

TITANIUM TODAY

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INDUSTRIAL EDITION





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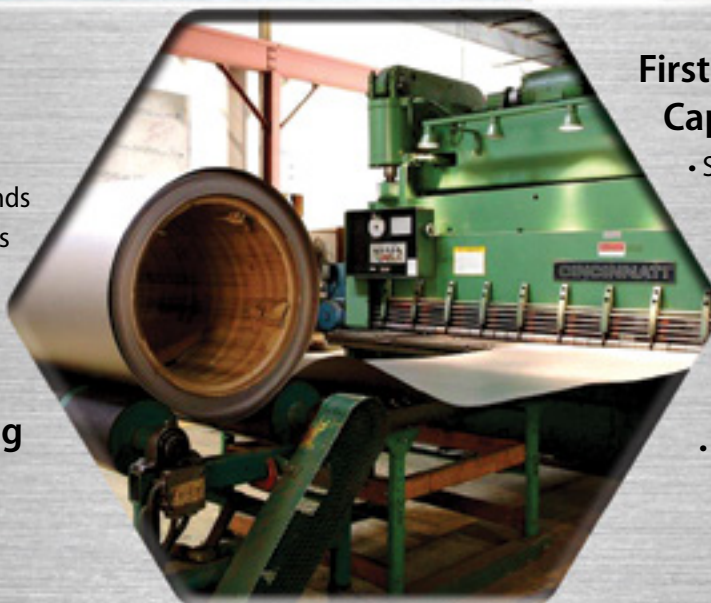
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Editorial

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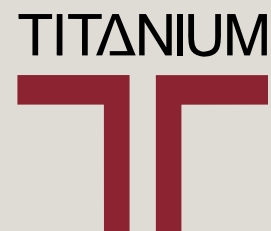
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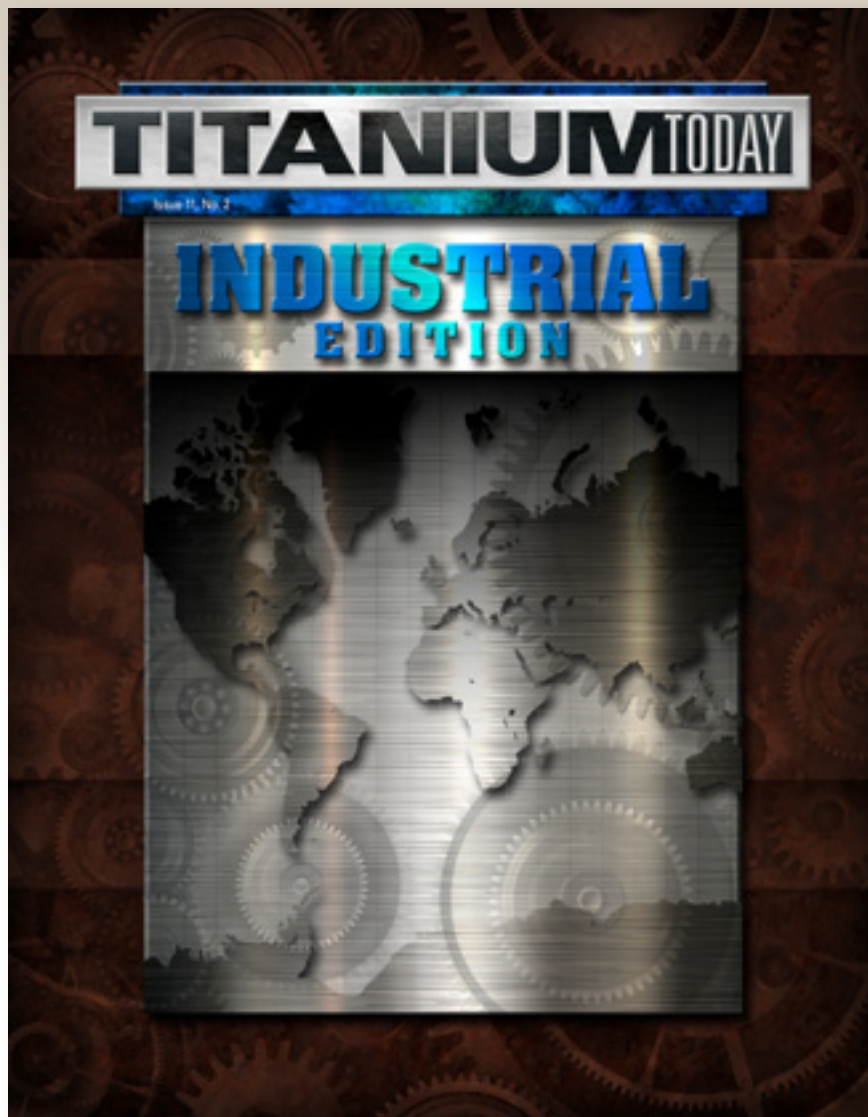
This edition's cover reflects corrosion stains on metal designed as the World Map.

Corrosion is a costly and sometimes dangerous problem associated with its effects on infrastructure, industry and daily life. For the titanium industry, it's an opportunity to distinguish itself and become part of an international dialogue to highlight the superior corrosion-resistant properties of titanium as a potential solution to these problems.

How big a problem is corrosion? According to George Hays, the executive director of the New York based World Corrosion Organization (WCO), 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.

Eugene Liening, a member of the WCO's board of administrators, said the correct approach to address corrosion issues should always start with proper design. He said design is the key for industrial projects as well as municipal infrastructure. "It starts with design using the correct materials," Liening said. "It includes developing corrosion-control strategies, faithfully executing those designs and strategies, and then maintaining a commitment for inspection and repair."

Life cycle costing has long been put forth as a favorable metric to demonstrate titanium's "good value" as a material of choice in a host of industrial applications. However, despite the math and logic that supports



the use of titanium compared with competing materials, industry executives admit that this argument, despite its merits, falls short. In some cases, titanium is passed over due to short-term budget constraints for so-called "less-expensive" metals. It's fair to say titanium's durability and affordability as a long-term investment for infrastructure or industrial projects simply doesn't convince everyone.

Barry Benator, the founder and president of Benetech Inc., Roswell, GA, defines life-cycle costing as a calculation to determine the long-term payback for an investment, taking into account the savings and cost over the entire life of a product or system. "The basic idea is: do I spend a bit more now to get a better system for the

long haul," Benator explained. "Customers are always concerned about their return on investment. A lot of this is intuitive, but some people have to understand it and 'see' it before they truly believe it".

Businesses and governments make important decisions based on financial benefits (and risks) to their organizations. For industrial projects like desalination installations, heat exchangers, and chemical or food processing, factors such as annual maintenance costs, reliability, production speeds and long-term performance come into play. And of course, material costs are factored into the front end of the equation.



Rob Henson

To introduce this edition of the magazine, we present our “guest publisher” for this issue: Rob Henson, who serves as the chair of the International Titanium Association’s (ITA) Industrial Sub Group, which is part of the ITA’s Applications Committee.

My name is Rob Henson and I’m the business development manager for VSMPO-Tirus US, Highlands Ranch, CO. It’s my pleasure to welcome readers to this edition of Titanium Today.

The international titanium industry continues to make strides in industrial applications around the world, in key business sectors such as oil and gas, desalination, heat exchangers, chemical processing, power generation, corrosion protection, and infrastructure projects. The wide range of developments reflects the ever-expanding global reach of titanium to deliver solutions in industry. You will “read all about it” in this publication!

I began my career in the late 1970s working in corrosion research under renowned corrosion scientist Dr. Te-Lin Yau at what was then Teledyne Wah Chang. Through most of the 1980s I continued this phase of my career, but as the 1990s approached the opportunities in sales and marketing for my knowledge became very attractive. The thrill associated with developing a new application or product and seeing it advance to an order still motivates me today. I joined Uniti Titanium in 2003 and then accepted a position with VSMPO in 2014.

As the chair of the Industrial Sub Group, I’m proud to say that the ITA takes an active role in promoting the use of titanium as a material of choice. One example of this is a decision to move forward on a project to update requirements for Grade 12 titanium in NACE MRO 175 specifications. You’ll see that I’m quoted in the article on this topic. I explain that my colleagues and I on the Industrial Sub Group decided to embark on this project because we feel it will have a beneficial impact the titanium industry globally.

The ITA’s executive board, led by its president Dawne Hickton, recently gave us the “green light” to proceed on this effort. This is just one example of leadership on the part of the ITA to advance the cause of removing barriers to the use of titanium. As I state in the article, this project is a first step, but we feel it’s a significant first step.

The ITA is a diverse group composed of more than 200 organizations and over 1,500 members from around the world. It’s a group that includes executives, sales and marketing representatives, engineers and designers, manufacturers, procurement experts and distributors as well as a wide assortment of other stakeholders. For more than 30 years the ITA has supported the growth and progress of the titanium industry. The ITA advances ideas in research, design, metallurgy and engineering, and serves as the leading forum to cultivate the exchange of ideas and support a diverse, dynamic, global industry.

You can experience this grand diversity in action by attending one of the conferences organized and sponsored by the ITA. The fourth annual TITANIUM EUROPE 2016 conference and exhibition will be held in Paris April 18-20. The 32nd annual TITANIUM USA gathering will run Sept. 25-28 in Scottsdale, AZ. I cordially invite you to call the ITA at (303) 404-2221 or visit the association’s website (www.titanium.org) to learn more about these events.

Despite Sluggish Trends in Oil/Gas Exploration, Titanium Opportunities Could Unfold in Refining and Downstream Petrochemical Production

Non-aerospace global industrial markets are expected to present a bumpy ride for titanium business in 2016 and through the first half of 2017, dictated in large part by the vicissitudes in global oil and gas sector. However, a decline at one end of the industrial business spectrum may in fact create opportunities at the other end for the titanium market.

Collapsing Oil, Gas Prices

Market analyst Chris Olin, the president and founder of the Olin Research Group LLC, Avon, OH, said that, compared with business activity in the aerospace sector, non-aerospace industrial markets for titanium are likely to be tepid for most of 2016, going into early 2017. Olin, on Dec. 18, 2015, conducted a conference call to share his outlook for titanium business in 2016.

Olin said his list of key non-aerospace global industrial markets include desalination, oil and gas, power generation, general industry and infrastructure, chemical processing, ocean and naval, and nuclear power. “We’ve been seeing weakness in the industrial categories—everything non-aerospace,” Olin observed, noting that, year to year, business levels could be down as much as 10 percent in 2016. “The main problem has been the collapse

in oil and gas prices. At the moment, there really are no positive outliers in industrial markets for titanium business.” As a result, he said distributors, quite wisely, have been hedging away from the industrial sectors and adjusting their inventory levels accordingly.

As Olin sees it, oil must recapture a level of at least \$50 per barrel to jump start a new wave of capital investments, which would have a cascading effect among various industrial markets. This would spark capital investment dollars. “It’s been tough to get major projects off the ground,” he said.

There is a potential for a rebound in industrial markets by 2017, he said, pointing to the fact that the titanium supply chain and overall inventory levels are now in “a much better balance” compared with recent years. “The major headwinds for industrial markets (seen during the second half of 2015) have died

down and there’s much less inventory pressure coming from distributors. The inventory levels of distributors are now lean. And the industrial markets are less bad.” As such, Olin anticipates improvement in industrial business for titanium during 2017, picking up momentum heading into 2018.

As industrial markets continue to adjust to the precipitous drop in oil prices, and fallout ripples through various business sectors, Rob Henson, the chair of the International Titanium Association’s Industrial Committee remained optimistic that the titanium industry will regain its momentum as the petroleum industry retargets capital investment during the next 12 to 18 months.

Henson said that the immediate effect of the downward oil price trend would be felt by the oil-well service industry as producers cut back on oil





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and gas exploration and production. One indication of this impact can be seen in the drop in worker headcount. The New York Times, in its Jan. 13, 2016 edition, reported that, worldwide, an estimated 250,000 jobs have been lost in the oil and gas industry since the downward pricing trend began in 2014.

A Shift in Capital Investments

In the United States, oil and gas production has been booming in recent years. Henson pointed out that while oil exploration is temporarily being put on hold, the major energy companies are well integrated and can shift capital investment dollars to other parts of their business, such as refining and downstream petrochemical production. Lower oil prices have resulted in strong demand for gasoline and diesel fuel, requiring refineries to run at very high levels of capacity utilization. The result has been strong earnings for the refiners. High margins and robust demand are leading refining plants to expand their facilities and embark on needed maintenance programs. Henson explained that titanium “really kicks in” when producers start upgrading and expanding their purified terephthalate acid (PTA) operations. Investment in refining plants sparks demand for titanium pipe, fittings, valves and sheet. In addition, titanium tubing is needed for heat exchangers and condensers for the production of low-sulphur fuels.

“Oil companies may be reducing their exploration actives and adjusting production, but they’re selling all the oil they produce and they continue to have strong margins on their refineries. There typically is a strong motivation (on the part of integrated energy companies) to expand petroleum refining,” Henson said. “Petrochemical expansion is usually good news for titanium fabricators, distributors and producers of mill products.

“There will be a shift in capital investment for the energy industry, but this can take a while to happen,” he continued. “It may not be enough to

“The main problem has been the collapse in oil and gas prices. At the moment, there really are no positive outliers in industrial markets for titanium business.”

‘move the needle’ significantly (in oil-related industrial markets), but there is reason for the titanium industry to be optimistic.” Henson also noted that future titanium business will be generated by investments in shale-gas ethylene plants. “The petrochemical industry is building a foundation for value-added products, as ethylene is a precursor chemical for many downstream products.”

Oil remains a closely watched global commodity and pricing fluctuations have an impact on many industrial markets, which in turn affects titanium demand. Oil prices hovered below \$30 per barrel as of mid-January. By comparison, the price had spiked to \$112 per barrel in June 2014 and registered about \$50 per barrel in January 2015. It’s no secret that oil prices have been volatile in recent years, affected by global politics and international tensions as well as the addition of more than 9 million barrels per day (BPD) of oil production in the United States. The situation regarding oil prices, exploration and production is expected to remain fluid in the coming months, with many variables to consider. News agencies, like Bloomberg Business, are reporting that Iran is poised to boost its oil production for the global market.

Shifts in the price of global commodities like oil can play out in different ways for different markets. For example, while jobs have been slashed due to slumping oil and gas exploration

and production, news reports indicated that sales of cars in the United States in 2015 registered nearly 17.5 million units, 6 percent above the previous year. Most industry observers pointed to declining at-the-pump gasoline prices as a major factor driving the uptick in vehicle sales.

According to one online report posted on Jan. 12 by the U.S. Energy Information Administration (EIA), Washington D.C. (http://www.eia.gov/forecasts/steo/report/us_oil.cfm), U.S. crude oil production is projected to decrease from an average of 9.4 million BPD in 2015 to 8.7 million BPD in 2016 and to 8.5 million BPD in 2017. The EIA said this forecast reflects “an extended decline in Lower 48 onshore production driven by persistently low oil prices that is partially offset by growing production in the federal Gulf of Mexico.” Founded in 1978, the EIA describes itself an industry group that “collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.” The EIA website, posted above, also provides several charts that track oil and liquid fuel production, pricing and inventories.

Desalination, Corrosion Markets

As for business prospects in other key titanium industrial markets, Henson noted that plans have been announced for desalination plants in California. However, these are slated to use reverse-osmosis technology, which offers only very limited demand for titanium, compared with thermal desalination. “We continue to make the argument for using titanium in reverse-osmosis desalination plants, but so far we haven’t succeeded yet in making our case stick,” he admitted. Regarding potential regional international business opportunities, Henson said India soon may emerge as a strong market for infrastructure investment, especially in the areas such as municipal water systems, power generating plants, and oil refining facilities.

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Last year, at the annual TITANIUM Conference and Exhibition, sponsored and organized by the International Titanium Association (ITA), Northglenn, CO, which was held in Orlando, FL, there was significant attention given to the potential role of titanium in addressing industrial and municipal corrosion problems throughout the world. George Hays, the executive director of the New York-based World Corrosion Organization (WCO), who spoke at the titanium conference, estimated that corrosion represents an annual worldwide cost of \$3 trillion for infrastructure and industry—the cost to repair, replace and maintain critical systems on a regular basis. 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.

Titanium could play a significant role in addressing this industrial business category, and Hays encouraged titanium executives to take a greater pro-active voice to address the situation and tout the properties of titanium to help solve corrosion problems. Hays said that “corrosion is a phenomenon that can be controlled using existing technologies and better design and engineering practices.” He also said the titanium industry needs to document its advantages in total life cycle costs, compared with other materials.

Henson, who also serves as the manager of business development for VSMPO-Tirus U.S., said titanium indeed has made strides in recent years to become a meaningful voice in the international corrosion conversation. However, he also acknowledged the titanium industry still has a considerable amount of work to do when it comes to educating people on the benefits of titanium, as well as dispelling lingering myths. In many corners, in industry and government, he said titanium is still seen as “an exotic, expensive material that’s difficult to handle. We need to continue

our efforts to educate people, on a much broader scale, about titanium.”

Regis Baldauff, director, industrial marketing, Titanium Industries Inc., Rockaway, NJ, in a recent presentation at a TITANIUM conference, supported Henson’s assessment of titanium as a material of choice for corrosion resistance, saying it has demonstrated “years of trouble-free seawater service in chemical, oil refining and desalination systems,” and is “immune to microbiologically induced/influenced corrosion.” Baldauff also said titanium, in comparison with competing materials such as stainless steel or copper/nickel alloys, provides life-cycle cost advantages.

