followed by barrier and copper metallization (from IBM)

Given the copper metallization scheme described above, the barrier deposition must have good step coverage and reduced overhang at the via/trench openings. To achieve this, OEMs have engineered PVD tools that utilize ionized PVD controlling the directionality of the ionized metal by wafer bias. Also the directionality of the argon ions causes re-sputtering of material from the top and bottom of the feature. The directional sputtering is achieved by source design and the use of RF power. The required step coverage can be achieved by using conventional planar tantalum sputtering targets or hallow cathode magnetron targets where sputtering takes place in the internal surface of the target.

For sub 0.10 µm copper integrated circuits a tantalum and tantalum nitride PVD barrier has various benefits, including good copper diffusion and good adhesion to the dielectric and copper. Tantalum nitride is a good diffusion barrier to fluorine as pure tantalum reacts with fluorine. Fluorinated dielectrics aid miniaturization by reducing the dielectric constant. Finally, tantalum acts as a nucleation layer for copper, enabling a (111) orientation which is critical for reliability. Advanced PVD barrier tools are required to form a TaTaN barrier structure. Also redeposition of the sputtered material is minimized, which is critical for maintaining low particle levels. The nitrogen concentrations at the dielectric and copper interfaces can also be tuned. A transmission electron microscopy image of Ta(N) step coverage is shown in Figure 4.

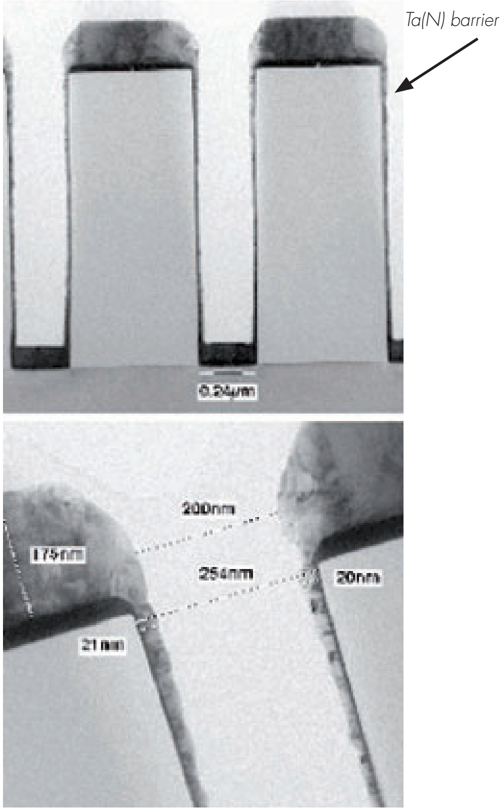
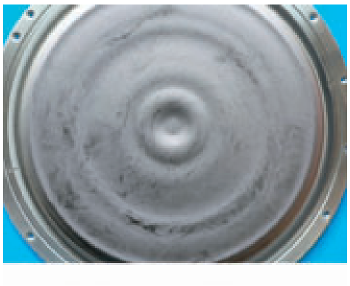


Figure 4: TEM cross-section of SIP Ta(N)/SIP Cu step coverage (Chin, Yao, Ding, Fu & Chen Applied Materials)

Given the sophistication of the PVD tools used to deposit advance copper interconnects, i.e. high aspect ratio step coverage, reduced particles and high throughputs, tantalum target metallurgy can greatly affect sputtering target performance. Fundamentally a sputtering target should have a consistent and uniform crystallographic texture minimizing areas of different textures (called texture banding), and gradual changes in texture (called texture gradients). The complexity of achieving a uniform and consistent crystallographic texture results from the use of electron beam melting necessary to purify tantalum to a level required for electronic applications, typically > 3N5, resulting in a billet whose microstructure consists of a few large grains. Combine this with the body centered cubic structure of tantalum which limits the available slip systems, it has been difficult to generate a tantalum microstructure that has a consistent and uniform texture devoid of texture banding and gradients. Fortunately great progress has been made in creating tantalum target metallurgy that is free of texture banding and gradients (see Figure 5). One example of this is AdvanTage™ (TM of Praxair) Tantalum sputtering targets which are texture band free having a uniform microstructure. This correlates to consistent through life sputtering performance and improved early life stability in thin film properties (see Figure 6). AdvanTage Tantalum allows targets to achieve full target life without drifting out of specification as the target approaches its useful life. Figure 7 shows that a tantalum nitride/tantalum film processed using an AdvanTage Ta sputtering target maintains critical thin film uniformity, while a traditionally processed target drifts to high thin film uniformity.



