TITANIUM TODAY

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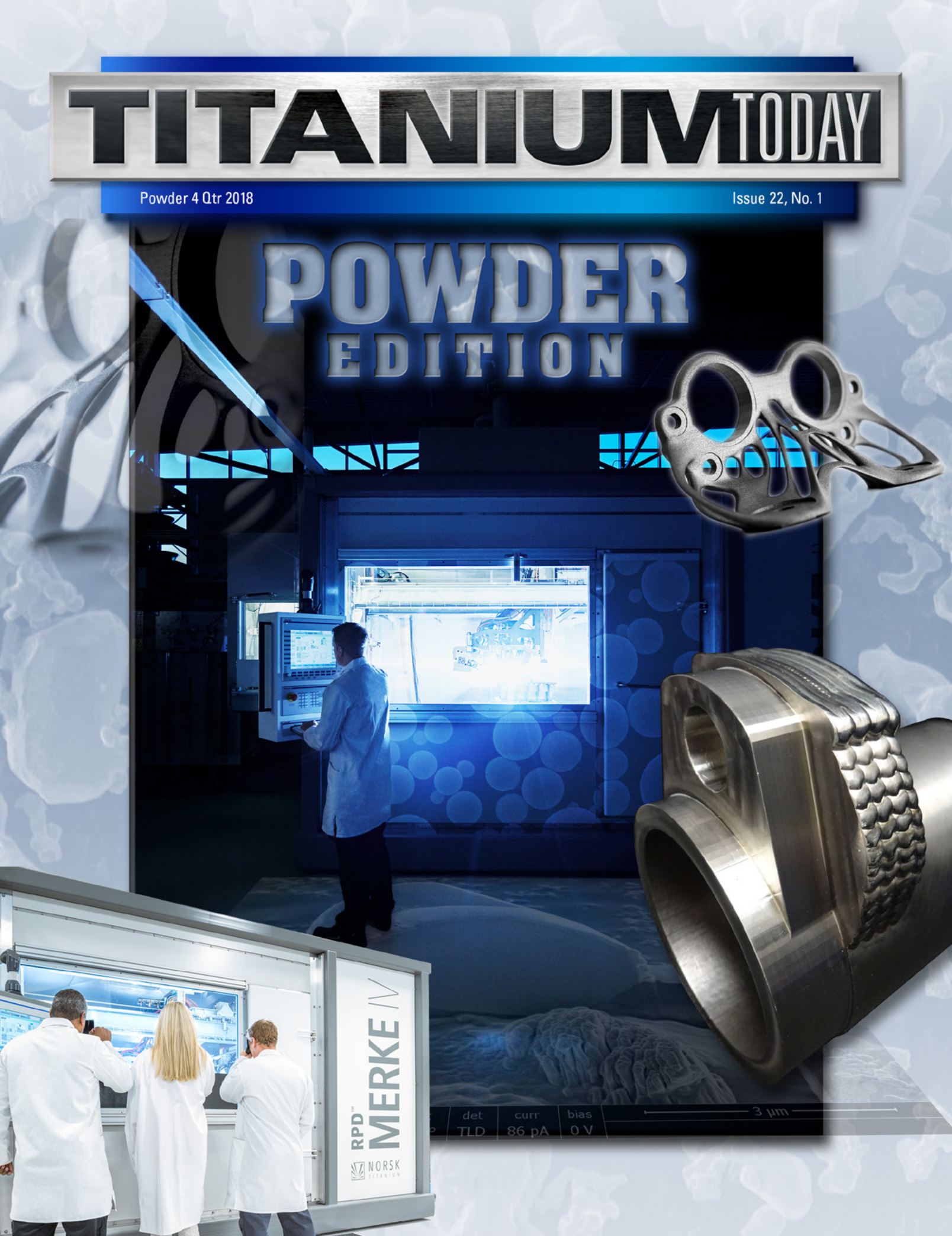
POWDER EDITION



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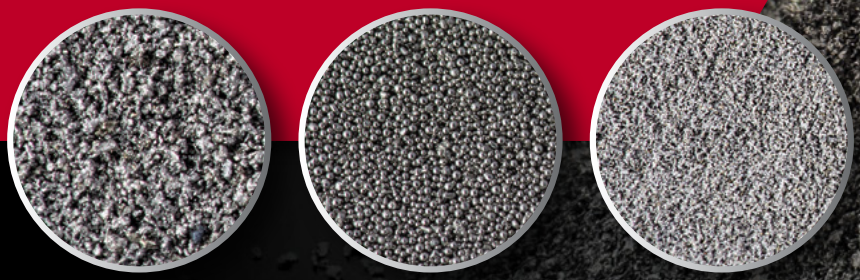

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TITANIUM TODAY
POWDER EDITION

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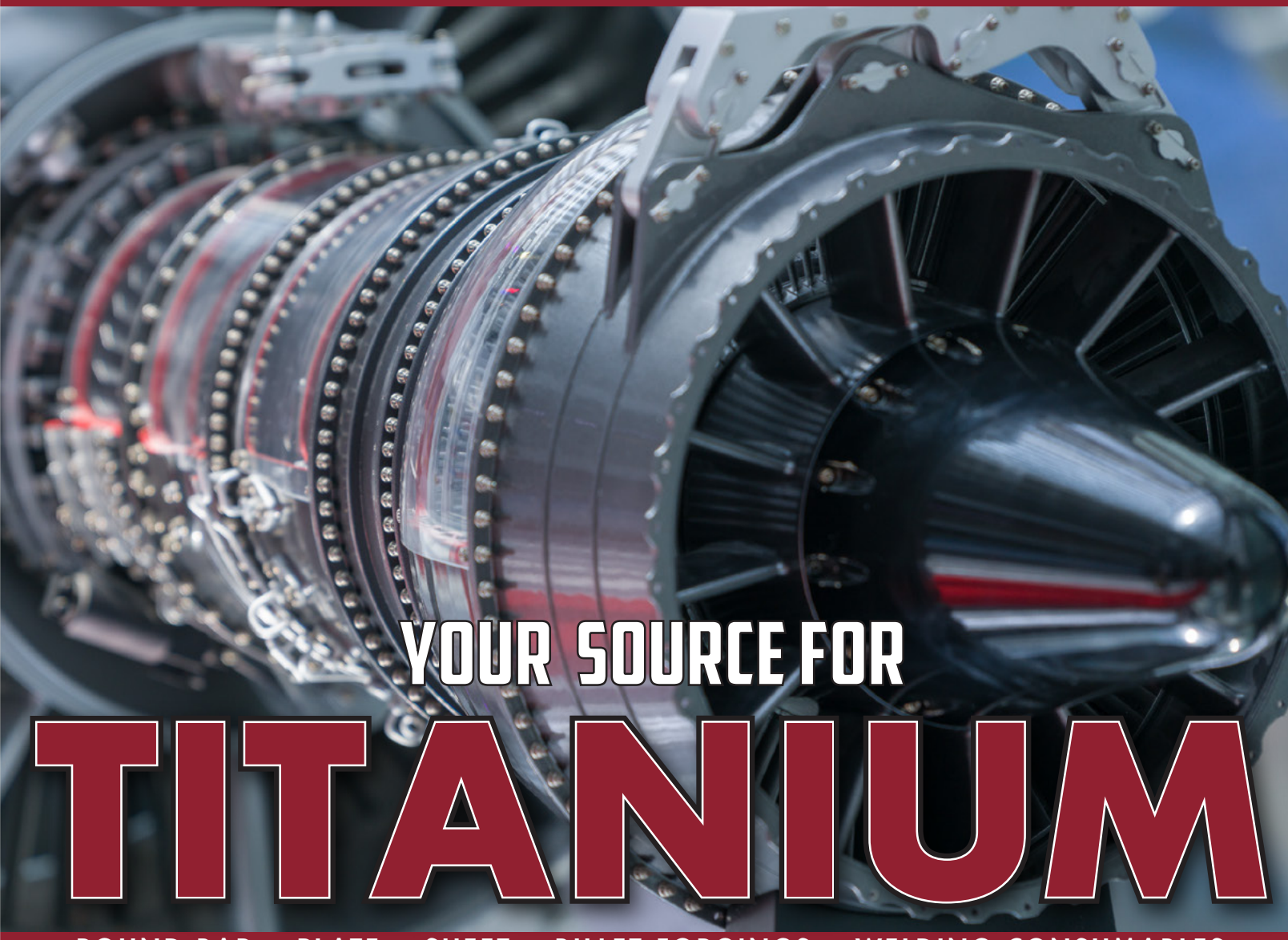

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Donald E. Larsen
Interim Plant Manager, Ti-Ingot and Director, Special Projects
Arconic Engineered Structures

Donald E. Larsen was formerly Vice President, R&D, General Manager Advanced Manufacturing for Arconic, a global technology, engineering and advanced manufacturing leader. In this role, he was responsible for leading R&D and production teams working on priority titanium technology projects, including 3D printing and advanced manufacturing activities. He also served as a liaison to the Arconic Technical Center (ATC) and Arconic's Whitehall Technology Center. Don retired Q3 of 2018, and has currently taken on the role of Interim Plant Manager Ti-Ingot Operation and Director of Special Projects.

Don joined the company in 1988 and has served in a number of roles focused on the research, development and production of titanium products. He has also held operational and sales and marketing roles with the company.

Don has a master's degree in metallurgical engineering from The Ohio State University, and is the holder of 11 U.S. patents. He has published more than 30 technical articles in the field of titanium. He is also a member of the International Titanium Foundation Board of Directors.

ITA Vice President

Michael G. Metz
President
VSMPO Tirus US

Michael Metz joined VSMPO - Tirus, US in November 2003 as Vice President, Commercial and was named President of the organization in 2007. VSMPO is the largest producer of titanium in the world, vertically integrated from titanium sponge manufacture through melting and mill products such as plate, sheet, bar, billet, wire, and welded and seamless tubing. In addition, VSMPO supplies titanium closed die forgings for airframe and engine applications. Mike has served on the International Titanium Association Board of Directors since 2007 holding the positions of Director, Vice President and President.

He has significant experience in the titanium industry, having had held positions in sales, distribution, product management, market research and forecasting at Titanium Metals Corporation from 1986 to 2003 before joining VSMPO. Mike graduated from Hamilton College in 1981 with a BA in economics, and from Carnegie – Mellon University in 1983 with an MBA.

ITA Secretary/Treasurer
Education Committee Co-Chair
Titanium Europe Conference Chair

Prof. Markus Holz
President, AMG's Engineering Systems Division
CEO, ALD Vacuum Technologies GmbH

Dr. Markus Holz was appointed President of AMG's Engineering Systems Division and CEO of Vacuum Technologies GmbH as per October 2012. He joined the ALD Management Board in October 2011. Dr. Holz graduated in Aerospace Engineering in 1986 and earned his PhD in 1992. Following his 10 years of service in the German Airforce, Dr. Holz began his career with ThyssenKrupp in 1992, where he assumed several executive positions mainly in the stainless steel and special metals branch. In 1999, Dr. Holz became Managing Director of ThyssenKrupp Titanium GmbH (formerly Deutsche Titan GmbH) and in 2002 he was appointed Managing Director of ThyssenKrupp Titanium S.p.A. (formerly Titania S.p.A.). Furthermore, he was responsible for Tubifi cio di Terni, Italien, from 2004 through 2007. From 2007 to 2009 he was CEO of the ThyssenKrupp Titanium Group (Germany and Italy). In January 2010 he joined the Managing Board of Hempel Special Metals, Oberhausen, Germany. He is Honorary Professor at University of Applied Sciences Anhalt Teaching Operations Management.

ITA Past President

Henry S. Seiner
Vice President – Business Strategy
TIMET, Titanium Metals Corporation

Mr. Seiner, TIMET's Vice President of Business Strategy, oversees the Marketing, Product Management, Purchasing and Production Planning organizations for TIMET. In this role, he has responsibility for and visibility into all aspects of TIMET's supply chain. Henry is based in TIMET's Toronto, OH facility — which is geographically and structurally in the middle of TIMET's global supply chain. He has held various positions in Production Planning, Manufacturing, Purchasing and Marketing in his 25 year tenure at TIMET.

Prior to coming to TIMET, Henry spent six years at U. S. Steel Corporation in Sales, Marketing and Production Planning. His educational background includes a Masters Degree from Carnegie Mellon University in Pittsburgh, PA and a Bachelor's Degree from Duke University in Durham, NC. Henry is a native

of Pittsburgh and continues to reside in Western Pennsylvania.

Albert Bruneau
President
Neotiss High Performance Tube
ITA Director

Neotiss High Performance Tube (formerly Vallourec) headquartered in France, is the worldwide leader of titanium and stainless steel welded tubes for heat exchangers, with facilities and sales forces based in five countries on three continents: France, United States, China, India and Korea.

Prior to Vallourec Heat Exchanger Tubes, Albert Bruneau has held numerous senior sales & marketing management positions within Vallourec group mainly for the Oil & Gas industry, involved in Europe, South America, Africa and Middle East.

Albert Bruneau graduated from French Engineering School ESPCI and conducted one Executive MBA at the French Business School HEC.

Brian J. Malloy
Vice President and Chief Commercial Officer
Carpenter Technology Corporation
ITA Director

Brian J. Malloy was named Vice President and Chief Commerical officer of Carpenter Technology Corporation in March 2016. Brian is responsible for overseeing all of the company's commericial operations which account for $2.2 billion in total annual net sales. This includes marketing, sales and customer service for both the Specialty Alloys Operations (SAO) and Peformance Engineered Products (PEP) business segments. Brian joined Carpenter in August 2015 as Vice President, Sales & Customer Service for the SAO segment, which accounts for nearly 80 percent of Carpenter's total annual net sales.

Edward J. Newman
Senior Vice President
United Alloys & Metals, Inc.
ITA Director

Edward Newman is the current Senior Vice President at United Alloys & Metals, Inc., a subsidiary of Cronimet USA. Mr. Newman has been involved in the titanium recycling industry for the past forty years. He previously held various positions related to the purchasing, processing, and marketing or titanium and high temperature alloy scrap. He has spoken at various metals conferences on subjects related to the recycling of titanium and various other aerospace metals. He holds a Bachelor of Science degree in Business Administration.

Mr. Newman is a current member of the International Titanium Association's Board of Directors.

Brett Paddock
President and Chief Executive Officer
T.I. (Titanium Industries, Inc.)
ITA Director

Brett is the President and CEO of Titanium Industries, Inc. His diverse metals background consists of engineering consulting, fabrication, manufacturing, contracting, and sales. He has held positions of VP of Sales and Marketing, Director of Operations, and COO during his career with Titanium Industries. Prior to joining Titanium Industries, Inc. in 2001, he was Director of Operations for one of the nation's largest structural steel fabricator/erectors and Principal of an Eastern US engineering design and consulting firm. He holds a bachelor's of science degree in engineering and a master's of science degree in structural mechanics from Lehigh University and is a licensed professional engineer in multiple states. Brett is currently serving as an Officer on the International Titanium Association's Board of Directors. Brett enjoys many outdoor sports including skiing, swimming and running as well as leisure time boating across the East Coast of the U.S.

Frank L. Perryman
President and Chief Executive Officer
Perryman Company
ITA Director

Mr. Perryman graduated from Millikin University in 1986 with a Bachelor of Science in Industrial Engineering. In 1988 he co-founded Perryman Company with his father and brother. Since December of 2008 he has held the position of President and CEO of Perryman Company. Perryman Company is a fully integrated supplier of specialty titanium products. From melting through finishing, Perryman produces titanium bar, coil, fine wire, net shapes, and hot rolled products for the aerospace, medical, consumer, industrial and recreation markets worldwide. Through its Forging and Fabrication Group the company also offers forging of titanium and other metals and fabrication of titanium, plastics, and other metals. Perryman Company is headquartered in Houston, Pennsylvania. Company offices are located in Philadelphia, Warsaw, IN, Los Angeles, London, Zurich, Tokyo and Xi'an.

Board of Directors *(cont.)*

Martin Pike
Vice President - Commercial
ATI Specialty Materials

ITA Director

Martin Pike is the Vice President - Commercial for ATI Specialty Materials with responsibilities which include international product management, sales, and long-term agreements with customers. Martin joined ATI in August 2001 and held several positions with increasing responsibility including Titanium Rolled Products, Product Manager and Director of Sales. Prior to joining ATI, Martin worked in manufacturing where he held various commercial positions including Regional Vice-President of Sales. His educational background includes a Bachelor's Degree from the University of North Carolina at Charlotte.

Michael Stitzlein
President
Tricor Metals

ITA Director

Mr. Stitzlein is President of Tricor Metals, a supplier of titanium mill products, forgings and fabrication of ASME-code equipment for the petrochemical, pharmaceutical, mining, aerospace, and biomedical markets.

Tricor is based in Wooster, Ohio, and has operations in Texas, California and Michigan. Stitzlein is a 1973 graduate of The Ohio State University. He earned an MBA at Ashland University, Ashland, OH, in 1989, and one year later purchased Tricor Industrial. The company has a headcount of more than 150 employees and stocks over 1 million pounds of inventory.

Graham P. Walker
Business Consultant
Ametek Specialty Metal Products

ITA Director
Education Committee Co-Chair

Graham P. Walker is currently Vice President, Sales and Marketing at AMETEK Specialty Metal Products. He is a qualified Metallurgist with a BSc from the University of Leeds (UK) and a MBA from Baldwin-Wallace College (OH).

Prior to joining Reading Alloys, he spent over twenty years in a variety of roles within the Foseco Group, specializing in product development and technical sales to the foundry and aluminum industries. His life and career include extensive foreign work and travel that provide a valuable international perspective.

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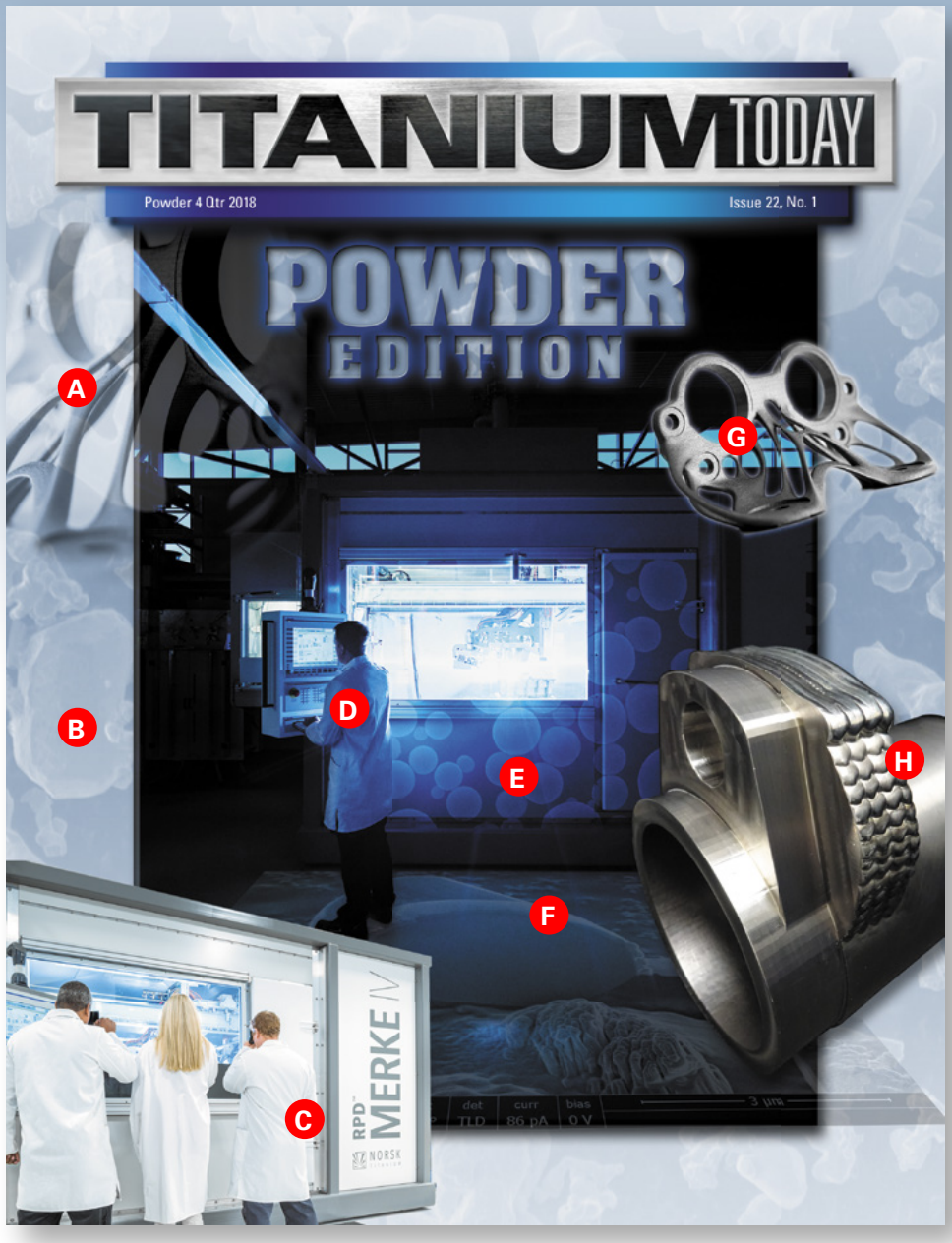
A&G Additive manufacturing promises lighter, better-performing parts—produced cheaper—such as the Arconic-designed, optimized titanium aerospace bracket shown here. Arconic has comprehensive capabilities in a variety of metals-based additive technologies, including direct, indirect and hybrid techniques. The company has developed metal 3D printed parts that have already orbited Earth on the Orion spacecraft—and are now taking flight on Airbus commercial aircraft. Images provided by Arconic. www.arconic.com/additive

B&F A Transmission Electron Microscope (TEM) is a large piece of scientific equipment that forms detailed images (called 'micrographs,' specifically 'transmission electron micrographs') of extremely small objects or areas of objects by passing a beam of electrons through a very thin slice of the area of interest.

Image "B" shows end of the six micron particle after being sliced by the TEM in order to look at the oxide layer. Image "F" is Na sponge powder at 800 X shows a sample of powder from which a six micron particle was selected. For reference, human hair is about 100 microns or about 15 times larger than this particle. Na irregular powder is not useable by the AM process but is used for undisclosed applications.

Images provided by Accushape, Inc. www.accushapeinc.com



C&D Norsk Titanium is the world's pioneering supplier of aerospace-grade, additive manufactured, structural titanium components. The company is distinguished in the aviation industry by its patented Rapid Plasma Deposition™ (RPD™) process that transforms titanium wire into complex components suitable for structural and safety-critical applications. RPD™ is the world's first FAA-approved, 3D-printed, structural titanium, delivering substantial lead-time and cost savings for aerospace, defense, and commercial customers. Image provided by Norsk Titanium AS www.norsktitanium.com

E Hoeganaes Specialty Metal Powders (HSMP) produces high-quality, gas-atomized titanium alloy powders for additive manufacturing processes. Spherical nickel-titanium particles as shown here are used in the medical industry as catheters and stents because of its superelasticity. Additional materials produced similar to powders shown include commercially pure Ti, Ti64, Ti6242, Ti5553, and Beta21S.
Image provided by Hoeganaes Specialty Metal Powders. www.gkngroup.com/hoeganaes

H Titanium extruded tubes has an electron beam additive titanium weld build up, which is then machined to profile. Nu-Tech Precision Metals manufactures by hot extrusion seamless pipe, tube, fittings, bar, rod and shapes for nuclear, aerospace, military, medical, offshore, mining, chemical, sub-sea and corrosive environments. In-house finishing options including OD grinding or machining, ID honing or boring, hot straightening, pickling, non-destructive testing and electron beam additive manufacturing and welding. Image provided by Nu-Tech Precision Metals. https://nutechpm.com/

An 'Inflection Point' on the Horizon? Efforts Continue To Accelerate the Advance of Titanium Powder Metal

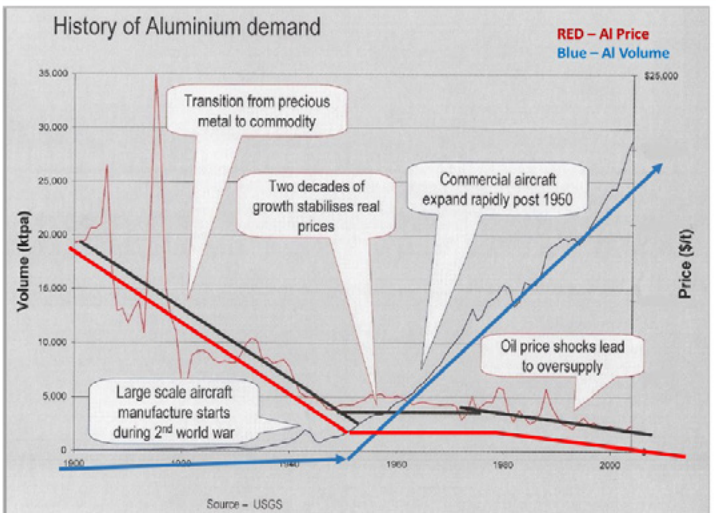
For Art Kracke, the president of AAK Consulting L.L.C., when it comes to assessing the potential future growth of the titanium powder metal sector, it's all about identifying a critical business "inflection point."

Kracke, who's been associated with the global titanium industry for four decades, taking a big-picture view, drew a comparison between advance manufacturing enabled by titanium powder metal and the inflection point of aluminum in the early 1950s—the period when aluminum evolved from a high-cost metal to an industrial commodity. He made the analogy during his presentation at the TITANIUM USA 2018 conference and exhibition.

As he pointed out in his presentation, aluminum made the transition to being a valuable commodity material from its once lofty heights as "the metal of kings." Much like titanium, aluminum's inherent properties of light weight and corrosion resistance made it a highly prized material 70 years ago for diverse industrial applications, including military and commercial aircraft manufacturing.

"The price of aluminum came down through technological improvements of the metal process," he said, describing the business environment for the key inflection point around 1950. He said that as the cost of aluminum went down, demand increased. The increased production further lowered cost, sparking greater demand; and this cycle continued justifying capital investments to expand production and promote greater research and development to improve aluminum and enhance its economic viability. Today, the metal of kings is a familiar industrial commodity that has a range of applications in aerospace, automotive and commercial products.

Model: Aluminum Price versus Volume

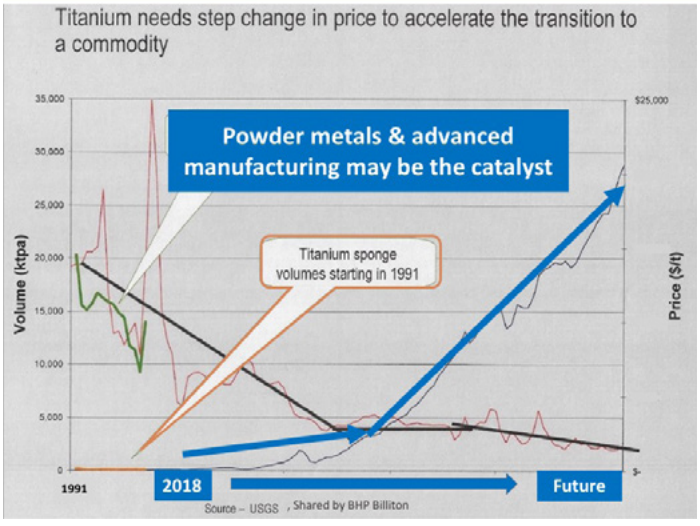


The moral of this story is that the titanium powder metal business could (and he underlined the word "could") follow the path of aluminum. He remains skeptical regarding the current generation of titanium powder, but he's also optimistic that the inflection point for titanium powder metal might be on the horizon.

Additive manufacturing has been the buzz of the international titanium industry for more than five years, and it holds the promise of being the much-needed inflection point to spur growth and a diversified range of applications. In previous years, titanium powders were a small, niche market with limited applications, such as a spray coating for biomedical implants, according to Kracke. "The limited applications didn't justify wider investment in research and development and powder production." However, given the promise of additive manufacturing, key factors are quietly, methodically beginning to emerge, such as improved techniques to produce the titanium powder to upgrade its consistency and characteristics, the ability to engineer unique alloy combinations, and new generations of additive manufacturing equipment for part production.

"So titanium powder metal is finding an application in additive manufacturing," Kracke observed. "This will boost production and the use of powders. As volume increases, this will justify the creation of new techniques to produce powder."

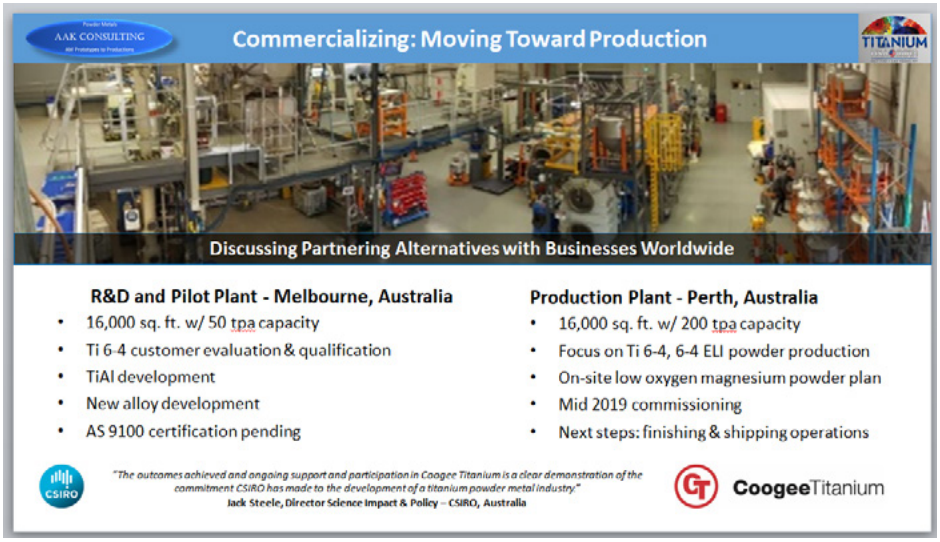
What if Titanium Replicates Aluminum's Growth?



It should be noted that one high-profile additive manufacturing operation currently uses titanium wire and not powder. As reported, Norsk Titanium, in 2017, began delivering structural, additive manufactured aerospace parts to industry giant Boeing. These first OEM-qualified components are now flying on the Boeing 787. Norsk utilizes its Rapid Plasma Deposition™ (RPD™) wire-fed process to produce near-net-shape titanium parts at its production facilities in Hønefoss, Norway, and Plattsburgh, NY. As a result, Norsk Titanium is the recipient of the International Titanium Association's (ITA) 2018 Titanium Applications Development Award. The take-away here: powder has competition when it comes to additive manufacturing.

A big driver in the use and development of titanium powder metal is the potential to achieve major cost reductions; in essence, a cost structure that would begin to move titanium towards a more commodity price tag via additive manufacturing. He said it's important to remember that additive manufacturing "is many technologies, not one thing. Additive manufacturing is an industry, not a single process."

In terms of the potential for cost reduction, he used the example of titanium when specified for aerospace applications, and the so-called buy/fly ratio for titanium. As a rule of thumb, manufacturers need to buy 7 or 8 pounds of titanium for every pound of titanium that becomes a part on an aircraft. The use of titanium powder metal in additive manufacturing has the potential (he underlined the word "potential") to reach a buy/fly ratio of less than 1.5 to 1. This would include post-processing machining, finishing and heat treating of near-net-shape additively manufactured parts. Additive manufacturing also provides design freedom and part consolidation, which further reduce cost while improving part and component performance. In terms of part metallurgical quality, it's generally believed that additively manufactured parts from titanium alloy powder are higher quality than castings, and that hot-isostatic pressing (HIP) would eliminate any part "discontinuity" created during the build process.



"There's still a lot of work to be done," he said.

As for the current established technologies to create titanium powder alloys, Kracke listed cold-wall induction melting (gas atomized by melting raw materials in a crucible); electro-induction gas atomization or EIGA (gas atomized from bar); plasma wire atomization (plasma atomized from wire); plasma rotating electrode powder or PREP (plasma atomized from precision straightened bar). These processes begin by melting titanium metal. He also cited the hydride/dehydride technique.

During his presentation at TITANIUM USA 2018, he called attention to a new approach; a technology being pursued by Coogee Titanium in Australia. Coogee Titanium is jointly owned by Coogee Chemical, headquartered in Perth, Australia, and CSIRO, the Commonwealth Scientific and Industrial Research Organization, an Australian government agency that spearheads scientific research. He cited efforts at two Coogee facilities in Australia: a research and development pilot plant in Melbourne; and an installation in Perth, slated to go online in 2019, which will have a production capacity of 200 metric tons.

Coogee Titanium's development work on the TiRO process began in 2008, and Kracke was careful not to reveal any proprietary details. He did say that the powder production technology is "melt-free," producing titanium alloy powder directly from chemicals such as titanium, aluminum, and vanadium chlorides. "It's the Kroll process reconfigured," he said, providing a basic overview. "It makes use of a fluidized bed that produces powder rather than a 'sponge cake.'" Commercial production of the Coogee powder will focus on Ti-6Al-4V and 6AL-4V ELI (extra-low interstitials). The research and development facility and the pilot plant will continue work on other titanium alloys such as TiAl (titanium aluminide).

When asked to reveal Coogee's plans to commercialize the process—perhaps forming an alliance or licensing agreement with an outside partner—he would only say that Coogee executives are "in discussions" with global companies.

An industry consultant located in Charlotte, NC, Kracke entered the titanium industry in 1980 with Teledyne Allvac, working in many areas including the development and sale of titanium alloys, superalloys and vacuum melted specialty steels. The company evolved into ATI Specialty Materials. ■

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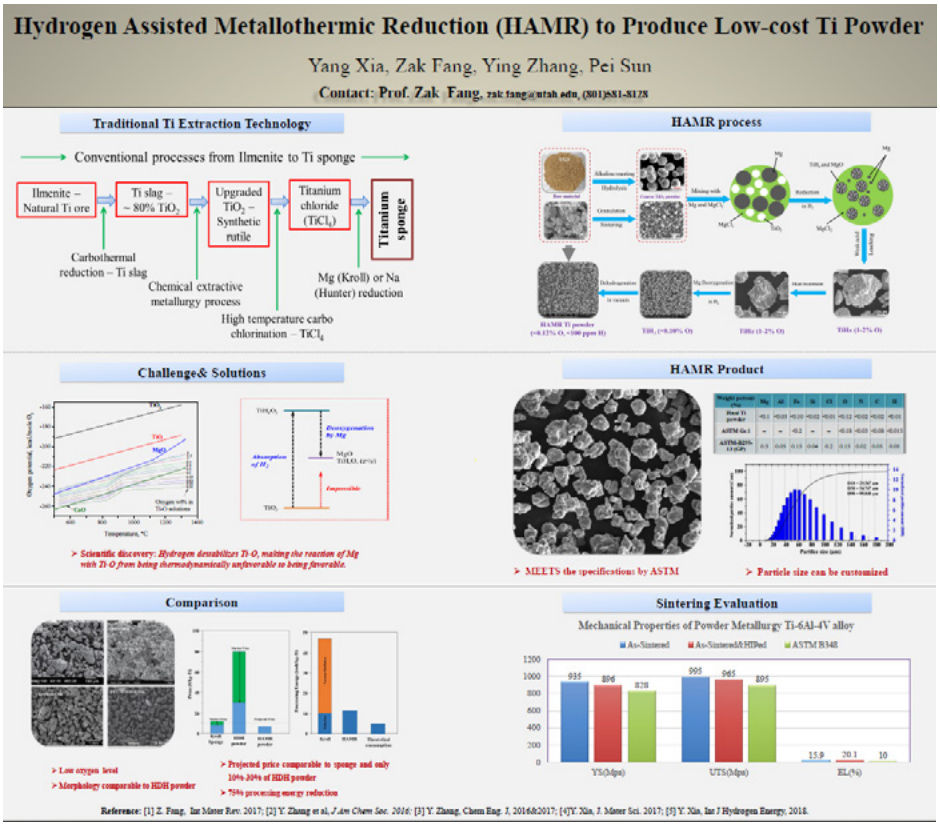
University of Utah Targets a Breakthrough To Produce Titanium Powder Metal Alloys

The Department of Metallurgical Engineering at the University of Utah, working in conjunction with the U.S. Department of Energy, is in the second phase of a pilot program to develop titanium powder metal alloys through a technology known as the Hydrogen Assisted Metallothermic Reduction (HAMR) process.

Z. Zak Fang, Ph.D., a professor of metallurgical engineering, described HAMR as "a breakthrough technology," as it uses hydrogen to "destabilize" titanium dioxide (TiO2) and Ti-O solid solutions, which in turn allows magnesium to reduce the level of oxygen. Fang said that this hydrogen-assisted technology is being developed as a lower-cost alternative to the traditional Kroll process, which reduces titanium tetrachloride (TiCl4), affectionately known as "tickle," with magnesium. HAMR, in effect, eliminates the chlorination used in the Kroll process, which creates titanium sponge. The end result is the production of pure titanium powder, or an alloy powder, that can form an ingot or function as an industrial powder for additive manufacturing or metal injection molding, powder metallurgy, or other near-net-shape manufacturing processes.

The second phase of the HAMR program involves working with commercial partners, like Boeing. "We are scaling up the HAMR program with industrial companies," Fang said. He described this phase as a "small pilot operation with metal production at a kilogram scale." He also noted that while HAMR is currently is a "batch process, we believe that it can be made into a continuous process," looking to eclipse the standard Kroll technology for producing titanium.

Information posted online by the University of Utah (https://powder.metallurgy.utah.edu/research/titanium-powder-metallurgy) states that the HAMR process can produce titanium metal at 40-percent less processing energy and 50-percent less cost than that of commercially pure titanium powder available commercially in the market today. In 2014, the University of Utah received funding from the U.S. Department of Energy's Advanced Research Project Agency-Energy (ARPA-E) program, with initiated the development of the HAMR process. Fang said one of the mandates of this ARPA-E program was to develop lower-cost "light" metals, like titanium, to support globally competitive industry applications.



Along with HAMR, the University of Utah is engaged in two other programs through the Department of Energy: ARPA-E, and Energy Efficiency and Renewable Energy (EERE). The first is the Granulation-Sintering-Deoxygenation (GSD) process for production of spherical powders needed for additive manufacturing and metal injection molding technologies. The second is Hydrogen Sintering and Phase Transformation (HSPT) process, which is a powder metallurgical approach for producing of titanium structural components with wrought-like microstructure and mechanical properties. The online information posted by the university suggests that the HSPT process could reduce the cost of making titanium components by more than 80 percent.

Fang has been working at the University of Utah for 16 years, and before that spent 11 years in the metals industry. He is a fellow at the National Academy of Inventors, the American Society of Metals, and the American Institute of Powder Metallurgy. ■

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- Ti 6Al-4V
- Ti 6Al-4V (ELI)
- Ti 7Al-4Mo

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- Alloy 625

Stainless Steel

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TITANIUM USA 2018 Executive Summary

Distinguished speakers set the tone for the proceedings at TITANIUM USA 2018, the 34th annual international conference and exhibition, which was held Oct. 7-10, 2018 at the Bellagio Resort in Las Vegas, organized and sponsored by the International Titanium Association (ITA). The conference gathered 960 professionals from 30 different countries and proved to be one of the highest attended ITA events in recent years.

Keynote speaker Tom Captain, retired vice chairman, global aerospace and defense leader, Deloitte LLP, the London-based international industry consultant and financial advisory firm, along with distinguished speakers Laurent Jara, vice president, metallic material procurement, Airbus S.A.S., Jeffrey Carpenter, director, aerospace materials and standards, Boeing Commercial Airplanes, and Thierry Viguier, vice president, Safran Materials Purchasing, all provided insights for the titanium industry as it navigates through business conditions and trends in the global aerospace market.

Annual Award Winners

The Las Vegas gathering also served as the venue to honor recipients of the ITA's lifetime achievement and application development awards. Russell Gordon Sherman, who developed alloys and heat treating protocols for the titanium industry and pioneered the high-volume production of titanium aerospace fasteners, received the 2018 Lifetime Achievement Award. Sherman was involved in developing titanium alloys and heat treating protocols to raise the mechanical properties and usability of the "wonder metal" during the formative years of the titanium industry, according to Hogue.

Sherman presented the initial findings from his research at Titanium Metals Corporation of America (Timet), Henderson, NV, at the ASM's convention in Philadelphia in October 1955, a paper titled "The Heat Treatability of Ti-6Al-4V." The backdrop to his research work came during the Cold War years of the 1950s, when the United States and the Soviet Union were vying for supremacy in aerospace.

Russ Sherman accepting the Lifetime Achievement Award from Henry Seiner, ITA President

Award accepted by Nick Mayer, Roxanne Warren, Mike Canario and Chet Fuller

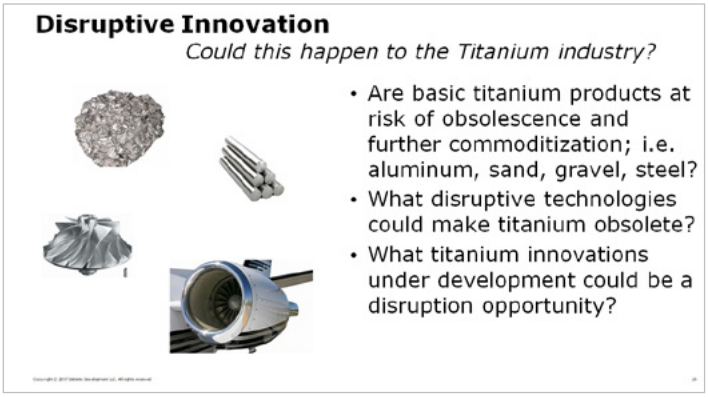
Norsk Titanium, the world's first FAA-approved supplier of aerospace-grade, additive manufactured, structural titanium components, garnered the 2018 Titanium Application Development Award. Norsk Titanium, in 2017 began delivering the structural, additive manufactured aerospace parts to industry giant Boeing. These first (original equipment manufacturer) OEM-qualified components are now flying on the Boeing 787. Norsk utilizes its Rapid Plasma Deposition™ (RPD™) wire-fed process to produce near-net-shape titanium parts at its production facilities in Hønefoss, Norway, and Plattsburgh, NY.

Norsk's Plattsburgh Development and Qualification Center (PDQC) houses nine of Norsk's proprietary RPD™ titanium printing machines. Norsk's Norwegian facility, known as the Engineering and Technology Center, continues to operate qualified and approved RPD™ machines.

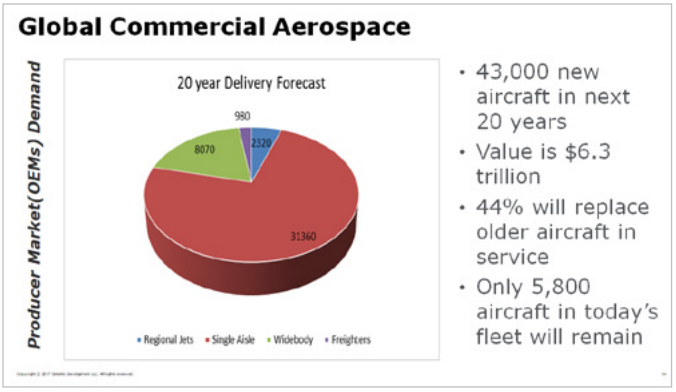
The RPD™ process uses titanium wire with plasma torches to print titanium structural components on an industrial scale. According to Norsk officials, this additive manufacturing technology has demonstrated it can be used to produce parts weighing over 100 lbs. They said that RPD™ is also 50-100 times faster than powder-based additive manufacturing systems and uses 25-50 percent less titanium than incumbent forging processes.

Featured Speakers

Captain, the keynote speaker, who has accumulated four decades of experience in commercial aircraft program launches, defense industry technology innovation, and manufacturing and engineering process improvement, shared his wisdom during his presentation titled "Aerospace and Defense Sector – Need for Innovation." He delivered an assessment of medium-range trends and unfolding aerospace industry dynamics, all of which will have an impact on the global titanium industry.