A View from Europe

Albert Bruneau, executive vice president of Vallourec Heat Exchanger Tubes SAS, Boulogne, France, a business unit of the Vallourec group, offered his outlook for titanium’s global trends in industrial markets this year. Vallourec is a leading global supplier for titanium and stainless steel welded tubes, with operations in Europe, the United States, China, India and South Korea.

Bruneau said the chemical processing market for titanium will suffer in 2016, as most applications are linked to the oil and gas industry. “All applications linked to the oil and gas market have dropped over 2015 and will probably not recover before 2017,” he said. “Moreover, the limited growth in China will impact the titanium consumption for some applications like PTA.”

By contrast, Bruneau said nuclear power consumption of titanium this year should be at a relatively solid level of around 3,000 metric tons, spurred by a ramp up of Chinese nuclear facilities to achieve a projected target of 58GW (gigawatts) installed in 2020. “This good Chinese consumption should be balanced by the postponement of many nuclear projects around the world, like in India or in Saudi Arabia,” he said. “The weight of China is consistent with the

commissioning of nuclear power plants in 2015: among 10 reactors connected, eight were connected in China.” He added that thermal power consumption this year should remain quite stable in line with a stable addition of coal and combined cycle power plants capacity.

Bruneau indicated that one bright spot for titanium desalination applications in 2016 will be the need for titanium tubing at the Facility D project in Qatar, which will use more than 2500 metric tons of titanium. “However, apart from this big project, titanium consumption (in desalination) remains limited,” Bruneau explained. “Most of the desalination projects using titanium are located in the Middle East and the market is strongly influenced by these big projects coming every two to three years. In parallel, the choice of titanium for desalination plant instead of aluminum brass or copper nickel could also be challenged in the future considering the significant drop of copper and nickel price on the market.”

Several online press releases described the Independent Water and Power Plant (IWPP), known as Facility D, a 25-year water supply desalination project, which involves Qatar General Electricity and Water Corporation (Kahramaa) and Qatar Electricity & Water Company (QEW). One press statement reported that the Facility D IWPP was ordered by Kahramaa, Qatar General Electricity & Water Corporation, to construct a 130 MIGD (million imperial gallons per day) desalination plant. It will be constructed nine miles (15 km) south of Doha, the capital of Qatar and is due to be completed in June 2018. The plant will be a hybrid desalination facility that will employ two different desalination processes: MSF (multi-stage flash) and RO (reverse osmosis). MSF is a thermal/evaporation desalination process that uses multiple heat exchangers and requires a high volume of titanium components, compared with RO, which is a membrane process that requires significantly less titanium. ■

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Industry Executive Mulls OTEC Market and Opportunities for Titanium Business

As spelled out in a related feature in this edition, the renewable energy technology known as Ocean Thermal Energy Conversion (OTEC), currently ramping up in the early stages of commercial development, could emerge as a new global industrial market for the titanium industry. Stephen K. Oney, Ph.D., who serves the chief science adviser for Ocean Thermal Energy (OTE) Corp., Lancaster, PA, offered his perspective on the current activity in this field, and provided insights regarding potential business opportunities for titanium.

Considering titanium's superior corrosion resistance to seawater, Oney confirmed that, in terms of applications in OTEC, titanium is a strong contender as a material of choice for heat exchanger components, such as tubing. "Titanium is primarily considered as a material option for heat exchangers," Oney stated. "Aluminum, stainless steel and titanium are the primary options for evaporator (warm surface-water heat exchangers) selection, while the condensers (deep cold-water heat exchangers) are a trickier proposition. The deep water is very low in dissolved oxygen, which makes aluminum and stainless steel less attractive options due to the need to oxidize a protective layer to prevent rapid corrosion of the equipment. Typically, titanium is the preferred material selected for condenser design.

"Titanium for heat exchangers is certainly a potentially very large and viable market, which should be recognized by the titanium industry," he continued. "Due to the corrosive nature of seawater, a life-cycle analysis is usually applied to the banks of heat exchangers (evaporators and condensers) required for power production and selection is based upon the cost/benefit between material options."

By way of comparison, Oney said that, regarding applications for larger OTEC seawater pipes, "titanium as an option would be extremely

cost prohibitive and overkill for performance, because pipes are so large and extensive." He said current designs for OTEC pipelines typically consider concrete, composites, and high-density polyethylene (HDPE). He did point out that there could be potential for titanium usage beyond heat exchangers for pump materials or other system components in contact with seawater such as separators. Steel, concrete, and composites are deemed better and more cost-effective options, he said.

Titanium's portfolio of properties is recognized by designers and engineers as an industrial material option for OTEC systems, according to Oney. However, he did indicate that "the impression of most engineers is that titanium is a very volatile (market) and typically expensive material option, which requires a detailed life-cycle cost analysis against its primary rival material options of aluminum and stainless steel. A more stable market would certainly go a long way to improving that image among OTEC design engineers as well as heat exchanger vendors, with whom we typically design alongside."

How might leaders in the titanium industry engage the OTEC market to discuss such concerns? "I believe the best place to begin such a conversation would be for the International Titanium Association (ITA) to communicate directly with large heat exchanger vendors to discuss their needs in manufacturing, and how to best stabilize long-term pricing as many manufacturing lead-times are several years out for OTEC heat exchangers at this time," Oney suggested. "With HX (heat exchanger) vendors onboard, convincing OTEC designers would be much easier. We all would prefer a cost-competitive titanium option. In addition, a subset of the OTEC technology, seawater air conditioning (SWAC) utilizes the deep, oxygen deficient seawater and therefore requires

consideration of titanium as the material selection for the system heat exchangers. This is a sizeable market as well and should be recognized as a great market for ITA members to address as well."

Oney confirmed that, like the Makai Ocean project mentioned in another article in this edition, global OTEC sites are currently operating as "pilot" facilities and not full-fledged commercial programs. Hawaii and China are among the most active areas regarding the development of OTEC pilot systems. "To date, there are no commercially operational OTEC systems providing base load energy. There are several SWAC systems that are commercially operating," He explained that SWAC is essentially "half" an OTEC plant and only utilizes the deep cold water as a means of replacing electricity and refrigerants to provide air conditioning to large electrical energy loads located along the coasts or large bodies of water. He said that commercially operational air conditioning systems utilizing seawater are located in Stockholm, Sweden; Bora Bora, French Polynesia; and Hawaii, while fresh-water versions using the same technology are operating at Cornell University, Ithaca, NY, and Toronto, Canada among others. He also mentioned that OTE Corp. currently has a large SWAC system designed and contracted for a large casino resort under construction in the Bahamas.

As for a real-world estimate on the power generating capabilities of an OTEC plant on an annual basis, Oney said that existing plant designs are projected at 10-20 megawatts (MW) for land-based systems, with offshore options beginning at the 100 MW range. "Realistically, OTEC plants offshore could likely be built up to approximately 500 MW size, but smaller, more realistic scales are needed to demonstrate the commercial viability of OTEC." How much overall energy currently is being generated by OTEC sites on a global



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basis? “Only several 100 kilowatts (kW) are being generated (Makai’s prototype and a small, pilot plant in Japan).” Theoretically, in the coming years, the potential for power generation is unlimited, he said.

Speaking as a professional science adviser, Oney shared his view on the existing “state of the art” for OTEC technology. He recalled that in 2009, NOAA (the National Oceanic and Atmospheric Administration an agency, based in Silver Spring, MD, within the United States Department of Commerce)—the government agency assigned to supervise and monitor OTEC development in the United States—held a forum with OTEC experts from all fields and came to the conclusion that OTEC was technically ready for commercial development in the less-than 10 MW floating configuration. He said this forum also cited improvements that were required to reach the goal of 100-plus MW offshore systems, a list that included: pipeline material and installation techniques; platform technology, gimbals for platform connection of pipelines; improved heat exchanger material;

designs for large HX banks; and subsea cables for carrying OTEC power from offshore to local grids.

Oney did note that the items on this list of “improvements” were not seen by the forum as serious roadblocks to large-scale implementation of OTEC technology; rather, they were considered achievable design and development areas that would be needed to meet the necessary technical and economic competitiveness of OTEC energy, in order to operate as a viable power plant option in tropical locations (which offer the proper ocean temperature conditions to the technology to work).

“I would concur with most of their findings and suggestions, except that I would focus on early development efforts on land-based systems in the 10-20 MW range, which is exactly what OTE Corporation (my company) is focused on for early stage OTEC facilities,” he said. “In my opinion, OTEC is technically ready for broad commercial application for these size OTEC plants, while SWAC systems are clearly commercially and economically competitive options for coastal systems today. With operational

systems at various locations and configurations across the globe, SWAC is ready for immediate broad-scale commercial implementation.”

Looking into his “crystal ball,” Oney imagined what the next generation of OTEC projects might look like 10 years from now. “The next generation of OTEC would be the large, floating platform systems delivering a working fluid such as ammonia or hydrogen in an offshore configuration,” he said. “The economy of scale is very compelling with OTEC and allows for a tremendously competitive product if scaled at or above 100 MW. This will require significant quantities and availability of titanium to support such a global implementation.”

Would titanium be a significant part of that “next generation” vision? “I believe titanium, if the price can be stabilized and maintain a competitive position, will have a tremendous future with OTEC,” he said. “We need corrosion- and biofouling-resistant materials with good thermal conductivity and titanium is the best available from an OTEC standpoint.”



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Technical Bulletin Reviews Guidelines for Welding Titanium Seawater Pipes

(This feature article is an edited, abridged version of a technical and research (T&R) bulletin, originally published by the Alexandria-VA based Society of Naval Architects and Marine Engineers (SNAME; website: <http://www.sname.org/home>). It describes guidelines for using titanium seawater piping in shipboard/marine structures. In particular, it discusses proper procedures for welding titanium pipe in shipyard environments. Fred A. Kriedt, John A. Mountford II, and Milton R. Scaturro are the authors of the article.)

Titanium has high erosion/corrosion resistance and—due to its low density at 0.163 lbs/in³ (4.51 g/cm³), being half that of copper/nickel (Cu/Ni) alloys—offers opportunities for both appreciable weight savings and ease of seawater piping applications. Ease of arrangement is possible because its effective immunity to seawater corrosion and high resistance to erosion/corrosion allows higher seawater velocities, leading to smaller pipe diameters for equal flow. Smaller pipe diameters provide more flexibility in piping arrangements and save space, thus increasing the compartment's utilization.

Weight savings can be achieved not only because of the lower material density and smaller pipe sizes, but also because smaller pipe diameters result in lower water volumes and therefore less weight inside the pipes. In addition, the weight of ancillary support piping structures can be reduced.

Due to its higher hardness and the self-healing capabilities of its protective oxide surface, titanium is highly resistant to seawater erosion and corrosion. This allows designers of piping systems to reduce diameter sizes and/or increase flow rates without concern as to the flow

velocities. While other materials can require that the flow be kept to specific lower maximum velocities, necessitating larger diameters, titanium has withstood flow velocities above 100 ft/sec (30.5 m/sec) and has outstanding abrasion and cavitation resistance. This also pertains to fittings, such as elbows and tees, where a sharp change of direction can and does cause erosion in other metals under normal conditions, necessitating maintenance and eventual replacement.

Titanium can and has been designed using smaller outside diameter (OD) sizes allowing for increased flow



Credit: Montalcone, Trieste, Italy Shipyard of Fincantieri



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velocities, which helps to significantly reduce fouling rates as well as reduce the need and time expended for maintenance and cleaning. The reduced pipe and water weights also allow increased payload capacity and compact arrangements in machinery runs, saving space. Because titanium has high erosion resistance the pipe diameters can be reduced with no concern as to increased velocities well above the maximums that are recommended for other metals.

The mechanical properties of commercially pure (CP) titanium Grade 2 compared with Cu/Ni alloys and stainless steel indicates why titanium is the proper choice exhibiting good strength characteristics coupled with its low density. The titanium grade used for seawater piping systems must have a high enough tensile and yield strength for system operational temperatures, be highly resistant to erosion, be reasonably easy to weld, and be ductile enough to be able to be formed in a similar manner to materials currently being used. CP Grade 2 titanium is the workhorse of the industrial sector and the marine industry, and best satisfies the strength requirements.

Choosing the proper grade of metal is important, and although system operation requirements (pressure, shock and fatigue) would be satisfied by many of the titanium alloy grades, the grade must fit the application and be capable of being manufactured or fabricated for that application. Grade 1 has the lowest residual content, which makes it the most ductile, lowest strength and the most formable of the CP grades. It is used primarily in plate and frame heat exchangers, where sheets of complex designs are formed. Besides Grade 2 meeting all the required criteria, it is also the most readily available grade used for industrial, commercial and marine applications. Alloy grades are generally much stronger and therefore not ductile enough to allow forming operations used to manufacture pipe

“Because titanium has high erosion resistance the pipe diameters can be reduced with no concern as to increased velocities well above the maximums that are recommended for other metals.”

or other seawater piping products (i.e. fittings) and are not suited or necessary for these specific marine applications. Thus, this resulted in the choice of CP Grade 2 titanium for the seawater piping systems.

Welding Titanium Pipe

In the past, welded pipe (primarily Cu/Ni) was not considered suitable for seawater piping because the shipbuilder could not bend the pipe. This was attributed to the raised internal longitudinal weld bead, pipe ovality and flat spots prevented the internal bending mandrel from being inserted into the pipe. Specifying and ordering titanium welded pipe in the full finished, annealed condition eliminates this problem and assures acceptable dimensional tolerances suitable for seawater piping systems.

Full finished (planished) welded pipe is accomplished by having the weld bead drawn over a mandrel in the inside diameter (ID), while the weld bead on the OD is rolled down directly after welding during the continuous production process. Planishing reforms the pipe after the longitudinal welds are completed by flattening and contouring the weld beads on the pipe's inner and outer diameters. This provides a pipe that is perfectly round and totally suitable for bending and fit-up of fittings. A full finished pipe is so smooth on both the OD and ID that it is difficult to distinguish from a seamless pipe and is significantly less expensive.

Using pipe bends rather than pipe fittings is typically considered to be an economical approach. Designers

will need to know early in the detailed design process the minimum bend radius for a corresponding pipe diameter in order to complete piping arrangement drawings. Normally the recommended center line radius (CLR) is 5D for all materials including titanium. It's a conservative value, but is not necessarily suitable for ship design. Required design-bend radii corresponding to pipe diameters that could be practically achieved must be developed and tested.

It's generally presumed that titanium is difficult to weld in a shipyard environment. While some added precaution is needed to minimize contamination, titanium actually welds very similarly to austenitic stainless steel. Once trained, the vast majority of welders actually prefer welding titanium and the reason is easily explained. The art of welding is primarily a technique of molten metal pool (weld puddle) manipulation. In order to fuse two pieces of metal together one would start a puddle of molten metal at the junction of each piece and move the puddle along the joint adding additional weld metal (filler metal) or autogenously welding (without filler metal).

The key to the ease of welding is how viscous the molten metal is. Titanium, as well as steel or many stainless steels, is non-viscous and forms a uniform puddle. In fact, CP titanium, being a commercially pure metal (approximately 99.4-percent pure), exhibits a very smooth weld bead. It does not have the complex oxides that are present in Cu/Ni and nickel alloy welds. Cu/Ni and nickel alloy weld puddles are very viscous and do not lay down or wet down well. For these reasons it is difficult for the welder to observe good fusion and leads to small pockets or areas of non-fusion. This is why Cu/Ni and nickel alloys are more apt to fail X-ray analysis and leak under hydrostatic testing.

What may be considered difficult about titanium fabrication is not the

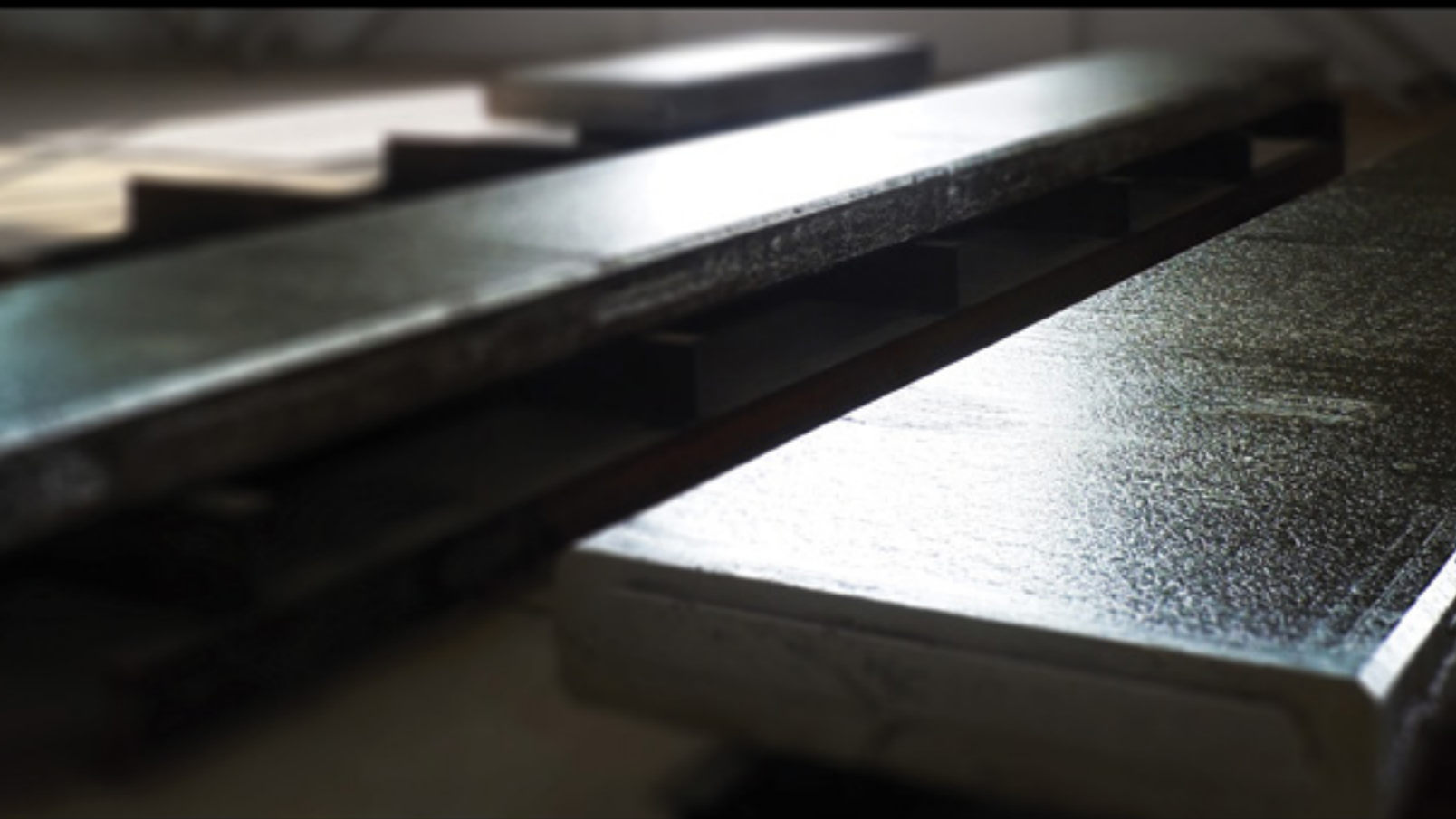


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welding, but the additional precursors required to provide an uncontaminated weld. Titanium is a reactive metal and, in the molten and hot solid state, has a much higher affinity for oxygen and nitrogen from the atmosphere. Cleanliness and purging requirements are therefore more stringent to avoid weld contamination. This necessitates the additional use of a trailing shield.