1st generation

2nd generation

3rd generation

Figure 5: Tantalum sputtering targets showing improvement in texture banding

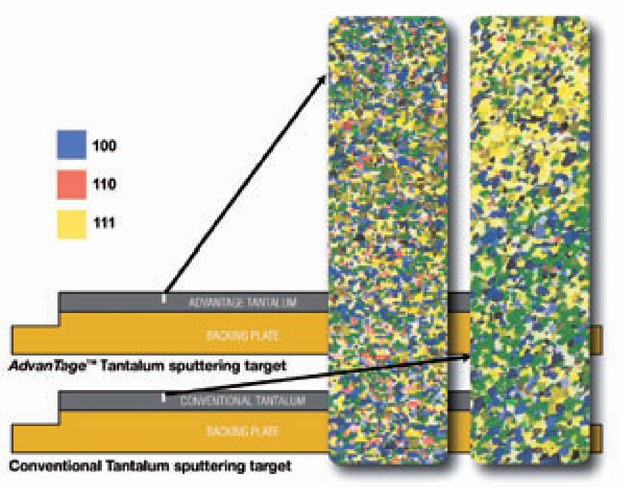


Figure 6: Color coded orientations in Electron Back Scattered Diffraction (EBSD) image demonstrate degree of texture banding. AdvanTage™ Tantalum target is texture band free (from Praxair)

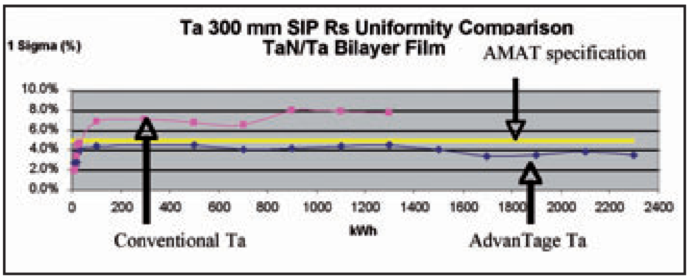


Figure 7: Tantalum 300 mm SIP Rs uniformity comparison for a TaN/Ta bilayer film. AdvanTage™ Ta shows consistent thin film uniformity throughout target life.

TSVs

A developing application for copper metallization is for through-silicon via (TSV) 3D integration (From Applied Materials Silicon Technologies Because Innovation Matters™). The goal of 3D integration of chips is to fabricate semiconductor devices that are faster, cheaper and smaller. Most recently 3D integration was engineered by miniaturization of circuits and components using wire bond and flip-chip stacking. Wire bonding can have inductive losses which erode device performance. One method of improvement is using TSVs. Fundamentally two or more vertically stacked chips are joined by vertical interconnects running through the stack and functioning as components of the IC. Stacking and the connecting die enable high performance devices to be made from components fabricated at non-leading edge geometries. The PVD barrier of copper TSVs is complex and expensive. Homogeneous TSVs utilize a Via Last approach in that the TSV is formed after the chip is made and is used to stack like chips. Potential applications included DRAMS. Heterogeneous TSVs use a more complex Via First approach in that the TSV is formed during the front end processing of the device. Via First is used to integrate different devices such as memory chips with logic chips (see Figure 8).

