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Contributor

Michael Gabriele  
A former managing editor with American Metal Market, Michael C. Gabriele has been a journalist for over 35 years and has done extensive freelance work for the International Titanium Association since 2005. He is based in Clifton, NJ.

Educational Instructors

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The strongest evidence of Alcoa’s ongoing transformation lies in aerospace. Already an historic global innovator, partner and multi-material solutions supplier, Alcoa is growing and diversifying with U.S. expansions and the acquisitions of Firth Rixson, TITAL and now RTI International Metals.

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A This is the front of the Gittler Guitar, showing the frets and the tuning gears. Because the frets are cylindrical, the contact point of string on fret is less than 0.001 inch.

Every Gittler guitar is hand-crafted. Construction begins with a heat treatment in which the titanium is put through a special process where it is “annealed to dead soft and stress relieved.” Then a machinist carefully shapes the backbone for perfect flatness and precise curvature, and cuts multiple notches for the frets. The piece is bent backward around a custom jig to open up the notches, and compression-fits the cylindrical frets into the notches. Then several microwelds at the notch corners are made to retain flatness and consistency. More information about the Gittler titanium guitar is available at www.gitterinstruments.com.

B Dunnett contends their titanium drum shell is the thinnest on the market, and is usually left unfinished. Over time and with use, the titanium acquires a deep rich finish.

Most metal drum shells require that the edges be bent over to add strength, however bending the metal also has the effect of changing the way it vibrates, thus eliminating its individual sound. Although the Dunnett drum has the thinnest shell, titanium is so strong that it does not require strengthening, and the resonant titanium sound is preserved. More information about Dunnett Drums along with a list of professional musicians who own titanium drums and recordings are available at www.dunnett.com.

C Eric Bono of EB Custom Knives worked with Mike Kobold to come up with a knife design out of SM-100 that would be robust enough for the first winter crossing across Antarctica. The design is “Little Bastard” and the cutting edge is almost 3” and OAL is about 7.75”. More information about EB Custom Knives are available at www.ebcustomknives.com.

D ‘Jali Bracelet’ made out of Titanium, 18ct gold, sterling silver 70mm x 70mm x 40mm by Meghan O’Rourke.

E “Unfolded”, bracelets made out of Titanium, sterling silver, 18ct gold 120mm x 120mm x 20mm by Meghan O’Rourke.

As a contemporary jeweller and metalsmith Meghan O’Rourke aims to create precious objects for the body that are both playful and ornate. After several years experience working in the retail jewellery industry, Meghan completed a Bachelor of Visual Arts & Design at ACArts where she specialised in jewellery. She then went on to spend several years as an associate designer and access tenant within the JamFactory’s prominent Metal Design Studio. Meghan has also gained recognition in various fine art awards and international residencies, including winning the National Contemporary Jewellery Award and a 6 week residency working in Delhi, India. More designs available at www.meghanorourkejewellery.com

F When John S. Ellett, president of Ellett Industries, got the idea for a titanium palm to be placed on his Pacific Ocean property, he posed a new challenge for his engineers. The palm trees began with artistic sketches that were then translated into AutoCAD. Looking around the recycling yard, they selected pieces of Grade 2 titanium. The leaves were laser-cut and then slightly bent so that they were realistically three-dimensional. With the aid of a four-axis laser cutter, pipe was turned into the trunk, which was rolled and welded. Bark was laser-cut and affixed to the trunk giving it a rough effect. The biggest challenge was the welding of the branches to the trunk, which required the same welding and purge techniques that are used on the fabrication of such things as pressure vessels. The difference was that all the high-quality welded joints had to be hidden from view. The end result was titanium’s beautiful luminous quality and its ability to withstand salt in a seacoast environment. Ellett Industries www.ellett.ca

G These titanium products are easier to carry than their steel counterparts. Vargo Outdoors now offers a wide range of titanium hiking and camping necessities. The cover displays a titanium pot lifter, a titanium mug, and a titanium alcohol stove heating water in a “bot,” a titanium bottle that doubles as a pot. Visit www.vargoutdoors.com to see the full line of titanium products, together with videos that show how they work.

THANK YOU TO OUR PHOTO CONTRIBUTORS
Please allow me to introduce myself. I have been in and around the titanium industry since 1979. (I’m 73 years old, but that is another whole story!)

In the late 1970’s, after having served a tour of duty in Vietnam and working with my GI Bill, I was grinding my way through a Master of Fine Arts program at the University of Kansas. There I saw my first jewelry work produced from titanium. I had been searching for a field of specialization within my studies, and I was struck by what I saw. As I began to investigate the material, two things became clear. One, this was an entirely new creative form, a new way for an artist to express. Two, I felt I could write a guide to its use for jewelers that would make it more accessible. This came to fruition in my MFA thesis: “Studio Preparation and Coloring of Titanium, 1981.”

While in the process of the writing my thesis, students began asking me to teach them how titanium worked. So, I began teaching workshops. I taught anodizing, and introduced cold and hot forging of Grade 1 titanium. With the aid of Dave Robertson and the staff at TICO Titanium, I was able to gather bits and pieces, scraps really, to teach the first classes.

Within the next year I came to the realization that it made no sense to teach the use of titanium if it was not readily available to the craftsmen. Thus the inception of Reactive Metals Studio, Inc. a small company (me in the beginning) dedicated to making and supplying titanium in the forms and quantities that a new market of artists would require. With the aid of industrial partners like TICO Titanium, Dynamet Incorporated, TIMET, Titanium Industries, Arnold Engineering and G&S Titanium we began to produce a product to the sizes and B&S specifications of the jewelry industry. So for the last 33 years I’ve been teaching students of all ages how to use and anodize titanium.

My journey of discovery is one of creative possibilities, the harnessing of titanium and its many possibilities. The area of consumer products development is fraught with many misconceptions, rumors and misunderstandings. We have the dual challenge of continuing to educate the producers of consumer products and at the same time excite the senses of the consumer with the beauty, strength and aesthetic of titanium.

These are exciting days, considering the advances in manufacturing technology and the ability to network with potential partners on a global basis. There are an untold number of consumer applications yet to be discovered. Our job remains one of pioneering of opening the doors to the future of consumer products.

Bill Seeley
ITA Consumer Committee Chair
timan42@gmail.com
928-301-2420
PO Box 851
Clarkdale, AZ 86324
Phil Poirier Utilizes an Ancient Engine to Create Distinctive Titanium Jewelry

In order to gain an edge and express his creativity as a metalsmith and titanium jewelry craftsman, G. Phil Poirier has invested in proprietary technology—a somewhat enigmatic machine that dates back to the 18th century.

Poirier's studio, located in Taos, NM, in the shadow of the Sangre de Cristo Mountains, houses six vintage “rose engine” devices, which sit side by side with modern CNC mill lathes and hydraulic presses. Poirier described the rose engine as an "esoteric tool" that jewelers have used for centuries; “a lathe on steroids” that employs rose cams and a horizontal spindle capable of cutting intricate, three-dimensional cuts and engraving into metal surfaces.

He said that rose engines were used years ago to cut the delicate patterns found on the legendary Faberge eggs and currently are used on expensive Swiss watches such as Breguet. The jeweled Faberge eggs were created for the Russian imperial family between 1885 and 1917. Online sources estimated that there were over 50 eggs created and about 40 still survive today. The eggs were produced by the House of Faberge, a jewelry maker based in St. Petersburg, Russia. Poirier noted that he is a student of jewelry history.

An online description explains that a rose engine has a headstock rocks back and forth across the spindle axis and can also move in a pumping motion in line with the spindle axis, controlled by rubber moving against a rosette or cam-like pattern mounted on the spindle, while the lathe spindle rotates. The complex, precise decorative patterns created by a rose engine onto a variety of substrates is known as a “guilloche.” When mounted on a work bench, a rose engine has a “clockwork” like look.

Formally trained as a goldsmith and silversmith, Poirier began his career as an artisan four decades ago. Growing up in San Diego, he first was attracted to metalsmithing in a high school art class. In the early 1970s he established his own business, creating silver and turquoise jewelry. Over the years his artistic concepts grew and he began expanding his pallet to include titanium, niobium and stainless steel.

As he explored the possibilities of titanium, his skill set grew to include anodizing the metal to create a spectrum of colors and textures. He also has mastered an ancient technique known as pattern-forging which dates back nearly 2,000 years. The process consists of welding two different alloys of steel and iron, folding and welding again many times to develop numerous layers. These layers, when revealed by etching, form an undulating pattern on the metal surface much like wood grain.

“Pushing the limits of what metals will do—that’s what inspires me,” Poirier said, describing himself as the principal engineer of his studio and “a hands-on guy.”

The artwork that Poirier creates using titanium typically consists of many techniques. He said that processes such as milling or lathe work are used to create the general shape of the design. Then additional processes are applied such as cutting with fly cutters and engraving with fixed point tools on one of the rose engines. Most of his titanium work is anodized with single or multiple colors. Many pieces will be crafted and then anodized, then re-machined or engraved, then re-anodized to develop multiple layers of color and depth in the titanium. Using ancient techniques with modern space-age materials is what gives Poirier his inspiration and his work it’s unique look.

Information posted on his website (http://www.poirierstudio.com) cites his many achievements. In 1992 was commissioned to create a memorial goblet for the Spertus Museum of Chicago, in honor of the 11 athletes that died at the Munich Olympic Games in 1972. He has created custom jewelry pieces for the Millicent Rogers Museum of Taos inspired by the Millicent Rogers southwest collection. In 1998 he participated in the Yaw Galleries’ Functional Vase Project with SOFA (Sculptural Objects Functional Art), NY. He was one of five artists invited to The University of New Mexico Harwood Museum exhibit “Objects, Five Master Craftsmen.” Poirier teaches techniques and tooling that he has invented at...
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Motorcycle ‘Queen of Speed’ Gets a Boost From Her High-Tech Titanium Exhaust System

When a world-class motorcycle rider pushes the envelope to achieve speeds in excess of 200 mph, it goes without saying that the machine she rides, engineered to provide maximum performance, requires a titanium exhaust system.

Valerie Thompson—known to her fans as “America’s Queen of Speed”—races one of America’s fastest BMW S 1000 RR land speed motorcycles, sponsored by Quicksilver Powersports Lubricants/CTEK Battery Charger, according to information on her website (http://valeriethompsonracing.com). Her racing career started in 2006, drag racing motorcycles on quarter-mile tracks throughout the United States. As a result of her success, she created her own land speed-racing team in 2012 and is a seven-time motorcycle land speed record holder with a personal best top speed of 217.7 mph (350.53 KM/H) on a one-mile course.

In 2016, Thompson returns to the National Hot Rod Association (NHRA) for a full-season circuit of pro stock motorcycle racing on a new George Bryce (Star Racing) prepared drag bike. She also plans to compete at select land speed racing events with her award-winning BMW S 1000 RR motorcycle.

As for the titanium exhaust system, Thompson said she recently had the opportunity to visit the Akrapovic manufacturing facility in Slovenia, where the system is produced. Her contacts at BMW Motorrad arranged for the plant tour. She said the Akrapovic exhaust system is designed to perform at high speeds and represents “the difference between winning and losing,” she said.

An Akrapovic spokesman said the exhaust system used by Thompson was specially designed for BMW racing motorcycles, such as the M3 GT4, and BMW Motorrad. The company representative said this isn’t a product line available to commercial customers. Though it has been engineered for high-speed racing, he described the titanium exhaust system as having some similarities with Akrapovic’s line of its commercially available “Evolution” exhaust systems. The exhaust system designed for Thompson’s motorcycle has titanium walls 0.65 mm thick and weighs 5.5 pounds (2.5 kg).

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motorcycles, Akrapovic manufactures titanium, stainless steel and aluminum alloy exhaust systems for high-performance cars in Europe, such as Ferrari, Lamborghini and Porsche. Information on the company’s website (www.akrapovic.com) states it has a workforce of over 800 employees and that, for its cast titanium parts, it maintains “scrupulous attention to chemical compositions and gas content. Gas content is crucial for the quality of cast titanium parts. Hardness and micro-hardness measurements, tensile properties, plastic properties and formability determinations are carried out for all incoming and new materials by a team of highly-skilled engineers. Such regular procedures ensure the best quality of the final product and the use of the best materials.”

An online article posted Sept. 12, 2014 by Motorcycle-USA.com reported Thompson set her seventh land speed record during the Utah Salt Flats Racing Association’s 28th annual “World of Speed” held at the Bonneville Salt Flats, Wendover Utah. “Her BMW Double R was fast right out of the trailer,” the article stated. “Six out of eight of Thompson’s passes were over 200 mph. On her last run of the event, Thompson enjoyed her best speed on the salt with a first pass at 209.85 mph and a return run of 207.71 mph, setting a new record at 208.81 mph.”

Originally from Tacoma, WA, Thompson currently resides in Scottsdale, AZ. She began her professional career in the banking business, then worked at a Harley-Davidson motorcycle dealership, which sparked her interest in racing. She began riding motorcycles in 1999 when she purchased Harley-Davidson Sportster and Fat Boy bikes.

In an August 2015 online article from RoadRunner Motorcycle Touring and Travel magazine, Thompson discussed the personal fitness and athletic requirements needed to be a competitive, high-speed motorcycle rider. “Physical fitness and mental focus are two major priorities in land speed racing,” she said, quoted in the article. “At 200 mph, you must be focused on the bike’s performance and handling or pay the consequences. During a race week, I get plenty of rest and eat balanced meals to sustain a high energy level. The top priority is keeping electrolytes fully charged and maintaining proper body hydration.”

As for the wisdom she’s gained over the years, she explained that land speed racing events are held on a variety of surfaces, ranging from salt flats and dry dirt deserts to paved airport runways. “The first priority is preparing for the track surface and its distance,” she said in the RoadRunner interview. “That means addressing tire configuration, gear selection, weather conditions, and numerous other considerations. On race day, the big trick is figuring out wind conditions, surface adhesion, and choosing the optimal riding position.”

She identified the Bonneville Salt Flats, “the world’s Cathedral of Speed,” as her favorite site for racing. “Where else can you go full throttle and see the curvature of the world?” she told the RoadRunner editors.

When not competing on the racing circuit, Thompson works as vehicle presenter at Barrett-Jackson Auction Company, LLC and Metro Auto Auctions in her hometown of Scottsdale, AZ. She also donates her time and support to inspire children overcoming personal challenges with charitable organizations such as HopeKids.org, which earned her the 2011 “American Women Riders Community Hero Award.” That same year she also received the “Red Carpet Award” for her inclusion in Delores Seright’s book, “Amazing Women: Shattering Barriers.” Her motto, posted on her website, reads: “The best protection any woman can have is courage.”

Founded in 1990, Akrapovic said the titanium it uses for car and motorcycle exhaust systems is produced exclusively for them. The company didn’t elaborate on the grade or alloy of the titanium, and didn’t identify the supplier, but said its titanium is “three times stronger and more heat resistant than any other titanium product on the market, in addition to being 40 percent lighter than stainless steel. This high strength allows the use of thinner insulation while still achieving the highest quality standards, bringing decisive advantages both on and off the race track.”

Valerie Thompson, “Queen of Speed” (continued)
FOR MORE INFORMATION:
Vulcanium Metals International, LLC
3045 Commercial Avenue
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Entrepreneurs in North America, Europe and Australia are exploring new possibilities for the use of titanium in the production of bicycles. In many cases, this exploration involves the use of 3D/additive manufacturing technology, although, for the most part, these efforts involve prototypes or early-stage production programs. Taken collectively, these projects demonstrate the creativity and vision needed to rethink how titanium can be used in a well-established consumer business sector.

On one level these programs are a re-examination of titanium in bicycles for sport and recreational use. Given its light weight, strength and durability, bicycle manufacturers became enamored with titanium in the late 1980s and early 1990s. Various sources indicate the Teledyne Titan, produced during the mid-1970s by Teledyne Linair Corp., Gardena, CA, was the first American production titanium bike.

During those years the key technology for titanium bicycle manufacturing focused on innovations in precision, thin-walled tubing used for cycle frames. However, relatively speaking, the cycling industry’s love affair with titanium was brief, as interest soon shifted to ultra-lightweight carbon-fiber composites.

A quick read of the many international magazines and trade publications reveals that the consumer market for bicycles takes it cues from advances in the highly competitive, international sport of cycling, with demanding, aerospace-like specifications for bike frames and related components. Bicycle manufacturing, especially for professional racing, is a complex balancing act that involves speed, safety, lightweight aerodynamic designs as well as the subjective category of rider “feel and comfort.”

“Bike riders and bike builders love titanium,” cycling historian and sage Jeff Groman, observed. Groman sold, built and repaired bikes for 35 years and was the proprietor of Classic Cycle on Bainbridge Island, WA. He acknowledged that while carbon fiber has overtaken titanium as a material of choice for competitive and recreational bike riders, there remains a loyal group of titanium bike fans, especially in North America. As a result, over the years, in order to serve these customers, most bike builders have learned how to properly weld and machine titanium, he said. And for riders who live in Groman’s neck of the woods—the habitually rainy Pacific Northwest—titanium bikes never rust.

“There’s no downside to titanium when it comes to bikes,” Groman continued. “For riders, titanium bikes have a great ‘feel,’” meaning that the bikes provide a solid, comfortable, smooth ride. “The feel is similar to steel for bike riders, but titanium is stronger and lighter. And when you get off the seat and pedal up hill, a titanium bike really moves.” Groman identified two current builders of custom titanium bikes in the United States: Moots Cycles (http://moots.com), Steamboat Springs, CO; and Lynskey Performance Designs (https://lynskeyperformance.com), Chattanooga, TN.

Aside from competitive racing, countries throughout Europe, such as the Netherlands and Denmark, and in many developing Third World countries, a bicycle is much appreciated as a means of practical transportation and consumer lifestyle fitness. In the United States, major metropolitan areas like Portland, OR, New York, Chicago and Minneapolis typically garner votes in surveys and
reader polls as “bicycle friendly” cities. Considering all this, a revival of interest in titanium in the consumer category of bicycles would be a potentially lucrative business trend for the titanium industry.

One of the bike builders exploring the 3D/additive manufacturing process is Dave Levy, the president and founder of Portland-based TiCycles Fabrication. Levy, during a recent phone interview, said the “Solid” bike was designed as a concept piece; a project intended to put the 3D process to the test. Levy said that while 3D offers intriguing potential for commercial production, his experience was that it was difficult to maintain accurate tolerances on a large structure, like a bike frame. He attributed this to “additive drift” during the multiple passes of the printing process.

Despite the challenges, Levy remained optimistic. “3D is a fantastic conceptual process. We pushed the design concept. Sometimes failures are more important that successes.” In fact, based on the insights gained from Solid project, he said TiCycles is currently consulting with a British company reviewing 3D technology for producing titanium bicycle components. “Titanium is a fantastic material for building bicycles,” Levy continued. “Titanium offers many benefits, such as excellent fatigue strength and light weight.”

In 2014 TiCycles, working with the design company Industry, also based in Portland, developed the “Solid” titanium bike, which received considerable attention at cycling trade shows and with various blogs. According to information posted on the TiCycles website (www.tycles.com), Levy began his career as a professional bicycle frame builder in 1986. Four years later he founded TiCycles in Seattle to focus on constructing custom performance frames in titanium and steel for bicycling enthusiasts. The company relocated to Portland in 2002 and opened a 2,300-square-foot fabrication facility in 2010. Levy has served as the president of the Oregon Bicycle Constructors Association (http://oregonframebuilders.org).

Renishaw Plc, the international British-based engineering corporation, in an alliance with Empire Cycles Ltd., Lancashire, England, recently produced a printed 3D titanium mountain bike frame. Much like TiCycles’ Solid program, the collaboration between Renishaw and Empire was a prototype project to define the capabilities of the 3D process technology. David Ewing, a Renishaw marketing representative, explained that the effort with Empire was “a study was to demonstrate many of the design and manufacturing advantages of additive manufacturing, using an object (a bicycle) that was functional and familiar.” The project used Ti6Al4V alloy, “atomized to create a fine powder suitable for additive manufacturing, with no binders or additives are required.” Ewing pointed out that Renishaw is also a distributor of additive manufacturing metal powders.

The Empire/Renishaw venture unveiled the 3D bike frame in early 2014 at various European trade shows. The frame weighed in at around 3 pounds and was bonded together using a structural epoxy specifically developed for titanium alloys. The 3D components were heat treated to remove internal stresses. Renishaw, which has a technical center in Chicago, launched its AM250 laser melting platform, a recent addition to its AM400 flexible metal additive manufacturing line of equipment.

Another European bicycle builder, Festka s.r.o., based in Praha-Vinořady, the Czech Republic, offers its “Asphalt” line of titanium cycles and the “Doppler” line of carbon fiber/titanium bikes. Information on the company website (http://www.festka.com) states that Festka maintains in-house production capabilities for working with titanium, such as TIG welding and CNC machines. For the Doppler series, Festka indicates it uses titanium Grade 9 (Ti3Al2.5V) tubes supplied by an outside vendor, which are paired with carbon fiber joints and lugs.

Bike manufacturers in Australia also are intrigued by the promise of 3D technology. Perth-based bike maker Flying Machine established a partnership with Commonwealth Scientific and Industrial Research Organization (CSIRO) to produce a prototype known as 3DP-F1, a bicycle that has 3D-printed...
Titanium in Bicycle Manufacturing (continued)

titanium lugs. An online article posted by Australian Manufacturing magazine reported that the eight bike lugs—the components that join the tubular frame of the bike—were designed and 3D printed at CSIRO’s Melbourne-based additive manufacturing facility Lab 22.

Alex Kingsbury, group leader, additive manufacturing for CSIRO of Australia, during a presentation at TITANIUM 2015 conference and exhibition held in Orlando, FL, said her organization’s Lab 22 is a center for development work in additive manufacturing. Kingsbury said this thrust by CSIRO reflects an ongoing effort throughout Australia to transition out of low-tech, high-volume manufacturing into high-tech, valued-added production. The hope, she said, is that this initiative will help create a robust supply chain for additive manufacturing in Australia. Equipment at Lab 22 includes powder bed and blown and spray machines, polymer 3D printers and scanners, and testing operations.

The Australian Manufacturing story quoted Matthew Andrew, the co-founder of Flying Machine, who said the use of 3D technology for this application has “surpassed his expectations.” The lugs, he said “fit like a glove” and the bike “rides even better than I had hoped. It’s light, stiff, fast and extremely comfortable. “We’ve wanted to use this technology for some time now, but until recently we didn’t know who to turn to make it happen.”

A separate online news article from Australia stated that, due to the success of the program, Flying Machine plans to begin incorporating the parts across its range of bikes. The report by the Australian Associated Press (AAP) news agency also quoted Andrew, who said the 3D printing technology “will allow the company to customize bikes to the measurements of customers.” It’s like a fully tailored fit system. In traditional manufacturing, parts are standardized and produced (in large volumes). Three-dimensional printing, by contrast, allows a manufacturer to make precise alterations quickly and easily, simply by updating a computer file. CSIRO’s $1.3 million high-tech 3D printer is the only one in Australia that could do the job at the right price point,” he said.