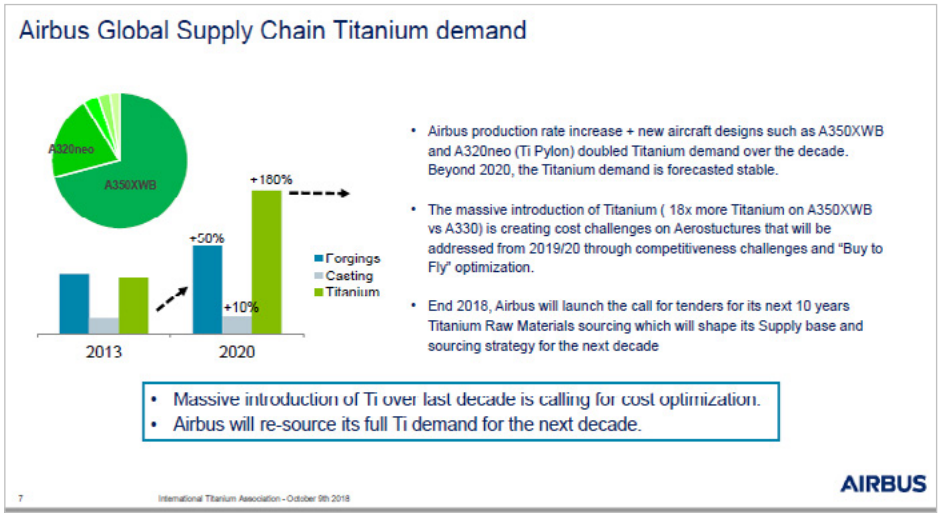
He reassured the conference audience that the commercial aerospace sector remains a growth business. However, he also took note of "disruptive innovations" and pointed out that the aerospace industry "is becoming commoditized, with pricing the main differentiator. Process technology advances will supplant production labor content almost entirely; from aero structures, electronics, systems to final assembly. Winners will be those companies that design and produce parts that are more innovative – better before cheaper."



According to Captain, disruptive innovation, which spans all industries in these early years of the 21st century, is an industrial convergence driven by technology and caused by the inevitable march of commoditization. "New technology becomes old quickly and at risk of exponential change."

For executives from aerospace OEMs, titanium supply chain issues have been the main topic of discussion in recent years at the ITA's annual titanium forums – and the Las Vegas confab was no exception. Jara of Airbus reviewed plans for titanium sourcing during the next 10 years. Jana oversees the Airbus IM3 (Integrated Metallic Material Management) transformation program. According to information posted last April in the newsroom section of the Airbus website (www.airbus.com), the company explained that IM3 is an Airbus-driven approach "that will see us challenging every part throughout our entire supply chain. We'll be working alongside suppliers to check that we're making the best possible decisions on materials and processes at every stage. Testing to check that a material has the properties we require is absolutely a key. Even though we choose reliable suppliers and trust them, we still regularly push materials to their limits in testing to be sure that they're safe and that we meet our responsibilities."

As for Airbus' interaction with the global supply chain for titanium, Jara said Airbus "will re-source its full titanium demand over the next 10 years. The massive introduction of titanium over the last decade is calling for cost optimization. The long term attractiveness of the aerospace industry is creating an environment with increasing competition at each layer of the value chain. The competition among materials is calling for an E2E (end-to-end) transformation of the fragmented metal value chain. The metal industry



needs to innovate all along its industrial value chain to remove the current waste (buy-to-fly ratio) and to develop the metallic products of tomorrow for Airbus' incremental developments and future aircrafts. The titanium value chain shall significantly improve its buy-to-fly ratio to remain the material of choice on Airbus incremental developments and future new products."

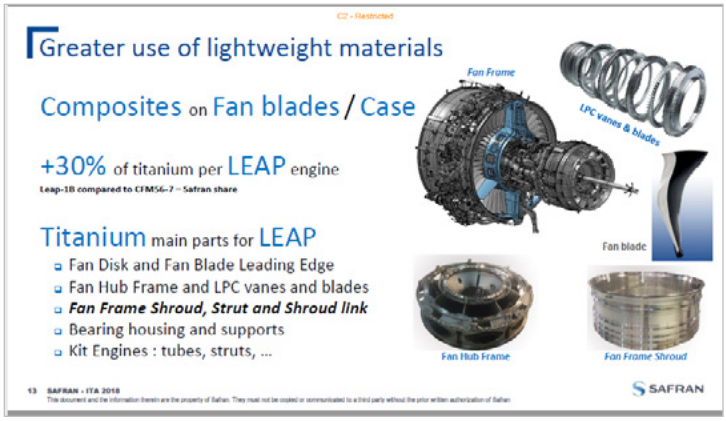
Much like Jara, Carpenter of Boeing focused his remarks on the commercial aerospace market outlook and its links with the global titanium supply chain. He said single-aisle jets will account for 73 percent of a projected 42,700 commercial airplane deliveries through 2037. Boeing, by way of Carpenter's remarks, continues to see supply chain strategies as the key to success for the aerospace and titanium industries. "Materials must 'buy their way' onto an airplane and earn the privilege to stay." The "keys to success" for the supply chain include a commitment to quality, delivery and rate readiness, increase competition, research and development, and innovation, according to Carpenter.

He took note of a "large, competitive titanium landscape," displaying a slide with an assortment of company logos from around the world. Regarding this competitive landscape, Carpenter asked the question: "where are you in the journey? Future business opportunities are tied to best value, working together, and PFS (Partnering for Success)."

Carpenter reaffirmed titanium's benefits in aerospace manufacturing – lightweight, corrosion resistance, the ability with withstand high temperatures, and compatibility with composites. However, he also said that, while titanium remains a material of choice in aerospace, "cost is limiting the additional use on airplanes."

He presented a slide that illustrated a "cost-reduction toolbox;" suggestions for companies that do business in the aerospace supply chain. Points listed in this graphic included embracing: new technology development, such as linear friction welding and additive manufacturing; the use of alternative materials, such as new titanium alloys; process improvements through supply chain efficiency and big-data analytics; and "future" technologies such as robotics and artificial intelligence.

Viguier shared Safran's expectations regarding the global titanium supply chain as he analyzed titanium's evolving role in modern jet engines. He said Safran "expects support" for the supply chain for two critical points: weight savings and cost savings. Viguier said the "challenge for the future on rotating parts is to have a titanium-based alloy that can replace the 6.2.4.2 without the problems of relaxation at "low temperature" (dwell effect) or replace Inconel 718." He said Safran uses in excess of 2,000 metric tons of high strength titanium for its landing gears, seeking a good compromise between mechanical properties (ultimate tensile stress, fatigue), density and easier maintenance (corrosion). He said "composite materials are catching a bigger share on the engine," providing a 500-pound weight savings on LEAP engines. "Aluminum materials are much cheaper than titanium by 10 times on plate.



"Aerospace is still a growing market (6-percent revenue passenger kilometers growth) and Safran has a major share on this story," he said. For the next decades, every working day, Safran will use 20 metric tons of titanium. Titanium-based alloys have a great future in this industry. Lighter parts help reduce fuel consumption and emissions and the resistance to high temperatures means thermal efficiency of turbomachines can be improved. Titanium powders could be extensively used by additive manufacturing new technologies, if they reach the market price."

World Titanium Industry Demand Trends

Henry Seiner, vice president, business strategy, Titanium Metals Corp. (Timet), examined trends for

(continued on page 29)

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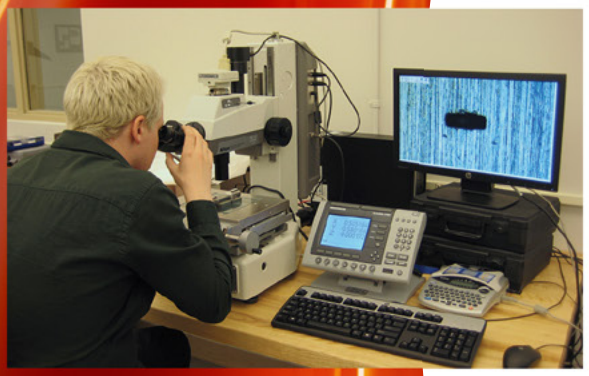

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Strategic Innovation Promotion Program in Japan Targets Development of Titanium Alloy Powder

(Note from ITA: the following article on titanium powder metal developments includes of coverage from the TITANIUM USA 2018 conference, recently held in Las Vegas, along with information posted online and company press releases.)

Yasuaki Sugizaki, chairman of the Japan Titanium Society, and the president and board member of OSAKA Titanium Technologies Co., Ltd., acknowledging the widespread expectations for the growth of titanium additive manufacturing and metal injection molding, and the related demand for new generations of titanium alloy powders to support those processes, said that Japan has embarked on a "Strategic Innovation Promotion Program" (SIP) that's based on industry, government and university cooperative efforts.

Sugizaki discussed SIP as a speaker at TITANUM USA 2018 conference and exhibition, sponsored and organized by the International Titanium Association (ITA). SIP is targeting the development of high-quality titanium and nickel-based powders to be used for the production of aerospace engine components. He added that the demand for titanium powder used in additive manufacturing is expected to rise sharply, reaching nearly 3,000 metric tons by the year 2026.

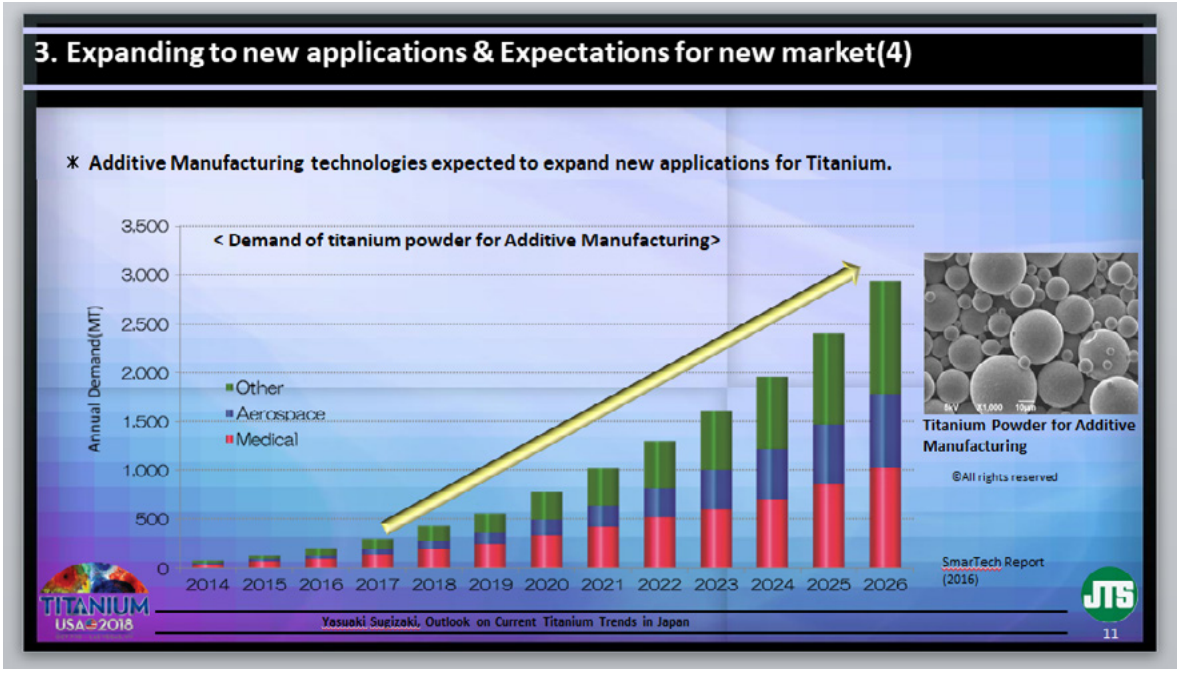
In a separate presentation at TITANIUM USA 2018, Nobuhiro Arimoto, general manager, High-Performance Materials Department of OSAKA Titanium Technologies Co., Ltd., discussed "The Superiority of Our Integrated Production from Titanium Sponge to Titanium Powder for Additive Manufacturing." Arimoto said his company's approach involves full control of "integrated production from material to titanium powder," adding that oxygen content is an important variable to manage.

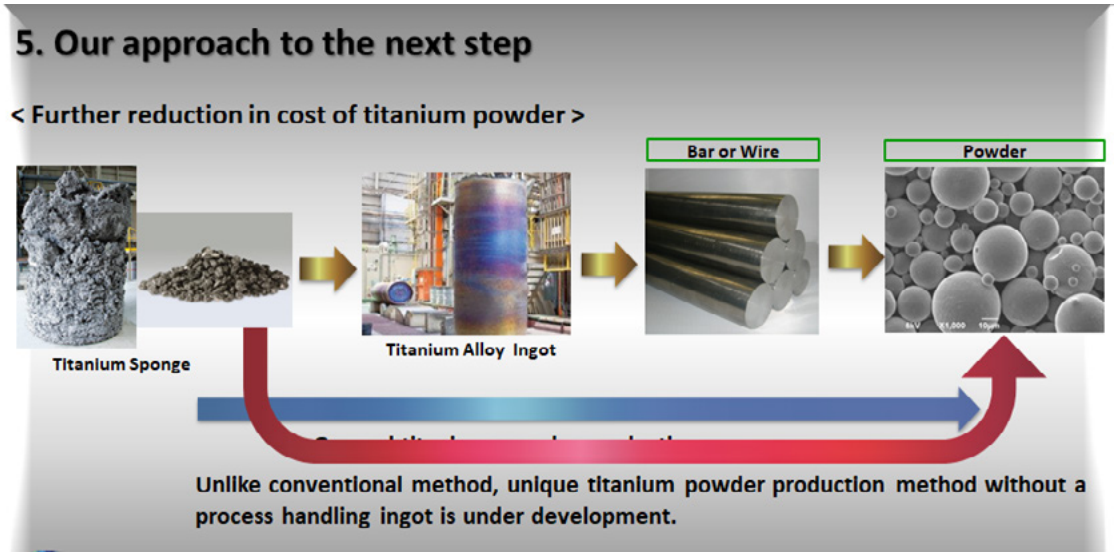
OSAKA is building a new $10-million plant dedicated to titanium alloy powder, Arimoto stated. The facility will have a production capacity of 100 metric tons per year and is slated to go online by the year 2020. He said that, unlike conventional methods, the OSAKA titanium powder production method will go from sponge to alloy powder, bypassing the typical intermediate steps of producing an ingot and bars, which is expected to reduce the overall cost of the titanium powder.

Arimoto said that as a titanium sponge manufacturer, OSAKA tackles "varied issues to supply products stably to the growing market and to meet customer needs by utilizing the new plant as well as the superiority of our integrated production processes for titanium powder."

Another presentation at TITANIUM USA 2018 by Dr. Sergey Prikhodko, a professor at the University of California, Los Angeles, explored the "Structure and Mechanical Behavior of Titanium Based Multi-Layered Materials Fabricated by Blended Elemental Powder Metallurgy for Anti-Ballistic Applications."

Prikhodko explained that anti-ballistic protection of the land systems mobility and protection of the fighting vehicles and military personnel is paramount in the success of defense and anti-terrorist operations. "The two most important anti-ballistic properties of the armor are penetration and fragmentation. Those require high hardness and strength from armor to eliminate sharpening effect of projectile as well as sufficient ductility in order to stop armor fragmentation. Traditional armor material is rolled homogeneous steel. However, steel armor can increase the overall weight of combat vehicle on about 15-20 percent. That causes reduction in mobility, maneuverability,





fuel efficiency, and requires stronger suspension, brakes, and more powerful engines."

He said the Army is in search of alternative lightweight materials for armor "and titanium is very attractive material in this list. Titanium alloys have a high mass efficiency compared to steel and aluminum. They have an excellent corrosion resistance. Titanium alloys are readily fabricated in existing production facilities and are easily recycled. The only disadvantage of titanium-based armor is its high cost compare to steel and aluminum when produced using traditional ingot technology." Due to the high specific strength of titanium, materials on its base are considered viable alternatives for low-weight armor. However, the feasibility of implementation is questionable when the armor parts are fabricated using traditional and pricy ingot and wrought technology.

Prikhodko suggested a more cost-efficient process of producing armor parts, using blended elemental powder metallurgy (BEPM) of titanium-base materials and multi-layered structures. He said that test results indicated that large, layered structures of titanium 6/4 alloy and metal matrix composites (MMCs) were successfully fabricated using the BEPM die-pressing protocol. "Sintered materials were characterized with uniform structure and composition within each layer and complete integration between the layers. During BEPM processing, the shrinkage levels of the base alloy and MMC are similar, enabling the successful fabrication of multi-layered structures without need for optimization of the sintering processing parameters for relatively large plates. Multi-layered plates fabricated in the course of this study using BEPM were successfully tested for anti-ballistic application."

An online newsletter posted by Altair Enlighten (www.altairenlighten.com), Troy MI, dated Jan. 29, 2018, reported that European automaker Bugatti Automobiles SAS, a division of the Volkswagen Group, has developed a brake caliper that can be produced by titanium additive manufacturing. The automotive part previously had been made from aluminum.

Laser Zentrum Nord of Hamburg, an institute that has formed part of the Fraunhofer research organization, worked with Bugatti to develop the titanium part. Bugatti representatives said the TiA6V4 powder alloy, used mainly used in the aerospace industry, offers considerably higher performance and lighter weight compared with the aluminum version of the part. The titanium brake caliper weighs 2.9 kg (6 pounds), while the aluminum component weighs 4.9 kg (11 pounds).

The special 3D printer at Laser Zentrum Nord, which was the largest printer in the world suitable for titanium at the start of the project, is equipped with four 400-watt lasers. Bugatti officials said it takes a total of 45 hours to print a brake caliper. During this time, titanium powder is deposited layer by layer. With each layer, the four lasers melt the titanium powder into the shape defined for the brake caliper and support structures. The additive-manufactured brake caliper maintains its shape until it has received stabilizing heat treatment to eliminate residual stress and to ensure dimensional stability.

Another report by the Altair newsletter stated that "ReportsnReports," a market research company based in India, has produced a study that estimates if the projected growth for additive manufacturing technology continues then the automotive industry will represent as much as $1.1 billion by 2019. This report is based on an insider interviewing program conducted with current and potential users of 3D printing technology in the automotive sector, as well as the application of latest standardized 3D printing opportunity forecasting methodology.

The newsletter also reported that Michigan-based Roush Industries is the first service supplier in North America to install the Concept Laser Xline 2000R, the largest powder-bed metal additive manufacturing system of its kind. The acquisition of the Xline 2000R aligns with Roush's plans to expand its additive manufacturing capabilities to accommodate multiple industries such as aerospace, automotive, defense, energy, medical, and consumer products. The Xline 2000R from Concept Laser has a build envelope of 800 by 400 by 500 mm (31 by 16 by 20 inches) for large-scale production. ■

South Africa Moves Forward, Stakes Its Claim as a Hub for Titanium Powder Metal Innovation

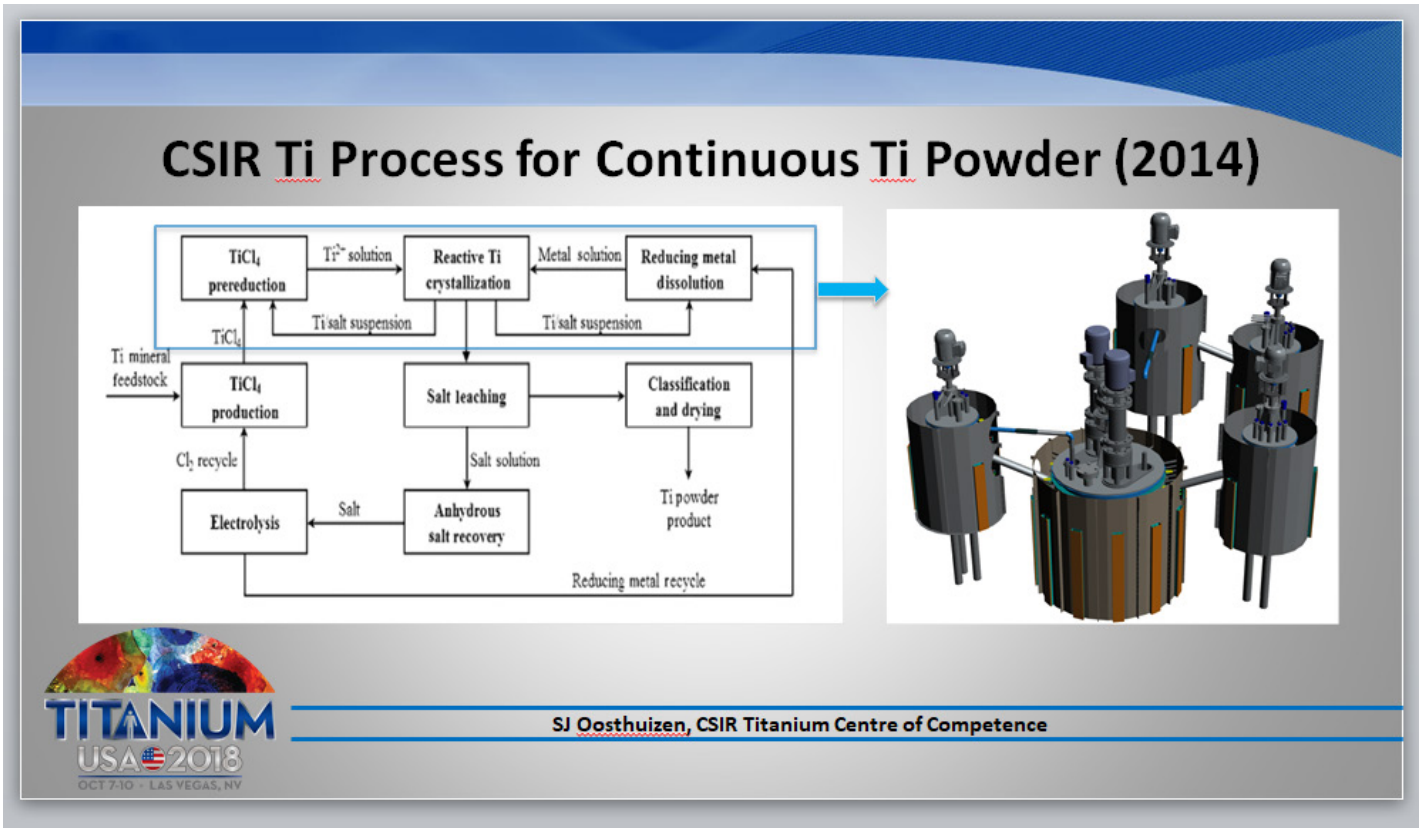
Research and industrial organizations in South Africa have made significant strides in recent years to establish that country as a hub for titanium powder metal development and innovation. S.J. Oosthuizen of CSIR Titanium Centre of Competence trumpeted these unfolding efforts in South Africa as a speaker at TITANUM USA 2018 conference and exhibition, sponsored and organized by the International Titanium Association (ITA).

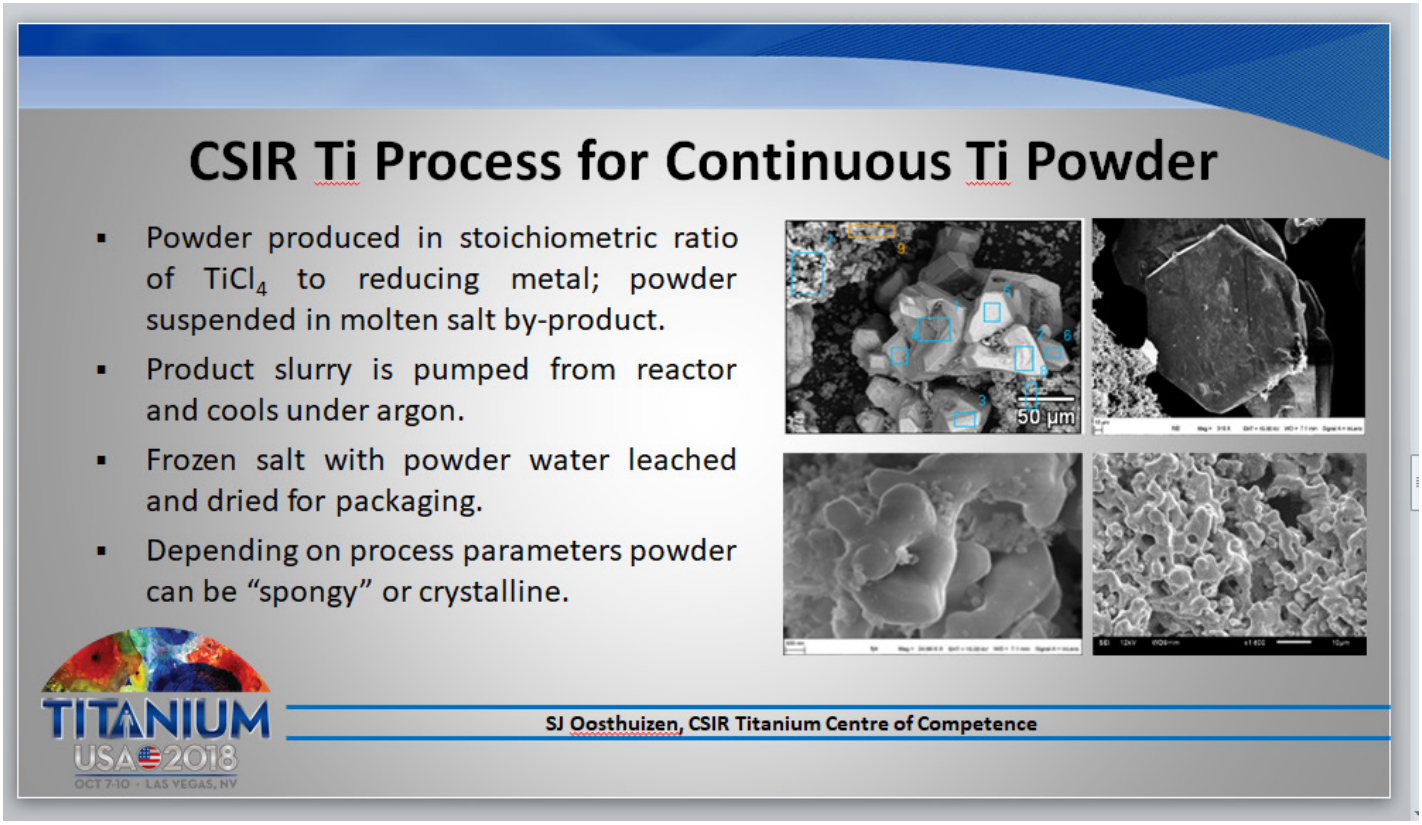
The focus on titanium powder metal, at least in part, is seen as a strategy to add value to South Africa's vast mineral base, as well as raise the country's profile on the global business stage—especially in the rapidly growing field of additive manufacturing. According to estimates by the U.S. Geological Survey, South Africa ranks fourth in world titanium reserves, behind leader China, Australia and India. It's believed that the country has some of the largest reserves of titanium-bearing minerals, such as ilmenite, primarily comprising of iron oxide and titanium dioxide.

Oosthuizen provided an update on the "Development of a Continuous Titanium Powder Production Process" in South Africa. Oosthuizen said CSIR (South Africa's Council for Scientific and Industrial Research) was tasked to develop a novel process for non-melt powder with cost advantages. During his presentation, Oosthuizen said that CSIR's goal was to create a system that offered competitive advantages as a continuous process with non-melt powder, water leach vs. vacuum distillation (with no entrapped/adhered chloride), and direct alloy production. Oosthuizen noted that a continuous powder process, conceived in 2012, was demonstrated in a plant commissioned in 2014 as the "Continuous Stirred Tank Reactor" system with molten salt pumps.

As spelled out in Oosthuizen's Power Point slide, the CSIR process for continuous titanium powder encompassed powder produced in a stoichiometric ratio of TiCl4 to reducing metal; powder was suspended in molten salt by-product. Product slurry is pumped from reactor and cools under argon. Frozen salt with powder water leached and dried for packaging. Depending on process parameters, the powder can be "spongy" or crystalline.

In 2007 CSIR began research and development into: primary processes for metal production, powder metallurgy, titanium investment casting, and additive manufacturing with "Project Aeroswift,"





which is touted as operating one of the world's largest titanium powder 3D printers. Project Aeroswift represents a collaborative venture between Aerosud Innovation Centre of South Africa and CSIR. The printer was designed and built as part of a partnership between Aerosud and CSIR's National Laser Center in Pretoria, South Africa, which is where the additive manufacturing printer is housed.

In a report filed in March 2017, the news organization Reuters stated that CSIR and Aerosud officials, working through their Project Aeroswift collaboration, were holding discussions with aerospace original equipment manufacturers Airbus and Boeing. The thrust of the talks focused on the possibility of having the Aeroswift 3D printer produce aircraft parts for the two aerospace giants.

The Reuters report quoted said Simon Ward, Airbus's vice president for international cooperation, based in Toulouse, France, as saying the discussions involved "how best to commercialize the process is a discussion we are currently having with the Aeroswift partners and relevant government agencies." The Reuters report noted that Airbus, which already sources parts for its A400M military transport aircraft from South Africa, has been offering Aeroswift support in terms of consulting, benchmark information and advice on what type of aircraft components are needed by Airbus.

Separately, according to information posted online, CSIR officials said the Titanium Centre of Competence recently unveiled a pilot plant to produce commercially pure titanium powder for downstream titanium alloy powder production and for the manufacture of titanium components for industry. The titanium pilot plant design targets the continuous production of titanium metal powder, a process is based on a CSIR-developed and patented high-temperature, alkali-metal reduction process, capable of producing titanium powder. ■

Remembering Career of an Industry Pioneer: Stanley Abkowitz Contributed to Development, Growth of Titanium Powder Metal

(Note from the ITA: Considering the information we've gathered for this report on developments in the field of titanium powder metal, we felt it was only appropriate to look back at the distinguished career of Stanley Abkowitz, the founder of Dynamet Technology Inc. He succumbed in October 2017 at the age of 90. A recipient of numerous awards, Mr. Abkowitz was a pioneer in the titanium industry and did a considerable amount of work in the field of titanium powder metal.)

Stanley Abkowitz was the first recipient of the International Titanium Association's (ITA) prestigious "Lifetime Achievement Award." He also won the ITA's 2013 "Applications Development Award" for his work that marked a new chapter in the use of titanium powder metal technology for the aerospace industry.

Interviewed in 2013, shortly after being selected for the ITA's Titanium Applications Development Award, Abkowitz said the award was more than just a personal honor. He felt it marked a new era for the use of titanium powder metal technology, especially for applications in the aerospace industry. At the time, Dynamet Technology, which was located in Burlington, MA, had received qualification approval from Boeing for the supply of Ti-6Al-4V alloy products for structural components on commercial aircraft.

As reported in 2013, a Boeing material specification was released with Dynamet as a "qualified manufacturer" for PM (powder metallurgy) Ti-6Al-4V for Boeing Commercial Airplanes. In retrospect, this was a major milestone in the development of titanium powder metal. The material specification permitted the Boeing Commercial Airplanes division and its supply chain to begin the process of substituting the PM Ti-6Al-4V alloy product as an alternative to machining from standard grades of Ti-6Al-4V.

Without revealing specific technical details, Abkowitz explained that Dynamet's advanced PM manufacturing technology involved the cold consolidation of blended elemental titanium and alloy powders and vacuum sintering, with or without subsequent hot isostatic pressing, to produce powder metal products in basic shapes and near-net shape forms.

A 1948 graduate of the Massachusetts Institute of Technology (MIT), Abkowitz, who was trained as a metallurgist, helped to establish the titanium industry in the United States through his work on developing Ti-6Al-4V, the widely used alloy used for numerous aerospace and industrial applications. In essence, this period was the coming of age of titanium's promise as "the wonder metal."

A member of the Watertown Arsenal, MA, during the early 1950s, the titanium/aluminum/vanadium alloy (Ti-6Al-4V) was hailed as a major breakthrough with strategic military significance for the United States. This was the period when Cold War tensions and fears over a potential nuclear conflict dominated the world order. In those early years, titanium production was ramped up for the production of the Lockheed U2 spy plane, which was introduced in the mid-1950s and performed high-altitude monitoring of Soviet Union military installations.

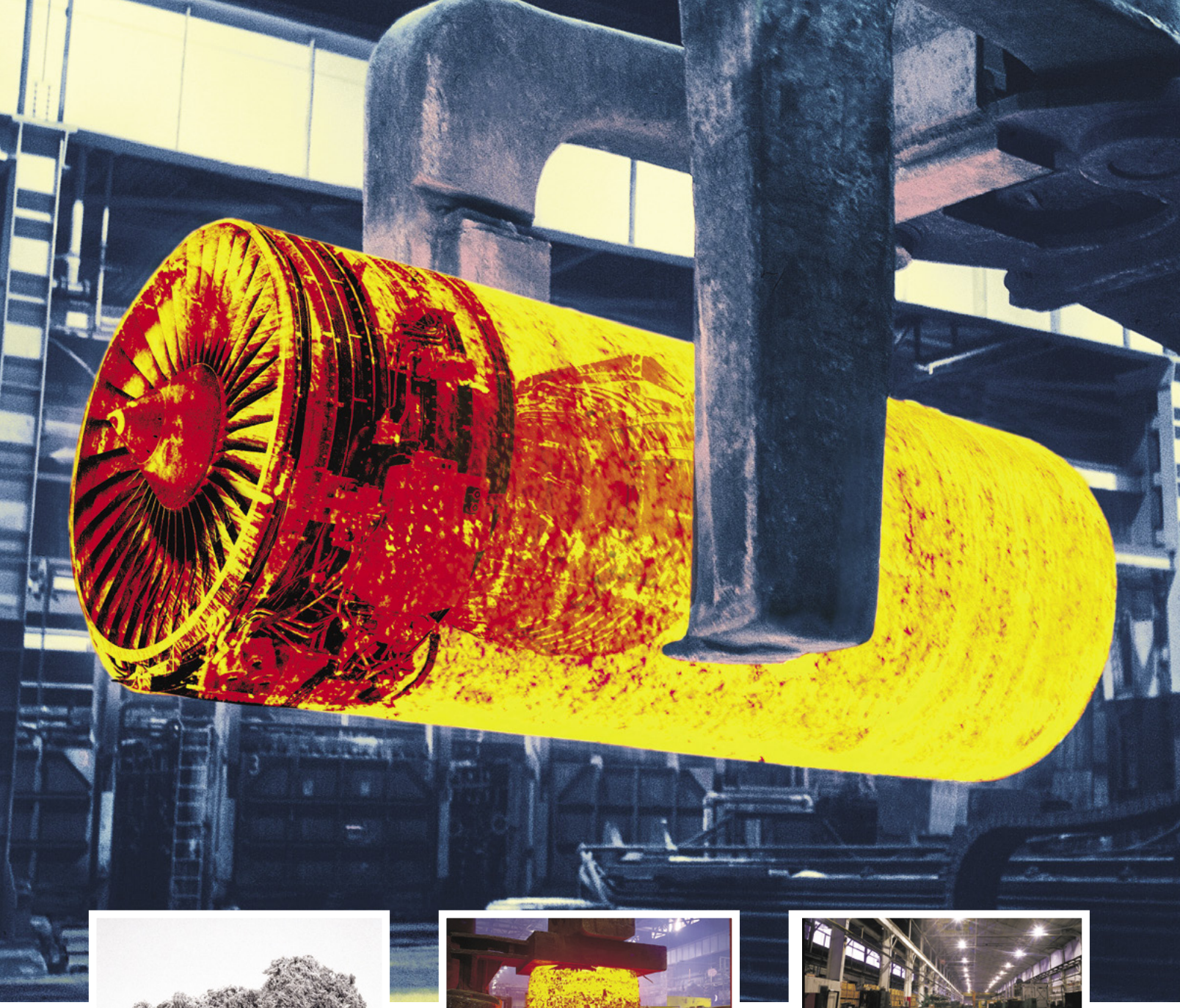
The New York Times, in its May 17, 1954 edition, carried an article titled "Titanium Studies Bring New Alloy; Light Material Developed by Army Reported as Tough as High-Strength Steel:"

> …laboratory tests showed the alloy to be 40 percent lighter in weight than high-strength steel. However, it is highly corrosion resistant and has properties that compare favorably with those of steel used in making heavy weapons, tanks and armor plate. The alloy was worked out by

Stanley Abkowitz, a member of the arsenal laboratory staff who was serving as a technical supervisor of a contract with the Armour Research Foundation of Chicago. The foundation is one of many agencies engaged in titanium research for the arsenal under government contract.

Information posted online by "Explore Chicago Collections" explained that Armour Research Foundation was one of the first private, not-for-profit contract research laboratories in the United States, founded in Chicago in 1936 by Armour Institute of Technology.

Abkowitz went on to write the first technical paper on the Ti-6Al-4V alloy in June 10, 1954, which he presented at a technical symposium held at Columbia University, NY. One year later he published Titanium in Industry, which was the first book to document the emergence of the young titanium business. Abkowitz, in 1999, also wrote a monograph titled The Emergence of the Titanium Industry. Along with the awards he received from the ITA, in 2005 ASM International awarded Abkowitz its "Lifetime Achievement Award." A 1972 ASM Fellow, Abkowitz also received the William Hunt Eisenman Award in 1999. ■



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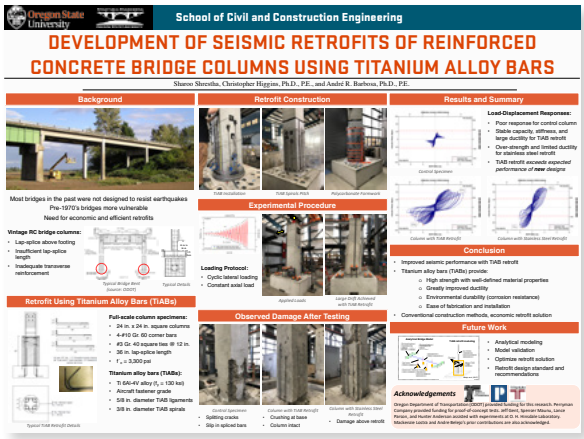
Five Poster Sessions Put a Spotlight on Work of University Scholars

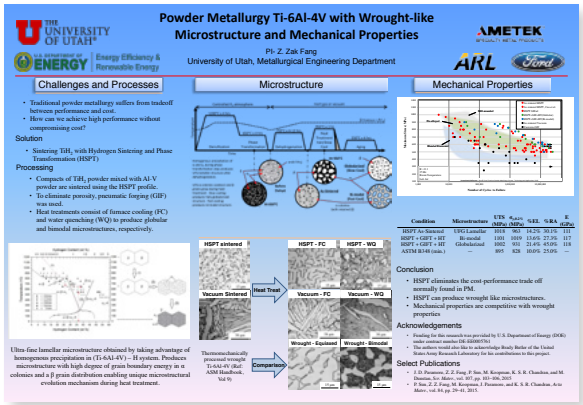
The TITANIUM USA 2018 conference and exhibition, which was held October 7-10, 2018 at the Bellagio Hotel and Casino in Las Vegas, organized and sponsored by the International Titanium Association (ITA), featured five poster sessions from university research students. The poster sessions focused on work to enhance titanium powder metallurgy, observing the use of lubricants for cutting tools, and studying seismic retrofits of concrete bridge columns using titanium alloy bars.

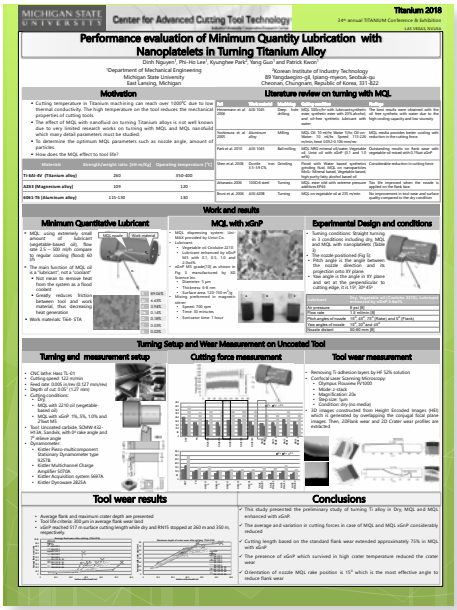
The list of poster-session scholars included Dinh Nguyen, Phi-Ho Lee1, Kyunghee Park, Yang Guo, and Patrick Kwon, from the Department of Mechanical Engineering at Michigan State University and the Korean Institute of Industry Technology; Sharoo Shrestha from Oregon State University's School of Civil and Construction Engineering; and Yang Xia, Ying Zhang, Pei Sun, James Paramore, Lu Yang, Matthew Dustan and Mark Koopman of the University of Utah's Department of Metallurgical Engineering.

The University of Utah's Mechanical Engineering Department, working through a grant from the U.S. Department of Energy, and cooperating with various industrial partners, displayed three posters at the TITANIUM USA gathering: "Powder Metallurgy Ti-6Al-4V with Wrought-like Microstructure and Mechanical Properties,"; "Obtaining Ultra-Fine Microstructure in Powder Metallurgy Titanium Alloys;" and "Hydrogen Assisted Metallothermic Reduction (HAMR) to Produce Low-Cost Titanium Powder."

Regarding the first poster on powder metallurgy Ti-6Al-4V, the study at the University of Utah first identified the challenge that traditional powder metallurgy "suffers from a tradeoff between performance and cost. How can we achieve high performance without compromising cost?" The team said the solution involved sintering TiH2with Hydrogen Sintering and Phase Transformation (HSPT). Compacts of TiH2 powder were mixed with Al-V powder and sintered using the HSPT profile. The study concluded that the HSPT technology eliminates the cost-performance trade off normally found in titanium powder metal, can produce wrought-like microstructures, and can achieve mechanical properties that are competitive with wrought titanium properties.







Oregon State University's School of Civil Construction and Engineering created a poster that provided details on the "Development of Seismic retrofits and Reinforced Concrete Bridge Columns Using Titanium Alloy Bars." This study found that a retrofit of titanium alloy bars improved the seismic performance of the bridge columns, provided high strength with well-defined material properties, improved ductility, and offered environmental durability and corrosion resistance, with the ease of fabrication and installation. ■

Arconic, Airbus Pursue Research Agreement to Build 3D Printed Aerospace Components

Arconic and Airbus are pursuing a multi-year, cooperative research agreement to advance metal 3D printing technology for aircraft manufacturing. As announced in 2017, the companies will develop customized processes and parameters to produce and qualify large, structural 3D printed aerospace components, such as pylon spars and rib structures, up to approximately 1 meter (3 feet) in length.

The agreement, unveiled at the November 2017 Formnext additive and advanced manufacturing conference in Frankfurt, Germany, combines Arconic's expertise in metal additive manufacturing and metallurgy with Airbus's design and qualification capabilities, building on its experience with regulatory agencies for certification.

The cooperative research agreement will utilize Arconic's electron beam, high-deposition rate technology to 3D print the parts. This technology is suited to produce larger aerospace components because it prints them up to one hundred times faster than technologies used for smaller, more intricate parts, according to Arconic.

In addition, Arconic said it will demonstrate the benefits of its proprietary Ampliforge™ process, which combines traditional and additive manufacturing. The Ampliforge™ process treats a near-complete 3D printed part using an advanced manufacturing process, such as forging, which enhances the properties of 3D printed parts, such as toughness, fatigue resistance and strength, compared with parts made solely by additive manufacturing, as well as reduces material input and production lead times. Arconic stated it will draw on additive and advanced manufacturing capabilities at its facilities in Cleveland and at the Arconic Technology Center outside Pittsburgh.

Arconic and Airbus achieve a 3D printing first—the installation of a 3D printed titanium bracket, shown here, onto a series production Airbus commercial aircraft, the A350 XWB.