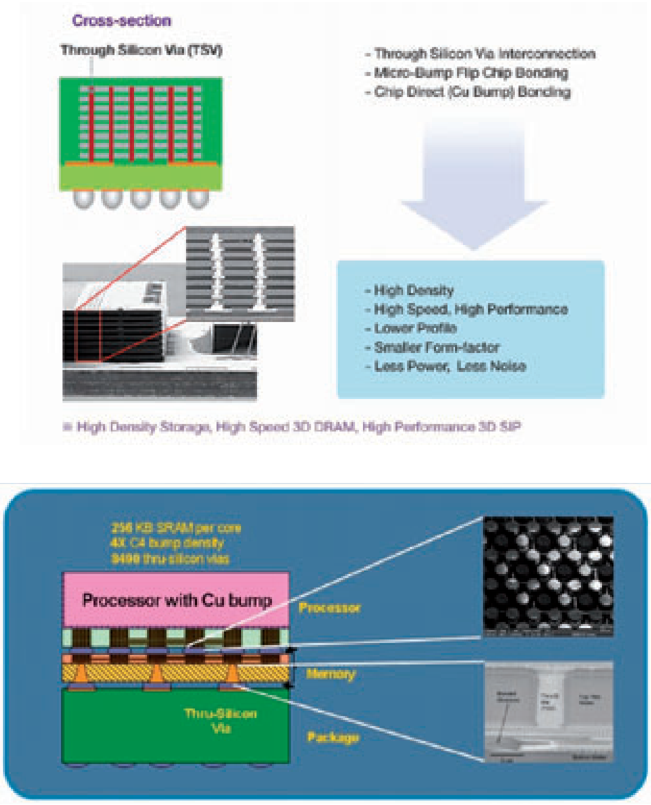


Figure 8: Through-Silicon Via 3D integration. Top: homogeneous TSV - Via Last for stacking of like chips. Bottom: heterogeneous TSV - Via First for 3D integration of different chips (from INTEL)

TFT-LCD

Another example of the expanding use of copper metallization is in thin film LCD flat panel displays. These interconnects are used for pixel creation and color formation via the color filter. The low resistivity of copper, approximately 60% less than traditional aluminum interconnects, enables transmission of media signals across entire large-area LCD screens without noise, creating sharp images with virtually no distortion or display jitters. The large targets used for TFT-LCD have typically been planar, but large rotary targets are beginning to be used because of their high efficiencies regarding material utilization (see Figure 9). So far, for TFT-LCDs, the barrier of choice for copper metallization is titanium.

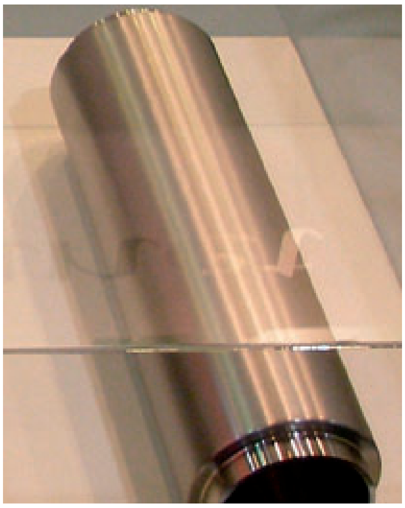


Figure 9: Example of a rotary sputtering target that can be used for a large area Thin Film Technology - Liquid Crystal Display (TFT-LCD)

PRODUCTION OF SUPERCONDUCTING NIOBIUM MATERIALS AT TVEL CORPORATION

This article was prepared from a paper presented by M.Y. Shlyakhov at the meeting of the T.I.C. held in Nevada, U.S.A., in October 2010. The paper was written by V.V. Rozhdestvenskiy, V.I. Kalantyr, V.N. Kazantsev, M.Y. Shlyakhov (JSC TVEL), A.E. Vorobieva, V.A. Drobishev (Bochvar Institut) and K.M. Abramushin (JSC ChMP)

Introduction

In 2008, JSC TVEL started a new production facility of low temperature superconductors at JSC Chepetsky Mechanical Plant (ChMP) to supply NbTi and Nb_3Sn strands for the International Thermonuclear Experimental Reactor (ITER). The facility includes large ingot production of Nb, NbTi and tin bronze alloys, fabrication of component parts (rods, tubes) and superconductor strands.

About TVEL

The core business of TVEL is nuclear fuel production. Joint Stock Company TVEL is one of the world key manufacturers of nuclear fuel. TVEL-labeled fuel feeds 74 commercial (17% of the global market) and 30 research reactors in 17 countries worldwide (see Figure 1). TVEL integrates large Russian enterprises specializing in nuclear fuel fabrication, supplies, scientific and engineering support to nuclear power plants (NPPs) in Russia and in foreign countries. TVEL enterprises produce nuclear fuel for different types of commercial, research and transport reactors. The end product - fuel assemblies (see Figure 2) - is manufactured at JSC Mashinostroitelny Zavod and JSC Novosibirsk Chemical Concentrates Plant. JSC Chepetsky Mechanical Plant is responsible for producing structural materials and zirconium alloy components of fuel.