Flying Machine, on its website (http://www.flyingmachine.com.au), said the bike’s frame is 3Al-2.5V titanium tubing bonded to the 3D printed Ti6AlV4 titanium lugs “using aerospace-grade super toughened epoxy adhesive. The lugs are produced in Melbourne and the frame building is done in our Perth studio.”

The AAP story also reported that the 3D technology also provides logistical benefits to Flying Machine to accelerate the production of bikes. Andrew said his company previously ordered steel lugs from overseas. “They took about 10 weeks to arrive. With 3D printing, that’s down to about 10 days,” he said, noting that titanium is also a superior material for this application, compared with steel.

According to information on its website (http://www.csiro.au), CSIRO officials said Lab 22, its $6-million manufacturing center located in Clayton, Victoria, Australia, “is making metal additive manufacturing more accessible for industry and increasing its adoption across Australia.” CSIRO said Lab 22 provides Australian companies “with a unique opportunity to access and explore new technologies so that they can innovate with less capital investment risk. We are able to capture 3D data and simulate both the manufacturing process and in-service part performance.”
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Knew Concepts ‘Accidentally’ Selects Titanium to Create Enhanced Birdcage Frame for Fret Saw

Who “knew?”

Choosing titanium as the material for the “birdcage” frame of Knew Concepts’ fret saw was a “happy accident,” according to Lee Marshall, company founder and chief designer. As a result, during the last three years, the world of metalsmithing artisans, jewelry designers and woodworking crafters have, quite literally, “beaten a path to his door” in Santa Cruz, CA.

The happy accident referred to by the 80-year-old Marshall, known to his legion of fans as “the saw guy,” occurred when he unexpectedly had the opportunity to purchase off-spec 1/8th inch thick, 6/4 titanium sheet. It dawned on Marshall that, with the proper design, a titanium birdcage frame would greatly enhance the stiffness and stability of his line of fret saws, which are used for cutting expensive materials such as gold and platinum, or doing intricate woodworking. The design was identical to the fret saw aluminum frames already in use, but when the distressed material ran out, the design had to be changed to improve “nesting” on the sheet to reduce waste. This led to the work that Marshall’s associate Brian Meek did to create the birdcage frame design.

Meek, operations manager for Knew Concepts, recalling the origins of the birdcage concept from 2009, said that Marshall developed the original “flat” design for the fret saw, which utilized aluminum. Having obtained the off-spec titanium sheet from distributor Supra Alloys Inc., Camarillo, CA, Meek said he and Marshall “spent about six months bending both of our heads trying to come up with a ‘pieced together’ version of the flat frame that would work. We came up with some very strong designs, but unfortunately, none of them had any torsional rigidity. They were rigid as anything in compression, but were ‘spaghetti’ in torsion.”

After a number of iterations, Meek took some of the spare prototype pieces to his home workshop, where he has a micro-scale tungsten inert gas (TIG) welder and started welding parts together to try and create a feasible concept. The recollection of this brainstorming shared by Meek offers a rare glimpse of an engineer’s inventiveness and the often-daunting trial-and-error process of developing a functional product design. Eventually, Meek said he received a bolt of inspiration from his seafaring days.

“I spent a chunk of my 20s sailing historical wooden ships, including a couple of summers working on a replica of the ‘Santa Maria’ back in the early 1990’s,” he said. “Once I looked at the pile of scrap titanium on the table, I got to thinking about how sailing ships stabilize their masts, which led me to weld a pair of the reject spine designs onto a set of legs, and then splay the top of the two spines apart, to generate a triangle truss. I welded some scrap titanium strip across the top of it to stabilize it, and suddenly had an immensely stiff truss. It quickly became very clear which way we needed to go.”

Meek said that the spine of the birdcage saw resembles the hull of a square-rigger ship. “The legs step into the truss the same way the masts of a sailing ship step into her keel, and the triangulations of the truss mimic the shrouds that stabilize the masts as they rise.” He said that, after his fit of inspiration, born of pure frustration, the design concept for the fret saw birdcage came together pretty quickly. He then looked to translate this inspiration to a CAD drawing. “I did finite element analysis runs on the truss design to shave the weight down to the absolute minimum we needed for full strength, as every extra gram in the truss is weight in the absolute wrong place for ease of use.”

In addition to his experience on vintage sailing ships, Meek has considerable experience working with titanium and wrote his master’s degree thesis on mechanical bonding of gold foils onto titanium substrates. He also noted that Daren Forbes, a retired “exotic materials” welder from Arc-Tec Welding,
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> Planned Drops
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> Multi Strand Blanking & Oscillate Winding

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Santa Cruz, CA, assisted Knew Concepts in the program. Meeks explained he designed the production version of the birdcage so that it goes together with a “Tab-A/Slot-B” setup, so that the rivets in the legs hold it together for welding. “It’s self-jigging. There is extra length designed into all the tabs to provide welding filler material. In the end, we can be proud to say that we’ve built the stiffest, most rigid fret saw in the history of the human species,” he declared, adding that “if only because nobody else has ever been quite that nuts.”

Marshall said using titanium also had ergonomic advantages, making the fret saw nearly half the weight of a comparable steel saw frame. While the fret saw frame is titanium, the saw blade is Swiss-made steel. Initially, he had enough titanium material to produce about 200 fret saws. Marshall knew he was on to something when they all sold, and he started getting orders for more saws. Knew Concepts purchased titanium 6/4 sheet from Supra. The fret saw, in 3, 5 and 8-inch sizes, was commercially launched and, as a specialty tool, has been a success for the company. Marshall explained that the saw’s rigid design not only offers greater cutting accuracy for the artisan, it also greatly extends the life and reduced the breakage of the saw blade, which is subjected to constant flexing. The saws are priced from $195 to $225.

Along with the fret saws, Knew Concepts also designs and markets titanium soldering clamps. According to information posted on its website (http://www.knewconcepts.com), the titanium strips can be easily bent into a wide range of specialized custom clamps for jeweler’s hard soldering operations. The website posting indicated that “titanium has several advantages over traditional steel clamps when it comes to soldering. Solder doesn’t stick to it. Enamel doesn’t stick either. It stays strong when red hot. It doesn’t erode and flake away at heat, so your clamp tips can be smaller. Most importantly, titanium doesn’t transfer heat nearly as quickly as steel clamps, so it interferes with nearby joints less than steel clamps do.” The clamps are sold in a pack of 10 “blanks” as straight, fully annealed, 4-inch strips, designed to be configured for individual soldering needs.

Marshall proudly described Knew Concepts as a “customer oriented small business” with five employees that sells and distributes products around the world. The company has a stable of Taiwan-built machine tools, such as a vertical machining center and a five-axis, twin-spindle lathe.

As for his own resume, Marshall said he was born in Kansas, lived in Denver and worked as a tool and die designer for many years. During the 1960s he was employed at Coors USA Chemical and Scientific Porcelain Co., and also worked on the Telstar satellite communications program. “I’ve been building specialized tools all my life,” he said, pointing out that he remains a “drafting table” designer.
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Artist VanderMey ‘Manifests’ Her Creativity in Jewelry, Sculpture by Anodizing Titanium

“I’m a manifester,” Sandra VanderMey declared when asked to explain her inner artistic determination as a sculptor and jewelry maker, whose work encompasses the innovative use of reactive metals such as titanium, niobium and tantalum. “I make my dreams happen.”

Over the years her work has garnered international accolades and numerous awards. According to information posted on her website (https://sites.google.com/site/futurelightmetalwork), VanderMey has won first place awards in national and international art competitions for her unusual metalwork. She exhibited her jewelry and wall sculpture in galleries around the world including Great Britain, South Korea, Japan, Sweden and Germany, while Vogue Magazine commissioned her to design bracelets.

Her first wallpiece, “Winterplanes,” was selected by the Smithsonian Institute for its National Air and Space Museum in Washington DC. Smithsonian Magazine along with numerous other periodicals, newspapers and international publications, Ornament Magazine, Metalsmith Magazine, American Craft magazine have featured her metalwork creations. Public and private collectors, galleries and interior designers commissioned her wall work.

In 1980 VanderMey earned her first master’s degree from the University of Iowa, where she focused on thin-film interference colors on reactive metals, titanium, niobium and tantalum. She first became intrigued with the artistic possibilities of working with reactive metals—the spectrum of vibrant colors and textures she could achieve via the anodizing process. It was during this period that she met William Seeley, the founder of Reactive Metals Studio, who had been doing pioneering work in anodizing titanium for fine art and jewelry applications. Working on her own via trial and error, along with advice from Seeley, VanderMey taught herself to master the anodizing process. Eventually, she became so proficient, she began teaching anodizing workshops in metalworking departments at college and universities throughout the country.

Her second graduate degree, which she earned in 1990—a Masters in Fine Arts—was in holography and reactive metals. She was the first student in the history of the University of Iowa to graduate with honors from their School of Art and Art History. After graduating she taught metalsmithing at Iowa State University, University of Iowa and Dordt College.

By the early 1990s VanderMey was ready to pursue her dreams to go to California, where she resides and works in Studio City, a Los Angeles neighborhood. Initially she received a contract from Disney Studios to do jewelry for Disneyland. Following through on a series of tips from networking contacts in the Hollywood circuit, she worked for Paramount Studios, which displayed her abstract,
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futuristic creations in the Star Trek movies series. As a result, her wall pieces were displayed in the films as part of the décor in the Starship Enterprise. Soon after, she began her career with Star Trek, creating wall sculpture for the television show. She produced numerous art pieces for the ships in all three Star Trek series, Next Generation, Voyager and Enterprise. Her art also appeared in Star Trek’s video games and in the feature film Star Trek Insurrection.

“I brought samples of my work to the people at Paramount,” she said. “They liked what they saw and I was hired. They never dictated to me; they just said they wanted something creative. It was quite remarkable. My dream came true. I’ve had a charmed life. That’s why I call myself a manifest.” And while she loves the Star Trek movies, she doesn’t consider herself to be a true “trekkie,” she confessed with a chuckle.

Her color pallet in working with reactive metals comes from her knowledge of the anodizing process. “When I work with titanium, I know what voltage to use to get the color I want for a piece,” she said. When creating art in her home studio, VanderMey wears heavy duty rubber gloves to shield herself from the dangers of high-voltage anodizing work. Along with her artistic skills, she also makes use of her metalsmithing abilities.

Sandra VanderMey was born in Grand Rapids, MI in 1949. She demonstrated an interest and talent in art at an early age and she began her artistic career as a painter. The statement on her website homepage sums up her accomplishments thus far as well as the thrust of her inner spirit as an artist: “I am inspired working with reactive metals. I have discovered the best of two worlds working with titanium, tantalum and niobium: the beauty of an intense and pure painterly pallet; and a tactile sense derived from working with metal. Both provide the perfect vehicle for me to express my love of nature.”

Phil Poirier Titanium Jewelry (continued from page 10)

venues around the world including the University of Central England’s Jewelry Design School. His work is exhibited in galleries in Colorado, New Mexico and California.

Poirier also produces his own tool designs and is the owner of Bonny Doon Engineering (http://www.bonnydoonengineering.com), a designer and manufacturer of specialty hydraulic presses and tooling for jewelry makers, metalsmiths and artists.

On the Bonny Doon website, he offered this environmental statement regarding his company’s energy policy:

“In keeping with our philosophy of responsible economics, Bonny Doon Engineering uses 100-percent renewable electricity in our facility. All of our power is generated on wind farms by our local power provider. Though it costs us more each month, helping to protect our environment and our future is an important part of our business vision.”
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<tr>
<td>Niobium</td>
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EXECUTIVE PROFILE; WOMEN IN TITANIUM

Polina Sparks, editor at Argus Media Ltd.

Polina Sparks, an analysis editor, non-ferrous metals, for London-based Argus Media Ltd., serves on the executive committee of the Women in Titanium (WiT) conference, the new group sponsored by the International Titanium Association (ITA). The WiT held its first meeting last October in Orlando, FL, just prior to the start of the ITA’s annual TITANIUM USA Conference and Exhibition, and Sparks was part of that gathering.

Working at Argus Media, Sparks is responsible for overseeing price assessments and consultations on pricing and has more than 15 years of experience in the metal markets and has written analytical reports on non-ferrous metal industries, markets and technologies. Previously, she worked as the editor and head of research at Metal-Pages, another Argus publication, and she developed coverage of the Russian/CIS non-ferrous metals industry at Metal Bulletin Ltd., also based in London. Sparks is a graduate of Cambridge University and has post-graduate qualifications in journalism and translation. She is bilingual in English and Russian.

Sparks grew up in Moscow and was surrounded by writers and by diverse languages, traditions and cultures. “For all their differences, Moscow and Cambridge are both international university cities with a strong intellectual and academic community,” she said. “This is where many of my mentors came from: writers, physicists, medical scientists, artists, linguists, and educators.” Sparks said her strongest professional and personal skill set is a willingness to learn and dedication to promoting learning. As a journalist, she described herself as having perseverance, good analytical skills, and a strong work and teamwork ethic.

1. By way of introduction, tell us about your career. How did you get into the field of journalism?

As a young person I was always writing, and my reading list included scientific and literary journals. I did my first internship on a national magazine when I was 15. Shortly after graduating I trained at a magazine in London, before studying for the National Council for the Training of Journalists diploma in newspaper journalism. I trained at local papers in southeast England and at The Guardian before joining Metal Bulletin in 1998, where I first began to write about the titanium industry. While working as senior assistant editor, I also studied for a law course, with a focus on media law.

After having children I moved on to work as a freelance journalist and editor, contributing to various publications, including Metal Bulletin. In 2007 I joined Metal-Pages as the editor. In 2013 I moved to head of research, to expand Metal-Pages’ analytical work. In 2014, Metal-Pages was acquired by the major commodities-focused publisher Argus Media, and I joined its editorial team. As an editor for Argus, I focus on analysis in high-temperature and aerospace metals. I also oversee the non-ferrous metals reference pricing service.

2. What are your thoughts on the WiT committee’s mission to attract young women to enter the field of titanium, as well as support women currently in the titanium business?

The atmosphere at the WiT meeting (in Orlando) was extremely positive and motivating. There was a team spirit and very inspiring and thought-provoking sessions. The need for mutual support and mentoring is not exclusive to women, but there is work to be done to attract women into the industry and to retain them. In the titanium industry you meet some remarkable women who bring great talent, tenacity and fresh ideas. So this is a mutually beneficial mission: to encourage women into the field, to show them that there is a supportive community here that welcomes them and will invest in their professional development.

3. What are your observations of the American business scene? How does it differ from Europe?

Business in the United States has a strong voice and strong ties. There is competition, but from a European perspective, the U.S. industry appears to be more integrated. It is united by national identity, practices, regulations, established business and logistical links, language and currency. As a national industry and labor market it protects itself as a whole from external competition. There is the “Buy American” drive; the U.S. International Trade Commission reacts quickly to dumping threats, and a major government contract awarded to an overseas firm can spark vocal debate in Washington.
In challenging times the U.S. industry closes ranks and consolidates. This is a very strong trend right now. And the industry takes the opportunity to invest overseas. This is helped today by the strong U.S. dollar. Europe is composed of many countries whose economies differ in focus and pace. There are national governments and associations, national fiscal and industrial policies. There are local languages and currencies. For example, the Euro is still not adopted by the U.K. or Norway. So along with a European business scene, there are national industries that sometimes co-operate and sometimes compete with each other.

Language and historic links between some countries facilitate unique business alliances. But individual European countries also have unique, historic ties outside Europe. This can make it easier for some of them to do business with countries in North or South America, Asia Pacific, Africa, the Middle East, Russia, and India. It can sometimes make more business sense, for example, for a U.K. company to partner with a U.S. or Asian firm than with a firm in Europe. In challenging times the European industry looks outward for opportunities and it brings in external investment, as seen in recent trends in mergers and acquisitions.

4. **What are some of the skills that you hope to bring to the Women in Titanium committee?**

I hope to bring in experience in communication, mentoring and education and to help expand WiT’s mission in Europe. Argus has a global reach and as a journalist and analyst I work with many sections of the industry and market. I can contribute ideas and help network. I look forward to being involved with a WiT meeting in Europe.

5. **At the Orlando ITA conference, there was much discussion about the importance of mentors and being a mentor. Who were your mentors? What sort of experiences, perspectives can you bring as a mentor to someone else?**

I am lucky to have had many inspirational mentors: personal, academic and professional, both women and men. The discussions and exchange of ideas you have with your mentors is what helps you grow academically and professionally, but the support, attention and reassurance that one gets from a mentor are equally important. I think of some people in the metals industry as mentors, even if they would not think of themselves in that role, because they have helped me grow in understanding of various aspects of the industry: technologies, trade practices, exchange and hedging mechanisms, and because they have welcomed and accepted me as a member of the industry.

I have also been a mentor to fellow journalists and to university students, including younger students at Newnham College, which pioneered women’s education at Cambridge University and continues to produce many of the U.K.’s leading female figures in science, industry and public life.

My teaching experience, at school and university level, is also something I bring to the table, having given presentations and lessons on metals and metals industry in schools. I would like to expand this networking experience with a focus on the titanium industry and opportunities it offers. I am in discussions with schools on speaking further about the industry, and I am looking to build links between the ITA and university students in the U.K. People often come to me for information on a particular industry or markets, so sharing knowledge is natural and part of being a journalist. Knowledge needs to be shared.

6. **What energizes you to get up and go to work each day?**

I’m energized by my dedication to covering the metals industry, which is a large part of my life, and to the Argus and Metal-Pages audience. We are committed to provide in-depth, accurate information for our readers. There is always something happening, something new to learn, and timely communication is important. I may get up early to speak to someone in East Asia and finish the day talking to someone on the U.S. West Coast. The metals industry is global. Argus is global, universal information service that can provide insights into many fields crucial to the metals industry. During a typical day I might speak to international producers, traders and buyers. I ask questions, reply to queries, get different perspectives and insights. All of this feeds into analysis of the market.

7. **Speaking as an experienced journalist, can you share some candid observations on the titanium business?**

The titanium industry is at its strongest and healthiest when it is open, transparent, ready to share and exchange information. I am always encouraged by the titanium industry’s ability to cross geographical boundaries and short-term political divides, and to cooperate, build and evolve. It is truly international.

But as the industry consolidates, there is less and less transparency, less disclosure, which is counterproductive. There is real hunger in the industry for information, for statistics and insight to enable accurate market
The following chart provides a quick overview of the features and advantages of TFC’s coating processes:

<table>
<thead>
<tr>
<th>substrates</th>
<th>advantages</th>
<th>benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Titanium</td>
<td>Stable base for other coatings &amp; adhesive bonding; appearance; color coding</td>
<td>Prevents fretting &amp; galling</td>
</tr>
<tr>
<td>Titanium Alloys</td>
<td></td>
<td>Natural, reproducible colors</td>
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</tbody>
</table>

**Titanium Anodizing**

<table>
<thead>
<tr>
<th>Aluminum</th>
<th>Non-toxic; Non-hazardous; Nonpolluting</th>
<th>Corrosion-resistance; No hydrogen embrittlement; High operating temperature (1100°F)</th>
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</thead>
<tbody>
<tr>
<td>Steel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alloys</td>
<td></td>
<td></td>
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<tr>
<td>Titanium</td>
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**Ion Vapor Deposition of Aluminum**

<table>
<thead>
<tr>
<th>Aluminum</th>
<th>Hardness; eliminates burning &amp; dissolution of parts</th>
<th>Allows aluminum application where wear, corrosion or other factors would otherwise exclude its use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum Alloys</td>
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**Hardcoat Anodizing of Aluminum**

<table>
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<tr>
<th>Virtually all metals</th>
<th>Automatic &amp; manual application; TFC processes comply with a variety of mil specs; combines with other coatings</th>
<th>Provides excellent lubricity; Improves corrosion resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid Film Lubricants</td>
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**Titanium Stable base for other Prevents fretting & galling**

**Titanium Alloys coatings & adhesive Natural, reproducible colors**

**Aluminum Hardness; eliminates Allows aluminum application**

**Steel Non-toxic; Corrosion-resistance**

**Alloys Non-hazardous; No hydrogen embrittlement**

**Titanium Nonpolluting High operating temperature (1100°F)**

**Virtually all metals Automatic & manual application; TFC**

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assessment. For Argus, timely and accurate information is important, communication and trust are vital. As companies expand and grow, it is an opportunity for them to become more open, more transparent. This is positive and should be embraced.

The titanium industry is always exciting. The times are challenging, but there is inspired innovation and real opportunities for growth. The future and competitive edge lie in quality not quantity. The titanium industry is becoming more conservative about growth projections in terms of volumes and is recognizing overcapacity, particularly in commoditized products, as a challenge. There is pressure from consumers to cut costs further, and falling prices of nickel, copper and aluminum are challenging titanium in industrial and aerospace components. But substitution is not universal, so long-term opportunities lie in applications where titanium offers an overwhelming advantage, be it in its strength-to-weight ratio or biocompatibility. The future for metals also lies in efficient use of materials and recycling. Titanium is already moving ahead quickly in these areas.

A big thanks to the International Titanium Association and the Women in Titanium committee for financially supporting 25 high school students this year as they work on STEM projects as well as career and education planning.

After serving nearly 50,000 students across eleven countries by leveraging professional mentor support from 22 countries, we know the impact this funding and the resulting mentoring will have. Teachers are already claiming the work happening in just three weeks eclipses what typically happens in an entire semester. Powerful. Thank you!

Less than one in a million high school students in the United States would mention “Titanium” as a potential career area. They know nothing about it. This is an opportunity to expose students to what is happening in your industry and create logical career and education paths for the students who are interested.

As we move forward we welcome additional support in a few key areas:

1. **Mentor Recruitment**:

   We welcome all members of the titanium industry to mentor projects beginning in January.

   All we ask is a solid commitment to communicate twice a week with your student and submit a 10 minute survey at the end of the project. You’ll receive 24/7 support throughout the project with plenty of tips along the way to be successful. All of your questions and comments will be addressed immediately. We’ll need mentors for authentic STEM projects as well as career and education planning projects. Every mentor is more than qualified to be successful on any project.

   To Apply: [http://www.telementor.org/mentors.cfm](http://www.telementor.org/mentors.cfm)

   Our goal is to recruit at least 25 Titanium professionals by January 25th - Thank you!

2. **Titanium Focused Projects**:

   We welcome the opportunity to work with you to develop projects where students are tackling real issues while leveraging products and services from your organization and its members. We have one project where students could build bomb-proof rain gauges that transmit data electronically to a state or national organization. That’s just one idea. I’m sure you would have many other authentic opportunities we haven’t thought of.