In a separate development posted online in September 2017, Airbus and Arconic said they had developed and installed a 3D-printed titanium bracket on a series production Airbus commercial aircraft, the A350 XWB. Arconic is producing the 3D-printed bracket at its additive manufacturing facility in Austin, Texas. ■

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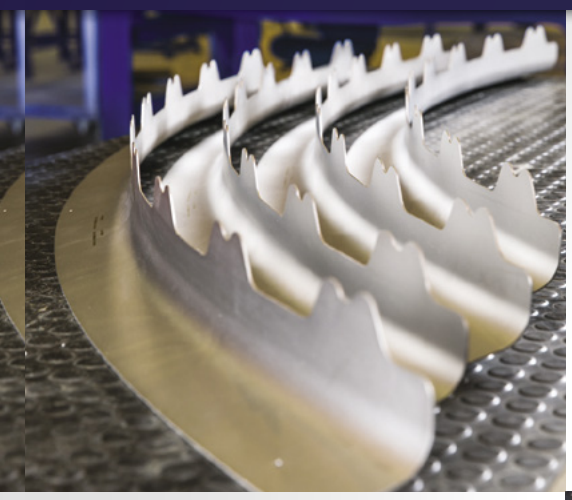

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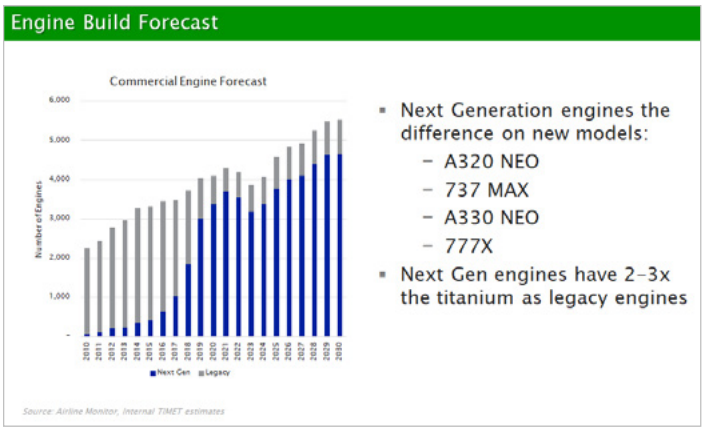
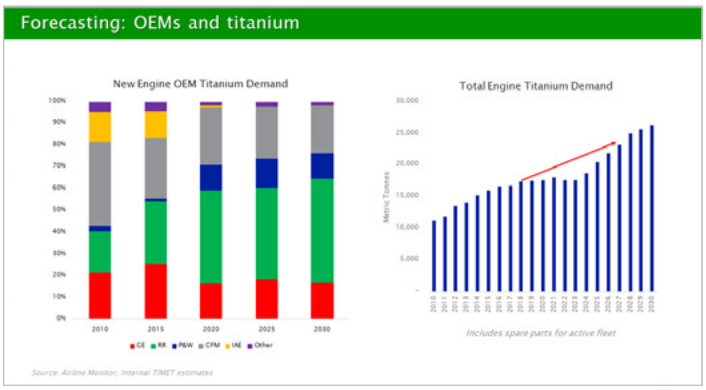




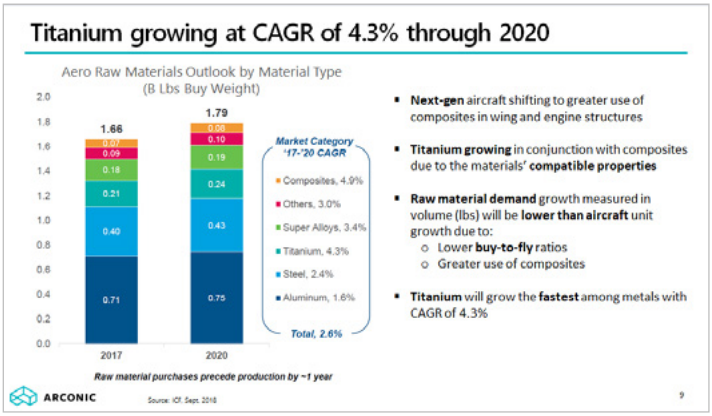
commercial aerospace engines during his presentation. For the global commercial jet engine build forecast, the combined next-generation and legacy engines are expected to reach over 5,000 units in 2030, compared with an estimated 3,500 engines in 2018. Seiner said next-generation engines will be used to power the A320 Neo, the 737 Max, the A330 Neo and the 777X. He noted that next-generation engines will have up to three times more titanium compared with legacy engines.

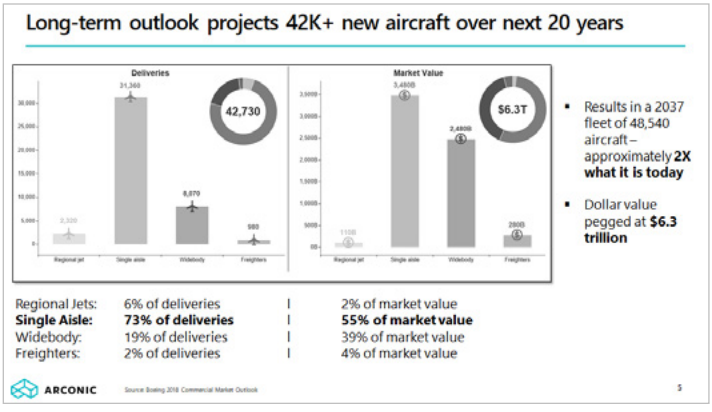
By 2030, it's projected that total titanium demand for commercial jet engines will reach in excess of 25,000 metric tons, with more titanium needed to meet performance specifications. For 2018, the total engine titanium demand is estimated at just over 15,000 metric tons. These figures are based on studies by Airline Monitor and internal Timet estimates.

Seiner mentioned concerns regarding the current climate of geopolitical uncertainty, particularly the recent trade disputes between the United States and China. He acknowledged the interest in additive manufacturing for engine production. He described it as being attractive for its potential cost savings, compared with traditional manufacturing methods, but noted that there are regulatory hurdles and a relatively "long-time horizon."

Jeremy Halford, president, Arconic Engineered Structures, reported on global titanium demand for aerospace structures. Halford began his talk by declaring that "the large commercial aircraft market has never been this good." Using 2017 figures, he said there were 1,500 aircraft deliveries, an "absolute backlog" of 13,000 units based on Boeing and Airbus estimates, and a relative backlog of nine years of production at 2017 levels. The projected unit production of commercial jets will reach 2,000 units by the year 2020. Among major aerospace metals, titanium demand is slated to grow at the fastest pace—a CAGR (compound annual growth rate) of 4.3 percent, through 2020.

Factors behind the buoyant outlook include forecasts for strong air traffic demand growth, fuel prices that are rising but still within the "sweet spot," and the profitability of airlines, giving them the ability to pay for new aircraft, according to Halford. He also identified challenges in the face of the soaring numbers. "The supply-side challenge is how to profitably deliver the backlog." He said an "industry shift" has emerged: an era of design to an era of delivery. Aerospace suppliers face a "squeeze," with pressure to reduce costs and improve efficiency. Industry restructuring from merger and acquisition activity across the global aerospace sector "is picking up speed and insourcing decisions are becoming the norm."





Albert Bruneau, president of Neotiss, addressed "Global Trends in Industrial Markets." Global titanium consumption for the industrial sector, which includes power, desalination, process, automotive and shipbuilding, is expected will register 28,112 metric tons this year and will top 30,000 metric tons

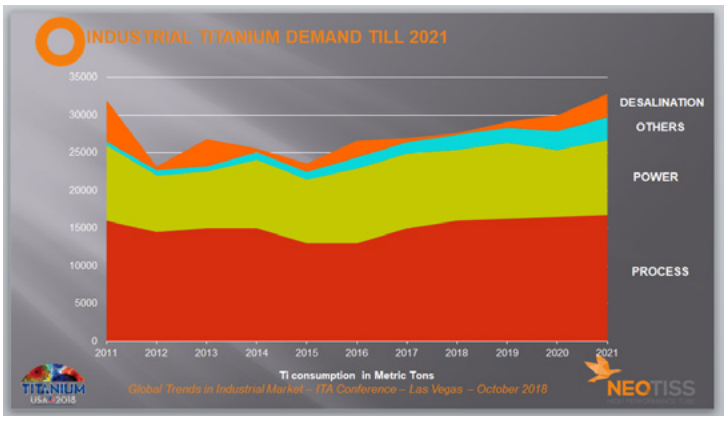
by 2021.

Regarding titanium's competitiveness in industrial markets compared with alternative metals, Bruneau observed that the market has been shaken with recent protectionist measures impacting negatively global aluminum, copper and nickel. "It's difficult to predict the trend over the medium to long term. Titanium's existing indicators remaining less reliable compared to other metals as nickel or copper." Bruneau suggested that, for titanium, there is a need to "rebuild a strong supply chain around non-military and non-aeronautics industrial markets." He said there are few specifications from end users, no care of origin or traceability, no specified process requested, and less innovation resources."

Bruneau said that, in the global desalination market, the trend currently doesn't favor titanium, as membrane reverse osmosis (RO) has emerged as the technology of choice, while thermal multi-stage flash distillation (MSF) is declining. For chemical processing, titanium remains strong, with consumption expected to reach around 17,000 metric tons by 2021.

He also assessed titanium's prospects in power generation. China is the largest market for nuclear power generation, with 19 units under construction and 28 units waiting for approval. For fossil fuels, natural gas-fired plants are "the cleanest and most efficient way of producing electricity." There are several projects in the final stages in the U.K, Malaysia, Thailand, Pakistan and Turkmenistan.

Marty Pike, Vice President – Commercial for ATI Specialty Materials, outlined "Titanium Demands and Trends in the Defense Market." The United States is expected to have a defense spending budget of around $700 billion in 2019, outpacing rivals such as China and Russia.



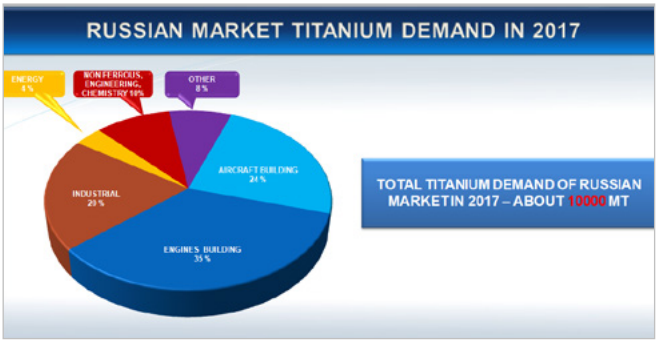
Geopolitical uncertainty continues to influence defense spending. As a result, titanium demand is picking up based on strong defense budgeting around the globe, Pike said. "Concerns over tariffs and sanctions continue to effect defense buying decisions. New defense platforms such as the new bomber, trainer and continued demand for fighters are driving year-over-year growth." He pointed out that there is only "limited growth" expected from renewed naval construction. "Acquisition cost outweighs life cycle cost savings. Initial acquisition cost and reliance on mature ship designs are barriers to titanium adoption

In addition to his presentation, Pike was installed as the newest member of the executive board of directors for the ITA.

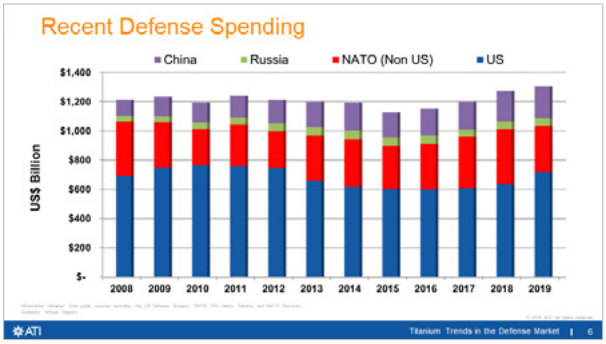
Michael Metz, president, VSMPO Tirus US, outlined trends in Russian titanium markets, saying that demand for titanium products in the Russian market is expected to reach 12,000 tons by 2022, compared with just over 10,000 metric tons in 2018. "The total demand of the Russian market for titanium products is characterized by a restrained growth in accordance with the forecasts of aircraft manufacturers, and stable demand for titanium products from the industrial sector, which development is governed mainly by the state projects."

VSMPO is the largest Russian producer of ingots, with an estimated capacity of 67,000 metric tons, while Avisma is the largest producer of sponge, with a capacity of 44,000 metric tons.

Metz said that, within the Russian market, electron beam technology for melting titanium ingots has been successfully developed over the last years. New high-strength titanium alloys, alloyed with aluminum, zirconium, niobium, iron, and designs of industrial electron beam installations with intermediate capacity, also have been developed.



The major consumers of titanium in the industrial sector of the Russian market are nuclear industry and shipbuilding. "Similar to the global industrial market, the Russian industrial sector is characterized by titanium consumption, which depends on the implementation of various industrial projects," he said. "The main demand-forming projects in shipbuilding are construction of drilling and production platforms, offshore equipment,



ships, specialized ice-class vessels for the development of the Arctic region, ships for inland waterways, patrol vessels."

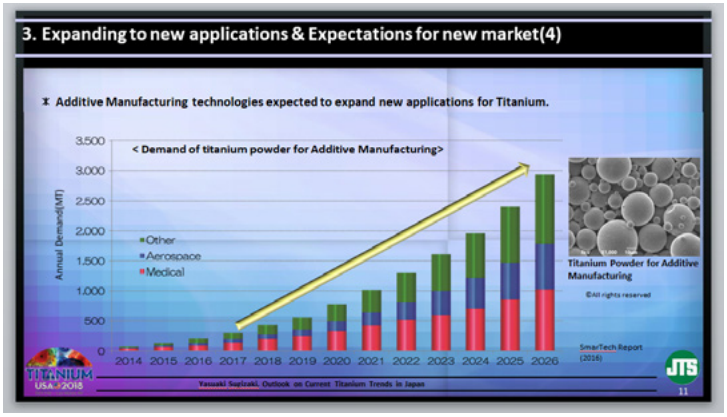
Metz said the Russian nuclear engineering has internal projects launched to develop and commission new nuclear power plants. "Rosatom backlog includes foreign nuclear orders for more than 10 years. The program of restoration of nuclear icebreaking fleet is being implemented as planned: the icebreaker Arktika was put into operation, construction of the icebreaker Siberia is being finalized, the keel of the next vessel, Ural, was laid."

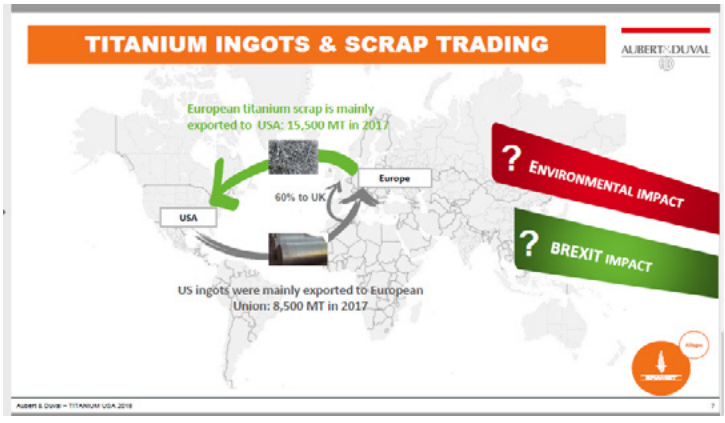
The dynamics of the development of the Russian aerospace sector is mainly controlled by the state program known as "Development of the Aviation Industry for 2013-2025," which includes sub-projects for the development of both aircraft and helicopter construction and aircraft engine building. It is also controlled by the State Program "Development of the Defense Industrial Complex," State Armament Plan 2027, and the Transport Strategy of the Russian Federation until 2030. Metz said the "Development of the Aviation Industry for 2013-2025" program is aimed at creating a highly competitive aviation industry and securing its position in the global market as the third manufacturer in terms of the output for aircraft engineering.

Mohamed Bouzidi, vice president for aerospace, energy and the defense strategic business unit of AUBERT ET DUVAL, outlined "Demand Trends from a European Perspective." He began with a chart that tracked and projected world titanium ingot production. According to his company's estimates, in 2017, the level for ingot production registered around 225,000 metric tons; that level will go up to a projected 250,000 metric tons by the year 2020.

Ingot exports from the United States totaled 9,000 metric tons in 2017. About 95 percent of that amount was exported to the European Union, including 65 percent to the United Kingdom. Scrap exports from the European Union in 2017 surpassed 20,000 metric tons, of which 71 percent was exported to the United States.

Yasuaki Sugizaki, chairman of the Japan Titanium Society, and the president and board member of OSAKA Titanium Technologies Co., Ltd., offered an "Outlook on Current Titanium Trends in Japan." He began his talk by noting that Japan accounts for about 25 percent of global titanium sponge production. "Japan supports stable supply of titanium sponge against volatile demand," Sugizaki said, adding that shipments in the near term will see stable growth due to the demand for titanium from the aerospace and industrial sectors. He said Japan also provides about 10 percent of global titanium mill product shipments.





Given the widespread expectations for the growth of titanium additive manufacturing and metal injection molding, and the related demand for titanium alloy powder to support those processes, Sugizaki said Japan has embarked on a "Strategic Innovation Promotion Program" (SIP) that's based on industry, government and university cooperative efforts. According to Sugizaki, the program is targeting the development of high-quality titanium and nickel-based powders to be used for the production of aerospace engine components. He added that the demand for titanium powder used in additive manufacturing is expected to rise sharply, reaching nearly 3,000 metric tons by the year 2026.

World Titanium Industry Supply Trends

A talk by David McCoy of TZMI examined "High-Grade Titanium Feedstocks Supply Under Pressure." Spurred by the aerospace and auto markets, which have had upward trends beginning in 2016, feedstock demand for titanium sponge reached 449,000 metric tons in 2018 and is expected to rise at 5.3 percent CAGR through 2022, according to McCoy. "TZMI believes that the strong demand from aerospace and new-energy automobiles will support demand growth for titanium sponge in the foreseeable few years."

McCoy displayed a chart for an outlook on rutile feedstock supply/demand to the year 2022. His bullet points indicated that the global rutile market is experiencing extremely tight market conditions, with a deficit position of 104,000 TiO2 units forecasted for 2018. He also listed "likely new rutile projects" such as two rutile-rich mineral sand

deposits in New South Wales, Australia; Iluka Resources Sembehun deposits in Sierra Leone; and the Engebø rutile deposits in Norway.

Terry Perles, president of MoTiV Metals LLC, reviewed "Master Alloy Market Trends and Analysis." Perles underlined several overview points, saying that quality is an absolutely critical attribute for master alloys given their use in critical applications. "A critical and highly variable cost component in master alloy production is the market price of raw materials, primarily vanadium and molybdenum. Assurance of supply of the broad range of master alloys is an important issue. The ability of the master alloy supplier to design solutions for titanium alloy producers is a critical value-added factor in the relationship."

He pointed out that master alloys in the titanium industry are binary, ternary or multi-component alloys used to efficiently and effectively allow the melting of titanium alloys. Vanadium and molybdenum master alloys account for approximately 90 percent of the total annual demand volume, and that more than 40 master alloys are regularly used by the titanium industry.

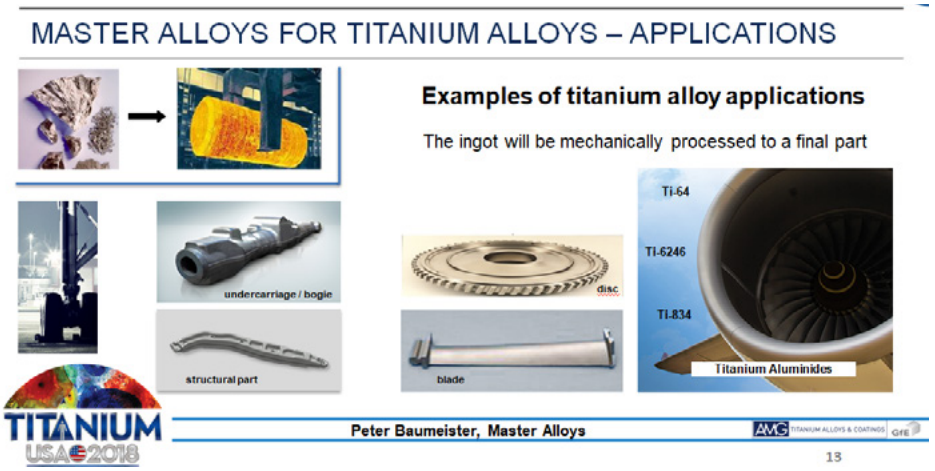
Demand for vanadium is expected to surpass 130,000 metric tons by 2025, compared with projected capacity of 90,000 metric tons during the same period. "It appears excess inventory is depleted and the supply base will struggle to meet demand in the next few years," he said. "There is a need for new sources of vanadium to meet the growing market demand, particularly from 2022 onward."

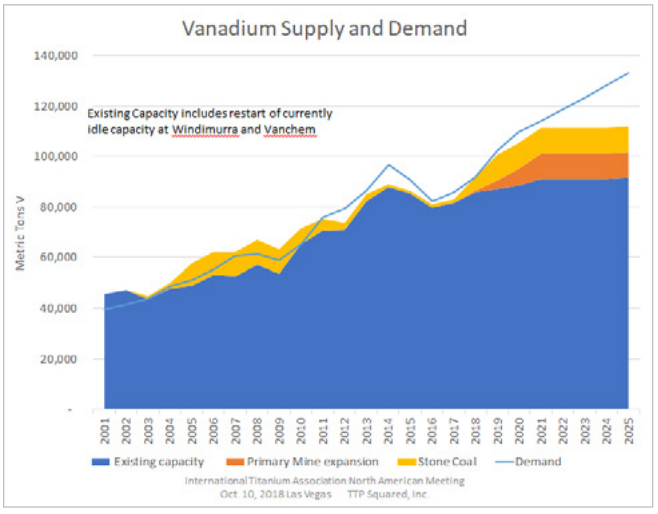
Perles said molybdenum demand was "very strong" during the first half of 2018, but there has been volatility for demand and consumption in recent years: a decline in 2015/16; followed by a strong bounce-back in 2017/18; followed by a possible reversion to trend or even weaker in 2019/20. "China has the potential to surprise on upside given its low per-capita use in 316 stainless (there was surprising stainless strength in 2017, especially in 300 series). Large supply shortfalls (for molybdenum), projected in 2018/19, which will have to be met by destocking."

Peter Baumeister, director, business unit alloys, GfE Metalle und Materialien GmbH, addressed "Master Alloys: Production Applications and Influences on Future Supply." Baumeister said the materials, a class of alloys that includes vanadium, molybdenum, niobium and chromium. Another influence on the future supply of master alloys involves the trend towards increased use of titanium scrap.

Master alloys are used for the production of titanium ingots, improving the mechanical properties, heat and corrosion resistance of the base titanium. He said raw material suppliers should provide clear strategic commitments supporting the titanium industry with sustained supply of consistent quality materials. In addition, there should be flexibility regarding pricing while balancing the expectations of customers and the capabilities while taking into consideration their own constraints.

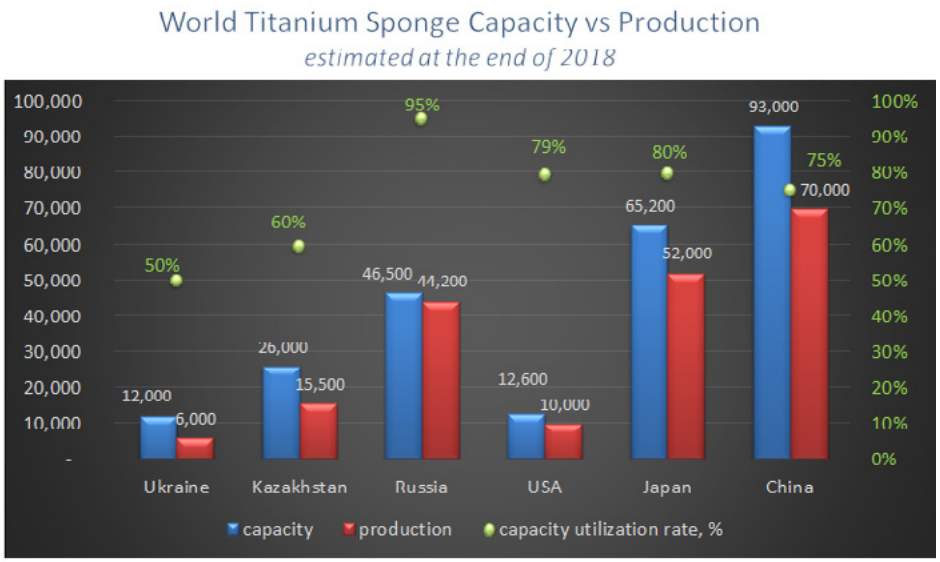
"Raw material suppliers should be willing to share commercial risk," he said. "A master alloy is not a commodity. Master alloys are essential for the titanium industry, and the titanium industry requires a healthy master alloy supplier base."





influences on future demand for master alloys for aerospace applications will increase, mainly driven by the Asian/Pacific region expansion, along with new civil aircraft designs that require much more titanium alloys per aircraft than past models. Aerospace master alloys require high purity raw

Sylvain Gehler, chairman of UKTMP analyzed "World Titanium Sponge Supply Trends." According to Gehler, 2017 world titanium sponge capacity was rated at 255,300 metric tons, with China identified as the country with the largest sponge production capacity at 93,000 metric tons. By way of comparison, the sponge production capacity in United States is estimated at 12,600 metric tons, while Japan has a production capacity of



Average rate of utilization of sponge capacity is 77%

65,200 metric tons.

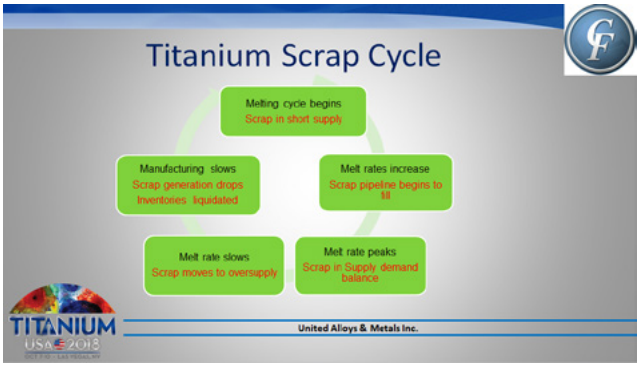
Gehler forecasted that the supply of titanium sponge will continue growing in 2019, but at a lower rate. "The main issue for sponge producers will be the sourcing of feedstock at a reasonable price level," he said. "Titanium sponge producers, except China, still have an operational production capacity reserve of 26,550 metric tons. The aerospace industry is not the only driver of this increased demand due to emergence of regional markets. Melters outside the United States are more dependent on sponge than on scrap, which will encourage sponge producers to increase production."

As for developments affecting the global titanium sponge market, low inventories have triggered an additional demand for sponge and increased sponge production, according to Gehler. Titanium sponge producers in the Commonwealth of Independent States (CIS) "were first to react to the additional demand for sponge; production in the CIS countries increased by 22 percent over the last two years." Other factors include increased demand for titanium products in China and Southeast Asia for chemical, oil and gas, energy and defense industries. "A strong demand for titanium mill products has lifted Russian sponge production close to a full capacity. Titanium sponge inventory has decreased worldwide; the biggest decrease is in the United States."

Ed Newman, senior vice president, United Alloys and Metals Inc., during his presentation, wondered whether there were "More Questions than Answers" when it comes to pondering future trends in the titanium scrap market. Scrap is a low-cost alternative to virgin materials, fills the void when raw materials are in tight supply, saves energy, and is good for the environment.

Newman said industrial demand for titanium scrap, estimated to be just over 30,000 metric tons in 2018, is expected to rise and then level off over the next three years to an annual level of around 35,000 metric tons.

Considering the effect of titanium sponge on the scrap market, Newman said sponge capacity remains available, but sponge inventories have dropped and prices have firmed. "There is some concern about adequate supply of feedstock to the sponge producers," he said.



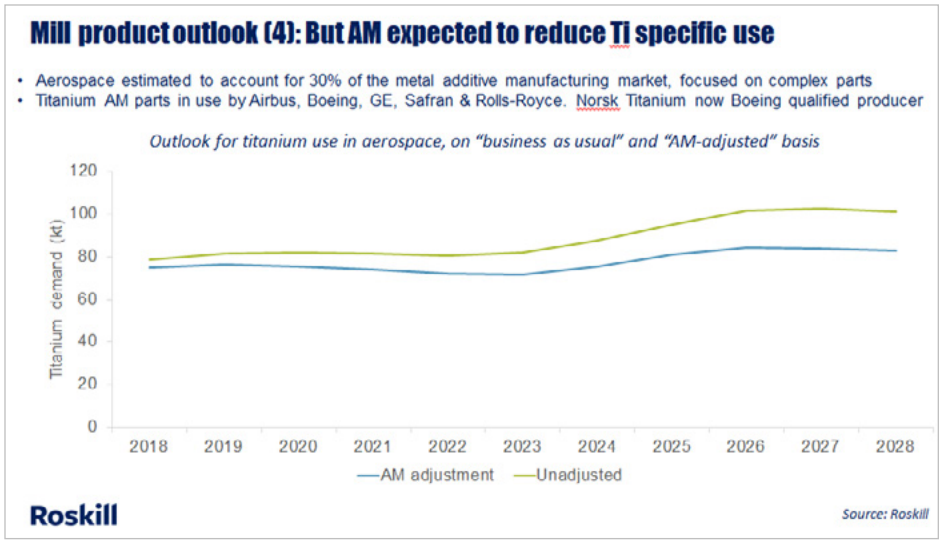
He said a major advantage in utilizing scrap in the titanium market is that the material is "an above-ground mine." Titanium and vanadium alloying units are readily available in scrap. "New mining operations are extremely expensive and require long lead times. Scrap comes to the market quickly and without the cost and risk of new mining operations. Scrap processors running at very high utilization rates. Current generation will require some increase in processing capacity."

Weighing the impact of recent tariffs on Chinese scrap titanium, he said a 10-percent tariff on all titanium scrap went into effect on September 24, 2018. "Tariffs will increase to 25 percent on January 1, 2019 without a new trade agreement."

Summarizing his presentation, Newman said the increase in scrap usage continues to be driven by availability and cost benefits, while trade disputes put a question mark on scrap imports to the United States. "Aircraft build rates continue at high rates increasing both supply and demand for scrap. Vanadium supply and pricing issues will put pressure on scrap. New scrap demand in Europe will change the flow of scrap. Low cost 30-percent ferro titanium should prevent major upward movement of ferro titanium prices from pressuring aerospace scrap prices."

Jessica Roberts, a manager with of Roskill, pondered the question: "What Will the Next Decade Bring" for titanium metal. Based on Roskill research, Roberts said that while there are challenges for the sector, next decade is projected to see reasonable growth.

Roberts said that titanium mill product demand is projected to grow at 2 percent per



year out to 2028, with industrial uses expected to perform strongly. Aerospace demand for titanium is expected to be impacted by growth of additive manufacturing and a larger share of models with lower titanium content. Aerospace is estimated to account for 30 percent of the metal additive manufacturing market, focused on the production of complex parts. She said commercial air framers have order backlogs representing around nine years of production, while jet engine deliveries forecast to grow 3 percent per year between 2018-2028. More than 5,000 military fighter aircraft are expected to be delivered between 2018-2028, led by the F-35 in the United States.

The availability of scrap for remelting is projected to decline, and more premium-grade sponge may be required. Premium-grade melted product capacity could require investments under "business as usual" aerospace titanium scenario. National policies present some risks to the sector. Russian sanctions and "no deal" Brexit are the main risks to titanium supply chains, while U.S./China tariffs are a risk to end-use markets such as aerospace.

Global Industrial Markets

Dr. Louis Pignotti, chief chemist, Kolene Corp., discussed "Molten Salt Cleaning of Titanium and Its Alloys: From Primary Metal Manufacturing to Finished Products." According to Pignotti, titanium and its alloys possess unique properties that present challenges for manufacturing. Molten salt is well suited to help with the surface preparation and cleaning (such as scale removal, paint stripping and dry lubricant removal) for many manufacturing processes associated with titanium.

Cleaning salts are composed of inorganic compounds that become liquid due to operating temperature (400-1200°F). They produce repeatable, consistent results even when supersaturated with reaction by-products and allow for the removal of by-products and addition of fresh chemicals allow for perpetual bath life.

Pignotti said molten salt bath systems should be custom engineered to meet production throughput, with robust, rugged designs provides a long service life. The systems should be fully hooded and ventilated and be energy efficient to compare favorably with conventional hot soak processes. Integrated handling systems can be manual or automated. The systems may require waste water treatment depending on alloys processed and local water discharge requirements.

The systems can be used for thermal coating and lubricant removal, paint stripping, and descaling of parts. "Salt bath cleaning can be used to remove a variety of surface contaminants," Pignotti said. "Salt bath cleaning provides efficient and economical processing of titanium parts."

Dr. Sungwook Kim, principal researcher at the Research Institute of the Industrial Science and Technology (RIST), provided insights on "Friction Stir Welding (FSW) of Ultra Fine Grained Titanium Plate." Kim said studies have been conducted to improve the strength of titanium by refinement of the grain size as means for further enhancing the physical properties. He presented information on FSW as a technology to consider for maintaining the metal's fine grain size.

According to findings from RIST, FSW welds of ultra-fine grained (UFG) titanium plate maintain the initial grain size of the base metal, and the FSW shielding box effectively shields oxygen more than local shielding. Regarding the mechanical properties of UFG titanium plate by FSW, there's uniform distribution of weld hardness (as indicated by a micro-hardness test), and the weld shows the tensile strength and elongation of over 90 percent of the base metal.

Dmytro Lazorkin, general director, Lazorkin Engineering LLC, presented a technical paper titled "High-Performance Technology and Equipment for Forging the Ingots and Blanks Made of Titanium Alloys and Specialty Steels, and Alloys Using Four Dies in Forging Presses." Lazorkin said a four-die forging device (FDFD) is a unique tool, which combines the advantages both of radial forging in radial forging machines (RFM) and conventional two-die forging method using a forging press.

Lazorkin said a FDFD consists of the lower and the upper cases, sliders, dies, and side guides. The lower case is rigidly secured to the press table. Prior to the start of the forging operation, the upper case is usually fixed to the movable cross-beam of the press. One die is fixed to the lower case, and remains stationary during the forging, while the other die is attached to the upper case, and always travels along with the press as it operates.

FDFD is used for the forging of ingots and the blanks made of all ferrous

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- Heat Treating
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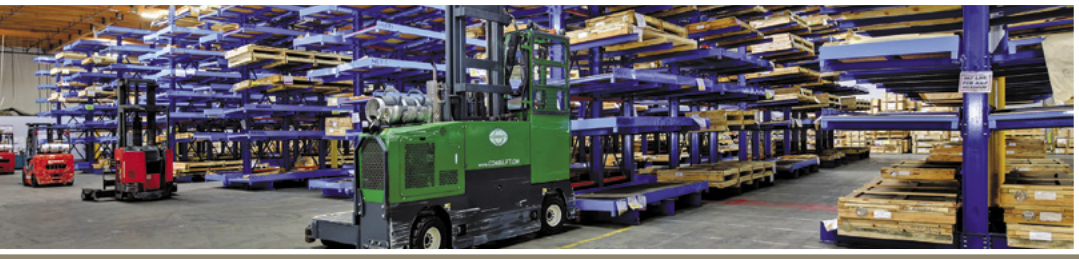

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materials, as well as for the forgings of non-ferrous materials, such as titanium, aluminum, titanium, nickel and copper based alloys. He said FDFD is a cost-effective alternative to RFM to ensure the production of forgings by four-die forging in the conventional forging presses, but with better metal quality and lower costs compared to RFMs.

Research and Analysis on Current Tariffs

Jeffrey Orenstein, a representative from the international law firm Reed Smith LLP, shared his thoughts on "Current Tariffs and Their Impact." Specifically, he analyzed the current situation of tariff battles between China and the United States.

Regarding the origin and overview of U.S. tariffs on Chinese imports, the authority for the tariffs falls under Section 301 of the Trade Act of 1974. The President ordered the office of the United States Trade Representative (USTR) to investigate whether China's practices related to technology were unreasonable or restricted U.S. commerce. The USTR team found that China's policies harmed the U.S. economy by at least $50 billion per year. In response to this, President Trump ordered 25-percent ad-valorem duties on certain Chinese-origin goods; initiated a World Trade Organization (WTO) case on China's licensing practices; and placed restrictions on Chinese investment aimed at obtaining key U.S. technologies.

The analysis for the "pro" side of these measures by the United States suggested that, because China engages in unfair trade practices, these tariffs may pressure China to make concessions. Domestic producers of covered products will benefit from a cost advantage. However, on the "con" side, Orenstein said that a tax or tariff on Chinese imports is effectively a tax on U.S. manufacturers that will, at a minimum, increase costs and likely cause job losses and other disruptions to U.S. industries. In addition, there is retaliation by China covering U.S. agricultural products, cars, aircraft, and high-tech industries, all of which hurts the ability of U.S. companies to compete both in the domestic market and abroad.

The likely impact of the tariffs would mean inevitably lead to higher prices for products that use titanium—a range that spans jet planes to medical implants, according to Orenstein. As a result, capital investments may decline and U.S. titanium producers may need to expand their operations.

Orenstein suggested strategies for coping with the current situation involving U.S. and Chinese tariffs:

- Confirm Applicability by making sure you have the right Harmonized Tariff Schedule (HTS) classification and country of origin
- Shifting Supply: In many cases, importers will shift to non-Chinese suppliers
- Passing On the Costs: If Chinese origin goods are the only option, the cost increase will typically get passed on to customers
- Absorbing the Costs: Companies that cannot pass-on the full 10 percent due to price competition may have to absorb some or all of the cost increase
- Stockpiling in a Bonded Warehouse: Delay payment of duties by keeping imported goods in a bonded warehouse. This has its own costs, but it is an option if: (1) payment at the time of entry is not practical: or (2) if you want to see if the tariff will be repealed (e.g., due to a trade deal or political change)
- Drawback: Goods manufactured with imported components subject to tariff may be eligible for "drawback" if the finished products are exported
- Product Exclusions: Product exclusion requests can be submitted by "interested persons," which would include various parties impacted by the tariffs, such as U.S. importers, U.S. manufacturers, consumers, brokers, and trade associations representing parties impacted by the tariffs.

Titanium in Medical Technology

Gene Kulesha of Onkos Surgical presented information on "a true industrial revolution" in the 3D printing of medical devices. Customized implants using titanium 3D printing have improved and the technology can support patient-specific printing, according to Kulesha. Titanium 3D printing for medical applications "has gone mainstream, but is still an untapped market. Regulatory agencies understand and embrace the technology."

He estimated that 3D printing of titanium medical devices registered $1 billion in 2017. "Demand is outpacing supply," he said. "There are few qualified contact manufacturers. Mass customization (of this market) is a maybe; clinical benefits must outweigh costs."

The global orthopedic device market was $52 billion in 2017, and the United States accounts for 50 percent of that market. Titanium accounts for up to 70 percent of hip, spine and trauma implants. He described 3D printed titanium knee implants as a "success story in the making;" a potential $4-billion market opportunity. Knee surgery, which requires numerous bone cuts and soft tissue manipulation, is more complex than hip surgery, he said.

Prabhu Gubbi, Ph.D., a technical specialist and scheme manager with BSI Group America reported on "Medical Device Regulatory Changes in Europe." BSI, a global company, with 81,000 clients in 180 countries, is involved in certification, consulting, and standards-related products and services. Gubbi said regulatory changes include classification rules (Annex VIII), conformity assessment (Annex IX to XI), general safety and performance (Annex I), technical file documentation (Annex II), risk management and clinical evidence.

Gubbi said that, for dealing with medical device regulatory changes, BSI helps customers bring their medical device products to market. "We ensure patient safety while supporting timely access to medical device technology

globally. "We provide our customers with conformity assessments, evaluations and certifications that are recognized and accepted worldwide. We provide added value to customers through information, training, knowledge and management systems solutions to anticipate, maintain and exceed compliance with internal and external requirements."

Mathew Thoppil, Ph.D., associate professor, Cedric W. Blazer endowed professors in biomedical science, addressed "Tribocorrosion Aspects of Titanium-Based Biomedical Implants: Current Concerns and New Directions." Thoppil said that the U.S. Center for Disease Control has estimated 78 million people will suffer from arthritis by the year 2040. "Titanium is widely used in hip and other joint replacement surgeries such as shoulder, elbow or knee or spinal fixation devices and in dentistry applications."

Thoppil defined tribocorrosion as an irreversible transformation of material in tribological contact caused by simultaneous physicochemical and mechanicals surface interactions. "Upon implantation, electrochemical interactions are induced by corrosion between the implant materials. As a result, complications like pitting, fretting, galvanic corrosion, and stress corrosion occur. Implant failure has been also associated with several other causes, such as infections in the implanted area, mechanical loosening, bone resorption, and an increase in time taken for osseointegration to occur apart from the fibrous tissue formation."

Thoppil's study also examined micro-arc oxidation and plasma electrolytic oxidation for titanium implants, as well as titanium nanotube corrosion resistance. He concluded that further research is needed to develop new surface coatings and modification methods to minimize tribocorrosion.

Powder Metallurgy

Art Kracke, the president of AAK Consulting LLC, presented "Titanium Alloy Powder: Accelerating Demand for Years to Come," reviewing the differing processes for producing titanium alloy powder metals and the size and growth rate of the titanium alloy powder market. Key end-use markets include biomedical, aerospace, automotive, industrial and consumer.

Kracke said that additive manufacturing, enabled by titanium powder metals, is developing innovations that lower cost while improving part performance and shortening development and production cycle-times.

Lower cost and improved performance will drive growth titanium alloy powder and advanced manufacturing, according to Kracke. This will be accomplished by: melt-free continuously produced powder alloys; continued developments in additive manufacturing; and interest for metal injection molding and compaction technology applications.

He mentioned two recent titanium alloy powder development facilities in Australia. The first, a 16,000 sq. ft. research and development pilot plant in Melbourne, is engaged in new alloy development, such as TiAl, and titanium 6/4 customer evaluations and qualifications. Meanwhile, a 16,000 sq. ft. production plant in Perth, with a production capacity of 200 metric tons per year, is slated to be commissioned by mid-2019, and will focus on titanium 6/4 and extra low interstitials 6/4.

A presentation by Dr. Sergey Prikhodko, a professor at the University of California, Los Angeles, explored the "Structure and Mechanical Behavior of Titanium Based Multi-Layered Materials Fabricated by Blended Elemental Powder Metallurgy for Anti-Ballistic Applications."

Prikhodko explained that anti-ballistic protection of the land systems mobility and protection of the fighting vehicles and military personnel is paramount in the success of defense and anti-terrorist operations. "The two most important anti-ballistic properties of the armor are penetration and fragmentation. Those require high hardness and strength from armor to eliminate sharpening effect of projectile as well as sufficient ductility in order to stop armor fragmentation. Traditional armor material is rolled homogeneous steel. However, steel armor can increase the overall weight of combat vehicle on about 15-20 percent. That causes reduction in mobility, maneuverability, fuel efficiency, and requires stronger suspension, brakes, and more powerful engines."

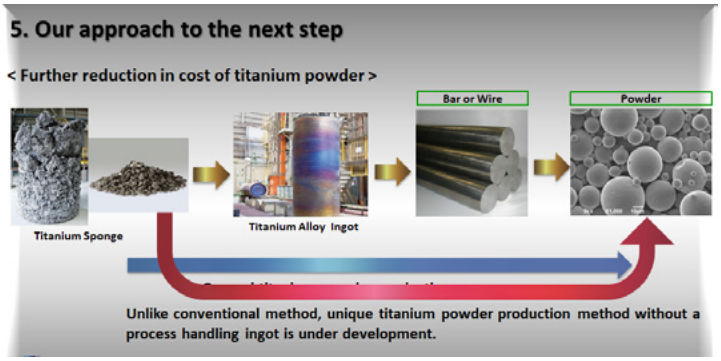
He said the Army is in search of alternative lightweight materials for armor "and titanium is very attractive material in this list. Titanium alloys have a high mass efficiency compared to steel and aluminum. They have an excellent corrosion resistance. Titanium alloys are readily fabricated in existing production facilities and are easily recycled. The only disadvantage of titanium-based armor is its high cost compare to steel

and aluminum when produced using traditional ingot technology." Due to the high specific strength of titanium, materials on its base are considered viable alternatives for low-weight armor. However, the feasibility of implementation is questionable when the armor parts are fabricated using traditional and pricy ingot and wrought technology.

Prikhodko suggested a more cost-efficient process of producing armor parts, using blended elemental powder metallurgy (BEPM) of titanium-base materials and multi-layered structures. He said that test results indicated that large, layered structures of titanium 6/4 alloy and metal matrix composites (MMCs) were successfully fabricated using the BEPM die-pressing protocol. "Sintered materials were characterized with uniform structure and composition within each layer and complete integration between the layers. During BEPM processing the shrinkage levels of the base alloy and MMC are similar, enabling the successful fabrication of multi-layered structures without need for optimization of the sintering processing parameters for relatively large plates. Multi-layered plates fabricated in the course of this study using BEPM were successfully tested for anti-ballistic application."

S.J. Oosthuizen of CSIR Titanium Centre of Competence offered an update on the "Development of a Continuous Titanium Powder Production Process." Oosthuizen said CSIR (South Africa's Council for Scientific and Industrial Research) was tasked to develop a novel process for non-melt powder with cost advantages. In 2007 CSIR began research and development into: primary processes for metal production; powder metallurgy; titanium investment casting; and additive manufacturing with Aeroswift, one of the world's largest titanium powder 3D printers.

