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TANTALUM-NIOBIUM INTERNATIONAL STUDY CENTER

PRESIDENT'S LETTER

Friends,

By the time you read this I hope that you have made all the necessary arrangements to attend what promises to be a very lively, informative and relevant Symposium. From the level of interest and registration activity I am confident that both the quality and depth of the papers to be presented will justify our members' attendance and investment of their and their company's precious time.

I have to take this opportunity to thank the contributors of papers to this year's Symposium: they have lived up to the very high standard that we have come to expect from our fellow members and I look forward to the technical sessions to come.

On reflection, the past few Symposium conferences have, in retrospect, marked major turning points in the history of our industries and we again look forward with some optimism after a sustained period that may be best described as 'challenging'. The ingenuity, adaptability and fortitude of our members constantly amazes me and confirms my belief that with such a resource we would be negligent not to utilise this experience and expertise in sharing this with other members of our fraternity at such a event.

I look forward to greeting you at the Symposium confident that the Secretary General and the Technical Promotion Officers have prepared diligently a full social, technical and cultural programme to inform, educate and entertain our membership.

William Millman
President

CONTENTS

TANTALUM AND NIOBIUM WORLD

The International Symposium 'Tantalum and Niobium World' will be held at the Royal Cliff Grand Hotel (see photograph), Pattaya, Thailand, from October 16th to 20th 2005.

The conference will open with a welcome reception on Sunday evening, October 16th, and the registration desk will be open from 10a.m. to 5p.m. on that day.

The formal business of the Tantalum-Niobium International Study Center will be carried out by the member companies on the morning of Monday October 17th.
The technical sessions of the Symposium will then open and run for the rest of the day on Monday, all day on Tuesday and for the morning of Wednesday. Abstracts of the papers proposed are printed in this Bulletin.

A plant tour of H.C. Starck (Thailand) is offered on Thursday, with an alternative tour of the Bayer MaterialScience polycarbonate plant offered to delegates of competitor processor firms.

A gala dinner on Monday evening will be generously sponsored by the Thailand Convention and Exhibition Bureau and by H.C. Starck Group companies.

ABSTRACTS

The following abstracts have been submitted for technical presentations to the Symposium 'Tantalum and Niobium World':

Review of statistics and industry news

William Serjak
Technical Promotion Officer
Tantalum-Niobium International Study Center

The Technical Promotion Officer is responsible for the publication of the statistics of the T.I.C. at all technical sessions. Because of problems collecting the data for the years 2002, 2003 and 2004, the actual data were not being reported; they were being estimated. By 2004, the estimates of the data were made with such little validity that only limited categories were presented at the technical session in October 2004. Now, again, all members are participating in the collection of statistics and valid statistics can be presented to the T.I.C. Where possible, comments will be made about the data.

In addition, the TPO will present the major news items that have changed and are changing our industry during 2004 and 2005.

Transport of tantalum raw materials: An evaluation of potential radiological risks

Douglas B. Chambers and Leo M. Lowe
SENES Consultants Limited

The Tantalum-Niobium International Study Center (T.I.C.) has commissioned a study of the transport of tantalum raw materials which contain varying levels of the naturally occurring radioactive material uranium and thorium (NORM). The main objectives of this study are to determine the radiological characteristics of tantalum raw materials and to evaluate the potential radiological exposures associated with the transport of these materials both during normal transport and in the event of an accidental spill. The study is being carried out by SENES Consultants Limited (SENES) supported by Alfred H. Knight International Ltd (AHK) for the physical and chemical analysis of the tantalum raw materials and, in certain instances, for carrying out radiation dose rate surveys at T.I.C. member company sites.

The study consists of an evaluation of radiation exposures associated with the transport of tantalum ore concentrates and tin slag, from source to processor. The first stage of the study involved the radiological characterization of tantalum raw materials. In order to develop this characterization, SENES and AHK defined a reference gamma radiation survey protocol for raw materials in their normal shipping configurations. Subsequently, a number of T.I.C. member companies carried out radiation measurements of a variety of tantalum raw materials. In addition, AHK carried out radiation surveys at a number of sites. While radiation surveys have been carried out on a reasonable range of tantalum raw materials, it is not possible to make measurements for all possible source materials and transport configurations. Hence, theoretical calculations have been carried out for a variety of source materials and transport configurations. The radiation survey data collected in this study were used to 'benchmark' the theoretical radiation dose rate calculations and to develop relationships between source materials and measured gamma exposure outside the containers in which the tantalum raw materials are transported. These relations can then be used as the basis for estimating potential gamma radiation fields for scenarios that were not included in the measurement program. Finally, the potential radiation exposures of transport workers and the general public were estimated for transport under normal operations and for transportation accidents including those involving spillage of the materials from their transport containers.