3. **Funding through Dollars for Doers and Corporate Matching**:

   Several of our current sponsors (Thomson Reuters, Merck, Intel, and Google) have what are called Dollars for Doers programs where employees log their time in our program and then we receive a check from the company based on how much time was logged. There is usually a threshold that has to be met. For example, once an employee has donated 20 hours at Thomson Reuters, and they take the five minutes it takes to log it, we receive a check for $500, allowing us to serve two students in the future. We want to work with sponsor companies and help them expand that program which will allow us to serve more students and spend less time raising funding.

   **Thanks again for making a difference!**

About WiT: Women in Titanium (WiT) is a networking group of collegial women presently in the titanium industry; and will promote, attract, and encourage high school and college women to enter the titanium industry. The objective of the group is to contribute to the growth of the overall titanium industry by providing mentoring, collegial and networking opportunities for women within the titanium industry and to take part in programs which advance gender equality in STEM fields for high school and college women.
Demand ‘builds’ for Architectural Titanium in High-Growth Asian, Middle East Markets

These days, Gary Nemchock keeps his bags packed for the numerous business trips he makes to discuss the benefits and advantages of using titanium in showcase architectural applications. Nemchock, the president and founder of Architectural Titanium, Lawrence, KS, has an appointment book that tracks his travels around the world to consult with architects, engineers and potential clients. He is a familiar face within the titanium industry, having delivered many programs for the annual TITANIUM conferences sponsored by the International Titanium Association.

Nemchock is bound by confidentiality agreements and is unable to discuss near-term projects that will utilize titanium as an aesthetic element on modern structures—other than to say he is working on new skyscraper designs. He did say that several construction projects in Asia are considering the use of architectural titanium in high-end, private residence, such as Chengdu, a city in China. The Middle East is also a major growth market. Nemchock estimated the current global market for architectural titanium is 500 tons.

He explained that, for many projects, titanium typically is used as a thin-gauge sheet (0.5 mm) to cover building walls and roofs. Architects, designers and construction engineers also appreciate titanium’s stability and low coefficient of thermal expansion (similar to industrial glass), which is half that of stainless steel or copper. In addition to titanium’s well-documented durability and corrosion resistance, Nemchock said the metal often garners interest as a material of choice due to its surface aesthetics and reflectivity. This reflectivity can be tailored to customer specification through the anodizing process, which can alter the spectrum of color and tone of titanium’s protective oxide surface layer. Reflectivity also can be controlled through processing at the mill.

On a parallel track, the electrolytic anodizing process also is used in titanium jewelry, to alter its surface color and reflectivity. He also mentioned a closely guarded surface-treatment system known as “Crystal Titanium,” a patented process and technology developed by Architectural Titanium. New York-based Architectural Record magazine lauded Crystal Titanium as a “top pick” in its 2011 Innovated Product Review.

During the last 20 years there have been a host of prominent buildings with world-class designs that have made use of architectural titanium—beginning with the well-known Guggenheim art museum in Bilbao, Spain, designed by Frank Gehry and unveiled in 1997. In the United States, two noteworthy structures have incorporated architectural titanium. First is the Houston-based headquarters of international shipping company Chipolbrok America Inc., designed by Ted Trout Architect and Associates Ltd. Completed in 2011, the four-story office building has a main entrance that features architectural titanium. Second is the Denver Art Museum, designed by Daniel Libeskind, which opened in 2006 and has over 21,000 square feet of titanium on its exterior surfaces.

Asia is home to many modern buildings and structures that feature the extensive use of architectural titanium. Recent examples, all competed in 2011, include Tokyo’s Haneda Airport D Runway Pier; the Hefei Lakeside International and Convention Center in China; and the Saemangeum Exhibition Center in Korea.

Nemchock’s journey into the realm of architectural titanium began in the late 1960s, when he was trained as a goldsmith designer in Copenhagen. Originally from Chicago, became a professor at the University of Kansas from 1971 to 1986. He became involved in the titanium industry when he was hired in 1997 to serve as a consultant with Timet. After 10 years at TIMET, he went off on his own and founded Architectural Titanium.

Photos from top to bottom: Private residence – Chengdu, China Dark golden crystal titanium panels The Prescott – Vancouver, Canada Natural crystal titanium panels Chipolbrok Headquarters – Houston, TX G-1 finish titanium cladding Palace – Jeddah, Saudi Arabia Interior anodized titanium panels
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British Virgin Islands Features Iconic Flamingo on New Pink Titanium Coin

Written by Michael Alexander, Coin Update (news.coinupdate.com)
Shared by International Titanium Association (titanium.org)

Admired for their color and grace, the flamingo is renowned for their pink feathers, sizable flocks, and a penchant for standing on one leg. An interesting fact about these majestic tropical birds is that their coral pink color does not occur naturally, but rather due to their prolific consumption of brine shrimp and blue-green algae, which contain pigments called carotenoids.

When a flamingo spots a potential meal while wading through shallow water, it plunges its head into the water, twists it upside down, and scoops the fish using its upper beak like a shovel.

Why do Flamingos often stand on one leg, with the other leg tucked beneath the body? The reason for this is not fully understood, but research indicates that standing on one leg may allow the birds to conserve more body heat, since they spend a significant amount of time wading in cold water. Flamingos are very social birds that live in colonies whose populations can number in the thousands. These large colonies are believed to make it easier for them to avoid predators, maximize food intake, and use scarce nesting sites more efficiently.

The coin is produced by the Pobjoy Mint, UK, on behalf of the British Virgin Islands Treasury. The design on the reverse side features a resplendent flamingo wading in shallow water before a flock of flamingos, along with the coin’s denomination of one, five, or ten dollars. The obverse of the coin features the effigy of Queen Elizabeth II created by Ian Rank-Broadley, with the year of issue included in the legend.

<table>
<thead>
<tr>
<th>Denomination</th>
<th>Metal</th>
<th>Weight</th>
<th>Diameter</th>
<th>Quality</th>
<th>Mintage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Dollar</td>
<td>Cupro-nickel</td>
<td>28.2 grams</td>
<td>38.6 mm</td>
<td>BU</td>
<td>unlimited</td>
</tr>
<tr>
<td>5 Dollars</td>
<td>Titanium</td>
<td>10 grams</td>
<td>38.1 mm</td>
<td>FDC</td>
<td>5000 pieces</td>
</tr>
<tr>
<td>10 Dollars</td>
<td>.925 silver</td>
<td>28.2 grams</td>
<td>38.6 mm</td>
<td>Proof</td>
<td>10,000 pieces</td>
</tr>
</tbody>
</table>

The coins will be produced in pink titanium, cupro-nickel, and Proof sterling silver, respectively. The Pobjoy Mint promotes their Titanium coins as being unique. They are exceptionally difficult to strike and, because colored Titanium reacts unpredictably during striking, no Titanium coin is exactly the same. There is a lined effect that is present on the coins that is also unique to Titanium metal.

Pobjoy Mint’s coloured Titanium coins have proved to be a great success with collectors, creating a new category of specialty coins on the market. For more information on these and other coins issued by the Treasury of the British Virgin Islands, please visit the Web site of the Pobjoy Mint. Information offered is in English, with international orders dispatched where applicable.

The Treasury of the British Virgin Islands has launched a new series of coins featuring one of the Caribbean’s most recognizable and vibrant birds, the flamingo.
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ITA Committee Strives to Draw Attention to Titanium Consumer Applications

**ITA** will administer the Consumer Applications committee, a group which will focus on promoting the growth of the overall titanium industry and to promote the selection of titanium as a competitive material by communicating information about consumer applications and uses to the public in support of ITA annual goals and objectives.

The committee will meet regularly and will be responsible for:

- Recommending trade shows where ITA could exhibit to promote titanium metal as a material of choice;
- Meeting regularly to discuss ideas for presentation topics and recommended speakers for the annual TITANIUM conferences in Europe and the US;
- Make suggestions for Titanium Today editorial topics;
- Share ideas for outreach programs and projects related to the committee’s mission and objectives.

Some of the ideas shared in recent meetings follow:

**Highlighting and Preserving Titanium Art**

The Consumer edition of the Titanium Today trade publication will include Artist Profiles by drawing attention to those unrecognized heroes who design beautiful works of art in reactive metals. The committee would like to gain support from the industry in hosting an art exhibition at the annual TITANIUM conferences. A gallery could be organized in the exhibition hall or as a separate reception for attendees to attend as part of the conference. Artists who design in zirconium, niobium, tantalum, and titanium, what is known as “reactive metals” would be invited.

Another topic of committee discussion has surrounded the idea of an organized Endowment for Titanium Art. So many pieces of titanium art have been lost or destroyed over the years, there are titanium designs that need to have a place for historical preservation and future viewing. Once the collection achieves a decent size, it could travel to museums around the world. This would be a great opportunity for the International Titanium Association to support consumer applications and gain industry participation.

**Education**

The committee is proposing outreach advocacy in 2016, debunking myths that give consumers unwarranted fear when considering the purchase of titanium rings. Emergency Medical Technicians, Fire Departments, and Hospital Emergency Rooms CAN remove titanium rings in case of an injured finger. Several non-destructive methods for ring removal are available before resorting to cutting a ring and in the rare event it becomes necessary to cut off a ring, emergency medical professionals have the necessary tools to cut through metals, including CP and Aerospace Grade Titanium. Tools that will cut through stainless steel will also cut through titanium rings. Consumers should consider the many advantages of wearing titanium rings which include strength and durability, style and comfort, biocompatibility, potential health benefits, popularity, availability & affordability.

The ITA Education committee is considering hosting teaching stations at the annual US conference on behalf of local high school science classes. Some of the ideas to support this endeavor from the Consumer committee include hosting an anodizing table where donated chips could be anodized and earring wires hooked to the piece so the students could wear their creations home. The committee is evaluating if the ITA may apply for an educational grant to help with costs in hosting the education stations at the conference.

The blacksmithing community is a highly organized group where the Consumer committee may be successful in launching educational workshops on their behalf. The committee would need out of spec ½ inch titanium bar donations from the industry along with volunteers with expertise in welding and hot forging to be successful.

The Consumer committee is always interested in your thoughts & suggestions – please contact ITA to learn more about the progress of Consumer committee activities or to donate materials & time.
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TITANIUM 2015 Forum:
Experts, Executives and Engineers Gather To Discuss Supply, Demand, Distribution and Global Supply Chain
By Michael C. Gabriele

Over 900 delegates from Australia, Asia, Europe, South America and North America gathered in Orlando, FL, Oct. 4-7 to meet, mingle and share timely information on the state of the titanium industry at TITANIUM 2015, the 31st annual international conference and exhibition sponsored and organized by the International Titanium Association (ITA).

Welcomed by Dawne Hickton, the president of the ITA’s board of directors, engineers, executives, stakeholders, end users, sales representatives and scientists attended and participated in speaker panels, which spanned a range of topics designed to illuminate the state of the art in the global titanium industry.

Supply and demand, and the various business and technology trends driving the industry, took center stage at Rosen Shingle Creek Golf Resort. The conference kicked off with the World Industry Demand Trends panel. Wade Leach, vice president, marketing and product management for Allegheny Technologies Inc. (ATI), declared that the future continues to look promising for titanium in the commercial aerospace business sector, considering the wave of new titanium-intensive jets that are slated to ramp up production in the near term, as well as his reading of airline profitability, moderate fuel costs and the projected, escalating trend of passenger miles. Leach did take note of “global uncertainties” in Greece, Syria and China, but added that global airline profitability rose significantly this year.

Addressing “Titanium Demand and Trends in the Airframe Market,” Leach said titanium will continue to be a material of choice in commercial aerospace, given the ongoing globalization of the supply chain, the roll out of new, higher performance titanium alloys and the anticipated technological advances in 3D/Additive manufacturing. He said the “commercial aircraft active fleet” registered 25,000 jets in 2014—a number slated to rise to double by 2035 to 50,000 aircraft.

Henry S. Seiner, vice president, business strategy, Titanium Metals Corp. (Timet), spoke on the “Evolution of Jet Engines.” Seiner said titanium continues to dominate in the compression section of jet engines, in applications such as fan blades, but today its position as a material of choice is being challenged by composites and aluminum alloys. He said titanium aluminides are making inroads in the combustion section of turbofan jets, being positioned as an alternative to nickel-based superalloys.

Of the 3,160 jet engines produced in 2014, Seiner said CFM International (the Snecma/Safran and General Electric joint venture) dominated the market, followed by GE, IAE (International Aero Engines), Rolls Royce and Pratt & Whitney.

Eric Roegner, president, Alcoa Titanium and Engineered Products and Alcoa Defense, discussed “Titanium in the Defense Market: Driving Growth Through Innovation.” Roegner said that, in terms of titanium demand, while overall U.S. defense spending has plateaued, “pockets of growth” remain in defense aerospace. As examples, he pointed to the F22 and F35 fighter jets as “great programs for titanium.”

Roegner mentioned that even though U.S. defense budgets have stabilized, it’s likely there will be growing demand for military hardware in the near term. “No one can predict what will happen,” he said. “There will be challenges and bright spots.” Among the bright spots will be a continuation of legacy programs, as well as new programs, for fixed-wing and rotary-wing military aircraft. Titanium demand for defense applications will continue to be driven by volatile environments throughout the world.
especially the Middle East, according to Roegner. “Volatility equals opportunity,” he surmised.

Much like other panel speakers throughout the conference, Roegner continued to stress the need for supply chains to reduce costs and improve efficiencies, saying that material applications are required to “buy their way” onto a jet program. “We need to take cost out of the supply chain and improve performance. How do you win? There has to be innovation across the supply chain.” Examples of this innovation, as identified by Roegner, include the development of titanium aluminides, progress in 3D/additive manufacturing, and novel bonding, welding and joining technologies.

Given Alcoa’s wide span of manufacturing and material options, Roegner cited challenges to titanium in military applications, saying that aluminum/lithium alloys are well positioned as an alternative to titanium on composite-intensive aircraft. He said these alloys, like titanium, have no issues with corrosion.

Michael Metz, president, VSMPO A.T.M. U.S., provided an overview and update on the Russian titanium market, saying that engines (29 percent), aircraft (28 percent) and shipbuilding (25 percent) are the three market categories that dominate.

The Russian aerospace market has consolidated into four groups: United Aircraft Corp., an original equipment manufacturer of civilian and military aircraft; engine builder United Engine Corp.; Russian Helicopters; and United Missile and Space Corp. Metz indicated that overall titanium demand from the Russian aerospace sector is anticipated to reach 8,000 metric tons by 2021, compared with nearly 7,000 metric tons this year. Total titanium demand for Russia in 2021 is expected to be 13,000 metric tons, slightly above the 2015 level of demand.

Kazuo Kagami, chairman of the Japan Titanium Society and president and representative director of Toho Titanium Co. Ltd., shared his “Outlook on Titanium Trends in Japan.” Kagami said sponge shipment for 2015 is expected to make recovery, projected to reach 45,000 metric tons, compared with 35,000 metric tons in 2014. Mill demand is gradually improving for the Japanese industrial market, expected to register nearly 15,000 metric tons this year, slightly above last year’s level.

Kagami underlined several examples of development efforts for Japan’s titanium industry, a list that included “Advanced Titanium Alloy and Production/Processing Technology for Next Generation Aircraft Structure”; “Innovative Structural Materials Association” (weight reduction of transportation equipment such as cars; “Cross-Ministerial Strategic Innovation,” which involves structural material for innovation of heat-resistant metallic materials; and the “Process of Direct Cast Titanium Slabs,” slab-cast technology by electron beam (EB) melting for industrial applications.

Kevin J. Cain, president of Uniti Titanium LLC, presented his “Industrial Titanium Demand Forecast,” an overview of the next five years. For Cain’s overall projection, he said industrial titanium demand this year (oil and gas, heat transfer equipment, electrical power,
chemical processing, and desalination) is slated to reach just over 25,000 metric tons in shipments, down slightly from the previous year. The demand is expected to grow to nearly 30,000 metric tons in 2020 (excluding shipments to Russia and China).

Cain said that demand for oil is forecasted to increase 15-20 percent over the next 20 years, while natural gas demand is likely to increase 45-50 percent. For electric power generation, he said approximately 6,000 metric tons of titanium will be consumed per year over the next five years in applications such as welded tubes, tube sheets and heat transfer equipment.

The chemical processing sector is expected to draw $100 billion of incremental capital investment by 2025. Cain estimated that the average annual consumption of titanium in the chemical process industry will be 10,000 metric tons per year for the next five years. For desalination, titanium consumption is estimated to be in the range of 2,000 metric tons per year, with the possibility to reach 3,000 metric tons by 2020.

**World Supply Trends**

**Derek Folmer**, chief marketing officer for Sierra Rutile Marketing Ltd., discussed “Rutile Economics: The Outlook for a Raw Material Critical to Manufacturing High-Quality Sponge.” The company, based in Sierra Leone, West Africa, a London-listed mining enterprise, supplies about 20 percent of the world’s rutile, according to Folmer.

Regarding global rutile supply, Folmer said only three companies are able to produce over 100,000 metric tons of rutile per year, with over 20 percent of supply held by vertically integrated companies. Global rutile production in 2014 was 745,000 metric tons, with Australia accounting for nearly half that total.

Rutile is commonly found with ilmenite, zircon, and other heavy minerals and represents the highest quality TiO2 feedstock. As for key industry trends affecting rutile, Folmer listed: declining reserves and grades; increasing ore body complexity; TiO2 pigment consumption growth outpacing rutile supply; rapid aerospace growth and vertical integration; and the emerging Chinese chloride TiO2 sector.

**David McCoy**, managing director of TZ Minerals International Pty Ltd., Victoria Park, Australia, provided a detailed review of the global titanium sponge market. McCoy identified key sponge producers around the world beginning with China, which had an output estimated at 68,000 metric tons in 2014, compared with 81,000 metric tons each year in 2012 and 2013. It’s believed China has an overall sponge production capacity of 150,000 metric tons, composed of more than 10 sponge producers. He said ongoing consolidation in China is expected to phase out smaller, less efficient sponge production plants, reducing the capacity to an estimated 100,000 metric tons.

China’s sponge exports have fluctuated sharply in recent years, according to McCoy, going from 1,000 metric tons in 2009, to 11,000 metric tons in 2011, to 6,000 metric tons in 2014. The largest export market for Chinese sponge produced in 2014 (36 percent) was South Korea followed by the United States (28 percent).

Titanium powerhouse Verkhnyaya Salda Metallurgical Production Association (VSMPO) of Russia produced 40,000 metric tons of sponge each year in 2013 and 2014. Japan’s sponge production was just over 30,000 metric tons in 2014, down from about 35,000 tons in the previous year. McCoy said Japan’s sponge exports have decreased in recent years, to 16,000 metric tons in 2014 compared with 31,000 metric tons in 2012. Sponge production in the United States registered 12,000 metric tons in 2014 compared with about 15,000 metric tons in 2013.

Several sources have estimated that the global production capacity for titanium sponge is in excess of 300,000 metric tons.

**Edward J. Newman**, senior vice president of United Alloys and Metals Inc., offered a review of titanium scrap processing trends. Regarding the vacuum arc remelting (VAR) method for producing ingots, the advantages for this process are that scrap can be included in raw material mix, but VAR melting does not remove high-density inclusions (HDIs) contamination. HDIs are particles of with a higher density than titanium, which diminish the mechanical properties of titanium, with the contaminating particles serving as crack-initiation sites. As such, VAR is best used for processing titanium scrap in its early stages.

As for cold hearth melting scrap processing, Newman said processed turnings can now be used without X-ray monitoring due to cold hearth’s ability to remove HDI’s. This advantage, he said, substantially increases the volume of titanium turnings returning to the titanium industry. He estimated that there are now 14 cold hearth furnaces operating in the United States.

Newman said the titanium industry must find a way to retain more of the scrap titanium units that are generated. For example, he pointed out that half of all titanium scrap generated goes to ferrotitanium or other “sacrificial” applications. Newman cited a 2014 United States Geological Survey (USGS) estimate of 25 million pounds of titanium scrap being consumed by steel and other industries.

In his summary points, Newman said scrap supplements sponge and master alloys to provide substantial low cost units to the market place. Advances in melting and processing technology have allowed for the continuing increase in titanium scrap recycling. “Titanium industry needs to continue to move towards capturing a
Implementation of buyback programs along with industry consolidation has stabilized both pricing and supply of scrap to producers. Scrap processing industry continues to provide valuable product, services, and innovation to the titanium industry."

Matt Schmink, vice president of sales for Global Titanium Inc., Detroit, examined ferrotitanium demand trends. According to Schmink, the use of ferrotitanium and titanium scrap as an alloying additive in the production of carbon steel and stainless steel has become an integral part of the titanium mill products "production spectrum." Global steel production in 2014 is estimated to be in excess of 1.6 billion metric tons. Roughly 80 percent of titanium use in steel is attributable to automobiles and appliances. Titanium’s requirement for steel production in 2014 was 73,684 metric tons.

Schmink showed a bar chart that projected the titanium requirement would reach more than 70,000 metric tons by 2022. He concluded that the ferrotitanium market will be well-supplied in the years ahead with a strong possibility for over-supply. He said this should act to keep prices for off-grade scrap and ferrotitanium depressed. However, innovation in the titanium industry could counterbalance this oversupply through improved scrap utilization and the development of new markets to utilize titanium scrap.

Terry T. Perles, president of MoTiV Metals LLC, Bridgeville, PA, examined market trends and analysis for master alloys. A master alloy is a value-added, semi-finished product, created for use as a raw material by the titanium industry, which typically contains two or more alloying elements to achieve enhanced properties, such as enhanced heat and corrosion resistance, for a specific application. 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.

Perles said quality is an essential attribute for master alloys given their use in critical applications. A highly variable cost component in master alloy production is the market price of raw materials. "The ability of the master alloy supplier to design solutions for titanium alloy producers is a critical value added factor in the relationship," he stated.

Global vanadium consumption this year will register 93,000 metric tons, with 92 percent of demand coming from the steel industry, compared with 5 percent from the titanium alloy industry. The 3-percent balance represents demand from chemical and energy storage applications. Global molybdenum consumption is estimated to be 525 million pounds for 2015.

Vanadium and molybdenum markets are experiencing 10-year lows in market prices today and current prices are not sustainable in the long run, according to Perles. Rationalization of vanadium production in South Africa and China could set the stage for a change in the vanadium market fundamentals in the near future. He said the molybdenum market is under pressure due to inventory accumulation over the past several years, combined with softening demand from the oil and gas sector, while primary molybdenum mines in China and North America will be under pressure.

Distribution Roundtable Panel

Titanium distributors throughout the United States are in a holding pattern regarding their business plans and metal inventories, waiting for a three-year business "sweet spot" that’s expected to begin unfolding by mid-2016. This was an example of the discussion among titanium executives participating in a "distribution trends roundtable" panel.