CSIR's goal was to develop a novel process that offered competitive advantages as a continuous process with non-melt powder, water leach vs. vacuum distillation (with no entrapped/adhered chloride), and direct alloy production. A continuous powder process, conceived in 2012, was demonstrated in a plant commissioned in 2014 as the "Continuous Stirred Tank Reactor" system with molten salt pumps, according to Oosthuizen. The CSIR process for continuous titanium powder encompassed powder produced in a stoichiometric ratio of TiCl4 to reducing metal; powder was suspended in molten salt by-product. Product slurry is pumped from reactor and cools under argon. Frozen salt with powder water leached and dried for packaging. Depending on process parameters, the powder can be "spongy" or crystalline.



Oosthuizen listed the perceived process benefits of the technology: continuous process vs. industry standard batch process; independent techno-economics studies, with the potential to match Kroll sponge production; the potential for heat recovery/energy generation from exothermic reaction; and the potential to tailor particle size, produce alloys or coat particles/powders with titanium.

Benedikt Blitz, managing director, SMR Premium GmbH, provided an "Update on Forged Special Steels, Remelting and Powder Metallurgy." Blitz's presentation highlighted recent developments in the world of forged special steels and remelted steels (nickel alloys, stainless steel, alloy tool steel and alloy steel) and gave an overview about end-user demand and structures of these special steels and also summarize the actual status of installations (forging presses and remelting units) on a global scale. He also focused on the production of metal powders and powder metallurgical steels and associated production technologies like metal injection molding.

Nobuhiro Arimoto, general manager, High-Performance Materials Department of OSAKA Titanium Technologies Co., Ltd., discussed "The Superiority of Our Integrated Production from Titanium Sponge to Titanium Powder for Additive Manufacturing." Arimoto said his company's approach involves full control of "integrated production from material to titanium powder," adding that oxygen content is an important variable to manage.

OSAKA is building a new $10-million plant dedicated to titanium alloy powder, Arimoto stated. The facility will have a production capacity of 100 metric tons per year and is slated to go online by the year 2020. He said that, unlike conventional methods, the OSAKA titanium powder production method will go from sponge to alloy powder, bypassing the typical intermediate steps of producing an ingot and bars, which is expected to reduce the overall cost of the titanium powder.

In summary, Arimoto said that as a titanium sponge manufacturer, OSAKA tackles "varied issues to supply products stably to the growing market and to meet customer needs by utilizing the new plant as well as the superiority of our integrated production processes for titanium powder."

Global Titanium Market Economic Drivers

Bank of America Merrill Lynch (BAML) research analyst Ronald J. Epstein provided an outlook on economic trends in the aerospace industry, examining the evolving titanium global supply chain, the Airbus and Boeing

duopoly, and plans to ramp up single-aisle aircraft deliveries. Epstein said BAML forecasts that combined deliveries for civilian aircraft, which includes large planes from Boeing and Airbus and regional jets from Bombardier and Embraer, will reach 2,095 aircraft in 2022, up from an estimated total of 1,736 in 2018.

Quoted in a separate press release, Epstein said global air traffic growth has remained strong between 6.5-7 percent so far in 2018. This falls within similar rates to the last 10 years but beats previous long-term estimates of 4.8 percent. As a result, airlines are expected to maintain strong order books to meet the sustained demand growth. He also noted that aircraft retirement peaked in 2013 at 3.5 percent of the total fleet. High oil prices and low interest rates drove airlines to retire more aircraft during that year, according to Epstein. This in turn injected serviceable use spare parts into the market, competing with new parts for aftermarket sales. Lower oil prices brought the retirement rate below 2 percent in 2017.

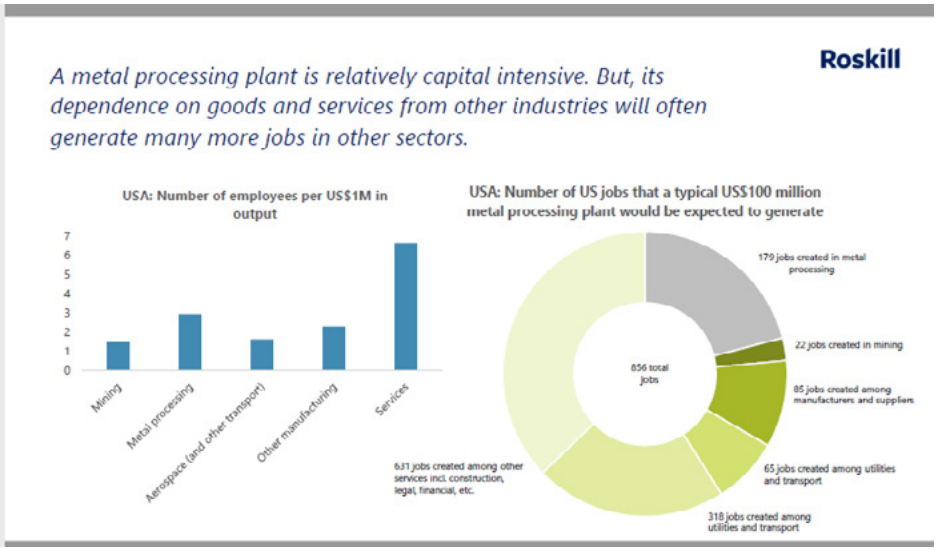
Thomas Hohne-Sparborth, director, economics and analytics, Roskill Information Services, analyzed "The Socio-Economic Impact of Metal Industries and Implications for Titanium." In his opening remarks, Hohne-Sparborth said the main purpose of his presentation was to "identify the socio-economic benefits created throughout the value chain and product lifecycle" of the metals industry.

He began by citing four bullet-point questions:

- Production: How many jobs depend directly on the mining and processing of cobalt, nickel or titanium?
- Usage: To what extend do downstream sectors depend on the use of these metals?
- Indirect: How much further activity is created among suppliers of energy, inputs, transport and services?
- Economic growth: How do such metals and their usage contribute to research, investment, revenue and tax income?

Hohne-Sparborth said that the socio-economic effects include direct effects from the titanium value chain (mineral mining, metal production, first use and end use, and recycling), as well as indirect effects from supporting industries (energy, transport, legal/financial, and chemical processing) and consumer spending.

"Mineral and metal processing industries contribute to local economies in a variety of ways, from generating employment, to research and development, and tax income," he said. He added that indirect effects take into consideration the requirements of metal industries for inputs from supporting industries, as well as income effects. Metal producers and suppliers will themselves trigger further demand for energy, chemical and transportation. "A metal processing plant is relatively capital intensive, but its dependence on goods and services from other industries will often generate many more jobs in other sectors."

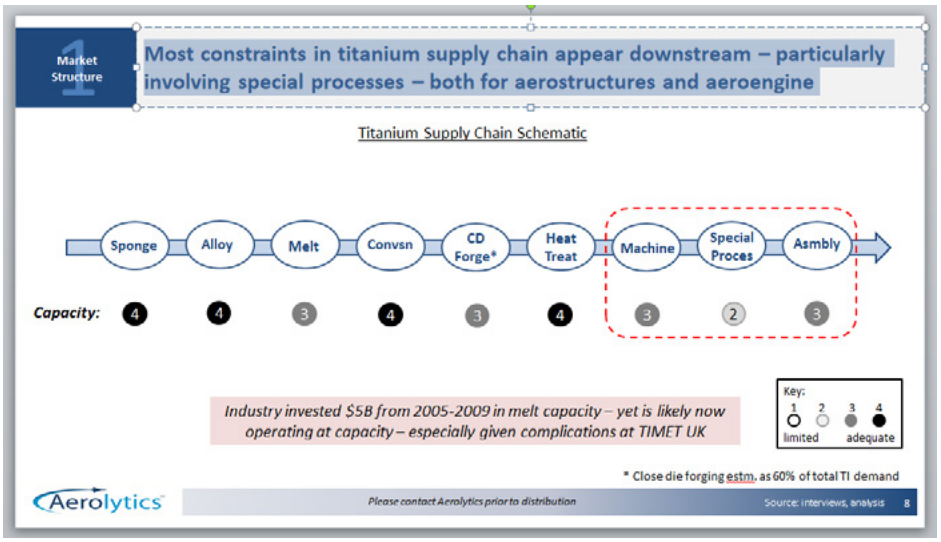


"Attributing socio-economic effects among downstream industries depends on the calculation of allocation factors for metals such as titanium," he said. He used a chart to illustrate the allocation factors of titanium in American aerospace manufacturing. He estimated that 30,000 metric tons of titanium is used for aerospace in the United States. It has a "back-of-the-envelope" value of $1 billion (in 2018, based on titanium 6/4 prices). The total value of aerospace manufacturing in the United States in 2018 is about $227 billion.

For his summary, Hohne-Sparborth noted that, for capital-intensive business sectors such as mining, metal processing and aerospace, "indirect effects often dramatically outweigh the 'on-site' effects on employment and other socio-economic indicators."

Bill Bihlman, president, Aerolytics LLC, discussed "Manufacturing's Evolution and Its Impact on Titanium for Aerospace." Bihlman said that, during past two decades, aerospace has experienced a shift in materials and associated manufacturing methods. Aircraft material evolution has shifted to carbon composites in the fuselage, engine and wing, with titanium being used for landing gear.

He said advances in CNC machining have changed traditional approaches to manufacturing components, with a "key enabler" being five-axis CNC machining. In aerostructures, there has been a movement towards larger "monolithic" structures to reduce part count and weight. For engines, the trend is towards increased machined tolerances for components for greater operational efficiency. In both categories, there is as



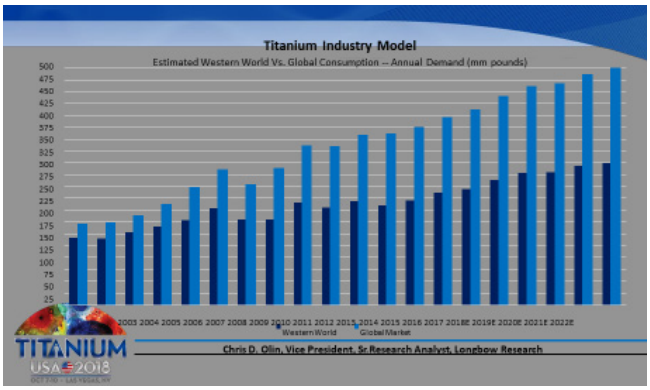
move toward near-net-shape technology for hard alloys that are difficult to machine.

Bihlman said automation has three basic subcategories, the most prominent of which is carbon fiber placement. Automated tape laying or fiber placement is the most prominent area of automation. The second most significant is robotic drilling and fastening for metallic structures. The third area is small scale with automated pallet systems and robotic CNC tool exchange.

Among his other observations, Bihlman said most constraints in titanium supply chain appear downstream, particularly involving special processes, both for aerospace structures and engines, while digital connectivity is impacting most areas of manufacturing, with varying degrees of success. In addition, he noted that laser fabrication (drilling, welding and cutting) is becoming increasingly more common in aerospace due to its high precision.

Christopher Olin, vice president, senior research analyst, Longbow Research, presented a titanium market update and a demand forecast, wondering if there is "real turbulence or just noise" in the industry. Longbow Research provides quarterly updates on various metal and aerospace markets (including specialty materials) through proprietary survey work and industry analysis.

According to Olin, the titanium market "is still strong. Titanium is within the 'sweet spot' of global demand, driving restored distributor/mill confidence and pricing leverage. Industry growth is back to the healthiest level we have seen since 2011—up 6-7 percent globally and 8-9 percent for the Western World. Our industry model is showing 5-6 percent global demand growth potential in 2019, supported by steady aerospace demand and favorable industrial and energy activity. Aero inventory could be too long heading into next year's 737/A320 production ramp. Titanium sponge and melt operating rates should start moving higher."



Along with the upbeat forecast, Olin did acknowledge that there is "quite a bit of noise in the titanium market," and listed these five factors as the source of the noise:

1. Rolls-Royce and Pratt & Whitney seeing another round of engine performance challenges
2. We believe there is too much inventory in the aerospace channel (parked fuselages)
3. China growth is likely to slow due to trade uncertainties with the United States
4. Rising interest rates
5. GE still having problems with its gas turbine business.

Overall, the Longbow 2018 forecast for Western World titanium demand is 260 million to 265 million pounds, with global demand seen at 435 million to 440 million pounds. He pointed out that Longbow lowered its 2019 outlook by one point (globally) to 5-6 percent. "This is the first time we lowered expectations (the one-point drop for the 2019 outlook) in two to three years," Olin said. "Still it's a good year, but we are looking for a bumpy one to two quarters."

Glenn McDonald, senior associate, AeroDynamic Advisory, examined "Aerospace Supply Chain Trends: Implications for Titanium." McDonald said three key factors that will shape aerospace demand for titanium during the next 10 years will be: Boeing's proposed New Middle of the Market (NMA) jet; supply chain bottlenecks; and geopolitics.

He said AeroDynamic expects the Boeing program to be launched in 2019, with a potential EIS (entry into service) by 2026. According to a June 20, 2018 online report by ainonline.com, Boeing is now in talks with more than 60 airlines to develop the right configuration for the NMA jet. The report said the NMA "is envisioned to carry 220 to 270 passengers and have a range of 5,000 nautical miles." The report also quoted a Boeing executive, who said the aerospace giant

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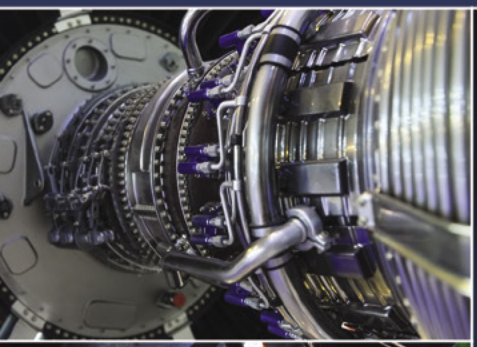

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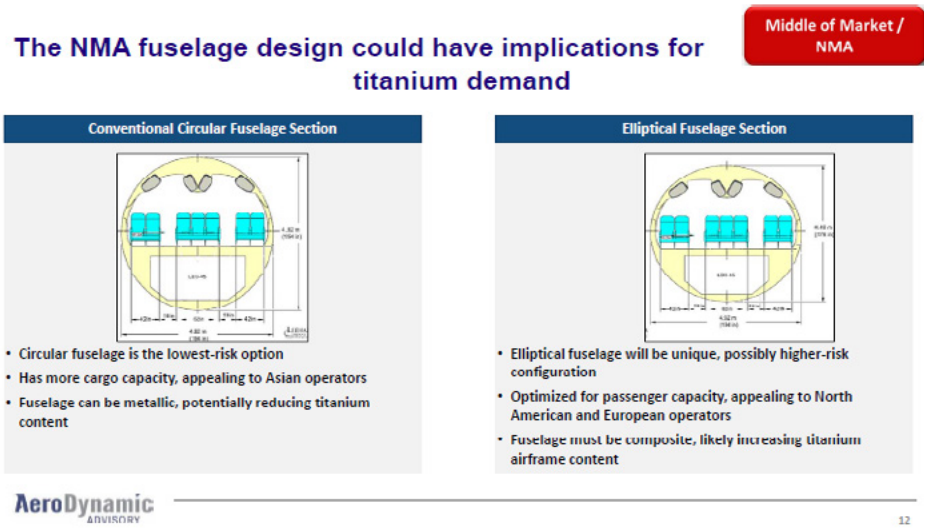


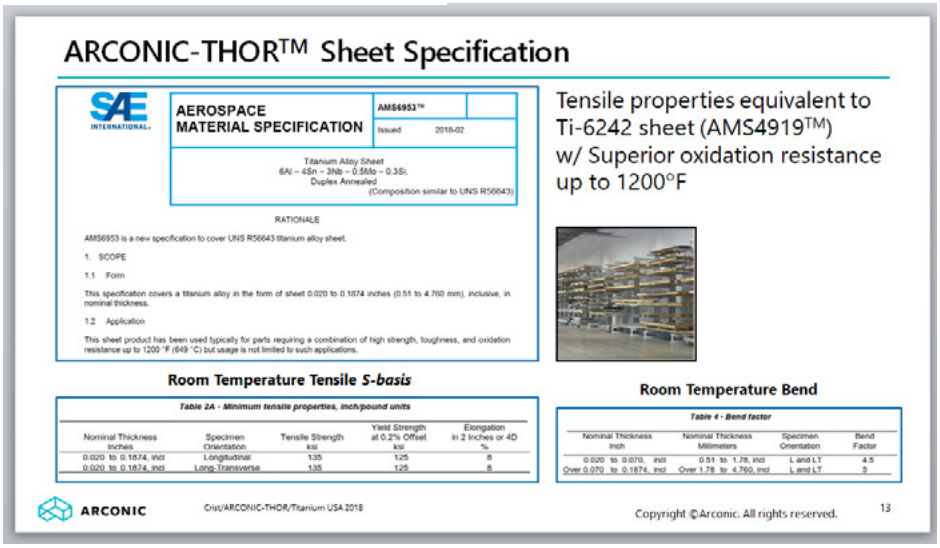
is "working on several aspects (of the NMA jet), like the life-cycle cost of the airplane and the supply chain, not just range or capacity. We want to make a revolutionary airplane."

McDonald said the NMA fuselage design could have implications for titanium demand, and that several engine suppliers already have submitted bids for the NMA platform. As for supply-chain bottlenecks, he said investment casting shortages, especially for turbine blades, have "hit engine OEMs hard." Forgings also are experiencing a host of issues. Geopolitical issues, such as trade sanctions, also may disrupt the global titanium supply chain. McDonald noted that, following the recent U.S. sanctions on Russian aluminum, aluminum prices spiked. In response, Russia threatened to cut off titanium supplies to the United States.

Aerospace

Ernie Crist of Arconic explored the "Improvements in Oxidation Resistance; A New Titanium Alloy for Aerospace Applications." Crist said the alloy known as ARCONIC-THOR™ provides superior oxidation resistance up to 1200 F and is lighter than alternatives to nickel superalloys.

Crist explained that fuel efficient jet engines provide enabling capabilities, with higher efficiency and reduced fuel burn. However, hotter engines also present structural challenge to adjacent systems such as pylons, nacelles, heat shields, plugs, and nozzles. As a result, temperature requirements exceed the current capabilities of titanium.



To meet the requirements, Arconic has introduced ARCONIC-THOR™; a 50-percent lighter conventional titanium alloy to nickel superalloys for next-generation aerospace systems, providing significant cost savings and fuel efficiency. Crist said superior oxidation resistant properties enable ARCONIC-THOR™ to operate at service temperatures 200°F higher than the current state-of-the-art titanium alloys. Arconic has completed successful development projects with commercial aerospace and defense customers, including the U.S. Air Force, Boeing and Honeywell.

Keith Fleming of investment casting system supplier Feinguss Blank reviewed "The Difference Between Know-How and Know-Why on a TiAl (Titanium Aluminide) Application." He listed the advantages of TiAl (lightweight, heat resistant, good strength) versus the disadvantages (expensive, difficult to cast and machine, and not weldable). In order to achieve successful results, TiAl applications require clean, proper wax, proofed dry time, exact casting parameters and non-reactive ceramics.

Daniel Finkeldei, scientific assistant, TUWien (Technische Universitat Wien), discussed the "Analysis of Chip Formation in Machining Nickel Based and Gamma Titanium Alloys." Chip formation is a primary indicator to analyze the surface quality of machined workpieces, according to Finkeldei. He said that while chip formation and surface quality are discussed in several studies in machining nickel based alloys, only a few investigations have been made in machining brittle/hard gamma TiAl. He provided results of an examination of TiAl chip formation through the use of a high-speed camera.

Mark Tomlinson, managing director, Metalysis Ltd., in a presentation titled "Metalysis: the Lab to Factory Journey," recapped the process to develop a promising laboratory experiment into a commercial reality. Since Metalysis was

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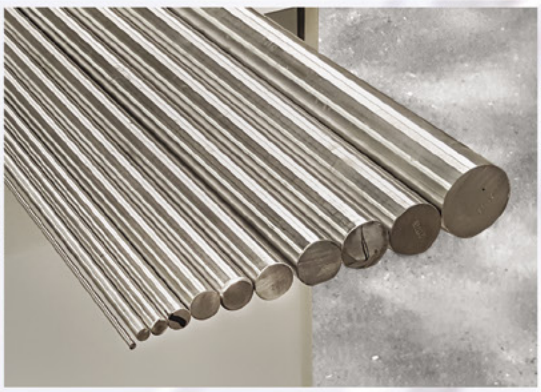

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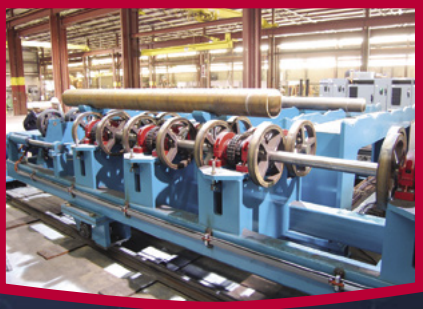

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established in 2005, the technology has been developed from a promising proof-of-concept to a true industrial process, according to Tomlinson. Plans in 2019 call for a Metalysis facility capable of delivering up to 1,000 metric tons of "distributed production" of titanium alloys suitable for aerospace, automotive and biomedical applications.

The Metalysis process involves electrochemical engineering, where electrons are used to remove oxygen from a range of metal oxides to create metals, alloys or intermetallics, all of which are suitable for a wide range of end-user applications in aerospace, automotive and advanced manufacturing.

Charles Young, metallurgist and business development manager for Tricor Metals, reviewed his company's role in the development and construction of NASA's Parker Solar Probe. The probe's titanium truss structure assembly (TSA) was built at Tricor's Wooster, OH, facility. The Applied Physics Lab of Johns Hopkins University designed, built and managed the overall solar probe project.

Young said Tricor's original design for truss structure used titanium Grade 9 tubes and titanium Grade 5 bars, but during 12-month design discussions Tricor decided to change the design to all titanium Grade 5. The titanium truss structure assembly weighed 55 pounds, with a height of nearly 48 inches, a top diameter of 70 inches and a bottom diameter of 40.7 inches. Tricor's fabrication process included five-axis CNC machining, drilling and tapping; chemical milling for tubes; hand TIG welding with an argon shield; and a FARO® 3D coordinate measuring machine.

NASA's Parker Solar Probe is named in honor of Eugene N. Parker, Ph.D., a former professor at the University of Chicago, who predicted the existence of solar winds in 1958. NASA launched the probe on Aug. 12, 2018, from Cape Canaveral Air Force Station, FL. It will travel through the Sun's atmosphere, providing the closest-ever observations of a star, according to NASA officials. Flying into the outermost part of the Sun's atmosphere, known as the corona, the probe will gather information to determine the origin and evolution of the solar wind.

Poster Sessions

TITANIUM USA 2018 featured five poster sessions from university research students. The list of poster-session scholars included Dinh Nguyen, Phi-Ho Lee1, Kyunghee Park, Yang Guo, and Patrick Kwon, from the Department of Mechanical Engineering at Michigan State University and the Korean Institute of Industry Technology; Sharoo Shrestha from Oregon State University's School of Civil and Construction Engineering; and Yang Xia, Ying Zhang, Pei Sun, James Paramore, Matthew Dustan and Mark Koopman of the University of Utah's Department of Metallurgical Engineering. The poster sessions focused on research to enhance titanium powder metallurgy, lubricants for cutting tools, and seismic retrofits of concrete bridge columns using titanium alloy bars.

Copies of the published posters along with video proceedings and slides from TITANIUM presenters are all available in the Events section of the ITA Website https://titanium.org/page/TiUSA18Proceedings. ■

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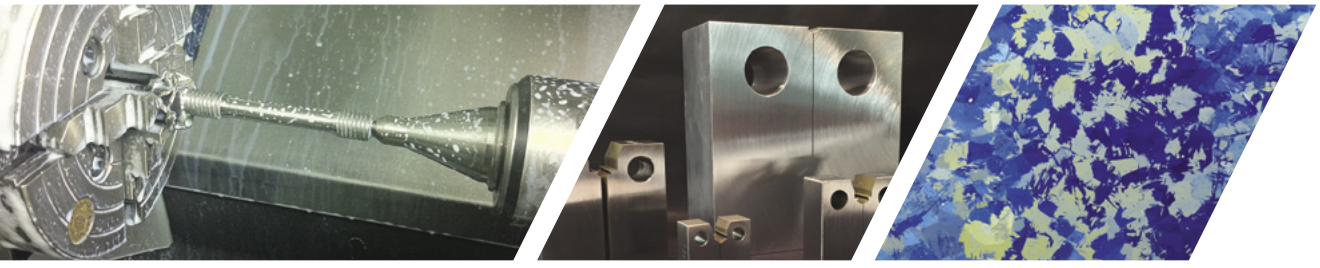

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A stay at the Hotel Savoyen Vienna is bound to be unforgettable – just like its namesake, Prince Eugene of Savoy. The hotel effortlessly combines old and new, occupying a revitalized building that was once home to the imperial Austrian state and court print works.

Organized industry tours include:

Borealis AG Europe's second and world`s eighth largest producer of polyethylene (PE) and with the acquisition of Agrolinz Melamine International (AMI), the company is expanding its product portfolio to include melamine and fertilizer. The tour will be hosted through a bus excursion and includes a general overview of Chemiepark Linz and Borealis Linz.

Rolling Mill Tour of BÖHLER. voestalpine BÖHLER Bleche GmbH & Co KG is a producer of single cross rolled sheets and plates of steel and special alloys. The product range varies from tool and high speed steel to special materials for the energy, oil & gas and aerospace industry. Within the special material segment super austenitic and super duplex steels with high demands on corrosion and heat resistance, nickel and nickel base alloys for even higher demands and titanium and titanium alloys are manufactured. voestalpine BÖHLER Bleche manufactures according the latest technological standards and has recently invested in state of the art rolling, heat treatment and flattening equipment, including a vacuum creep flattening machine. The tour will include both mill sites, the rolling and the finishing mill, where all manufacturing steps from heat treatment, cutting, quality control, flattening and surface finishing are performed.

Mobile Convention Center, Alabama USA

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Download Conference Brochure Here

ITA's 35th anniversary meeting, hosted and organized by the International Titanium Association (ITA). TITANIUM USA 2019 will be held at the SMG Mobile Convention Center in Alabama. Presentations will host a variety of topics including world titanium supply & demand trends; powder metallurgy / additive manufacturing; commercial aerospace; medical; and the 2nd anTi Corrosion day will be dedicated to topics serving the global industrial markets.

Industry Related Tours:

Just minutes from the Convention Center is Airbus Mobile, an **assembly site for Airbus's Commercial Airplanes** division. The site is the major assembly and delivery site for Airbus commercial aircraft in the United States and will be one of the largest employment centers in the state. The site will serve as one of four final assembly and delivery points for the Airbus A320 family. Aircraft will be delivered as a whole from the Mobile Aeroplex at Brookley surrounding the Airbus facility. Special Thanks to Airbus SAS for making this tour possible.

Tuesday Evening Tour & Dinner will be offered at the USS Alabama Memorial Park. USS Alabama (BB-60), a South Dakota-class battleship, was the sixth ship of the United States Navy named after the US state of Alabama.

Alabama was commissioned in 1942 and served in World War II in the Atlantic and Pacific theaters. Alabama was decommissioned on 9 January 1947 and placed in the reserve fleet in Puget Sound Naval Shipyard Bremerton, Washington. Visitors are allowed to view the inside of the main gun turrets and anti-aircraft guns. The powder magazine was opened to the public through some holes that were cut, and stairs put in.

In conjunction with the Singapore Air Show Singapore ITA is pleased to host the 2nd TITANIUM ASIA conference in Singapore at the Grand Hyatt Singapore hotel.

Exhibition Reservations are available now

Download TITANIUM ASIA 2018 Executive Summary Report

TITANIUM ASIA 2018 Conference Video Proceedings

Based just outside of Denver, Colorado, the ITA (Titanium.org), is a membership-based international trade association dedicated to the titanium metal industry. Current ITA membership is comprised of more than 200 organizations and over 1,500 individual members worldwide. Established in 1984, the ITA's main mission is to connect the public interested in using titanium with specialists from across the globe who may offer sales and technical assistance.

ITA educates engineers, designers and business executives on titanium's superior properties and explains how those properties may be developed to enhance products and services. The organization also strives to advance ideas in research, design, metallurgy and engineering, and serve as the leading forum to cultivate the exchange of ideas and support a diverse, dynamic, global industry.

The executive summary report was developed by Michael Gabriele, an independent freelance writer on behalf of the International Titanium Association (ITA) and is intended to provide a broad overview of the event. The summary provided is based on the information interpreted, but is not intended to be either exhaustive or inclusive of all announcements or information provided at the event.

Retirement

Ian S Hodges

Managing Director, TIMET UK Limited

Hodges began his career at TIMET in the late 1970's focused mainly on the development of Titanium for Chemical and Process Industry applications before specializing in Aerospace applications. He was appointed Managing Director in 2005 in addition to his European Sales and Marketing responsibilities.

Hodges recently retired as Chairman of the ADS Aerospace Members Committee the UK Aerospace Industry's Trade Association. He was also a key member of the Aerospace Growth Partnership (AGP) team that successfully secured support to develop the future of the UK's Aerospace Industry.

Work Anniversaries:

Randy Roberts 30 years at Allegheny Technologies

Kalai Arasu 13 years at Perfect Technology (S) Pte Ltd / PT Perfect Precision Engineering

Rigoberto Vazquez 1 year at Sunland Aerospace Fasteners

Rodney Sheets 5 years at Carlton Forge Works

Jud Parker 17 years at Duncan Press, Inc.

Michael Green 1 year at Dominion Metallurgical

Sergio Martin 7 years at Delta Heat Treat

Nikolay Gushevilov 3 years at Metallo Chimique NV

Steven Wilson 13 years at Crescent Manufacturing

Dmitry Gromovich 21 years at VSMPO-AVISMA

Career Announcements:

Michele Ricks Purchasing Agent-Boeing Commercial Aircraft at LMI Aerospace - A Member of the Sonaca Group

Dr. Hajo Drees, MBA CEO at Berlin Institute Supply Chain Management

Craig Sullivan President at A.D. Tubi USA, Inc.

Ross Miles Commodity Trader at Viant Commodities

Lawrence Buhl President at Elmet Targets

In Memorium:

Dave Warren

Director Special Projects
Retech Systems LLC

Passed away on September 17, 2018 from a long battle with disease.

Matthew J. Donachie Jr.,

85, of Winchester, passed away on Oct. 22, 2018.

Matthew graduated from Holyoke High School in 1950. He was a graduate of Rensselaer Polytechnic Institute with a Bachelor of Science in metallurgical engineering and attended Massachusetts Institute of Technology, where he earned his Sc.D. During his time at MIT, he met the love of his life, Martha Gaines, and they married in 1955 while he was still in school. Matthew and Martha eventually moved to Manchester, Conn., where they raised their four children. Matthew was an accomplished metallurgist who worked for Pratt and Whitney Aircraft for more than 30 years. He was an adjunct professor at the Rensselaer Polytechnic Institute Graduate Center in Hartford, Conn., for 55 years. Matt was passionate about providing information to people, and he found great pleasure and reward in teaching, staying in touch with many students later in life. As an accomplished metallurgist, he published several papers and books on metallurgy.

He was especially proud of his book "Titanium, a Technical Guide" that has been a principle information book on titanium for years. Matthew was a longtime member of ASM International (American Society for Metals) and became a Fellow of ASM in 1989.

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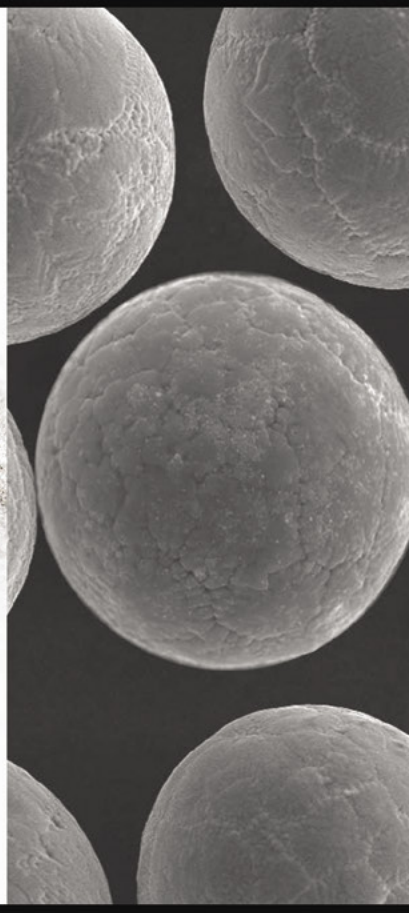

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International Titanium Association Welcome New Members 2018

Flowserve
www.flowserve.com

The Flowserve Corporation is an American multinational corporation and one of the largest suppliers of industrial and environmental machinery such as pumps, valves, end face mechanical seals, automation, and services to the power, oil, gas, chemical and other industries. Headquartered in Irving, Texas, which is a suburb of Dallas, Texas, Flowserve has over 19,000 employees in more than 60 countries. Flowserve sells products and offers aftermarket services to engineering and construction firms, original equipment manufacturers, distributors and end users. The Flowserve brand name originated in 1997 with a merger of BW/IP and Durco International.

GKN Hoeganaes Corporation
http://www.gkngroup.com/hoeganaes/pages/default.aspx

Hoeganaes Corporation is the world leader in the development and production of atomized metal powders. We span the globe with facilities in the Americas, Europe and Asia.

Hangzhou King Titanium

King Titanium is an intermediate manufacturer and full-service distributor of premium titanium mill products. We specialize in supplying titanium mill products to machine shops, fabricators, prime contractors and subcontractors for aerospace, automotive, chemical, medical, oceanographic, oil & gas, semiconductor, recreational and other industries worldwide

Hankook Titanium Co., Ltd

www.titanium.co.kr

International purchaser of Minerals, Chemicals & Metals. 3,730 Employees.

KMML
www.kmml.com

Manufacturer of Titanium Sponge, TiO2 pigment, Zircon, Rutile, Sillimanite etc. The Kerala Minerals and Metals Limited (KMML) is a flagship public sector unit under the state ownership, currently engaged in the manufacture of TiO2 pigment through chloride route, Ti sponge, Zircon, Sillimanite etc. Normally in India, the Titanium Metal is produced only by the Government Organizations. Ti sponge produced at KMML is further processed at MIDHANI (Mishradhathu Nigam Limited), Hyderabad, a central public sector organization handling some of the strategic materials in the country.

Kocks Pittsburgh Company

http://www.kocks.de/en/company/locations/pittsburgh/

For KOCKS innovation is a part of tradition. Innovation was at the beginning of the company's history with the idea of applying the 3-roll technology to forming tube as well as wire rod and bar. To date it determines the development of the company. To follow new avenues and to continuously optimize what seems to be perfect – this tradition keeps the company young and thrills our customers.

KOS, LTD.
www.koswire.com

Our company, KOS Ltd. started producing stainless steel rope on 1969. For almost 50 years' experience, nowadays KOS Ltd. is one of the top company on manufacturing high quality stainless steel wire and rope. For the last 10 years, business was expanded to superalloy to answer the demand from our customers in domestic and abroad.

To answer the serious global competition, now we are focusing on manufacturing Titanium Bar and Wire. This project has been started several years ago and it is almost done. Our big target is to supply high quality product and service to meet the optimal delivery time.

We have unique technology to save production cost including manufacturing strategy. We have special furnace, centerless grinding, precision straightening machinery and production area only for Titanium manufacturing.

KOS Ltd. takes a step closer to consumable, medical and aerospace titanium market.

Matmatch GmbH
https://matmatch.com

Matmatch is an online platform that helps product designers and engineers to find, evaluate and source materials. With a database of thousands of materials, an intuitive search tool, and supplier listings, it changes the way product teams find materials for their products. For material suppliers, we offer a new way to reach customers online. As a go-to source of information for engineers, Matmatch is the perfect platform for suppliers to raise awareness of their products and brand. We offer insights, analytics and opportunities to promote their expertise.

Nooter Construction

http://nooterconstruction.com

Serving the refinery, chemical, power and other industries for over 100 years.

Precision Metal Grinding LLC
http://www.pmgrinding.net/

Precision Metal Grinding is a grinding service company that supports the aerospace and medical industry. Providing the highest quality of surface finishes for critical applications (Ra and Rz). Capable of machining thin sheet (minimum: 0.008") and thick plate (maximum: 6.00") up to 78.00" wide x 230.00" long. Precision Metal Grinding offers a standard thickness tolerance of +/- 0.001" and can provide +/- 0.0005" upon request. Our standard practices ensure consistency over large orders and from batch-to-batch. With years of experience under our belt, we are capable of machining Titanium, Stainless Steel, Aluminum, Nickel-base Alloys, Magnesium, Cobalt-base Alloys, Zirconium and others.

Contact us with your unique requirements today.

SES, LLC
www.seseng.com

SES is a leading supplier of equipment and services for the metals industry. SES handles projects ranging from small specialty items to major capital expansions, as well as redesign/rebuild of existing equipment. Our strategic partnership with Daisho Seiki Corp, Japan, has broadened our ability to supply Bar Turning and Burnishing Technology to the North American Market. Capabilities include complete supply of Turning and Polishing Lines for bar manufacturers/processors. Custom cell layouts including cut-to-length, chamfering, NDT inspection, prove-up stations, hex bundling, can be added to suit requirement. Testing of equipment with customer supplied material can be performed at SES' manufacturing facilities.

Headquartered in Alliance, OH, our over 40-year history includes design and supply of transfer cars, transporters and all meltshop equipment, slab handling equipment, long product handling and processing equipment, strip processing equipment, coil handling equipment, custom designed and built equipment, automation & Level I/II system design, complete system integration, PLC, drives, & HMI integration, power and control system design, and facilities engineering.

TITOMIC Limited
www.titomic.com

Titomic is an Australian additive manufacturing specialist for industrial scale manufacturing by our proprietary Titomic Kinetic Fusion process for Titanium and other metals. Co-developed with CSIRO, the Titomic process overcomes the limitations of additive manufacturing (3D printing) melting technologies for metals to manufacture complex parts without shape and size constraints. Benefits include:

World's fastest build rates, 30 times faster than the largest commercial 3D printers available

Leverage superior materials with the fusion of dissimilar metals and blended alloys

Production volumes without tooling

Stronger structures without welding, folding or bending

Reduced time to market; faster manufacturing time + localized production

Lower production costs

We provide surface engineering and end-to-end production support; equipment, software, training prototyping, product testing, manufacturing modeling, technical support and maintenance.

Coogee Titanium Pty., Ltd
www.coogee.com.au

Coogee Titanium is a division of Coogee Chemical, a long-established privately held chemical business headquartered near Perth, Australia. Titanium R&D is based in the Melbourne, Australia area. Coogee has leveraged their chemical engineering expertise to advance a Kroll-like process for the continuous production of titanium and titanium alloy powder to production. A production facility with Gen 4 equipment is being built in Kwinana, Western Australia, Coogee Chemicals' headquarters and a major operations facility. The production plant will focus on the production of Ti 6-4 low oxygen powder for additive manufacturing, MIM, and other advanced manufacturing applications. Alloy development will remain in Melbourne.

Shasta Services LLC
www.shastainc.com

Shasta provides high-quality grinding, machining, cutting and robotic scarfing services, primarily to the titanium industry. In business since 1974, Shasta operates multiple MidWest-style grinders to condition the surface of various metals, primarily titanium, for most major US titanium producers.

Shasta and its affiliates also provide robotic scarfing, high-volume torch cutting and a variety of machining services such as bar peeling, center-less grinding, saw cutting, straightening, polishing, turning, testing and various other services.

Shasta is focused on providing high quality services with a quick turnaround time.

NSL Analytical Services, Inc.
www.nslanalytical.com

A recognized leader in analytical testing, NSL Analytical Services, Inc. is an Independent Commercial Testing Laboratory specializing in Inorganic Elemental Chemical Analysis, Metallurgical and Microscopy Evaluations, Polymer Materials Testing and Metal Powder Evaluations. NSL Analytical helps customers achieve the highest standards of product quality from design to launch by providing accurate, reliable and repeatable materials testing results through Trust, Technology and Turnaround.

TSI Incorporated
www.tsi.com

TSI Inc. serves a global market by investigating, identifying and solving measurement problems. As an industry leader in the design and production of precision measurement instruments, TSI partners with research institutions and customers around the world to set the standard for measurements relating to aerosol science, air flow, chemical analysis, indoor air quality, fluid dynamics, biohazard detection, and even scrap metal sorting and plastics identification. With headquarters based in the U.S. and field offices throughout Europe and Asia, TSI has established a worldwide presence in the markets we serve. Every day, our dedicated employees turn research into reality.

Cosen Saws
www.cosensaws.com

Founded in 1976, Cosen is one of the world's leading band saw manufacturers with a broad product line and a global sales network including Cosen USA and Cosen Europe. Cosen's North American office and warehouse is located in Charlotte, NC. From there, the company provides an extensive selection of service replacement parts and local machine technicians. Our warehouse inventory contains over 100 new machines in stock and ready to ship at all times.

Trent Titanium Limited
www.trent-ti.co.uk

Processor of titanium scrap for all sectors of Titanium.

Metals & Alloys (UK) Ltd.

We are involved in the manufacturing of Ferro titanium and recycling of titanium scrap alloys.

LL-resources GmbH
www.LL-resources.com

LL-resources is an independent, global mineral resource commodity management, trading and consulting establishment. We are running our own productions for Ferro Titanium, both in Sweden as well as in Russia. We offer our partners the total value chain solution (ore body to market) by maximizing value and minimizing risks. By firmly applying to our corporate governance, high quality standards and procedures & responsibility scheme we are in the position to guarantee professionalism, innovativeness and top quality to our diverse pool of small and midsized corporations as well as global players.

Ningbo Chuangrun New Materials Co., Ltd
www.crnmc.com

Ningbo Chuangrun New Materials Company (CRNMC) is a start-up company which was established in 2012, mainly focus in manufacturing of high purity titanium. Located in Ningbo, Zhejiang Province, CRNMC possess electrolysis refining process and double-gun EB melting process in house. CRNMC also has two branches in Zunyi and Baoji, for titanium sponge manufacturing and high purity titanium processing, respectively.

CRNMC provides world-class high purity titanium products in various of purities (from 99.95% to 99.999%), serves semiconductor industry, vacuum coating industry as well as aerospace industry. Not limited to high purity ingots, CRNMC supplies high purity titanium mill products such as sheets, blanks, billets, tubes and also high purity titanium powder.

CRNMC produces in well-established quality control system with ISO 9001 certificate and conducts business with professional knowledge and absolute integrity.

Kolene Corporation
www.kolene.com

Kolene Corporation was founded in 1939 in Detroit by John Shoemaker. It continues today as a privately held company with 3rd and 4th generation Shoemakers active in the business.

Kolene specializes in designing and developing metal cleaning processes utilizing fused or molten inorganic salts. One of our major applications is surface conditioning of titanium oxides forming lubricant removal. Surface conditioning prior to pickling and chemical milling promotes uniform surfaces and metal removal. Processes to remove vitreous lubricants and molybdenum disulfide are available.

Kolene designs both process equipment and process chemicals to provide single-source cleaning systems.

Video proceedings by Dr. Louis Pignotti from TITANIUM USA here "Molten Salt Cleaning of Titanium and Its Alloys: From Primary Metal Manufacturing to Finished Products" located at Titanium.org

Precision Abrasives
www.precisionabrasives.net

We are the industry leader in abrasives and abrasive applications for the primary metals market. We offer the most reliable technical services and the widest selection of engineered products in the industry

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Kennametal
www.kennametal.com

Kennametal is a global leader in the production of master alloys and converter of ultra-pure, and converter of ultra-pure, premium-quality custom metal alloys and metal-alloy powders.

Stack Metallurgical Group

http://www.stackmet.com/

The Stack Metallurgical Group consists of heat treating facilities in Portland, Oregon and Spokane, Washington, as well as Aerospace Aluminum Processing in Salt Lake City, Utah. The combined capacity and versatility of these three facilities rivals nearly any other thermal processor in the western United States.

The Stack family prides itself on safety, quality, and outstanding customer service. We have long been a trusted supplier to numerous quality-critical industries including aerospace, energy, and medical implant. As evidence of our service-based culture, the Salt Lake City facility is the proud recipient of the Boeing Supplier Excellence Award 9 times.