The T.I.C. has submitted a study proposal to the International Atomic Energy Agency's (IAEA) Coordinated Research Program (CRP). This CRP deals with the safety and transport of NORM, a subject of great interest to T.I.C. and its member companies. The study will assist the IAEA's Transport Safety Standards Committee (TRANSSC) in its deliberations concerning the degree of control required for the safe transport of NORM materials and in its discussions of issues surrounding denial of shipments. The Canadian Competent Authority to TRANSCC has agreed to sponsor the T.I.C. study.

Tantalum compounds as precursors for the semiconductor industry

S. Kirchmeyer, K. Reuter, G. Passing
H.C.Starck GmbH

Roadmaps have been established in the electronic industry to coordinate research, development and production of semiconductor chips. Following the road maps, line widths decrease continuously, copper replaces aluminium as metal in wiring lines and silicon dioxide is substituted by materials either with low dielectric constants in insulating structures or by materials with a high dielectric constant in integrated capacitors (e.g. DRAMs).

Currently materials are preferably deposited by physical vapor deposition (PVD). Due to the increased aspect ratios of structures in the chip there is a growing demand for chemical vapor deposition (CVD) and atomic layer deposition (ALD) processes. During CVD and ALD volatile precursors are decomposed and the resulting material is deposited on the chip in a complex chemical reaction.

H.C. Starck has access to high purity metal chlorides of tantalum, niobium, tungsten and molybdenum. These chlorides are versatile starting materials for corresponding alkoxides and amides. Tantalum alkoxides and amides in particular serve as precursors in various CVD and ALD processes. Tantalum alkoxides serve as CVD-precursors for dielectric layers in the manufacturing of DRAMs. Tantalum amides and amidimides are used to produce tantalum nitride (TaN) barrier layers for copper wiring to protect dielectric structures from highly mobile copper ions.

Present status and trends in development of the cemented carbide industry in China

He JiLin, Liu RuiRui
Ningxia Orient Tantalum Industry
Xie Kangde
Zhuzhou Cemented Carbide Group

The paper will outline the status of the cemented carbide industry in China, such as its construction, its output and shipments, products pattern, technical development and market development. Also a short review of its future development, including the prospects for Ta(Nb)C application in cemented carbides, will be given.

Niobium in superconductors for the Large Hadron Collider at CERN

Barry Valder
Wah Chang

The presentation will briefly describe the CERN organization and the inception of the Large Hadron Collider programme. It will also identify the various wire strand manufacturers and talk about their contribution to the overall success of the project. The performance of Wah Chang, and by inclusion

that of Wah Chang's suppliers, will be covered. The presentation closes with a look forward to the future and the next high energy physics projects.

Embrittlement of tantalum wires during capacitor manufacture

Guangxin Wang, John Moore, Philip Lessner
KEMET Electronics

An investigation has been conducted into the embrittlement of tantalum lead wires during tantalum capacitor manufacture. There are two types of brittle leads. One is primarily related to the high oxygen content in tantalum powder. The oxygen diffused from tantalum powder into tantalum wire during sintering as well as the oxygen picked up in later stages of the capacitor manufacture process is responsible for this type of tantalum wire embrittlement. The other type of tantalum wire embrittlement is associated with the damage to the wire caused by welding. Hydrogen absorption in the damaged area plays a large role in the second type of tantalum wire embrittlement. In addition, oxygen can be easily picked up in the damaged area at elevated temperature. Both types of wire embrittlement involve diffusion of gaseous elements in tantalum. They are of a cumulative nature. This paper reports the major findings of the investigation. The mechanisms of the two wire embrittlement types are discussed. Effective solutions for solving the problem of wire embrittlement have been identified and successfully tested.

Development of Niobium Powder Injection Molding

G. Aggarwal, S. J. Park and I. Smid
CISP, The Pennsylvania State University

It has been only during the past four decades that niobium has been consumed on an industrial scale. Pure niobium and niobium base alloys constitute less than 2% of the global niobium market. Niobium being a refractory metal does not have a powder cost penalty as in ferrous materials, since refractory parts are formed from powders. This article details a systematic approach to the development of feedstock for powder injection molding of niobium. It has been proven that powder injection molding is a viable forming technique for pure niobium. Further, rheological properties have been combined to determine optimal and critical solids loading. Based on simulation, injection temperature and pressures were determined for optimal filling time. For the first time a processing window has been identified based on the rheological behavior and simulation of niobium feedstock.