Choices for branch connections include pipe fittings, fabricated joints, saddle joints and socket welding outlets. Fabricated joints (joints made by creating a circular or elliptical hole in a pipe and welding another pipe fitted into the hole) should be suitable for low-stressed joints. Saddle type branch connections, attached to the pipe run with a fillet weld and to the branch with a socket weld, should be considered for more highly stressed joints. Pipe fittings used to make branch connections require three welded joints; whereas socket welded outlets require only two.

Field welded joints are required when the shop fabricated pipe assemblies are too long to be assembled into modules in one piece and/or after module erection where module to module piping connections must be made. Using flanged connections for module to module pipe connections to prevent field welding is not recommended for three reasons: (1) modular building tolerances are not suitable for the tight flange tolerances in the axial, face-to-face directions or for bolt-hole alignment; (2) flanged connections are more expensive requiring flanges, additional hardware, galvanic isolation testing and additional labor to assemble and (3) reasonable and economical field welding can be achieved as long as proper procedures are followed.

Bio-Fouling, Galvanic Corrosion

Bio-fouling experience was based on a hybrid sea water system design, with titanium piping and only a few titanium components and, for the most part, nickel/aluminum/bronze components.

This required that the sea water design velocity be kept well below the minimum of 15 feet/second recommended for titanium to protect components. If velocities are not high enough to minimize soft bio-fouling, a food source becomes available and infestation will occur. Extensive bio-fouling did occur about two to four years after the ships went into service. For any future designs with less than 15 feet/second, regardless of material, an antifouling system will be necessary. If design velocities are above the 15 feet/second minimum titanium allowable, costs can be controlled by designing a scheme that will allow antifouling procedures to be conducted while the ship is in port. Regardless of piping or component materials, there will be times when the system is shut down (no velocity), thus requiring the need to consider antifouling strategies.

Galvanic corrosion will occur whenever three conditions are present together: (1) Two metals with different galvanic potentials; (2) Both metals are in contact with the same electrolyte and (3) Both metals have a metal electrical path between the two metals. Removal of any one of these three conditions will prevent galvanic corrosion. Because titanium is "more noble" (highly resistant to corrosion and oxidation), having a higher potential than most other metals commonly used in sea water piping systems, it is the other metal (not titanium) that is damaged. Careful consideration should be applied at the design stage due to the fact that titanium is a noble metal. This property of titanium will cause certain metals to undergo galvanic corrosion in the presence of an electrolyte (seawater). Seawater, an excellent electrolyte, is the product being transported by the piping system and therefore cannot be removed. If titanium or some other metal with equal galvanic potential is used throughout the system, galvanic corrosion will not occur. Galvanic corrosion can be prevented by electrical isolation, but will add additional

complications and expense to the ship building and maintenance process. Therefore, it is best to use titanium or components with equal potential wherever possible, thus preventing the need for electrical isolation.

Summary

Commercial grade titanium piping is not difficult to work with in a shipyard environment. Although tighter cleaning and purging requirements exist (i.e. longer set-up times), the material is easy to weld. CP Grade 2 titanium is readily weldable by shipyard workers in the shop and in the field. Titanium is more reactive, having a high affinity for oxygen and nitrogen, and therefore requires more extensive set up for welding. The actual welding itself is no more difficult than ferrous materials and is much easier to weld than Cu/Ni alloys and some stainless steels. Introduction of titanium welding to the shipyard is considered to be no more difficult than the introduction of aluminum welding to the shipyards in the past.

Modular construction is the preferred method for ship construction. As a result, titanium pipe fabrication begins in the pipe shop where the majority of the welding takes place. Piping runs are fabricated in lengths as long as possible and still capable of being assembled into modules. It's best to inspect and hydrostatically test all completed welds at this stage. The majority of the assembly takes place in the modular stage of the shipbuilding process. Modules are pre-fabricated blocks of the ship, weighing from 50 tons and above. Once erected, the titanium pipe runs between the modules are connected by couplings or welded joints. The ship is then launched, tested and delivered.

Cold forming required for pipe bending, lapping ends or extruding for branch connections is not difficult. The major difference between titanium and other materials is titanium's "spring-back" characteristics. ■



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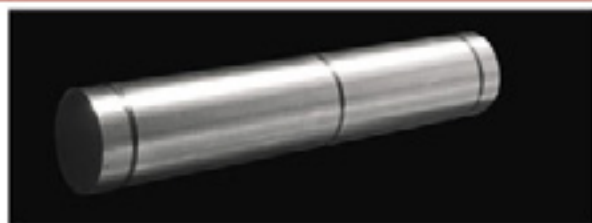
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EXECUTIVE PROFILE; WOMEN IN TITANIUM



Flo Haynes,

Weber Metals, Inc.

As verified by the many miles recorded on her car's odometer, WiT member Haynes 'enjoys the ride' in the titanium industry

As a member of the Women in Titanium (WiT) committee, Flo Haynes brings a business perspective that reflects more than three decades of experience in the international titanium industry. She also brings a high level of commitment and passion to her work. Haynes serves as the raw material purchasing manager for Weber Metals Inc., Paramount, California. Founded in 1945 by Edmond L. Weber, the company is a titanium and aluminum forging supplier, with a significant amount of its work dedicated to the aerospace industry.

In the question-and-answer format that appears below, Haynes discusses her career at Weber Metals and shares thoughts about her role as a mentor—supporting the mission of the WiT committee, to attract and retain more female engineers, designers, metallurgists and executives. Along with her work in the titanium business, Haynes is dedicated to the cause of raising money for cancer research as well as being a “passionate advocate for animals.”

The WiT committee, sponsored by the International Titanium Association (ITA), held its first meeting last October in Orlando, FL, just prior to the start of the ITA's annual TITANIUM USA Conference and Exhibition.

1. By way of introduction, tell us about your career history. How and when did you get into the titanium business?

I have worked in the titanium business for over 31 years. I started at Weber Metals in production control and worked my way into managing accounts receivable, raw material purchasing and accounts payable. The raw material purchasing required a full-time position as Weber has expanded.

2. Describe the business mission of Weber Metals as a forging company. Does your company have a global profile? What industrial markets does Weber Metals serve?

Our mission at Weber Metals is to grow the business while taking prudent risk in order to earn a competitive return on assets entrusted to us, to maintain a positive reputation for Weber Metals and our owners, to invest in, challenge and respect our employees, to set the standard for safety, quality and delivery and to exceed our customer's expectations.

Weber Metals is a global supplier of highly engineered forged products, supporting customers across the North American, European, and Asian continents. While Weber does supply into other industrial markets, including semiconductor capital equipment, its mainstay is the global aerospace supply chain. High-quality titanium forgings help build platforms from single aisle to jumbo commercial aircraft, business and regional jets, and rotating and fixed-wing military.

Weber has also become a supplier for North American aero-engine customers, and will continue to grow that footprint along with entry into extra-large forgings with the installation of a 60,000-ton hydraulic press due to begin production in the first quarter of 2018.

3. What is your official job description as the raw material purchasing manager at Weber Metals?

I procure all the raw material for Weber while maintaining the organization's quality, delivery and cost objectives. I'm responsible for the aluminum and titanium scrap sale and recycle plans. I also develop strategies to support business plans relative to long-range forecasting and material strategies including but not limited to negotiation of long-term contracts and risk mitigation plans.

4. 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?

I have been attending the ITA conferences for seven years and just in this timeframe the increase in women has been substantial. With the help of WiT, I hope we double the amount of women attending the ITA conference in 2016. The women in WiT are amazing, positive and supportive and I'm proud to be part of this group. WiT is bringing together the female attendees (and some males)

at the ITA. In the past we never had gatherings that motivated comradery.

5. What are some of the business/life skills and experiences that you hope to bring to the WiT committee?

The titanium industry is ever changing and at times it's a roller coaster and you just need to hold on for the ride—but what a ride! The people I have met in this industry have a wealth of experience and knowledge and are willing to share with anyone who asks questions. I'm excited about being on the ground floor of WiT and watching us grow.

6. Last year, at the Orlando ITA conference and the WiT meeting, there was much discussion about the importance of mentors and being a mentor. Who were your mentors?

In the early years, all of my supervisors were very strong women who instilled a high work ethic, morals and the fact that, if you want to make it in this business, you needed to be strong and not be afraid to speak out. Mentoring is much more about coaching and counseling. It's much more about the qualitative and subjective parts of our job, dealing with frustration, giving constructive criticism, handling disappointment, behaving with humility and compassion.

7. What sort of experiences and perspectives can you bring as a mentor? Do you currently serve as a mentor to anyone, inside or outside of the titanium industry? What type of business/life skills can you pass on in a role as a mentor?

Mentoring is fun for me. To share my knowledge and experience with someone who is just starting out and watch their growth is awesome. I mentor high school/college students/seniors at Mary S. Robert's Pet Adoption Center. To have them walk in unsure of themselves and take them under my wing and teach them about the animals and watch their growth as they gain experience and knowledge is very rewarding for me, as well as the animals they come in contact with now and in the future.

I have been on the Paramount Education Partnership (PEP) committee for the last eight years. PEP awards scholarships each year with the goal of making education beyond high school financially accessible. The majority of the applicants come from broken homes. Many of them have had a very hard childhood, but they have prospered with 4.0 grade point averages, been in many groups at school, and volunteered countless hours within the

community. They have overcome all the obstacles in their way to make a better life for themselves and for their families.

My dad was a Reserve Officers' Training Corps (ROTC) instructor, and he passed away in 1998. Our family started a scholarship fund in his name for ROTC students continuing their education after high school. Each year we select one or two students to receive the scholarship.

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

I love my job and have commuted over 905,000 miles in the last 31 years! Weber continues to grow and keeping up with the pace sometimes can be a challenge, but it's a welcome challenge, which makes every day filled with lots of work. I never get bored.

9. We noticed the "Breast Cancer Awareness" logo on your email correspondence. Are you involved in this cause? If so, how?

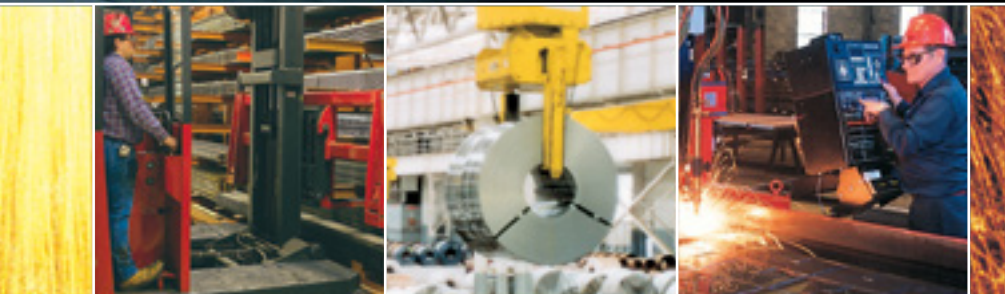
I'm involved in bringing breast cancer awareness to men and women. I lost my aunt to breast cancer and one of my best friends is currently battling bone cancer as a result of her prior breast cancer. Breast cancer is the most common cancer among women in the United States, other than skin cancer. It is the second-leading cause of cancer death in women, after lung cancer. In 2015 over 40,000 women died of breast cancer.

Normally you think of breast cancer as only affecting women. Breast cancer is about 100 times less common among men than among women. For men, the lifetime risk of getting breast cancer is about 1 in 1,000. The number of breast cancer cases in men relative to the population has been fairly stable over the last 30 years. I'm hoping by having the breast cancer symbol on my emails it will prompt men and women to think about breast cancer; to hopefully perform a monthly self-exam, get a yearly physical exam and, most importantly for women, a yearly mammogram.

I have participated in walks for breast cancer, whether it's actually walking or doing work behind the scenes to gather donations for the "Relay for Life" (a national fund-raising campaign to support cancer research, sponsored by the American Cancer Society). ■

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ITA'S WOMEN IN TITANIUM ANNOUNCES 2016 ACTIVITIES & EVENTS

Denver, Colorado -- International Titanium Association's Women in Titanium (WiT) Committee has organized an ambitious slate of activities for 2016, with gatherings to be held in Paris, France; Pittsburgh, Pennsylvania; and Scottsdale, Arizona. The WiT executive committee met in January to discuss 2016 activities.

The executive committee unanimously agreed to host the next WiT event in Paris on Monday, April 18, 4:30-6 p.m., which will coincide with the ITA's TITANIUM EUROPE 2016 conference and exhibition (April 18-20). The event will be a reception with tabletop displays, focusing on items WiT chooses to promote. The Paris Marriott Rive Gauche Hotel and Conference Center is the site for TITANIUM EUROPE 2016.

WiT will host a summer meeting in the Pittsburgh area June 16-17 at the Sheraton Pittsburgh Hotel at Station Square. The itinerary will include a "Fundamentals of Titanium" workshop taught by Frauke Hogue; an evening networking reception, and a tour of the Dynamet Incorporated facility in Washington, PA. A subsidiary of Carpenter Technology Corp., Dynamet Incorporated is an international supplier of titanium alloy products.

The second annual WiT conference will be held in conjunction with the 2016 TITANIUM USA conference, Sept. 25-28, at the JW Marriott Phoenix Desert Ridge Resort and Spa in Phoenix (Scottsdale, AZ). Much like the first WiT conference, which was held last October in Orlando, FL, the Scottsdale forum



will be an all-day event featuring guest speakers with expertise in various fields of business and career development.

This year the WiT committee is involved in various programs, including "STEM in 30," a STEM (science, technology, engineering and mathematics) project being sponsored by the ITA Education Committee in cooperation with the Smithsonian Air and Space Museum, Washington D.C., along with various

mentoring initiatives.

Dawne S. Hickton is the chair of the WiT committee and also serves as president of the ITA's executive board. She is a consultant with Alcoa Inc., Pittsburgh, and a member of the board of directors for Norsk Titanium AS, Oslo, Norway. Other members of the WiT executive committee include Dawne Michelle M. Pharand, vice chair and the director of sales and business development for Dynamet Inc.; Holly Both, vice president of marketing at Plymouth Tube Co.; Cynthia Heatherington, vice president, human resources at Titanium Metals Corp. (TIMET); Polina Sparks, editor, Argus Metal-Pages.com; and Jill McGibbney, medical products manager, Metalwerks PMD Inc.

The primary mission of the WiT committee is two-fold: to develop a networking group of collegial women currently employed in the titanium industry; and to attract high school and college female students to enter the titanium industry.



Register Online at
www.womenintitanium.org

2nd ANNUAL

WOMEN IN TITANIUM CONFERENCE

Sunday, September 25, 2016 | 10:00 am – 5:00 pm

J. W. Marriott Desert Ridge Resort

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Running on Empty – The Fast Paced Life & Adrenal Fatigue

Dr. Karen Jacobson, *High Performance Strategist*

Invest Your Way to Financial Empowerment: What Every Woman Should Know

Laurie Itkin, *CDFA The Options Lady, Financial Advisor, CDFA, Amazon Best-Selling Author, and Speaker*

Persuasive Presentations, Business & Professional Communication, & Interviewing Skills

Karen Williams, *Lead Coach – Bold Echo Communication Solutions*

Be Safe: Advice for the Today's Woman Traveler

Laurie Latham, *Owner/Lead Instructor – PlayItSafe Defense*

Radical Leadership: A New Era for Today's Organizations

Craig Zablocki, *Motivational Speaker & Author*

In Memoriam



John Ferderber, beloved husband, father, grandfather, brother, uncle and friend passed away February 8, 2016 in Salt Lake City at the age of 78. John was born in Price, Utah to John Ferderber and Mary Mackey Ferderber on December 28, 1937.

John graduated from Carbon High School in 1955 and received a scholarship to play football at Utah State. He received his B.S. Degree in Industrial Management from USU in 1960. He married Nancy Jane Crellin on May 26, 1962 in Salt Lake City. Their marriage was later solemnized in the Jordan River Temple.

