Abstracts from TITANIUM 2005 Conference
September 25-27, 2005
Scottsdale, Arizona

J. Landis Martin, Chairman and CEO - TIMET
World Industry Trends
Mr. Martin will be speaking about the public markets for titanium companies and its impact on the industry.
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Timothy G. Rupert, President & CEO - RTI International Metals Inc.
World Industry Trends
Titanium plays an essential role in critical military aircraft and other defense hardware around the world. Mr. Rupert will review the history of titanium's development for defense-related applications and discuss the relative contribution of military applications as it relates to annual titanium U. S. industry shipments. The presentation will highlight several significant military titanium applications, including aerospace, naval, and ground support systems, as well as discuss the growth of new applications and the resulting opportunity for the titanium industry.
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Sylvain Gehler, Managing Director - Specialty Metals Company
World Industry Trends
Titanium Mining and Sponge Production in Kazakhstan and Ukrainia.
Review of World Ti Sponge supply situation as well as trends for the years to come taking into account announced ti sponge production capacity increases in Japan, USA , Russia and China.
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Edward F. Sobota Sr., President - TechSpec Incorporated
World Industry Trends
Can We Process What We Need?
The processing of titanium cast material to plate, sheet, forgings, and bar utilizes both in-house and out-sourced facilities. Mr. Sobota will review past processing practices and facilities and what the titanium industry is doing to increase its capacity and make itself more independent of outside processors.
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John P. Monahan, President & CEO - VSMPO Tirus, U.S.
Forecast of Russian Titanium Products
Mr. Monahan will be speaking about recent trends of titanium production in Russia, and will present a projection of how those trends may influence and shape the future of titanium manufacturing activity in Russia and the supply of Russian titanium into the global market.
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Markus Holz, Managing Director - Titania S.p.A.
Titanium's Wuthering Heights
Over the past twelve months the European Titanium market has observed a rather steady growth in demand for both CP and Aerospace grades with a number of industrial applications in power generation and desalination, and the success of the Airbus program (Airbus A380) and the new tranche of Eurofighter, respectively.

However, it has also been confronted by a severe shortfall in raw material supplies coupled with boosting prices as an effect of a massive demand for this metal gobbled up by the steel industry as a minor alloying element (Ferro-Titanium).

Activities in emerging markets have been frozen due to these unstable market conditions with the impending risk that titanium may be replaced by other competing materials thus affecting the titanium industry at large, as well as the negative impact on all research and development activities for new applications.

We have grounds to expect that the situation will remain unchanged until mid-end of 2006.
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Kazuharu Nogami - Toho Titanium Co., Ltd.
Progresses of Titanium Industry in Japan
The titanium industry in Japan has grown steadily, experiencing rather small ups and downs. In 2004, there were a record high number of shipments for both sponge titanium and mill products in Japan. Since a strong demand for titanium can be expected to continue not only in Japan but also in other countries for at least a couple of years, the two sponge titanium producers in Japan have decided to expand their production capacities. In addition, facing the upcoming shortage of melting capacity in Japan, some Japanese companies are considering expanding the capacity.

As recent topics, a project for developing new technologies in refining and fabricating, newly developed titanium alloys in Japan, and the increasing role of Japanese companies in building large commercial aircrafts will be presented.

Japan is now working on establishing worldwide standards for titanium under the ISO, and will host "The Eleventh World Conference on Titanium" in 2007.
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Mark S. Kamon, President - Dynamet Incorporated
World Industry Trends Summary Presentation
Mr. Kamon will provide a world market overview for titanium shipments, global consumption and major market drivers. Presentation will also include general comments on the current state of the titanium market and its future.
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Monday Keynote Address: Mr. Frank Doerner, Managing Director of Structural Technologies – Bowing Company
Mr. Frank Doerner has been with The Boeing Company since 1983 and has a broad engineering background spanning Flight Test Engineering, Production Operations, and Materials and Process Engineering. He is currently the Managing Director of the Structural Technologies, Prototyping & Quality (STP&Q) organization within Boeing's centralized R&D organization - The Phantom Works.