Niobium for catalysts

Robson S. Monteiro
CBMM - Companhia Brasileira de Metalurgia e Mineração

A comprehensive view of niobium chemistry and applications in the field of heterogeneous catalysis will be presented. Among several functions of niobium compounds in catalysis are roles as promoter, active phase, support, solid acid and redox materials. Niobium-containing catalysts have been employed in various chemical reactions of industrial interest ranging from dehydration of alcohols, selective oxidation of light alkanes, acid-catalyzed hydrocarbon chain rearrangement and cracking to environmental applications such as DeNO$_X$, hydrotreating and photocatalysis. Most recently, niobic acid is making its way in the production of biofuels from renewable sources. This presentation will also highlight CBMM's development efforts in delivering high-quality niobium compounds to be used in the making of technical catalysts.

High temperature structure stability study on niobium-containing nickel-base superalloys

Xishan Xie and Jianxin Dong
High Temperature Materials Research Laboratories
University of Science and Technology Beijing

Niobium characterizes with important strengthening on superalloys not only on solid solution strengthening but more important precipitated phase strengthening also. Ni_3M, where M can be Al, Ti, Nb or Ta, is the most important precipitation strengthening phase, such as γ' or γ'' in Ni-base superalloys. Niobium has critical importance for development and application of Inconel 718 (with ~5%Nb) in today's aero-engine, gas turbine and power engineering industries because of the large part they play in superalloy application. The recently developed new alloy Inconel 740, to be used in ultra super-critical power plant as super-heater tubes at 750°C for 21st century thermo project in the world, also contains approximately 2% niobium.

These Nb-containing superalloys should be put in service for very long time, such as 103, 104 and 105 hours at high temperatures for aero-engines, gas turbines and power plants respectively.

During long service at high temperatures, many complicated structure changes may take place. For reliability and safety reasons, the structure stability study is an important issue in the field of superalloys. This paper will introduce the detailed structure changes and their relationships with mechanical properties during long time exposure at high temperatures.

Research results have provided a deep understanding of the structure stability at high temperatures and reasonable application of these materials in high temperature industries.

Development of niobium-based superalloys for ultra-high temperature applications

Ryohei Tanaka, Isao Iwanaga and Yoshikazu Matsumura
Japan Ultra-high Temperature Materials Research Institute
Toshio Narita
Research Group of Interface Control Engineering,
Graduate School of Engineering, Hokkaido University

Niobium-based superalloys are candidate materials for gas-turbines that can be used without cooling at temperatures higher than 1300°K, at which temperature range the strongest nickel-based single-crystal superalloys can not be applicable. This paper describes research and development of niobium-based superalloys in Japan.

During the development, solid solution and dispersion strengthening mechanisms were fully utilized through the additions of such alloying elements as Mo, W, Si, Hf and C. Typical chemistry and its creep-rupture strength of the strongest niobium-based superalloy developed is as follows: Nb-16Si-5Mo-15W-5Hf-5C(at%), with creep rupture life over 100 h under 150 MPa at 1773°K. The temperature capability of the alloys under a criterion of 137 MPa-1000 h corresponds to about 1700°K, which is about 320°K higher than that of the strongest nickel-based single crystal superalloy, TMS-162, recently developed by NIMS in Japan. The niobium-based superalloys, however, have inadequate resistance to oxidation at elevated temperatures. Therefore,

a novel coating process is now under development with electro-plating of a rhenium-based alloy film, followed by chromium and aluminium pack cementation. The coating consisted of a duplex layer structure, an inner layer of δ(Re-Cr) or Re solid solution with Cr, and an outer Cr-Al alloy or βNiAl layer. The inner Re-rich layer act as an effective diffusion barrier againstaluminium inward diffusion from outer aluminium rich layer and niobium outward diffusion from niobium-alloy substrate.

The value of an integrated tantalum supply chain to the semiconductor industry

S. Bardus, M. Morris and C. Wickersham
Cabot Supermetals

Technology changes in the semiconductor industry are driving the growth in the use of tantalum thin films. Driven by the need for smaller transistor geometries and larger numbers of transistor interconnections, the semiconductor industry is turning to copper layers lined by tantalum thin films to improve within-chip signal transmission performance. The semiconductor industry is characterized by demanding quality, cost, responsiveness, and performance requirements. These requirements are reviewed. Solutions and methods to meet these requirements are proposed and compared to alternatives. A unique, integrated value chain is proposed as an optimum solution to support the growth and challenges in this advanced market segment.

Raw material supply and demand (including status of new sources such as Nigeria, Great Lakes region, Mozambique)

Michael Tamlin
Sons of Gwalia

The paper will present a broad review of sources of raw material supply and the demand for these materials.