He started his professional career with Hercules Powder Co. but spent most of his career in the metals industry finally ending as a Senior Vice President for National Steel Corp. and Titanium Industries. John excelled leading turn-around situations through his many talents of leadership, loyalty and friendship. His career took him to many parts of the world. He retired in 2000 and will be dearly missed by those who worked with him. Upon retirement John was active in the LDS Church, working in the Manhattan Temple, serving a Family History Mission and fulfilling various callings within the Church. He even served as a girls basketball coach in North Branch New Jersey.

John is survived by his wife, Nancy; sons, Mark Robert and Courtney James; daughter, Kristin Ferderber; 13 grandchildren; and his sister, Marilyn Enger. Preceded in death by parents, John and Mary; brother, Tony Angotti; sister, Ruth Atkinson; and reunited with beloved son, Lance Jon.

Career Announcements



We proudly announce that starting the year 2016 **Mr Otis Claeys** will take over the General Management (CEO) of LCMA. He's now working for the company since almost 10 years and was previously active

as CFO and COO of the company. The former CEO, Mr Igor Turkin, will become Technical Director and will work hand in hand with Mr Thomas Mitidieri who's our Production Manager. This reorganisation is necessary to secure the future of the company, expand our accreditation in the aerospace industry, optimise production in Europe and last but not least constantly improve quality of our products and service.



Eric Petereit was promoted to the position of Managing Director of Retech Systems LL, effective January 15, 2016. It is with great pleasure that Retech Systems LLC and SECO/WARWICK formally announce

the promotion of Eric Petereit to the position of Managing Director of Retech. Eric's time at Retech began in September of 2007 as a Program Manager. Most recently he held the position of Director of Operations, where he was responsible for engineering and design, program management, purchasing, fabrication and assembly, as well as shipping.



Jim Goltz, Retech's former owner, will be stepping down after 12 years as the President of Retech Systems LLC. Jim will continue to support the organization as Senior Advisor at Retech and will likewise

continue his involvement as a member of SECO/WARWICK Group's Supervisory Board.



Souderton, PA, February 8, 2016 – Solar Manufacturing is pleased to announce that **Marty Benegalia**, President of Southern Thermal Systems, will assume the role of a sales representative focusing on the areas in Texas, Oklahoma,

Kansas, Arkansas, and Louisiana. Marty joins Solar Manufacturing with a technical background of 20 years in metallurgy and heat treating as well as experience in the petrochemical and oilfield equipment industries.

In making this announcement, Pete Reh, VP of Sales remarked, "Marty brings a wealth of experience to our Sales Team. He is well known in the industry and his customers have confidence in him. And being centrally located in Granbury, Texas in the Dallas-Fort Worth area, Marty will continue to serve this region of the country well for Solar Manufacturing."

Marty added, "The vast technical and process expertise that Solar offers to our industry is truly unequalled. The diverse product offerings and outstanding quality of manufacturing makes this new partnership truly exciting for our company."

For more information about Solar Manufacturing, please contact Pete Reh at 267-384-5040 x1509, or via email pete@solararmfg.com and visit us at www.solararmfg.com.

Anniversaries

Andrew Bayne has a work anniversary. Celebrating 13 years at TIMET

Julien Brelle has a work anniversary. Celebrating 6 years at TiRus International SA

Moe Khan has a work anniversary. Celebrating 2 years at Alloy Metals Company

Christopher Jackson has a work anniversary. Celebrating 4 years at RETECH Systems LLC

Jennifer Lopata has a work anniversary. Celebrating 8 years at TSI Titanium, a PRV Metals Company

John Parke has a work anniversary. Celebrating 11 years at VSMP0-Tirus, US

Henry Pena has a work anniversary. Celebrating 1 year at California Metal & Supply Inc.

Jeff Sasek has a work anniversary. Celebrating 1 year at Dynamet - Carpenter Technology Corporation



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Job Postings

MACHINE OPERATOR

Schaffer Grinding

Montebello, California USA

Tasks & Responsibility:

- Must demonstrate mechanical aptitude, math skills, and read micrometers.
- Dependable and willing to learn the grinding trade.
- Ability to apply common sense understanding to carry out instructions furnished in written, oral, or diagram form.
- This job includes bending, lifting, moving, and standing.

Job Requirements:

- High School graduate or equivalent
- Possess good mechanical aptitude
- Willing to work overtime and different shifts
- Has worked in a machine shop environment

Salary is based on experience. Please contact Heather O'Connell-heather@schaffergrinding.com if interested. No phone calls please.

MAINTENANCE LEADER

Schaffer Grinding

Twinsburg, Ohio USA

Tasks/Responsibilities

- Machinery repair/plant maintenance
- Familiar with pneumatic, hydraulic, and electric systems
- Working knowledge of hand tools
- Read and interpret equipment manuals in order to perform required maintenance and breakdown service.

Job Requirements

- Good mechanical and electrical skills
- Some machining and welding experience preferred
- 5- 10 years' experience

Salary is based on experience. If interested please contact Heather O'Connell-heather@schaffergrinding.com. No phone calls please.

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Bahco/ Snapon

Houston, Texas

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Are you mechanically inclined and experienced operating and adjusting metal cutting machines/tools and other equipment? Do you enjoy traveling and working in teams and independently while servicing customers? Do you have outside industrial sales experience? If so, the following technical sales position may be the right opportunity for you.

Qualifications/Requirements

BA degree in Business, Marketing or 3-5 outside sales experience required. Associate's degree in machining or other technical/mechanical equipment, a plus

Valid driver's license with clean driving record and ability to travel overnight (25-50%)

Prior experience working in industrial environment; technical training in metals metallurgy, cutting tools.

Strong communication skills, comfortable working with and presenting to all levels in an organization.

Snap-on offers a competitive compensation package, which includes a base salary, plus bonus opportunity and company vehicle and a complete benefits package. For information and to submit your resume please go to www.snapon.com and click on Corporate, Careers and Current openings and search under the state of Texas for Technical Sales.

TITANIUM RESEARCH ENGINEER ATI

Robinson, North Carolina

Description & Details

ATI - Robinson is seeking qualified candidates for the following position:

Titanium Research Engineer

This position is responsible for providing technical assistance to the operation and maintenance of the gas atomizer(s) for the production of titanium based gas atomized powders and experimental alloys. Plan and conduct assigned programs and propose new research programs involving titanium, titanium powder and other materials/ processes as required.

Essential Job Functions include the following, other duties may be assigned:

1. Plan and conduct assigned production and research programs involving titanium powder:

Supervise processing of customer orders for titanium powder and titanium powder products.

Support adherence to customer production agreements.

Review and approve specifications.

Provide technical data and associated costs for outside contract quotations.

Conduct experimentation and evaluations to further develop induction skull melting and the gas atomization process providing solutions to customers development needs.

Prepare and issue technical reports on completed work.

2. Provide technical assistance to the operating and production personnel of standard gas atomization units in an efficient and accurate manner by:

Addressing known safety issues with technicians and operators to safely and efficiently produce titanium powder.

Maintaining material inventory and requisitioning raw materials as needed. Determining melt consumables and maintenance items.

Anticipating potential production delays and potential equipment breakdowns to specify needed maintenance and use problem solving to minimize equipment downtime.

3. Lead/provide technical support to titanium atomization improvement projects and activities.
4. Supervise activities of supporting personnel to effectively and efficiently accomplish assigned objectives.
5. Assure that employees adhere to company safety policies.
6. Develop and maintain communications in a cooperative and professional manner with all levels of staff and outside contacts.
7. Pursue technical growth and be aware of opportunities to improve performance through professional and personal growth, and development through technical meetings, literature review, and formal courses.

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Qualified candidates will possess:

Education: Bachelor's Degree in Engineering (preferably metallurgy, metallurgical engineering or material science) is required.

Five or more years of product engineering/manufacturing experience is required.

Strong communication skills (verbal, written, oral, listening & approachability).

Excellent computer skills (specifically Microsoft Office products).

Candidate must be a U.S. citizen or equivalent per ITAR requirements

ATI Metals and its subsidiary companies will provide equal employment opportunities to all applicants without regard to applicant's race, color, religion, sex, gender, genetic information, national origin, age, veteran status, disability status, or any other status protected by federal or state law. The company will provide reasonable

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REPRESENTATIVE - BAND SAWS
Snap-on Incorporated**
Los Angeles, California

Job Requirements:

3-5 years outside sales experience in an Industrial environment and with distributors and/or agency reps.

A proven track record of prior goal achievement showing solid increases in sales and in customer growth is required.

The ideal candidate will have prior experience selling cutting tools.

Mechanically inclined and capable of operating / adjusting machines, and have technical knowledge of metal cutting tools and other equipment.

Previous experience working as machine operator, or experience in the sawing industry is a plus.

Must be willing to travel to customer locations and to meet with customers, distributors and / or end users. The majority of travel will be in the greater Los Angeles area; however this position may require overnight travel (25 to 50%).

Solid organizational, customer service, presentation skills and the ability to communicate effectively and appropriately to various levels in an organization are required.

Must have the ability to convey enthusiasm along with product knowledge to close the sale

Bachelor's degree in business, marketing or equivalent sales experience required.

An Associate's Degree in machining or other technical/mechanical equipment, is a plus.

Prior technical training in metals, metallurgy, cutting tools is required.

Must have a valid driver's license and impeccable driving record

Must be proficient in using the Internet for research, in working with spreadsheets and databases and efficient working in all Microsoft Office suite products including

Outlook, Word, Excel and Power Point software.

Bilingual in English and Spanish is a plus.

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If your skills, experience and interest match this opening, you are encouraged to apply. Local candidates in greater Los Angeles area also encouraged to apply, since we are not offering relocation at this time.

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Working with company support to help "close the sale", and grow the territory are key objectives for this position. The assigned territory will cover the California saw industry markets with an emphasis on the greater Los Angeles area. As the band saw industry changes, the territory assigned may be modified to meet growing demand.



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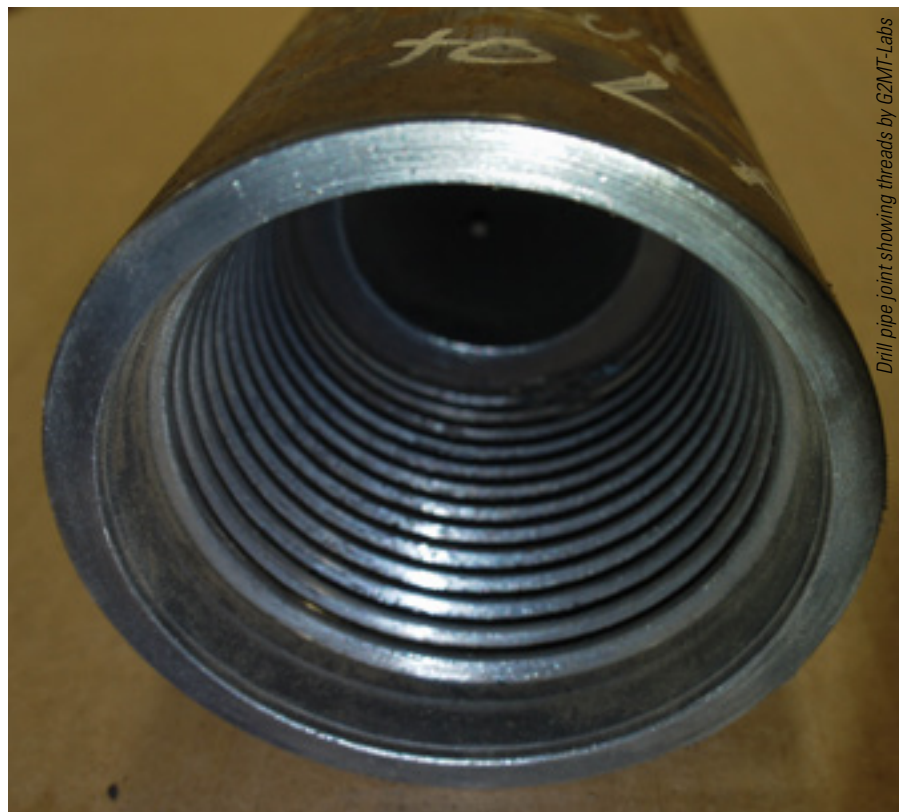
ITA's Industrial Sub Group Moves Forward to Update Titanium Grade 12 Requirements, Expand Applications

The Industrial Sub Group of the International Titanium Association (ITA), part of the ITA's Applications Committee, has achieved a significant first step in a project to update requirements Grade 12 titanium in NACE MRO 175 specifications, which is a standard for the petroleum and natural gas industries regarding the use and performance of industrial materials in a corrosive, hydrogen-sulfide work environment. The hope is that updating certain requirements will open up significant business opportunities for the titanium alloy.

The executive board of the ITA recently approved funding for the project, giving the Industrial Sub Group the green light to move forward. This is believed to be the first time the ITA has taken on an industry specification-related project to expand the use of titanium.

Rob Henson, chair of the ITA's Industrial Sub Group, said the Industrial Sub Group selected this task because updating requirements for the production of Grade 12 titanium under the MRO 175 standard "will impact the titanium industry globally. It is a tangible deliverable to advance the cause of removing barriers to the use of titanium. This is a first step, but it's a significant first step."

He said the first step to move the project forward involves working with the Corrosion Centre of Exova Group Plc, West Midlands, U.K., which will conduct testing on titanium Grade 12 and present the findings to Houston-based NACE, formerly known as National Association of Corrosion Engineers. NACE serves 30,000 members in 116 countries and is recognized globally as the premier authority for corrosion control solutions. Henson described Exova as "the perfect choice" to work with NACE, given Exova's track



Drill pipe joint showing threads by G2MT-Labs

record in such projects.

Nickel alloys are currently the material of choice under the MRO 175 standard for use in "severe service" hydrogen sulfide environments for the oil and gas industry. However, if requirements for titanium Grade 12 are updated, Henson said this will create an important business opportunity for the titanium alloy, as it is less expensive than nickel alloys while offering equal or enhanced in-service performance properties.

Applications for titanium Grade 12 in oil and gas production would include valves, pipes, fittings and heat exchangers. Such components, under MRO 175, must be certified to resist "catastrophic cracking" and failure when operating in a corrosive hydrogen sulfide environment. The

MRO 175 standard addresses an industrial material's ability to withstand stress cracking in a hydrogen sulfide environment, also known as a "sour service" or "sour gas environment." Titanium Grade 12, an alloy that includes nickel and molybdenum, is very resistant to hydrogen sulfide industrial environments and represents a perfect application for this material, according to Henson. However, he pointed out that titanium Grade 12 mill practice is currently "not in harmony" with the MRO 175 specification, originally written in the 1980s, in areas such as basic mill practices, plate hardness and heat-treating techniques.

NACE standards, such as MRO 175 (maintenance, repair, and overhaul), are determined through a collection of laboratory experimental data and

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field experience. Having established a roadmap for this program with Exova, Henson guessed that the process to have titanium Grade 12 fully approved under NACE's MRO 175 (also known as ISO 15156, the international designation of the standard) will be completed by the end of 2017.

Henson, who also serves as the business development manager at VSMPO-Tirus US, Highlands Ranch, CO, noted that the titanium industry, in recent months, has been receiving more Grade 12 requests for sour service related to oil and gas production, but there are several requirements that are problematic. Grade 12 is a higher strength material than Grade 2, but it has a considerably lower maximum hardness value. Grade 2 in the specification has a 100 HRB max (HRB is a Rockwell Hardness test), but Grade 12 is limited to 92 HRB. "While some have developed a procedure for hardness testing of titanium, what is especially troubling are the anneal parameters," Henson said. "The specification tells us what the properties have to be, but at the same time it's telling us how to make it with the annealing requirements. That becomes a real problem with today's manufacturing technologies when running continuous anneal lines for flat products.

Titanium Grade 12 is of interest because of superior corrosion resistance and strength compared to Grade 2

(commercially pure titanium), low density, a global manufacturing base for the full range of mill products, and a favorable price point compared with titanium/palladium alloys or nickel alloys. "We believe the global production of Grade 12 today falls in an annual range of 500 to 1,000 metric tons, depending on project activity in industries such as chemical processing, waste-water treatment and certain mining projects," Henson said.

"The ITA committee for industrial applications identified this as a task that we should examine more closely to see what would be involved with updating the specification," Henson continued. "From a materials selection standpoint, weight of equipment is becoming more of an issue as they move these production units to floating systems and additional weight comes with quite an additional cost component. While in the past they might have selected nickel alloys, today titanium is competitively priced against nickel (even after the collapse of the price of nickel over last year) and because of the weight penalty, titanium is sought after."

The mission of the ITA Applications Committee is to facilitate new applications for titanium in industrial markets, remove barriers to potential end-use applications, and define the need for new technology for fabrication equipment and components. NACE MRO 175/ISO 15156 specifications have

been identified as a high-priority target because the petroleum and natural gas industries materials for use in H₂S-containing environments in oil and gas production. Seventy percent of world oil reserves and 40 percent of gas reserves contain high levels of sulfur. With energy demand growing the production of sour resources will increase dramatically, modifying the NACE MRO 175 standard is a benefit to any organization in the titanium industry involved in the energy markets.

The final report will be issued to ITA membership including all requirements required by NACE to allow the ITA to choose to submit ballot changes to MRO175/ISO 15156-3. The results will be presented to the maintenance panel and oversight committees.