Mr. Doerner manages a ~$60M/year R&D portfolio of projects spanning across all major Boeing sites and performed by multi-disciplined teams of engineers. The STP&Q Organization supports all of Boeing's major business units by developing common materials and structures technologies and enabling manufacturing processes. STP&Q is also actively collaborating with external technology sources to bring the best possible technical solutions to our varied product lines. Examples of technologies being developed: friction stir joining; high-volume composite fabrication; portable assembly robotics; advanced aluminum, titanium and steel alloys; fail-safe monolithic structures; direct digital manufacturing; and multifunctional-smart structures. These advanced technologies are applicable to multiple Boeing products, thus promoting synergy and lowering overall development costs to the company. As the technologies are successfully transitioned to Boeing product lines, they result in significant cost savings – over $300M in 2004 – as well as improved product performance.

Mr. Doerner has a B.S. in Mechanical Engineering from the University of Colorado; an M.S. in Mechanical Engineering from Washington University in St. Louis; and an Executive MBA from Washington University in St. Louis.

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Thomas E. Williams Jr., ATI Allvac
Outlook on Commercial Aerospace Market
Mr. Williams will chair a panel discussion on titanium in the commercial aerospace market. His introductory presentation will highlight the growth of the commercial aerospace market and its impact on titanium demand. The drivers behind the accelerating growth of titanium will be discussed along with a forecast of titanium shipments for commercial aerospace applications. Mr. Williams will conclude with a review of Allegheny Technologies' actions to meet the growing demand for titanium.

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Dave Richardson, VSMPO Tirus, U.S.
An Update on Ti-5Al-5Mo-5V-3Cr
Since first introducing Ti 5-5-5-3 at the 2003 ITA conference in Monterey, the alloy has been selected for key structural components on the Boeing 787, parts which would have traditionally been made from Ti 10V-2Fe-3Al. In addition, the unique properties of this alloy and competitive costs of fabrication have led to expanded applications, replacing Ti 6Al-4V in certain instances.

This paper will review the history of Ti 5-5-5-3, provide an update on typical mechanical properties and discuss some of the current applications.

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Peter Summerfield, Rolls Royce plc
The Trent 1000
As the fifth generation in the Trent family, the Trent 1000 will feature the same successful three-shaft architecture as its Trent predecessors and its detailed design will reflect 35 million hours of Trent engine service experience.

This low risk engine design, coupled with an enhanced engine development test programme will ensure that the Trent 1000 delivers world beating reliability and durability from day one in service.

The Trent 1000 engine for the new Boeing 787 aircraft brings the best value and lowest life cycle costs to airlines. We have focused on both engine and service design with the aim of minimising not just the cost of operation, but also providing the best overall value.

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John Fanning, TIMET
Recent Developments in Metastable Beta Strip Alloys for Commercial Aerospace
Beta alloys provide useful combinations of physical and mechanical properties as well as a wide range of processing options. Usage of TIMETAL 15-3 and 21S for fabricated sheet metal structures continues to increase. TIMETAL 15-3 is currently used for ECS (Environmental Control System) ducting on the Boeing 777 and, more recently, on the Airbus A380. For applications that require exposure to higher temperatures, such as engine exhaust assemblies, TIMETAL 21S is now used on the Boeing 777, Airbus A340 and various other civil and military aircraft.