Tantalum resources in China

He JiLin and Tu ChunGen
Ningxia Orient Tantalum Industry
Mao MeiXin
Yichun Tantalum and Niobium Mine

The paper will profile the present status of China's tantalum deposits and tantalum mines: 60 000 tonnes Ta_2O_5 have been proven and tantalum deposits have been found in more than ten provinces. At various times there have been more than ten mines operating. Yichun is the largest open-pit mine, while Nanping is the largest underground mine. The paper will also outline the achievements of China's tantalum mines both in optimising their exploitation-beneficiation processes and in improving their environmental protection.

Niobium – Plentiful and reliable technological solution

José Isildo de Vargas
CBMM – Companhia Brasileira de Metalurgia e Mineração

Some of the aspects associated with the supply and demand of niobium and its evolution are discussed in this paper. An outline of Companhia Brasileira de Metalurgia e Mineração (CBMM) and its recent contributions to the development of new applications following the needs of the niobium supply chain are presented.
The development of industrial processes at CBMM, as the leading niobium supplier, is described, including the recent expansion plan leading to the increase of ferroniobium production capacity to 70 000 tonnes per year.

CBMM of Araxá, Brazil, with its vast reserves of niobium-rich pyrochlore has established itself over the decades as the world's most comprehensive supplier of niobium products. Through its policies and practices, CBMM has made niobium one of the most reliable and market stable engineering materials.

Gwalia operations: overview of factors involved in large scale operations

Michael Tamlin, Santi Pal, Kevin O'Keefe
Sons of Gwalia

The factors to be considered in the operation of large scale mines such as those at Greenbushes and Wodgina differ from those of smaller scale mining or collecting operations.

The giant Ghurayyah tantalum-niobium deposit, Saudi Arabia – a future source of raw materials.

Patrick Cheetham
Tertiary Minerals

Tertiary Minerals plc's Ghurayyah Ta-Nb–Zr-U-REE deposit is located in NW Saudi Arabia close to the Red Sea. An inferred mineral resource of nearly 400 million tonnes grading 245 grammes/tonne of Ta_2O_5 and 2840 grammes/tonne of Nb_2O_5 is defined by drilling of a 900m wide plug of mineralised granite, open at depth. The deposit exhibits remarkable grade continuity, no internal waste, and can be extracted by cheap open-pit mining methods. The fine-grained tantalum- and niobium-containing ore-minerals can be concentrated by flotation with good recoveries and with subsequent magnetic separation of a zircon by-product. A number of different processing routes have been considered for production of marketable products, including a Fe-Nb-Ta alloy. A detailed economic and technical scoping study suggests the deposit has commercial potential as a future source of supply of tantalum, niobium and zircon raw materials and a mine life of over 100 years. Significant contents of uranium and rare earth elements have yet to be evaluated. The project financing regime in Saudi Arabia is very favourable with Government funding and a new mining code supporting the development of the project if feasibility studies, now in progress, are positive.

Tantalum and niobium compounds for electronic, optical and catalytic applications

Karsten Beck
H.C. Starck GmbH

Niobium pentoxide and tantalum pentoxide can be found in various commercial applications. Among the most important ones are their use in optical bulk materials, as optical thin films, as dopants in multi layer ceramic capacitors (MLCC) and ferrites, and as precursor materials in the synthesis of lithium niobate and lithium tantalate. Single crystals of lithium niobate and lithium tantalate are employed in the production of surface acoustic wave (SAW) filters used as frequency filters in electronic applications.

All these applications have one major feature in common:

Nb_2O_5 and Ta_2O_5 are reacted with at least one other reagent through a solid state type of reaction to give the final product. For solid state reactions both thermodynamic and kinetic factors are important. Thermodynamic considerations show whether or not a particular reaction should occur. This solely depends on the type of compounds used in the reaction. On the other hand kinetic factors determine the rate at which the reaction occurs. These factors include transport of matter to the reaction interface, reaction at the interface, and transfer of matter away from the reaction. Since the interface between two reactants plays such an important role in solid state reactions, it is obvious that the morphology of the reactants involved in the reaction strongly influences the kinetic factors of this reaction. In order to account for this demand, H.C. Starck is able to provide a set of different morphologies of niobium and tantalum pentoxides for these applications. Examples include the use of spherical tantalum pentoxide in the synthesis of lithium tantalate, and very fine niobium pentoxide needed as dopant for MLCCs.