Brett Paddock, the president and chief executive officer of Titanium Industries Inc. (TI), Rockaway, NJ, served as the moderator of the panel. The roundtable included Greg Himstead, vice president of sales and marketing for TI; Dr. Igor Krenitski, executive vice president of Grandis Titanium, Rancho Santa Margarita, CA; Ron Krajcik, director of sales and marketing of Tricorp Metals, with divisions in the Midwest, Texas and California; Stephen Patera, vice president of sales for Titanium Processing Center, New Baltimore, MI; Oliver Frankenheim, director of sales from S & D Spezialstahl Handelsgesellschaft mbH, Stelle, Germany; Vladimir Dolynuk, president, Tico Titanium, Wixom, MI; along with market analyst Chris Olin, the president and founder of the Olin Research Group LLC, Avon, OH. According to information posted on their respective websites, these distributors carry a wide range of inventory: titanium plates, sheets, wire, bars, tubes, ingots and billets, and most provide other
high-end industrial metals such as nickel alloys.

The executives indicated that the current holding pattern is due to tepid business conditions in the industrial and oil and gas sectors, which have offset generally positive activity in the key commercial aerospace industry. “In the macro business environment for titanium, things were more positive just four months ago, Olin said. “We’ve been seeing weakness in the industrial categories—everything non-aerospace.” As a result, he said distributors have been hedging away from the industrial sectors and adjusting their inventory levels accordingly.

Olin anticipated that the “sweet spot” for the titanium supply chain will kick in next year, when production begins to ramp up for titanium-intensive commercial jet platforms such as the Boeing 787 and 777X and the Airbus Neo, A380 and A350. It’s expected that the aforementioned industrial and oil and gas sectors will show signs of improvement during this time frame (2016-2018), complementing the commercial aerospace business activity, and thus creating the sweet spot, all of which is expected to spur the supply chain to boost titanium inventory levels.

The sweet spot may be off to an early start for the titanium supply chain as Alcoa Inc., on Oct. 5, announced a $1-billion deal to supply aerospace fastening systems to Airbus, with many fasteners fabricated from titanium. Earlier this year Alcoa fortified itself to expand its aerospace business through the acquisition of RTI International Metals, Inc.

Regarding the potential effects of Alcoa’s purchase of RTI, or Berkshire Hathaway’s acquisition of Precision Castparts Corp., distributors, speaking generally, said they initially saw the deals as positive developments, providing “confidence and capital” to the titanium aerospace supply chain. “The merger and acquisition activity we’ve seen this year means that companies with deep pockets are investing in the titanium industry,” Paddock said. “All of this will help to expand the industry and open up distribution channels. It also will bring new talent and new ideas into the titanium industry.” Olin picked up on this point during his remarks, saying that the titanium industry needs a greater influx of young people to help spark innovation.

Himstead said that inventory management remains the number-one tool for distributors to control costs. This involves not just tracking levels of in-house titanium, but also predicting industry cycles and minimizing the shipment time of mill to customers. “We’re all doing our best to understand the cycles of the titanium industry, to put inventory stock in at the right time,” Krjenitski said. “We always want material on the shelf to support our customers. Managing inventories doesn’t necessarily mean lower inventories.”

Krajcik said the titanium industry deserves credit for overcoming the extreme price volatility that has hampered the industry over the decades. The result of this has been an eight-year period of relative price and supply stability, which has enabled service centers and distributors to better manage their inventory levels. “Titanium is value priced,” he said. “Titanium today is a great value, especially in the corrosion market.”

**Commercial Aerospace**

Waldir Gomes Concalves, senior vice president, customer support and services worldwide for Embraer Executive Jets of Brazil, presented a profile of his company and offered a market forecast. Concalves said Embraer is composed of four divisions—Commercial Aviation, Executive Aviation, Defense and Security, and Systems. Embraer has operations in Brazil, North America, Europe and Asia, with more than 19,000 employees and 2,300 employees in joint ventures and affiliates.

Regarding his commercial aviation market forecast, Concalves said that for planes with 70-130 seats, Embraer projects 6,350 jet deliveries during the next 20
years, a market valued at $300 billion. The United States represents the largest market for this category during that time span, followed by Europe and China. As for executive jets, he said the company forecasts deliveries of 9,250 jets during the next 10 years, with a value of $265 billion. North America represents the largest market for executive business jet category.

Concalves displayed a pie chart that illustrated Embraer’s annual titanium purchasing profile. Fasteners (41 percent) represented the company’s biggest titanium procurement category, followed by forgings (36 percent), plates and bars (19 percent), sheets (3 percent) and tubing (1 percent).

William T. Shaffer, director-materials and standards for Boeing Co., gave an “Outlook for Titanium in the Commercial Aerospace Market.” Boeing’s projections were for 38,000 new jet deliveries through the year 2034, a market dominated by Asia at 14,300 units, followed by North America, 7,890 units and Europe, with 7,310 units. A graphic by Shaffer offered details on Boeing’s commercial jet supply chain: 1 billion parts procured each year; $43 billion spent; 5,400 factories and 500,000 people.

Thomas T. Cochelin, head of titanium and special alloys raw material procurement for Airbus S.A.S., shared his thoughts on “Key Strategic Enablers for a Successful Airbus Titanium Supply Chain.” Innovation is occurring as a result of a “supply centered” (and not just a “product centered”) supply chain.

He provided a list of the strategic supply chain enablers as defined by Airbus: reducing costs; “de-risking” with the ability to meet ambitious ramp-up production schedules; creating an efficient and consistent global footprint; innovation on current and future programs; and developing synergies within the Airbus group and extended enterprise.

Citing 2014 company consumption levels, Cochelin said that, “every working day,” the manufacturing operations of Airbus require 30 metric tons of titanium. He summarized his presentation with this statement: “Together, a strong Airbus supply chain community can create the new costs/standards that are requested to deliver what Airbus has sold to its customers and shareholders.”

Melting

Thomas Branscomb, director of technology, Buntrock Industries, discussed “Shell Materials and Casting Methods for Casting Titanium Alloys with Minimum Alpha Case.” Branscomb’s recommendations to make titanium castings with minimum alpha case: use a low shell temperature; use small gates to avoid high metal/mold interfacial temperature; use centrifugal casting; use yttria as a face coat ceramic rather than zirconia. Potential metal savings and less chemical milling may more than offset the cost premium of yttria compared to zirconia.

Stephen Fox, director, corporate research and development for Timet’s Henderson technical laboratories, presented “Recent Developments in Melting and Casting Technologies for Titanium Alloys.” Fox said that, during the last 20 years, melting and casting technologies have evolved to meet industry needs. He reviewed the expansion in melting capacity and provided overviews on melting technologies (cold hearth, vacuum arc, electron beam, plasma arc, skull), along with information on powder and additive processes. Fox concluded his talk by saying that technological challenges for the future include integrating accurate process information, developing an accurate prediction of critical structures and rapid and transient events associated with powder and additive processes.

Christopher Jackson, a market analyst with Retech Systems LLC, presented information on gamma PAM (plasma arc melting) of near-net shape titanium aluminide alloy ingots. As noted by other speakers, Jackson said that titanium
aluminide alloys are finding expanded applications in aerospace and automotive markets. Nathaniel Slinkert, director of VAR products, Retech Systems LLC, presented information on increased productivity using flexible hearth melting configurations, which he said enhances production flexibility while increasing throughput.

Industrial

“Case Studies Supporting a Titanium-Tubed Heat Exchanger Upgrade from Copper Nickel” was a talk given by Dennis Schumeth, the principal and owner of Titanium Tubular Consultants. He pointed out titanium’s advantages of superior corrosion resistance, reduced weight, ease of fabrication, conventional lead times, expanded industry capacity and competitive costing.

Gary Lantzke, the chief executive officer of Callidus Welding Solutions Australia, shared insights in “Wear Resistant Options for High-Pressure Acids Leaching Applications” and the advent of titanium nitride surface modification.

MariaPia Pedeferri, associate professor, Politecnico di Milano, Dipartimento di Chimica, Materiali e Ingegneria Chimica, addressed “Advances in the Development of Surfaces Functionalities of Titanium.” Pedeferri said her research focuses on developing precise control of the anodizing process. She said titanium anodic oxidation is a powerful technique for tailoring the surface properties of titanium oxide surfaces—affecting everything from color to corrosion resistance of the metal.

Automotive

James Hostetler, vice president of TMS Titanium, presented an overview of “Titanium and the Auto Racing Industry,” demystifying the welding, cutting and machining of titanium to create application solutions for auto racing. He also stressed the weight-saving advantages of titanium components compared with steel components.

Dr. Jurgen Kiese, head of the department for process development of titanium at VDM Metals GmbH, unveiled results of research work that targets “A New Class of Oxidation-Resistant, Microstructure-Stabilized and Cold-Workable Titanium” for automotive exhaust system applications. Kiese indicated the development work involved CP titanium Grade 1S that attained enhanced oxidation resistance through the addition of silicon, iron and niobium, along with an improved microstructure stability.

“Rethinking the Automotive Uses of Titanium as a Result of the New Emissions Paradigm,” a paper by Graham Withers, president of CYCO Tech Corp. Pty Ltd., reviewed proposed emission standards issued last June by the U.S. Environmental Protection Agency and the Department of Transportation’s National Highway traffic Safety Administration. Withers said the standards already in place for model years 2014-2018 will result in emission reductions of 270 million metric tons and save vehicle owners more than $50 billion in fuel costs. As such, he then considered the use of titanium in automotive springs, fasteners and exhaust, engine and brake systems, all of which would highlight titanium’s weight savings and corrosion resistance advantages.

Government Funded Projects

“Innovating the Future of Titanium Production at the U.S. Department of Energy,” a talk by Dr. James Klausner, program director of the Advanced Research Projects Agency—Energy (ARPA-E), outlined research programs at ARPA-E that include over 380 energy technologies across 20 focused program areas in transportation and stationary energy initiatives. The programs include vehicle lightweighting through the use of titanium, aluminum and magnesium; titanium metal and
powder research projects; and innovations in metals recycling.

Jordi Perez, a scientist at SRI International, spoke about “Fluidized Bed Processes for Production of Metal Alloys and Composites.” Perez said applications include metal/ceramic nanocomposites, nanostructured powders, and the infiltration/deposition of metals such as aluminum and vanadium on titanium sponge. These technologies have the potential to develop scalable production of feedstock for 3D printing, laser sintering and powder metallurgy; materials with better mechanical properties at high temperatures; and new lightweight, high-strength alloys and composites.

Z. Zak Fang, a professor of metallurgical engineering at the University of Utah, presented a paper on “A Novel Energy Efficient, Low Cost Chemical Pathway for Titanium Production.” Fang provided details on the University of Utah’s Direct Reduction of Titanium Slag (DRTS) process. He stated that high-purity, low-oxygen titanium powder can be produced directly from “upgraded titanium slag” (UGS), without high-temperature processes such as chlorination.

**Economics**

Nicholas Pastushan, chief investment officer, CIT Transportation Finance, shared his thought on “A Lessor’s View of Aircraft Markets and Global Economics.” Pastushan tracked various trends in the commercial aerospace industry, such as the rising annual delivery rate of aircraft and the growth in global air traffic, with an emphasis on the upward trends of Asian markets.

Peter Zimm, principal, ICF International, examined “Aerospace Production and Supply Chain Outlook.” Zimm said current aggregate aerospace raw material demand is 1.56 billion pounds, with titanium representing 11 percent of that total (compared with aluminum at 47 percent and steel alloys at 21 percent). Aerospace titans Boeing and Airbus account for nearly two-thirds of that raw material demand.

Zimm estimated that the total aerospace raw material market is worth $12.4 billion, with titanium representing the largest material by market value at $3.4 billion. As for the supply chain outlook, he pointed to Alcoa’s acquisition of RTI and the purchase of Precision Castparts Corp. by Berkshire Hathaway. Much like presentations in the Commercial Aerospace and Industrial Titanium Demand Forecast panels, Zimm said the supply chain must be ready to adapt to the “new reality” of higher service level deliveries and downward cost pressures.

**Machining**

“Advancements in Insert Cutting Edges and Coatings,” a paper by Kevin Maples, cutting tool solutions specialist with Walter USA LLC, indicated that grade development and cutting edge preparation are key factors when machining titanium. He said the cutting edge of the tool is subject to high thermal loads due to the relatively low thermal conductivity and density of titanium.

Maples said a higher degree of “rake” angle is required to form a chip, while honing or “rounding” the cutting edge helps protect the insert from chipping and notching. Coolant concentration is a key factor in chip removal and cooling and for titanium machining the coolant concentration should be 10-12 percent when mixed with water, according to Maples. In addition, Maples provided...
details on two coating processes: CVD, a chemical process used on carbide indexable inserts with cutting edges that are less sharp; and PVD, a physical process that is used on carbide indexable inserts with sharp cutting edges.

Another Walter USA representative, William Radtke, manager of regional competence center Americas, described “Cryogenic Machining,” which can improve tool life and productivity when machining titanium through the use of carbon dioxide (CO2), known as the “CryoTec” process.

Reinhard Fitz, sales director, North American operations for the Starrag Group AG, discussed “High-Volume Titanium Cutting Challenges, Technology and Solutions.” He shared a detailed analysis on ways to boost cutting speeds, increase tool life, and improve overall machining productivity through the optimization of chip removal.

Advanced Titanium Manufacturing

Kurt Faller, chief executive officer of MetCon LLC, presented a paper on “The Largest Cost Reduction Opportunity for Titanium in a Quarter Century: Electrochemical Conditioning and Finishing.” According to Faller, a significant factor leading to the high cost of titanium mill products is the “relatively poor yield from ingot to finished mill product. The single greatest contributor to this yield loss is the conditioning required to remove cooling cracks and alpha case caused by each thermo-mechanical processing step (forging, rolling, extrusion and hot forming).

Faller said MetCon’s electrochemistry technology retains the bulk metal, while focusing on “healing” the cooling cracks. According to Faller, MetCon’s technology delivers a 4-percent yield and a 5-percent cost improvement for each electrochemical conditioning step, compared with conventional, “subtractive” ingot conditioning methods such as grinding and bar peeling.

Dr. Berthold P. Erdel, president, IMS Co., discussed “The Shift to Material-Centered Manufacturing,” with a focus on aerospace production. In his presentation abstract, Erdel said his prediction that the concept of “Light, Small, Simple, Fast, Smart, and Strong” will permeate all of manufacturing, has turned out to be what constitutes today’s manufacturing networks. He explained that lean manufacturing principles dominate efforts on the factory floor, followed by government mandates of “green” manufacturing (environmentally friendly practices) and more recently “blue” manufacturing (strategies to minimize energy consumption).

“Spurred on by the need to become more fuel efficient, operate lighter, faster, safer, and lower the environmental footprint, the aerospace industry, even more so than automotive, has begun to turn to ever more advanced materials,” according to information in his abstract. “Innovative manufacturing processes have part material at the center of it all to secure components and subassemblies that can meet the stringent demands for increased strength, minimum weight, higher temperature resistance, less maintenance, lower noise level and safe, extended service life.” He said that, given these characteristics and the necessary product changes and enhancements in form and function, advanced manufacturing has moved from machine-centered to “material-centered” regimes.

Erdel also shared his insights on the “360 Impact on Manufacturing,” which involves the development of new generations of metal alloys to meet higher physical demands, such as the high-performance titanium 5553 alloy (Ti-5Al-5V-5Mo-3Cr). The 360 Impact also includes “innovative recovery and recycling processes and solutions of 100 percent of metal returned into the supply chain.”

Yoshinori Ito, senior researcher at Kobe Steel Ltd., presented “Technologies for Reliable Titanium Alloy Forgings Focusing on Ultrasonic Inspection in the Aerospace Industry.” Ito said process design is a key technology to provide high quality titanium forgings. “Establishment of forging simulation technique and processing window is essential.” Kobe Steel recently opened production facilities that produce large titanium forgings to meet stringent aerospace specifications. One facility, Japan Aeroforge, which opened in 2013, operates a 50,000 metric ton forging press.

A joint presentation by representatives from Vulcan Engineering and Norton Abrasives Saint-Gobain focused on “Advancements in Titanium Conditioning.” They defined metal conditioning as the process to remove defects such as scale,
cracks, forge marks from ingots and billets prior to metalworking operations. The talk reviewed a list of metal grinding techniques and related equipment, and noted advances in safety features and digital machine controls “that allows for greater mastery over the entire grinding process.”

### 3D/Additive Manufacturing

For intriguing developments regarding the buzz over 3D/additive manufacturing, the most noteworthy announcement came one month before the start of TITANIUM 2015. Alcoa, in a Sept. 3 press release, trumpeted a $60-million expansion of 3D/additive operations at its research and development center in Pittsburgh. The investment, which targets complex, high-performance aerospace components, features Alcoa’s Ampliforge™ process, a technique that combines additive and traditional manufacturing for enhanced properties, according to the press release.

“Alcoa is investing in the next generation of 3D printing for aerospace and beyond,” Klaus Kleinfeld, Alcoa chairman and chief executive officer stated in the press release. “Combining our expertise in metal alloys, manufacturing, design and product qualification, we will push beyond the limits of today’s additive manufacturing. This investment strengthens our leadership position in meeting fast-growing demand for aerospace components made using additive technologies.”

Rob Gorham, director of operations for America Makes, said the interest for 3D/additive manufacturing at his group involves “smart collaboration and the growth of the ecosystem” for the leading-edge technology. Components of the roadmap to develop the technology involve a focus on design (product and process), materials (next-generation alloys), process (next-generation production equipment), value chain (advanced sensing and inspection), and the 3D/additive manufacturing genome (physics-based modeling and simulation).

America Makes is associated with the National Network for Manufacturing Innovation (NNMI), a network of 45 regional hubs throughout the United States that coordinates public and private investment in emerging advanced manufacturing technologies.

Alex Kingsbury, group leader, additive manufacturing for CSIRO of Australia, said her organization’s Lab 22 is a center for development work in additive manufacturing. Kingsbury said this thrust by CSIRO reflects an ongoing effort throughout Australia to transition out of low-tech, high-volume manufacturing into high-tech, valued-added production. The hope, she said, is that this initiative will help create a robust supply chain for additive manufacturing in Australia. Equipment at Lab 22 includes powder bed and blown and spray machines, polymer 3D printers and scanners, and testing operations.

Ryan R. Dehoff, Ph.D., a member of the research staff at Oak Ridge National Laboratory, provided an update of “In-Situ Process Monitoring and Big Data Analysis for Additive Manufacturing of Ti-6Al-4V.” The work at Oak Ridge involves all phases of 3D/additive manufacturing: planning, execution, outcome and data analysis. He noted the development work on data analytics for “merging science and manufacturing,” creating a 3D/additive framework. Process monitoring is critical in understanding the dynamics of 3D operations.

Denhoff said Oak Ridge is the largest science and energy laboratory for the U.S. Department of Energy, with 4,400 employees, a $1.65 billion budget, and $500 million in modernization investment.

### Powder Metallurgy

Professor Z. Zak Fang of the University of Utah, who also delivered a presentation for the Government Funded Projects panel, presented “Sintering Ti-6Al-4V in Hydrogen to Achieve Wrought-like Microstructure and Properties.” He began by stating long-standing issues that have hampered conventional powder include problems with mechanical properties such as fatigue performance and fracture toughness, a coarse lamellar as-sintered microstructure, and the high costs associated with post-sintering thermal mechanical processing.

As an alternative, he presented details of his work on a new, patented, hydrogen sintering and phase transformation (HSPT) process. He said that sintering titanium in hydrogen can deliver wrought-like microstructure and properties by simple press and sintering, without costly processes. He summarized by stating that sintering Ti-6Al-4V in hydrogen yields
ultrafine microstructure. The as-sintered HSPT microstructure can be heat treated to achieve wrought like microstructure, and that Ti-6Al-4V produced by HSPT has excellent fatigue properties equivalent to that of wrought alloys.

Dr. Vladimir Moxson, president and chief executive officer of ADMA Products Inc., discussed the “Manufacturing of Hydrogenated Titanium Powders and Titanium Components for Critical Applications.” He said ADMA has developed an innovative process for manufacturing of titanium hydride (TiH₂) powder. ADMA’s proposed process can transform the titanium production because it overcomes the technical challenges of the Kroll’s process by partially replacing molten magnesium with hydrogen gas as a reducing agent to produce TiH₂ instead of titanium, according to Moxson. As a result, titanium components for critical applications can be produced from hydrogenated titanium powder via the ADMA process. ADMA has a pilot-scale unit for manufacturing of TiH₂ powder, with an annual capacity of 250,000 pounds, developing ADMA’s “blended elemental powder metallurgy approach.”

Dr. J.C. Withers, chief executive officer of Materials and Electrochemical Research (MER) Corp. addressed the topic of “Electrolytic Titanium Powder Production from Ore Sources.” Withers stated MER discovered in the late 1990’s that TiO₂ and ore containing TiO₂ could be carbothermically treated to produce Ti₃OC. As a result, TiO₂ and ore containing TiO₂ can be carbothermically reduced to Ti₂OC, which can be chlorinated at 180-400°C to produce low-cost TiCl₄. Low cost TiCl₄ can be used: as a feed to electrolytically produce titanium powder on a continuous basis; and as a feed for Kroll sponge production.

Withers said Ti₃OC is electrically conductive and can be used as an anode to electrolytically produce titanium powder on a continuous basis at a projected cost less than Kroll sponge. The electrolytic process provides control to produce titanium powders in preferred sizes directly useable in powder metallurgy processing. The electrolytic process has demonstrated that it is possible to produce alloy powder such as Ti-6Al-4V at a cost near that of sponge. He said a low-cost titanium or Ti-6Al-4V alloy powder provides a paradigm for powder metallurgy to produce titanium componentry as well as an enabling feed for the various additive manufacturing processes.

Recycling of Titanium

Richard Dolbec, director of research and development for Tekna Plasma Systems, delivered an overview of his company’s inductively coupled plasma (ICP) technology, which has been developed to recycle titanium powders by transforming particles of various shapes into “perfect spheres” in order to boost material flow, packing, density and purity.

Jerry Faitelson, Vice President of Goldman Titanium Inc., substituting for Stacie Greenfield Stone, the director of new business development, outlined the company’s quality, processing and safety procedures for its scrap operations. Faitelson said the role of the titanium scrap processor is to turn unprocessed revert into a finished product that meets titanium melters’ specifications; to be a reliable way station to hold excess inventory for melters; and to have just-in-time, certified, furnace ready scrap readily available.

The title of Robert G. Lee’s presentation was straightforward and to the point: “Hazardous Titanium Does Not Belong in a Landfill.” Lee, the chair of the ITA Safety Committee and president of Accushape Inc., Portland, OR, said the ITA provides substantial safety resources for members, users and first responders, with an emphasis on fire prevention. Lee said the mission of the ITA safety committee is to bring awareness to safety issues when handling and working with titanium. However, he reiterated numerous disclaimers during his presentation. “Every titanium producer, distributor and user must develop their own safety plans to meet the conditions unique to their use of titanium, especially

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**Titanium Scrap Processing**

**Solids: Finished Product**

**Premium Grade Feedstock**

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the generation and storage of titanium fines that may present a fire and or explosion hazard,” Lee stated.