This presentation will review the history of the alloys, provide an update on mechanical properties and discuss current applications.
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Stephen L. Luckowski, US Army ARDEC
Titanium – Protecting the Soldiers of Operation Iraqi Freedom
As operations in Iraq continue, the Army has continued to examine methods to improve force protection without sacrificing operational effectiveness. Titanium is playing a growing role in applications where the combination of ballistic performance and light weight are required to maintain system performance. This presentation highlights the efforts of the US Army Armament Research Development and Engineering Center (ARDEC) to apply titanium in specific Army systems—both those currently operating in Iraq as well as future systems still under development.
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James Shields, US Army
Affordability of Titanium Components for the Lightweight Howitzer
This presentation will discuss the implementation of
titanium investment casting on the U.S. Marine Corps U.S. Army's next generation 155mm towed howitzer. Implementation of castings during Engineering and Manufacturing Development (EMD) led to improved product
quality, and reduced risk in achieving full rate production requirements.
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James Dorsch, United Defense
Military Ground Vehicles: The Challenges for Titanium Application
Titanium alloy is currently a leading candidate to improve ballistic performance and reduce weight for future armored vehicles. Significant challenges exist that may limit the widespread application of titanium. These include cost and availability, difficulty in joining and inspecting, reduced machining rates and incorporating it into ceramic armor systems. One particular challenge is that titanium ground vehicle structures and components must withstand threats not typically encountered on other military systems. Therefore shock and penetration resistance are necessary which may affect efforts to develop low cost manufacturing methods. One vehicle manufacturer will review their experience with applying titanium and provide remarks on how these challenges could be met.
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John Fanning, TIMET
Military Applications for Beta Alloys
As discussed in the other presentations of this session, Ti-6Al-4V is the baseline alloy for most military uses. However, the search continues for alloys with specialized properties that may offer performance advantages for some military applications. This presentation focuses on the potential use of beta alloys with regards to two aspects of military applications: ballistic protection and applications requiring good elevated temperature properties.
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Tuesday Keynote Address: John Walsh, Walsh Aviation
Commercial Aircraft Markets – Up or Down and for How Long?
Mr. Walsh will discuss the current market boom in orders for the Boeing and Airbus aircraft markets and the slowdown of the regional jet markets for the Bombardier and Embraer regional jet aircraft.

Traffic trends, airline profits, aircraft orders and forecasted new aircraft delivery rates in the 2006, 2007 time period will be discussed in detail. The implications for longer term aircraft delivery rates as a result of the upsurge in near term deliveries will also be addressed.

The introduction of the new aircraft designs from the four major airframe manufacturers on the long term aircraft and titanium markets will be analyzed and will make for what is expected to be a lively Q&A session.
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Edwin H. Kraft, EHK Technologies
Overview of Emerging Titanium Technologies
Recent years have seen a significant increase in interest in new technologies for production of titanium metal and in processes to form primary metal into useful product forms. Much of this effort has focused on reducing the cost of primary Ti or mill product. This overview will reexamine the status of the approximately 20 processes being developed for primary metal production. Some of these reduction processes have made significant progress, while others have been abandoned and new efforts started. Advancements have also been made in melt processing of sponge and scrap into ingot and slab and will be reported. Progress in investment casting and similar processes will be reviewed. Methods of consolidation of new powder materials is receiving increased attention and will be addressed in this overview as well as in full papers during the panel session.
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Oscar Yu, RTI International Metals Inc.
Beta-C Spring Made from PAM Single Melt Input Stock
Beta-C is a high strength titanium alloy widely used for spring and fastener applications. Spring and fastener input stock is currently manufactured by rolling billets forged from conventional double melt VAR (2 x VAR) ingots. Recent advances in plasma arc melting (PAM) single melt technology offer a potential to reduce the input stock cost by directly rolling the as-cast near net shape PAM ingots instead of the conventional forged billets. A 5" diameter as-cast PAM ingot was rolled to 0.60" bars which were then processed to smaller diameter centerless ground bars for making springs. The evaluation of microstructures and mechanical properties of the bar input stock as well as the finished spring will be presented.
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Yong Mao, National Institute for Materials Science
Microstructure, Tensile Deformation and Fracture Behaviors of Ti2AlNb Alloys
The orthorhombic Ti2AlNb intermetallic alloys have been widely studied as potential materials for high temperature applications. The aim of this paper is focus on microstructure-tensile property-fracture behavior correlation of Ti2AlNb alloys. The tensile deformation and fracture behaviors of Ti2AlNb alloys have been studied at room and elevated temperatures. Several different lath, equiaxed and duplex microstructures were investigated to identify microstructure -property relationships. In particular, the effects of the morphologies, sizes and volume fractions of α2, O and B2 phases in these microstructures were examined. The results showed that lath microstructure of O+B2 phases with remaining primary β grain boundaries exhibited lower elongation and intergranular fracture behavior, equiaxed microstructure with fine O phase grains in B2 matrix exhibited the best elongation and transgranular fracture with ductile dimples, and duplex microstructure with equiaxed α2/O particles and fine O phase laths in B2 matrix also exhibited greater elongation and transgranular fracture. The initiation and propagation of cracks in the equiaxed and duplex structures during the SEM in-situ tensile process was also observed and the fracture mechanism of the alloy was discussed.
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Greg Rigby, BHP Billiton Technology
PolarTM Titanium - Development of the BHP Billiton Titanium Metal Production Process