A fairly new field showing strong growth is the use of niobium, and to a much lesser extent tantalum, for catalytic applications. Niobium and tantalum oxide containing catalysts are used, for example, in the direct oxidation of methane to formaldehyde, the ammoxidation of ethane to acetonitrile, and the oxidative dehydrogenation of propane to propylene. Often only small amounts of niobium or tantalum are added as dopants to yield the desired catalyst. In order to ensure homogeneous distribution of the added niobium, a water-soluble niobium compound is of advantage. NAmOx, an ammonium niobium oxalate complex (formula: $[NH_4][Nb(=O)(C_2O_4)_2]x\ 5H_2O$) and a commercial product of H.C. Starck, is a completely water-soluble, crystalline white powder. It is stable in air and non-hygroscopic in contrast to other niobium compounds such as Nb-chloride and Nb-ethoxide, hence it needs no protective atmosphere during storage and handling. Calcination of NAmOx results in ultra pure Nb_2O_5, with purity levels up to 99.99%.
Niobium pentoxide is not only used as a catalyst dopant but also as catalyst backbone. Hence, it is potentially interesting to use niobium pentoxide possessing a high specific surface area as a catalyst backbone, since heterogeneously catalyzed reactions are surface-dependent reactions. Unfortunately, high specific surface powders often display very small particle sizes, resulting in unacceptable Hall Flow properties. Therefore, H.C. Starck developed an economic process yielding niobium pentoxide with a specific surface area of up to $180m^2/g$, while still showing good Hall Flow properties.

Esterification of palm oil by niobium-based acid catalysts to produce biodiesel

António T. Pereira, Kensley A. Oliveira and Robson S. Monteiro
CBMM – Companhia Brasileira de Metalurgia e Mineração
Donato A.G. Aranda, Rafael T.P. Santos and Rafael R. João
Escola de Química da UFRJ

The quest for alternative sources of energy other than fossil fuels has become nowadays public policy and government-driven agenda associated to the need of a sustainable growth of modern societies. Among several programs worldwide, the feasibility of using bioethanol and biodiesel as substitutes for gasoline and diesel, respectively, has been successfully demonstrated in countries such as Brazil and Germany, where one can find entire car fleets running on biofuels only. The advantages are renewability, help in reducing carbon dioxide emissions, and a significant decrease in particle matter and sulfur compound releases from tailpipes.

Although most of the currently produced biodiesel comes from the transesterification of vegetable oil triglycerides with methanol through a homogeneous base or acid catalysis, the esterification of free fatty acids is becoming increasingly important as a way to add value to biomass waste such as used frying oils, fatty acidic sewage or fatty acids from refined animal fats and vegetable oils. An acid catalyst of either homogeneous or heterogeneous naturecan be used to carry out the esterification. The benefit of a heterogenous catalyst is that the catalyst can be more easily separated and recycled. This contribution aims to demonstrate that niobium-based solid acids can be used as an effective heterogeneous catalyst for the esterification with methanol of free fatty acids of palm oil. Typically, palm oil has 4 to 8 wt% of free fatty acids in its composition, and is thus a good source of fatty acids after refining.

Biocompatible titanium alloy with a large amount of niobium

Mitsuo Niinomi
Toyohashi University of Technology

Nowadays beta type titanium alloys composed of non-toxic elements are mostly developed for biomedical implants such as artificial hip joints, artificial teeth roots, bone plates and screws, etc. because they show low Young's modulus that is favorable for homogeneous stress transfer between implant and bone. For the constituent elements of low modulus beta type titanium alloys, niobium is mainly selected because niobium is grouped into non-toxic elements and a beta-stabilizing element for titanium. A large amount of niobium is added in order to achieve the lowest Young's modulus. For example, Ti-Nb-Ta-Zr system alloy with a large amount of niobium is the most favorable titanium alloy system for biomedical implants. In Ti-Nb-Ta-Zr system alloy for implants, a fairly large amount of tantalum is also added because tantalum is also a non-toxic beta-stabilizing element and effective for reducing Young's modulus.

Niobium is very effective not only for reducing Young's modulus of titanium alloys, but also for creating functional titanium alloys, namely super elastic or shape memory titanium alloys. Functional titanium alloys are applicable for dental wires, stents, catheters, etc. Therefore, applications of titanium alloys become much wider. Niobium is a key element for developing functional titanium alloys with low Young's modulus for biomedical applications.

Mechanical compatibility of Ti-Nb-Sn alloy implant in hard tissues

Shuji Hanada
Tohoku University

To develop low Young's modulus titanium alloys having high strength for bone implant applications, Young's modulus and tensile strength of beta Ti-Nb-Sn alloys consisting of non-cytotoxic elements were investigated as functions of alloy composition and microstructure. Based on the observation that precipitation of athermal and isothermal omega particles in beta titanium alloys increases Young's modulus significantly, tin is added to Ti-Nb alloys to suppress or retard omega transformation. It is found that Young's modulus of beta Ti-Nb binary and Ti-Nb-Sn ternary alloys possesses a minimum around the composition where athermal omega transformation is almost completely suppressed by quenching from the beta phase region at high temperature. At the composition very weak omega reflection or diffuse scattering is observed by

Transmission Electron Microscopy (TEM). Referring to the theoretical calculation of beta phase stability, the relationship between Young's modulus and the stability of beta Ti-Nb-Sn alloys was investigated. Quenched, unstable beta Ti-Nb-Sn alloys exhibit low Young's modulus by optimizing alloy composition for beta phase to be unstable without athermal omega transformation. Cold rolling after quenching further decreases Young's modulus in the rolling direction. This decrease is explained by preferred texture evolution of stress-induced martensitic transformation. Low Young's modulus of 40-50GPa and high strength over 800MPa are simultaneously achieved in beta Ti-Nb-Sn alloys by appropriate combination of alloy composition, cold rolling and heat treatment. Young's modulus of Ti-Nb-Sn alloys can be made equal to that of human bones of 10-30GPa by pore introduction through powder sintering.