CARPENTER TECHNOLOGY CORPORATION ANNOUNCED IT HAS ACQUIRED LPW TECHNOLOGY FOR APPROXIMATELY $81 MILLION.

LPW is based in Widnes, Cheshire, United Kingdom with additional processing operations near Pittsburgh, Pennsylvania. LPW employs approximately 80 people.

"Our aggressive development in key aspects of Additive Manufacturing demonstrates our commitment to build on our industry-leading position in this space," said Tony R. Thene, Carpenter's President and Chief Executive Officer. "The acquisition combines LPW's metal powder lifecycle management technology and processes with our technical expertise in producing highly engineered metal powders and additively manufactured components."

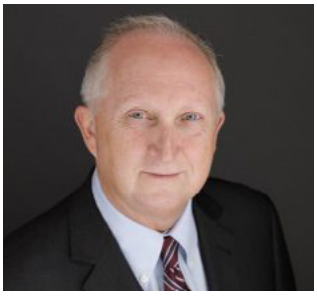
Lifecycle management technology is becoming increasingly important to understanding how materials behave before, during, and after production in the powder-bed fusion process. Understanding powder behavior is critical as AM becomes more widely adopted and implemented across various industries.

"LPW's innovative platforms and enabling technology further solidify Carpenter's position as a preferred provider of end-to-end next generation Additive Manufacturing solutions," said Phil Carroll, LPW's founder. "I'm extremely proud of the accomplishments we've achieved at LPW and I'm excited to be part of Carpenter's continued growth and leadership in AM."

Carpenter's additive portfolio, including recent investments in Puris, a titanium powders producer; CalRAM, a leader in electron beam and laser powder-bed fusion additive manufacturing services, and construction of an Emerging Technology Center in Athens, Alabama represent a significant force positioned to capitalize on the rapid AM growth.

RSM Corporate Finance LLP served as exclusive financial advisor to LPW Technology Ltd. on the transaction.

NEW CONSULTANT, MICHAEL SHIELDS, JOINS CUMBERLAND



September 08, 2018

Mr. Shields brings over 35 years of experience in business and industry. He has traveled the world extensively, visiting well over 500 companies and manufacturing operations in support of new product development, contract negotiations and generally ensuring the performance and reliability of the supply chain. The majority of his career has been spent in the automotive industry beginning with General Motors. He moved from the shop floor to the executive suite with subsequent jobs at ITT Automotive, Valeo, and Delphi Technologies gaining experience in various functional roles (production, quality, engineering and purchasing). These experiences helped build a broad technical knowledge in various industrial processes (raw materials, casting, forging, machining, fabrication, electronics and assembly).

After working in automotive, Mr. Shields moved to the world of aerospace where he served as Vice President – North America Purchasing for the Safran Group. In this role he established the North America International Purchasing Office, building a team of experts in sourcing, procurement, new program development, lean-sigma and quality to provide supply chain services to Safran affiliates.

Mr. Shields holds a degree in mechanical engineering from Kettering University (General Motors Institute) and a MBA from the University of Michigan.

Cumberland Highstreet Partners

Formed in London in 2016, Cumberland Highstreet Partners was created in response to the need for executive leaders to have access to a team of proven, experienced professionals who possess a deep domain knowledge of manufacturing. We bring accomplished and creative industry experts to the table who have personally led significant organizations. We are executives with proven track records of successfully navigating the ever-changing needs and requirements of industry.

WORLD FIRST CLAIMED FOR 3D PRINTING TITANIUM CAR WHEELS

HRE and GE Additive's AddWorks team have used electron beam melting (EBM) technology, a form of 3D printing (additive manufacturing) to create a new prototype wheel made from an advanced titanium powder, unveiling what is said to be the first automotive wheel to be made with this process.

https://www.youtube.com/watch?v=9F2FMIzXw5M&feature=youtu.be

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Harness our leading-edge vacuum technology to help assure your flight-critical parts go the distance.

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MAANSHAN IRON & STEEL CO., LTD. ROLLS FIRST BAR ON 3-ROLL RSB® 5.0

Maanshan Iron & Steel Co., Ltd. (Masteel) has successful commissioned the new small bar mill incorporating a Reducing & Sizing Block (RSB®) 370++/4 in 5.0 design by Friedrich KOCKS GmbH & Co KG.

The KOCKS 3-roll RSB® 5.0 is the core equipment in the new 400.000 t/a SBQ Mill which is finishing straight bars for automotive, aerospace and mechanical engineering applications within a dimension range of Ø 16.0 – 100.0 mm at a maximum speed of 18 m/s. Beside the RSB® also the real-time closed-loop control system SCS® (Size Control System), a light section profile measurement gauge 4D EAGLE® and the Thermo-Mechanical-Rolling (TMR) process including automation was supplied.

KOCKS RSB® 370++/4 with SCS® and 4D EAGLE® profile gauge

GENERAL MANAGER HIRED TO OVERSEE TACTIC DIVISION OF LABORATORY TESTING INC.

HATFIELD, PA, November 20, 2018 – Laboratory Testing Inc. (LTI) has hired a General Manager to oversee its new ultrasonic testing (UT) equipment division, TAC Technical Instrument Corporation (TACTIC), in Trenton, New Jersey. The position was filled by Michael Coulton, who brings over 30 years of high-level leadership experience to the company.

As General Manager of TACTIC, Coulton will have responsibility for developing and implementing operational business plans and strategic long-range plans, including organizational design and development, the supply chain, production processes, and new product and service offerings. For the past two years, Coulton was employed by McCarthy Engineering Associates, Inc. as Chief Operating Officer. His prior employer was Benjamin Obdyke Inc. for 30 years, where he most recently was the General Manager. Coulton is a graduate of Drexel University with a Bachelor of Science degree in Commerce and Engineering Sciences.

TACTIC was purchased by Laboratory Testing Inc. on July 20, 2018. The two companies have a long-standing relationship going back to the early 1980's, when LTI purchased its first immersion ultrasonic test system from TACTIC to perform UT testing. LTI currently runs seven immersion UT systems manufactured by TACTIC on two work shifts.

TAC Technical Instrument Corporation has been in the ultrasonic inspection business since 1962, developing and selling a product line of immersion ultrasonic inspection systems and accessories, providing parts, repairs and training. The company previously performed independent ultrasonic testing services, which are now being offered through LTI. The majority of TACTIC's standard products are designed to inspect cylindrical materials, such as tube, pipe, bar and billet, however, the company has also provided UT equipment to inspect hexagonal and square billet.

"We anticipate a great future for TACTIC and are very excited to see how Michael will lead the division," said Mike McVaugh, CEO/

President of LTI. "His 30 years of experience in manufacturing, with positions of increasing responsibility, provide an extensive background in the areas of production, engineering product development and management to take TACTIC to new levels."

Laboratory Testing is an accredited, independent materials testing laboratory that offers a wide-range of destructive testing, nondestructive testing and metrology services to businesses in the aerospace, power generation, defense, medical and other industries. Precision test specimens are prepared in the machine shop at LTI for all types of testing.

About Laboratory Testing Inc. -- Laboratory Testing Inc. (LTI) of Hatfield, PA is an independent, family-owned materials testing and metrology laboratory in business since 1984. The laboratory specializes in metal testing, but also analyzes powdered metals, ores, ferroalloys, polymers, composites and ceramics. The services offered by LTI include mechanical testing, metallurgical testing, chemical analysis, corrosion testing, nondestructive testing, specimen machining, failure analysis, dimensional inspection and calibration. All results are documented in Certified Test Reports or Certificates of Calibration. LTI is NADCAP and A2LA accredited, ISO/IEC 17025 certified and in compliance with ISO 9001 and ISO 13485. LTI Metrology, a division of Laboratory Testing Inc., provides NIST-traceable dimensional inspection and calibration services. On-site calibration, repairs, new instruments and replacement parts are offered. Information on Laboratory Testing Inc. services and accreditations is available at www.labtesting.com, sales@labtesting.com or 800-784-2882.

NOVEMBER 2018 PCC METALS GROUP PRICE INCREASE

Effective November 24, 2018 the TIMET, Titanium Metals Corporation, business unit of the PCC Metals Group will raise base prices by 3-5%. The increase will apply to all product forms and includes, but is not limited to, the following alloys: 6-4, 6242, 6246, 10-2-3, TIMETAL® 17, TIMETAL® 21S, TIMETAL® 407.

The price increase affects all shipments globally from TIMET's manufacturing and service center network. The base price increase is necessary to support continued investment and growth in our business to serve our global customer base. Through this challenging economic and demanding manufacturing environment the PCC Metals Group remains committed to safety, quality and delivery.

Additionally, the Special Metals business unit of the PCC Metals Group is reviewing possible pricing actions due to increasing costs of critical raw material inputs. An announcement regarding nickel ingot and mill product pricing is expected in the near future.

Please contact your PCC Metals Group sales representative if you have any questions.

BIG CHANGES AT RETECH SYSTEMS LLC

Since 1963 Retech Systems has been manufacturing vacuum melting systems in Northern California…but that is all about to change. The next step in the story of Retech comes with a transition of much of the manufacturing and assembly previously done in Ukiah, CA to facilities in Swiebodzin, Poland. All of the future work done at the SECO/Warwick facilities in Poland will be per the established Retech standards with the focus on maintaining all expectations associated with the Retech brand. The Ukiah office will be downsized and will retain our experienced engineers, leading technical directors, technologists, and service staff. Key leadership roles will continue to be filled and Retech's unique R&D Center will continue to be built up. Ultimately, the company will then maintain a west coast office along with the recently opened east coast office in Buffalo, NY.

In the words of Retech's President, Earl Good, "This is an effort to both strengthen our organization and to satisfy our customer's expectations. Ultimately, we are confident that the new organizational structure and footprint will enable Retech to be much closer to our global customers while improving our competitiveness in the industrial markets we serve."

Retech will now be better positioned to support both large capital projects while also satisfying the regular, daily customer service needs our customers demand and deserve. This transformation has taken place due to efforts by both the Retech and SECO management teams as a purposeful reinvestment into the company with the most significant beneficiaries being Retech's customers.

VERDER scientific

Solutions for Quality Control in the Titanium Industry

Heat Treatment

CARBOLITE GERO is a leading manufacturer of high temperature furnaces and ovens from 30 °C to 3000 °C with a focus on vacuum and special atmosphere technology. With more than 100 years of experience in thermal engineering our products are used in research laboratories, pilot plants and manufacturing sites worldwide.

www.carbolite-gero.com

Elemental Analysis

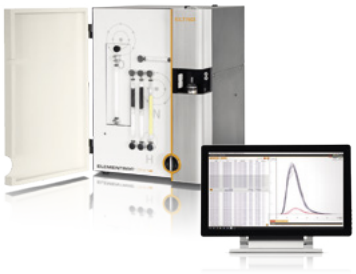
ELTRA is one of the world's leading manufacturers of elemental analyzers for rapid and accurate analysis of solid materials. Our elemental analyzers provide tailor-made solutions for a wide range of samples and concentrations. Thousands of satisfied customers worldwide are proof of the quality and reliability of ELTRA analyzers.

www.eltra.com

Milling & Sieving

RETSCH is the leading solution provider for neutral-to-analysis sample preparation and characterization of solids. Based on a century of experience RETSCH develops size reduction and sieving equipment which is characterized by excellent performance, operating convenience, safety and a long lifetime.

www.retsch.com



Verder Scientific Inc. · 11 Penns Trail · Suite 300 · Newtown · PA 18940 · USA
Phone: +1 866-473-8724 · info@verder-scientific.us · www.verder-scientific.com

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Above Material Technology Co., Ltd.

+86-10-82371996
www.amt-alloys.com
export@amt-alloys.com

Above Material Technology Co., Ltd (AMT) is very good at welding metallurgy of Titanium wires and powders. AMT is very professional in producing World Top Quality Titanium Alloy Wires at superior Strength and Elongation, and Titanium alloy powders at superior Density and Flowability, for 3D Printing or Additive Manufacturing and welding. AMT holds annual production capacity 500 tons in Titanium alloy wires and powders.

AMT Titanium alloy Wires are silver shiny spooled with superior micro-alloyed as well as Low Impurity. AMT Titanium Rod owns pretty logo printing and neat end-cut. The diameter of AMT Titanium Wires and Rods can be 0.1-5.0mm.

Our Titanium Powders are highly spherical with few satellite and porosity. The oxygen and other contaminants are very low and the particle size distribution is tailorable.

With innovativeness, strictly quality control, competitive price and extensive technological expert, we are committed to high quality customer demand and can always keep high quality owing to consistent process and quality management. New plant for unique patent processes and products is under construction.

For more information, please visit our website: www.amt-alloys.com.

Accushape™ Inc.

+1-503-977-9348
www.accushapeinc.com
accushapeinc@msn.com

Accushape™ has fully integrated facilities for processing Titanium Sponge Granules, with custom screening, particle size and shape modifications, application development, pressing and sintering of parts, machining and metal finishing processes. Accushape™ is a member of the International Titanium Association.

ACNIS® International

+33 (0)4 72 14 55 00
www.acnis-titanium.com
contact@acnis-titanium.com

Since 1991, ACNIS® International is a leading stockholder and distributor of alloyed and non-alloyed titanium in all forms and sizes. With the acquisition of AEROMETALS & Alloys in 2014 ACNIS® International has strengthened its position in the aerospace field.

ACNIS Group provides a unique cutting service in Europe, through its state-of-the-art sawing, waterjet, laser and shearing machines.

Among our wide product range, we offer bars, sheets, tubes, flat, hexagonal and square bars, tubes, welding wire, forged parts and powder. We serve our customers from our head office in Lyon, France, but also from our 3 service centers located in Paris (AEROMETALS & Alloys®), Brazil (ACNIS® Do Brasil) and China (ACNIS® Asia).

In 2018, ACNIS® International can provide CE marking for dental application products.

ADMA Products, Inc.

+1-330-650-4000
www.admaproducts.com

ADMA Products Inc. is AS9100 registered fully integrated manufacturer of ADMA Hydrogenated Titanium Powder, ADMATAL® net shape and near net shape powder metallurgy titanium and titanium alloy products. These products, produced by ADMA under its proprietary and patented "solid state" (non-melt) consolidation processes, meet all critical specifications and standards, including Aerospace Materials Specifications (AMS). Components made from ADMA Hydrogenated Titanium Powder are characterized by high purity, refined microstructures, low oxygen content, excellent "weld-ability", low energy input, almost 100% "buy to fly ratios", low cost, and performance that is superior to those of titanium ingot based products. ADMA additionally specializes in stainless steel, nickel, niobium, zirconium and other advanced materials produced by powder metallurgy processes.

Advanced Optical Technologies

505.313.7068
www.advanced-optical.com

Advanced Optical Technologies Inc. (AOT) provides non-destructive surface and crystallographic characterization of titanium and other aerospace materials. AOT's patented polarization-classification imaging (PCI) is an extension of polarized-light microscopy that provides crystallographic orientation images in air at much higher speeds and over larger areas than EBSD.

AOT offers multi-dimensional micro- and nano-structural material characterization, mapping, and assessment for a more complete understanding of complex materials and devices, and develops custom sensors for defense and commercial customers.

Akrapovič Titanium Castings LLC

+386 1 78 19 261
www.akrapovic-foundry.com

Akrapovi**č** is a producer and supplier of Titanium investment casting and carbon-fiber composites products. With many years of experience and constant development in the Titanium processing industry we can offer our customer high quality build to print products out of required certified material, precision and flexible delivery time and full service approach of our high specialized team support.

ALD Vacuum Technologies GmbH

+49 6181 3070
www.ald-vt.com
info@ald.vt.de

ALD Vacuum Technologies – High Tech is our Business

ALD is a worldwide leading supplier of advanced furnace systems for melting, casting, coating and heat treatment of metals under vacuum.

ALD furnaces are used for the production of especially pure and specially alloyed metals, materials and parts. Our customers are comprised of the leading manufacturers of materials used in aerospace, energy, semiconductors, medical and commercial markets for a variety of applications that require those super-alloys, reactive and refractory materials as well as rare earth and powder materials.

ALD Vacuum Technologies also is the industry leader in EB PVD Thermal Barrier Coating Systems and our Precision Casting Systems are used for

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super-alloy, Titanium and Ti Aluminide cast parts. Our expertise in heat treatment furnace technologies and sintering furnace technologies are utilized by leading automotive manufacturing companies as well as the tool manufacturing industries for highly critical parts in gear case and fuel injection systems and specialty tools.

ALD has worldwide representation and services through wholly owned subsidiaries in North America, Japan, Russia, Mexico, India, Thailand, Poland, France and China. With more than 20 representatives across the globe, working together with nearly 400 employees at our corporate headquarters in Hanau, Germany ALD is able to provide timely and knowledgeable services and support.

ALD is part of the AMG, Advanced Metallurgical Group N.V., Netherlands, a public listed technology company with leading market position and interesting growth potential.

Alloy Works, Inc.

704-645-0511 ext. 118
JWoock@Alloyworks.com; Todd.Tomczyk@timet.com

AlloyWorks, a TIMET company, specializes in plasma cold hearth melting titanium aluminides, standard titanium alloys, and CP. AlloyWorks products are used to produce parts in aerospace, industrial, and military applications. AlloyWorks is AS9100, ISO 9001 certified and holds approvals from several leading engine companies.

Alloy Metals Company

562-219-7831
www.alloymetalsco.com
moe@alloymetalscompany.com

Alloy Metals Company is a full line distributor and key supplier of aerospace, defense and industrial grade titanium and other hard alloys.

Ampere Scientific

www.amperescientific.com

Ampere Scientific is the manufacturer and distributor of the VARmetric measurement system, seamlessly integrating existing process measurements and passive sensor technologies to monitor and visualize arc locations during the melting process. VARmetric couples with standard process signals to evaluate process dynamics and correlate this data with product quality measures. Thus, for the first time ever, the VARmetric system allows the user to visualize and act upon deleterious operating conditions, conditions that are not apparent in traditional VAR monitoring systems, during melting, conditions that could lead to safety related operations or defect formation.

American Prosthetic Components

American Prosthetic Components is a manufacturer of prosthetic components.

American Titanium Works LLC

+1-603-398-3342

American Titanium Works LLC is completing plans to build a new, green-field, integrated, world-class titanium manufacturing facility in the southeast of the United States. ATW is targeting the defense, industrial, commercial, consumer and emerging markets with a range of products and services including alloy and commercially pure titanium plate, bloom, billet, slab, and ingot.

Applications for our products will include defense ballistics and general military equipment construction, chemical processing equipment, oil & gas systems, pulp & paper production facilities, medical implants, and a wide and growing range of consumer goods.

Arcam Group

Arcam Group provides cost-efficient Additive Manufacturing solutions for production of metal components. Arcam's Electron Beam Melting (EBM®) technology offers design freedom combined with excellent material properties and high productivity. Arcam provides Electron Beam Melting systems through Arcam EBM in Sweden, powder metals through AP&C in Canada and implant contract manufacturing through DiSanto in the U.S.

Arconic

+1-231-894-7330
www.arconic.com

Arconic (NYSE: ARNC) creates breakthrough products that shape industries. Working in close partnership with our customers, we solve complex engineering challenges to transform the way we fly, drive, build and power. Through the ingenuity of our people and cutting-edge advanced manufacturing techniques, we deliver these products at a quality and efficiency that ensure customer success and shareholder value. For more information: www.arconic.com. Follow @arconic: Twitter, Instagram, Facebook, LinkedIn and YouTube.

Architectural Titanium LLC

+1-785-842-2299
www.architecturaltitanium.com

Architectural Titanium provides the most experienced consultants for worldwide applications in architecture, art and design. We look forward to the opportunity to share our expertise and support your design concepts through the entire process of samples, details, specifications, procurement, fabrication and installation.

Aries Alloys

+919870401466
www.ariesalloys.com
kalpesh@ariesalloys.com

India's leading Stockholder of Titanium, Nickel Alloys & Stainless Steel Mill Finished Products, Re-Usable & Scrap.

ARIES Manufacturing

+1 704-289-8531
www.aries-manufacturing.com

ARIES Manufacturing: ARIES Manufacturing, formerly marketed as The Cyril Bath Company and ACB Company, is part of an International corporation known as the ARIES Alliance. This group of aerospace focused businesses provides innovative metal forming and joining solutions to the aerospace

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industry. The foundation of its technologies is stretch forming of aluminum alloy sheet for fuselage skins, as well as aluminum and titanium profiles for airframe structure components. The company's stretch presses are equipped with the latest CNC control systems, designed and developed by its in-house software engineers. Our stretch forming customers include the leaders in commercial and business aircraft manufacturing, in addition to their complete supply chain network. ARIES Manufacturing has developed a very innovative Hot Stretch Forming process, or HSF®, to contour titanium profiles for airframe component applications. This high temperature forming process precisely stretch forms titanium extrusions to the exact part design contour. The hot stretch formed part is then machined and finished into a critical airframe component. This valuable forming process saves starting titanium weight by offering a near net profile solution; contoured in a controlled, repeatable process, with minimal residual stress. In addition, under ARIES Manufacturing, we hot form and superplastic form titanium sheets for applications in nacelle and pylon components. Our facility in Nantes, France operates 12 hot forming/Superplastic Forming presses of varying sizes. Additionally, we can laser or machine trim, spot weld, hot brake form, and perform assembly work. All of our hot presses are designed and built within our corporation businesses. Finally, ARIES manufacturing has a facility in Grenoble, France that can perform pocket milling and final trimming on large aluminum alloy fuselage skins. This contract manufacturing work utilizes our internal expertise and design engineering of a very innovative "mirror milling" type CNC machining center.
Tel: +1 704-289-8531 • www.aries-manufacturing.com

ATI
+1-412-394-2800
www.ATImetals.com
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ATI is a global manufacturer of technically advanced specialty materials and complex components. ATI is a market leader in manufacturing differentiated products that require our unique manufacturing and precision machining capabilities as well as our innovative new product development competence. Our capabilities range from alloy development to final production of highly engineered finished components, as well as producing powders for use in next-generation jet engine forgings and 3D-printed aerospace products. ATI offers our customers a unique supply chain solution that Creates Long-Term Value Thru Relentless Innovation®.

Avon Metals Ltd.
+44-1452-874500
www.avonmetals.com

Avon Metals is a manufacturer of aluminum products and a recycler of specialty metals.

We make high purity aluminum pellets/shot for the Titanium Industry.

Specialty metals and scraps processed/traded included CP Titanium, 6/4 Titanium, Molybdenum, Zirconium, Tantalum, Vanadium, Chromium.

We are buyers/consumers of off grade Vanadium-Aluminum type alloys in lump and powder forms.

BAHCO
+1-800-446-7404
www.snapon.com/industrialbrands
industrialbrands@snapon.com

Bahco's 3860 Multi Chip Carbide bandsaw blade has been developed specifically for cutting Titanium Alloys. The 3860 Multi Chip Carbide blade improves and optimizes Bandsaw operation with a World leader in Cutting Technology. In the 1980's Bahco developed and Patented the first "Set Tooth" Carbide Bandsaw blade to provide fast, efficient cutting of exotic alloys and have led the way in this sector ever since.

Bahco is a registered trade name of Snap-on Incorporated a leading global innovator, manufacturer and marketer of tools, diagnostics, and equipment, software and service solutions for professional users. Products and services are sold through the company's franchisee, company-direct, distributor and Internet channels. Founded in 1920, Snap-on is a $2.8 billion, S&P 500 Company headquartered in Kenosha, Wisconsin. Our Mission - The most valued productivity solutions in the world. Snap-on Incorporated P.O. Box 1410 Kenosha, WI 53141-1410, U.S.A. 262-656-5200.

Banner Medical
+1-800-323-9732
www.banner-medical.com
dstoettner@banner-medical.com

Banner Medical specializes in providing complete single-source cold finished bar, plate, sheet and supply chain solutions for the medical, dental, and aerospace industries. We carry over 1 million pounds of raw and finished goods inventory to service our customers quickly. Our complete offering of stainless, titanium, aluminum, alloy, nickel and cannulated products coupled with unique value-added services sets Banner Medical apart. Some of these unique value- added services include:

- Custom supply chain management solutions
- Complete traceability from melt source to finished product
- In-house non-destructive testing
- Vendor managed inventory (service) and JIT programs
- Line marking
- Niton Gun material analysis
- Near-net shape machining/Blanking
- Precision saw cutting
- Waterjet cutting
- Quality Throughout

Each Banner facility is ISO 9001: 2008 certified. Medical production facilities are ISO 13485:2003 certified. Our Carol Stream facility is also AS9100C: 2009 certified

Bao Ji Chang Zheng Metal Materials Co., Ltd.
+86-09173154969
www.baojicz.com

Bao Ji Chang Zheng Metal Materials Co., Ltd. is a professional company specializing in research & development and production of functional materials used in vacuum coating. The general manager of the company graduated from the Material School of Xi'an Jiaotong University and has nearly 20 years of experience in functional material research and development. The technical consultant of the company graduated from the Material School of Xi'an Jiaotong University and went to Brandenburgische Technische Universität Cottbus for scholarly communication. He is currently a Humboldt scholar, professor, senior researcher and doctoral tutor. The company has professional technical R&D personnel and a well-qualified team, experienced production and processing technicians of sputtering targets. We provide high quality sputtering targets for tool coating, decorative coating, architectural glass coating, microelectronic semiconductor coating, photovoltaic coating, etc.

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Baoji City Changsheng Titanium Co., Ltd
+86-18066-945217
www.bjcsty.com

Baoji City Changsheng Titanium Co., Ltd is located in Baoji City, which is known as the "Titanium City." Our factory was established in 2006, and as a professional manufacturer, we specialize in the production of titanium and titanium alloys. At present, we have complete production lines of metallic titanium and titanium alloy materials, with nine engineers, 20 advanced artificers and 30 production artificers.

Our main product is pure titanium and titanium alloy tube; titanium anode product; titanium wire and TiNi alloy wire; titanium porous sintered filter product; and other titanium and titanium alloy product OEM processing machines.

We possess advanced processing technology, newly-developed products and scientific cultural ideals. We insist to put people and customers first, and now the whole team is making efforts to build a better corporation with advanced technology, scientific management, first-class talents and a prosperous future. We will use our excellent products and science service, should to shoulder with our real friends to broaden a wider international market.

Baoji JHY Titanium Industry Co., Ltd
+86-917-3372996
stella@ti-bolts.com

Baoji JHY Titanium Industry Co., Ltd was founded on 25-09-2002. It is a professional manufacturer for titanium and titanium alloy fasteners and machined products. We can produce them according to different standards, like GB, ISO, DIN, ANSI and JIS etc. They are widely used in petroleum, metallurgy, chemical, pharmacy, marine engineering, racing car, motorcycle, bicycle, yacht, outdoor camping and sports equipment.

Our company insist the "Quality First" strategy rather than "Low priced" one to earn trust from customers, which has been proved correct after 15 years in this industry. Now over 85% our products are exported to Japan, United States, United Kingdom, Germany, Netherlands and other European countries.

Baoji Jiaqi Metal Co., Ltd.
+86- 917-3371688
www.jqmetal.com
daniel@jqmetal.com

Baoji Jiaqi Metal Co., Ltd. was founded in 2012. The core team members of our company have more than 30 years engaged in titanium, zirconium, nickel, tungsten, molybdenum processing experience. We supply hundreds of enterprises with prime quality products.

Our company has advanced and complete titanium wire & rod production technology and equipment. We focus on high purity and bright surface titanium wire, high strength, high plasticity, high torsion angle and high precision titanium rod. Our titanium wire and rod are widely used in 3D printing, medical, aviation and chemical industries.

Our company has passed the international quality system ISO9001:2015 and aviation quality system AS9100:2016 certification to ensure stable and reliable product quality.

We provide customers with high cost-performance titanium wire, titanium rod and ensure good quality and time delivery. We provide not only materials but also material solutions for providing customers with a full range of service and value-added service.

Baoji Telison New Materials Co., Ltd
+86-15319406242
www.telison.com

Our products include high purity sponge titanium powder, TC4 alloy powder, spherical titanium powder for 3D printing, titanium hydride powder and so on. With low content of oxygen, iron, hydrogen and nitrogen, these products shown in normal metal color and own excellent formability ,uniform particle size, proper apparent density as well as stable and high quality. The company was founded in March 2016, with registered capital of 10 million RMB. It covers a total area of 37,000 square meters, mainly contributes to the R&D, manufacturing and sale of metal powder for additive manufacturing, rare metal and its alloy (including Ti, Ta, Nb, Zr, Be), as well as import and export business of intelligent metal processing equipment and technology. In 2018, we invested more than 100 million RMB to set up a large-scaled automatic production line of high-quality metal powder series products. After completing the project, it is estimated that the annual output of irregular angular powder and spherical powder for 3D Printing will reach 440 tons as well as the equipment manufacturing will realize the full automation development. And we will insist on improving manufacturing process, optimize full-automatic intelligent production line and strive to provide customers with high-quality products and excellent service in the future.

Baoji Tibolt Tech Co., Ltd.
+86-186-9004-4650
www.ti-bolt.com

Ti-Bolt has been a supplier of Grade 5 Titanium of Ti-6AL-4V fasteners and hardware for over 10 years. As an expert of lightweight fasteners used on most of racing applications, such a bicycles, motorcycles, motocross industry, ATVs, snowmobiles, race cars, etc., we deeply understand the safety guaranteed by high quality materials is the first consideration for end-users, so we say "No" to any other poor or recycled titanium.

Ti-Bolt is located in Titanium Valley of China, but our customers are global and include small and large dealers and companies who demand the best in their own industry. With a wide range of customers, you can have confidence in the quality of our Grade 5 titanium bolts and professional service you will receive.

Baoji Titanium Industry Co., Ltd.
+86 917 3382 075
www.baoti.comiedept@baoti.com

Baoji Titanium Industry Co., Ltd (Baoti) is the biggest manufacturer of titanium mill products and titanium alloys in China. An integrated production system that includes melting, forging, rolling, drawing and fabricating enables Baoti to manufacture various products such as titanium sponge, ingot, billet, bar, wire, plate, sheet, tubing, forging, casting of all grades of CP titanium and most titanium alloys as well as many down-stream products in accordance with AMS, ASTM, MIL, ASME, ISO, DMS, AWS, JIS specification. These products are widely used in every kind of industry ranging from aerospace and automotive to sports, medical, chemical and petrochemical industries. Baoti is an ISO9001 and NADCAP approved company.

Baoji Unique Titanium Industry Co., Ltd.
+86-0917-6269698
www.uniqueti.com

Baoji Unique Titanium Industry Co., LTD is an integrated enterprise that contains research and development, manufacture, sales of titanium and

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titanium alloy materials, created in August 2010. We invested and built a collection of melting, forging and machining production line of titanium and titanium alloy, and other nonferrous metal. The main products: titanium ingots, titanium bars and billets, titanium wires, titanium rings, titanium sheets and plates, titanium tubes and pipe fittings, various kinds of forgings, standard parts and other rare metal products. Our titanium and titanium alloy materials are widely used in 3D printing, bio-medicine, military and aerospace, commercial and chemical fields.

We possess strong technical strength and complete production system of melting, forging, annealing, machining and others, and possess 3 tons vacuum consumable arc melting furnace, vacuum annealing furnace, machining center, annealing and straightening machine, inspection and testing facilities. We also possess the production line of high purity titanium and titanium alloy powder. Our company carries out AS9100C/EN9100:2009 Aerospace Certification and ISO9001:2008 International Quality Management System Certification. With sophisticated and reliable production equipment, mature and advanced processing technology, product quality is qualified and stable. The company could produce according to GB / T, GJB, ISO, AMS, ASTM, MIL and other standards, and meet aviation, aerospace, marine, military, medical, chemical and other industries of domestic and international market demand for titanium.

Baoji Xilitong Non-Ferrous Metal Production Co., Ltd

+86-0917-3372281
www.xlt-china.com

Baoji Xilitong Non-Ferrous Metal Products Co., Ltd was founded in 2008 in Baoji City, Shaanxi Province and is ISO 9001:2008 certified and aerospace certification is reviewing now. We are expected to pass the EN9100 certification in October 2018, in order to serve our customers.

Our company relies on "Chinese Titanium City" strong strength for efficient sharing of integration. We have a young, energetic and innovative team, and we also have a unique geographical, materials and research advantages.

We are mainly titanium and titanium alloy material (bar, plate, tube, wire, fasteners and CNC machining parts) supplier. We have titanium and titanium alloys products over 300T in stock with complete specifications, including titanium rod, titanium wire, titanium plate, titanium tube, titanium fasteners etc. We insist production and management be honest, quality first, attention to management, and customer first.

Baoji Ziyu Metal Material Co. LTD

+86-0917-3818091
www.ziyumetal.com

Baoji Ziyu Metal Material Co. LTD specializes in the production of titanium and its alloys of various specifications bar, ring, cake and forgings. The main production equipment used by the company: 1.5~10 ton electric arc furnace, 4500 ton fast forging machine, 4 ton electric liquid hammer, 1 ton air hammer 2, bar mill, precision forging machine, 40 type ten roll hot straightening machine, centerless grinding machine, sand belt polishing machine, and a batch of related auxiliary heating equipment. It has the ability of smelting, billet, forging, annealing, sawing, cutting, straightening and polishing. The processing capacity of the finished material is over 100 tons. It can be machined to produce domestic GB/T, GB, GJB standards and foreign AMS, AMSE, ASTM and other standards of titanium bar. The company has more than 30 registered employees, of whom 5 are above undergraduate level, 6 are technical secondary school or above, and 18 of them are technicians and technicians. The company's main products are titanium and its alloy rings, bars, forgings, plates and medical titanium alloy bars. The company purchase high quality and high grade titanium sponge, according to the technical requirements of the product, material selection, ingredients, smelting, forging, heat treatment, mechanical processing, and so on, can ensure the stability and consistency of product quality.

Baosteel Special Metals Co., Ltd.

+86-021-26032903
www.baosteel.com

Baosteel Group is the largest and most advanced integrated steel company in China. Baosteel Special Metals Co., Ltd is a subsidiary company of Baosteel Group. Baosteel Special Metals Co., Ltd grew out of Shanghai No. 5 Steel Works, and started manufacturing of titanium alloys since 1968. The main titanium products include: ingot, slab, billet, bar, plate, coil, stock, isothermal forging and so on.

BHN Special Materials Ltd.

+86 411 8924 9999 ext 8088
www.bhn-materials.com
sales@bhn-material.com

BHN special Materials Ltd. is a leading high quality master alloy producer in Dalian, P.R. China. BHN is certified according to EN9100:2009 and ISO 9001:2016.

BHN provides the full range of Vanadium, Molybdenum, and Niobium containing binary alloys for the Titanium Industry for aviation, military, and medical application in China and abroad.

The expertise of BHN is to supply tailor-made multinary master alloys well designed to simplify the customers' manufacturing process to improve their competitiveness.

To learn more about BHN, please visit our website at http://www.bhn-materials.com/.

BIBUS METALS

+41 44 877 54 11
www.bibusmetals.com
info@bibusmetals.ch

BIBUS METALS Group is 100% Swiss owned, and since 1979 a leading distributor and stockholder of Titanium (CP and Titanium alloys) as well as Nickel based alloys, Cobalt-Chromium and 316LVM (1.4441) in Europe and Asia. BIBUS METALS Group is a supplier for different applications in medical, chemical, aerospace, automotive, oil & gas, power generation industries and offers:

Sheets/Plates, Wire/Bars, Tubes/Pipes, Strip/Foil, Welding wire, Screw/Nuts, Profiles

The fully integrated Service Centres are located in Switzerland, Germany, Czech Republic, Poland, Hungary and China to ensure reliable and rapid service for customers worldwide.

Where necessary the entities of the Group are certified according ISO 9001, EN/AS 9120 for aerospace and EN ISO 13485 for medical. Quality, flexibility and tailored solutions are of great importance for the whole BIBUS METALS Group.

For further information please email to info@bibusmetals.ch

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Blaser Swisslube AG

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www.blaser.com
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Blaser Swisslube AG is an independent and family-owned Swiss company founded in 1936. Blaser Swisslube is represented in more than 60 countries on all continents. The company develops and produces high-performance cutting fluids for customers who manufacture tiniest to large titanium components as well as critical and structure components, particularly for aerospace and medical. Blaser Swisslube's goal is to optimize manufacturing processes and to improve their economic efficiency, productivity and machining quality. In close cooperation with the customers Blaser Swisslube presents new solutions to fully exploit the potential of machines and tools by using the right metalworking fluid which becomes a liquid tool. This promise is backed by excellent products, customized services, competent experts and its long experience in the metalworking industry. For more information please visit www.blaser.com.

Bodycote

+1-310-604-8000
www.bodycote.com

With more than 180 locations in 23 countries, Bodycote is the world's largest provider of heat treatment and specialist thermal processing services. Through heat treatment, metal joining, surface technology and Hot Isostatic Pressing (HIP), Bodycote improves the properties of metals and alloys, extending the life of vital components for a wide range of industries, including aerospace, defense, automotive, power generation, oil & gas, construction, medical and transportation. Customers in all of these industries have entrusted their products to Bodycote's care for more than 30 years. Bodycote is the vital link for additive manufactured titanium components, providing property improvement through HIP and heat treatment post processing services.

Butech Bliss

330-337-0000
www.butechbliss.com
sales@butech.com

Butech Bliss is a designer and manufacturer of capital equipment, repair components and engineering and field services for metals producers and processors that roll, forge, melt, flatten, stretch, shear and extrude metals of all types. Butech Bliss is located in Salem, Ohio and is home to one of the largest manufacturing facilities in the industry. With over 50 engineers on staff, 400,000 sq. feet, 100+ machining centers, full fabrication and assembly departments, 200 ton crane capacity and a dedicated rail spur, Butech Bliss is equipped to handle any project. Butech Bliss product offerings include copper crucibles, liners, molds, hearths, etc. for VAR, ESR, PAM and EBM Re-melting equipment as well as Rolling Mills, Forging and Extrusion Press upgrades and Coil, Plate and Sheet processing equipment for all metals. Butech Bliss is comprised of Butech Inc., E.W. Bliss (Bliss-Salem), Loewy Machinery and Lombard Industries.

Calvi Holding S.p.A

+39 039 331071
www.calviholding.it; www.calvinetwork.com
contact@calvinetwork.com

Born from the aggregation of multinational entities with over 700 years of combined experience in the engineering and manufacturing of special steel profiles based on customers' specifications, Calvi Holding S.p.A. owns controlling stakes in 12 manufacturing companies operating in the metallurgical and mechanical industries.www.calvinetwork.com

The group's operations are organised into two divisions: the metallurgical division, which specialises in manufacturing special steel & titanium profiles based on customers' specifications with hot and cold forming technologies, and consists of the 9 companies in the Calvi Network Special Steel Profiles and the diversified mechanical division, made up of 3 companies that manufacture lifting units for forklifts.

The Network, which boasts a long history of manufacturing steel and a world-class know-how, presents itself as a partner for the manufacturing of special sections for countless applications in a wide range of industrial segments, including energy, aerospace, medical, automation, and machine tools, and addresses the growing needs of the market for forming solutions.

Carbolite Gero

Carbolite Gero Business Unit
Manager: Michael Hager
(920) 567-0024
www.verder-scientific.com
info-us@verder-scientific.com

Carbolite Gero, part of Verder Scientific, has 80 years of experience and a reputation for quality and reliability, which are invaluable in the aerospace industry. Furnaces and ovens from Carbolite Gero are the first choice for many of the aerospace industry's most respected companies for the heat treatment of aircraft components. Equipment is available for both initial manufacture and MRO (maintenance, repair and overhaul) to AMS 2750E within a Nadcap environment. Carbolite Gero products are already widely used by leading aerospace manufacturers and as a result we are able to offer excellent references.

CEFIVAL SA - SIDERVAL S.p.A

CEFIVAL +33 1 39 37 12 25; SIDERVAL +39 342 67 41 11
www.cefival.fr; www.siderval.it
commercial@cefival.fr; siderval@siderval.it

CEFIVAL and SIDERVAL manufacture special sections and tubes with hot extrusion process to obtain near net shape profiles. The engineered shapes are studied and manufactured according to customer's requirements in a wide range of solid and hollow sections. Our manufacturing process improves the buy to fly ratio. Main grades are titanium, inconel, stainless and carbon steel, super alloys, nickel alloys and other on requirement. Main application fields are aeronautics for aircraft ring engines (CFM56, GE90, GP7000, CF6-80, SM146, Gen X) and structural parts (such as seat tracks, floor and wings stiffeners, door hinges…), power generation for nuclear (ia drive rods) and conventional applications, architecture, defense, medical and food industry. Cefival is NADCAP certified.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Chaoyang Jinda Titanium Co., Ltd.

+86 421 2976177
www.jinda.cc

Chaoyang Jinda Titanium Co., Ltd.(Jinda Titanium)was founded in August, 2006.The main products are Jinda brand titanium sponge(famouse brand products in Liaoning Province) and titanium ingot and other processed products. Production ability per year for titanium sponge is 10,000 tons, for ingot is 2000 tons and 40,000 tons for anhydrous magnesium chloride.

Jinda Titanium is the National High-tech Enterprises with unique production technology, advanced inspection instruments and strong technical force. Jinda Titanium passed ISO9001 Quality Management System,ISO14001 Environmental Management System, GB / T28001 Occupational Health and Safety Management System, GJB9001B Military Standard Quality Management System, AS9100C Aerospace Quality Management System Certification and ISO / IEC17025 National Laboratory Accreditation.

The quality of Jinda titanium sponge is stable. Self R & D MHT-90 high-quality titanium sponge and small size titanium sponge have become the preferred raw materials of aerospace and defense, marine engineering and other high-end usage of titanium industries.

Jinda Titanium is a member of the International Titanium Association, the vice managing director of Chinese non-ferrous metal industry association titanium zirconium Hafnium Branch, the vice managing director of Titanium Industry Progress and the director of Baoji Titanium Association. Jinda Titanium comprehensive ranks forefront in titanium industry.

Chesapeake Industrial Cleaning Products, Inc.

+1-410-340-9052
www.chesapeakeindustrial.com

Chesapeake Industrial formulates and supplies manufacturing chemicals and degreasers to titanium recyclers and processors. Cleaners for removing oil from turnings, dirt and oil from scrap, cutting fluids from formed products and other typical operations are our expertise. Chesapeake provides a wide range of formulated products from general cleaners to high spec materials made at facilities in several US locations. Products specifically designed for individual operations can be formulated for costs often lower than 'off-the shelf' materials. Chesapeake has served customers in the titanium industry for over 10 years. Drums, Totes and Bulk deliveries of materials are all available.

China Huaxia Special Metal Limited

0086-21-58770128
www.nonferrous-metal.com; www.csmhuaxia.com
helen@nonferrous-metal.com; csm@nonferrous-metal.com

China Huaxia Special Metal Limited is one of the largest manufacturers of titanium, nickel & nickel alloy, stainless steel/duplex & supper duplex with forms at sheet/plate, seamless tube/pipe, bar/rod, wire, welded pipe, seamless & welded fitting, flange, valve, clad material etc. With the logo CSM (China Special Metal), we hope to be the best one of special metal manufacturer in China. CSM always treat the quality as our life, CSM invest the quality and future. CSM material have been widely used in oil & gas industry, chemical industry, construction industry, sports industry etc, many big companies in these field have approved CSM material. CSM took the pride in CSM titanium sheet used in 2012 London Olympic Village decoration, CSM has the mission to be the enterprise to improve the position of Chinese titanium products in the international market.

China Steel Corporation

+886-7-802-1111
http://www.csc.com.tw/csc_e/pd/mlg/mlg.html

China Steel Corporation provides high quality titanium products, including ingot, plate, sheet, bar, wire coil and tube, for a wide range of applications in architecture, chemical industry, heat exchangers, copper foil facilities, fasteners, desalination, electronics, sports industry, leisure and moving forward to biomedical and aerospace application.

The stable and reliable quality of CSC's titanium products have gained the acceptance of Asia industries widely, and CSC has also been selected as the first priority provider to purchase their needed titanium materials owing to CSC's quick and efficient technical services. CSC will continue to improve customer services and the technical technologies both for customers and CSC itself to promote Titanium Alloy products' international competitiveness.

CMI Industry Metals

+1-330-332-4661
www.cmigroupe.com
Industry.americas@cmigroupe.com

CMI Group designs, integrates, modernizes and maintains equipment for industries like energy, defense, metals, environment, and transport and industry in general.