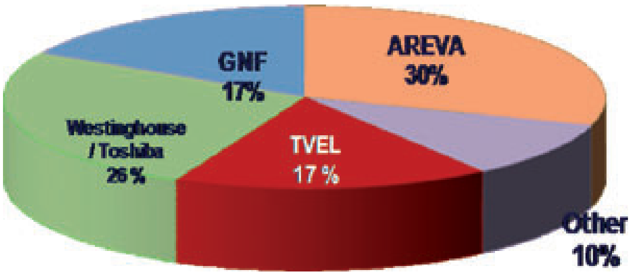


Figure 1

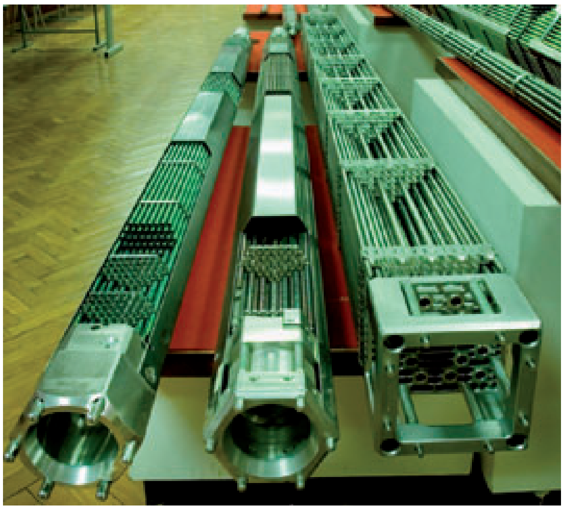


Figure 2

About Chepetsky Mechanical Plant

Joint Stock Company Chepetsky Mechanical Plant is located in Glazov, which is situated in the center of Russia, in the north of the Udmurt Republic, 1000 kilometers from Moscow. JSC Chepetsky Mechanical Plant is the only facility in Russia which produces zirconium and zirconium alloy items.

Production of zirconium, zirconium alloy items and zirconium-based chemical compounds are the main activities of the enterprise (see Figures 3, 4 and 5). Additionally the plant reprocesses all types of natural uranium raw materials, produces depleted uranium-based items to generate uranium tetrafluoride. The enterprise manufactures fuel channels for the Russian NPPs with RBMK reactors, metal calcium and metal calcium alloy items.

Figure 3

Figure 4

Figure 5

About ITER

Progress in High Energy Physics and Fusion relies on the successful outcome of currently existing projects such as LHC and ITER[i]. The magnet systems of each facility consume around 1000 tons of superconductors.

ITER is a unique international project. ITER members are: the U.S.A., the European Union (via EURATOM), Japan, China, the Republic of Korea, Russia and India. Together, these nations represent over half of the world's population.

ITER is a large-scale scientific experiment that aims to demonstrate that it is possible to produce commercial energy from fusion. In Moscow, on June 28th 2005, high representatives of the ITER members unanimously agreed on the site proposed by the European Union: the ITER installation would be built at Cadarache, near Aix-en-Provence, in Southern France.

The scientific goal of the ITER project is to deliver ten times the power it consumes. From 50 MW of input power, the ITER machine is designed to produce 500 MW of fusion power - the first of all fusion experiments to produce net energy.

The main commercial applications of superconductivity are concentrated in the field of medical diagnostic and scientific research instruments such as NMR spectrometers, research thermonuclear reactors and high field magnets. Almost all of these applications involve low temperature superconductors (LTS). Practically, the choice of low temperature superconductors is limited to Nb_3Sn and NbTi wires. Without superconducting technology most of these applications would not be viable.

Many experts believe the future development of superconducting technology is closely related to the electric power industry[ii]. The high power density and electrical efficiency of superconductor wire result in compact, powerful devices and systems that are more reliable, efficient, and environmentally friendly. More than fifty demonstrations and prototypes of superconducting power equipment have been successfully carried out worldwide. Most of them use high temperature materials (HTS):

- HTS cables, fault current limiters, transformers and SMES to eliminate grid congestion by increasing the power bandwidth of existing grid networks.
- HTS motors and generators for industrial, utility and maritime propulsion systems.