Sustainability assessment of metals – The challenges of increasing regulation

Kay Nimmo
ITRI-Tin Technology Ltd

Legislation around the world is increasingly being based on the principles of sustainability: economic growth achieved in tandem with the development of communities and respect for the environment. Concepts such as producer responsibility, product liability and product stewardship are forcing manufacturers to focus on the entire life cycle of their product, from raw material supply, through manufacturing processes, to customer use and recycling at the end-of-life. All sectors of the metals industry should be prepared to address the significant questions raised by the increasing focus on sustainability assessment.

The new EU Chemicals Policy, called REACH, is an example of impending regulation that will have a very significant business impact on the metals industry. REACH is a process requiring the **R**egistration, **E**valuation and **A**uthorisation of the use of **C**hemicals within the European Union in order for their safety to be proven and for their continued use to be permitted. All metals, including tantalum, are classed as substances requiring registration, and industry therefore needs to prepare for the detailed technical environmental and human health assessment data required for REACH registration to ensure continued access to the EU market.

This paper will summarise background information on sustainability assessments, describe the requirements of the draft REACH Directive, and discuss, as examples, some of the actions now being taken by ITRI and the tin industry as part of their sustainability programme.

Modern Steel Sheet for Automobile

Shunichi Hashimoto
CBMM Asia

The automobile and steel industries are highly bound by the strong links between their supply and demand. The progress of steel sheet corresponds to demands from the automobile industry. The keen issues of automakers in recent years are reducing the weight of the automobile body while maintaining sufficient safety by using high strength steel sheet from the viewpoints of both fuel efficiency and crash worthiness. The characteristics of the steel sheets for an automotive body have been changed drastically according to the changes in the demands.

Hot rolled steel sheets are applied to chassis parts such as suspension arms, cross members and wheels. Stretch flangeability is an important characteristic as well as Total Elongation (El) for these applications. Ferrite-bainite steels with niobium are widely applied in a range from 490 to 780MPa Tensile Strength (TS).

Cold rolled steel sheets – most of them are Zn-coated steel sheets – are applied to structural parts and body panels. The proportion of high strength steel sheet in new vehicles is approximately 50%. High strength steel sheets higher than 980MPa are widely applied to structural parts, reinforcement and impact door guard bar.
Niobium is the essential element for the production of automotive steel steels through various mechanisms. For IF (Interstitial Free) steel, niobium works as the element to improve deep drawability through stabilization of interstitial solute carbon and nitrogen. For steels so called 'Advanced high strength steel sheet', such as ferrite-bainite steel, DP (ferrite-martensite) steel and TRIP-aided (Transformation Induced Plasticity) steel, niobium works as the element to control grain size and transformation behavior.

Niobium in modern pipeline steels

Klaus Hulka
Niobium Products Company

Large diameter pipes for the transportation of crude oil and natural gas have been the frontrunner in the development of high strength low alloy (HSLA) steel. For the last three decades the processing route of pipe steel has been via the thermomechanical rolling process, requiring niobium microalloying. In this period the dominant steel grade has been X 70 and this material still maintains its position.

Several developments have taken place in recent years:
1. The aim for higher transportation capacity promotes the application of steel with higher strength, such as X 80, and even X 100 to X 120 has been developed and considered.
2. The exploitation of deeper wells requires the transportation of sour-gas-containing media and pipelines have to be resistant against hydrogen induced cracking.
3. Offshore pipelines need relatively high wall thickness in combination with good toughness, which can not be produced by conventional thermomechanical rolling.

All these demands can be fulfilled only with clean steel (low sulphur content) of low carbon content. With a lower carbon content one can make use of higher niobium contents and levels up to 0.10% have been applied successfully. The optimization of these grades includes an increase in the severity of thermomechanical rolling followed by accelerated cooling regimes including direct quenching. Many of these modern pipe steels are pearlite-free, and low carbon bainite has become the dominating microstructure. Niobium, being in solid solution at finish rolling, also serves to promote this microstructural constituent.