Members of the ITA's Industrial Committee, in addition to Henson, include **Jim Grauman** of Timet; **Regis Baldauff**, Titanium Industries Inc.; **Ron Schutz**, Alcoa Titanium and Engineered Products; **Bill Brownlee**, Titanium Fabrication; **Mike Stitzlein**, Tricor Metals; **Mitch Dziekonski**, Titanium Engineers; and **Chris Wilson**-Uniti Titanium. Henson also pointed out that representatives from mills, distributors and manufacturers provide the ITA's Applications Committee with a broad perspective on the industry as well as "tremendous technical expertise to evaluate projects." ■





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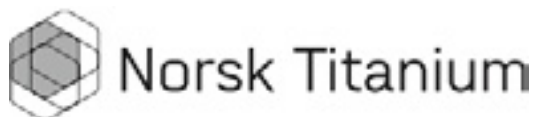
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Thermo-Calc Software is a leading developer of software and databases for calculations involving computational thermodynamics and diffusion controlled simulations. With more than 30 thermodynamic databases covering a broad range of materials and systems including Fe-based alloys, Ni-, Al-, Mg-, Ti-, alloys, solders, oxides and slags, aqueous systems and more, Thermo-Calc is a powerful tool for performing thermodynamic and phase equilibria calculations for multicomponent systems. Our add-on programs, DICTRA and TC-PRISMA, extend the software by allowing for accurate simulations of diffusion in multicomponent alloys and the prediction of precipitation kinetics. And our software developments

kits enable Thermo-Calc to be called directly from the user's own software or from MATLAB®. -Reduce the number of costly, time-consuming experiments -Increase the value of experiments by better understanding the results -Define safe and optimal processing windows in terms of composition tolerances and temperatures -Base decisions on scientifically supported models, tools and data -Make predictions that are difficult or impossible with experiments

<http://www.thermocalc.com>



TITAN ENGINEERING

Titan Engineering-Singapore is a stockists & distributors of titanium mill products, stocking a complete range of prime titanium round bars, plates, sheets, billets and various additional shapes to suite your requirements. Industries that we commonly serve include aerospace, oil and gas, medical, defense, chemical, automotive, precision engineering, tooling, marine and recreational industries.

<http://www.titanium.com.sg/>



Laube Titanium Mill Products is a division of Laube Technology. Laube began its long history of quality and service in 1948 as a Chicago based warehouse distributor of steel mill products. Anticipating the growing influence of the Pacific Rim countries in supplying product to the United States, Laube's corporate offices were moved to the west coast in 1961. Strategically poised, Laube became an industry leader, pioneering the importation of metal products from Asia and elsewhere. Today the Laube group consist of three separate divisions. Those are: Titanium Mill Products; Offering titanium forms of sheet, plate, bar and coil from both domestic and foreign mills. The Custom Metal Parts division, which specializes in providing the industry with unique metal components usually designed for a specific use; and Electronic Components and Assemblies Division. This department supplies all types of custom control panels and keyboard assemblies. Laube is a privately held, family run company and continues in its proud heritage of providing decades of quality product at competitive costs.

www.laubetitanium.com

ALCOA ANNOUNCES MULTIYEAR SUPPLY CONTRACTS WITH BOEING VALUED AT MORE THAN \$2.5 BILLION

Contracts include Alcoa's Largest-Ever Fastener Deal; Agreement to Supply Ready-to-Install Seat Tracks for Every Boeing 787 Dreamliner

- Deals strengthen Alcoa's position on newest Boeing platforms, including the 737 MAX, 777X and 787 Dreamliner
- Draws on titanium, machining and assembly capabilities gained through RTI acquisition
- Contracts build on last year's aluminum sheet and plate deal with Boeing, valued at more than \$1 billion

NEW YORK—(BUSINESS WIRE)—Lightweight metals leader Alcoa (NYSE:AA) today announced long-term supply contracts with Boeing (NYSE:BA) valued at over \$2.5 billion. Alcoa will supply multi-material fastening systems for every Boeing platform in its largest fastener deal ever. Alcoa also will supply ready-to-install titanium seat track assemblies for the entire 787 Dreamliner family.



These contracts build on last year's deal with Boeing for flat-rolled aluminum sheet and plate products, valued at more than \$1 billion. That agreement established Alcoa as a sole supplier to Boeing for wing skins on all of its metallic structure airplanes. Alcoa plate products, used in applications such as wing ribs, wing skins or other structural parts of the aircraft, are used on every Boeing platform, including the 787. The agreement

“Alcoa has positioned itself to win in a multi-material aerospace industry, and these deals are the latest proof points that our strategy is working,” said Alcoa Chairman and Chief Executive Officer Klaus Kleinfeld. “We are proud to partner with Boeing as it delivers sophisticated airplanes to meet the world's increasing demand for air travel.”

Under one contract, Alcoa Fastening Systems & Rings will supply advanced titanium, stainless steel, alloy steel, aluminum and nickel-based superalloy fastening systems for every Boeing platform, including the 777X—Boeing's newest commercial airplane—the 737 MAX—scheduled for first delivery in 2017—and the 787 Dreamliner. Alcoa will produce these fastening systems at seven of its global manufacturing facilities.

Alcoa also announced a second agreement under which it is the sole supplier of ready-to-install titanium seat track assemblies for all three members of the 787 Dreamliner family of airplanes. RTI International Metals (RTI)—now known as Alcoa Titanium & Engineered Products (ATEP)—has provided seat tracks for the 787-9 and 787-8 variants under a contract signed in 2007. This contract, as amended by RTI and Boeing immediately prior to the acquisition, reinforces ATEP's position on those variants and adds seat tracks for the 787-10. Seat tracks are critical structural assemblies that mount to the floor of the airplane, secure passenger seats and reinforce the structure of the fuselage. Titanium seat tracks are stronger, weigh less and offer superior corrosion resistance compared with traditional materials.

Alcoa is supplying the seat tracks, from raw material to finished part, by utilizing its titanium ingot melting and billetizing, extrusion, machining, processing and assembly capabilities gained through the RTI acquisition.

also established deeper collaboration on new, high-strength and corrosion-resistant alloys, including aluminum-lithium.

About Alcoa Aerospace

Alcoa's aerospace businesses will form part of the new Value-Add Company, to be launched following Alcoa's previously announced separation in the second half of 2016. The Value-Add Company will be a differentiated supplier to the high-growth aerospace industry with leading positions on every major aircraft and jet engine platform, underpinned by market leadership in jet engine and industrial gas turbine airfoils, and aerospace fasteners.

About Alcoa

A global leader in lightweight metals technology, engineering and manufacturing, Alcoa innovates multi-material solutions that advance our world. Our technologies enhance transportation, from automotive and commercial transport to air and space travel, and improve industrial and consumer electronics products. We enable smart buildings, sustainable food and beverage packaging, high performance defense vehicles across air, land and sea, deeper oil and gas drilling and more efficient power generation. We pioneered the aluminum industry over 125 years ago, and today, our approximately 60,000 people in 30 countries deliver value-add products made of titanium, nickel and aluminum, and produce best-in-class bauxite, alumina and primary aluminum products. For more information, visit www.alcoa.com, follow @Alcoa on Twitter at [www.twitter.com/Alcoa](https://twitter.com/Alcoa) and follow us on Facebook at www.facebook.com/Alcoa.

About Alcoa Fastening Systems & Rings (AFSR)

Alcoa Fastening Systems & Rings (AFSR), a business unit of Alcoa, is a leading worldwide designer and manufacturer of fastening



Innovation is in our DNA

Alcoa advances our world as a premier provider of material innovations and differentiated products.

Alcoa Titanium & Engineered Products is sharpening that innovation edge, expanding Alcoa's reach into titanium—the world's fastest-growing aerospace metal—and delivering advanced technologies and materials capabilities, such as metal 3D-printing, for greater innovation power in aerospace and beyond.

Learn more at www.alcoa.com.

Advancing each generation.



systems and rings, including specialty fasteners, fluid fittings, assembly components, installation systems, and seamless rings for aerospace and industrial applications. Headquartered in Torrance, California, the business unit employs 8,700 people at 39 manufacturing and distribution and logistics locations in 13 countries. For more information, visit www.afsr.alcoa.com.

About Alcoa Titanium & Engineered Products (ATEP)

Alcoa Titanium & Engineered Products (ATEP) supplies advanced titanium and other specialty metals products and services to the commercial aerospace, defense, oil & gas and medical device markets. The business unit offers a portfolio of titanium mill products, extruded shapes, formed, and 3D-printed parts, as well as high speed machined components and engineered product forms produced from metal powders. It is an innovation leader in 3D printing and advanced powder materials technologies for aerospace, medical and oil & gas applications, as well as cutting-edge alloys such as titanium-aluminides.

Forward-Looking Statements

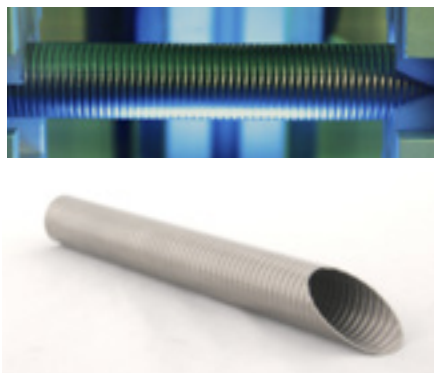
This release contains statements that relate to future events and expectations and as such constitute forward-looking statements within the meaning of the Private Securities Litigation Reform Act of 1995. Forward-looking statements include those containing such words as “anticipates,” “expects,” “plans,” “should,” “will,” “would,” or other words of similar meaning. All statements that reflect Alcoa’s expectations, assumptions or projections about the future other than statements of historical fact are forward-

looking statements, including, without limitation, statements regarding Alcoa’s separation transaction; the future performance of Value-Add Company if the separation is completed; projections of competitive position, market share, or growth opportunities of Value-Add Company; and the expected timing of completion of the separation. Forward-looking statements are not guarantees of future performance and are subject to risks, uncertainties, and changes in circumstances that are difficult to predict. Such risks and uncertainties include, but are not limited to: (a) uncertainties as to the timing of the separation and whether it will be completed; (b) the impact of the separation on the businesses of Alcoa; (c) Alcoa’s inability to realize expected benefits from the separation or the risk that the separation may be more difficult, time-consuming or costly than expected, which could result in additional demands on Alcoa’s resources, systems, procedures and controls, disruption of its ongoing business and diversion of management’s attention from other business concerns; (d) the potential failure to retain key employees while the separation transaction is pending or after it is completed; (e) deterioration in global economic and financial market conditions generally; (f) unfavorable changes in the markets served by Alcoa, including the aerospace market; and (g) the other risk factors discussed in Alcoa’s Form 10-K for the year ended December 31, 2014, and other reports filed with the U.S. Securities and Exchange Commission. Alcoa disclaims any obligation to update publicly any forward-looking statements, whether in response to new information, future events or otherwise, except as required by applicable law. Market projections are subject to the risks discussed above and other risks in the market.

VALLOUREC HEAT EXCHANGER TUBES PRESENTS ITS LATEST INNOVATION: THE NEW VALHELIX™ TITANIUM TUBE DESIGNED TO ENHANCE THE PERFORMANCE OF STEAM SURFACE CONDENSERS.

Vallourec Heat Exchanger Tubes, world leader in premium welded tubular solutions, serving energy, process and desalination markets, presents VALHELIX™, a titanium tube with a patented helix design configuration which generates turbulences in the cooling water and consequently increases the overall heat transfer of the tubes. It has been developed through intensive research and trials to achieve the best balance between heat transfer improvement and pressure drop.

Trials performed on a pilot condenser for a wide range of parameters simulating industrial operating conditions confirmed a heat transfer improvement of minimum 40 % compared to a smooth titanium tube with limited extra pressure drop. Its



design has also been optimized to have the dimensional properties in accordance with the ASTM B338 standard and the ease of cleaning has been verified.

For a new project, using VALHELIX™ reduces the cost and size of the condenser. For a revamping project, it increases the output of the power plant if the condenser is a bottleneck or can compensate a loss of efficiency due to a change of operating conditions such as an increase of the temperature of the cooling water.

VALHELIX™ is the best solution available on market to enhance the performance of steam surface condensers.



Master alloys dedicated to performance, delivery, reliability and value.

Your **premier source** for high-performance, high-purity master alloys and titanium powders. Industries from aerospace to medical rely on our solutions, including today's largest aircraft and jet-engine manufacturers, which have approved our master alloys for use in the production of critical parts and key components.

Reading Alloys is your premier source for world-class technical support and customer service, too. Talk to us about your needs for high-performance, high-purity solutions. Contact us at rai.sales@ametek.com.

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Sheet | Plate | Bar |
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**VULCANIUM
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SERVICES**

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**VMI works with you to customize
your inventory management/
supply chain solution. Vulcanium
is committed to freeing up your
critical resources, reducing your
manufacturing bottlenecks and
minimizing your scrap costs.**

FOR MORE INFORMATION:

3045 Commercial Avenue • Northbrook, IL 60062
Phone: 888-326-7556 • Email: titanium@Vulcanium.com
www.Vulcanium.com



ARIES GROUP BECOMES ARIES ALLIANCE

ARIES Group, the parent company of ACB and Dufieux in France and Cyril Bath in the USA, three entities well established in the aerospace industry, becomes ARIES ALLIANCE and confirms its transformation into a highly respected industrial group.

With world leaders within its specialty markets, ARIES ALLIANCE organizes its group structure to consolidate its position and continue a high level of performance for its customers.

ARIES ALLIANCE provides two different but complementary activities:

- 1 The design, fabrication, installation and support of metal forming presses, large dimension panel milling machines, and linear friction welding machines, all designed for the aerospace industry under the brands ACB, Cyril Bath and Dufieux.
- 2 The production and supply of aeronautical parts for aircraft and engine manufacturers under the global brand ARIES MANUFACTURING.

Since the group foundation in 2000, ARIES ALLIANCE has developed its capabilities through continuous technical research

and development that spawns new technologies. This active commitment to find new and improved methods benefits our customers by creating significant value through the use of highly innovative and unique products and services.

By adding Alliance to the existing name ARIES, the group confirms its strategy to develop complementary and synergistic capabilities, products and companies in order to better serve the aerospace market.

This name change, combined with a new graphic identity, has been implemented throughout the enterprise. This talented team of people and resources will bring greater visibility, consistency and relevance to the fast-growing ARIES ALLIANCE.

Contact:
Jessica Blanchet
Marketing and Communication Manager
Tel: +33 (0) 2 51 13 84 00
Jessica.blanchet@acb-ps.com

ABOVE MATERIAL TECHNOLOGY CO., LTD

is very professional in titanium wires since 1997, specialized in R&D and manufacturing. We always work hard "To Be the Global Leader in the High Performance Alloys". As a standing member of China Welding Association, we are proud to be a well known and top quality brand in China and supply our top and consistent quality Titanium wires with competitive price to USA, Europe and Japan for years.

Our Titanium wires can be used in welding, 3D printing, medical and glasses. We can supply big piece weight and level wire winding. We Our titanium wires are fully according to AMS 4954, AMS 4951, AWS A5.16 and ASTM B863 standard, and have four unique characteristics:

1. **Shiny Clean** — Our wires are very



shining & clean.

2. **Precise Weight** — Our wires can be weight control precise.
3. **Pretty Printing** — Our wires can be stamped beautiful according your requirement.
4. **Neat End Cut** — Our wires are neat end-cut with shiny and homogenous color.

We are committed to high quality market demand and can always keep high quality owing to consistent process,

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FAX: (86-10)82376796
URL: www.amt-alloys.com

MAKINO INTRODUCES THE T1 5-AXIS HORIZONTAL MACHINING CENTER FOR HIGH-EFFICIENCY JOB-SHOP PRODUCTION

Makino introduces the T1 5-axis horizontal machining center for high-efficiency machining across a wide range of large part applications. The machine's rigid design, versatile cutting capabilities and sizable work envelope make it an ideal fit for industrial component manufacturing and aerospace job-shop environments, where machining of both soft and hard metals is required.

"The T1 5-axis machining center is designed to handle parts of any shape, in any material," says David Ward, horizontal machining center product line manager. "The T1's unique casting and kinematic structure provide ideal accessibility to large prismatic or cylindrical workpieces. The machine features a plus 45-degree to minus 110-degree A-axis tilting spindle, which, coupled with a deep chest column design, allows a minus 90-degree spindle centerline positioning to 550 mm (21.6 inches) beyond pallet center. As a result, large workpieces that are 1-meter (3.2 feet) square by 500 to 800 mm (19.6 inches to 31.4 inches) high can be machined in a single five-sided machining process. The value of the T1's operation consolidating 5-axis accessibility is compounded by its spindle capability. The torque and power of the 12,000-rpm spindle make it highly productive in the machining of non-ferrous, ferrous and hard-metal materials, putting shop owners in a unique position to deliver highly competitive machining solutions for workpieces of any shape and any material."

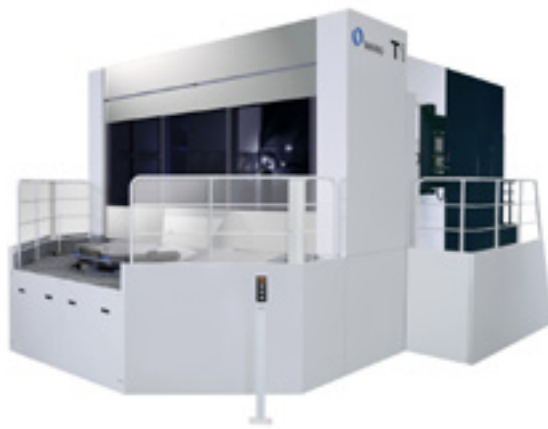
The T1 is ideal for large parts commonly machined in industrial, energy and aerospace industries, and it provides X-, Y- and Z-axis travels of 1,500 mm (59.1 inches), 1,300 mm (51.2 inches) and 2,000 mm (78.7 inches), respectively. Workpiece limitations on the 1,000-mm (39.3 inches) pallets are 1,500 mm (59.1 inches) in diameter by 1,500 mm (59.1 inches) tall. Maximum pallet payload is 3,000 kg (6,600 lbs).