Although several HTS projects are underway in the Russian Federation[iii], LTS projects still remain dominant there. The main driving factor for the development of LTS in Russia is the participation in the ITER project.

Superconductor technology of NbTi and Nb_3Sn strands for ITER was developed by JSC VNIINM (Bochvar Institute for Organic Materials, Moscow).

About VNIINM

JSC VNIINM is a big scientific center in Russia in the field of material science and physics of metals. VNIINM performs research in nuclear power reactor fuel, spent fuel reprocessing and waste management, material science of fissionable and reactor structural materials, metallurgy and superconductor materials.

The ITER members announced an international tender for the production of Nb_3Sn superconducting materials. Over 15 companies applied but only 6 coped with the task. VNIINM was one of them. VNIINM has produced a pilot lot of NbTi and Nb_3Sn strands under ITER specifications. Several tests were performed in different labs to check the quality of these strands. As a result of these tests Russia was allowed to produce over 200 tons of Nb_3Sn and NbTi superconductors for ITER.

To meet the obligations of the Russian Federation under the ITER project, the Ministry of Atomic Energy decided to create a superconductor production at Chepetsky Mechanical Plant. ChMP already had relevant experience and specialists and was partially equipped.

At the next stage VNIINM issued the basic and specified versions of the feasibility report. With the financial support of the Russian Federation, TVEL conducted a number of tenders for the delivery of equipment: over 100 unique systems manufactured by leading companies of the United States, Germany, France, Austria and Italy.

It should be noted that the required level of superconductor parameters has been toughened twice by ITER administration. This required the constant improvement of production technologies. Therefore the requirement of $J_{nc} > 800$ A/mm^2 (at 12 T, 4.2K) assumes the attaining of critical current density in Nb_3Sn phase higher than 2670 A/mm^2, which is not a trivial task. This task was solved as JSC ChMP has close ties with the developer of the superconductor technology, JSC VNIINM. Under the supervision of VNIINM, ChMP issued the first big lot of Nb_3Sn superconductor strands by 'bronze' technology in 2007 (see Figure 6).

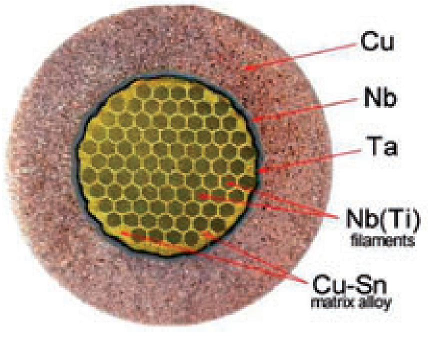


Figure 6

Two well established technologies are generally used for the production of Nb_3Sn strands - the so-called bronze process and the internal tin process. Due to some peculiar differences in these methods the process of optimization could be different, but principal approaches have a lot in common. Critical currents in the Nb_3Sn strand depend on the volume fraction of the superconducting phase and the pinning of the magnetic flux vortices on lattice defects, the critical temperature (T_c), and the upper critical field (B_{c2}). The key advantage of the bronze method is that the extrusion of a large composite billet is possible at the initial stage of deformation. Good metallurgical bonding of all elements of the composite billet is guaranteed. But the coprocessing of the bronze matrix and the niobium filaments during all steps of the manufacture requires numerous intermediate annealing steps due to the high rate of deformation hardening and consequent limited ductility of the Sn rich bronze.

The objectives of R&D for NbTi multifilamentary strands performed by VNIINM were to develop NbTi strands with high critical current density (J_c), low losses and high wire uniformity. For mass production it is also very important to have a technology that is capable of producing long piece lengths with greater yields.

One of the crucial problems was to avoid significant filament sausaging (the variation in filament diameter along the length of the wire). The most important factor influencing sausaging was the formation of brittle Cu-Nb-Ti intermetallic inclusions at the superconductor-Cu interface. These inclusions do not deform uniformly with the filament during wire drawing, leading to filament sausaging. Introduction of an Nb diffusion barrier was used to prevent intermetallic formation.

As a result of these efforts, a kind of national record was established: the length of one Nb_3Sn superconductor strand was 18 km - thereby proving that the technology was efficient.