In particular, he cited the hazards of titanium “swarf,” which is revert produced at an estimated level of 5 million pounds per year. Swarf is a term used to describe fine scrap. Like dust and powders, Lee said swarf is considered to be a major fire hazard because it’s readily susceptible to ignition. If discarded in a landfill, swarf, over time, creates explosion hazards.

**Consumer Applications**

Professional golfer John Cook and Edward Rosenberg, designer and chief executive officer of Spectore Corp., were the speakers for the consumer panel. “Change” was the underlying theme in both presentations. Cook, a member of the 1993 U.S. Ryder Cup team and an 11-time winner on the PGA tour, discussed how titanium clubs have helped to change the game of golf. Rosenberg expounded on how his work in the “Rapid Innovation for Titanium in the Consumer Products” became an element of change in the 3,000-year-old tradition of jewelry design, craftsmanship and production. He said Spectore has spent considerable time on the “science of consumer purchasing” to develop innovative jewelry designs for women and men.

**Award Recipients**

Walter E. Herman received the prestigious 2015 Lifetime Achievement Award. Herman’s resume traces the early development of the titanium industry, from the Cold War days of the 1950s and through the decades of commercial development. He played a key role in the development of the first industrial electron beam cold hearth melting process (EBCHM) for removal of high- and low-density inclusions from recycled titanium. Herman also was lauded for his work in the development of corrosion applications for titanium used in the chemical and metal finishing industry.

Christopher Higgins, the Cecil and Sally Drinkward Professor of Structural Engineering in the School of Civil and Construction Engineering at Oregon State University, is the recipient of the 2015 International Titanium Association’s (ITA) Titanium Application Development Award. Higgins, working with Perryman Co., Houston, PA, was cited for his role in developing a novel titanium application for repairing highway infrastructure.

The Oregon Department of Transportation (ODOT), Salem, OR, selected a repair concept by Higgins—a titanium “staple” to reinforce fractures in the reinforced concrete—which was deployed by ODOT on the Mosier Bridge, an “overcrossing” of Interstate 84, which is a major east/west corridor for the state. Higgins designed the idea of the staple and the requirement of a surface treatment that would allow titanium alloy bars to be used to strengthen concrete bridges.

Perryman Co. manufactured the titanium staples and developed the methods to produce the surface treatment. Oregon State tested alternatives and selected the final pattern. Perryman handled the entire production of the staples in house—from start to finish. Perryman engineers then went on site to collaborate with repair contractors for the installation of the staples.

**Distinguished Guest Speakers**

George Hays, the executive director of the New York-
based World Corrosion Organization (WCO), shared his expertise on the global challenges of industrial, infrastructure and municipal corrosion and urged the titanium industry to take a greater role in addressing the issue. According to Hays, corrosion represents an annual worldwide cost of $3 trillion for infrastructure and industry—the cost to repair, replace and maintain critical systems. Here in the United States, Hays said the cost for corrosion control and repair represents about 3.3 percent of annual gross domestic product (GDP) or well over $300 billion.

Here in the United States, there is a sense of urgency when it comes to corrosion problems with state and regional infrastructure. Hays said the vast majority of U.S. bridges already have exceeded their original design life. Two years ago the Reston, VA-based American Society of Civil Engineers (website: http://www.asce.org) issued its “Report Card for America’s Infrastructure,” which reviewed bridges, dams, levees, tunnels, roads, water systems, and other areas, and issued a cumulative grade of D-plus, compared with a D from the group’s 2009 study.

Hays said he considers titanium to be a significant material in the efforts to address corrosion problems. He said titanium, as a specified material to address corrosion problems, plays out well when a project undergoes a comprehensive life-cycle cost review. However, he said titanium’s reputation as an “expensive” material still raises eyebrows. “Corrosion is a phenomenon that occurs slowly over time. The problem is that, too frequently, management or government officials take a short-range view of a project,” he said, noting that state governments are especially sensitive to keeping a lid on short-term costs.

Regis K. Conrad, director, division of advanced energy systems, Office of Fossil Energy, U.S. Department of Energy was the second distinguished guest speaker at the conference. Conrad provided an overview of advanced energy systems, some of which offer business opportunities for the titanium industry. In his presentation, Conrad said research is underway to develop technologies that enable cost effective, environmentally sound electrical power via oxygen-fired combustion systems. He identified three national energy technology laboratories in the United States, located in Albany, OR; Morgantown, WV; and Pittsburgh.

Conrad said the world will face great energy challenges with ever increasing environmental constraints. As a result, advanced, more efficient energy power systems will be needed. He said the Materials Research Program is poised to have even greater impacts on future energy systems, developing novel materials for high-temperature applications; next-generation materials with higher strength and better oxidation resistance; advanced coatings for metals; and computational materials design and lifetime prediction for extreme environments.

International Titanium Association (ITA), has issued a “Call for Papers” to be presented at the TITANIUM EUROPE 2016 Conference, which will be held 18-20th of April, 2016 at the Paris Marriott Rive Gauche Hotel & Conf. Center located at 17 Boulevard Saint-Jacques, Paris France. TITANIUM EUROPE 2016 is the 4th annual European conference hosted by the International Titanium Association.

The Organizing Committee is seeking market oriented and technical papers alike. Abstracts from ITA Members, Non-Members and Academia are encouraged.

Abstract Submission Requirements and guidelines are located on the ITA Website at www.titanium.org. Abstracts must contain preferred panel of topic, keywords, and any co-authors with contact information for the conference proceedings. Only abstracts in English will be considered.

Interested presenters should indicate which of the following panels they would like to participate: Raw Materials, Melting Techniques; Alternative Energy; Commercial Aerospace; Fabrication, Military/Defense; Automotive; Medical; Economy/Finance; Energy Exploration and Production; Mining; Manufacturing Technology; New Materials; Consumer Goods/Recreation Products or Other Industrial Markets.

Questions may be directed to ITA at 1-303-404-2221 or by email at ita@titanium.org.

TITANIUM EUROPE 2016 is designed to suit the needs of titanium industry professionals, suppliers, customers and stakeholders. The gathering offers a full spectrum of information on the latest business, technology and market trends and developments in the global titanium industry. It provides an excellent forum for expert discussions, continuing education, networking opportunities and more.

The Call for Papers Deadline is February 29, 2016.

Jennifer Simpson, executive director of the ITA, also announced “early” registration incentives are available for the European event now through the 30th of November. ITA staff members are available to answer any questions regarding registration, exhibition and housing or simply visit www.titanium.org for more details.
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In addition to pricing fundamentals, Metal-Pages also publishes daily commentary covering current and future supply and demand balances, global transaction activities, the latest trends in consumption, recent technological developments and relevant corporate activities and statements.

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http://www.cleveland-research.com/

Edge Titanium

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 forging and machining of components for the orthopaedic, spine and trauma markets. Edge works with its customers to provide cost-effective solutions that satisfy pricing requirements and materials support for its strategic products. Value-added services include precision grinding, precision sawing, non-standard grades and sizes, and just-in-time inventory programs. The company conducts business internationally with customers around the globe.

www.edgeintl.com

EFC Systems Inc.

EFC - Electrostatic Finishing Components and Systems, Inc., an American engineering and manufacturing firm serving both the domestic and international markets, is a complete systems supplier for advanced spraying technologies. We design, fabricate, and repair electrostatic finishing components - turbine and spray gun systems - at our headquarters in Havre de Grace, Maryland.

http://efcusa.com/

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Goldman Titanium

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 1955, and we have continuously expanded our business over the years. Titanium is the only metal we handle, making us experts in our field. 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.

http://www.goldmanti.com/
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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 sub-contractors for aerospace, automotive, chemical, medical, oceanographic, oil & gas, semiconductor, recreational and other industries worldwide.

http://www.king-titanium.com

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Kaman Precision Products

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www.kaman.com

Kevin Kreitman
Fire Chief-Redding CA & Safety Consultant

Chief Kreitman has 34 years’ experience in the fire service beginning his career as a firefighter in Albany Oregon. Chief Kreitman worked as a firefighter/paramedic and held his paramedic certification for 28 years; he was promoted to the rank of Battalion Chief in 1989, Assistant Chief in 1994, and was promoted to Fire Chief for the City of Albany in 1999 until accepting the Fire Chief’s job with the City of Redding, California in September 2008. During Chief Kreitman's time in Albany Oregon he worked closely with the numerous metals industries in the area, and wrote a research paper on the proper handling of titanium and zirconium metal fires. Kevin is a consultant available to provide assistance to the titanium industry & others seeking information on the safe handling of combustible metals.

Laboratory Testing Inc.

Laboratory Testing Inc. (LTI) provides Materials Testing, Nondestructive Testing and Calibration Services with accurate results, fast turnaround, and cost efficiency. LTI is A2LA and Nadcap accredited, ISO/IEC 17025 certified and approved by primes and other leading companies. Since 1984, LTI has provided a wide-array of businesses with test results and certified reports to meet their quality and regulatory requirements. The technical experts and support team help clients get their jobs done and find the answers they need. With a nearly 100,000 sq. ft. facility, Lab Testing, near Philadelphia, PA, is one of the largest independent testing laboratories in the USA and fully capable of handling and testing materials of all shapes, sizes and quantities. Although we specialize in metals and alloys, some test services are available for polymers, ceramics and more. We constantly strive to “Exceed your expectations with quality, service and delivery.”

http://www.labtesting.com/

Tenova Core

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http://www.tenova.com/
Overon Group

Overon Group Corporation was founded in Atlanta, Georgia to represent the interests of Russian companies and their products in Engineering of marine equipment, Small Wind Energy, Organization of production, Investment, Property and asset management, Sales and Marketing.

www.overongroup.com

Able Electropolishing

Since 1954, Able Electropolishing has been a metal finishing pioneer and is now the world’s largest electropolishing specialist. We provide metal finishing services to companies from a wide variety of industries that use common and specialty metal alloys. Because of our expensive capabilities, thousands of companies rely on our metal finish services as the last step in their metal part production.

www.ableelectropolishing.com

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The values of PSD AERO contribute to the company’s economic performance with respect for people, environment and regulation, and aim to meet the stakeholder’s expectations now and in the future.

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http://www.psdaero.com

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As a global supplier, we are a reliable, trusted, and value-added partner to your supply chain.

www.valencesurfacetech.com

The Olin Research Group, LLC

The Olin Research Group is a specialized firm that offers MARKET UPDATE REPORTS for various carbon steel, stainless, specialty materials (titanium & nickel-based alloys), and aerospace company executives. We do this by leveraging our network of industry contacts (distributors, mills, producers, and buyers) and 18-years of experience in the investment world. Together, we can provide unique insights from a “top-down” or “bottoms-up” perspective. Our partners have an edge versus the competition -- for planning and up-to-date market share analysis.

The “value-add” in our research comes from the combination of charting momentum and/or highlighting inflection points. We do this by using data gathered from quarterly surveys. We provide a twist in our reports by incorporating industry models, channel sentiment gauges, and the feedback we are getting from the larger, publicly-traded companies. Our goal is to provide customers with a different perspective on each metal/aero category, also gauging the relative health of main end-markets. We believe this gives our customers an enhanced ability to navigate through any market challenges and/or opportunities. Our data collection or indexes can also be measured against peers. Track your company’s performance versus an anonymous sample group. See where you stand (by region or product category).

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www.tekna.com

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www.patmooneysaws.com

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www.standarddie.com

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Cogitic is an engineering and manufacturing company specializing in the machining, assembly and test of complex components and assemblies produced from exotic alloys. Large 5-axis capability with full CMM validation of all products.

www.cogitic.net

IHI Corporation

IHI Corporation is a Japanese company which produces aircraft engines (new parts production and O/H), aero-space system (rocket system and propulsion system), turbochargers for automobiles, ships, industrial machines, power station boilers and other facilities, suspension bridges and other transport-related machinery.

www.ihi.co.jp/enlindex.html

Manufacturing Technology Inc.

MTI provides engineering solutions and needed equipment for the joining of titanium and other metals in fabrication of net shape and near net shape components and assemblies.

www.mtiwelding.com

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Ospray™ Fire Suppression is the manufacturer of Aquaxera™ Fire Suppression Agent. Aquaxera™ is a dual acting agent that is able to extinguish Titanium fires in seconds, returning the remaining material to ambient temperature. Aquaxera™ also acts as an inerting agent, reducing the ignitability of surrounding material during extinguishment. OsprayTM also does specialty sprinkler system design and system conversion from existing water sprinkler systems.
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From the Wire

EUROPE’S TOP AIR & SPACE COMPANIES HOLD ADDITIVE MANUFACTURING SUMMIT AT NORSK TITANIUM

OSLO, Norway--(BUSINESS WIRE)--Norsk Titanium AS (NTi), the world’s only supplier of aerospace-grade, additive manufactured, structural titanium components, hosted a European additive manufacturing summit on December 1st at its Technology Center in Oslo, Norway. Norsk executives granted unprecedented access to the company’s patented Rapid Plasma Deposition (RPD) process to aerospace participants of the European Space Agency’s (ESA) €20 million AMAZE initiative.

NTi owns and operates the only wire-based additive manufacturing factory in ESA’s cooperative program, Additive Manufacturing Aiming Towards Zero Waste & Efficient Production of High-Tech Metal Products (AMAZE), which is Europe’s largest working team on the subject of metal additive manufacturing.

"Norsk Technology is pleased to host our AMAZE partners and provide the first-ever insider’s look into the production phase of our RPD technology," said NTi Chief Executive Officer Warren M. Boley, Jr. “We are revolutionizing the metal manufacturing industry with radically less expensive aerospace-grade titanium components, and our participation in AMAZE allows collaboration with European manufacturers and early access to our technology.”

The overarching goal of AMAZE is to rapidly produce large defect-free, additively-manufactured components, ideally with close to zero waste, for use in the European high-tech industries, such as aeronautics, space, nuclear fusion, automotive, and tooling. The project, launched in 2013 by David Jarvis of the ESA, is supported by 9 European countries and 28 active partners, including 19 industrial companies, 8 universities and 1 intergovernmental agency.

The AMAZE companies had the opportunity to watch a live demonstration of NTi’s 4th generation RPD machine produce a unique structural titanium spar for one of the world’s largest commercial aircraft manufacturers. The aircraft part was produced in a fraction of the time and cost of the forging process being replaced by NTi’s proprietary technology, which uses plasma to melt titanium wire in an inert argon atmosphere to be precisely and rapidly built up in layers to a near-net-shape that requires very little finish machining.

Since 2007, NTi has been working to develop and commercialize additive manufactured, aerospace-grade titanium components to generate unprecedented savings in time and cost over legacy forging and machining operations. The company’s full rate production machines are the result of 9 years of research and each can produce 22 metric tons of aerospace-grade titanium parts per year. In 2016, NTi will break ground in the U.S. on the world’s first industrial-scale additive manufacturing facility for aerospace production.

To view photos from the AMAZE summit visit, please visit http://j.mp/NorskTitaniumAS.

About Norsk Titanium AS

Norsk Titanium AS (NTi) is a global leader in manufacturing premium quality titanium components for aerospace and industrial applications. The company has revolutionized the industry with its patented Rapid Plasma Deposition (RPD) process that transforms titanium wire into complex components that are up to 70 – 80 percent complete. NTi’s wire deposition technology reduces time from CAD drawings to manufacturing of finished titanium components and is the world’s only aerospace-grade, structural titanium process. www.norsktitanium.com

Contacts
Norsk Titanium AS
Media contact:
Chip Yates, +1-949-633-1065
VP of Marketing
media@norsktitanium.com

UL FIRE EXTINGUISHING AGENT TEST PROTOCOLS FOR TITANIUM FIRES NOW BEING REVIEWED

Bill Coviello President of the TLI Group Ltd, and a member of the Underwriters Laboratories Standards Technical Panel No. 605, which cover rating, and performance during fire tests, of fire extinguishers intended for use in attacking Class A, B, C, D, and K fires. These requirements also cover performance during fire tests of fire extinguishing agents for application on Class D fires, announces that he has initiated a proposed UL Test Protocol Fire Standard for titanium, and zirconium extinguishing agents. The reason for the proposal is that presently there are no standards for any independent agency to test and certify that an extinguishing agent has met the protocols required for certification that it can safely extinguish these types of fires. We are hoping that the STP 605 Committee will approve for release these test protocols during the upcoming year. This would finally allow for the titanium industry to now select extinguishing agents that meet fire safety standards. Please note assistance with developing the Protocol Testing Standards by several members of the Titanium Association.

Contact:
William Coviello
603-504-4183 Telephone
william@tligroup.com Email
THE MID-WEST™ DESIGN

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U.S. PATENT OFFICE ISSUES SOLAR MANUFACTURING 20 BAR FURNACE PATENT 9,187,799

Souderton, PA, November 30 – Solar Manufacturing announced today the United States Patent and Trademark Office (USPTO) has officially issued a patent for the new 20 bar super quench vacuum furnace as Patent number 9,187,799. The official patent is available to the public at USPTO.gov.

One major advantage of the new design is the use of movable radiation baffle doors that prevent heat loss during heat cycles and open wide to avoid pressure drops during cooling cycles. The application of the open doors in combination with the use of a plenum fan arrangement, generous annular space for uniform gas flow, and a low static pressure loss nozzle design provide inert gas quenching capabilities typically achieved only with oil quenching by concentrating the available system horsepower on the task of producing a high nozzle exit velocity. The system also permits excellent cooling at lower pressures. Low pressure cooling is typically sacrificed by undersized fans normally selected for high pressure quench systems. The new system operates in a constant horsepower mode over a large range of quenching pressures.

Commercially, Solar Manufacturing’s first 20 bar high pressure quench vacuum heat treating furnace is located at Solar Atmospheres of Western PA. The furnace has a 36” x 36” x 48” work zone with a 5,000 lbs. load capacity, and the cooling rates are reported to be significantly better than any other high pressure gas quench furnace currently in production.

ABOUT SOLAR MANUFACTURING
Solar Manufacturing designs and manufactures all types of vacuum furnaces for heat treating, brazing, carburizing, nitriding and hydriding/de-hydriding and offers replacement hot zones and spare parts for various vacuum furnace brands. To learn more about the new 20 bar furnace or any other equipment in our diverse line of products and services, contact Pete Reh, VP of Sales, at 267-384-5040 or pete@solarmfg.com. Additional information can be found on our web site – www.solarmfg.com.

Pictured is Solar Manufacturing’s 20 bar high pressure quench vacuum heat treating furnace currently in production at Solar Atmospheres of Western PA.

PRESIDENT TITANIUM ACHIEVES AS9120 REV. A CERTIFICATION

Hanson, Massachusetts, USA – December 1, 2015 – President Titanium Co., Inc., one of the world’s largest distributors of domestic melted/manufactured titanium products servicing the aerospace industry, announced that as of 14 November 2015, it’s Quality Management System is now a certified to the AS9120 Rev. A Standard along with its current certification to the ISO 9001:2008 Standard in quality assurance by TUV Rheinland of North America, an ANAB accredited auditing company.

The AS9120 Standard is a quality management system based on the ISO 9001:2008 Standard along with several additional requirements specifically focused towards the aerospace industry and has recently become a required standard in the titanium’s aerospace industry per AS6279.

“Distributors and manufacturers in today’s titanium industry providing products and/or services to the aerospace industry are now required to have their quality management systems in compliance with one or more of the AS Quality Standards,” said John Toler, President Titanium’s QC/QA Manager. “Achieving AS9120 Certification to remain viable and competitive in today’s titanium aerospace market was extremely important to us and by attaining this certification, it ensures our ability to continue to provide quality, domestic titanium products to our customers.”

For more information, contact President Titanium Co., Inc. at 243 Franklin St., Hanson, Massachusetts, 02341; by calling at 781-294-0000 or 800-225-0304; by fax at 781-293-3753; by email at sales@presidenttitanium.com; or visit us on the web at www.presidenttitanium.com.

About President Titanium Co., Inc. -
President Titanium is a small, veteran and family owned business, located about 30 miles south of Boston and has been providing its customers in the aerospace, medical, military, and commercial industries with quality, domestic titanium products since 1973.

President Titanium is an approved supplier to many of the major aerospace companies and all of our products are 100% traceable and certified back to their point of original melt/manufacture. President Titanium is able to provide copies of the original melt/manufacture cert for all of our products to our customers.

For a copy of our AS9120 Certification or for more info, please visit: www.presidenttitanium.com.
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ROLLED ALLOYS INTRODUCES NEW KASTOTEC AC5, 20” BANDSAW

Windsor, Connecticut - Rolled Alloys has announced the addition of its new KASTOtec AC5, 20” diameter bar bandsaw. The AC5 is a fully hydraulic and automatic high-performance bandsaw with a horizontal saw. It performs particularly well on tool steels and material which is difficult to cut such as Titanium, Hastelloy, and Inconel.

“We will now have two large diameter production bandsaws to tackle production cutting over 8” diameter. The addition of the KASTOtec AC5 will help us manage our lead-times more effectively and eliminate bottle necks,” says Chris Beaulieu, General Manager at the Rolled Alloys Windsor location.

About Rolled Alloys:
One of the largest suppliers of stainless steels, nickel, cobalt and titanium alloys, Rolled Alloys maintains 13 locations across North America and Asia. For additional information about the company, please visit www.rolledalloys.com.

TITANIUM INDUSTRIES (T.I.) ANNOUNCES FACILITIES EXPANSIONS, NEW PROCESSING EQUIPMENT, AND NEW STORAGE SERVICES

T.I. has started a new service center in Seattle, WA, USA and has also expanded its existing Asia Headquarters in Taipei, Taiwan. The new 10,000 square foot Seattle distribution and first stage processing facility serves the aerospace, industrial, medical, and oil and gas customers in the Pacific Northwest and Western Canada. In Taiwan, T.I. has relocated into a new larger 20,000 square foot service center in New Taipei City strengthening T.I. support of all customers throughout Asia.

With the installation of a newly acquired Cincinnati Shear, T.I.’s Garden Grove, CA, USA service center has added a new capability to cut flat products more efficiently. The new shear has a width capacity of 10 feet (3.0 m) and can cut up to 0.750” (19 mm) thick flat stock across many alloy families. This shear adds to the extensive bar saw, plate saw, and waterjet cutting capabilities of T.I.’s largest service center. This improvement addresses customers’ growing demand for near net shape parts, and allows for faster deliveries across the entire T.I. service center network.

In an ongoing effort to support supply chain optimization, T.I. is now offering public bonded warehousing service at its Rockaway, NJ, USA and Shanghai, China facilities. This new capability provides secure heated storage complete with racks, export packing, export compliance, and an inventory system that conforms to U.S. Customs 19 CFR 19.12 for inventory control and record keeping. T.I. offers this service for the stocking of bulk metals, as well as other durable goods. The locations of these facilities are strategic to servicing global markets and are close to some of the most active ports in the world.

These improvements are key to the continued development of T.I.’s global network which now includes twelve global sales and stocking facilities in the Canada, United Kingdom, Norway, India, China, Taiwan and the USA (CA, FL, IL, NJ, TX, and WA), as well as, four standalone sales offices in Brazil, Germany, and the USA (CT, OH).