A new process aimed at large scale manufacture of titanium metal is under development by BHP Billiton, the world's largest diversified resources company. The BHP Billiton process, in which solid TiO2 is electrolytically reduced to solid metal in a molten CaCl2-based electrolyte bath, is intended to offer a viable alternative to conventional titanium manufacturing processes.

In this paper, key aspects of the development path for the BHP Billiton process are discussed, leading from fundamental bench-scale experiments that measured the effect of temperature, applied potential, and cathode form on the reduction reaction rate, to the design of scaled-up intermediate and pilot-size reactors. Engineering and operating characteristics from the project's one tonne CaCl2 molten salt reactor are given, including compliance with BHP Billiton's zero harm philosophy for health, safety, environmental and community impacts. The paper provides details on power application and heat balance of the reactor, design of the off-gas handling system, process control and instrumentation selection and design and molten salt bath management. Chemical analyses of typical output from the reactor is also given, highlighting the quality and morphology of the metal product, and potential for market integration.
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Masa Rao, University of California, Santa Barbara
Titanium Micro-Machining via Plasma Etching: An enabling technology for low-cost, high-volume manufacturing of titanium components on the micrometer-scale
This paper details the recent development of a new process technology that enables, for the first time, fabrication of complex high-aspect-ratio structures with micrometer-scale features in titanium. This technology, based on plasma etching techniques adapted from the microelectronics industry, offers a number of advantages relative to other prevailing metal micro-machining methods including: a) high volume, low cost batch manufacturing; b) complex design capability with micrometer to sub-micrometer feature size; c) thin-section, high aspect ratio structure fabrication capability without machining-induced damage or residual stress; and d) highly arrayed device fabrication with high precision and tolerances.
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Dr. Corby G. Anderson, Montana Tech
The TEMPER and Free Form Fabrication Titanium Initiatives at The Center for Advanced Mineral and Metallurgical Processing.
Titanium is a metal of increasing strategic importance. The Center for Advanced Mineral and Metallurgical Processing (CAMP) at Montana Tech is currently directing two titanium initiatives. The first program, TEMPER, is focused on producing low cost titanium through the identification and development of new mining, beneficiation and extraction technologies which will significantly reduce the cost of titanium production. This will directly benefit military and commercial applications. Emphasis is being placed on development of the domestic titanium ore bodies thus reducing the use of foreign titanium ore. Secondly, CAMP is evaluating new technologies for fabrication of titanium utilizing the Solid Free Form Fabrication initiative. These technologies may drastically reduce the cost and time to manufacture titanium components. Because of the high strength to weight ration of titanium coupled with it’s superior corrosion characteristics, these programs will be of vital importance to the United States military. An overview of these two titanium initiatives will be presented at the meeting.
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Graham A. Keough, Consarc Corporation
New Developments In Induction Skull Melting (Ism) Of Titanium And Titanium Aluminide Alloys, The Use Of AC Plus DC Fields To Increase Superheat