In 2008 representatives of the ITER Organization visited the Chepetsky Mechanical Plant and got acquainted with all the preparatory work to set up a production facility for mass production of superconductors for ITER. The delegates appreciated the work carried out at the Glazov plant to transfer know-how from experimental level to commercialization and mass production.

By 2009 TVEL finished construction of all necessary infrastructure and production areas at ChMP. ChMP became a unique plant since it includes all manufacturing steps for the fabrication of the superconducting strands (both Nb_3Sn and NbTi) from melting and casting of the alloys to the transformation of composite billets and the drawing down of fine-filament wires, as well as the related Quality Assurance and Quality Control procedures.

The superconductor plant can be regarded as the complex of three separate facilities: the niobium production, the copper and niobium alloy production and the superconductor strand manufacturing workshop.

The niobium production facility includes an area for the calcium-aluminothermal reduction of niobium pentoxide in a shaft melting furnace and an area with vacuum electron beam furnaces (see Figure 7) to obtain niobium with a required structure and mechanical properties. The final products of this facility are high purity Nb ingots (see Figure 8) with specified hardness for each component of the superconductor restack: Nb diffusion barrier, Nb rod, Nb for NbTi alloy. Differently from the traditional aluminothermal technology, metallic calcium was added to the raw materials mixture. It helped to achieve a good separation of the metal phase from the slag.

Figure 7

Figure 8

The copper and niobium alloy production facility includes induction melting furnaces, vacuum-arc furnaces, a vacuum-packing furnace, a vacuum furnace for homogeneous annealing and an electrode welding rig. This facility can produce high homogeneity NbTi ingots, bronze ingots with high tin content (Cu-14% mass Sn).

The major part of the equipment used for superconductor production is concentrated in the superconductor strand production facility (see Figure 9). The technology requires numerous intermediate annealing steps when producing superconductor strand, so this facility includes a considerable number of drawing machines with different drum diameters and heat treatment equipment from the world's leading producers.

Figure 9

To ensure the quality of superconductor strands, numerous tests must be performed during manufacturing and at the final stage. Most of these tests are quite sophisticated and require cryogenic temperatures (4.2K). For example, critical current, hysteresis loss and RRR measurements shall be performed in a helium cryogenic environment and in a high magnetic field. All these measurement equipments, including a liquid helium plant, are available at ChMP.

The successful development of the new superconductor facility at ChMP is a striking example of relying on the available experience in the nuclear fission area of the plant to provide an excellent synergy for the production of superconducting wires (see Figure 10).

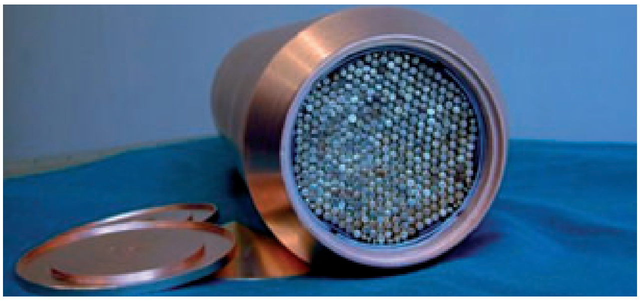


Figure 10

After the conclusion of the ITER programme in 2014, JSC TVEL plans to continue the development of the superconductor plant at ChMP with commercial products.

JSC TVEL has a long-term history of fruitful collaborations with leading research centers in the Russian Federation in the superconductor area, such as JSC VNIINM, Russian Research Centre 'Kurchatov Institute', Efremov Scientific Research Institute of Electrophysical Apparatus (NIIEFA).

TVEL performs a development programme that implements the following R&D: superconducting NbTi wire for MRI; wire for SIS-100 magnets (FAIR - Facility for Antiproton and Ion Research, Germany, GSI); MgB_2 conductor; 1G HTS wires; 2G HTS wires; High Strength, High Conductivity Wires for power applications.

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[i] http://www.iter.org
[ii] http://www.ccas-web.org/superconductivity/electicpower/
[iii] http://global-sei.com/news/press/10/10_18.html

MEMBER COMPANY NEWS

Firadec

Firadec has nominated a new delegate to the T.I.C.: Mr Claude Boudet replaces Mr Laurent Mangnan. His e-mail address is: claude.boudet@sicsafco.com