Dynamic Stiffness and Rigidity

When producing large, heavy components, a machine tool should deliver the dynamic stiffness and rigidity critical to achieving the highest level of cutting stability. The construction of the T1 meets such requirements with thick Z-axis bed castings, wide slideway surfaces and a deep-chest, monolithic column design, supporting the X- and Y-axis. These features are enhanced with Makino's Active Damping technology that removes cutting vibrations from each axis. Together, these design considerations yield enhanced cutting stability, greater productivity and longer tool life.

High Power Rotary Axis and A/B Configuration

The machine's B-axis rotary table offers a 360-degree rotational



speed of 3,600 degrees per minute, which is supported by 10,000 Nm of continuous torque (29,000 Nm peak). The spindle tilting A-axis offers 6,300 Nm of continuous torque (20,000 Nm peak), and enhances spindle and workpiece accessibility with a compact 400-mm (15.7 inches) pivot distance.

Traditional approaches for 5-axis machining use trunnion tables for rotary motion. The T1 employs an alternate design with a unique A/B-axis configuration that eliminates the need to tilt the workpiece by shifting A-axis motion to the spindle side. This simple change in 5-axis kinematics

delivers significant improvements over trunnion solutions. Operators also benefit from unobstructed visualization of the cutting zone and a reduced distance between floor and pallet top for simplified fixture and part handling.

Superior Accuracy and Rigidity

Large, heavy workpieces oftentimes cause beam deflection to occur in traditional trunnion tables, which can result in inaccurate part positioning. The T1 removes this issue with its B-axis rotary table and robust bed casting to support the load stresses from large, heavy workpieces. Additionally, its unique A/B rotary axis configuration eliminates shifting mass deflections caused by tilting the workpiece, ensuring consistent accuracy regardless of rotary axis position.

For the premium aerospace job shop, the ability to respond to a wide range of workpiece materials should not mean multiple, partially utilized machining centers or compromised spindle performance. The T1 has been specifically developed with a unique direct-drive spindle capable of high-performance operation in a wide variety of materials. The T1 spindle is ready for the challenges of titanium and nickel-based alloys with 1,000 Nm (737 ft-lbs) of torque that is available from 20 rpm all the way to 1,000 rpm. Extending the high torque levels out to 1,000 rpm ensures that the T1 is ready to take advantage of future hard-metal tooling developments. The T1 is equally competent in aluminum with a top spindle speed of 12,000 rpm. Continuous power of 56 kW (75 HP) is maintained from 1,000 rpm to the maximum 12,000-rpm level. The T1 spindle uses the HSK-A100 spindle interface for superior rigidity and accuracy.

Chip and Coolant Management

The high-volume nature of aluminum machining and high temperatures generated during titanium roughing present challenges for chip and coolant system designs. Considerations for these workpiece materials are inherent in the T1's systems. Key

KASTO High Performance Saws

Designed to cut the toughest materials with ease



Plate and Cut-off Saws

Cutting Capacity

Bar Stock: up to 100 " diameter

Plate : variety of thickness &
cut length up to 500"

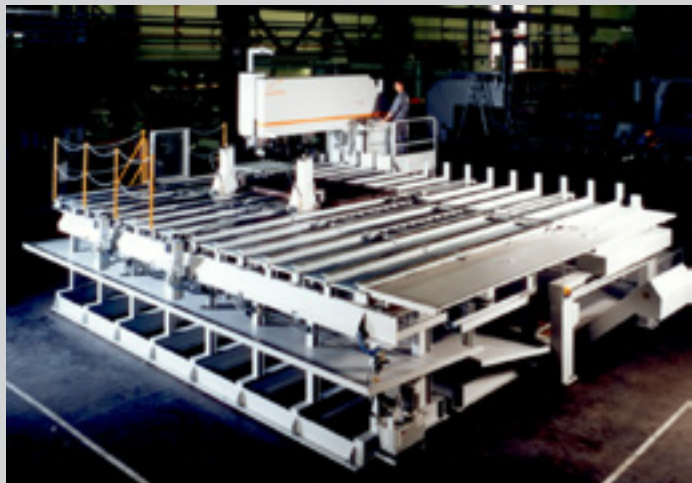
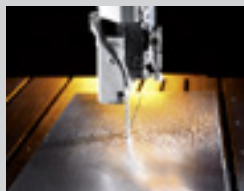


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aspects include a high-pressure, high-volume through-spindle coolant system delivering up to 1,000 psi at 26 gallons per minute directly to the cutting tip. This system effectively eliminates heat from the cutting zone, extends perishable tool life and optimizes chip evacuation during heavy roughing operations. Twin coolant tanks each store 264 gallons of water-soluble coolant. Standard cyclonic filtration and coolant temperature controller ensure continuously available clean and thermally stable coolant. Large chip volumes are quickly and efficiently removed from the machine via twin internal hinge conveyors and a dual-layer lift-up chip conveyor, enabling heavy roughing operations without limitation or concern.

Improved Utilization and Automation

The T1 offers numerous capabilities for improved utilization and reductions in non-cut time. A 60-position automatic tool changer (137-position optional) and an automatic pallet changer ensure uninterrupted operation. The T1 may also be integrated with Makino's MMC2 (Makino Machining Complex), a highly flexible automatic pallet transfer and storage system which enables long

periods of unattended operation. Because it uses the same 1,000-mm (39.3 inches) pallet design as the 4-axis Makino A100E, both the T1 and A100E can reside in the same MMC2 system. This identical design allows sharing of fixtures and workpieces between the machines to create a powerful 4- and 5-axis machining solution.

About Makino

A world leader in advanced CNC machining centers, Makino is committed to providing high-performance, leading-edge machining technologies and innovative-engineered process solutions that enable manufacturers to focus on making what matters. Makino offers a wide range of high-precision metal-cutting and EDM machinery, including horizontal machining centers, vertical machining centers, 5-axis machining centers, graphite machining centers, and wire and Ram EDMs. Makino's flexible automation solutions provide reduced labor costs and increased throughput in a variety of production volumes and designs. Makino's engineering services offers industry-leading expertise for even the most challenging applications across all industries. For more information, call 1-800-552-3288 or visit makino.com.



INTRODUCING UNITED PERFORMANCE METALS THE STRENGTH OF THREE BECOMES THE POWER OF ONE

Newtownards, Northern Ireland – January 25, 2016 – United Performance Metals, Vulcanium Metals International and Aerodyne Alloys have joined forces to become United Performance Metals – A single source for titanium and hi-temperature specialty alloys serving customers in the United Kingdom and the European Union (EU).

The company maintains titanium, stainless steel, nickel, cobalt and cobalt chrome moly products in many forms including sheet, coil, strip, plate, bar, forged block and near net shapes. Processing capabilities at this facility include water jet, bar saw, plate saw and shear.

Vulcanium Metals International in Northbrook, Illinois will continue to use its traditional name during the European transition.

About United Performance Metals

Located in Newtownards, Northern Ireland, United Performance Metals offers a full range of titanium, stainless steel, nickel, cobalt and cobalt chrome moly in sheet, coil, plate, bar and forged block, and near net shapes. FIRSTCUT+® Services include water jet, bar saw, plate saw and shear. United Performance Metals is a subsidiary of O'Neal Industries (onealind.com), the U.S.A.'s largest family-owned group of metals service centers, is the parent company of United Performance Metals. With sales of approximately \$2.4 billion in 2015, O'Neal Industries is based in Birmingham, AL and has more than 80 specialized facilities throughout North America, Europe, and Asia.

For more information, visit upmet.uk.

TITANIUM FINISHING COMPANY

248 Main Street, PO Box 22, East Greenville, PA 18041 • Tel (215) 679-4181 • Fax (215) 679-2399
Email titaniumfinishing@comcast.net

The following chart provides a quick overview of the features and advantages of TFC's coating processes:

Titanium Anodizing

substrates

Titanium
Titanium Alloys

advantages

Stable base for other coatings & adhesive bonding; appearance; color coding

benefits

Prevents fretting & galling
Natural, reproducible colors

Ion Vapor Deposition of Aluminum

Aluminum
Steel
Alloys
Titanium

Non-toxic;
Non-hazardous;
Nonpolluting

Corrosion-resistance
No hydrogen embrittlement
High operating temperature (1100°F)

Hardcoat Anodizing of Aluminum

Aluminum
Aluminum Alloys

Hardness; eliminates burning & dissolution of parts

Allows aluminum application where wear, corrosion or other factors would otherwise exclude its use

Solid Film Lubricants

Virtually all metals

Automatic & manual application; TFC processes comply with a variety of mil specs; combines with other coatings

Provides excellent lubricity
Improves corrosion resistance

www.titaniumfinishing.com



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Titanium is demanding. To succeed, you need everything Makino titanium ADVANTiGE brings to your shop floor. From higher metal-removal rates to extended tool life, ADVANTiGE technology delivers on-time performance, builds your reputation and secures your company's future.

Build your business cutting the materials that matter most.

makino.com/ADVANTiGE

WHEN YOU MAKE WHAT MATTERS





At the end of 2015, a certification audit of quality management system for correspondence to the requirements of an international standard EN 9100:2009 "Aerospace standards series. Quality management systems. Requirements" was performed at ZAPOROZHYE TITANIUM & MAGNESIUM COMBINE (Ukraine) by Bureau Veritas. In view of the results of the audit, Bureau Veritas made a decision that quality management system of ZTMC corresponds to the requirements of the international standard EN 9100.

The company began preparing for certification in March 2014. In order to prepare for certification according to the requirements of the international standard EN 9100, on the basis of existing quality management system according to the requirements of ISO 9001,

ZTMC revised and redeveloped 86 company standards during this period of time.

In July 2015, the first stage of a certification audit according to the requirements of the international standard EN 9100 was passed.

At the end of 2015, ZTMC successfully passed the second (final) stage of a certification audit of quality management system for correspondence to the requirements of the international standard EN 9100:2009 "Aerospace standards series. Quality management systems. Requirements".

Currently, ZTMC is carrying out registration in the OASIS database, which is planned to be finished in the nearest time.

SUPRA ALLOYS RELOCATES TO LARGER BUILDING



CAMARILLO, CA – January 25, 2016: Supra Alloys recently completed moving its corporate office to a larger building in Camarillo located less than a half mile from its previous location.

For Supra Alloys, a Division of TITAN Metal Fabricators, the new space means they will have a larger and new work space with additional onsite services and new amenities for employees.

Supra Alloys now occupies the second level of two-story office owned by its parent company with its service center operations below. "This new location provides greater efficiency in how we serve clients. We are now also able to offer more onsite services such as custom welding and fabrication, more processing capacity, first state machining and access to an engineering and design team," said General Manager, Craig Schank.

"We were fortunate that TITAN had the existing space to allow for the expansion of including Supra Alloys in our facility. Since the two companies work close in some similar industries, it makes sense to be able to share some resources without compromising quality or service. The move also allowed Supra Alloys to upgrade its data and communication systems as well as network infrastructure," said President, Steve Muscarella.

The entire move took over a period of a few weeks after the building construction was complete and did not affect any customer orders or services.

Supra Alloys new address is:

352 Balboa Circle

Camarillo, CA 93012

Supra Alloys' main and fax phone numbers remain the same with new extensions.

About Supra Alloys

Supra Alloys is one of the leading distributors in the world for Titanium and Titanium Alloys. The company is a fully stocked service center that routinely supplies special metal products to the aerospace, medical, sports and recreation, pulp and paper, chemical processing and metal finishing industries. Supra Alloys production services include saw cutting, shearing, custom slitting of strip and close tolerance chemical milling. <http://www.supraalloy.com/>

About TITAN Metal Fabricators, Inc.

TITAN is one of the world's foremost fabricators of corrosion-resistant equipment for the process industries. The company's core business is custom-design engineering and manufacture of Heat Exchangers, Pressure Vessels, Columns, Reactors, and Piping using reactive metals (Titanium, Zirconium, Tantalum, and Niobium) and high nickel alloys (Duplex, Hastelloy, Inconel, Monel, and others) specifically for use in corrosive applications within the Chemical, Petro Chemical, Oil & Gas, Fertilizer, Mining, Power Generation, Pharmaceutical, and Steel Manufacturing industries. TITAN has manufacturing operations in USA, India and China, as well as sales facilities in 35 countries. <http://www.titanmf.com>

Contact:

Donna Brown

dbrown@titanmf.com

352 Balboa Circle, Camarillo, CA 93012 USA

Ph: (805) 487-5050

INDUSTRIAL APPLICATION OF TITANIUM

Titanium had been known as a rare metal recently. As for now titanium is the most important reinforcing material. Its role increases rapidly in aviation, shipbuilding, and rocket-construction. As well, titanium is used for “peaceful purposes”. For example, there are roofs covered with titanium-zinc alloy in Paris and other European cities. Ductility, low electrical conductivity, high corrosion resistance, mechanical characteristics, and properties, due to which human body doesn’t reject titanium, make it perspective for a wide application, including medicine.

Nowadays Titanium cluster is being formed in Russian industry with the purpose of getting new stages of titanium processing and titanium production application widening. Titanium cluster’s development is one of the main activities of the Special Economic Zone “Titanium valley” that was created on the territory of Verkhnyaya Salda city in Sverdlovsk region.

At the moment Sverdlovsk region (Russia) represented by OJSC “Corporation “VSMPO-AVISMA” releases 25% of the world titanium production, this figure characterizes country’s share at the international titanium business. “VSMPO-Avisma” Corporation produces high-technology deep processed titanium components beginning with the ingots made of special chemical composition and finishing with the final production with unique strength characteristics and shape.

There are 33 titanium-base alloys at the “VSMPO-Avisma” Corporation that are used in finished production in such high-technology spheres as: aviation, shipbuilding, nuclear power, chemical and petrochemical industries, oil and gas.

Traditionally, titanium alloys are widely used in aviation and engine production, in shipbuilding they are used as well very often.

Titanium alloys creation for shipbuilding has been continued for the whole period of the titanium industry formation. Titanium and

its alloys are used for civil, military ships and submarines in the body structure, propulsion power units and water rotation units. Today FSUE Central Research Institute of structural materials “PROMETEI” and OJSC “Corporation “VSMPO-AVISMA” cooperate in new titanium alloys creating.

More than 8000 tons of titanium mill products for the shipbuilding have been produced by these 2 companies.

During the last 15-20 years titanium application has increased in the spheres of geophysics, oil and gas sector.

Increasingly titanium is used as construction material for nuclear power plants: for production of turbine rotor blade and exchanger equipment.

The OJSC “Corporation “VSMPO-Avisma” participated in all projects of nuclear power facilities construction in Russia as well as in foreign projects: NPP “Kudankulam”, NPP “Tian Wang” and others.

“VSMPO - New Technologies” is a subsidiary of the OJSC “Corporation “VSMPO-Avisma”. There will production of mechanical processed forgings of titanium alloys for aviation application be organized at “VSMPO-New Technologies”. Production facility location at the special economic zone “Titanium valley” will increase the amount of machined parts and the degree of titanium products processing with the purpose of manufacturing almost ready-to-use aviation items.

Contact:

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SOLAR ATMOSPHERES SOUTHEAST VACUUM FURNACE CAPACITY

Greenville, SC, January 11, 2016 - Solar Atmospheres newest facility in Greenville, South Carolina has a wide range of vacuum processing capacity now available. From furnaces suited for small lots and development cycles to a 24 foot long vacuum chamber capable of processing up to 50,000 lbs at 2400°F. All backed by AS9100 and Nadcap quality systems to provide the assurance that your product is being processed as it should be.

A sampling of the processing capability offered at the Greenville, SC location:

Current vacuum furnace capability:

Hot Zone Dimensions	Max Temperature	Max Load (lbs)
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36" wide x 36" high x 48" deep	2500°F / 1370°C	5,000
36" wide X 36" high X 48" deep (10 bar)	2500°F / 1370°C	5,000
54" wide X 54" high X 288" deep	2650°F / 1454°C	50,000

Wide range of processing options including vacuum carburizing and cryogenic processing

Metallurgical testing laboratory to provide product and process validation from surface hardness testing to microstructure evaluation

President Steve Prout states, "the US Southeast continues to grow and attract manufacturers supporting a broad range of

market sectors. We are proud to be a supplier that is positioned to support this growth and we are excited to find ways to help our customers achieve their goals and contribute toward their success."

For additional information on our processing options and our capabilities, contact Mike Harper at mikeh@solaratm.com, and visit us at www.solaratm.com.

ABOUT SOLAR ATMOSPHERES SOUTHEAST

Solar Atmospheres Southeast specializes in vacuum heat treating, vacuum brazing and vacuum carburizing services. Using state-of-the-art furnace technology, Solar serves over 18 metal working industries including Aerospace, Medical, Automotive, and Power Generation. With processing expertise and responsive service, Solar processes small or large parts efficiently with a wide range of vacuum furnaces. Sizes range from lab furnaces to 24 feet long. Solar's unique capabilities, consistent quality and responsive service produce bright scale-free parts with minimal distortion that are delivered on time. With an in-house R&D team of metallurgists, Solar works with customers to develop innovative, custom solutions. For more information, visit www.solaratm.com

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INTERNATIONAL TITANIUM ASSOCIATION, SMITHSONIAN MUSEUM TO COLLABORATE ON 'STEM IN 30' WEBCAST, TO AIR MARCH 16

Denver, Colorado – The Education Committee of the International Titanium Association (ITA), in cooperation with the Smithsonian Air and Space Museum, Washington D.C., is sponsoring a webcast “STEM in 30.” The first STEM in 30 webcast is slated for Wednesday, March 16 at 11 a.m., and then will be reprised at 1 p.m. EST.