The melting and casting of highly reactive metals into net shape parts has been problematic due in large measure to the limited superheat. Because liquid Titanium reacts so rapidly with conventional crucible materials, it is typically melted in a water cooled copper crucible before pouring into the mold. A significant part of the energy coupled into the melt is transferred by conduction to the water thus limiting the superheat. Harding et al. reported some improvement in superheat using high power ISM, but, the results we still well below desirable superheat levels.
The presenter will give a brief history of the evaluation of the potential increase in superheat by using a DC field to damp the turbulent stirring of the melt and thus the heat transfer to the base and side wall of the crucible.
A new ISM crucible design developed by Consarc has been tested at the University of Birmingham in 2 series of tests. Overheads will show the configuration used and a short video of an actual melt will be displayed.
The results of the second series of tests melting Titanium Aluminide and CP Ti, show approximately 80 % increase in superheat using the new design when the DC field is turned on compared to the superheat achieved with high power ISM. The results are considered significant.
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Vladimir S. Moxson, ADMA Products, Inc.
Low Cost Titanium Components for Armor and Structural Applications
This presentation is related to the direct powder rolling process for producing titanium and titanium alloy plates and covers the activities performed against a cooperative agreement between the U.S. Army Research Lab and ADMA Products, Inc. on manufacturing low cost P/M Ti-6Al-4V alloys for armor and structural applications.
Titanium alloys exhibit attractive mechanical properties, good corrosion resistance and low density, but they are expensive. The presented direct powder rolling (DRP) process has the potential to produce plate/strip/sheet/foil products from Titanium and its alloys at cost effective manner. Blended elemental (BE) powders are used in this DRP process. In the BE method, titanium powders and appropriate alloying additions (generally in the form of a cost-effective master alloy such as Al-V) are blended together and cold consolidated by directly roll-compacting to form strip, sheet or plates of near final thickness. Subsequent heat treatment produces materials which has tensile properties equivalent to those of the ingot metallurgy and meet the MIL-DTL-46077F specification requirements for armor plate. This presentation reviews the general powder rolling process, microstructures, properties, and ability to produce composite multi-layer strip. The results of this study also demonstrate that the advanced Gamma Titanium Aluminides/Titanium alloy composite plates may be also produced cost effectively by direct powder rolling process.
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Michael G. Metz, VSMPO Tirus US
Raw Material Supply in Russia
Mr. Metz will speak on the raw material supply outlook from Russia, and its role in the global titanium market.
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Vasily I. Semeniuta, Grandis Titanium
Titanium Scrap Situation And Latest Trends In Ti Scrap Demand And Supply
Current up-cycle in Titanium industry is very different from any of previous cycles. This is the first ever Titanium cycle that is “synchronized” with global industrial cycles. Each of earlier Titanium cycles came independently from global industrial cycles. We can indicate three major demand components in current Titanium cycle – (1) demand for Titanium units from steel industry to accommodate steel consumption for China industrial growth, (2) demand for CP Titanium for industrial projects in China and South East Asia and (3) demand for aerospace industry in Western World. This cycle is the first one started not by increasing

demand for Titanium products (like all previous cycles), but by demand from outside Titanium industry – for Ti units for steel production.

Increase in Ferro-Titanium production started in the fourth quarter of 2003 lead to increase in demand for Titanium scrap. Then recovery of Titanium industry started in 2004, both industrial and aerospace sectors simultaneously, and created additional demand for Titanium scrap. Combination of three powerful factors of demand created unseen competition for Titanium units. Prices for low grade scrap for Ferro-Titanium production increased almost ten times since lows in 2002 to peak in March 2005. Prices for "vacuum" quality scrap for Titanium ingot production increased about 8 times.

During presentation we will try to analyze scrap supply situation in the current cycle, difference of this cycle from all previous cycles and try to forecast scrap situation for short- and mid-term future.
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Bob Bunting, STRATCOR, Inc.
Vanadium
Vanadium is a critical metal in the production of titanium alloys. It has recently experienced record price levels as a direct result of a massive imbalance between worldwide supply and worldwide demand.

This presentation analyses the reasons for this supply/demand imbalance. Historical sources of supply are described and future potential sourcing is also reviewed. Current production capacity by source is also listed as is the potential for future increases in capacity and production.