Greg Himstead, T.I. Vice President of Sales and Marketing, comments “Throughout all market conditions, we are always listening to the needs of our customers, their regions, and their industries. We take a long term view and invest step-by-step in our service center network so that we are positioned as the best value global performance metals solutions provider. Stay tuned for future enhancements as we continue to evolve to meet the changing needs of our customers.”

T.I. (Titanium Industries Inc.) is the global leader in performance metal solutions for the aerospace, medical, industrial and oil and gas markets. We are the largest independent distributor of Titanium and Specialty Metals stocked throughout our global service center network. We maintain and are continually expanding our state of the art processing and near net shape capabilities, such as water jet cutting, saw cutting, and shearing. We provide tailored supply chain solutions through our T.I. Materials Management methodologies and Program Management competence. We continuously focus on lean and process improvements while maintaining AS9100 and ISO9001 certifications at all locations worldwide. Our award winning sales team has been providing dependable quality driven solutions to customers since 1972.

www.titanium.com
Fuel options abound with the new Vargo titanium Converter Stove available now through www.vargooutdoors.com and specialty retailers worldwide.

Building upon the popularity of the Hexagon Wood Stove and years of customer feedback, Vargo is launching a new product to increase the usefulness of its top-selling stove. The Converter Stove is an alcohol and fuel tab/gel stove that can be used alone with a windscreen or inserted into the Hexagon Wood Stove to create a complete multi-fuel cook system. The Converter Stove combined with the Hexagon Wood Stove can burn alcohol, fuel tabs, fuel gels, and any biomass fuel for incredible versatility*.

Weighing just 1.6 oz. (48 grams), the Converter Stove pairs with either the titanium or stainless steel version of the Hexagon Wood Stove for a complete multi-fuel stove system for under 6 oz. and 9 oz. respectively. The Converter Stove switches easily between alcohol and fuel tab/gel burning modes by simply flipping it over. Its collapsible stand serves as a pot stand when used alone or, when inserted into the Hexagon Wood Stove, hangs the stove at the ideal distance between the stove and cookware for optimal cooking efficiency and soot prevention. The retail price is $39.95.

On why he created the Converter Stove, Vargo CEO, Brian Vargo, said, “For years customers have been using the Hexagon Wood Stove as a windscreen and backup stove option for our current alcohol stoves. The problem was that, due to the distance between the stove and pot, the stoves burned inefficiently and created a lot of soot on the bottom of the pot. We knew we needed to create a stove that would sit at a closer distance to the pot to improve cooking efficiency and to reduce soot altogether.”

When relying on alcohol, fuel tabs, or fuel gels as a primary fuel source, the Converter Stove allows the Hexagon Wood Stove to serve as an effective windscreen and emergency backup stove that can burn available biomass fuels like wood. When primarily using the Hexagon Wood Stove, the Converter Stove can serve as a backup stove (with fuel) when conditions are too wet or when biomass fuel options are scarce (e.g. deserts, beaches, above tree line, etc.). Lastly, the Converter Stove can be used as a standalone multi-fuel stove with the addition of a windscreen.

The Vargo titanium Converter Stove is available now through www.vargooutdoors.com and specialty retail stores worldwide.

For more information about the Vargo titanium Converter Stove including product images and video, please visit www.vargooutdoors/converter-stove.

Vargo Titanium Converter Stove – MSRP $39.95

FEATURES:
• Converts the Hexagon Wood Stove into a complete multi-fuel cooking system
• Can be used as a standalone alcohol and fuel tab/gel stove
• Switches easily between alcohol and fuel tab/gel burning modes
• Stand folds flat for compact storage

SPECIFICATIONS:
• Stove diameter: 2.4 inches (61 mm)
• Stove height: 1.2 inches (32 mm)
• Stand diameter (open): 4.2 inches (107 mm)
• Stand height: 2.9 inches (32 mm)
• Weight: 1.6 ounces (48 g)

*Hexagon Wood Stove and Aluminum Windscreen are sold separately.

About Vargo:

Since 2002, Vargo has been an award winning manufacturer of innovative ultralight backpacking gear. Primarily using titanium, an ultralight yet ultra-strong material, Vargo has developed a unique line of products that reflect its commitment to improve and simplify outdoor gear design and utility.
When it comes to precision bar, no one offers You more:

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STANLEY ABKOWITZ RECEIVES JACOB (JESSE) N. ERLICH ACHIEVEMENT AWARD

On Thursday, October 22, 2015, the Boston Patent Law Association’s (BPLA) Invented Here! Committee celebrated Massachusetts Inventors Day by holding its fifth annual Invented Here! event to honor New England’s innovators and their innovations. This year, the event recognized an inventor who is a leader in the titanium industry, and started in that industry at its very beginning — the 1950s. The inventor, Stanley Abkowitz, has received patents in each of the past seven decades: 1950s, 1960s, 1970s, 1980s, 1990s, 2000s, 2010s, and has patent applications pending! Mr. Abkowitz’s innovations have made their way into military, commercial, and consumer products. Titanium is currently being used in products such as aircraft, missiles, medical devices, automobiles, bicycles, and golf clubs, and has many other applications.

Mr. Abkowitz’s patents have enabled others to follow in his path and continue the growth of the very important titanium industry. During a short speech, Mr. Abkowitz shared with the audience how his titanium process and compounds are created and used in the development and production of titanium components. He also passed around and explained some interesting show-and-tell pieces related to his inventions.

When asked by a member of the audience what makes a successful entrepreneur, Mr. Abkowitz replied: “The entrepreneurial mind has to be creative, must have the passion to pursue the goal, must be willing to take certain risks and, of course, must have the vision to target a worthy end product.”

As part of the evening’s recognition, Mr. Abkowitz received the first annual Jacob (“Jesse”) N. Erlich Achievement Award for his outstanding accomplishments, as illustrated by his patents and the span of time over which he was awarded those patents. Laura Erlich and Adam Erlich, wife and son of late BPLA Past President and former partner at Burns & Levison, Jesse Erlich, were in attendance at the event. Also in attendance were Lorraine Abkowitz, wife of Stanley, and their daughter Susan Abkowitz. Susan, a co-inventor with her father Stanley on some of the more recent patents, also participated in the event by serving as a panelist with Stanley and responding to questions from the audience during a questions and answers period.

MEALS AND ORES BENEFIT FROM TRANS-PACIFIC PARTNERSHIP

WASHINGTON – U.S. Under Secretary of Commerce for International Trade Stefan M. Selig today released the Trans-Pacific Partnership (TPP) Opportunities for the U.S. Metals and Ores Sector Report. The report details how the elimination of various tariffs and other TPP commitments to level the playing field will benefit American companies competing in TPP markets. The Metals and Ores Sector includes products such as iron and steel, aluminum alloys, titanium products, and ores of molybdenum, copper, and zinc.

“U.S. businesses and workers in the metals and ores sector will be positively impacted by the elimination of many barriers once TPP is enacted,” Selig said. “TPP is a high-standard agreement that levels the playing field for our products, making Made-in-America goods more attractive to the fast growing Asia Pacific region.”

The U.S. metals and ores industry employed one million workers in 2014. During the same time period, exports totaled $3.1 billion to the TPP markets where we do not currently have trade agreements. The report details the current barriers the sector faces in TPP countries, and demonstrates how the industry stands to benefit once the trade agreement enters into force.

Currently there are five TPP countries with which the United States does not have preferential market access – Brunei, Japan, Malaysia, New Zealand, and Vietnam. Once TPP becomes law:

- Japan will eliminate import taxes on 99.7 percent of U.S. metals and ores exports immediately
- Brunei will eliminate import taxes on 99.3 percent of U.S. metals and ores exports immediately
- Vietnam will eliminate import taxes on 85.1 percent of U.S. metals and ores exports immediately and 95.4 percent within four years
- Malaysia will eliminate import taxes on 80.4 percent of U.S. metals and ores exports immediately and 86.8 percent within four years

To view the full report, go to http://www.trade.gov/fta/tpp/industries/metals.asp
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Chris Olin is the head of the specialty materials & aerospace-related research team. Each quarter, we offer a free update report on the visible trends in key markets (like titanium and nickel-based alloys) for any company/person that completes our quarter survey(s). We also host a series of webcasts to highlight the interesting themes and potential topics.

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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. Armstrong Process® technology is intended to lower the production cost of powders suitable for direct consolidation, to lower the manufacturing costs of titanium products through powder metallurgy processing, and to reduce the environmental impact of titanium production.

CSIRO High Performance Metal Industries
+61 3 9545 8644
www.csiro.au/TitaniumTechnologies

The High Performance Metal Industries Program, is engaged in applied R&D across the metal value chain, specialising in novel metal production techniques, interfaces/corrosion, metal forming, and additive manufacturing / 3D printing, particularly for Titanium and its alloys. HPMI partners with commercial industry in applied research or to develop new technologies as well as provides consulting services use of specialized facilities, and aims to be a global leader in the knowledge and application of fundamental metals technologies. 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.

Cyril Bath Company
+1-704-289-8531
www.cyrilbath.com

Cyril Bath produces titanium air frame components by Hot Stretch Forming HSF® titanium profiles in lengths up to 30 feet long. Most of these air frame components are provided as machined and finished, ready for airplane assembly installation. We purchase titanium in extrusion or rolled product forms.

Danieli Corporation
+1-724-778-5400
www.danieli.com

Danieli Centro Maskin combines Swedish, North American and Italian technology together with know-how gained through our experience of 55 years of activity in the field of Surface Conditioning, NDT Inspection and Finishing Lines for the titanium industry. Danieli Centro Maskin surface conditioning, drawing, straightening, peeling, centerless grinding, cutting, and tube finishing lines, incorporate the most modern engineering and design technologies.

Danieli Wean United is recognized worldwide as a leader in the field of engineering and manufacturing of complete hot and cold mill complexes for ferrous and non-ferrous metals.“

Danobat S. Coop
+34 943 748 150
www.danobatbandsaws.com
bandsaws@danobat.com

Sixty years have gone by since DANOBAT manufactured its first machine. Nowadays DANOBAT Band Saw Machines does not simply make band saws, but innovates in the field of machine tools.

DANOBAT Band Saw Machines strategy is to offer custom solutions for highly complex sawing applications on high-tech products. The aerospace, automotive, rail, industrial resources, wind power, oil and gas sectors and outsourcing workshops are the main trading sectors of DANOBAT Band Saw Machines.

The technological leadership of DANOBAT Band Saw Machines in the development and manufacture of horizontal and vertical band saws makes it possible to offer leading-edge and highly effective sawing solutions to our customers.

DANOBAT Band Saw Machines provide solutions for solid bars, pipes and plates with the highest accuracy.

Automatic band saw machines, wagon style or gantry for large dimensions and vertical plate saws are the solutions offered by DANOBAT.

DGA
+33 1 4619 8074
www.defense.gouv.fr/dga

The preparation for the future of defense systems involves imagining possible futures, anticipating threats and risks, advancing technology and developing European partnerships. Its aim is to provide France with the means necessary for its defense and security policy with the desired level of autonomy and respect for its international commitments. To prepare for the future, the Armaments Procurement Agency (DGA) ensures continual access to the necessary industrial and technological base by developing strategies for research and technology, industry and cooperation. In order to do this, DGA participates in preparing

DHL Drawback Services
+1-585-328-7130
www.dhldrawback.com

DHL Drawback Services is a licensed Customhouse broker specializing in duty drawback matters. With offices in Houston, Texas and Rochester, New York, we have over 20 years’ experience obtaining the maximum in allowable duty drawback refunds and excise tax credits for our clients in a compliant, timely, thorough, and professional manner that imposes the least amount of administrative burden on our client’s time and resources.

DKSH Switzerland Ltd.
+41 44 386 72 72
www.dksh.com
ti@dksh.com

Pioneers in sourcing of Titanium bars and plates from Japan and China: DKSH Advanced Metals is part of a Swiss group with 140
years of experience in bridging Asia and the West. For the last 30 years, we have been instrumental in introducing high quality titanium and titanium alloys from top quality Japanese and Chinese producers to European, US and South East Asian customers. We serve stockists as well as end users in the Medical, Aerospace, Automotive, Chemical, Oil & Gas and other high tech industries. Our wide range of services includes access to a comprehensive stock of Ti semi-finished products, advanced supply chain management such as vendor managed inventory and subcontracting for machining and forging, tailor made financing solutions and metallurgical expertise. Our deeply rooted knowledge of sourcing and subcontracting markets coupled with our Swiss sense for premium quality ensures that we remain at the forefront of innovation when it comes to serving your needs.

Dufersco SA
+41 91 822 56 00
www.dufersco.com

Dufersco Group is the ultimate shareholder of Vanchem Vanadium Products (Pty) Ltd. (“Vanchem”). Vanchem is one of the world’s top five vanadium producers and its assets comprise mining activities and various vanadium oxide, ferro-vanadium, and vanadium chemical production facilities. Visit our websites at www.vanchemvanadiumproducts.com and www.dufersco.com

Dynamet Incorporated
+1-800-237-9655
www.cartech.com/dynamet

Dynamet Incorporated, a subsidiary of Carpenter Technology Corporation, is a leading domestic and international supplier of high quality titanium alloys for the aerospace, medical, consumer, motorsports, and recreation industries. Design engineers rely on Dynamet for the highest quality titanium wire, bar, fine wire, strip, and shaped products in which light weight, strength, biocompatibility and superior corrosion resistance are important.

For nearly 50 years, Dynamet has been delivering excellence and innovation in the manufacture of titanium and other specialty metal products and has earned an international reputation as the premier supplier of heading wire and bar to manufacturers of aerospace fasteners. Material is sourced from a select group of qualified global suppliers to meet Dynamet’s specialized requirements which in turn is processed to meet precise customer and industry specifications.

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 forging and machining of components for the orthopaedic, spine and trauma markets. Edge works with its customers to provide cost-effective solutions that satisfy pricing requirements and materials support for its strategic products. Value-added services include precision grinding, precision sawing, non-standard grades and sizes, and just-in-time inventory programs. The company conducts business internationally with customers around the globe.

EFC Systems, Inc.
+410-939-7155
www.efcusa.com

EFC - Electrostatic Finishing Components and Systems, Inc., an American engineering and manufacturing firm serving both the domestic and international markets, is a complete systems supplier for advanced spraying technologies. We design, fabricate, and repair electrostatic finishing components - turbine and spray gun systems - at our headquarters in Havre de Grace, Maryland.

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

ELG Utica Alloys, Inc. 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.

Evraz Stratcor, Inc.
+1-312-533-3650
www.evrazstratcor.com

EVRAZ Stratcor offers titanium producers one-stop shopping for all their master-alloy requirements. Using a state-of-the-art, ISO approved production facility that is focused on meeting the ever-increasing quality needs of the aerospace industry, we can provide a full range of vanadium and other master alloys, including innovative and customized specialty alloys that are marketed and managed by EVRAZ Stratcor, Inc. based in Chicago, Illinois.

EWI
+1-614-688-5000
www.ewi.org
info@ewi.org

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 814.688.5000.
Producers, Distributors, Fabricators, OEM’s, & Vendors to the Industry

FAE S.A.
54-11-6326143/94/95
www.fae.com.ar
fae@conuarfae.com

FAE is an Argentinean company qualified by Airbus for supplying hydraulic titanium Ti-3Al-2.5 tubing for Family 320. Also is the first Latin-American company in getting a tier one contract with EADS group. 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 which are up to 35 meters long. These tubes are also made in nickel alloys 690 & 800 for steam generators for nuclear power plants. 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 ingots and bars in titanium alloys and bright annealed finish seamless instrumentation titanium tubes (O.D ¼” up to 5/8”). FAE is certified according UNE EN 9100: 2009, ISO 9001: 2008, ISO 14001: 2004, OHSAS 18001: 2007, PED 97/23/EC & CSA N285.0 standards. It’s products are exported to countries all over the world and they are used in aerospace and corrosion resistant applications. Now also NADCAP certified company for heat treating and non destructive test.

Fine Tubes
+44 (0)1752 876416
www.finetubes.com
www.superiortube.com

Fine Tubes is a leading global manufacturer of precision tubing in titanium, stainless steel, nickel and zirconium alloys. The company manufactures tubes in both seamless and welded forms used in mission critical applications across a range of specialty markets including oil and gas, aerospace, nuclear, power generation, chemical process and medical devices.

Titanium tubing expertise:
- Seamless titanium tubes from 1 mm (0.040”) OD to 50 mm (2”) OD. Straight lengths up to 18 ft.

Fine Tubes has achieved NADCAP approval for Ultrasonic Testing, Heat Treatment and Fusion Welding and offer a comprehensive portfolio of titanium products in the following alloys: Ti CP (Grade 1), Ti CP (Grade 2), Ti 6Al/4V (Grade 5), Ti 3Al/2.5V (Grade 9), Ti 5Al/4V and Ti 4Al/2.5V.

Proudly based in the United Kingdom, Fine Tubes operates a number of state-of-the-art titanium processing facilities including:
- Pilger Rolling Mills
- Draw Benches
- Vacuum Furnace Heat Treatment
- Chemical Processing
- Conditioning & Degreasing

Along with its US-based sister mill, Superior Tube, Fine Tubes is a unit of AMETEK Specialty Metal Products, a division of AMETEK, Inc., a leading global manufacturer of electronic instruments and electromechanical devices.

Fluor Corporation
864-281-8385
www.fluor.com

Fluor Corporation (NYSE: FLR) is a global engineering and construction firm that designs and builds some of the world’s most complex projects. The company creates and delivers innovative solutions for its clients in engineering, procurement, fabrication, construction, maintenance, and project management on a global basis. For more than a century, Fluor has served clients in the energy, chemicals, government, industrial, infrastructure, mining and power market sectors. Headquartered in Irving, Texas, Fluor ranks 109 on the FORTUNE 500 list. With more than 40,000 employees worldwide, the company’s revenue for 2013 was $27.4 billion. Visit Fluor at www.fluor.com and follow on Twitter @FluorCorp.

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 components for demanding applications. For many years, our efforts focused exclusively on the medical device industry. But eventually we realized that our unique skills are valuable to other industries, as well.

No matter what your application may be – when you source your materials from Fort Wayne Metals, you know you’re dealing with a company that understands the critical importance of quality. After all, our employees have experience producing materials that ultimately end up in the human body. And this means we uphold the highest standards throughout our entire production process. In fact, we are 9100C and ISO 9001 certified and maintain a A2LA - ISO/IEC 17025 compliant Materials Testing Laboratory.

Available grades:
- Commercially pure Titanium (ASTM F-67 · ASTM B348 · ASTM B-863 · ISO 5832-2):
  - Grade 1 Titanium
  - Grade 2 Titanium
  - Grade 3 Titanium
  - Grade 4 Titanium
  - Alloyed Titanium
  - Ti-6Al-4V ELI (ASTM F-136 · ASTM B-348 · ASTM B-863 · ISO 5832-3)
PRODUCERS, DISTRIBUTORS, FABRICATORS, OEM’S, & VENDORS TO THE INDUSTRY

FRIEDRICH KOCKS GmbH & Co KG / KOCKS PITTSBURGH COMPANY
+49-2103-7900
+1-412-367-4174
www.kocks.de
marketing@kocks.de

FRIEDRICH KOCKS GmbH & Co KG was founded in 1946 by Dr.-Ing. Friedrich Kocks. We have been successfully operating worldwide in the field of rolling mills for tube, wire rod and bar as independent, medium sized family owned company.

By a consistent and future-oriented development of our products, our technology has acquired a leading position on a global scale. KOCKS rolling mills are the benchmark for creative application oriented solutions as well as first class competence in engineering and manufacturing. Following its policy, KOCKS will pursue these constant innovations so that KOCKS will provide tomorrow’s technologies today.

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

Frugi 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.

G&L Manufacturing, Inc.
+1-931-528-1732
www.gandltubing.com

G&L is a manufacturer of welded tubing in a full range of corrosion resistant and high temperature alloys including stainless steels, nickel alloys and titanium. From demanding heat transfer applications, to safety critical fuel delivery systems, to life supporting medical applications G&L’s tubing has been exceeding customer expectations for over 30 years. G&L’s proprietary tube forming and welding technology is designed to deliver precise dimensional control and consistent weld integrity. G&L tubing is offered in cut to length, level wound and loose wound coil, as well as custom shapes. We are located at 1975 Fisk Rd., Cookeville, TN 38506 USA

G&S Titanium, Inc.
+1-330-263-0564
www.gs-titanium.com

G&S Titanium manufactures many grades of titanium in the form of round and hex bars, fastener wire, spring wire, weld wire, precision ground medical bars, and fine wire. This includes the standard grades such as CP Gr. 1-2-3-4, 6AL-4V, 6AL-4V Eli, as well as hard to find alloys such as 3-8-6-4-4, 13-11-3, 6-2-4-2, 8-1-1, Gr. 7, Gr. 9, Gr. 12, 21S, 230, 679, 685, 829, etc.

Gautier Steel Ltd.
+1-814-691-6050
www.gautiersteel.com

Gautier Steel Ltd. has the capabilities to turn your ideas into reality. Our 3 rolling mills allow us to provide a broad range of shapes and sizes, whether you desire a non-standard section or a special length. We satisfy the most demanding customer specifications.

From the engineers in our on-site Roll Shop to the highly skilled craftsmen who operate our mills, Gautier is experienced, knowledgeable and versatile. We begin with a flow sheet determining the number of passes it will take on the mill to roll your shape. Our advanced wire EDM machine, templates are cut with exacting tolerances – down to less than .001”. These templates are used for operation of tracer lathes and as inspection fixtures. This same system produces programs for turning rolls on our CNC lathe. When it comes to quality at Gautier Steel, you are in control.

GeoCorp, Inc.
+1-419-433-1101
www.geocorpinc.com

Manufacturer of thermocouples and thermocouple wire with an ISO 17025 accredited temperature calibration lab. All of our products meet the requirements of AMS 2750 Rev. E & BAC 5621K. Custom built thermocouples ship in days-not weeks. We offer material with a maximum temperature tolerance not to exceed +/- 2°F or .2% whichever is greater. This tighter tolerance allows for easier furnace testing during surveys and/or system accuracy tests. GeoCorp has a tenured staff that attends annual Nadcap meetings. We also attend the AMEC (committee that writes AMS 2750 Rev. E) meetings to work on updating specifications and addressing any customer issues with AMS 2750 Rev. E or Nadcap. Call today if you have any questions about thermocouples or wire as they pertain to Nadcap.

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

GfE, founded in 1911, is a leading manufacturer and global supplier of high performance metals and materials.

During the last 40 years GfE has gained valuable expertise in the production of master alloys. As part of the AMG Advanced Metallurgical Group N.V., GfE offers a wide range of high quality...
products that meet the highest technical requirements for the aerospace industry. GfE’s master alloys are used in titanium and nickel based super alloys, to produce special parts for aircraft engines, land based turbines, off-shore drilling applications, and exterior shields.