Collection for recycling, and effect on input for processors

Michael Tamlin
Sons of Gwalia

In addition to minerals obtained directly from mining operations, other materials, which may be secondary or recycled, are also an important source for processors.

Tantalum solid electrolytic capacitors: applications and opportunities

W.A. Millman, Dr T. Zednicek, Dr Z. Sita and Stanislav Zednicek
AVX Tantalum Division

Tantalum has long been a favoured capacitor technology in space-limited designs. Recent years have seen the emergence of one or two equivalent technologies offering many of the advantages of tantalum, such as volumetric efficiency and reliability. One notable rival already well into its commercialisation phase is very high cv mlcc capacitors. A circuit designer trying to choose between these capacitor systems has a number of trade-offs and subtleties of operation to consider and these are discussed in this paper.

New polymer dispersions for solid electrolyte capacitors

Udo Merker, Klaus Wussow and Wilfried Lövenich
H.C. Starck GmbH

The Equivalent Series Resistance (ESR) of electrolytic capacitors has been reduced to single digit values by the introduction of conductive polymers over the last few years. While the lowering of ESR is still the driving force for development, capacitor manufacturers now devote their efforts increasingly to improvements in reliability. The quality of the outer conductive polymer layer of tantalum polymer capacitors is a key factor for leakage and ESR stability. We have developed a conductive polymer dispersion which allows for the formation of a dense coating with outstanding properties on tantalum anodes. The new conductive polymer coating prevents the penetration of graphite and silver particles into the dielectric and thus ensures that leakage currents are low. Good adhesion of the coating to the anode results in low ESR.
Finally an excellent self-healing ability and general physical properties make the processing easy and fast compared to standard processes. Properties of our polymer dispersions, applications and new developments will be discussed in our presentation.

Influence of MnO_2 crystal structure on the equivalent series resistance of tantalum capacitors

C. Mota Caetano and R. Monteiro
EPCOS
D. Dias, P.A. Carvalho
IST, Lisboa

The development of solid electrolytic tantalum capacitors with MnO_2 as the counter-electrode has been carried out to decrease the equivalent series resistance (ESR). Capacitor samples produced under different pyrolysis conditions have been characterized in terms of equivalent circuit parameters. The $Ta/Ta_2O_5/MnO_2$ system has also been characterized by transmission electron microscopy (TEM). Electron diffraction TEM results allowed characterization of the microstructure and furthermore revealed the complex crystalline structure that affects the electrical properties of the semiconductor layer. Electrical characteristics and stress test comparisons are discussed. Optimized pyrolysis conditions improved the ESR distribution and stability. A new Speed Power II family has been introduced into the EPCOS Tantalum Electrolytic Capacitors product spectrum. The new temperature profile, combined with a high area/volume efficiency anode, has led to the introduction of a new Speed Power III family offering ESR levels up to 45mOhm.

Tantalum capacitors in more efficient, better performing packages challenge multilayer ceramic capacitors

John Prymak, Mike Prevallet and Edward Chen
Kemet Electronics

The capacitance per unit volume of multilayer ceramic capacitors (MLC's) is now approaching that of tantalum capacitors. In addition, the construction of MLC's gives them an advantage in equivalent series resistance (ESR) and equivalent series inductance (ESL) compared to tantalum capacitors of a similar size. This presents a two-fold challenge to tantalum capacitor manufacturers: to increase the efficiency of the packaging to utilize more of the volume with the tantalum body, and to increase the performance characteristics of the device.

The facedown termination packages allow improvements in both of these areas. Modifying the lead frame configuration allows more of the package volume to be utilized by the tantalum pellet structure, thereby increasing capacitance. By feeding the electrical contact to the bottom face of the package, extraneous lengths are eliminated, thereby improving three performance characteristics: ESR, ESL, and power dissipation capabilities.

This paper is intended to review:
1. Improved capacitance efficiencies attained through increased volume utilization of the packaging
2. Improved characteristics of the new packaging versus the old
3. Advantages of these newly packaged tantalums versus ceramic chip capacitors.

Addressing tantalum capacitors' technology challenges

Alex Eidelman and Pavel Vaisman
Vishay Israel

Since the electronic industry downturn in the year 2001, tantalum capacitor producers have faced numerous challenges. Continuous price erosion, competition with high capacitance MLCC and perceived shortage of supply are just some examples of present threats.

Vishay Tantalum addresses these challenges by offering the most advanced and reliable products.
Newly developed powders with specific charge of more than 100K CV/g open opportunities to achieve specific capacitance values unreachable with other dielectrics. The paper will describe novel packaging technologies which allow the advantages of modern materials to be materialized to the full. Product concept, performance characteristics and development road map will be presented.