The reasons behind the recent surge on worldwide consumption are also described, and future prospects for demand are analyzed.
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Michael J. Magyar, U.S. Geological Survey
World Molybdenum Market Overview
No discussion of the present day molybdenum market would be complete without going back to the beginning of the U.S. molybdenum mining – the Climax Mine. High atop the Continental Divide in central Colorado sits the Climax "glory hole," a ½-mile wide, 1,000-foot deep crater that is the result of more than 75 years of mining. At one time, this single mine supplied 75% of the world's molybdenum needs.

An overview of the history of the Climax Molybdenum Company shows the development of molybdenum from a laboratory curiosity to a vital metal traded worldwide. From that starting point, background information on molybdenum mineralization, recovery, and processing will be presented.

A discussion of primary versus byproduct molybdenum production will lead into a breakdown of supply and demand from a global perspective. Some data on consumption by end use will be presented both by commodity and by market. Finally some perspective will be provided on the forces at work in the molybdenum market that are driving the recent price rise to historic levels.
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Tadahiko Furuta - Toyota Central R&D Labs., Inc.
Development of Titanium Alloys Controlled an Elastic Property
It is common knowledge that titanium alloy is highly attractive material for aeronautical, aerospace, automobile, marine, and military applications because it has tremendous properties such as specific strength and corrosion

resistance. Nowadays the applied field of that is spread out not only transport components, but also a wide range of the applications for artificial bone, implants, medical equipment, and sporting good. Therewithal, the development of titanium alloy having a new functionality has been conducted. In particularly, it is very important to control the elastic property on developing innovative products.

In this paper, the activity of Toyota Central R & D Labs., Inc. regarding titanium alloys controlled an elastic property has been introduced. Those are (1) a TiB reinforced titanium metal matrix composite obtained via a cost-effective powder metallurgy process for automobile engine parts. We realized that TiB particle is the only ideal reinforcement, which has high rigidly, strength and thermodynamic stability in titanium alloy, and (2) Gum Metal, a new multifunctional beta-titanium alloy, Ti-24at%(Ta+Nb+V)-(Zr +Hf)-O, which shows ultra-low Young's modulus, ultra-high strength, ultra-high elastic deformability, and super cold formability without work hardening. Each and/or complex function of Gum Metal must offer a wide range of the applications in the emerging markets.

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Takashi Yashiki - Kobe Steel, Ltd.
New High Performance Titanium for Exhaust Systems--Further Study

Mechanical properties, formability and high temperature oxidation resistance of Ti-1.5Al and our new alloy were introduced in ITA 2004 conference. The use of Ti-1.5Al is mainly for motorbike exhaust systems. Ti-1.5Al was registered with ASTM standard as Gr.37 after the conference.
In ITA 2005 conference, in-depth research results of our new alloy, whose name is Ti-1.2ASNEX, will be introduced. This research was done in order to develop the titanium alloy which had high temperature oxidation resistance more than Ti-1.5Al. Ti-1.2ASNEX has excellent high temperature oxidation resistance and practical formability. This alloy is consequently considered to be applied to not only motorbike exhaust systems but also automobile exhaust systems.

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Hiroaki Otsuka - Nippon Steel Corporation
Development of High-performance Titanium Alloys for Automotive Exhaust Systems

Recent growth of titanium use in several automotive parts has made titanium one of the major materials in automotive industry. In particular, a great deal of CP titanium has been used for mufflers and exhaust pipes in motorcycles and the application range of titanium is now expanding to four wheeled vehicles. However, there is a strong requirement of materials having higher performance at elevated temperature with keeping good formability from the viewpoints of rising operation temperature and manufacturing cost. To properly respond to this tough issue, we, Nippon Steel, have developed a new alloy especially for automotive exhaust systems.

The alloy has 1mass% of alloying element X, which contributes to increase strength at temperature up to 700°C without deteriorating formability at room temperature, resulting in the high-performance alloy with both excellent high temperature strength and cold formability. In this presentation, the concept of alloy design is at first described and some of the properties including twice higher strength at 700°C than that of CP Gr.2 and better or equivalent cold formability compared with CP Gr.1 and Gr.2. Other properties needed in automotive exhaust system such as weldability, corrosion resistance and performance stability in relation to long term use are also introduced.