Present on all five continents, CMI numbers more than 5,500 experienced employees who combine technological expertise and the management of international projects.

As such, CMI has supplied innovative heat treatment technologies, combining field proven reliability and cutting edge technology for every application since 1923.

Grounded on the experience of well-known brands like Electric Furnace Company (EFCO) and French ATI Furnace, CMI Industry provides heat treatment products to process a wide range of materials in a multitude of sizes, shapes and thermal cycles.

Based on its great historical knowledge and evidenced by numerous worldwide references, heat treatment products supplied by CMI comply with local, national and international safety and quality standards, including: NFPA 86; NEC (NFPA 70); UL508a; AMS 2750; NADCAP.

Consarc Corporation

+1-609-267-8000
www.consarc.com
sales@consarc.com

Consarc Corporation, an Inductotherm Group Company, is a manufacturer of vacuum furnaces for the titanium forging and casting industry. Consarc custom designs and manufactures Reactive Vacuum Arc Remelting (RVAR) furnaces for primary electrode melts of compacted sponge titanium and titanium alloys, and secondary melt furnaces for remelting fully dense electrodes. Consarc also designs and manufactures fully customized Induction Skull Melting (ISM) systems for melting titanium in a refractory free environment for casting or ingot withdrawal. Consarc is ISO 9001-2008 certified, and with operations on 5 continents, is well equipped to tackle fully customized furnace projects globally.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Continental Steel and Tube Company
+1-954-332-2290
www.continentalsteel.com/Titanium/default.asp

Continental Steel and Tube Company is one of the world's leading value added volume suppliers of quality metals. With an outstanding global reputation, our team of expert sales associates can supply a comprehensive inventory of metals to meet any application requirements.

Continental Steel supplies a wide range of metals including, titanium, stainless steel, nickel, steel, aluminum, hot/cold rolled, galvanized, and stainless and electrical steel in carbon and alloy grades. Our long list of Titanium Grades includes CP4 Gr1, CP3, Gr2, CP2Gr3, CP1 Gr4, Gr7, Gr5 Ti 6AL-4V, Gr6, Gr9, Gr 12, , Gr 19 (Beta C) & Gr 11. Our materials are available in coils, sheets, strips, plates, angels, bars, rounds squares, hexagons, and other custom shapes. Continental also offers tubing or pipes in welded, DOM and seamless.

Coogee Titanium Pty., Ltd
www.coogee.com.au

Coogee Titanium is a division of Coogee Chemical, a long-established privately held chemical business headquartered near Perth, Australia. Titanium R&D is based in the Melbourne, Australia area. Coogee has leveraged their chemical engineering expertise to advance a Kroll-like process for the continuous production of titanium and titanium alloy powder to production. A production facility with Gen 4 equipment is being built in Kwinana, Western Australia, Coogee Chemicals' headquarters and a major operations facility. The production plant will focus on the production of Ti 6-4 low oxygen powder for additive manufacturing, MIM, and other advanced manufacturing applications. Alloy development will remain in Melbourne.

Cosen Saws
888-720-5371
www.cosensaws.com

Founded in 1976, Cosen is one of the world's leading band saw manufacturers with a broad product line and a global sales network including Cosen USA and Cosen Europe. Cosen's North American office and warehouse is located in Charlotte, NC. From there, the company provides an extensive selection of service replacement parts and local machine technicians. Our warehouse inventory contains over 100 new machines in stock and ready to ship at all times.

Cristal Metals Inc.
+1-815-221-2281
www.cristalmetals.com
itp.billing@cristal.com

Cristal Metals was formed in 1997 as International Titanium Powder (ITP) to develop and commercialize Armstrong Process® patented and proprietary technology for high purity metal and alloy powders with specific emphasis on titanium. Powders produced through the Armstrong Process® can be used as spheroidization feedstock for additive manufacturing to provide customized compositions. Powders may also be employed to manufacture parts through direct consolidation to lower processing costs for titanium parts via powder metallurgy processing.

CSIRO Metal Industries Research Program
+61 3 9545 8644
https://www.csiro.au/en/Research/MF/Areas/Metals
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The Metal Industries (MI) Research Program is engaged in applied research across the metal value chain, specialising in novel metal production techniques, interfaces/corrosion, energy systems, metal forming, and additive manufacturing / 3D printing, particularly for Titanium and its alloys. Strong Multiphysics modelling techniques are combined with practical experimentation to understand and develop advanced solutions for Australia and the global industry. MI undertakes independent and collaborative research, and partners with industry and academia around the world. MI also provides consulting services, use of specialized facilities, and additive manufacturing training to Australia's Manufacturing Industry, including through its 'Lab22 Additive Manufacturing Innovation Centre'. The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is Australia's primary national research body, with over 5,000 researchers active over a wide range of fundamental and applied research challenges.

Cumberland Highstreet Partners
http://cumberlandhighstreet.com

Cumberland Highstreet Partners provides executive leaders access to a team of proven, experienced professionals who possess a deep domain knowledge of manufacturing. Services include Strategic Planning, Mergers & Acquisitions Assessments, Executive Leadership Mentoring, Supply Chain Optimization and Commercial Strategies.

Danobat S. Coop
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www.danobatcuttingsolutions.com; www.danobatgroup.com
salessaws@danobat.com

DANOBAT focuses on the design, development and manufacture of machine tools, high value-added production systems and fully flexible solutions, adapted to our customer's needs.

Internationalization has been an ongoing process. Therefore DANOBAT has production plants and service centers in Spain, Germany, UK, USA and Italy, as well as an important sales and service network which covers 40 countries.

Innovation is one of DANOBAT's hallmarks since it started its activity 65 years ago. Among its wide range of innovative solutions, DANOBAT offers its latest developments of customized solutions for the most stringent cutting processes. The latest technologies are utilized to achieve the highest rigidity and precision.

DANOBAT machines provide an ergonomic and high-end solution with a user-friendly and powerful software, and provides cutting edge sawing solutions.

DANOBAT supplies sawing solutions to customers demanding the highest technological requirements, in aerospace, oil & gas, forging industry, energy, mold and die, automotive, steel manufacturers.

DANOBAT is part of the DANOBATGROUP, the machine tool division of the Mondragon Corporation. With a turnover of 260 million euros and 1300 people, it is one of the main Machine Tool and production system manufactures in Europe.

More info, please visit us at: www.danobatcuttingsolutions.com

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Design Group
253-926-0884
www.bwdesigngroup.com

Design Group brings a broad and extensive depth of engineering and operating experience in titanium to work for you. With our expanded resources, and our understanding of the critical requirements of the RG/PG world opens the door for us to benefit your organization. Our experience and ability to assist across all facets of an operation, including sponge, sponge processing, scrap and scrap handling, scrap processing, blending, melting, finishing, flattening, and other operations, allows for integrated, comprehensive solutions.

We can partner with you to Optimize Processes and assist with reviews of your operations in regards to RG/PG standards and expectations. We will utilize our experience to upgrade or replace equipment to improve or increase your production capabilities. We can provide Facility Audits, Feasibility Studies, FEED Studies, and Detailed Engineering for new process and manufacturing facilities, including the integration of your control and data systems for reporting, chronological documentation and MIS reporting. And, we can audit your processes against industry quality standards and provide paths for continuous quality improvement.

We partner to make you better.

Duferco SA
+41-91-8225600
www.dith.com

Duferco Group is the ultimate shareholder of Vanchem Vanadium Products. (Pty) Ltd "Vanchem" and acts as its only distributor.

In 2016 Duferco SA has also taken up a long-term distributorship agreement for vanadium products from Chengde Steel HBIS "Chengde."

Chengde is an integrated steel and vanadium producer. Chengde vanadium products range include FeV50%, FeV80%, as well as standard and high-purity vanadium oxides and vanadium carbide nitride (VCN).

Edge International
+1(937) 395-7222
www.edgeintl.com
metals@edgeintl.com

Edge International, located in Dayton, Ohio, is an ISO 13485-certified stocking distributor of raw materials, specializing in medical grade Cobalt-alloys, Stainless Steels and Titanium for the manufacture of implants and instruments for the orthopaedic, spine and trauma markets. Edge works with its customers to provide cost-effective solutions and concentrates on the medical market to ensure the highest level of compliance, quality and service. Value-added services include precision grinding to size and tight tolerances, precision sawing, non-standard grades and sizes, and just-in-time inventory programs. Edge conducts business internationally, supplying to customers around the globe.

ELG Utica Alloys, Inc.
+1-315-574-1680
www.elguticaalloys.com

EUA is one of the world's largest Titanium, Nickel and Cobalt alloy recycling companies. We operate under the tightest quality standards, utilize the latest equipment, offer unparalleled service, are fed by over 40 sister yards worldwide and have the financial backing of ELG Haniel GmbH.

ELTRA
Applications Specialist: Cesar Ballester
(267) 757-0351 ext. 109
www.verder-scientific.com
info-us@verder-scientific.com

Eltra Elemental Analyzers, part of Verder Scientific, plays a key role to ensure that desired properties of the materials used in the construction of airplanes are met. Such material is subject to rigid testing and comprehensive quality control. This includes for example elasticity or the protection from embrittlement. ELTRA GmbH has over 30 years of experience in manufacturing of elemental analyzers for the determination of Carbon, Sulfur, Nitrogen, Oxygen and Hydrogen content, in metals and powders, with some of the analyzers specifically optimized for applications in the aerospace industry.

EWI
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EWI is the leading engineering and technology organization in North America dedicated to developing, testing, and implementing advanced manufacturing technologies for industry. Since 1984, EWI has offered applied research, manufacturing support, and strategic services to leaders in the aerospace, automotive, consumer electronic, medical, energy, government and defense, and heavy manufacturing sectors. By matching our expertise to the needs of forward-thinking manufacturers, our technology team serves as a valuable extension of our clients' innovation and R&D teams to provide premium, game-changing solutions that deliver a competitive advantage in the global marketplace. To learn more, visit www.ewi.org, email info@ewi.org, or call 614.688.5000.

FAE S.A.
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www.fae.com.ar
fae@conuarfae.com

FAE is an Argentinean company qualify for supplying hydraulic Ti-3Al-2.5V tubing for A320 family being the first Latin-American company in getting a tier one contract with Airbus. One of its main activities, apart from aerospace, is the manufacturing of seamless commercial pure titanium and titanium alloy tubes, straight or U bend for heat exchangers and instrumentation. The nuclear business is the origin of the company and the Zirconium cladding tubing for the nuclear fuel elements constitutes the main product of the company. It also produces nickel alloys 690 & 800 tubes for nuclear steam generators up to 35 meter lengths.

FAE is certified according to UNE EN 9100: 2016, ISO 9001: 2015, ISO 14001: 2015, OHSAS 18001: 2007, PED 97/23/EC & CSA N 285.0.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

FE Mottram Ltd
+44 1142446723
www.femottram.com

UK manufacturer of tailor-made and high grade ferro titanium.

Fine Tubes | AMETEK Specialty Metal Products

+44 (0)1752 876416
www.finetubes.com
sales.finetubes@ametek.com

Fine Tubes, part of AMETEK Specialty Metal Products, is a leading global manufacturer of precision tubing in high performance titanium, stainless steel and nickel alloys.

The company manufactures tubes in both seamless and welded forms used in mission critical applications across a range of specialty markets including aerospace, oil and gas, nuclear and medical.

TITANIUM TUBE EXPERTISE
- Seamless titanium tubes from 1 mm (0.040 in) OD to 45mm (1 5/8 in) OD
- Straight lengths up to 5.5 metres (18 ft.)

TITANIUM ALLOYS
Fine Tubes offers a comprehensive portfolio of titanium tubing in the following alloys:
Ti CP (Grade 1), Ti CP (Grade 2), Ti 6Al/4V (Grade 5), Ti 3Al/2.5V (Grade 9)
The tube mill has achieved NADCAP approval for Ultrasonic Testing, Heat Treatment, Fusion Welding, Chemical Processing and Fluid Distribution Systems.

WORLD CLASS TUBE MILL
Based in the United Kingdom, Fine Tubes operates several state-of-the-art titanium processing facilities including:
- Pilger Rolling Mills
- Draw Benches
- Vacuum Furnace Heat Treatment
- Chemical Processing
- Conditioning & Degreasing

Our metallurgical and engineering experts are ready to support your teams in developing competitive solutions for your most demanding technical challenges.

Fine Tubes, Superior Tube, Hamilton Precision Metals, AMETEK SMP Wallingford, AMETEK SMP Eighty Four and Reading Alloys – all leading manufacturers of advanced metallurgical products – form the AMETEK Specialty Metal Products division.

Flowserve
1 (972) 443-6500
www.flowserve.com

The Flowserve Corporation is an American multinational corporation and one of the largest suppliers of industrial and environmental machinery such as pumps, valves, end face mechanical seals, automation, and services to the power, oil, gas, chemical and other industries. Headquartered in Irving, Texas, which is a suburb of Dallas, Texas, Flowserve has over 19,000 employees in more than 60 countries. Flowserve sells products and offers aftermarket services to engineering and construction firms, original equipment manufacturers, distributors and end users. The Flowserve brand name originated in 1997 with a merger of BW/IP and Durco International.

Forecreu

World leader in high speed steel hollow bars for drills and coolant fed taps.

World leader in cannulated bars in stainless steel and titanium for surgical tools and implants.

Fort Wayne Metals
+1-260-747-4154
www.fwmetals.com
info@fwmetals.com

Fort Wayne Metals has a long history of producing precision titanium bar, wire and wire-based components for demanding applications. For many years, our efforts focused exclusively on the medical device industry. But our skills are just as valuable in many other critical applications.

After all, we understand the critical importance of quality: our employees have experience producing materials for applications designed to save lives. We uphold the highest quality standards throughout our production process – beginning with melting material in our own furnace. We are 9100C and ISO 9001 certified, and maintain a A2LA - ISO/IEC 17025 compliant Materials Testing Laboratory.

Available diameters:
Wire: 0.001" (0.0254 mm) to 0.062" (1.5748 mm)
Coil: 0.040" (1.016 mm) to 0.500"(12.70 mm)
Bar: 0.0787" (2.0 mm) to 3.000" (76.20 mm)

Available grades:
Commercially pure Titanium (ASTM F-67 • ASTM B348 • ASTM B-863 • ISO 5832-2)
Grades 1 - 4
Alloyed Titanium
Ti-6Al-4V ELI (ASTM F-136 • ASTM B-348 • ASTM B-863 • ISO 5832-3)

Friggi N.A.
+1-519-421-9291
www.friggiamerica.com
info@friggiamerica.com

Friggi N. A. Inc., provides premium metal and aluminum cutting solutions to the North American market. With over 70 years manufacturing experience we now offer large vertical plate and block saws, high-speed carbide saws, plasma, and waterjet cutting solutions. Within our product line, we offer specialized equipment to cut challenging materials like Titanium or exotic metals with extreme precision and performance. Our plate saw capacity is over 20 feet and our Gantry models will cut blocks up to 140" with minimal material handling. Machines are available in automatic or semi-automatic version to cover any requirement. We service many key market segments including aerospace, automotive, defense, oil and gas, steel service centers, forging and mold makers. Whether the application is to cut ferrous or non-ferrous metals for ingot, bar, block, or plate we offer the best solution for our clients' production needs.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Gautier Specialty Metals, LLC
814.535.9200
www.gautierspecialty.com
sales@gautiersteel.com

Gautier's premier plate mill provides rolling capacity for advanced high performance metals to a variety of industries.

At its heart is a 58" wide 4 High Mesta Reversing mill, capable of rolling the most difficult of specialty metals. The mill is expandable to 110" wide in the future. Building on Gautier's long legacy of short lead times and excellent customer service, GSM will be able to provide high quality alloy, tool and stainless steel as well as advanced nickel based and titanium alloys.

Large Alloy Selection: Alloy & Tool Steel, Stainless Steel, Nickel Based Super Alloys and Titanium

Built for Conversion on a quick turnaround.

GfE Metalle und Materialien GmbH
+49 911 9315 299
www.gfe.com
alloys@gfe.com

AMG TITANIUM ALLOYS & COATINGS GfE

GfE, founded in 1911 and being part of AMG Advanced Metallurgical Group N.V., is a leading manufacturer and global supplier of high performance metals and materials.

We offer a wide range of high-quality master alloys that meet the highest technical requirements for different specialized sectors, mainly aerospace, super alloy industry and ship-building.

Furthermore titanium as high-purity HDH powder is produced by GfE for thermal spray coatings. Its specific characteristics offer an advantageous material for porous layers on medical implants.

Our product spectrum is completed by inter-metallic Titanium Aluminum light weight alloys, known as gamma Titanium Aluminide alloys. Its present applications include low pressure turbine blades (LPT) for civil aircraft engines as well as turbocharger wheels for the automotive industry.

GfE is certificated in accordance to ISO 9001, EN 9100, ISO 14001, ISO 50001 as well as BS OHSAS 18001 and operates an accredited laboratory according to DIN EN ISO/IEC 17025.

GKN Hoeganaes Corporation
+1-856-829-2220
http://www.gkngroup.com/hoeganaes/pages/default.aspx

Hoeganaes Corporation is the world leader in the development and production of atomized metal powders. We span the globe with facilities in the Americas, Europe and Asia.

Global Titanium Inc.
1-313-366-5300
www.globaltitanium.com

Global Titanium is a leading producer of ferrotitanium, titanium scrap products, and titanium HDH powder. Located in Detroit, Michigan, Global Titanium serves the steel, stainless steel, aluminum, and titanium industries. Global Titanium is an ISO 9001:2008 registered company with a strong commitment to safety, quality, and customer service.

Goldman Titanium, Inc.
716.823.9900
www.goldmanti.com
info@goldmanti.com

Goldman Titanium, Inc. purchases and processes scrap titanium in order to supply the highest quality finished product to our customers. As a pioneer in the titanium industry, our company was first established in 1958, and we have continuously expanded our business over the years. Titanium is the only metal we handle, making us experts in our field.

Goldman Titanium is certified to AS9100D with ISO 9001:2015, complying with the rigorous requirements of the aerospace and defense industries. Our company's products have been approved by major U.S., European, and Asian melters, as well as by master alloy producers, steel and stainless steel producers, and ferro titanium producers.

Grandis Titanium
+1-949-459-2621
www.grandis.com
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GRANDIS TITANUM is an ISO 9001:2008 certified worldwide supplier of titanium products like Titanium Bars, Sheets, Plates and Wire for the Industrial, chemical and Additive Manufacturing / 3-D printing industries. Company maintains warehouses in Los Angeles and Rotterdam, and USA sales offices in California, Ohio and Oregon. We also have sales offices in South Korea, China, Russia, Belgium and Italy.

Hangzhou King Titanium
+86-571-86532468
www.king-titanium.com
info@king-titanium.com

King Titanium is an intermediate manufacturer and full-service distributor of premium titanium mill products. We specialize in supplying titanium mill products to machine shops, fabricators, prime contractors and subcontractors for aerospace, automotive, chemical, medical, oceanographic, oil & gas, semiconductor, recreational and other industries worldwide.

Hankook Titanium Co., Ltd
www.titanium.co.kr/

International purchaser of Minerals, Chemicals & Metals. 3,730 Employees.

Haynes International Inc.
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www.haynesintl.com
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Haynes International, Inc. is one of the world's premiere manufacturers of titanium tubing. HAYNES® Ti-3Al-2.5V alloy is used for aircraft hydraulic systems. Our seamless Grade 9 titanium tubing is produced to many industry specifications, including AMS 4943, AMS 4944, AMS 4945, AMS 4946, AS5620, SB 338/B 338Gr9 and UNS R56320. Additionally, Haynes is a leading developer, manufacturer and marketer of high-performance nickel- and cobalt-based alloys used in corrosion and high-temperature applications.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Hempel Special Metals AG
+41 44 823 88 24
www.hempel-metals.com

Hempel Special Metals AG is one of the largest stockists for Titanium, Nickel Alloy and Zirconium in Europe. Our companies are located in Switzerland, Germany, UK, Poland and we do have various sales representatives all over the world. Our main businesses are chemical process industry, flue gas desulfurization, oil & gas, medical and watch industry. Beside all standard titanium grades we stock special grades (Grade 4, 5, 5-ELI, 7, 9) in bars, sheet/plates and tubes. Our services include individual stocking, cutting, sawing, plasma, laser- and water jet cutting, individual bar marking and turning. We supply material tailor made and in packages for special projects.

Hi Tech Alloys, Inc.
+1-925-937-3836

Incorporated in 1982.

Hoeganaes Specialty Metal Powders
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http://www.gkngroup.com/hoeganaes/pages/default.aspx
AMinfo@hoeganaes.com

Hoeganaes Specialty Metal Powders engineers gas-atomized metal alloy solutions for the aerospace, medical, and automotive industries. Located in Cinnaminson, New Jersey, USA, Hoeganaes Specialty Metal Powders provides complete support and consistent quality required to meet the most demanding applications. AncorTi Ti6Al4V and commercially pure Ti are available in a range of particle sizes and purities including those that meet ASTM specifications. Additional alloys have been developed to encompass even more demanding characteristics needed beyond standardized product lines. Qualified powders are ideal candidates for additive manufacturing and applications used in the aerospace, chemical, marine, and medical industries. Contact our technical sales lead to learn more about what we can offer you.

Hogue Metallography

Services Include:
- Metallographic Services
- Sample Preparation - metals and non-metals
- Documentation - macro and micro
- Interpretation of Microstructures and metallographic
- Failure Analysis
- Industrial Problem Solving
- Litigation
- Laboratory Design
- Equipment selection
- Selection of optimum consumables
- Layout

Consulting may be performed on site, in the field, or at my laboratory. Training Courses Offered.

HORIE Corporation
+81-256-66-2237
www.horie.co.jp
a-tanabe@horie.co.jp

Horie Corporation is the world leader at surface engineering of Titanium such as precision coloring, etching, grain controlling and the solution provider to complex titanium fabrications. Horie has developed its original titanium technology using Horie's electro-chemical technology and surface treatment technology. Our titanium knowledge provides our customers with unequaled solutions in titanium. Horie will continue to develop many new products and search the unlimited possibilities and beauty of titanium.

Independent Forgings & Alloys Ltd
+44-114-234-3000
www.independentforgings.com
sales@independentforgings.com

Independent Forgings & Alloys ltd is an open die forge with expertise in titanium, nickel and steel alloys. Processing ingots to billets, rolled/ hammer forged rings and flat bars through our onsite capabilities which include a 1600 tonne open die press, 2 x ring rollers, 3 forging hammers, NADCAP approved heat treatment and machining facility.

Inductotherm Corp.
+609-267-9000
www.inductotherm.com
sales@inductotherm.com
President: Bernard Raffner
Director - Technical: Bert Armstrong
Director – Sales: Andrew Procopio

PRODUCTS and SERVICES - Inductotherm manufactures a complete line of induction heating and boosting systems for titanium slabs, billets, blooms, bars and rods prior to rolling. Other products include vacuum induction melting, holding, pouring, heating and coating equipment for thermal applications in air or controlled atmospheres for the metals industry. Coreless and channel furnaces with capabilities up to 500 tons; power supplies up to 42,000 kW; automated pouring systems with vision control; computer controls and charge handling systems.

Industrial Metals International Ltd.
+1-631-981-2300
www.industrialmetals.com

IML is a supplier of bar, sheet, tube, wire, rings and forgings in aluminum, titanium, nickel stainless steel, alloy and bronze products. In business for over 40 years, IML is approved by companies such as Rolls Royce, Boeing, Airbus, UTAS, GE, and Pratt and Whitney. Located near JFK Airport in NY, IML is able to offer same day shipping to countries worldwide with no minimum order charge for stock items.

INTECO melting and casting technologies GmbH
+43 3862 53110-0
www.inteco.at
inteco.austria@inteco.at

INTECO is proud to be nowadays the worldwide leader in metallurgical process technology and the related equipment offering controlled melting, remelting, atomization and solidification processes for special steels, super alloys as well as titanium and its alloys.

INTECO - over the last decades - has performed significant and internationally well recognized developments and has successfully put into operation all respective and relevant production processes such as:

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

- Steelmaking, Refining and Casting
- Vacuum Induction Melting (VIM)
- Electro-Slag-Remelting (ESR)
- Vacuum-Arc-Remelting (VAR)
- Titanium Production
- Powder Technology
- Production Management systems
- Consulting Services

Merging process technology and supply of the related equipment, together with our clear focus on the continuous improvement of existing as well as the development of new technologies represents our sustainable strategy well.

Invera

+1-610-325-0124
www.invera.com
peterd@invera.com

Invera is the leading supplier of ERP software for the metal distribution industry. Our STRATIX software provides advanced functions for sales, inventory control, production, shipping and outside processing of specialty metals.

Metal Specifications, Mill Test Certs and third party certificates can be controlled within STRATIX and as required emailed to customers upon shipment.

Full product traceablity enables companies to have complete control and accountability of all material purchased, processed and shipped to customers.

Invera also provides INVEX for eCommerce and Customer Web Service options over the internet. Coupled with the INVEX-CRM applications companies can optimize the sales process by recording quotes, activities and tasks. STRATIX-ONE a Decision Support & Management Dashboard provides executives and managers with real time sales, operations and financial information.

Because STRATIX was designed from the ground up for metal distributors and processors the inventory can be accessed using metal industry nomenclature. A complete solution tailor made for titanium metal companies.

Jiang Su Heng Feng Bellows Co., Ltd

+86-0523-88339866
www.jyhf.com

Jiangsu Heng Feng Bellows Co., Ltd. is one of the famous bellows manufacturers in China. The company is located in the economic development circle of the Yangtze River Delta - Taizhou City, Jiangsu Province. Founded on August 28, 2001, the company has a registered capital of 86 million. The factory is more than 24,000 square meters and has nearly 100 employees, including 30+ scientists and technical staffs. It is a company with optimized management, excellent staff, world leading production technology, and excellent product quality, integrating R&D, production, and foreign trade.

Since its establishment in 2001, the company has passed ISO9001: 2000 certification, the People's Republic of China special equipment (pressure piping) manufacturing license, license number: TS2732171-2020, ISO14001 environmental management system certification, OHSAS18001 occupational health and safety management system certification.

Jiangsu Tiangong Technology Company Ltd.

0511-86319358
www.tggj.cn
rongjun_jiang@tiangong-tools.com

JIANGSU TIANGONG TECHNOLOGY CO., LTD was established in 2010, is a wholly owned subsidiary of Tiangong International. The company is located in JuRong City, JiangSu Province. our company is a production, sales strategy based on titanium and titanium alloy new materials, Tiangong has smelting, forging, hot rolling, cold rolling, finishing a series of production process of finished materials, the main products are titanium ingot, titanium bar, titanium tube, titanium plate, titanium coil, hot rolled tape. Titanium wire etc.

KASTO, Inc.

1-724-325-5600
www.kasto.com
sales@us.kasto.com

KASTO, Inc is the world's only COMPLETE supplier of Metal Cutting Machinery offering all available Metal Sawing methods. These include Band Saws, Plate & Block Saws, Cold Circular Saws & Hacksaws. Customers benefit from un-biased recommendations about which Metal-Cutting Equipment is best for their application. We also offer complete Storage and Retrieval Systems!

Kennametal

888-777-6852
www.kennametal.com
k-hntv.inside-sales@kennametal.com

Kennametal® is a leading global manufacturer of industrial tooling, premium-quality metals, master alloys and metal powders. Founded in 1938, Kennametal employs more than 11,000 people around the globe serving customers in more than 60 countries.

With a variety of capabilities and expertise to match, Kennametal consistently delivers cost-effective solutions that meet or exceed the titanium industry's strict purity, chemical, and particle-size specifications. Their experience in Vanadium (VAI), Molybdenum (Ti-17, AlMoTi, AlMoV), Niobium (AlNb) and Chromium(AlCr) master alloy production is consistently proven in on-time deliveries and exceptional product quality.

Kennametal's aerospace grade master alloys are manufactured via open air, inert gas, aluminothermic and/or VIM, where absolute control over impurities, inclusions, oxygen and minor additions are maintained. Prior to their release, Kennametal ensures that all alloys meet specification through stringent quality and test systems, which are certified to AS9100/IS9001, NADCAP and ISO17025.

All of Kennametal's customers are met with personalized and professional service on every inquiry. Materials and manufacturing experts are always available to consult on material applications and specific solutions.

Keywell Metals, LLC

+1-773-572-6173
www.Keywell.com

Keywell Metals, LLC is the industry leader in specialty steel recycling and a worldwide purchaser, processor and seller of titanium scrap metal for ingot formulation, alloy additions and ferro-titanium production. In addition to the complete range of processing capabilities, Keywell Metals, LLC operates the largest and most modern fully equipped on site analytical laboratory in the

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scrap metal industry. Every product shipped from Keywell Metals, LLC is fully certified and guaranteed to meet Customer Specification.

Kings Mountain International (KMI)

+1-704-739-4227
www.kmiinc.net
sales@kmiinc.net

Kings Mountain International (KMI) is an ISO9001:2015 / AS9100D certified precision grinding company.

KMI processing includes:

- Flat / Tapered / Contoured precision thickness machining
- Tolerances to +/-.001" (.0005" upon request)
- Sizes up to 110" x 360: larger sizes upon request
- Weight control for Aerospace applications
- Thin sheet grinding to .010"
- Surface Finishes from 250 RMS to 12 RMS and finer
- Polishing of sheet and plate to #3,#4 or #8 mirror. Non-directional also available

Benefits:

- State of the art measurement instrumentations
- Experience with all types of metals
- Plate / Sheets arrive clean, damage free and ready for fabrication

Industries we serve:
Aerospace / Defense/ Energy / Commercial Aircraft / Architecture

The Kerala Metals and Minerals Limited (KMML)

+91-94960-12538
www.kmml.com
md@kmml.com or managerprojects@kmml.com

Manufacturer of Titanium Sponge, TiO2 pigment, Zircon, Rutile, Sillimanite etc. The Kerala Minerals and Metals Limited (KMML) is a flagship public sector unit under the state ownership, currently engaged in the manufacture of TiO2 pigment through chloride route, Ti sponge, Zircon, Sillimanite etc. Normally in India, the Titanium Metal is produced only by the Government Organizations. Ti sponge produced at KMML is further processed at MIDHANI (Mishradhathu Nigam Limited), Hyderabad, a central public sector organization handling some of the strategic materials in the country.

Kocks Pittsburgh Company

+1 (412) 3 67 – 41 74
www.kocks.de/en/company/locations/pittsburgh/
kpc@kocks.de

For KOCKS, innovation is a part of tradition. Innovation was at the beginning of the company's history with the idea of applying the 3-roll technology to forming tube as well as wire rod and bar. To date it determines the development of the company. To follow new avenues and to continuously optimize what seems to be perfect – this tradition keeps the company young and thrills our customers.

Kolene Corporation

313-273-9220
www.kolene.com

Kolene specializes in designing and developing metal cleaning processes utilizing fused or molten inorganic salts. One of our major applications is surface conditioning of titanium oxides and forming lubricant removal. Surface conditioning prior to pickling and chemical milling promotes uniform surfaces and metal removal. Processes to remove vitreous lubricants and molybdenum disulfide are available.

Kolene designs both process equipment and process chemicals to provide single-source cleaning systems.

Kolene Corporation was founded in 1939 in Detroit by John Shoemaker. It continues today as a privately held company with 3rd and 4th generation Shoemakers active in the business.

KOS, Ltd

+82-10-7175-2650
www.koswire.com
chlee@koswire.com

Our company, KOS Ltd. started producing stainless steel rope on 1969. For almost 50 years' experience, nowadays KOS Ltd. is one of the top company on manufacturing high quality stainless steel wire and rope. For the last 10 years, business was expanded to superalloy to answer the demand from our customers in domestic and abroad.

To answer the serious global competition, now we are focusing on manufacturing Titanium Bar and Wire. This project has been started several years ago and it is almost done. Our big target is to supply high quality product and service to meet the optimal delivery time.

We have unique technology to save production cost including manufacturing strategy. We have special furnace, centerless grinding, precision straightening machinery and production area only for Titanium manufacturing.

KOS Ltd. takes a step closer to consumable, medical and aerospace titanium market.

Laboratory Testing Inc.

+44 800-219-9095
www.labtesting.com
sales@labtesting.com

Laboratory Testing Inc. is an accredited, independent laboratory specializing in Materials Testing services, including chemistry, high-cycle fatigue, fracture toughness, fatigue crack growth and tensile testing. We test input materials, prototypes and finished products.

Our Machine Shop can prepare all specimens and samples for testing, and runs on two work shifts for reliable, fast turnaround. We also build out specimens to order for customers who do their own in-house testing.

LTI has been in business since 1984 and has a team of over 170 employees that includes engineers, chemists and other technical experts. This group has years of experience in the aerospace, power generation, medical, transportation and other industries.

LTI is NADCAP accredited, A2LA accredited to ISO/IEC 17025, and compliant with ASME NQA-1, ISO 9001 and ISO 13485. Our lab is on the approved supplier list of hundreds of prime contractors, industry agencies

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and customers. Testing is performed to ASTM standards and industry specifications.

With a 104,000 sq. ft. facility near Philadelphia, PA, LTI is one of the largest full-service testing laboratories in the USA and fully capable of handling and testing materials of all shapes, sizes and quantities. Call or visit www.labtesting.com for a fast quote.

LAI International

+1-518-273-3912
www.laico.com/industrial

LAI International (formerly Zak Incorporated) is a fully integrated design, fabrication, machine, and test facility. We engineer, manufacture, and refurbish crucibles, liners, molds, and accessories for the remelting and production of specialty metals. Our manufacturing and consulting experience has contributed significantly to the VAR, ESR, Plasma, EB, C.C., and EBPVD processing industries. This experience, along with our precision CNC machining capabilities, will extend your product life cycles and improve the reliability of your process. Our ISO 9001-2008 certified services include a full range of dual pallet, multi-axis CNC machining centers with live tooling; MIG, TIG, and stick welding of copper and other dissimilar metals; hydro, helium, X-ray and other available NDT services. For more information about Zak Incorporated, please visit us at www.laico.com/industrial

L.C.M.A.

+352 26 55 43-1
www.lcma.lu
Mr. Otis Claeys – CEO: claeys@lcma.lu
Mr Thomas Mitidieri –
Production Manager: Thomas@lcma.lu

Founded in 1996, LCMA is now a fully integrated producer, processor and distributor of a wide range of semi-finished titanium and titanium alloy products for aerospace, medical, petrochemical and industrial applications.

We work with several manufacturers based in Ukraine and Europe who convert our Grade 1 to 5 ingots in forged and rolled bars, sheets, plates, coils, spools, electrodes, tubes and more. LCMA is ISO 9001:2015 and AS9100D aerospace approved and is PED97/23EC certified.

Being part of a vertical integrated structure LCMA controls quality at all production processes and all products are US, EC and HB tested. We deliver to customers all over the world and our Quality, Experience, Flexibility, Short lead time, Large stock and Competitive prices makes us one of the key players on the market.

Please contact us at fax: +352 26 55 13 45 or Email : lcma@pt.lu

LL-resources GmbH

+43-316-890-368
www.ll-resources.com
Marc.gutschy@ll-resources.com

LL-resources is an independent, global mineral resource commodity management, trading and consulting establishment. We are running our own productions for Ferro Titanium, both in Sweden as well as in Russia. We offer our partners the total value chain solution (ore body to market) by maximizing value and minimizing risks. By firmly applying to our corporate governance, high quality standards and procedures & responsibility scheme we are in the position to guarantee professionalism, innovativeness and top quality to our diverse pool of small and midsized corporations as well as global players.

LOTERIOS S.p.A.

+39-02-9648281
www.loterios.com

LOTERIOS is a leading fabricator of titanium pipe, fittings, shell and tube heat exchangers and vessels as required.

Louyang Hexin Titanium Industry Co., Ltd

Luoyang Hexin Titanium Industry Co., Ltd was founded in 2014. Our company produces titanium products since 2014, including rods, tubes, and plates.

Products are widely used in petrochemical, sait. Offshore industry, energy generation and other industries. Typical applications include: Titanium and titanium alloy bar for hot-rolling; Titanium alloy standard parts; All kinds of corrosive fluid transmission pipeline system; Titanium bicycle tube; automobile exhaust pipe; Offshore aquaculture

Mair Research S.p.a.

+39 0445 634 444
www.mair-research.com
salesdept@mair-research.com

Since 1977, MAIR Research has offered specialized equipment and services to the steel industry, specifically helping tube and bar producers to create profitable and efficient production processes in a safe environment.

The highest levels regarding innovation and quality are achieved through young and well experienced technical personnel, for the electrical design, software programming and the pre and after sale service.

Single stand-alone equipment or customized complete and integrated finishing lines are developed by an experienced team of technicians and are entirely manufactured in two modern production facilities covering a total surface area of 36000 sqm.

Mair Research has gained significant experience in the field of finishing lines for tubes and bars by supplying turnkey solutions to customers in over 45 nations. Recently, fully integrated, automatic lines have been produced by Mair Research for the most demanding customers worldwide.

Thanks to the reliability of our equipment we reach important targets on the field of special alloys and titanium alloys. The modern controls and a dedicated softwares developed for the finishing field allows fully automatic processing on the lines and consequent reduction of production cast with high repeatability standards.

Mair Research can be your one-step supplier for all your finishing lines.

For additional info do not hesitate to contact us via our website: www.mair-research.com

Makino

1-800-552-3288
www.makino.com

A world leader in advanced CNC machining centers, Makino is committed to providing high-performance, leading-edge machining technologies and innovative engineered process solutions that enable manufacturers to focus on making what matters. Makino offers a wide range of high-precision metal-cutting and EDM machinery, including horizontal machining centers, vertical machining centers, 5-axis machining centers, graphite machining centers, and wire and sinker EDMs.

Makino's flexible automation solutions provide reduced labor costs and

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increased throughput in a variety of production volumes and designs. Makino's engineering services offers industry-leading expertise for even the most challenging applications across all industries. For more information, call 1-800-552-3288 or visit makino.com.

Matmatch GmbH
+49-152-56445541
www.matmatch.com

Matmatch is an online platform that helps product designers and engineers to find, evaluate and source materials. With a database of thousands of materials, an intuitive search tool, and supplier listings, it changes the way product teams find materials for their products. For material suppliers, we offer a new way to reach customers online. As a go-to source of information for engineers, Matmatch is the perfect platform for suppliers to raise awareness of their products and brand. We offer insights, analytics and opportunities to promote their expertise.

ATS-MER
+1-520-574-1980
www.mercorp.com

The technologies MER pursues includes: Rapid Additive Manufacturing, Titanium Powder and Fabrication by Additive Manufacturing, Metal and Carbon Matrix Composites, Electrochemical Systems, Porous Materials, Coatings, Spinel and Nanotechnology. MER develops processing to produce titanium more economically that includes lower cost than sponge and downstream additive manufacturing processing to produce low cost titanium components. These technologies include producing titanium powder directly from ore/TiO2 at a cost substantially lower than that of Kroll sponge, engineering the Kroll process entirely in one reactor at a reduced cost, producing titanium alloy powder from ore/TiO2 and one-step production processing near net shape alloy components at a cost of under $10/lb.

Medart, Inc.
+1-724-752-2900
www.medartglobal.com
sales@medartglobal.com

Medart designs and manufactures centerless bar peelers, coil to coil peelers, coil to bar peelers, straighteners, fastener wire pay-off systems, take up systems, plane straighteners and engineered material handling equipment. Purpose built processing equipment for the titanium industry.

Metals & Alloys UK Ltd
+44-(0) 114 354 0117
www.metalsandalloys.co.uk
Aaron James: aj@ferroti.com

We are a trusted manufacturer of Ferro titanium and supplier of Titanium scrap and Noble alloys. Specializing in Titanium, we buy and sell all grades of Titanium scrap. All incoming scrap is sorted and prepared at our UK facilities. Depending on the quality of the Scrap, it will either be used in our Ferro titanium production or recycled back to the metal industry.

METALVALUE
+33680562848
metal@honnart.fr

METALVALUE provides strategic consulting services and invests into selected industrial companies.

Metalwerks PMD, Inc
+1-724-378-9020
www.metalwerks.com

Metalwerks PMD, Inc. produces a wide variety of specialty metals, superalloys and developmental alloys in Iron, Nickel and Cobalt based alloys. We melt current and developmental titanium alloys in ingot form from 400 grams to VAR ingots weighing up to 5000 pounds. We also convert these ingots into mill products for use by our customers.

Metalysis Ltd.
+44 (0) 1709 872 111
www.metalysis.com
kartik.rao@metalysis.com

Metalysis is a UK-based technology company, which has developed a proprietary process to produce metal powders at low cost using electrolysis. It is currently focused on the production of tantalum and titanium alloy powders for use in conventional and additive manufacturing, with a variety of applications in industries including aerospace, electronics, bio-medical, petro-chemical and automotive.

MetCon, LLC
+1-724-888-2172
www.MetConLLC.net

MetCon provides conditioning and finishing services for both intermediate and finished products, including bloom, billet, bar, plate, sheet, and machined or fabricated components employing a patented "Green" electrochemical technology. Product yields and costs are dramatically improved when compared to conventional processing. The technology can also provide alpha case removal, precise gauge removal, and ultra-bright micropolishing. MetCon is based in Monaca, PA, 30 miles northwest of Pittsburgh.

Mega Metals, Inc.
+1-602-258-6677
www.megametalsunlimited.com

Mega Metals Inc., is a globally recognized high quality processor of Titanium Turnings and Solids. We are certified by major mills and casting houses for prepared aerospace grade material. Our philosophy is to unite the highest quality in customer service with the highest quality of our materials, in order to serve the expanding international demands of the metals recycling industry.

METRACO NV
+32 56 234400
www.metraco.be

European traders of ferro-alloys and non-ferrous metals. Specialized mainly in ferro titanium, titanium sponge and manganese metal. Supplying all

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grades of FeTi 70 % and buyers of titanium scrap and low grade sponge for FeTi production. Supplying steel grade sponge directly to steel mills and master alloy producers worldwide.

MetSuisse® Distribution AG

+41 44 586 02 74
www.metsuisse.com
info@metsuisse.com

MetSuisse® reflects the precision and high quality products the industry requires. Next to our experience we are the first metal distribution company specialized in the medical industry, and operate strictly according to ISO 13485 (Medical) and the GDP standards valid for pharmaceuticals (besides ISO 9001). The stringent and precise requirements found in the medical & watch industry has given us the experience and abilities required to meet the various requests. Currently, we are specialized mainly in the metals titanium zirconium, CoCrMo, medical stainless and tungsten alloys. However, you can contact us with any of your sourcing requests. We work with dedicated partners worldwide.

MetSuisse® has a unique grinding facility allowing: precision grinding of titanium foils, sheets and plates technology applied for the Swiss medical and watch industry no min. quantities for CP Grade 1, 2, 4 and Ti6Al4V Eli min. 0.09 +/- 0.015 mm (= in inch 0.003543307" +/- 0.000590551").

We can ground up to a format of 1'000 x 2'000 mm.

Mid-West Machine

+1-205-663-0732
www.vulcangroup.com
sales@vulcangroup.com

Mid-West Machine™ provides metal conditioning equipment and systems for the Steel and Titanium industries. This includes both bonded wheel and coated abrasive belt grinders. We offer Traveling, Stationary, Gantry, Overhead, and Ingot End Grinders as well as material handling equipment for processing slabs, billets and rounds through the grinders.

Mobile Alloys

323-570-8914
http://mobilealloys.com

Titanium and titanium alloy scrap processing.
Prepared vacuum grade additive.

Monico Alloys

(310) 928-0168
www.monicoalloys.com
info@monicoalloys.com

Monico Alloys specializes in the processing of titanium scrap in the form of solids and turnings. Monico is a Global Mill processor for Titanium Scrap metal ISO 9001:2008 and approved by every major titanium melter. Monico Alloys prepares bulk-weldable solids, feedstock, cobbles, and turnings to rotor quality specifications. Monico Alloys remains the industry leader by utilizing only the latest scrap processing technology. Monico Alloys offers a wide variety of Titanium Alloy inventory which includes CP, 6-4, 6-2-4-2, 6-6-2, 3-2.5, and others.

MoTiV Metals, LLC

+1-412-897-3066
www.motivmetals.com

MoTiV Metals, LLC is an independent sales and marketing company supplying molybdenum, titanium, vanadium and other products to the global steel, titanium and chemical industries. The company has a vast array of expertise and knowledge in domestic and international sales, logistics and supply chain management.