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.

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

GIE Media Inc. - Industrial Division
216-393-0264
www.OnlineTMD.com
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www.OnlineTES.com
www.TodaysMotorVehicles.com
emodic@gie.net

The Industrial Division of GIE Media publishes four manufacturing and design B2B magazines: Aerospace Manufacturing and Design, Today’s Medical Developments, Today’s Energy Solutions, and Today’s Motor Vehicles. All four publications are manufacturing and design oriented and provide insight into the latest developments in material selection, production processes, equipment, tooling/workholding, quality/metrology, and automation.

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.

GNB Corporation
+1-916-395-3003
www.gnbvalves.com

GNB has a proven track record of manufacturing high quality, reliable vacuum products since 1968 and is known as America’s leading manufacturer of large vacuum valves. In addition, GNB offers a diverse range of vacuum products and services, including: inline chambers, slit valves, gate valves, pendulum valves, angle valves, vacuum chambers, liquid nitrogen traps, custom flanges and fittings, viewport, bellows, multi-coolant baffles, throttle plates, and much more. With our expert group of engineers, GNB can efficiently customize our clients’ products. Extensive experience combined with an outstanding reputation for high quality products and customer service, GNB is the valued resource for your next vacuum system.

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 1955, 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 ISO 9001: 2008 and AS9100:2009, Rev. C, 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
titanium@grandis.com

GRANDIS TITANUM is a major worldwide supplier of titanium products like Titanium Bars, Sheets, Plates and Wire for Industrial and Chemical applications. Company maintains warehouses in Los Angeles and Rotterdam, and sales offices in USA: California, Ohio and Oregon, also in South Korea, China, Russia, Belgium and Italy.

Hangzhou King Titanium Co., Limited
http://www.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 sub-contractors for aerospace, automotive, chemical, medical, oceanographic, oil & gas, semiconductor, recreational and other industries worldwide.

Haynes International Inc.
+1-765-456-6000
www.haynesintl.com

Haynes International, Inc., headquartered in Kokomo, Indiana, USA, is a leading developer, manufacturer and marketer of high-performance nickel- and cobalt-based alloys used in corrosion and high-temperature applications. Our highly-trained staff and technicians provide superior customer service, worldwide technical support and on-one consultation in selecting the proper alloy for the application. In addition to stocking our standard product forms, our global service centers offer value-added services to shorten your cycle time, reduce material waste and increase your operation’s efficiency. Haynes International is a partner in your entire material management system and provides value far beyond the alloys themselves.
Hempel Special Metals GmbH  
+49 208 6204 0  
www.hempel-metals.com  

Hempel Special Metals in Germany is one of the largest stockists for Titanium, Nickel Alloy and Zirconium in Europe with companies in England, Poland, Switzerland, Italy and various sales representatives. 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

Hi Tech Alloys, Inc. has a GFM radial forge for producing bar. The GFM uses 4 dies to produce more force to the center of the bar than rolling or drawing methods. Our GFM produces 120 tons of force per die, 900 times per minute. Rolling mills have difficulty with some of the more difficult (Beta) alloys at lower processing temperatures. Our process produces a more refined grain structure due to the 360 degree directed force and the high forging forces.

H.P.A. is a secondary producer of the high performance alloys. We process small to medium lots of materials; excellent for prototype research, and providing low volume or specific alloys (normally requiring a mill quantity). Short production lead times are achievable because we start with available stock and produce the diameter you require. Call us when your job requires a shorter lead time.

Hogue Metallography  

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

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 unequalled solutions in titanium. Horie will continue to develop many new products and search the unlimited possibilities and beauty of titanium.

IHI Corporation  
www.ihi.co.jp/enlindex.html  

IHI Corporation is a Japanese company which produces aircraft engines (new parts production and O/H), aero-space system (rocket system and propulsion system), turbochargers for automobiles, ships, industrial machines, power station boilers and other facilities, suspension bridges and other transport-related machinery.

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. - Long Products Division  
+609-267-9000  
www.inductotherm.com  
sales@inductotherm.com  
President: Bernard Raffner  
General Manager: Bert Armstrong  
Director – Sales: Andrew Procopio  
National Sales Manager: Kevin Bertermann  

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; automatic pouring systems with vision control; computer controls and charge handling systems. 
The project focused on improving the general wear and friction properties of titanium-base alloys for improved performance in self-lube bearing systems at high loads.

KamaticsRWG initiated a formal R&D phase-gate project. In applications that require low overall weight, titanium alloy is a popular choice for bearing material. For years customers using these bearings struggled with the fact that at very high bearing distress, KamaticsRWG wanted to eliminate the problem for customers in search of a highly efficient lightweight bearing. In contrast, titanium alloy bearings can also be subject to surface coefficients. Titanium alloy bearings can also be subject to surface coefficients. Titanium alloy bearings can also be subject to surface coefficients. Titanium alloy bearings can also be subject to surface coefficients. Titanium alloy bearings can also be subject to surface coefficients.

KamaticsRWG recently developed a new technology called TDH (Titanium Diffusion Hardening). TDH is a titanium thermal diffusion process that consistently yields a high hardness case layer with an affected depth that is unmatched by other titanium surface engineering processes. In applications that require low overall weight, titanium alloy is a popular choice for bearing material. For years customers using these bearings struggled with the fact that at very high bearing loads, titanium alloys tend to exhibit less-stable dynamic friction coefficients. Titanium alloy bearings can also be subject to surface distress. KamaticsRWG wanted to eliminate the problem for customers in search of a highly efficient lightweight bearing. In 2011 KamaticsRWG initiated a formal R&D phase-gate project. The project focused on improving the general wear and friction properties of titanium-base alloys for improved performance in self-lube bearing systems at high loads.

KamaticsRWG ran several tests on TDH treated products including high-load wear testing, high-load product testing, tensile testing, impact testing (Charpy V-Notch), compact tension testing, and erosion testing. The TDH treated journal bearings successfully passed high-load wear test requirements at four times the required cycles with one-tenth the allowable wear. The TDH treated spherical bearings successfully passed high-load product testing. In comparison the liner wear results were proportionate with standard all-stainless spherical bearings.

Invera

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 traceability 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. 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.

Kevin Kreitman, EFO

Chief Kreitman has 36 years’ experience in the fire service beginning his career as a firefighter in Albany, OR. He was Fire Chief with the City of Albany from 1999 until accepting the Fire Chief’s job with the City of Redding, CA in Sept. 2008. Kreitman developed significant experience during his time in Albany dealing with the numerous metal industries handling materials that presented unique fire hazards. Based on those hazards, Kreitman wrote a paper on the proper handling of titanium and zirconium metal fires.

He's a member of National Fire Protection Association (NFPA) Combustible Metals committee and has been active in the standard process with emphasis on the development of the Fire Prevention, Fire Protection and Emergency Response Chapters. He has written articles on dust & combustible metal hazards and conducted presentations at national conferences; he has assisted NFPA and the National Institutes for Occupational Safety and Health on investigations and publications dealing with combustible metal hazards, and was an author of the Combustible Metals chapter in NFPA’s recent 9th Edition of the Fire & Life Safety Inspection Manual.

Keywell Metals, LLC

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 ferrotitanium 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 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 ISO 9001:2008 / AS9100C 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

L.C.M.A.
+352 26 55 43-1
www.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 9001:2008 and EN9100:2009/AS9100:2009 aerospace approved.
Being part of a vertical 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

Laboratory Testing Inc.
800-219-9095
www.labtesting.com
sales@labtesting.com
Laboratory Testing Inc. (LTI) provides Materials Testing, Nondestructive Testing and Calibration Services with accurate results, fast turnaround, and cost efficiency. LTI is A2LA and Nadcap accredited, ISO/IEC 17025 certified and approved by primes and other leading companies. Since 1984, LTI has provided a wide-array of businesses with test results and certified reports to meet their quality and regulatory requirements. The technical experts and support team help clients get their jobs done and find the answers they need. With a nearly 100,000 sq. ft. facility, Lab Testing, near Philadelphia, PA, is one of the largest independent testing laboratories in the USA and fully capable of handling and testing materials of all shapes, sizes and quantities. Although we specialize in metals and alloys, some test services are available for polymers, ceramics and more. We constantly strive to “Exceed your expectations with quality, service and delivery.”

LHI Metals
+1-86-949-1699
www.LHImetals.com
Combining the strengths of Alloy Metals, Supra Alloys & Tico Titanium, LHI Metals offers the convenience of “one-stop” shopping with a variety of inventories and value added services. Satisfying customers for a combined 75+ years, our knowledgeable and courteous sales staff is dedicated to meeting and exceeding our customer requirements, from small quantity or specialty items to thousands of pounds of mill products. LHI Metals is ISO 9001 registered, with AS 9120, Pratt & Whitney LCS/MCS, and specialized medical approvals to better serve the aerospace and medical markets. We specialize in titanium for Medical Devices. Plate, sheet, strip, foil, billet, bar and wire. Bar inventory is centerless ground to +/-.0005” and to precision tolerances of +/- .00025” or better. In-house sawing, shearing and waterjet capabilities. Ti 6AL4VELI in various rectangular bar sizes. Inventory certifiable to ASTM F136, F67, F1472 specifications. Testing and certification provided for other OEM specifications.

Lord Steel Industry Company Limited
+86-512-62861001
www.lordsteel.com
Lord Steel International Co., Ltd. (LSI SIP), belong to LORDSTEEL, is a global leading solution provider and manufacturer agent in Tube & Pipe of Stainless Steel, Nickel Alloy, Copper Alloy and Titanium. We are specializing in high performance condenser tubes, heat exchanger tubes, high purity stainless steel tubings, Titanium alloy & Cu/Ni Alloy Tubings. We end up many year’s control of UNS S44660/UNS S44735 super ferritic stainless steel condenser tubes supplied by US and European Manufacturers.
LSI People not only see our products as normal Industry products, we take them as artwork with high quality value. In every LSI people’s heart, Quality is always first. High service level shall be our added value in the products. Competitive price and our promise in the lead time shall Strengthen the mutual Trust relationship between LSI people and our clients.
Lucideon
+1-518-382-0082
www.lucideon.com

Lucideon is a leading global expert in materials development, testing and assurance. Expertise includes chemical analyses, metallurgical evaluations, mechanical testing and failure analysis. Industries served include:

- Aerospace & Defense
- Automotive & Transportation
- Construction
- Electronics
- Industrial Equipment, Components & Metal Fabrication
- Materials Manufacturing
- Medical Devices
- Nuclear Energy
- Power Generation

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 customised 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 ERW and Seamless tubes by supplying turn key solutions to customers in over 45 nations.

Recently a great number of producers of OCTG tubing have chosen Mair Research as supplier of their finishing lines taking the tube from the mill and delivering it in a bundle after having undergone the required finishing and testing operations, e.g. ID beam removal, chamfering, hydrotesting, visual and NDT inspections, coating, automatic bundling and strapping.

Data management and tube tracking are all features developed by our staff and integrated in the lines.

The range of Mair Research comprises also Bar finishing equipment with the possibility to supply fully integrated lines, e.g. peeling, straightening, multicutting, chamfering, automatic bundling and strapping.

A world leader in advanced CNC machining centers, Makino provides 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 Ram EDMs. Our flexible automation solutions provide reduced labor costs and increased throughput in a variety of production volumes and designs. With Makino engineering services, we offer industry leading expertise for even the most challenging applications across all industries. For more information visit makino.com.

Manufacturing Technology Inc.
www.mtiwelding.com

MTI provides engineering solutions and needed equipment for the joining of titanium and other metals in fabrication of net shape and near net shape components and assemblies.

Materials & Electrochemical Research (MER) Corporation
+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, Spineland 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.

MetaLinx Material Management, Inc.
www.MetaLinx.com

MetaLinx Material Management, Inc. announces the opening of a MetaLinx® Technology Demonstration Site situated near DFW Airport in Carrollton, Texas. The MetaLinx® System, an
internationally patented and proven technology, assures complete transparency and accountability of recyclable materials. By this unique means, a high degree of material management and control is achieved from scrap creation through material sale when full containers are released by the system. MetaLinx® identifies system containers and tare weight; continuously monitors content weight and records all variance; automatically transmits action alerts by e-mail, fax, text and voice messaging; issues transaction reports/invoices computed by index-based price formula; and produces real time and stored inventory data and reports accessible via the MetaLinx® Web Portal. To arrange a demonstration at your earliest convenience; please contact Dr. Bert Erdel at berte@metalinx.com or David H. Jones at davidj@metalinx.com

METAVALUE
+33 680 56 2848
metal@honnart.fr

METAVALUE 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.metalconditioning.com

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 23 44 00
www.metraco.be

European traders of ferro-alloys and non-ferrous metals. Specialized mainly in ferro-titanium, titanium sponge and manganese metal. Supplying all grades of FeTi 70 % and buyers of titanium scrap and low grade sponge for FeTi production. Supplying steel grade sponge directly to steelmills and masteralloy 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. Being the first metal distribution company specializing in the medical and watch industry, MetSuisse has been able to specialize in sourcing for these industries. The stringent and precise requirements found in the medical & watch industry has given us the experience and abilities required to meet the various requests. 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). 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.

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.
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.

Montana Precision Products
+1-360-653-9388
www.seacast.com
SeaCast operates four full service investment casting foundries which cast a wide range of alloys including stainless steel, nickel-based superalloys, titanium and aluminum. Foundries in Marysville, WA, Seattle, WA, East Greenwich, RI and Butte, MT offer extensive in-house support services such as CNC machining, heat treat, NDT and assembly. The company serves a wide variety of industries including aerospace, defense, industrial pumps, industrial gas turbines, medical, transportation and computer hardware. SeaCast’s manufacturing processes have earned ISO9000, AS9100 and NADCAP certifications.

MoTiV Metals, LLC
+1-412-200-5832
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-AI, Mo-AI, and other alloys.

nanoPrecision Products, Inc.
+1-310-597-4991
www.nanoprecision.com
nanoPrecision Products is a designer, developer & manufacturer of precision products with applications in the telecommunication, data communications, consumer electronics, mil/aero and bio &medical device markets. We employ various metals in our products including titanium. The products we are introducing to the market that utilize titanium are anticipated to consume large volume of material.
organization and development are created. The territory of the SEZ is located close to the OJSC “VSMPO-Avisma” Corporation, the world’s largest titanium producer, supplier of raw materials, forgings and finished production for Boeing, Airbus, Rolls Royce, Goodrich, Embraer, GE. Thus, the territory is known after the name “Titanium Valley”. The companies investing in the SEZ get prepared sites with all the necessary utilities. Moreover, they are exempted from customs duty on import of capital goods, VAT as well as from the corporate profit for the first 10 years. The total area of the territory of a special economic zone “Titanium Valley” is more than 580 hectares. The main object of the SEZ is investors’ attracting whose purpose is manufacturing of value-added and high technology products.

The Olin Research Group

(216) 246-0221
www.olinresearchgroup.com

The Olin Research Group is a specialized firm that offers MARKET UPDATE REPORTS for various carbon steel, stainless, specialty materials (titanium & nickel-based alloys), and aerospace company executives. We do this by leveraging our network of industry contacts (distributors, mills, producers, and buyers) and 18-years of experience in the investment world. Together, we can provide unique insights from a “top-down” or “bottoms-up” perspective. Our partners have an edge versus the competition -- for planning and up-to-date market share analysis.

The “value-add” in our research comes from the combination of charting momentum and/or highlighting inflection points. We do this by using data gathered from quarterly surveys. We provide a twist in our reports by incorporating industry models, channel sentiment gauges, and the feedback we are getting from the larger, publicly-traded companies.

Our goal is to provide customers with a different perspective on each metal/aero category, also gauging the relative health of main end-markets. We believe this gives our customers an enhanced ability to navigate through any market challenges and/or opportunities. Our data collection or indexes can also be measured against peers. Track your company’s performance versus an anonymous sample group. See where you stand (by region or product category).

Perhaps you are looking for specific market intelligence? Our research team can assemble a survey that fits your needs and answers your questions.

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.
Producers, Distributors, Fabricators, OEM’s, & Vendors to the Industry

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.

Pat Mooney, Inc.
www.patmooneysaws.com

Pat Mooney Saws is a 3rd generation family owned and operated business that has been innovative in serving the metal sawing industry since 1949. We specialize in the sales, support, and service of metal sawing machinery and saw blades. We are the exclusive North American Sales and Service center for the following saw manufacturers: Danobat High Production Bandsaws, ishijimax CNC Carbide Cutoff Systems, FMB Precision Miter Gear Driven Bandsaws, PMI Aluminum and Non-ferrous Sawing Systems, and OMP Precision Tube and Bar Sawing Systems. Pat Mooney Saws has over 500 saw installations in North America.

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

Perryman Company is a vertically integrated producer of specialty titanium products. From melting, forging, and fabrication to finished product, Perryman’s quality and technical expertise is unmatched. Perryman supplies and services customers in the aerospace, medical, consumer, and recreation markets worldwide. Approvals include ISO9001:2008; AS9100, and NADCAP. Perryman Company is headquartered in Houston, Pennsylvania. Company offices are located in Philadelphia, Warsaw, IN, 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.

Praxis Powder Technology, Inc.
+1-518-812-0012
www.praxisti.com
info@praxisti.com

Praxis Powder Technology is an ISO-13485 certified manufacturing company that produces titanium components via powder metallurgy for the medical, aerospace and consumer markets. Praxis specializes in titanium via metal injection molding (MIM) and developed the only known qualified TiMIM process in the world. We have perfected our proprietary process to provide high-performance parts for a variety of demanding applications while satisfying stringent regulatory requirements. Pioneers in the development of titanium metal injection molding (TiMIM), Praxis’ specializes in the design, engineering and quality manufacture of small, complex titanium components.

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 & 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.

Prolog Titanium Corporation Co. Ltd.
+662-920-4046
www.titanium.co.th
sales@titanium.co.th

Prolog Titanium Corporation is Thailand’s largest supplier, distributor and stockiest of high quality titanium metal products. With its unique combination of strength, light weight, corrosion resistance and other metallurgical properties, titanium is used in hundreds of diverse aerospace, defense, medical, chemical, electrical, automotive and other industrial applications where no other metal is a as reliable or economical, especially on a life cycle costing basis. We can supply to other high performance reactive metals such as Niobium, Molybdenum,
Tungsten, Zirconium and Tantalum which have best properties to resist extremely corrosive, abrasive and ultra-high temperature.

Quad Engineering Inc.
+1-416-391-3755
www.quadeng.com

Quad Engineering is a well-established company supplying engineering services and equipment for the metals industry, including the titanium industry. Quad provides process engineering for rolling of titanium shapes and flat product. Quad designs and supplies rolling mill equipment for titanium production. This includes rolling mill stands and auxiliary equipment; roller tables; transfers; cut to length lines; induction heating lines. Quad also provides installation engineering services including foundations, buildings, piping.

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 or vacuum melting; permanent mold, shell mold and sand mold casting; welding, thermal spraying, ultrasonic welding, LENS laser additive manufacturing, vacuum heat treating and hot isostatic pressing.

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.

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 TiO² 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.

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.

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. We have 3 locations in Eastern United States.

Roll Forming Corporation
+1-502-633-4435
www.rfcorp.com

Roll Forming Corporation’s Aerospace division offers Inline custom welding solutions and advanced fabrication applications. RFC’s highly skilled and experienced laser welding team is NADCAP approved for a range of aerospace welding and laser welding processes. Additionally RFC offers in house NDT, CWI and NADCAP accredited inspection.
Producers, Distributors, Fabricators, OEM’s, & Vendors to the Industry

Roll Forming Corporation has taken the initiative in technical development, and collaborating with our customers to find creative solutions to overcome many program hurdles. Our laser welders put us at the forefront of the Aerospace industry in-line laser welded fabrications, RFC continues to lead the way as our inline custom welding solutions, and advanced fabrication applications are RFC’s core competencies. For more information call (502) 633-4435 ext. 338.

Rolled Alloys
+1-800-321-0909
www.rolledalloys.com
sales@rolledalloys.com

Rolled Alloys is a global supplier of specialty alloys for commercial aviation, defense and space exploration. Our comprehensive inventory includes titanium, nickel alloys, cobalt alloys and stainless steels. We offer a full range of titanium products in plate, sheet and bar. In addition, we forge material to customer specific dimensions and specifications. Rolled Alloys holds many quality approvals and several certifications for special processing from prominent aerospace companies. Our many global inventory locations are each equipped with state-of-the-art processing equipment, supporting just-in-time and cut-to-size contract requirements.

Roskill Information Services Ltd.
+44 (0)208 417 0087
www.roskill.com
info@roskill.co.uk

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-Tech Corp.
+886-6-6235143 ext. 2500
www.s-tech.com.tw
dicktsai@gmtc.com.tw

STC is the only non-ferrous alloy manufacturer in Taiwan. Our main products are non-ferrous alloys which include titanium alloys, nickel alloys, and specialty alloys which strength widely used in a variety of application in key industries such as the chemical industry, aerospace industry, oil & gas Industry, medical industry and energy industry. In-house capability includes consist of forging, rolling, heat treating, finishing and supplying forged and machined components by customers’ requirement. To reach your requirements, we put tremendous efforts on quality improvement and on-time delivery by 6-Sigma and lean manufacturing management. STC is your reliable partner for high performance specialty alloys needs. Certification System ISO 9001 / ISO 13485 / ISO 17025 / AS 9100 / NORSOK / PED / Baker / Westland / Hitachi / EGAT

S. Letvin & Son, Inc.
+1-310-327-0590
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; heavy, dense, clean and extremely consistent in chemistry and gases. Our 6/4 titanium feedstock package is approved and desired by most major titanium mills, as well as many smaller investment casters worldwide.

S+D Spezialstahl Handelsgesellschaft mbH
+49-211-230999-19
www.s-dspezialstahl.de

The S+D Spezialstahl / S+D Speciality Metals Group 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.