The STEM in 30 webcast may be viewed live on the Smithsonian’s website at <http://airandspace.si.edu/explore-and-learn/stem-in-30/> or the live broadcast may also be viewed on the NASA TV at website <http://www.nasa.gov/multimedia/nasatv/>. The program will also be archived on this website for future viewing. STEM in 30 webcasts are online learning experiences, but are filmed in front of a live audience. If you are interested in bringing your school group to a live filming of STEM in 30, please email STEM in 30 at email address STEMin30@si.edu

The ITA is a strong advocate of STEM (Science, Technology, Engineering and Mathematics) education and workforce development. The STEM education movement has gained traction in the United States in recent years—a curriculum designed to cultivate students, female and male, in the skills needed for 21st century manufacturing and engineering fields.

STEM in 30 is an interactive classroom program consisting of 30-minute live webcasts that will engage middle school students in STEM topics. Students will be able to chat with experts, submit their questions to be answered live, take a poll, discover related content, and participate in follow-up activities.

Dr. Markus Holz, the co-chair of the ITA’s Education Committee, explained that the innovative STEM in 30 education program “enables the ITA to reach out to young professionals at an international level and enhance their careers in a flexible, state-of-the-art manner and support the development of future leaders in the titanium industry worldwide.”

Content for the initial STEM in 30 webcast will focus on the development of the legendary Lockheed SR-71 Blackbird. It also will feature a conversation with Stanley Seagle, a lifelong

executive in the titanium industry. Built of titanium, the futuristic SR-71 Blackbird is the world’s fastest jet-propelled aircraft. Unveiled in 1966, it was designed as a long-range reconnaissance aircraft with a top speed in excess of 2,000 miles per hour and a range of more than 3,000 miles. SR-71 Blackbird’s performance and operational achievements placed it at the pinnacle of aviation technology developments during the Cold War.

Seagle has been involved in titanium industry since the industrialization of the metal in the early 1950’s. He spent the early portion of his career in technical research, formulating titanium alloys. He eventually transitioned into marketing and focused on developing titanium applications for various industries. After 38 years, he retired from the business and pursued consulting work, which included instructing hundreds of professionals in the ITA’s “Fundamentals of Titanium” workshop series. In 2001 he was honored with ITA’s prestigious “Titanium Lifetime Achievement Award.”

Jennifer Simpson, executive director of the ITA, said “the first webinar will focus on the Lockheed SR-71 Blackbird and will be the first of three productions the ITA will sponsor in cooperation with the Smithsonian Museum in 2016. The next segment will focus on the Mars Rovers, followed by a segment dedicated to Moon Rocks. We would like to thank Service Steel Aerospace for providing the titanium and steel samples we will use for the first broadcast. Our success is dependent on the support we receive from our membership to make these projects possible.”

The Co-Chairs for ITA’s Education Committee are Dr. Markus Holz is President, AMG’s Engineering Systems & Division CEO, ALD Vacuum Technologies GmbH and Mr. Graham Walker, Vice President, Sales and Marketing for AMETEK – Reading Alloys. Both also serve on the ITA’s executive board. Jennifer Simpson is the executive director of the International Titanium Association. Michael Gabriele is a freelance writer on behalf of ITA. For more information on the ITA Education committee, please visit www.titanium.org or contact 1-303-404-2221.

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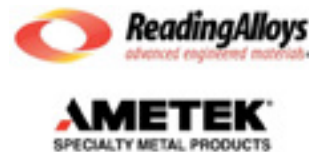
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The company transforms revert, through rigorous process, into material which can be re-melted, to produce new nickel, cobalt, or titanium alloys. Revert consists of excess alloy material which can arise from high performance component manufacturing, from decommissioned parts, and from the melting process.

Caledonian Alloys provides customers with a range of tailored revert management services designed to enable them to optimize the use and value of their own revert material.

Accredited with all major vacuum and high temperature melters worldwide, Caledonian Alloys supplies fully processed nickel and titanium revert material to the melting industry. We also purchase revert material from a wide range of industrial customers throughout the world.

CEFIVAL

+33 1 39 37 12 25

www.cefival.fr

commercial@cefival.fr

Manufacturing of hot extruded special sections, tubes and rings for aircraft engines in any kind of steels, nickel alloys and titanium alloys. Main application fields: aeronautics (for aircraft engines and structural parts), energy (nuclear and conventional applications), medical and food industry.

Chaoyang Jinda Titanium Co., Ltd.

+86 421 2976177

www.jinda.cc

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

Jinda Titanium passed ISO9001 Quality Management System, ISO14001 Environmental Management System, GB / T28001 Occupational Health and Safety Management System, GJB9001B Military Standard Quality Management System, AS9100C Aerospace Quality Management System Certification and ISO / IEC17025 National Laboratory Accreditation.

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

Chesapeake Industrial Cleaning Products, Inc.

+1-410-340-9052

www.chesapeakeindustrial.com

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

China Huaxia Special Metal Limited

0086-21-58770128

www.nonferrous-metal.com; www.csmhuaxia.com

helen@nonferrous-metal.com;

csm@nonferrous-metal.com

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

China Steel Corporation

+886-7-802-1111

http://www.csc.com.tw/csc_e/pd/mlg/mlg.html

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

Quality and safety have been the eternal pursuit of China Steel when customers choose China Steel as supplier. All our production and products are strictly enforced in compliance with industry standards. Furthermore the object of our effort is to cost effectively to not only meet but also exceed your most demanding requirements.

Cogitic Corporation

www.cogitic.net

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.

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

Consarc Corporation

+1-609-267-8000

www.consarc.com
sales@consarc.com

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

Continental Steel and Tube Company

+1-954-332-2290

www.continentalsteel.com/Titanium/default.asp

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

Continental Steel supplies a wide range of metals including, titanium, stainless steel, nickel, steel, aluminum, hot/cold rolled, galvanized, and stainless and electrical steel in carbon and alloy grades. Our long list of Titanium Grades includes Ti 6AL-4V ELI. Our materials are available in coils, sheets, strips, plates, angles, bars, rounds squares, hexagons, and other custom shapes. Continental also offers tubing or pipes in welded, DOM and seamless.

Cristal Metals Inc.

+1-815-221-2281

www.cristalmetals.com
itp.billing@cristal.com

Cristal Metals was formed in 1997 as International Titanium Powder (ITP) to develop and commercialize Armstrong Process® patented and proprietary technology for high purity metal and alloy powders with specific emphasis on titanium. 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
www.csiro.au/en/Research/MF/Areas/Metals.aspx

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.

BHN Special Materials Ltd.

+86 411 8924 9999 ext 8057 /8022

www.bhn-materials.com
sales@bhn-material.com

Dalian BHN Special Materials Ltd. is one of the state-of-the-art manufacturers and suppliers of high-grade master alloys for applications in the titanium, steel and aluminum industries. BHN is a customer-oriented company which is engaged in research, product development, manufacturing and improvement of melting technology, and successfully achieved the EN9100:2003 that is valid from September 2013 to Sep. 2016.

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, windpower, 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.

DHL Drawback Services

+1-585-328-7130

www.dhl drawback.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.

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

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.

Duferco SA

+41 91 822 56 00

www.duferco.com

Duferco 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.duferco.com

Duisburg Tubes Production AG

+49 203 6003 315

www.dtp-ag.eu

sales@ntp-ag.eu

The Duisburg Tubes Production AG is a German manufacturer and developer of high quality seamless tubes made of zirconium, titanium and nickel-based alloys with over 50 years of experience.

As a supplier of cladding tubes for fuel rods for the nuclear industry the DTP AG is the reliable partner for all demanding applications. To fulfill all quality requirements is the second nature.

The range of application is as mentioned before the nuclear industry. Moreover the use in all kind of tubular heat exchangers, in the aviation industry, in the chemical industry, in the oil and gas industry, in the food processing industry and many other demanding environments.

The cold pilger mill seamless tube production is a special form of cold rolling and guarantees high precision and close tolerances. The combination of pilger know-how and the sophisticated annealing knowledge leads to an extraordinary product quality.

The quality management system is conform to ISO 9001, ISO 5001, ISO 14001 and EN 9100.

Dynamet Incorporated

+1-800-237-9655

www.carttech.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.elguticalloys.com

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

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

Evrax Stratcor, Inc.

+1-312-533-3650

www.evraxstratcor.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 614.688.5000.

FAE S.A.

54-11-63261493/94/95

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. Its 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.

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

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)

FRIEDRICH KOCKS GmbH & Co KG / KOCKS PITTSBURGH COMPANY

+49-2103-7900
+1-412-367-4174
www.kocks.de
sales@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.

Friggi N.A.

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

Friggi N. A. Inc., provides premium metal and aluminum cutting solutions to the North American market. With over 70 years manufacturing experience we now offer large vertical plate and block saws, high-speed carbide saws, plasma, and waterjet cutting

solutions. Within our product line, we offer specialized equipment to cut challenging materials like Titanium or exotic metals with extreme precision and performance. Our plate saw capacity is over 20 feet and our Gantry models will cut blocks up to 140" with minimal material handling. Machines are available in automatic or semi-automatic version to cover any requirement. We service many key market segments including aerospace, automotive, defense, oil and gas, steel service centers, forging and mold makers. Whether the application is to cut ferrous or non-ferrous metals for ingot, bar, block, or plate we offer the best solution for our clients' production needs.

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.

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

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.

Global Titanium Inc.

1-313-366-5300

www.globaltitanium.com

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

Goldman Titanium, Inc.

716.823.9900

www.goldmanti.com

info@goldmanti.com

Goldman Titanium, Inc. purchases and processes scrap titanium in order to supply the highest quality finished product to our customers. As a pioneer in the titanium industry, our company was first established in 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 TITANIUM 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.

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 one-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

+49208 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

Hogue Metallography

Services Include:

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

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

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

HORIE Corporation

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

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

Independent Forgings & Alloys Ltd

+44-114-234-3000
www.independentforgings.com
sales@independentforgings.com

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

Inductotherm Corp. - Long Products Division

+609-267-9000
www.inductotherm.com
sales@inductoerm.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.

Industrial Metals International Ltd.

+1-631-981-2300
www.industrialmetals.com

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

Invera

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



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

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

Full product 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.

KASTO, Inc.

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



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

Kevin Kreitman, EFO

530-921-1711
klkreitman@gmail.com

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

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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

+1-773-572-6173

www.Keywell.com

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

Kings Mountain International (KMI)

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Kings Mountain International (KMI) is an ISO 9001:2008 / AS9100C certified precision grinding company.

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- Thin sheet grinding to .010"
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- Polishing of sheet and plate to #3, #4 or #8 mirror. Non-directional also available

Benefits:

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- Plate / Sheets arrive clean, damage free and ready for fabrication

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L.C.M.A.

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www.lcma.lu

Mr Otis Claeys – CEO

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Mr Igor Turkin – Technical Director

turkin@lcma.lu

Mr Thomas Mitidieri – Production Manager

Thomas@lcma.lu

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



We work with several manufacturers based in Ukraine and Europe who convert our Grade 1 to 5 ingots in forged and rolled bars, sheets, plates, coils, spools, electrodes, tubes and more. LCMA is ISO 9001:2008 and EN9100:2009/AS9100:2009 aerospace approved and is PED97/23EC certified.

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.

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Email : lcma@pt.lu

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

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Laube Technology

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www.laubetitanium.com

tisaales@laube.com



Laube Titanium Mill Products is a division of Laube Technology. Laube began its long history of quality and service in 1948 as a Chicago based warehouse distributor of steel mill products. Anticipating the growing influence of the Pacific Rim countries in supplying product to the United States, Laube's corporate offices were moved to the west coast in 1961. Strategically poised, Laube became an industry leader, pioneering the importation of metal products from Asia and elsewhere. Today the Laube group consist of three separate divisions. Those are: *Titanium Mill Products*; Offering titanium forms of sheet, plate, bar, tube, pipe, and coil from both domestic and foreign mills. The *Custom Metal Parts division*, which specializes in providing the industry with unique metal components usually designed for a specific use; and *Electronic Components and Assemblies Division*. This department supplies all types of custom control panels and keyboard assemblies. Laube is a privately held, family run company and continues in its proud heritage of providing decades of quality product at competitive costs.

LOTERIOS S.p.A., a TIMET Company

+39-02-9648281

www.loterios.com

LOTERIOS S.p.A. core business: TIMET Italian Service Center (sheets, plates, bars, forgings, etc.) and leading fabricator of titanium pipe, fittings, shell and tube heat exchangers and vessels as required.

Mair Research S.p.a.

+39 0445 634 444

www.mair-research.com

salesdept@mair-research.com

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

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

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

Mair Research has gained significant experience in the field of finishing lines for ERW and Seamless tubes by supplying turnkey 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, hydro testing, 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, multi-cutting, chamfering, automatic bundling and strapping).

Makino

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www.makino.com



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.

Developing customized friction welding solutions utilizing Titanium and other precious metals for customers in many different industries and countries has helped position MTI as a global leader. We have over 800 friction welders on six continents, purchased by satisfied customers who include research centers dedicated to the promotion and development of innovative uses of friction welding. MTI continues to be at the forefront on how to use force and motion for advances in near net shape manufacturing. Please visit our website for full detail examples. We also provide on-site manufacturing welding services from our headquarters in South Bend, Indiana and our location in Kingswinford, England.

We are here to help you with complete technical solutions and manufacturing support by providing everything from Weld Development to Process Design, Manufacturing Services to Next Generation Manufacturing, Machine Specifying to Machine Build, Installation, and Service—a true "one stop" shop. Our approach is about working closely with your team to solve your manufacturing problems. This approach allows us to provide you seamlessly integrated manufacturing cells that meet your production needs.

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, Spinel and Nanotechnology. MER develops processing to produce titanium more economically that includes lower cost than sponge and downstream additive manufacturing processing to produce low cost titanium

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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.

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www.medartglobal.com
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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.

METALVALUE

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metal@honnart.fr

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

Metalwerks PMD, Inc

+1-724-378-9020
www.metalwerks.com

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

Metalysis Ltd.

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

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

MetCon, LLC

+1-724-888-2172
www.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 234400
www.metraco.be

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

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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.

MetSuisse has a unique grinding facility allowing:

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

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,

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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.

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-Al, Mo-Al, 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.

Norsk Titanium AS

+47 97 42 22 00

www.norsktitanium.com

info@norsktitanium.com

Norsk Titanium AS is the world's pioneering supplier of aerospace-grade, additive manufactured, structural titanium components. The company is distinguished in the aviation industry by its patented Rapid Plasma Deposition™ (RPD™) process that transforms titanium wire into complex components suitable for structural and safety-critical applications. The Norsk Titanium research and development team is committed to displacing the age old and inefficient forging process with a precision wire deposition technology embodying substantial savings for aerospace, defense, and commercial applications. www.norsktitanium.com

North American Alloys

+1-800-985-2250

www.northamericanalloys.com

steve@northamericanalloys.com

Now celebrating our 32nd year in business, North American Alloys processes titanium alloy scrap for recycling and warehouses stocks of new and surplus lots of titanium mill products. North American Alloys warehouse in Kennewick, WA handles titanium sheet, plate, bar, billet and tubing. Please visit our website at www.northamericanalloys.com to view our current inventory of titanium products. North American Alloys is always seeking new sources of excess inventory materials in titanium, cobalt or nickel alloys and specialty metals such as tantalum, columbium, zirconium and beryllium. Contacts: Michael Shulimson – President, Steve Meredith, Director of Sales and Peter Rockefeller, Warehouse Manager.

Nu-Tech Precision Metals

+1-613-623-6544

www.nutechpm.com

Nu-Tech Precision Metals manufactures by hot extrusion seamless pipe, tube, fittings, bar, rod and shapes for nuclear, aerospace, military, medical, offshore, mining, chemical, sub-sea and corrosive environments. Shapes, especially those for the aerospace industry, fit within a 12" (300 mm) circle size. Our extrusion process creates a near-net shape that reduces material and machining costs overall. Our ability to alpha-beta process results in improved fatigue resistance over beta extrusions...contact us to learn more about how this process will benefit your extrusion requirements. Seamless pipe schedules from 1.5" (40 mm) to 14" (350 mm) plus specialty sizes and wall thickness. Custom extrusions in all grades of Ti Zr Nb Ni Cu Hf Ni, specialty stainless, carbon steels, copper, and high purity aluminum alloys. Bi-metal extrusions such as titanium clad copper, copper clad niobium tubes for RF cavities, nickel clad steel, etc are extruded resulting in a metallurgical bond. Sputtering tubes and backing tubes are our specialty!

"Titanium Valley" Special Economic Zone" OJSC

+7-343-378-45-83

titanium-valley.com

welcome@titanium-valley.com

Titanium valley is the special economic zone (SEZ), based in Russia, Sverdlovsk region, where unique conditions for production 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. For the moment there are 8 resident companies, organizing their production in different industrial spheres at the SEZ. The key resident is LLC "Vsmo-New Technologies", that will start their production of machined titanium components for aerospace companies, mostly for Boeing, in 2017.

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The Olin Research Group

(216) 246-0221

www.olinresearchgroup.com

chrisolin@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.

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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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OSAKA Titanium technologies Co., Ltd.

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Oscar Production Group Ltd.

+380 56 770 1234

www.oscar-tube.com.ua

mail@oscar-tube.com.ua

Manufacturer of cold and hot formed seamless titanium tubes and rods.

Overon Group

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The company has been producing valves and equipment details from titanium for more than 50 years.

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as most modern machining, welding and heat-treatment equipment provides guaranteed quality of produce. Production process of every detail is being controlled by all necessary destructive and non-destructive methods.