MoTiV Metals LLC offers Master Alloys to the Titanium industry, through its relationship with BHN Special Materials Ltd, including V-Al, Mo-Al, and other alloys.

Multi-Etch LLC

(928) 634-5307
www.multietch.com
info@multietch.com

Multi-Etch is a low-acid (pH 6.8), far safer etchant for titanium and other metals, with a less toxic waste stream, when compared with hydrofluoric and nitric acids. Preparing titanium with Multi-Etch enables anodizers to produce brilliant colors and welders to achieve welds that can withstand the rigors of deep space and deep ocean uses. Multi-Etch is also used to brighten titanium mill products and tumbled titanium parts, and to erase anodizing mistakes. Industries regularly using Multi-Etch include aerospace, medical, dental, jewelry and other arts, marine, architectural, and industrial.

NEOTISS

+33 1 70 98 30 05
www.neotiss.com
contact.fra@neotiss.com

NEOTISS is leader in the manufacturing of titanium and stainless steel thin welded tubes serving all demanding industry markets from power generation to desalination, process, automotive and more. Our products include not only bare, straight tubes but enhanced surface tubes, such as low fin, helix and corrugated tubes as well as u-bent tubes for special applications. The highest level of quality and safety in the market is guaranteed by stringent control procedures and unchallenged technical experience. The best testimony of product quality is the long list of references, worldwide. Our R&D teams develop ambitious innovation and research programs to enhance the performance of the tubes in the toughest environments. We have high manufacturing capacities, with production mills on three continents, Asia, North America and Europe, (namely in China, France, India, South-Korea, the USA) as well as a secured access to superior quality titanium strip.

NF&M International

www.nfm-titanium.com

NF&M International, Inc., subsidiary of VSMPO-Tirus US, is a producer of premium quality triple melted and standard grade titanium bar and billet products for the aerospace market and manufacturer of small-diameter precision tolerance bar and seam free coil products for aerospace fastener, automotive and medical applications. NF&M also provides a wide range of conversion services, including intermediate grinding and finishing of bar/billet, heat treating, straightening, bar peeling, bar polishing, pickling and inspection. NF&M's Nadcap approved laboratory performs room temperature tensile, hardness, hydrogen analysis and micro/macrostructure evaluation.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Ningbo Chuangrun New Materials Co., Ltd
+86-574-62067588
www.crnmc.com
mohan.su@crnmc.com

Ningbo Chuangrun New Materials Company (CRNMC) is a start-up company which was established in 2012, mainly focus in manufacturing of high purity titanium. Located in Ningbo, Zhejiang Province, CRNMC possess electrolysis refining process and double-gun EB melting process in house. CRNMC also has two branches in Zunyi and Baoji, for titanium sponge manufacturing and high purity titanium processing, respectively.

CRNMC provides world-class high purity titanium products in various of purities (from 99.95% to 99.999%), serves semiconductor industry, vacuum coating industry as well as aerospace industry. Not limited to high purity ingots, CRNMC supplies high purity titanium mill products such as sheets, blanks, billets, tubes and also high purity titanium powder.

CRNMC produces in well-established quality control system with ISO 9001 certificate and conducts business with professional knowledge and absolute integrity.

NobelClad
+1 303.665.5700
www.nobelclad.com
sales@nobelclad.com

NobelClad is the world leader in the field of explosion welding. We have more than half a century of expertise, and we are the one company with the most global resources and infrastructure committed to clad, offering bi-metallic solutions for complex industrial markets, including oil and gas, chemical, and transportation. We work with global partners across the supply chain not only to deliver the highest-quality, most cost efficient clad materials on time, but to inform and help develop project specifications from the onset. Our design ingenuity, technical proficiency, and unparalleled dependability make us an invaluable resource for process architects, engineers, and fabricators alike. That's why our clad materials are the preferred specification for high stakes industrial infrastructure applications all over the world. Specialties: Explosion Welded Clad, Longitudinally Welded Pipe, Pressure Vessels, Heat Exchangers, Structural Transition Joints, Electrical Transition Joints, Cryogenic Transition Joints, Flat Plates & Cylinders, Heads, Tube Sheets.

Nooter Construction Company
314.421.7211
www.nooterconstruction.com
kekitchen@nooter.com

Nooter Construction Company is a national full-service industrial construction contractor. Nooter Construction Company has a long history of providing innovative solutions to complex problems with field service of reactive alloys. We have the capability to perform large capital projects and smaller maintenance work that requires specialty welding with materials such as titanium. Please give Nooter Construction Company a call to discuss your projects where reactive alloys will be processed and welded in the field.

Norsk Titanium
U.S. Customers: +1 518 324 4010
European Customers: +47 97 42 22 00
www.norsktitanium.com
U.S. Inquiries: info@norsktitanium.com
European Inquiries: post@norsktitanium.no

Norsk Titanium AS is the world's pioneering supplier of aerospace-grade, additive manufactured, structural titanium components. The company is distinguished in the aviation industry by its patented Rapid Plasma Deposition™ (RPD™) process that transforms titanium wire into complex components suitable for structural and safety-critical applications. Norsk Titanium is a tier-1 supplier to Boeing and is committed to cost-reducing aerostructures and jet engines for the world's premier aerospace manufacturers. RPD™ is the world's first FAA-approved, 3D-printed, structural titanium, delivering substantial lead-time and cost savings for aerospace, defense, oil and gas, and commercial customers.

European Customers: +47 97 42 22 00

North American Alloys
+1-800-985-2250
www.northamericanalloys.com
Contacts:
Steve Meredith, Director of Sales: steve@northamericanalloys.com
Peter Mason, Outside Sales: petermason@nothamericanalloys.com
Michael Shulimson, President: michael@northamericanalloys.com
Peter Rockefeller, Warehouse Mngr.: peter@northamericanalloys.com

Now celebrating our 35th year in business, North American Alloys processes titanium alloy scrap for recycling and warehouses stocks of new and surplus lots of titanium mill products. North American Alloys warehouse in Kennewick, WA handles titanium sheet, plate, bar, billet and tubing.

Please visit our website at www.northamericanalloys.com to view our current inventory of titanium products. North American Alloys is always seeking new sources of excess inventory materials in titanium, cobalt or nickel alloys and specialty metals such as tantalum, columbium, zirconium and beryllium.

NSL Analytical Services, Inc.
+1-216-438-5200
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mgorris@nslanalytical.com

A recognized leader in analytical testing, NSL Analytical Services, Inc. is an Independent Commercial Testing Laboratory specializing in Inorganic Elemental Chemical Analysis, Metallurgical and Microscopy Evaluations, Polymer Materials Testing and Metal Powder Evaluations. NSL Analytical helps customers achieve the highest standards of product quality from design to launch by providing accurate, reliable and repeatable materials testing results through Trust, Technology and Turnaround.

Nu-Tech Precision Metals
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shook@nutechpm.com

Nu-Tech Precision Metals manufactures by hot extrusion seamless pipe, tube, fittings, bar, rod and shapes for nuclear, aerospace, military, medical,

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offshore, mining, chemical, sub-sea and corrosive environments. Extruded shapes, especially those for the aerospace industry in 6Al-4V, fit within a 12" (300 mm) circle size. Our extrusion process creates a near-net shape that reduces material and machining costs overall. Our ability to alpha-beta process results in improved fatigue resistance over beta extrusions… contact us to learn more about how this process will benefit your extrusion requirements. Seamless pipe from 1.5" (40 mm) to 14" (350 mm) plus specialty sizes and wall thickness. In-house finishing options including OD grinding or machining, ID honing or boring, hot straightening, pickling, non-destructive testing and electron beam additive manufacturing and welding are a few of the services we offer.

Oerlikon

https://www.oerlikon.com

Oerlikon Metco is a global leader in surface engineering solutions that bring benefits to customers through a uniquely broad range of surface technologies, equipment, materials, services, specialized machining services and components. The surface technologies such as Thermal Spray and Laser Cladding improve the performance and increase efficiency and reliability. Oerlikon Metco provides a comprehensive manufacturing, distribution and service network, catering to aviation, medical, power generation, automotive and other strategic growth industries such as additive manufacturing and operates a dynamically growing network of more than 50 sites in EMEA, Americas and Asia Pacific.

OSAKA Titanium Technologies Co., Ltd.

+81 3 5776 3103
www.osaka-ti.co.jp

OSAKA Titanium technologies Co., Ltd. manufactures premium quality titanium sponge mainly for aerospace use, high-purity titanium billet and polycrystalline silicon for semiconductor industry, titanium powder for powder metallurgy and additive manufacturing, and other titanium-silicon related products.

Paris Saint-Denis Aero

http://www.psdaero.com

PSD AERO is one of the main supplier for raw materials products of key players in the aviation sector (for example AIRBUS, SAFRAN, AIRBUS HELICOPTERS, DASSAULT AVIATION, etc). Our Quality Management System meets the IAQG's series requirements.

Our stock at your disposal is the biggest Aerospace metallic stock in the world.

With our experience and rigor acquired during the last few decades, the company consists of 90 staff members that have enabled us to increase our turnover 10 times in 10 years.

We are providing solutions in cutting optimization (conventional saws but also waterjet).

Description of our waterjet capabilities:

- Size up to 12 000 x 3 000 mm
- Waterjet Pressure up to 6000 bars
- Mono et Multi cutting heads
- Part up to 10 tons

PCC Metals Group

http://www.pccmetalsgroup.com/

The PCC Metals Group brings together TIMET, a vertically integrated titanium supplier; and Special Metals, a leader in nickel alloy development. With over 200 years of collective experience, each organization is an R&D leader in their respective industries. The PCC Metals Group unites the unique capabilities of each company, leverages their strong metallurgical expertise, and is able to better serve customers in the specialty metals market.

PCC Revert Group

http://www.pccforgedproducts.com/brands/caledonian_alloys/

The PCC Revert Group combines the assets of Caledonian Alloys and SOS Metals, and is the world leader in the management of nickel and cobalt base superalloy and titanium alloy recycling for the aerospace, land-based turbine, and chemical industries. The company transforms revert into material ready for remelitng to produce new nickel, cobalt, or titanium alloys. The Revert Group provides customers with a range of tailored revert management services designed to enable them to optimize the use and value of their own revert material. Accredited with all major vacuum and high temperature melters worldwide, Caledonian Alloys and SOS Metals supply fully processed nickel and titanium revert material to the melting industry. Both SOS Metals and Caledonian Alloys also purchase revert material from a wide range of industrial customers throughout the world.

Perryman Company

+1- 724-746-9390
www.perrymanco.com

Perryman Company is a vertically integrated producer of specialty titanium products. Our operations include melting, forging, and fabrication to finished products. Perryman's quality, technical expertise, and customer service is unmatched. Perryman supplies and services customers in the aerospace, medical, consumer, recreation, infrastructure and 3D printing/additive manufacturing markets worldwide. Approvals include ISO 9001:2015; AS9100D and NADCAP. Perryman Company is headquartered in Houston, Pennsylvania. Our melting facility is located in Coal Center, PA and our hot rolling and finishing operations are in Houston, PA. Additional intermediate processing is located in Frackville, PA. Company sales offices are located in Houston, PA; Philadelphia, Los Angeles, London, Zurich, Tokyo, and Xi'an.

Plymouth Engineered Shapes

800-718-7590
www.plymouth.com
jlake@plymouth.com

Plymouth Engineered Shapes is the premiere provider of near-net extruded shapes for a large variety of applications. All customers want to squeeze more cost out of their parts and Plymouth Engineered Shapes offers the solution in Titanium, Stainless steel, Alloy steel, or Nickel-based alloys. Our Engineers are capable and willing to work with your design engineers to develop the most optimum near-net shapes possible to make your finished parts. No other manufacturer in North America offers so much experience in special shape technology, or provides so many value-added options to meet your product specifications.

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PM International Suppliers

(863) 644-6300
www.PMfirst.com
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We supply pipe and fittings, tubing, valves, flanges, bars, sheet and forgings with numerous worldwide sources for limitless applications. PM International Suppliers specializes in providing products in exotic materials such as duplex, super duplex, 6% molybdenum stainless-steels, titanium, copper nickel and nickel alloys.

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Precision Abrasives

412-809-9822
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www.precisionabrasives.net

We are the industry leader in abrasives and abrasive applications for the primary metals market. We offer the most reliable technical services and the widest selection of engineered products in the industry.

We are the Largest US Distributor for Conditioning Wheels, Roll Grinding Wheels and Large-Diameter Cut-Off Wheels. We are Norton's Only Primary Metals Market Specialty Distributor and VSM's Fastest Growing Distributor over the last four years. We are the Exclusive Distributor for Mid-West Machines for the Primary Metals Market.

Precision Metal Grinding, LLC

+1-949-872-2976
www.pmgrinding.net
sales@pmgrinding.net

Precision Metal Grinding is a grinding service company that supports the aerospace and medical industry. Providing the highest quality of surface finishes for critical applications (Ra and Rz). Capable of machining thin sheet (minimum: 0.008") and thick plate (maximum: 6.00") up to 78.00" wide x 230.00" long. Precision Metal Grinding offers a standard thickness tolerance of +/- 0.001" and can provide +/- 0.0005" upon request. Our standard practices ensure consistency over large orders and from batch-to-batch. With years of experience under our belt, we are capable of machining Titanium, Stainless Steel, Aluminum, Nickel-base Alloys, Magnesium, Cobalt-base Alloys, Zirconium and others.

Contact us with your unique requirements today.

Precision Thin Metals

http://www.arnoldmagnetics.com/Precision-Thin-Metals

The Precision Thin Metals (PTM) business of Arnold Magnetic Technologies produces thin and ultra-thin alloys that improve the power density of motors, transformers, batteries and many other applications in Aerospace, Industrial, Motorsport, and Medical markets. Customers rely on us for thin-rolled titanium in applications that demand high performance and consistent quality. Arnold's Precision Thin Metals business offers titanium products in a number of commercially pure grades and several standard alloy compositions. Our titanium and titanium alloys are available in cold rolled or annealed condition. PTM is Nadcap certified for heat treatment.

President Company Ltd.

+886-227411-190
www.presico.com.tw
presico@presico.com.tw

President Co., Ltd., established in Taiwan in 1969, is one of the largest titanium stockists in the Asia. Our business focus on the trading of high quality titanium with diverse stocks. Besides, our product includes titanium slabs, sheets, bars, wires, pipes, fasteners, castings, etc. We commit to supply the most satisfying high quality titanium materials for users with quick lead time and favorable after sales service. Currently, our sales network is well deployed all over China, Taiwan and South-East Asia countries.

President Titanium Co., Inc.

+1-800-225-0304
www.presidenttitanium.com
sales@presidenttitanium.com

President Titanium has the largest inventory of domestic 6Al/4V, 6Al/4V ELI, and Grade 4 titanium bar, sheet & and plate in the country. We have been serving the aerospace, military and medical industries since 1973. Most orders shipped in 1-2 days, call for our free booklet.

Product Evaluation Systems, Inc.

724-834-8848
www.PES-Testing.com
Mic@PES-Testing.com

Product Evaluation Systems (PES) an independent testing laboratory, located in Latrobe, PA. PES is a proven partner in materials testing and offers exceptional turnaround specializing in mechanical, metallurgical, chemical and nondestructive testing and analysis. Since 1979, PES has been proud to offer exceptional personalized response to customer needs and our Rapid Response, Dependable Delivery continues to help our clients streamline the process of outsourcing their materials testing. PES is both NADCAP and ISO 17025 accredited and holds multiple customer accreditations such as GE Aviation, Pratt & Whitney (MCL), Rolls-Royce Aerospace (SABRe) and ATI Nuclear. Accreditation awarded to PES covers mechanical testing, test specimen preparation, metallography, chemical analysis and nondestructive evaluation. Industry sectors include, but are not limited to, Aerospace, Additive Manufacturing (AM), Power Generation, Oil & Gas, Mining and Recovery/Reclamation.

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Quebec Metallurgy Center

+1-819-376-8707
www.cmqtr.qc.ca

The Quebec Metallurgy Center is a technology transfer center located in Trois-Rivieres, Quebec, Canada. Our activities focus on supporting the technological development of manufacturing companies in the metallurgical sector. CMQ has developed a broad expertise on the transformation and development of advanced alloys such as titanium, zirconium, aluminum and nickel. Our semi-industrial metalworking facility is equipped for short series production with controlled atmosphere casting, induction skull melting, plasma arc melting, permanent mold, shell mold and sand mold casting; advanced welding, thermal spraying, heat treating, hot isostatic pressing, additive manufacturing (directed energy deposition, binder jetting and ultrasonic welding) and non-destructive testing.

RathGibson

+1-608-754-2222
www.rathgibson.com
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RathGibson is one of the world's leading manufacturers of precision welded tubing and pipe in both stainless and specialty alloys. From straight lengths to coil, welded and drawn, or seamless tubing and pipe, our products can be made from any of our 40 high-performance alloys so that they will reliably perform no matter how demanding or corrosive the application. At RathGibson, a successful technical process to meet any customer requirements is a priority, so that only the finest and most high quality tubing is delivered. That is why RathGibson invests in unique capabilities to develop customizable products for industries including power generation, renewable, oil and gas, petrochemical, food and dairy, beverage, pharmaceutical, and general commercial.

Reading Alloys | AMETEK Specialty Metal Products

+1-610-693-5822
www.readingalloys.com
Jennifer.Rieger@ametek.com

Reading Alloys, part of AMETEK Specialty Metal Products, is one of the world's premier manufacturers of high quality master alloys as well as titanium metal powders. Our products are approved for use in critical aerospace and medical applications that require the most stringent quality requirements and demand the highest purity.

MASTER ALLOYS

Reading Alloys produces a wide variety of master alloys comprised of vanadium, molybdenum, niobium, chrome, and aluminum among other elements. Critical applications include:

- Rotor grade titanium
- Aerospace and non-aerospace grade titanium
- Vapor phase aluminizing (VPA)
- Commercial metals
- Super alloy metals applications

HIGH PURITY TITANIUM POWDERS

Reading Alloys manufactures high purity hydride-dehydride (HDH) titanium powders:

- Thermal Spray/Medical Powders - Ti sponge, Cp Ti, and Ti 6Al/4V
- Ti powders for Powder Metallurgy (P/M) applications
- Ti powders for sputtering targets
- Advanced Coating Alloys Al/Cr, Al/Co, CODEP

In addition, a series of gas-atomized specialty powders for hard-facing, brazing, and thermal sprays further compliment the product offerings.

ADVANCED MANUFACTURING PROCESSES

Reading Alloys is known for its superior expertise in the following processes:

- Aluminothermic smelting
- Induction melting
- Vacuum sintering
- Toll melting
- Cold isostatic press (CIP)
- Hydride/dehydride (HDH)

Our quality system is certified to ISO 9001:2008 and AS9100C and we have a fully accredited lab that is NADCAP certified.

For the widest product portfolio, unsurpassed reliability, and unmatched technical expertise, trust Reading Alloys.

Reading Alloys, AMETEK SMP Eighty Four, Fine Tubes, Superior Tube, Hamilton Precision Metals and AMETEK SMP Wallingford – all leading manufacturers of advanced metallurgical products, such as powder, strip and tube – form the AMETEK Specialty Metal Products division.

ReMelt Scientific, Inc.

+1-330-440-0402
www.remeltinc.com
sales@remelt.net

ReMelt Scientific is a global supplier of Titanium Chip Melt Preparation Systems and Weigh and Blend systems. We specialize in titanium and high temperature alloy chip crushing, centrifuging, aqueous wash and solvent cleaning, thermal drying, fines screening, and magnetic and gravimetric separation to prepare chips to for melting. We also specialize in Weigh and Blend systems that weigh and blend titanium chips, sponge, master alloys, aluminum, iron, and TiO^2 to achieve customer specified chemistry requirements.

Renton Coil Spring Company

+1-425-255-1453
www.rentoncoilspring.com
info@rentoncoilspring.com

Renton Coil Spring Co. (RCS) is a world-class spring manufacturer for aerospace and performance markets and has been providing superior quality parts and performance since 1949. Design and material capabilities, along with complete performance solutions has lead RCS to become a top supplier of quality springs, wire forms, assemblies, and flat metal parts with thousands of applications across the world.

Reactive Metals Studio, Inc.

+1-928-634-3434
www.reactivemetals.com

Founded 1981, a supplier of exotic metals to include titanium and niobium to the jewelry and decorative arts market. We consult, teach and supply anodizing equipment. We supply jewelry components, chain and findings in titanium. We are small order specialists catering to the medical, crafts and arts community. RMS distributes MULTI-ETCH, a user friendly titanium etch. Multi Etch prepares titanium jewelry, medical & dental components for bright, smooth anodizing without the dangers of Hydrofluoric acids.

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Retech Systems LLC

+1 (707) 462-6522
www.retechsystemsllc.com
sales@retechsystemsllc.com

Retech is the world's leading supplier of Electron Beam (EB) and Plasma (PAM) Cold Hearth furnaces for melting and refining titanium and titanium alloys. Retech advanced vacuum metallurgical systems also include Vacuum Arc Remelt (VAR), VAR Consumable (Skull) Casting, EB and PAM Consolidation furnaces, Plasma Welders, Vacuum Induction melting (VIM), Precision Investment Casting (DS/SC/EQ), Cold Wall Induction melting and casting, Vacuum Heat Treating, and Gas Atomization for metal powder production. All our furnaces are available in various sizes and configurations, from simple laboratory-scale to large, custom engineered systems. Further, we provide customer access to a wide range of in-house resources, including technology, material and process development. Identifying customer needs, as well as understanding the importance of producing relevant, viable, and cost-effective technologies, is the foundation upon which Retech is built.

Retsch

Retsch Business Unit Manager:
Kyle James
(267) 757-0351 ext. 104
info-us@verder-scientific.com

Retsch, part of Verder Scientific, is the world leader in solid material sample preparation equipment for quality control and research and development laboratories. Our expertise and devotion to providing the highest quality products for accurate and reproducible sampling methods is unsurpassed. Our selection of mills, sieve shakers, and sample dividers offer the industry standards for sample preparation.

Rex Heat Treat

+1-215-855-1131
www.rexht.com
chris.constable@rexht.com

Rex Heat Treat is a family owned and operated business that was founded in 1938. We take pride in our ability to partner with our customers to gain insight regarding their future needs. We are a leader in customer service and quality for the heat treating industry. Our unique furnace design allows us to water quench titanium raw material and formed parts up to 16' long to meet aerospace and medical specifications. We have furnaces capable of annealing up to 30,000 lbs. in one batch and we are approved by almost all major Aerospace companies. We have 3 locations in Eastern United States, Anniston Al., Bedford PA., and Lansdale, PA. Rex Heat Treat has experienced metallurgists on site and we offer testing services. We look forward to exceeding your expectations with timely communication and time performance.

Rolled Alloys

+1-800-321-0909
www.rolledalloys.com
onlinesales@rolledalloys.com

Rolled Alloys, a global leader in specialty alloys, offers a comprehensive inventory in titanium, stainless steels, nickels alloys and cobalt alloys. We offer extensive processing capabilities, in-depth knowledge of material specifications, supply chain management support, and metallurgical expertise.

Rolled Alloys holds many quality approvals and certifications in the aerospace and medical industries. We are a preferred supplier to companies that are respected around the world for their exceptional quality standards.

Roskill Information Services Ltd.

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info@roskill.com

Roskill global market reports include the latest information on supply, demand, end-use applications, trade and prices for a wide range of metals and minerals including titanium, molybdenum and vanadium. Roskill reports also provide informed forecasts of future trends.

Roskill's expert researchers make a thorough and objective analysis of all available data, from sources across the globe. This includes a large and invaluable network of contacts including the key industry players in these markets, making Roskill's research unrivalled in terms of breadth, depth, accuracy and expertise.

To build on this wealth of data, Roskill also offers bespoke consultancy services that can help to explore and understand any specific scenarios or analysis requirements you may have.

S. Letvin & Son, Inc.

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www.titaniumscrap.com

S. Letvin & Son, Inc., specialists in processing high temperature scrap metals, has been in business since 1947. We prepare a high quality 6/4 titanium feedstock package that meets AMS 4928 Chemistry Specifications. We have developed a unique and proprietary process to return mixed 6/4 titanium fasteners to specification 6/4 titanium. The final product is 6/4 titanium "Rotor Grade" feedstock, which is heavy, dense, clean and extremely consistent in chemistry and gases. Our 6/4 titanium feedstock package is approved and desired by most major US Titanium Mills, as well as many smaller investment casters worldwide.

S+D Spezialstahl Handelsgesellschaft mbH

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S+D Spezialstahl GmbH, member of the BIBUS Holding AG, is one of Europe's largest stockists for semi-finished high-performance materials like titanium and titanium alloys, special stainless steel for aviation and aerospace or nickel and nickel alloys.

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We deliver just in time any time. At S+D we are able to cut all our materials according to our customer's exact requirements utilising our "state of the art" bar saws and plate saws. We also offer precision water jet cutting. Our just in time service provides our customers with cost savings and security of supply. S+D is aerospace approved according to EN 9120 issued by DNV GL

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Sandinox Comercio, Importação e Exportação LTDA
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www.sandinox.com.br

Established in 1986, Sandinox is the largest medical distributor for the Brazilian market, offering a full range of products in titanium, cobalt, and stainless steel alloys for the medical industry. Our goal is the constant search for technologically advanced products and materials that will ensure quality and the desired satisfaction of our customers.

Sandvik Materials Technology Product Unit Special Metals
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www.smt.sandvik.com

Product Unit Special Metals with two manufacturing locations (Sweden and USA) belongs to Sandvik Materials Technology and is a long term experienced manufacturer of seamless tubes and complementary products in Titanium, Titanium alloys and Zirconium based materials for a broad range of industrial applications as well as applications within nuclear, aerospace and medical industries.

The full scale commercial manufacture, which started in 1964 is fully integrated from VAR-remelting of Titanium resp. Zirconium sponge up to finished product.

Scanacon, Inc.
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At Scanacon, our mission is to help stainless, titanium, zirconium and specialty alloy finishers achieve efficient, high quality production at the lowest cost.

With over 30 years' experience as the World's preferred supplier of acid management equipment, our knowledge, experience and equipment offers the producer the ability to achieve productive, efficient and cost effective finishing operation. Our solutions have consistently proven themselves across a wide range of pickling, etching and milling applications for all wrought and cast forms.

Scanacon understands that ease of use, low maintenance requirements and efficiency is key to designing process equipment that delivers value, day after day. No two producers or applications are exactly alike. Delivering value requires a knowledge that can only be gained by experience and is why Scanacon continues to be the chosen supplier for acid management system by all major producers, worldwide.

Schaffer Grinding Co., Inc.
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www.schaffergrinding.com
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SCHAFFER GRINDING CO. is a toll processor of aerospace alloy materials including: Titanium, high temperature alloys, nickel based alloys, and ferrous materials. Processes include: Precision sheet and plate grinding (90" X 240"), band saw cutting, planer milling, rotary and surface grinding. Schaffer Grinding offers its customers coast to coast service with production facilities in California and Ohio.

Sector3 Appraisals, Inc.
+1-718-268-4376
www.sector3appraisals.com

METALS & CHEMICALS INVENTORY VALUATIONS FOR ABL FINANCING

Sector3 Appraisals is an independent appraisal firm specializing in the metals and chemicals industries. We value inventory as well as machinery & equipment at all levels of the manufacturing chain, from major producers to distributors and OEMs through Tier-II suppliers. Clients use Sector3 valuations to secure financing for working capital, M&As, and debtor-in-possession settlement. Sector3 also provides liquidation consulting.

Sector3's focused expertise produces a targeted, insightful and truly useful appraisal.

We help companies and lenders decipher the underlying value of raw materials, metals, chemicals, plastics, and commodity inventory and machinery and equipment. We are successful because we:

- Specialize in the metals, chemicals, plastics, and commodity markets;
- Offer extensive metals, chemicals, and plastics valuation experience
- Believe customer service is a long-term objective.

These advantages set Sector3 apart from other appraisal companies, and have made Sector3 one of the largest metals, chemicals and commodity appraisal firms in the U.S.

Service Steel Aerospace
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Service Steel Aerospace is a customer oriented stocking distributor of high performance stainless steel, titanium, alloy steel, nickel based super alloy, and maraging steel. We are committed to providing quality products to the aerospace industry and other critical application industries throughout the world. SSA performs a wide array of value added processing services designed to meet the specific needs of our customers. Our commitment to the quality and service has made SSA the leader in the industry for over 40 years.

SES, LLC
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www.seseng.com
ses@seseng.com

SES is a leading supplier of equipment and services for the metals industry. SES handles projects ranging from small specialty items to major capital expansions, as well as redesign/rebuild of existing equipment. Our strategic partnership with Daisho Seiki Corp, Japan, has broadened our ability to supply Bar Turning and Burnishing Technology to the North American Market. Capabilities include complete supply of Turning and Polishing Lines for bar manufacturers/processors. Custom cell layouts including cut-to-length, chamfering, NDT inspection, prove-up stations, hex bundling, can be added to suit requirement. Testing of equipment with customer supplied material can be performed at SES' manufacturing facilities.

Headquartered in Alliance, OH, our over 40-year history includes design and supply of transfer cars, transporters and all meltshop equipment, slab handling equipment, long product handling and processing equipment, strip processing equipment, coil handling equipment, custom designed and built equipment, automation & Level I/II system design, complete system integration, PLC, drives, & HMI integration, power and control system design, and facilities engineering.

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Shaanxi CXMET Technology Co., Ltd.

+86-13571-725644
www.cxmetti.com

Shaanxi CXMET Technology Co., Ltd. was established in 2005 with a registered capital of 10, millions, covers an area of 5,000 square meters and is located in the "China Titanium Valley."

We are specialized in R&D and sales engaging in titanium, nickel, zirconium, hafnium, tungsten, molybdenum, tantalum, niobium and their alloys products. Our products are widely used by domestic and oversea professional users in aviation, marine, petroleum, chemical, powder metallurgy, medicine, sports, electronics, vacuum coating, etc.

Shaanxi HuaMei Material Technologies Co., Ltd. (HMTi)

+86-18690-402457
www.hmti-material.com
Sunny@hmti-material.com / eric_wang@hmti-material.com

Shaanxi HuaMei Material Technologies Co., Ltd (HMTi) is located in Baoji City called the "Titanium Valley" in China, and covers an area of 14,000 square meters for world-leading facilities.

HMTi has been focused on researching, developing and manufacturing high performance titanium alloys and products with high finished products rate since it was founded. Its main products include plates/sheets, rods/bars, tubes/pipes and forgings which are widely used in the aerospace, shipbuilding, military, ocean engineering and biomedical industries, such as Ti6242s, Ti6246, Gr23, Ti62222s, Ti-6AL-3Nb-2Zr-1Mo and etc. As a high-tech enterprise, HMTi is conducting the certification of Chinese Military Standard and AS9100.

Shaanxi Lasting Titanium Industry Co., Ltd.

00 86 29 89651035 89651082
www.lastingtitanium.com
info@lastingtitanium.com; titanium01@263.net

Shaanxi Lasting Titanium Industry Co., Ltd. is the leading Titanium manufacturer and exporter in China. With more than 20 years' experience, we own two mills in Baoji -The Chinese Titanium City. We are mainly engaged in melting, forging, rolling and machining manufacturing line in titanium and titanium alloy, with an investment of USD 50 million. Exported 3000 mt ingots, 2500 mt forgings and 5000 mt machined parts annually. Our main products include titanium ingots, slabs, bars/rods, plates/sheets, pipes/tubes, forgings, fittings, wire, powder, standard parts, non-standard equipment and other corrosion resistant metals such as zirconium, tantalum, tungsten, molybdenum, niobium.

Shasta Services LLC

www.shastainc.com

Shasta provides high-quality grinding, machining, cutting and robotic scarfing services, primarily to the titanium industry. In business since 1974, Shasta operates multiple MidWest-style grinders to condition the surface of various metals, primarily titanium, for most major US titanium producers.

Shasta and its affiliates also provide robotic scarfing, high-volume torch cutting and a variety of machining services such as bar peeling, center-less grinding, saw cutting, straightening, polishing, turning, testing and various other services.

Shasta is focused on providing high quality services with a quick turnaround time.

Sierra Alloys / TSI Titanium/ PRV Metals Companies

+1-626-969-6711
www.prvmetals.com

Manufacture and supply forged and rolled products in Titanium alloys, nickel-cobalt base alloys, precipitation hardened stainless and high alloy steels from small rectangular and round bar to large section size open die forged bar and stock.

Simonds Saw

www.simondssaw.com

Manufacturer of industrial saw blades. The oldest cutting tool manufacturer in North America, Simonds offers one of the broadest and most trusted names found anywhere in the world of cutting tools. Many industries have grown to depend on the quality and innovation of Simonds products and services. We have a continuing tradition of quality, design, and innovation. Simonds has innumerable patents, a global leader in high-performance and high-production sawing. The first bandsaw manufacturer in the world to be ISO certified and we remain certified so today. We set our goals high and our customers have grown to expect it.

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Solar Atmospheres

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www.solaratm.com
info@solaratm.com

Solar Atmospheres provides vacuum thermal processing for titanium material, parts, forgings, and weldments. With the world's largest commercial vacuum furnaces up to 48 feet long, Solar is capable of vacuum processing furnace loads of bar, billet, sheet, and plate up to 150,000 pounds under 1x10-6 Torr vacuum levels. Specific heat treat services provided are: degassing, beta annealing, homogenizing, age hardening, creep forming, Superplastic Forming (SPF), hydriding/dehydriding, stress relieving and Fluorescent Penetrant Inspection. ISO9001:2015 / AS9100D Registered, Nadcap Accredited for heat treating and NDT (Non-destructive testing), MedAccred Accredited for heat treating, and Boeing approved in heat treating, NDT (Non-destructive testing) services and BASCA (Beta Anneal Slow Cool Age). Solar Atmospheres serves customers with plants located in Pennsylvania, South Carolina, and California.

Solar Manufacturing, Inc.

+1-267-384-5040
www.solarmfg.com
info@solarmfg.com

Solar Manufacturing designs and manufactures high performance, technically advanced and energy efficient vacuum heat treat furnaces. Models range from compact R&D size furnaces to mid-size horizontal production furnaces to huge car-bottom vacuum furnaces for large heavy workloads. Our furnaces feature improved graphite insulation materials, curved graphite heating elements, tapered gas nozzles, high velocity gas quench systems, SolarVac® 4000, and 5000 interactive control systems,

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and ConserVac energy management system. We design for vacuum heat treat processes such as hardening, brazing, annealing, stress relieving, normalizing, tempering, sintering, low pressure carburizing and vacuum gas nitriding. Solar knows vacuum heat treating inside out. Our engineers and metallurgists bring decades of expertise to the design side of the business and our knowledgeable technicians provide world-class manufacturing keeping Solar in the forefront of vacuum furnace innovations. As an ITA member company, Solar welcomes the opportunity to assist our customers in choosing the right vacuum furnace, replacement hot zone, spare parts and service for your needs.

Specialty Metals Company

+32- 2645-7670
www.uktmp.kz
Sylvain.gehler@specialtymetals.be; Danielle.vanoverschelde@specialtymetals.be

Specialty Metals Co is the major shareholder of UKTMP (Ust Kamenogorsk Ti Mg plant) located in Kazakhstan. UKTMP produces Ti sponge, CP and alloy ingots and slabs.

Specialty Metals Processing, Inc.

+1-330-656-2767
www.specialtymetalspro.com
bwilson@specialtymetalspro.com

Specialty Metals Processing (SMP) is a leading processor of titanium plates, slabs, sheets and coil. Located in northeast Ohio, SMP has one of the largest abrasive belt grinding and polishing operations in the U.S. Our 170,000 sq. ft. facility houses multiple processing lines. We are your reliable source for precision grinding where we can accommodate widths up to 72", material thickness up to 10" and lengths up to 240". We are your reliable source for gantry grind services where we can accommodate widths up to 144", material thickness up to 24" and lengths up to 1200". In addition, we are your reliable source for pinch roll grinding, alpha case removal and reconditioning.

- Precision grinding up to 72" wide and 244" long
- Ability to polish/grind/recondition plate/slabs up to 12' wide by 100' long
- Providing #3, #4, # 6, brushed or matte finishes or custom matched abrasive belt finishes, one or two sides.
- Providing #7 and #8 buff finish on stainless coil
- Offering special inspections, packaging, line marking & PVC options
- ISO 9000 certified since 1996
- Offering one stop shopping on many orders
- Same day quoting on most inquiries
- One sheet or truck load quantities, no order is too big or too small

Please visit our website atwww.specialtymetalspro.com

Specialty Metallurgical Products Co. Inc.

717-246-0385
www.smptitanium.com

Specialty Metallurgical Products (SMP) was started in 1984 by James H. Clark (Jim Clark Sr.), when he envisioned the need for a better, less costly grain refiner than the then standard master alloy. Originally the company was started to produce Master Alloy in Shot form, however that product never made it into the marketplace. Instead SMP was the first company to produce and offer a 100% titanium tablet to the aluminum alloy producers, free from binders and salts. Today, almost all aluminum smelters use 100% titanium tablets/pucks to make their titanium additions.

The Company's manufacturing Plant and Offices are located in Red Lion, Pennsylvania and have been since 1994. Although the Company has relocated several times in the last 20 years, it has never moved out of York County, Pa.

Spectore Corporation

954-481-8422
www.spectore.com
info@spectore.com

Spectore Corporation was founded in 1983 to reinvigorate the 3,000 year-old traditions of the jewelry industry with its introduction of titanium as a new noble element. New technologies were perfected to manipulate this extremely tenacious and non-traditional metal. The company's ambitious designers and R&D team have persistently explored the potential of titanium to create truly unique collections. This resulted in being awarded the 2010 Titanium Development and Advancement Award by the ITA. Today Spectore remains dedicated to the development of new methodologies for the design, engineering and manufacturing of high-end consumer products made of titanium.

Spectore Corporation designs and manufactures for a range of world class brands focusing on consumer products from household, sporting, technology, apparel, corporate gifting and jewelry. Spectore Corporation has also developed their own in house designer brand, Edward Mirell which has won a wide range of national and internationally recognized design awards.

Stack Metallurgical Group

503-285-7703
http://www.stackmet.com/

The Stack Metallurgical Group consists of heat treating facilities in Portland, Oregon and Spokane, Washington, as well as Aerospace Aluminum Processing in Salt Lake City, Utah. The combined capacity and versatility of these three facilities rivals nearly any other thermal processor in the western United States.

The Stack family prides itself on safety, quality, and outstanding customer service. We have long been a trusted supplier to numerous quality-critical industries including aerospace, energy, and medical implant. As evidence of our service-based culture, the Salt Lake City facility is the proud recipient of the Boeing Supplier Excellence Award 9 times.

Stack offers the most modern heat treating and metal processing equipment, a comprehensive list of aerospace and OEM approvals, and a highly-talented team of experts ready to exceed your highest expectations.

Starrag USA Inc.

+1-859-534-5201
www.starrag.com
ussales@starrag.com

Engineering precisely what you value

Starrag Group is a global technology leader in manufacturing high-precision machine tools for milling, turning, boring and grinding workpieces of metallic, composite and ceramic materials.

Principle customers are internationally active companies in the Aerospace, Energy, Transportation and Industrial sectors. In addition to its portfolio

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of machine tools, Starrag Group provides integrated technology and maintenance services that significantly enhance customer productivity.

Aero Structures Five and six axes high torque machining centers, 50 cubic inches per minute of Ti metal removal with the highest degree of accuracy. That's STARRAG.

Aero Engines
Blades, Blisk, IBRs, Impellors and Casings – Processing requirements drive our machine design providing the highest accuracies and throughput.

Avionics
Complex machining for extremely precise parts for fuel injection, combustion chambers, flight controls and gyroscopes.

State Nuclear Baoti Zirconium Industry Company

+86-0917-8661607
www.sn-zr.com

State Nuclear Baoti Zirconium Industry Company (hereinafter referred to as "National Nuclear Zirconium Industry") was jointly funded by the National Nuclear Power Technology Corporation and Bao Ti Group Co., Ltd. in November 2007, and is under the management of the National Nuclear Power Technology Corporation. The shareholders are State Nuclear Power Technology Corporation, Baoti Group Co., Ltd. and Bairui Trust Co., Ltd., with registered capital of RMB 2.6 billion.

The Straumann Group

+41 (0)61 965 11 11
www.straumann.com

Founded in 1954, with the introduction of the world's first one-stage dental implant in 1974. More than 35 years of clinical evidence with over 100 scientific publications per year that meet the highest standards of research.

Straumann is the premium offering within the Straumann Group, which unites global and international brands that stand for excellence, innovation and quality in tooth replacement and esthetics.

Headquartered in Basel, Switzerland. Engineering and implant manufacturing in Switzerland, with other production sites for biomaterials and CAD/CAM in Europe, the United States and Japan.

As a global leader in implant, restorative and regenerative dentistry we share your passion for quality and the desire to achieve the best restorative outcomes. In collaboration with leading clinics, research institutes and universities, Straumann conducts research, develops and manufactures dental implants, instruments, prosthetics, as well as dental biomaterials for use in tooth replacement and restoration, or to prevent tooth loss. As technological advancements are changing dentistry fundamentally, Straumann offers a broad range of products and solutions for both conventional treatment and digital workflows including guided surgery, intra-oral scanning and CAD/CAM restorations.

Strohecker Incorporated

+1-330-426-9496
www.strohecker.com

Well-established specialist in the fabrication and repair of copper crucibles, hearths and related equipment used in VAR, ESR, EBM, PAM, as well as various similar processes. Serving producers of the reactive metals and alloys, nickel alloys, refractory metals, and steel alloys.

Structure Medical, LLC

www.structuremedical.com

Structure Medical is a leading manufacturer of medical implant products that are used by orthopedic surgeons to treat disorders of the musculoskeletal system. Orthopedic surgeons use these medical devices to treat trauma, sports injuries, degenerative diseases, tumor and congenital conditions.

Structure Medical was founded in Naples, FL in 2004 and established a second facility in Mooresville, NC two years later. The company uses the most advanced machine tooled available around the world to produce products that meet the highest quality standards.

Sumitomo Corporation of Americas

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www.sumitomocorp.com
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Sumitomo Corporation of Americas (SCOA) is a wholly-owned subsidiary of Sumitomo Corporation, which is one of the leading trading companies in Japan. SCOA is an integrated global trading firm with diversified investments in a wide variety of industries, products and services.

Supra Alloys, a division of Titan Metal Fabricators

805-388-2138
www.supraalloys.com
sales@supraalloys.com

Supra Alloys is a Titanium Mill Products-stocked Titanium Service Center with the convenience of extensive in-house processing capabilities, with a Management System certified to AS 9100D & ISO 9001:2015 & ISO 13485: 2016. Located in Camarillo, California & Dayton, Ohio USA, Supra routinely provides Titanium for applications in the aerospace, medical, Industrial and sports/recreation industries throughout the world.

T-M Vacuum Products, Inc

856-829-2000
www.tmvacuum.com
eurbanski@tmvacuum.com

T-M Vacuum Products has more than 50 years' experience designing and manufacturing various standard and custom size vacuum furnaces and vacuum ovens in both rough and high vacuum configurations with temperatures up to 2,000°C.

We specialize in all metal hot zones and strive to create the best vacuum furnaces and vacuum ovens possible. Our team of experienced engineers and highly skilled technicians build the best systems in the industry. Our systems typically exceed 20 years of life in a full-time 24/7 production environment. This means that each vacuum furnace and vacuum oven, you purchase from us is the most advanced and cost effective on the market.

As an ITA member company, T-M Vacuum is more than happy to assist customers in choosing the right vacuum furnace to meet their needs. Contact us or visit our web site for more information

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Tekna Advanced Materials
www.tekna.com

Tekna offers spherical titanium powders specifically engineered for additive manufacturing applications.

These powders are produced by inductively-coupled plasma, a proprietary technology developed by Tekna which leads to high-purity powders having high density and flowability.

The Council for Scientific and Industrial Research (CSIR)
+27-128412600
www.csir.co.za

The Council for Scientific and Industrial Research (CSIR) is South Africa's leading national research and development organization. The Titanium Centre of Competence (TiCoC) within the CSIR has a mandate to develop technology building blocks needed to establish a new South African titanium industry. The TiCoC is developing a suite of complementary technologies to add value to South Africa's vast resources of titanium. This programme primarily focuses on the development and commercialisation of cost-effective processes for primary titanium metal production and its conversion into finished and semi-finished products. The recently established Titanium Pilot Plant situated on the CSIR campus, is an important milestone in this entire process. Parallel to this the TiCoC is developing and adapting technologies to consolidate "low-cost" titanium powders into products. Formal collaboration agreements have been signed between the CSIR and global companies such as Boeing, Airbus and EADS. These mutually beneficial agreements support South Africa's long-term economic development goals that include the supply of titanium to many industries, including aerospace.