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Gary Nemchock - Architectural Titanium
Architectural Projects Completed in 2004

Architectural titanium installations completed since October 2004, as well as several currently under construction, will be featured in this presentation. Included will be the progress of the Denver Art Museum as construction will be near completion for opening in 2006.
Other commercial installations:
Mauna Kea Astronomy Education Center –
Hilo, Hawaii
Albany Courthouse – Albany, New York
Government Building – The Netherlands
Shopping Mall – Rome, Italy
Clinique des Cedres – Grenoble, France
Library – Tromso, Norway
Office Interiors – Malaysia
Oostpoort – The Netherlands
UCLA Men's Gym – Los Angeles, California
Military Training Facility – The Netherlands
Crystalline Tower – Cincinnati, Ohio
DFS Watch Store – Hong Kong
INCS-Chino Factory Showroom – Nagano, Japan

Residential installations in Palm Springs, Boston, Pebble Beach, Aspen, Ontario, San Pedro, Del Mar, Laguna Beach, and Belgium will also be shown.
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Patrick L. Boster, RTI Energy Systems Inc.
Deep Water Engineering Solutions Using Titanium - The Devil is in the Detail
Offshore deep water exploration and production of hydrocarbons provides a rich target for energy companies. Regions such as the Gulf of Mexico are reported to have the super fields under deepest waters, well below the ocean floor.Physical challenges exist where water depths are approaching 10,000 ft, with subsequent drilling of an additional 20,000ft below the mud line. These oil & gas producing wells often time contain highly corrosive media with well bore pressures up to 20,000 PSI and temperatures in excess of 350oF.

Energy operators experience producing well conditions that are further complicated by the affect of the structural challenges of the offshore environment; i.e. dynamic stresses, metocean affect, material fatigue damage and the occasional hurricane presenting interesting challenges for the engineering community.

The successful performance of titanium products has lead to increasing acceptance in the energy industry.

This presentation will provide an overview of deepwater offshore production facilities and upstream development projects. Included in the presentation will be details behind the engineering application of titanium, detailed engineering efforts for construction and the successful field installation.
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Akio Okamoto - Kobe Steel, Ltd.
The Ocean Thermal Energy Conversion Plant and Titanium
"Ocean Thermal Energy Conversion"(OTEC) is a new method of generating electricity utilizing huge amounts of thermal energy of ocean. This method of power generation, producing exceedingly low carbon dioxide, is expected as a countermeasure to solve the energy issues crucial to human race. For OTEC plant, the most

important material is titanium. The development of titanium plate-type heat exchanger boosts the performance of OTEC to practicable level.
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Dan McWhorter, Verichek Technical Services Inc.
Spark Analysis of Titanium Alloys with a Cu Electrode
Titanium Alloys present some unique challenges to your Quality Control personnel when it comes to Alloy Identification. All phases of the Titanium Industry require that the material be identified and controlled at some point. This process actually begins at the recycling facility.

Equipment utilized:
Recyclers and Titanium metal producers and users utilize both X-ray and visible light spectrometers for this purpose. Some of this instrumentation can be very old and still provide accurate results. The metalscope and Fuschs are such machines.
(Detail of the instruments currently used by the industry.)

Instruments Available:
Description and type of instruments available new.
Their application and limitations.

Why Tungsten materials are a hazard for Titanium producers.

Description and technical data on the Test Master from WAS:
It's application and results of testing using both a Tungsten and a Copper Electrode.

Conclusion:
Speed and accuracy is still the key to rapid through put of material with a new emphasis on trace analysis. Ru adds value on 6-4 applications.

Guaranteeing specifications for low Si, Pd, Sn, and other elements in CP can add profit and cut production steps for the end user, thus adding value.

The trust and working relationship between supplier and user are always being evaluated.
Providing safe, tungsten free material, with 100 per cent guaranteed alloy verification will always be in vogue.
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