Providing capacitors with the high energy density and high power needed for demanding pulse applications in GPRS and GSM modules is another important development. It yields to the tantalum industry the highest capacitance values, approaching the area of Super Capacitors. The construction, electric characteristics and technology of such low profile non-flammable products will be discussed.

Extending the performance of tantalum powders for electrolytic capacitors

J. Koenitzer and R. Mariani
Cabot Supermetals

A novel, low-temperature sintering route has been explored to develop a uniform neck size within the porous sintered body. Higher CV/g for a given forming voltage is expected because the powder surface area is preserved. Also, higher forming voltages for a given powder type are expected because the narrow necks between sintered particles are reduced or eliminated. The method involves using a vapor-phase sinter-aid to promote surface transport during sintering while limiting or precluding bulk transport. The process results in the filling in of the narrows between sintered particles without bulk densification. Initial experiments validated the expected outcome.

Niobium Oxide Capacitors

W.A. Millman, Dr T. Zednicek, Dr Z. Sita, Stanislav Zednicek
AVX Tantalum Division

With a volumetric efficiency that is unrivalled, and a host of other advantages besides, tantalum capacitors have become a staple of a wide variety of designs, notably in portable appliances, telecommunications, computing and medical systems. However, certain shortcomings have given impetus to the search for alternatives. This paper explores one based upon niobium oxide and compares its performance to tantalum, polymer, aluminium and ceramic capacitors.

Tantalum flake for high reliability capacitor applications

T. Izumi, J. Koenitzer, S. Krause, L. Mann,
Y. Noguchi and S. Yuan
Cabot Supermetals

Flake morphology has greater CV/g potential as compared to nodular powders, and for a given CV/g has been demonstrated to result in lower DC leakage than nodular powders. The paper will compare the performance of current flake products to that of nodular powders and potential improvements in flake technology will be discussed. Special emphasis will be given to high-voltage applications.

NEWS ITEMS

DLA/DNSC

The Defense National Stockpile Center of the Defense Logistics Agency in the U.S.A. has announced changes to some of its systems. Sales solicitations and amendments will continue to be posted on the DNSC website at https://www.dnsc.dla.mil, but printed copies will not be posted to customers any longer. To receive notifications by e-mail, potential customers should provide DNSC with a current e-mail address in order to be sent individual messages: send your company information by fax to +1 703 767 5484 or 5494, or by e-mail to martha.hochberg@dla.mil or twila.white@dla.mil.

From October 1st 2005, payments for materials purchased from DNSC must be made by wire transfer only. Details of new payment methods will be included in sales solicitations from October 1st. Also a new system for submitting shipping instructions and monitoring the status of sales contracts is being instituted, through access to the Defense Working Capital Fund Accounting System (DWAS). To use DWAS, companies must complete a web access request form to receive a user name and password. Apply to Martha Hochberg at the e-mail address or fax number above.

Publication of the Annual Materials Plan FY2006 for the year beginning October 1st 2005 can be expected from that date.

T.I.C. TRANSPORT COMMITTEE

Mr Kenneth Hunt has been a valued contributor to the work of the T.I.C. Transport Committee since its inception, and this Committee would like to express its appreciation to him for all his efforts. Mr Hunt was among a number of employees which Cabot Supermetals let go in a recent restructuring.

King Metallurgical/Taike Technology

King Metallurgical, a member of the T.I.C. of long standing, has made major changes. In future its name will be Taike Technology (Suzhou) Co., Ltd, and it has a new address:
Taike Technology (Suzhou) Co., Ltd.
No. 20 Chengyang Road,
Suzhou Xiangcheng Economic Development Area,
Suzhou,
Jiangsu,
China 215131.
Tel.: +86 512 6576 0786
Fax: +86 512 6576 9929

Sons of Gwalia

The company has moved:
Street address:
Level 3, 30 The Esplanade,
Perth, WA 6000, Australia.

Postal address:
Locked Bag 40, Cloisters Square,
Perth, WA 6850, Australia.

On August 30th 2005 the administrators of Sons of Gwalia announced that the company's status would change from 'Administrators Appointed' to 'Subject to Deed of Company Arrangement'. Creditors have given administrators more time to sort out the affairs of the company. Writs for negligence and breach of duty have been issued against company founders Peter and Chris Lalor and other directors, and the auditors Ernst and Young.

Contract discussions with major customer Cabot are still without conclusion, and due to go to arbitration in September 2005. The future status of the tantalum business and its mines at Greenbushes and Wodgina has not been settled, as it might be restructured in one of several possible ways.

EPCOS

Dr Werner Lohwasser, based at the Epcos plant in Evora, Portugal, has been nominated as the delegate to the T.I.C., succeeding Dr Josef Gerblinger.

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The T.I.C. is an *association internationale* under Belgian law.