The Pennsylvania State University

Materials research conducted by iMatSE students and faculty lead to advances and discoveries that become the building blocks of tomorrow. Through formal coursework in small classes and participation in cutting-edge sponsored research, students in the Intercollege Graduate Degree Program in Materials Science and Engineering enjoy a graduate education that prepares them well for their future careers.

iMatSE students receive full funding (stipend and tuition) in the form of fellowships or research assistantships. Program Highlights:

- Penn State ranked #1 in funded materials research in the US (NSF)
- Thesis-based Ph.D. and M.S. degrees
- Multi-disciplinary research programs and centers
- Over 50 MatSE and affiliated faculty members
- Approximately 150 current graduate students
- Specialized laboratories and shared facilities

Thermo Fisher Scientific

Thermo Fisher Scientific delivers best-in-class handheld x-ray fluorescence (XRF) analyzers designed to meet our customers' most complex analytical challenges. Thermo Scientific™ Niton™ XRF analyzers serve metal manufacturing, processing and recycling customers in 75 countries with more than 40,000 units installed worldwide. A culture of innovation and a track record of breakthrough achievements have defined our instruments since we first invented the handheld XRF analyzer. Now the fastest, most accurate and smallest XRF analyzer for elemental determination has arrived. Discover the Niton XL5- part of the industry-leading Niton family of products, the Niton XL5 offers unmatched speed, performance and portability. Discover how Thermo Fisher Scientific can help you achieve greater confidence in your metal fabrication operations.

TiFast
+39 0744 736 307
Irene Brogi, info@tifast.com
www.tifast.com

TiFast is the new European leader in the production of titanium bars, ingots, billets and wires for the aerospace, medical, defence, racing and industrial markets worldwide, with high level of quality, competence and competitive conditions for the most challenging applications.

TiFast, located in Italy, has built a modern titanium plant with state-of-the-art technologies. TiFast has a fully integrated production, including a melting plant, a rolling mill for bars and wires, a precision finishing shop. TiFast has also its own integrated laboratories and R&D facilities.

TiFast can supply titanium bars with very close tolerances, special heat treatments, including stress relieving, with a full range of finishing.

TiFast is certified by the American NADCAP for Aerospace and ISO 13485 for Medical Device. TiFast is also ISO 14001 certified for Environmental, German TÜV ADWO, AS 9100, ISO 9001 and PED for Pressure Equipments.

Timesavers International B.V.
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www.timesaversint.com
timesaversint@timesaversint.com

Manufacturer of wide-belt grinding and brushing machines for stainless steel sheet and coil finishing; lasercut, punched, routered and flame cut deburring and edge radiussing; cast iron, ferrous, non-ferrous and titanium high precision calibration. Timesavers is based in Goes, The Netherlands, with regional offices around the globe in Shanghai (China), Taichung (Taiwan), Kuala Lumpur (Malaysia) an Timesavers Inc, in Minneapolis (USA). Worldwide the company has more than 200 employees supported by a network of local dealers and partners.

TIMET, Titanium Metals Corporation

+1 610 968 1300
www.timet.com

First in Titanium Worldwide

Titanium Metals Corporation (TIMET) is one of the world's largest fully integrated titanium producers and the only remaining North American sponge producer. Since 1950, TIMET has been leading the industry in mill and melted products, supplying nearly one-fifth of the world's titanium. We convert rutile ore into sponge; melt and refine ingot and slab; and manufacture mill products. TIMET has a global network of service centers supported by its seven primary melting or mill facilities in Henderson, Nevada; Toronto, Ohio; Morgantown, Pennsylvania; Vallejo, California; Witton, England; Waunarlwydd, Wales; and Ugine, France. With products ranging from sophisticated high temperature alloys used in jet engines, to advanced corrosion resistant alloys used in the chemical industry, TIMET's reach spans the breadth of the titanium applications, and has the technical depth to support developments across a wide range of applications. TIMET's

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fully integrated supply chain, dedicated research facilities, and decades of experience make us the partner of choice for titanium.

TIODIZE Company, Inc.

+1-714-898-4377
www.tiodize.com

Titanium Anodize, Aluminum Anodize, Dry film Lubricants, Corrosion Coatings, Paints &Primers, Teflon Coatings, Manufacturers of Composite Parts (Carbon & Glass)

TiBrasil Titanio Ltda.

+55 (11)3712-2000
titanio@titanio.com.br

Distributing new and top quality titanium, in metallic form, in raw material (plates, tubes, rods, rods, etc.), components, complete equipment and/or services is the purpose of Tibrasil Titânio Ltda.

The key to our success is to provide the best service to our customers, whether in the analysis of titanium applications, and/or in the supply of materials and manpower. Tibrasil Titânio Ltda. has an exclusive source of accumulated know-how, which since 1972 in Brazil has been solving various problems.

In addition to titanium, Tibrasil Titânio Ltda. has in its product line, similarly, the Niobium, Tantalum and Zirconium.

Enjoy the benefits of being a registered customer with cumulative advantages.

The staff of Tibrasil Titânio Ltda. is highly trained to serve you. Because titanium is a metal with ingenious applications, we are already waiting for your specific idea and/or problem.

Tibrasil serves a wide range of industries including petroleum refining, petrochemical, chemical, pulp and paper, metal refining, pharmaceutical, bio-medicinal, surface treatment, mining, steel, pollution control, among others.

TITANIUM Consulting & Trading S.r.l.

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info@tct.it

Certified UNI EN ISO9001:2008 and UNI EN 9120:2010, With 20 years of experience, Titanium Consulting and Trading, based in Florence, Italy, with a distribution center in Milan and affiliated offices and distribution centers in both Germany and England, is a privately owned stockist/distributor of titanium mill products.

Being a major supplier in the European market for titanium mill products and its alloys, we can guarantee a prompt delivery for products including ingots, slabs, round bars, hexagonal bars, profiles, welding wire, plates, sheets, coils, tubes and pipes, as well as fasteners, forgings, flanges and fittings. Most ex-stock materials are shipped the next working day with full traceability for all items supplied

Products supplied are employed in a wide range of applications, including aerospace, medical devices, industrial, and chemical.

In 1996, Titanium Consulting & Trading further expanded its operations by setting up dedicated facilities to manufacture finished products on request. Processes available include cutting, welding, forming, turning, heat treatment and finishing.

TITANIUM ENGINEERS

+1-281-265-2910
www.TitaniumEngineers.com

TITANIUM ENGINEERS supplies Titanium Bar, Seamless Tubing and Finished Components for oilfield and other industrial markets. Our capabilities include the expertise to process titanium to meet demanding and unique customer specifications. We specialize in bar, seamless titanium tubing and also offer products manufactured by: forging, rolling, and machining using common ASTM grades of titanium including: Titanium Grade 5, Titanium 6-2-4-6, Titanium Beta-C. With our metallurgical background we will support your team from design, through prototyping, and finally into full-scale production of components.

Titanium Fabrication Corporation

+1-973-808-4961
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TITANIUM FABRICATION CORPORATION
TITANIUM TI FAB DIVISION USA
TITANIUM TI LIMITED DIVISION CANADA

A World leader for over 45 years in the application, design and fabrication of quality Titanium and Zirconium process equipment, whether solid or clad construction. Extensive experience in rotating, offshore, marine or ordinance equipment. Most extensive titanium field welding/erection service capability in the world. Mill products available from stock. For more information email bbrownlee@tifab.com.

Titanium Finishing Company

+1-215-679-4181
www.titaniumfinishing.com
melinda@titaniumfinishing.com;
melanie@titaniumfinishing.com

Metal finishing services include: Titanium Anodize; Hardcoat Anodize of Aluminum; application of Cerakote and Application of Solid Film Lubricants. We also have our Federal Firearms License. We are a small, women owned business, and have been family owned and operated since 1970.

Titanium Industries, Inc. (T.I.)

1-888-482-6486
www.titanium.com
sales@titanium.com

T.I. is the global leader in specialty metals supply for the aerospace, medical, industrial and oil & gas markets. Holding the world's most complete inventory of specialty metals across a global service center network, T.I. delivers supply solutions at all levels of sophistication and complexity. With a globally experienced and technically driven team, T.I. has been providing dependable, quality driven service to our customers since 1972.

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Titanium International Group SRL

+39-051-6814893
www.titanium.it
tig@titanium.it

TIG is an European stockist and distributor of Titanium, Nickel alloys and Steels for Aerospace, Medical, Automotive and other high demanding end use markets.

TIG is EN9100 and EN9120 certified and has several customers approvals. TIG provides cut to size services with more than 30 saw cut machines and 3 dynamic waterjet cut machines.

Contact us for a quotation! Your mission is our priority!

Titanium Processing Center

+1-888-771-9449
www.titaniumprocessingcenter.com

AS 9100 and ISO 9001 certified, Titanium Processing Center is your go to source for quality titanium products. Titanium Processing Center is a stocking distributor of a wide range of titanium mill products. Our standard inventory of titanium bar, sheet, plate, tubing and pipe is complimented with specialty fasteners, fittings, forgings and fabrications. In-house capabilities include waterjet & saw cutting, shearing, turning and drilling.

All material is mill certified and fully traceable to the original manufacturer. Our dedicated staff is committed to providing our customers with the courteous and prompt attention that they deserve. Delivering quality products on-time and in compliance with your requirements remains our priority at Titanium Processing Center.

Titanium Products and Consulting, Inc.

+1-412-779-6358
www.titaniumproductsandconsulting.com

The focus of Titanium Products and Consulting, Inc. is primarily in two areas. The first is a consulting role for titanium and titanium alloy products, processes and applications. The second is to provide manufacturing and conversion capability with value added properties to enhance your applications performance and lower the overall cost. The ultimate goal is to provide enhanced customer service and technical assistance to make it easier and cheaper for new applications to be developed.

TITOMIC Limited

+61-408-572-035
www.titomic.com
Chris.w@titomic.com

Titomic is an Australian additive manufacturing specialist for industrial scale manufacturing by our proprietary Titomic Kinetic Fusion process for Titanium and other metals. Co-developed with CSIRO, the Titomic process overcomes the limitations of additive manufacturing (3D printing) melting technologies for metals to manufacture complex parts without shape and size constraints. Benefits include:

- World's fastest build rates, 30 times faster than the largest commercial 3D printers available
- Production volumes without tooling
- Stronger structures without welding, folding or bending
- Reduced time to market; faster manufacturing time + localized production
- Lower production costs

We provide surface engineering and end-to-end production support; equipment, software, training prototyping, product testing, manufacturing modeling, technical support and maintenance.

TMS Titanium

+1-858-748-8510
www.tmstitanium.com
info@tmstitanium.com

TMS Titanium is a leading supplier and stocking distributor of titanium mill products to a variety of industries including, aerospace, medical, racing and commercial. By combining product and industry knowledge, commitment to specialty industries, access to titanium and reliable inventory, TMS is able to consistently provide titanium to its customers in order to keep their production moving forward. TMS works with their trusted network of suppliers, finishers and fabrications to fulfill their customers' specific titanium needs, while producing the best quality products available.

Toho Titanium Co., Ltd.

+81 467 87 7023
www.toho-titanium.co.jp

Toho Titanium Company, Ltd. manufactures titanium metals such as premium quality titanium sponge for aerospace and other applications, titanium ingot (CP and Alloy), high purity titanium ingot/billet for semiconductor industry and electronic materials including high purity titanium dioxide and ultra-fine nickel powder etc.

Trepanning Specialties, Inc.

+1-562-633-8110
www.trepanningspec.com

Trepanning & machining services. Specializing in hollow bar conversions to pipe, tube, ring and sleeves. Size capacity up to 55" O.D., 21" I.D yielding a 26" core & can saw cut up to 22". Work with stainless steel to more "exotic" high temperature materials like Titanium, as well as non-metallic materials such as plastic and wood. Full machine shop offering trepanning, gundrilling/BTA, turning, saw-cutting, facing & specialty emergency services. We offer blind shipments. Material can be provided. Family run and Veteran owned since 1973. Contact us via phone (562)633-8110 or email: trepan spec@yahoo.com.

Trent Titanium Limited

+44-1246-290655
www.trent-ti.co.uk
Daniel.nix@trent-ti.co.uk

Processor of titanium scrap for all sectors of Titanium.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

Tricor Metals

330.264.3299
www.tricormetals.com
info@tricormetals.com

Introduction
We are a woman-owned, small business with facilities in Wooster, OH, Conroe, TX, Plymouth, MI and Oxnard, CA with over 25 years' experience in the supply of titanium mill products, titanium forgings and fabrication of ASME Code equipment for the petrochemical, pharmaceutical, mining, aerospace, and bio-medical served markets.

What we do
We provide quick-ship service center sales and processing of ASTM and AMS grades of titanium mill products and titanium forgings. We also design and build fabricated process equipment built with the most advanced corrosion resistant metals, provide reactive metal and high alloy welding repair services, and supply high performance Astrolite® welding wire.

Where are our facilities
Our fabrication and distribution facilities are in Wooster, Ohio and Conroe, Texas. We process and distribute aerospace grade welding wire from our Astrolite Alloys division in Oxnard, CA. And we operate a technical sales office in Plymouth, MI.

Titanium mill products & custom forgings
We maintain one of the world's most complete inventories of titanium mill products in ASTM grades for corrosion including sheet, plate, pipe, fittings, bar, billet, wire, tubing, and fasteners. And we maintain staged billets for custom forgings. We offer advanced processing including water jet cutting, saw cutting, and shearing. We provide custom parts manufacturing and just-in-time inventory for 'blanket' order processing to meet our customer's needs. We stock AMS-grades of titanium sheet, plate, bar and billet for aerospace and bio-medical served markets.

Fabrication of advanced corrosion resistant metal
In our ASME code shops in Ohio and Texas we build custom process equipment including: tanks, towers, pressure vessels, piping spools, shell & tube heat exchangers, plate and frame heat exchangers, and custom welded parts. We specialize in advanced metals for solving corrosion such as titanium, tantalum, zirconium, niobium, nickel alloys, duplex stainless and stainless steel.

Field and factory weld repairs
Our repair teams can be mobilized globally for field work. Or we can repair in our facilities. We specialize in welding of advanced corrosion resistant metals like titanium, tantalum, zirconium, niobium, nickel alloys, duplex stainless and stainless steel. Available with 24 hour notice for emergency repairs.

Astrolite® Alloys - Welding wire and titanium for aerospace
We stock, process, clean, process, and package Astrolite® UltraGrade™ high performance welding wires for aerospace, power, and turbine engines.

TSI | ChemLogix

800-874-2811
www.tsi.com/metal-analyzers/
answers@tsi.com

TSI | ChemLogix manufactures handheld and online laser based metals analyzers. The TSI Chemlite™ Laser Metals Analyzer is a handheld instrument that will measure Al, Mg, and Ti in as little as one second. Ergonomically designed, industrially-hardened and inherently safe, the Chemlite is the only regulation free handheld for measuring Titanium. Verify or sort your Titanium on the spot with ease and confidence. The Chemline process sensor can be utilized in an online scrap sorting system. TSI can provide sensors or turnkey solutions to fit your specific application.

TZMI, Inc.

+1 281 956 2500
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TZMI is an independent consulting company that works with a wide range of global clients to provide insight and expert advice on opaque mineral, metal and chemical sectors. Our uniqueness is that TZMI contains technical and operational experience, together with strategic and commercial competency, to provide a full service offering to our clients.

As trusted advisors, our reputation is underpinned by having an experienced cross-section of technical specialists around the globe. TZMI partners with clients from the private and public sectors to provide bespoke solutions across markets and strategic services; and also technical and engineering services. Our clients range from the world's 500 largest companies through to mid-sized companies and small businesses.

TZMI regularly releases market reports and periodicals on relevant subject matters which support the consulting activities and ensure up-to-date, high quality and comprehensive data, analysis and information is provided. TZMI annually hosts the largest titanium and zircon industry conference. Email: marketing@tzmi.com

Ulbrich Stainless Steels & Special Metals, Inc.

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www.ulbrich.com
information@ulbrich.com

Ulbrich Stainless Steels & Special Metals, Inc., is a leading processor of a variety of different alloys including, but not limited to: stainless steels, PH grades, nickel and nickel alloys, cobalt alloys, niobium, zirconium, titanium and titanium alloys. Commercially Pure Titanium: Grade 1, Grade 2, Grade 3, Grade 4, and Titanium Alloys: Grade 9 (Ti 3-2.5), Ti 15.3.3.3 and 21s (Ti Beta21s), as well as the aforementioned metals are available in strip, foil, flat, round and shaped wire. Nitinol, Grade 5 (Ti 6-4) and Ti 6.2.4.2. are available in limited widths at Ulbrich. Please inquire for more detail on all of our product offerings.

United Alloys & Metals, Inc.

+1-562-273-7004
www.uametals.com

United Alloys & Metals is one of the World's leading processors of all grades and forms of Titanium Scrap for all Titanium applications. Both our Santa Fe Springs, CA and Columbus, OH plants have full processing capabilities and are certified to ISO 9001:2000 standards.

Producers, Distributors, Fabricators, OEM's, & Vendors to the Industry

United Performance Metals

888.282.3292
www.upmet.com
sales@upmet.com; sales@upmet.uk

United Performance Metals (UPM), an O'Neal Industries affiliate company, is a global distributor of high-performance metals serving customers in a variety of industries, including aerospace, fastener, medical, power generation, oil and gas, semiconductor and many others.

UPM offers a comprehensive inventory of products, including Stainless Steel, Nickel Alloys, Cobalt Alloys, Cobalt Chrome Moly, Titanium, Duplex Stainless Steel, PRODEC®, Aluminum, and Alloy Steel in coil, sheet, strip, plate, bar and near net shapes.

FIRSTCUT+® Processing Services include slitting, shearing, cut-to-length, leveling, edging, laser gauge measurement, sawing, precision cold saw cutting, laser cutting, water jet cutting, plasma cutting, precision blanks, boring, trepanning, chamfering & facing, deburring, first stage machining, heat treating and ultra-sonic testing.

Our certifications include AS9100D, AS9100C Belfast, ISO 9001:2015, ISO 9001 Belfast, ISO 13485, GE Aviation S1 (S1000), Pratt & Whitney LCS and laser cutting approvals NADCAP AC7116, and GE S422.

United Performance Metals is headquartered in Cincinnati, OH and maintains nine service centers worldwide including Oakland, CA, Los Angeles, CA, Hartford, CT, Chicago, IL, Greenville, SC, Belfast, Northern Ireland, Budapest, Hungary, and Singapore.

Uniti Titanium

+1-412-424-0440
www.uniti-titanium.com

Uniti Titanium brings together two major global titanium producers with complimentary manufacturing and technical capabilities, Allegheny Technologies Incorporated (ATI) of the United States, and VSMPO-Avisma (Verkhnaya Salda Metallurgical Production Association - Berezniki Titanium -Magnesium Works) from Russia, to create a joint venture focused on titanium mill products for industrial and other non-aerospace, non-military and non-medical markets. Uniti Titanium integrates the synergistic use of raw material, melting, hot rolling, finishing, research and technology resources of the two companies.

UTC Aerospace Systems

+1-216-429-4227
www.utcaerospacesystems.com

Provide, Manufacture and Assemble landing gear for the aerospace industry.

Verder Scientific, Inc.

President, Georg Schick:
(267) 757-0351 ext. 160
www.Verder-Scientific.com
Info-us@Verder-Scientific.com

Verder Scientific Inc., comprised of the Retsch, Carbolite Gero, and ELTRA brands sets the standard in high-tech scientific equipment serving research institutions, analytical laboratories as well as manufacturing companies for decades. The company manufactures and supplies instruments for sample preparation, elemental analysis as well as heat treatment of solid materials.

Verichek Technical Services, Inc.

+1-412-854-1800
www.verichek.net
Sales@verichek.net

Verichek Technical Services, Inc. is an ISO/IEC 17025:2017 Accredited Laboratory for PMI Testing, Hardness Testing, and OES Calibration. We provide a value-added service to our customers in the form of Training, Preventative Maintenance, Spare Parts, Service, Repair, and Calibration of OES Instrumentation. As a third party service and calibration provider to businesses in the metals industry, we also offer the best and highest quality OES, XRD, and Retained Austenite Measurement Instrumentation from GNR. Additional offerings include rental and refurbished instrumentation for cost-effective solutions to our customers. Visit our site or call us to learn more!

Vested Metals International LLC

904-495-7278
www.vestedmetals.net
info@vestedmetals.net

Vested Metals International is an ISO 9001 and AS9100 certified raw material specialty metals distributor with decades of experience specializing in hard to find alloys, grades, and sizes. We offer various grades of stainless steel, titanium, tool and alloy steels, aluminum, and high temperature nickel and cobalt based alloys. We pride ourselves on helping customers meet and exceed niche requirements.

VSMPO – AVISMA

+7-34345-55764
www.vsmpo.ru

VSMPO-AVISMA, the world's largest producer of titanium, holds more than 300 international quality certifications and approvals at major aerospace OEMs and medical device companies. VSMPO-Tirus operations in the US, the UK, Germany and China provide regional sales, distribution and service center processing.

VSMPO - Tirus, US

+1-720-746-1023
www.vsmpo-tirus.com

VSMPO-Tirus, US is the North American sales and distribution division of VSMPO-AVISMA, the world's largest producer of titanium, holding more than 300 international quality certifications. VSMPO-Tirus US distributes ingot, forgings, slab, sheet, plate, bar, and billet to the aerospace, medical, and consumer products industries. VSMPO-Tirus US also manufactures small diameter bar and coil for medical and aerospace fastener applications.

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VSMPO - Tirus China Ltd.

+86 10 8455 4688

VSMPO-Tirus China ltd. is the Chinese sales and distribution division of VSMPO-AVISMA, the world's largest producer of titanium, holding more than 300 international quality certifications. VSMPO-Tirus China distributes ingot, slab, sheet, plate, bar and billet to the aerospace, medical, and consumer products industries.

VSMPO Tirus GmbH

+0049 69 905477-25
www.vsmpo.de

VSMPO TiRus GmbH is responsible for the sales and distribution of titanium semi-finished products in Europe (except the UK), Brazil and Israel to the aerospace, medical and automotive industries. The company was established in 1999 in Frankfurt/Main. The German affiliate of the largest vertically integrated international titanium producer VSMPO-AVISMA offers optimum service, including custom-made processing of semi-finished products as well as a comprehensive transport service. We offer cut-to-size material (bars, billets, sheets and plates) to meet our customers' individual operational needs. TiRus GmbH also distributes electrodes, ingots, rolled rings and different types of forgings.

VSMPO Tirus UK Ltd.

+(0) 1527 514111

VSMPO Tirus UK Ltd. is the UK's sales and distribution division of VSMPO-AVISMA, the world's largest producer of titanium, holding more than 300 international quality certifications. Tirus UK distributes ingot, forgings, sheet, plate, bar, and billet to the aerospace, medical, and consumer products industries.

VSMPO Titan Ukraine Ltd.

+380 562 313092
www.tw-vsmpoavisma.com

VSMPO Titan Ukraine Ltd. is fabricator of seamless tubular products from titanium and its alloys. It is a part of the world's largest producer of semi-products and finished titanium products - JSC Corporation VSMPO-AVISMA (Russia) which supplies billets and bars to the plant. It is guarantee of quality competitiveness of manufactured production for the customers. Annual production capabilities of the enterprise is 700 tons of cold-finished titanium tubes (diameter 3-134 mm and wall thickness 0,2-9 mm), and in cooperation additionally 200 tons of hot-finished titanium tubes (outside diameter 169-325 mm and wall thickness 7-30 mm). Engineers and technical specialists are developing new technologies of titanium tubes production and new types of products. For example, octahedral and ribbed tubes, special kind of thin tubes for silphons, technologies of long-length tubes production, etc. VSMPO Titan Ukraine Ltd. has all equipment necessary for different tests and QA inspections. It allows manufacturing not only according to the international and national standards, but meeting any customer's requirements.

Webco Industries

+1-918-245-2211
www.webcotube.com
titanium@webcotube.com

Webco delivers North America's widest range of tubular products, rapidly fulfilling urgent orders and helping customers avoid costly unscheduled shutdowns and production delays. Customers in the aerospace, automotive, chemical processing, industrial, oil & gas, power generation and other industries, rely on Webco's strength, agility, and innovation to deliver solutions for their most challenging requirements. In fact, Webco manufactures and distributes millions of feet quality tubing made to meet today's most demanding specifications.

Our welded and seamless titanium tube products are available in variety of grades and sizes, standard/off-the-shelf or tailored to meet customers' unique requirements.

Webco maintains a culture for relentlessly pursuing process and product excellence, enabling ever-improving productivity/product quality. For a current list of our ISO, PED, and other certifications as well as ASME, ASTM, and other specifications offered, visit webcotube.com.

Weber Metals, Inc.

+1-562-602-0260
www.webermetals.com

Weber Metals, Inc. specializes in Aluminum and Titanium open and closed die forgings for the Commercial and Military Airframe, Air and Land Turbine, Nuclear and Semiconductor industries. Our press sizes range in size from 1200 to 33,000 tons. We have capabilities to perform heat treatment, non-destructive and destructive testing in house. Our forgings range in size from 1 pound to 11,000 pounds. Our aluminum stress relieved forgings are some of the most stable products in the industry for machining.

Wellmet International Inc.

+1-909- 594-9639
www.wellmetusa.com

Wellmet is located in California USA and we have been supplying and distributing Titanium Sponge and Titanium Powder for more than 20 years. We can also supply other non-ferrous metals with approved quality. Our Titanium Sponge producer is ISO9001:2008 certified and sponge quality is approved by world main consumers.

Westbrook Light Alloys Ltd.

+44-1246-292292
www.wbrl.co.uk

Buyers and seller of titanium scrap. All grades and forms of Ti scrap bought for use in UK production of Ferro Titanium for sale worldwide to end users. Standard and special grades produced to order with all packing and sizing options available to satisfy customer requirements. We also buy/trade titanium scrap for upgrading, processing and on sale.

West Penn Testing Group

+1-724-334-1900
www.westpenntesting.com

West Penn Testing Group is a full-service, independent testing laboratory with diverse inspection and testing capabilities since 1952. They provide an

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extensive array of non-destructive, chemical, metallographic, failure analysis and mechanical evaluation services, serving customers in these industries: aerospace, medical, power generation, commercial, military, raw materials, refractories, oil and gas, and the automotive industry. They have three locations in New Kensington, Pennsylvania and Richburg, South Carolina and perform testing nationally and internationally. Their 79,000 sq. ft. facilities accommodate parts up to 20,000 lbs. www.westpenntesting.com

Western Metal Materials Co., Ltd

+86-029-86968431
www.c-wmm.com

Western Metal Materials Co., Ltd. is a high-tech enterprise established by the northwest non-ferrous Metal research institute, which was established on December 28, 2000. The company listed on the Shenzhen stock exchange on August 10, 2007. The stock is referred to as "western material" and the stock code is "002149."

Western materials has become a group of seven holding subsidiaries and a chemical inspection center approved by the national laboratory. There are more than 1400 employees, including 148 PHDS and masters. The company is in the three districts of Xi'an and Baoji, covering more than 1,300 mu.

Company has formed by titanium industry (including titanium and titanium alloy processing and layer metal composite materials, rare metal equipment manufacturing and pipe fittings, etc.) as the main business, covering metal fibre material and products, rare metals, tungsten molybdenum materials and products such as industry pattern of diversification. The products are widely used in aviation, spaceflight, navigation, information, electronics, energy, environmental protection and other important areas of the national economy.

Company will wholeheartedly create the world's leading rare metal material processing base as the goal with the business philosophy of "advanced technology, excellent quality, steady development, win-win cooperation," so that we will grasp business opportunities and create a bright future.

Western Superconducting Technologies Co. Ltd.

+86-29-8651-4505
www.wstitanium.com
dxh@c-wst.com

Western Superconducting Technologies Co., Ltd. (WST), founded in 2003, is headquartered in Xi'an, China. WST is leading supplier of titanium and its alloys material including Ti6Al4V, Ti6Al4V ELI, Ti6242, Ti6246, Ti662, Ti811, Ti38644, Ti1023, Ti6Al7Nb, NbTi in the forms of ingot, billet, forging, slab, bar, rod, wire and profile in the domestic & oversea market. Our products are mainly used in aerospace, medical, automotive industries and other critical industries.

WST possess most advanced 10 tons VAR furnaces and series of high speed forging presses to manufacture 6000 tons ingots and 4000 tons bars per year. We have gotten the certificate of ISO 9001, AS 9100, NADCAP and ISO 14001, strict quality control system make largest assurance for our high quality products. WST's titanium alloy bars hold over 85% domestic aerospace market.

Western Titanium Technologies Co., Ltd.

+86-029-86968668
www.c-wtt.com

Western Titanium Technologies Co., Ltd (WTT) was established in 2004. It is a large scale and high-tech state-owned company specialized in the developing and producing Titanium, Zirconium, Nickel and their alloy materials and supplying them around the globe in the chemical industry and power generation, aerospace and turbines, oil and gas, Medical, and Military.

Based on almost completely production process from melting, forging and rolling, we mainly produce semi-finished products and pre-materials in the form of ingot, forgings, bars, plate and sheet, seamless tube and pipe in titanium and titanium alloys, zirconium and nickel and nickel alloys.

As the largest subsidiary company of Western Metal Materials Company (WMM), we will rely on more than 50 years research experience, innovative spirit and inspection plant to continuously increase market demands, broader application ranges and supply high qualified products.

Westmoreland Mechanical Testing & Research

+1-724-537-3131
www.wmtr.com
us.sales@wmtr.com

WESTMORELAND
Mechanical Testing & Research Inc.

Westmoreland Mechanical Testing & Research is a world leader in materials testing. WMT&R serves a broad range of industries including aerospace, automotive, medical, and power generation. We support customers with our highly-skilled staff and advance facilities. Our turnaround time is unbeatable, and with over 300,000 square feet of accredited production and testing space, we have the capacity and equipment to handle any materials testing project. WMT&R's testing expertise includes: Mechanical Testing, Composites, Fatigue, Stress/Creep Rupture, Fracture Mechanics, Metallography, Chemical, Heat Treat, Thermal Analysis, and Physical Properties Testing. For more information, please visit www.wmtr.com or email us.sales@wmtr.com.

Wyman Gordon

http://www.pccforgedproducts.com/brands/wyman_gordon/

Wyman Gordon is a worldwide supplier to the aerospace and industrial gas turbine markets. We hold quality accreditations for all of the major airframe and engine manufacturers for both civil and military applications. Wyman Gordon creates rotating closed-die forgings which are critical for aerospace and land-based gas turbines. Wyman Gordon also manufactures structural forgings for airframe, nuclear, petrochemical, power generation, and space applications.

Xi'an Jinhao New Metal Materials Co., Ltd.

+86-29-88726537
www.xajinhao.com

Founded in 2004, Xi'an Jinhao New Metal Materials Co., Ltd, is a specialized company for titanium and titanium alloys products. We can offer high quality titanium rods, sheets, tubes, forgings and wires according to ASTM, AMS,

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MIL, ISO and BS; also kinds of titanium fasteners and machined parts by customers drawing.

Our products have successfully passed the authentication of ISO9001:2000 quality management system in 2005. Our products are broadly applied in aerospace, defense, offshore, as well as chemistry, medical industries etc. The products have been mainly exported to Europe and US, also Germany, Russia, Switzerland, and Netherlands Singapore, Indonesia, etc.

Xi'an JoinXin New Material Technology Co., Ltd

+86-029-8655 4066
www.ti2025.com

Xi'an JoinXin New Material Technology Co., Ltd (JoinXin Technology) is a subsidiary of state-owned listed company Western Metal Materials Co., Ltd. in Xi'an, China (Stock code:002149). It is also an important member of Northwest Institute for Non-ferrous Metal Research which is the earliest organization engaged in the research of titanium and titanium alloy in China. The R&D team of JoinXin Technology has inherited 60 years' titanium and titanium alloy research and development experience of Northwest Institute for Non-ferrous Metal Research, which has made abundant brilliant achievements:

- The first to apply TC9 Titanium alloy to the advanced aircraft engines in China
- The first to obtain the certificate of airworthiness to use the titanium fastener for aircraft in China
- The first to produce the titanium-steel composite plate in China
- The first to develop the titanium-steel composite satellite connector
- The first to develop and create titanium-steel composite pot in the world

Now the technology development team is starting again. Relying on the resources of Northwest Institute for Non-ferrous Metal Research and Western Metal Materials Co., Ltd, titanium is used as core material to create the brand of ZX-TiG, a series of titanium daily necessities, aiming to keep people far away from heavy metal pollution, rust erosion and coating hazards so as to meet their growing needs for a better life. ZX-TiG products include titanium composite pans and pots, small household appliances with pure titanium components, pure titanium tea sets, pure titanium drinking ware, pure titanium tableware and so on. Our vision is to utilize the progress of new material science and technology to provide people with safer and healthier products.

Xi'an Keshang Fluid Equipment Engineering Co., Ltd

+86-13892830858
xakslt.com/index.html

Xi'an Keshang Fluid Equipment Engineering Co., Ltd. is a new technology enterprise producing chemical pumps of various special materials such as titanium, zirconium, nickel and Hart alloy. The company has the Department of technology, sales department, supply department of production department, quality management department, after-sales service department, engineering department and so on.

The products are mainly used in the fields of petrochemical, coal chemical, salt and chemical industry, especially in the fields of ionic membrane caustic soda, vacuum salt making, chemical fertilizer, acetic acid, copper foil, paper making, coking, seawater desalination, environmental protection and other industries.

Xi'an Metals & Minerals Import & Export Co., Ltd.

+86-29-65659719; +86-29-65659718
www.tiwmo.com
info@tiwmo.com; wxd@tiwmo.com; hj@tiwmo.com

As a leading manufacturer and distributor of Titanium, Molybdenum and Tungsten products in China, Xi'an Metals and Minerals Import &Export Co. Ltd., has joined into manufacturing, researching and competing in Titanium industry. We supply Titanium and its alloys in various forms as per ASTM, AMS and other main internationally recognized specifications. Our advantage is the most competitive prices as well as guaranteed high quality! Our products are exported worldwide, and gained high reputation because of their excellent performance.

Xi'an Saite Metal Materials Development Co., Ltd.

+86 29 86523213
www.xsma.com

Xi'an Saite Metal Materials Development Co., Ltd. (SAITE) invested by Northwest Institute for Nonferrous Metal Research (NIN) is a professional high-tech enterprise which earliest engaged in materials of nitinol shape memory alloy and medical titanium alloy. With 330,096 square feet areas, 270 sets of advanced equipment and more than 300 employees, SAITE has the expertise and ability to meet and exceed their customers' needs. The total asset has arrived RMB 200 million since it was established in 2000.Saite specializes in manufacturing high performance titanium, nitinol alloy and titanium art ware for a good variety of customers and markets worldwide. We are committed to providing our customers with the highest quality products and service.

Xi'an Saite Simai Titanium Industry Co., Ltd.

+86-29-86966136
www.simaiti.com

Xi'an Saite Simai Titanium Industry Co., Ltd. (Simai) is a leading producer of technically advanced titanium alloy, shape memory alloy and specialty non-ferrous materials for almost 20 years in China.

As one of the largest companies of Northwest Institute for Nonferrous Metal Research (NIN) Group, Simai provides tailored supply chain solutions through our Materials Management methodologies ad Program Management competencies. Simai continuously focuses on lead and process improvements while maintaining ISO9001, ISO 14001, OHSAS18001 and ISO13485 certifications.

Simai's high-performance materials and advanced process solutions are an integral part of critical applications. Our wire, bar, fine wire, strip and shaped products have been used for applications requiring superior corrosion resistance, light weight, strength and biocompatibility.

Xi'an Tianli Clad Metal Materials Co., Ltd

+86-029-86968315
www.c-tlc.com

Xian Tianli Clad Metal Materials Co., Ltd. (hereinafter called "TLC") was formerly Clad Metal Materials Lab of Northwest Institute for Nonferrous Metal Research. Our Company was established in 25th Dec 2003. TLC has already become a leading manufacturer and professional company producing

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laminated clad metal materials in China. TLC owns the product structure of taking rare refractory metal clad plates (with materials such as Titanium/Steel, Zirconium/Steel, Tantalum/Steel) as its leading products as well as taking corrosion-resistance clad metal materials and transition joints as its two swings. TLC has obtained many certificates from quality and product, such as ISO 9001, SO14001, ISO18001, PED, and ASME. The products are widely used in different application fields.

Starting in the 90s', the realization of rare metal clad materials large quantities exported to Germany, America, Finland, Israel, India and other countries. TLC is the only supplier of clad metal material for domestic war industry, formulate relevant military specifications with clad metal materials. TLC's clad material product quality has reached the international similar products technical level, gradually in the chemical, PTA, steam turbine auxiliary condenser tube sheet, power plant chimney, and nuclear power, marine with clad plate, zirconium/steel, and tantalum system equipment in areas such as a domestic precedent.

ZIROM S.A.

+40 246 216666
www.zirom.ro
zirom@zirom.ro

ZIROM came into prominence, over the last decades, as one of the largest producers of titanium and titanium alloys in Central and South-Eastern Europe. Ever since the foundation, a permanent emphasis has been laid on its development, through technological optimization and through development of the technology for melting titanium and zirconium scrap by combining EB and VAR technologies, and further, the development of free forging process.

The products manufactured, ingots and forged semi-finished products, are intended both for cutting edge fields (aviation and nuclear areas) and various fields (metallurgy, chemical industry, medical technique and devices).

The ZIROM's integrated management system (quality, environmental, health & safety) and the ZIROM's products are certified by LRQA in accordance with the following standards: ISO:9001:2008, EN 9100:2009, ISO:14001:2005, OHSAS:18001:2008, NORSOK M-650 .

Zirom can also provide a series of services like melting the secondary recycle materials, turning/grinding/cutting/milling the surface of products, full chemical and mechanical analyses, LP, US +Eddy testing.

ITA SHINES A 'SPOTLIGHT' ON TITANIUM INDUSTRY

The International Titanium Association (ITA) is launching its "Industry Spotlight" series, a new communications and information tool for the global titanium industry.

ITA associates will interview executives of member companies, creating a short video profile of the company's operations. During the interview segment, executives will talk about the company's genesis and history, their current business strategies, as well as the products and services they offer as part of the global titanium supply chain. The videos are online for ITA members, industry observers and stakeholders and will be included in the quarterly online editions of Titanium Today.

ITA is currently scheduling video interviews for the Industry Spotlight series. To learn how your company may be included in this series, contact Jennifer Simpson, ITA

ITA Industry Spotlight – Titanium Finishing Company

ITA Industry Spotlight – MetCon

ITA SHINES A 'SPOTLIGHT' ON TITANIUM INDUSTRY *(Continued)*

SOLAR ATMOSPHERES

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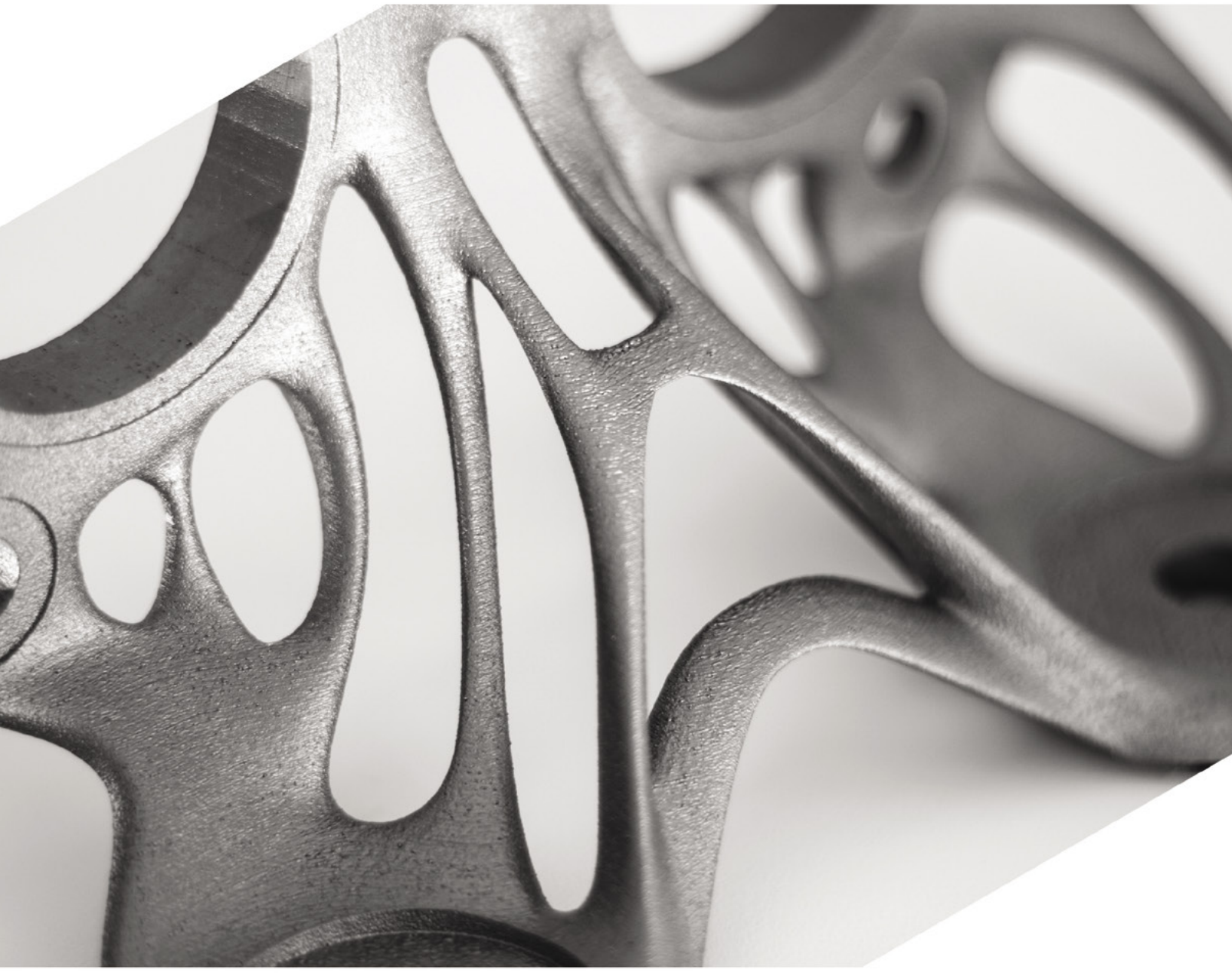
ITA Industry Spotlight – Solar Atmospheres



Where the Future Takes Shape.

Arconic creates breakthrough products that shape industries. Working in close partnership with our customers, we solve complex engineering challenges to transform the way we fly, drive, build and power. Through the ingenuity of our people and cutting-edge advanced manufacturing techniques, we deliver these products at a quality and efficiency that ensure customer success and shareholder value. Learn more at www.arconic.com.

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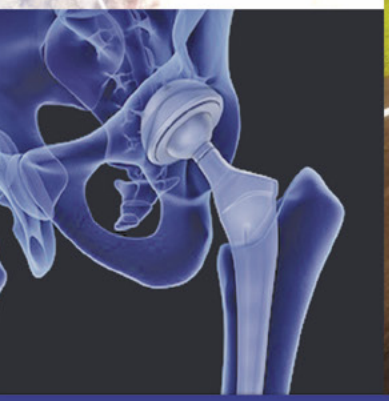

Reliability & Superior Results

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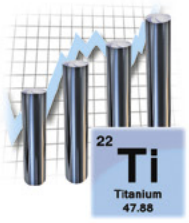
The Most Trusted Name in Testing Titanium

Westmoreland Mechanical Testing & Research has earned a worldwide reputation as a leader in testing titanium materials for advanced industries including aerospace, automotive, medical, military, additive manufacturing and more.

The130,000 square foot state-of-the-art material testing, research, development and machining facility operates 24/7, 365 days a year, allowing for custom setups and schedules requiring quick-turnaround.

As the application of titanium becomes more prevalent in manufacturing, WMT&R will be at the forefront and remain current on industry requirements.



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Westmoreland Mechanical Testing & Research

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