We supply into the following markets:
Aviation and Aerospace / Motor Sports / Defence Technology / Medical Technology / Offshore / Petrochemical / Chemical and Process Engineering / Plant and Equipment Manufacturing / Electroplating / Turbine Manufacturing / Marine Engineering / Energy Industry / Automotive Industry / Universities and Research Institutes

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

Sandinox Comercio, Importação e Exportação LTDA
+55 15 3335 3565
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.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Contact Information</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandvik Materials Technology Product Unit Special Metals</td>
<td>+46-26-260000, <a href="http://www.smt.sandvik.com">www.smt.sandvik.com</a></td>
<td>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.</td>
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<tr>
<td>Sierra Alloys / TSI Titanium PRV Metals Companies</td>
<td>+1-626-969-6711, <a href="http://www.prvmetal.com">www.prvmetal.com</a></td>
<td>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.</td>
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<tr>
<td>Schaffer Grinding Co., Inc.</td>
<td>+1-323-724-4476, <a href="http://www.schaffergrinding.com">www.schaffergrinding.com</a>, <a href="mailto:info@schaffergrinding.com">info@schaffergrinding.com</a></td>
<td>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.</td>
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<tr>
<td>Solar Atmospheres</td>
<td>+1-855-934-3284, <a href="http://www.solaratm.com">www.solaratm.com</a>, <a href="mailto:info@solaratm.com">info@solaratm.com</a></td>
<td>Solar Atmospheres provides vacuum thermal processing for titanium material, parts, forgings, and weldments. With the world’s largest 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, hydriding/dehydriding, stress relieving and Fluorescent Penetrant Inspection. Solar is Nadcap, ISO9001:2008 and AS9100C Registered 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.</td>
</tr>
<tr>
<td>Sector3 Appraisals, Inc.</td>
<td>+1-718-268-4376, <a href="http://www.sector3appraisals.com">www.sector3appraisals.com</a></td>
<td>Sector3 Appraisals, Inc. is a metals and chemicals valuation company offering a complete portfolio of asset valuations and advisory services regarding inventory, machinery and equipment and risk management.</td>
</tr>
<tr>
<td>Solar Manufacturing, Inc.</td>
<td>+1-267-384-5040, <a href="http://www.solarmfg.com">www.solarmfg.com</a></td>
<td>Solar Manufacturing designs and manufactures all types of vacuum heat treating, sintering, carburizing, and nitriding furnaces, as well as offers replacement hot zones and spare parts for various vacuum furnace brands. Our vacuum heat treating furnaces are designed to be the most energy efficient, cost effective, highest performing and most technically advanced furnaces on the market. With models ranging from compact laboratory size furnaces to mid-size horizontal production furnaces to huge car-bottom vacuum furnaces, we design for heat treat processes such as hardening, annealing, sintering, stress relieving, normalizing, and tempering. 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, and a ConserVac energy management system.</td>
</tr>
<tr>
<td>Service Steel Aerospace</td>
<td>+1-800-426-9794, <a href="http://www.ssa-corp.com">www.ssa-corp.com</a>, <a href="mailto:sales@ssa-corp.com">sales@ssa-corp.com</a></td>
<td>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.</td>
</tr>
<tr>
<td>Specialty Metals Company</td>
<td>+32-2645-7670</td>
<td>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.</td>
</tr>
</tbody>
</table>
Producers, Distributors, Fabricators, OEM’s, & Vendors to the Industry

Specialty Metals Processing, Inc.
+1-330-656-2767
www.specialtymetalspro.com

SMP has been a toll processor for twenty years serving OEM’s, End-Users, Mills, Service Centers, Fabricators and Job Shops in the non-ferrous flat rolled industry; including sheet, plate, slab, square billet and coil. We specialize in assisting you with your most demanding surface critical applications: from .013” light gauge coil to 10” + thick slabs. Centrally located in Ohio, SMP has the largest abrasive belt grinding operation in the US. Make us your reliable source for polishing, precision grinding, surface finishing and reconditioning. In addition, we uniquely offer cut-to-length, slitting, coil grinding/polishing and coil buffing for a complete package on coil processing. Assisting customers in reducing freight and production costs and turn around times.

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Please visit our website at www.specialtymetalspro.com for a brochure, line card, take a plant tour or talk to an expert.

Spemet Company Limited
+1-886-225-85761
www.spemet.com.tw

Spemet was established since 1987. We emphasis on various usage of Titanium. We have all kinds of raw materials and parts on stock to supply customer’s need. We respect each customer’s need. Besides, cooperating with leading companies to develop superior products, we are also willing to work with customer to elaborate specific products. We believe that improving technology of production and quality is the way to face the challenges of the market.

Standard Die
www.standarddie.com

Standard Die is a full-service metal stamping and drawing company. We specialize in small parts made from a wide range of specialty metals ranging from coppers to refractory metals and other exotic materials. Our service, product quality and speed are unmatched in the industries we serve. We cultivate partnerships with our customers and you can work one-on-one with our design engineers and enjoy an active role in the design and manufacturing of your product.

Starrag USA Inc.
+1-859-534-5201
www.starrag.com
ussales@starrag.com

Starrag Group is a global technology leader in manufacturing high-precision machine tools for milling, turning, boring and grinding of small, medium-sized and larger workpieces of metallic, composite and ceramic materials.

- Principle customers are internationally active companies in the Aerospace & Energy, Transportation & Industrial Components and Precision Engineering sectors. In addition to its portfolio of machine tools, Starrag Group provides integrated technology and maintenance services that significantly enhance customer productivity.
- Starrag Group products are marketed under the following strategic brands: Berthiez, Bumotec, Dörries, Droop+Rein, Heckert, Scharmann, SIP, Starrag, TTL, and WMW. Headquartered in Rorschach/Switzerland, the Starrag Group operates manufacturing plants in Switzerland, Germany, France, the UK and India and has established a network of sales and services subsidiaries in numerous other countries. Starrag Group is listed on the SIX Swiss Exchange (Symbol: STGN).

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+1-330-426-9496
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www.sumitomocorp.com

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 products and services.

TE Wire & Cable
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www.tewire.com
sales@tewire.com

TE Wire & Cable LLC, a Marmon Wire & Cable/Berkshire Hathaway Company, is a premier thermocouple and specialty wire and cable manufacturer that was formed from the Wire and Cable Division of the Thermo Electric Corporation. Since 1941, the company has been manufacturing high-quality wire and cable solutions for the thermo-sensing and temperature measurement markets. TE Wire & Cable manufactures a full line of thermocouple wire and cable—from iron and nickel-based alloys to copper instrument and control cable. The company maintains an in-house ISO17025 Accredited laboratory directly certified by the National Institute of Standards and Technology (NIST), allowing it to calibrate its own wire. This results in a higher quality product at a lower cost and with improved performance. TE Wire & Cable is highly regarded as the industry leader and has maintained a reputation for providing high-quality temperature measurement wire and cable products with short lead times and competitive prices. TE Wire's thermocouple wire and thermocouple extension cable solutions can be used for several metallurgy applications, including heat treatment, component testing, furnace surveys and metals production.

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www.tekna.com

Tekna has been the world leader in the design and development of integrated inductively coupled plasma systems for the past 25 years. These systems are used in a variety of industrial processes, from the synthesis of nanomaterials to the production of micrometric spherical powders. As a new product for 2015, Tekna is proud to launch a high quality spherical Ti-6Al-4V (grade 23) on the market; specifically for additive manufacturing, coating and molding.

Tenova Core Inc.
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www.tenovacore.com
core@tenova.com

Tenova Core designs and supplies advanced melt shop equipment and industrial reheating, heat treating and specialty furnaces for the metals industry. Custom furnace designs include car bottom, roller hearth, tip-up, rotary hearth, box type, bell type, walking hearth as well as vacuum type furnaces. Tenova Core also provides a complete range of technical services including equipment revamps/upgrades, tune-ups, inspections, maintenance evaluations and training as well as energy savings, environmental, reliability and productivity studies.

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.

Thermo Scientific

Thermo Scientific delivers best-in-class handheld and mobile x-ray fluorescence (XRF), near infrared (NIR), Fourier Transform Infrared (FTIR), and Raman-based analytical instruments to meet customers’ most demanding applications. Our Niton XRF analyzers serve metal processing, manufacturing and recycling customers in more than 75 countries, with more than 40,000 units installed worldwide. A culture of innovation and a distinguished history of breakthrough achievements have defined our instruments, since we released the first handheld XRF analyzer in 1994. Now, with the introduction of the Thermo Scientific Niton XL5, the fastest, most accurate and smallest XRF analyzer has arrived. Part of the Niton family of industry-leading instruments, Niton XL5 offers energy, metal fabrication and automotive industries performance, portability and speed never before seen in a handheld analyzer. In addition, the new Niton XL2 100G complements the instrument portfolio by providing rapid general metals identification in a value platform, giving customers cost-efficient, reliable, real-time results right where they’re needed.

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www.tifast.com
info@tifast.com

TiFast is an European producer of titanium ingots, slabs, billets, bars and wires for industrial, medical and aerospace markets worldwide. TiFast is fully integrated with a melting plant (3 furnaces including a VAR), a rolling mill, a bars precision finishing shop, laboratories and R&D facilities. TiFast can supply bars in a full range of titanium grades with a lot of possibilities of finishing: close tolerances (from h7), surface finishing, straightening...

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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
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www.timet.com
Titanium Metals Corporation (TIMET) is one of the world’s largest fully integrated titanium producers. 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 fully integrated supply chain, dedicated research facilities, and decades of experience make us the partner of choice for titanium.

TIPRO international co ltd
+86 29 89181603
www.tipro-international.com	terry@tipro-international.com
Tipro produce aerospace titanium bars and wires for many years and signed LTA with some famous aerospace companies.
As a AS9100 and EN 9100 approved company,
We can supply titanium products as follow: AMS 4921;AMS 4928 ;AMS 4965; AMS 6931; AMS -T-9047 ; BS TA11 ;

TITAL GmbH
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alcoa.tital@alcoa.com
We are an industry leader in the manufacture of titanium and aluminum investment casting products. From our headquarters in Bestwig, Germany, we supply customers around the world in the fields of aerospace, electronics, optics, industrial and medical systems, Formula 1 racing, and general motor sports.

TITANIUM Consulting & Trading S.r.l.
+39-055-642543
www.tct.it
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, Inc.
+1-281-265-2910
www.titaniumengineers.com
Titanium Engineers Inc. 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.

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[www.tifab.com](http://www.tifab.com)

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melinda@titaniumfinishing.com  
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Metal finishing services include: Titanium Anodize; Hardcoat Anodize of Aluminum; IVD Aluminum Coating; and Application of Solid Film Lubricants. We are a small, women owned business, and have been family owned and operated since 1970.

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Titanium Industries, Inc. (T.I.) is the global leader in performance metal solutions for the aerospace, medical, industrial and oil & gas markets. Holding the world’s most complete inventory of performance metals across a global service center network, T.I. delivers supply chain solutions through its Materials Management brand at all levels of sophistication and complexity. With a globally experienced and technically driven team that now includes wholly owned subsidiary Pierce Spafford Metals, Inc. T.I. has been providing dependable, quality driven solutions to customers since 1972. [www.titanium.com](http://www.titanium.com)

**Titanium International Group SRL**  
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We are a service provider for Aerospace, defense, automotive, medical, racing, packaging and special applications. We store and sell titanium, nickel, steel & cobalt alloys and services. We have water-jet machines and more than 30 cutting centers. We offer a wide range of product forms full size, cut to size and tailored services. We can also machine and heat treat your items. We are EN9100 & EN9120 approved. Our job is to supply standard and non-standard materials and solutions, on spot and contract businesses, integrating all your non-core activities.

**Titanium Processing Center**  
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[www.titaniumprocessingcenter.com](http://www.titaniumprocessingcenter.com)

Titanium Processing Center is a stocked supplier and distributor of a wide range of titanium products, from bars and billets to sheets and plugs. We’re focused on providing high-quality products and services on top of fast turnaround and delivery.

Our experienced staff provides value-added services, including sawing, sheering, turning, waterjet and plasma cutting, drilling, and more. We have no minimum order requirements, so whether you order a single, small part or a batch of a thousand large components, we can deliver the materials or fully fabricated products you need.

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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.

**TMS Titanium**  
+1-858-748-8510  
[www.tmstitanium.com](http://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](http://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.
Producers, Distributors, Fabricators, OEM’s, & Vendors to the Industry

Torresin Titanio s.r.l.
+39 049 88 44 873
www.titanio.com

Torresin Titanio s.r.l. is a leading Stockist and Service Center of Titanium and Nickel Alloys semi-finished mill products. We stock plates, sheets, wire, bars, coils, tubes, pipe and fittings. All material is according to ASTM, ASME and NORSOK standards. Our Service Center is equipped with 4 water jet cutting machines, saw cutting, guillotine and slitters. ISO 9001:2008 certified company.

Totall Metal Recycling
+1-618-877-0585
www.tmrusa.com

Totall Metal Recycling is an ISO 9001:2000, ISO 14001:2004, OHSAS 18001 & R2 (E-Scrap) certified scrap metal processing facility located just east of St. Louis, Missouri in Granite City, Illinois. Totall Metal Recycling specializes in the processing and recycling of various types of scrap materials including nonferrous metals, ferrous metals, hi-temp alloys, titanium, precious metals scrap, and turnings &residues of all types of metals as well.

Trepansing Specialties, Inc.
+1-562-633-8110
www.trepanningspec.com

Trepansing & 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.

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 titanium mill products, titanium forgings, 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 welding wire.

Where are our facilities
Our fabrication and distribution facilities are in Wooster, Ohio and Conroe, Texas. We also operate technical sales facilities in Plymouth, MI and Oxnard, CA.

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.

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.

Tricor Alloys - Welding wire and titanium for aerospace
We stock, clean, process, and package UltraGrade™ high performance welding wires for aerospace, power, and turbine engines. We stock AMS-grades of titanium sheet, plate, bar and billet for aerospace and bio-medical served markets.

Tzimet Titanium & Alloys s.r.l.
+39-0382-914401
www.tzimet.it

Tzimet Titanium & Alloys srl, is an Italian private Company specialized in the PROCESSING & PREPARATION of reactive and refractory metal scraps: Titanium and its Alloys, Zirconium, Niobium and Tantalum. These scraps, of different alloys, are dedicated after preparation, to be remelt in vacuum process from our customer:

- Titanium CP Gr. 1-2-3-4, 6 Al-4 V, 6 Al-4 V eli, Ti Pd (Gr. 7-11-16-17), Ti Gr. 12, IMI 367 (Ti 6 Al 7 Nb), Ti 15-3-3-3, Zirconium, Niobium, Tantalum

Tzimet Titanium & Alloys buy and sell these scraps: Titanium and Titanium Alloys, Zirconium, Niobium, Tantalum. Tzimet Titanium & Alloys has acquired in August 2014 the Certification ISO 9001:2008

Tzimet Titanium & Alloys srl is supplier of scrap for domestic market normally Ti CP and foreign market (USA, Germany, Russia, England), the material supplied is used for production of ingots Ti and its alloys and Fe-Ti for: Petro-chemical application (Ti CP, Ti Gr.12, Grade 7-11-16-17), Surgical application (Ti 6Al 4 Veli, IMI 367), Fe-Ti (steel-factory) oreiglia@titanium.tzimet.it
TZMI, Inc.
+1 281 956 2500
www.tzmi.com
marketing@tzmi.com

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.
+1-203-239-4481
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 15.5.3.3 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.

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 (Verkhnyaya 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.

Universal Technical Resource Services, Inc.
+1-856-667-6770
www.utrs.com

Engineering services company, primarily focused on delivering services to the US Government. UTRS maintains a research and development facility working with material science projects, specifically with titanium and titanium alloys.

University of Northern Iowa
+1-319-273-7085
www.mcc.uni.edu

UNI’s metal Casting Center, established in 1989, has achieved unique stature as the premiere not-for-profit US research and development facility specializing in manufacturing technologies and materials for the metal casting industry. The MCC testing laboratory and pilot-plant demonstration facility are the most advanced of their kind. The center’s primary mission is to assist the foundry industry by developing technical solutions to keep this primary industry competitive in a global economy.

UTC Aerospace Systems
+1-216-429-4227
www.goodrich.com

Provide, Manufacture and Assemble landing gear for the aerospace industry.

Valence Surface Technologies
844-4-VALENCE
www.valencesurfacetech.com
info@valencesurfacetech.com

Valence Surface Technologies is the largest independent surface treatment company serving highly technical and complex industries such as aviation, military, space, satellite, medical device and semiconductor. We offer the most comprehensive set of surface technology and special processing capabilities for high-value, mission-critical parts.

Our state-of-the-art facilities are located in key aerospace and high-tech manufacturing hubs throughout the U.S. These facilities, coupled with our comprehensive approvals and breadth of capabilities, allow us to successfully service customers around the world with premium quality and service, optimal lead times, streamlined supply chain logistics and lower costs. Each of Valence’s 10 sites offer titanium and hard metal special processing.

As a global supplier, we are a reliable, trusted, and value-added partner to your supply chain!
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www.vallorec.com

Vallorec Heat Exchanger Tubes is leader in the manufacturing of titanium and stainless steel welded tubes for heat exchangers serving energy, process and desalination markets. Our products include not only bare, straight tubes but enhanced surface tubes, such as low fin 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.

VDM Metals
+1 973 437-1664
www.vdm-metals.com

VDM Metals has been developing high-performance materials for particularly demanding applications and processes for decades. Our product portfolio of titanium, nickel, zirconium and special stainless steels is wide and varied – it includes
- sheet & plate
- strip
- wire
- rods, bars & forgings
- Pre-material for seamless & welded pipes and tubes.

We focus on the specific demands of very different industries. Our strength is the development of tailored material concepts. In many key technologies, our materials are an indispensable prerequisite for the industrial-scale implementation and reliable control of important processes: in aerospace, energy and environmental engineering, electrical and electronic engineering, the automotive, chemical and petrochemical industries, offshore and marine engineering, and in industrial furnace construction.

In an ever more complex market with all its different demands and expectations, we have made it our principle to always develop new material solutions together with our customers.

Verichek Technical Services, Inc.
+1-412-854-1800
www.verichek.net


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.

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.hsmp.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.
Producers, Distributors, Fabricators, OEM’s, & Vendors to the Industry

VSMPO Tirus UK Ltd.
+44 (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 siphons, 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.

Vulcanium Metals International
+1-888-326-7556
www.vulcanium.com
titanium@vulcanium.com

Vulcanium Metals International, a leading distributor and processor of titanium and high performance alloys, serves global aerospace, medical device and industrial markets. VMI’s fully operational facilities in the US and UK carry a complete line of inventories in titanium sheet, coil, plate, bar and forged block products of CP, Ti-6AL-4V and Ti-6AL-4V Eli grades as well as CCM and 316L stainless round bar. FIRSTCUT+® services offer a comprehensive suite of first-stage processing including precision shearing and sawing, machining, chamfering and facing, deburring and finishing, leveling, slitting, and laser and water jet cutting. VMI also offers inventory management solutions to save its customers supply chain costs and reduce manufacturing bottle-necks. Vulcanium is a specialty division of United Performance Metals, one of more than a dozen companies comprising O’Neal Industries, Inc. (onealind.com), parent company of the USA’s largest, family-owned group of metal service centers. AS9100 & ISO 9001 LEAN Quality Management

Webco Industries
+1-918-245-2211
www.webcotube.com
heat_exchanger@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, TS, 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.

Welded Pipe Industries s.r.l.
+39 049 8844878
www.wpisrl.com

WPI s.r.l. is a leading manufacturer of welded pipes OD 6” to 82” and wall thickness up to 60mm, pipe spools and vessels in special materials like Titanium, Nickel Alloys, Duplex, Superduplex, SM0254 and 904L. NORSOK approved manufacturer.

Wellmet International Inc
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www.wellmetusa.com

We supply and distribute Titanium Sponge and Titanium Powder. We represent the largest Titanium sponge and powder producers in China. We can also supply other non-ferrous metals which are of Chinese origin with approved quality. The Titanium Sponge producer is ISO9001:2008 certified and sponge quality is approved by world main consumers.
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 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 Smelting & Metals, Inc.
+1-503-623-8341
www.westernsmelting.com

Western Smelting & Metals Inc in Dallas, OR is a third generation metal recycling business with almost 60 years of experience in the industry. We are the most preferred locally owned metal recycling service provider with 30 year of experience in titanium processing. Our experts provide valuable information to the clients to help them make a right decision about the formulation of materials. Whether it is blending, sizing or sorting of metals, our experts ensure that we deliver fast and exceed our clients’ expectations. Depending upon the clients’ needs, we also provide aluminum, cobalt and nickel alloys.

Western Superconducting Technologies Co. Ltd.
+86-29-8651-4505
www.c-wst.com
than@c-wst.com

Western Superconducting Technologies Co., Ltd. (WST), located in Xi’an, the capital city of Shaanxi Province, China, is a leading corporation for the production, R&D, and marketing of titanium ingot, billet, bar, wire, slab, plate, etc. Especially from the ingot to bar and wire, WST has the most advanced and integrated production line and quality assurance system in the world. The production capacity for bars is 4000 tons per year, and 6000 tons for ingots. WST is an ISO 9001:2008, AS 9100C and Nadcap approved company and the products are widely used in the aerospace, medical, offshore, sporting, car and petroleum chemical market.

Yunnan Titanium Industry Co., Ltd.
+86 136-6874-2964
www.ytico.com.cn
Ytico_os@163.com

Yunnan Titanium Industry Co., Ltd (Yunti) is specialized in the production and processing of titanium strip and coil and dedicated to technology research of titanium industry in China, which has manufactured ability from titanium slab to cold rolled titanium strip and coil with minimum thickness of 0.1 mm, Yunti has rich technical resources and innovation ability, Yunti has established the standard quality management system, Occupational Health and Safety & Environment management and systems based upon international standards. Yunti has a production capacity of 5,000 tons titanium coils per year.

Its products range from 800 ~ 1400 mm in width, 0.1 ~ 10 mm in thickness, 2000kg - 8000kg in weight, the quality and performance of titanium strip is stable. The surface is of good consistency, and mainly used for the manufacturing of titanium welded pipe, anodizing plate, plate heat exchanger etc.
Zak, Incorporated
+1-518-273-3912
www.zakinc.com

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.zakinc.com

Zirom SA
+40 246 216666
www.zirom.ro
zirom@zirom.ro

Zirom SA came into prominence, over the last decades, as one of the largest producers of titanium and titanium alloys in 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 recycle material, by combining EB and VAR technologies, and further, the development of free forging process. The products manufactured, ingots and forged products, are intended both for cutting edge fields (aviation and nuclear areas) and various fields (metallurgy, chemical industry, medical technique and devices).

Our company is certified, according to international standards: AS 9100 / EN 9100, ISO 9001, ISO 14001.

Zirom SA can also provide a series of services like melting the secondary recycle materials, machining/grinding the surface of products, full chemical analyses, LP, US+ Eddy testing.

ZTMC Zaporozhye Titanium & Magnesium Combine
+38 067 466 5791
www.ztmc.zp.ua

Zaporozhye Titanium-Magnesium Combine (ZTMC) located in Zaporozhye city industrial zone, Ukraine, is one of the first in the work and unique in Europe titanium sponge manufacturer. It works since 1956. During this period production facilities were modernized and rebuilt more than once, which allowed to modernize technological processes and to increase titanium sponge production volume. ZTMC as a reknowned sponge manufacturer has been investing in the new technologies to increase both its capacity and allow us to supply high quality sponge to various customers around the globe. The wide range of ZTMC products are represented by titanium sponge, titanium ingots, titanium casting, refined titanium tetrachloride, ferrotitanium, titanium slag, casting. The quality of ZTMC products is guaranteed by a certified quality management system in accordance with the requirements of the International Standard ISO 9001:2008. Currently works underway to create and implement the requirements of the management system for Aviation standard EN 9100.

www.lordsteel.com  E-mail:enquiry@lordsteel.com

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