Parker, Messina & Associates, Inc.

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www.pma-engr.com

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

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

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Precision Castparts is the world leader in structural investment castings, forged components, and airfoil castings for aircraft engines and industrial gas turbines. Airbus, Boeing, GE, Rolls-Royce, and many other leading manufacturers depend on us for critical airframe, engine, power generation, medical, and general industrial components. With few exceptions, every aircraft in the sky flies with parts made by PCC.

Perryman Company

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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. Our Spectralloy facility is engaged in the recycling of titanium revert raw material for use in various titanium melt processes in the manufacture of titanium ingots. 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.



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Plymouth Engineered Shapes

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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.

President Company Ltd.

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www.presico.com.tw

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

President Titanium Co., Inc.

+1-800-225-0304

www.presidenttitanium.com

sales@presidenttitanium.com

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

Quebec Metallurgy Center

+1-819-376-8707

www.cmqr.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.

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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

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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

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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.

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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.

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

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

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

terms of breadth, depth, accuracy and expertise.

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

S. Letvin & Son, Inc.

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www.titaniumscrap.com

S. Letvin & Son, Inc., specialists in processing high temperature scrap metals, has been in business since 1947. We prepare a high quality 6/4 titanium feedstock package that meets AMS 4928 Chemistry specifications. We have developed a unique and proprietary process to return mixed 6/4 titanium fasteners to specification 6/4 titanium. The final product is 6/4 titanium "Rotor Grade" feedstock; 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.

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www.s-d-group.com

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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:

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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

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is the constant search for technologically advanced products and materials that will ensure quality and the desired satisfaction of our customers.

Sandvik Materials Technology Product Unit Special Metals

+46-26-260000

www.smt.sandvik.com



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

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

Schaffer Grinding Co., Inc.

+1-323-724-4476

www.schaffergrinding.com

info@schaffergrinding.com

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

Sector3 Appraisals, Inc.

+1-718-268-4376

www.sector3appraisals.com

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.

Service Steel Aerospace

+1-800-426-9794

www.ssa-corp.com

sales@ssa-corp.com



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.

Sierra Alloys / TSI Titanium

PRV Metals Companies

+1-626-969-6711

www.prvmetals.com

Manufacture and supply forged and rolled products in Titanium alloys, nickel-cobalt base alloys, precipitation hardened stainless and high alloy steels from small rectangular and round bar to large section size open die forged bar and stock.

Solar Atmospheres

+1-855-934-3284

www.solaratm.com

info@solaratm.com



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.

Solar Manufacturing, Inc.

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www.solarfmfg.com



Solar Manufacturing designs and manufactures high performance, technically advanced and energy efficient vacuum heat treat furnaces. Models range from compact R&D size furnaces to mid-size horizontal production furnaces to huge car-bottom vacuum furnaces for large heavy workloads. Our furnaces feature improved graphite insulation materials, curved graphite heating elements, tapered gas nozzles, high velocity gas quench systems, SolarVac® 4000, and 5000 interactive control systems, and ConserVac energy management system. We design for vacuum heat treat processes such as hardening, brazing, annealing, stress relieving, normalizing, tempering, sintering, low pressure carburizing and vacuum gas nitriding. Solar knows vacuum heat treating inside out. Our engineers and metallurgists bring decades of expertise to the design side of the business and our knowledgeable technicians provide world-class manufacturing keeping Solar in the forefront of vacuum furnace innovations. As an ITA member company, Solar welcomes the opportunity to assist our customers in choosing the right vacuum furnace, replacement hot zone, spare parts and service for your needs.

Specialty Metals Company

+32- 2645-7670

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.

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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 turnaround times.

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Spectore Corporation

954-481-8422

www.spectore.com

info@spectore.com

Spectore Corporation was founded in 1983 to reinvigorate the 3,000 year-old traditions of the jewelry industry with its introduction of titanium as a new noble element. New technologies were perfected to manipulate this extremely tenacious and non-traditional metal. The company's ambitious designers and R&D team have persistently explored the potential of titanium to create truly unique collections. This resulted in being awarded the 2010 Titanium Development and Advancement Award by the ITA. Today Spectore remains dedicated to the development of new methodologies for the design, engineering and manufacturing of high-end consumer products made of titanium.

Spectore Corporation designs and manufactures for a range of world class brands focusing on consumer products from household, sporting, technology, apparel, corporate gifting and jewelry. Spectore Corporation has also developed their own in house designer brand, Edward Mirell which has won a wide range of national and internationally recognized design awards.

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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Well-established specialist in the fabrication and repair of copper crucibles, hearths and related equipment used in VAR, ESR, EBM, PAM, as well as various similar processes. Serving producers of the reactive metals and alloys, nickel alloys, refractory metals, and steel alloys.

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Sumitomo Corporation of Americas (SCOA) is a wholly-owned subsidiary of Sumitomo Corporation, which is one of the leading trading companies in Japan. SCOA is an integrated global trading firm with diversified investments in a wide variety of industries, products and services.

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Supra Alloys, a division of Titan Metal Fabricators

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Supra Alloys offers a fully-stocked Titanium Service Center with the convenience of extensive in-house processing capabilities. Located in Camarillo, California USA, Supra routinely provides Titanium for applications in the aerospace, chemical processing, medical, metal finishing and sports/recreation industries throughout the world.

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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.

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-Calc Software

<http://www.thermocalc.com>

Thermo-Calc Software is a leading developer of software and databases for calculations involving computational thermodynamics and diffusion controlled simulations.

Our extensive library of databases includes three dedicated specifically to titanium and TiAl-based alloys, making Thermo-Calc a powerful tool for performing thermodynamic and phase equilibria calculations for multicomponent systems.

Our add-on programs, DICTRA and TC-PRISMA, allow for accurate simulations of diffusion in multicomponent alloys and the prediction of precipitation kinetics. And our software development kits enable Thermo-Calc to be called directly from the user's own software or MATLAB®.

Common calculations for Ti-alloys:

- β transus temperature T_β
- Sensitivity of T_β to impurity content of O, C and N
- Volume fraction of α and β
- Partitioning of alloying elements between α and β phases

Common calculations for TiAl-alloys:

- α transus temperature
- $\alpha_2 + \gamma$ eutectoid temperature
- Formation of the B2 phase

Formation of minor phases such as Ti₅Si₃

TICO Titanium

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www.ticotitanium.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.

TiFast

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www.tifast.com

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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.

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Manufacturer of wide-belt grinding and brushing machines for stainless steel sheet and coil finishing; lasercut, punched, routed 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) and 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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First in Titanium Worldwide

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.

TIODIZE Company, Inc.

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www.tiodize.com

Titanium Anodize,
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Tipro international co ltd

+86 29 89181603

www.tipro-international.com

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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 ;

Titan Engineering Pte Ltd.

(+65) 6853 7424

www.titanium.com.sg

sales@titanium.com.sg

Titan Engineering is a Singapore based distributor of Titanium, High Temperature metal & Specialty alloys. Titan has an extensive stock of prime titanium metal plates, sheets, round bars and welding rods in CP grades and Ti6Al4V grades. Our supply range includes Nickel, Inconel®, Monel®, titanium heat ex-changer seamless & welded tubes and MMO coated anodes. Titan is an approved supplier to Rolls-Royce and other major OEMs. Let Titan be your partner in your titanium procurement.

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, 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.

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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

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bar, seamless titanium tubing and also offer products manufactured by: forging, rolling, and machining using common ASTM grades of titanium including: Titanium Grade 5, Titanium 6-2-4-6, Titanium Beta-C. With our metallurgical background we will support your team from design, through prototyping, and finally into full-scale production of components.

Titanium Fabrication Corporation

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www.tifab.com

A World leader for over 40 YEARS in the application, design and fabrication of quality titanium and zirconium process equipment, whether solid or clad construction. Extensive experience in rotating, offshore, marine or ordinance equipment. Most extensive titanium field welding/erection service capability in the world. Mill products available from stock. For more information email bbrownlee@tifab.com.



Titanium Finishing Company

+1-215-679-4181

www.titaniumfinishing.com

melinda@titaniumfinishing.com
melanie@titaniumfinishing.com

Metal finishing services include: Titanium Anodize; Hardcoat Anodize of Aluminum; 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.



Titanium Industries, Inc. (T.I.)

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www.titanium.com

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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.



Titanium International Group SRL

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www.titanium.it

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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

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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www.titaniumproductsandconsulting.com

The focus of Titanium Products and Consulting, Inc. is primarily in two areas. The first is a consulting role for titanium and titanium alloy products, processes and applications. The second is to provide manufacturing and conversion capability with value added properties to enhance your applications performance and lower the overall cost. The ultimate goal is to provide enhanced customer service and technical assistance to make it easier and cheaper for new applications to be developed.

TMS Titanium

+1-858-748-8510

www.tms titanium.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.

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Toho Titanium Co., Ltd.

+81 467 87 7023

www.toho-titanium.co.jp

Toho Titanium Company, Ltd. manufactures titanium metals such as premium quality titanium sponge for aerospace and other applications, titanium ingot (CP and Alloy), high purity titanium ingot/billet for semiconductor industry and electronic materials including high purity titanium dioxide and ultra-fine nickel powder etc.

Trepanning Specialties, Inc.

+1-562-633-8110

www.trepanningspec.com

Trepanning & machining services. Specializing in hollow bar conversions to pipe, tube, ring and sleeves. Size capacity up to 55" O.D., 21" I.D. yielding a 26" core & can saw cut up to 22". Work with stainless steel to more "exotic" high temperature materials like Titanium, as well as non-metallic materials such as plastic and wood. Full machine shop offering trepanning, gundrilling/BTA, turning, saw-cutting, facing & specialty emergency services. We offer blind shipments. Material can be provided. Family run and Veteran owned since 1973. Contact us via phone (562)633-8110 or email: trepan_spec@yahoo.com.

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) oreglia@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

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the world's 500 largest companies through to mid-sized companies and small businesses.

TZMI regularly releases market reports and periodicals on relevant subject matters which support the consulting activities and ensure up-to-date, high quality and comprehensive data, analysis and information is provided. TZMI annually hosts the largest titanium and zircon industry conference. Email: marketing@tzmi.com

Ulbrich Stainless Steels & Special Metals, Inc.

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www.ulbrich.com

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Ulbrich Stainless Steels & Special Metals, Inc., is a leading processor of a variety of different alloys including, but not limited to: stainless steels, PH grades, nickel and nickel alloys, cobalt alloys, niobium, zirconium, titanium and titanium alloys. Commercially Pure Titanium: Grade 1, Grade 2, Grade 3, Grade 4, and Titanium Alloys: Grade 9 (Ti 3-2.5), Ti 15.3.3.3 and 21s (Ti Beta21s), as well as the aforementioned metals are available in strip, foil, flat, round and shaped wire. Nitinol, Grade 5 (Ti 6-4) and Ti 6.2.4.2. are available in limited widths at Ulbrich. Please inquire for more detail on all of our product offerings.

United Alloys & Metals, Inc.

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www.uametals.com

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United Performance Metals

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www.upmet.com

sales@upmet.uk



United Performance Metals, a leading distributor and processor of titanium and high performance alloys, serves global industrial markets. Headquartered in Hamilton, Ohio, United Performance Metals maintains branches in La Mirada, California; Houston, Texas; and Belfast, Northern Ireland as well as sales and stocking locations worldwide. Facilities in the US and UK carry a complete line of inventories in titanium, stainless steel, nickel, cobalt, and cobalt chrome moly available in sheet, coil, plate, forged block and round bar. First-stage processing services include precision blanks, laser & water jet cutting, cut-to-length, sawing, shearing, chamfering & facing, deburring, first stage machining and laser gauge measurement. O'Neal Industries (onealind.com), the U.S.A.'s largest family-owned group of metals service centers, is the parent company of United Performance Metals. With sales of approximately \$2.4 billion in 2015, O'Neal Industries is based in Birmingham, Alabama and has more than 80 specialized facilities throughout

North America, Europe, and Asia. AS9100 & 9120, PWA 119, ISO 9001 & 13485, AS7003, EE02-S-422

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 - Berezniaki 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.

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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.

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Vallourec 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.

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- strip
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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.

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www.vsm-po.ru

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VSMPO - Tirus, US

+1-720-746-1023

www.vsm-po-tirus.com

VSMPO-Tirus, US is the North American sales and distribution



division of VSMPO-AVISMA, the world's largest producer of titanium, holding more than 300 international quality certifications. VSMPO-Tirus US distributes ingot, forgings, slab, sheet, plate, bar, and billet to the aerospace, medical, and consumer products industries. VSMPO-Tirus US also manufactures small diameter bar and coil for medical and aerospace fastener applications.

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VSMPO Tirus GmbH

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www.vsm-po.de

VSMPO TiRus GmbH is responsible for the sales and distribution of titanium semi-finished products in Europe (except the UK), Brazil and Israel to the aerospace, medical and automotive industries. The company was established in 1999 in Frankfurt/Main. The German affiliate of the largest vertically integrated international titanium producer VSMPO-AVISMA offers optimum service, including custom-made processing of semi-finished products as well as a comprehensive transport service. We offer cut-to-size material (bars, billets, sheets and plates) to meet our customers' individual operational needs. TiRus GmbH also distributes electrodes, ingots, rolled rings and different types of forgings.



VSMPO Tirus UK Ltd.

+(0) 1527 514111

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VSMPO Titan Ukraine Ltd.

+380 562 313092

www.tw-vsm-po-avisma.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



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(outside diameter 169-325 mm and wall thickness 7-30 mm). Engineers and technical specialists are developing new technologies of titanium tubes production and new types of products. For example, octahedral and ribbed tubes, special kind of thin tubes for silphons, technologies of long-length tubes production, etc. VSMPO Titan Ukraine Ltd. has all equipment necessary for different tests and QA inspections. It allows manufacturing not only according to the international and national standards, but meeting any customer's requirements.

Vulcanium Metals International

+1-888-326-7556

www.vulcanium.com

titanium@vulcanium.com



Vulcanium is a supplier of titanium, stainless steel and cobalt chrome moly in sheet, coil, plate, bar and forged block. FIRSTCUT+® Services include precision blanks, laser cutting, water jet cutting, cut-to-length, sawing, shearing, chamfering & facing, deburring, first stage machining and laser gauge measurement. Corporate headquarters are located in Chicago, Illinois. For more information, visit www.vulcanium.com.

Vulcanium is a specialty division of United Performance Metals. O'Neal Industries (onealind.com), the U.S.A.'s largest family-owned group of metals service centers, is the parent company of United Performance Metals. With sales of approximately \$2.4 billion in 2015, O'Neal Industries is based in Birmingham, AL and has more than 80 specialized facilities throughout North America, Europe, and Asia.

Webco Industries

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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.

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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.

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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.

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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.



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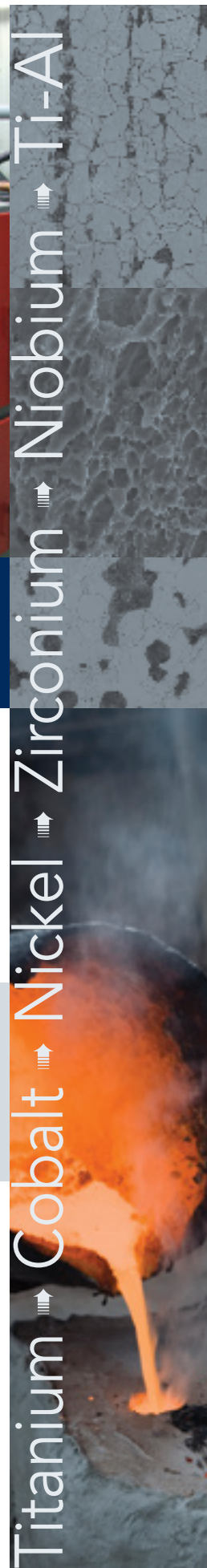


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Western Superconducting Technologies Co., Ltd. (WST), located in Xi'an, the capital city of Shaanxi Province, China, is a leading corporation for the production, R&D, and marketing of titanium ingot, billet, bar, wire, slab, plate, etc. Especially 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.

Westmoreland Mechanical Testing & Research Inc.

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Westmoreland Mechanical Testing & Research is a world leader in materials testing. Founded in 1967, WMT&R serves a broad range of industries including aerospace, automotive, medical, and power generation. We support our customers with our highly-skilled staff and advanced facilities. Our turnaround time is unrivaled, and with over 300,000 square feet of accredited production and testing space, we have the capacity and equipment to handle any materials testing project. WMT&R's testing expertise includes: Mechanical Testing, Composites, Fatigue, Stress/Creep Rupture, Fracture Mechanics, Metallography, Chemical, Heat Treat, Thermal Analysis, and Physical Properties Testing. For more information, please visit www.wmtr.com or email us.sales@wmtr.com.

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Wyman-Gordon is a worldwide supplier to the aerospace and industrial gas turbine markets. We hold quality accreditations for all of the major airframe and engine manufacturers for both civil and military applications. Wyman-Gordon creates rotating closed-die forgings which are critical for aerospace and land-based gas turbines. Wyman-Gordon also manufactures structural forgings for airframe, nuclear, petrochemical, power generation, and space applications.

Xi'an Metals & Minerals Import & Export Co., Ltd.

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As a leading manufacturer and distributor of Titanium, Molybdenum and Tungsten products in China, Xi'an Metals and Minerals Import & Export Co. Ltd., has joined into manufacturing, researching and competing in Titanium industry. We supply Titanium and its alloys in various forms as per ASTM, AMS and other main internationally recognized specifications. Our advantage is the most competitive prices as well as guaranteed high quality! Our products are exported worldwide, and gained high reputation because of their excellent performance.

ZIROM S.A.

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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.

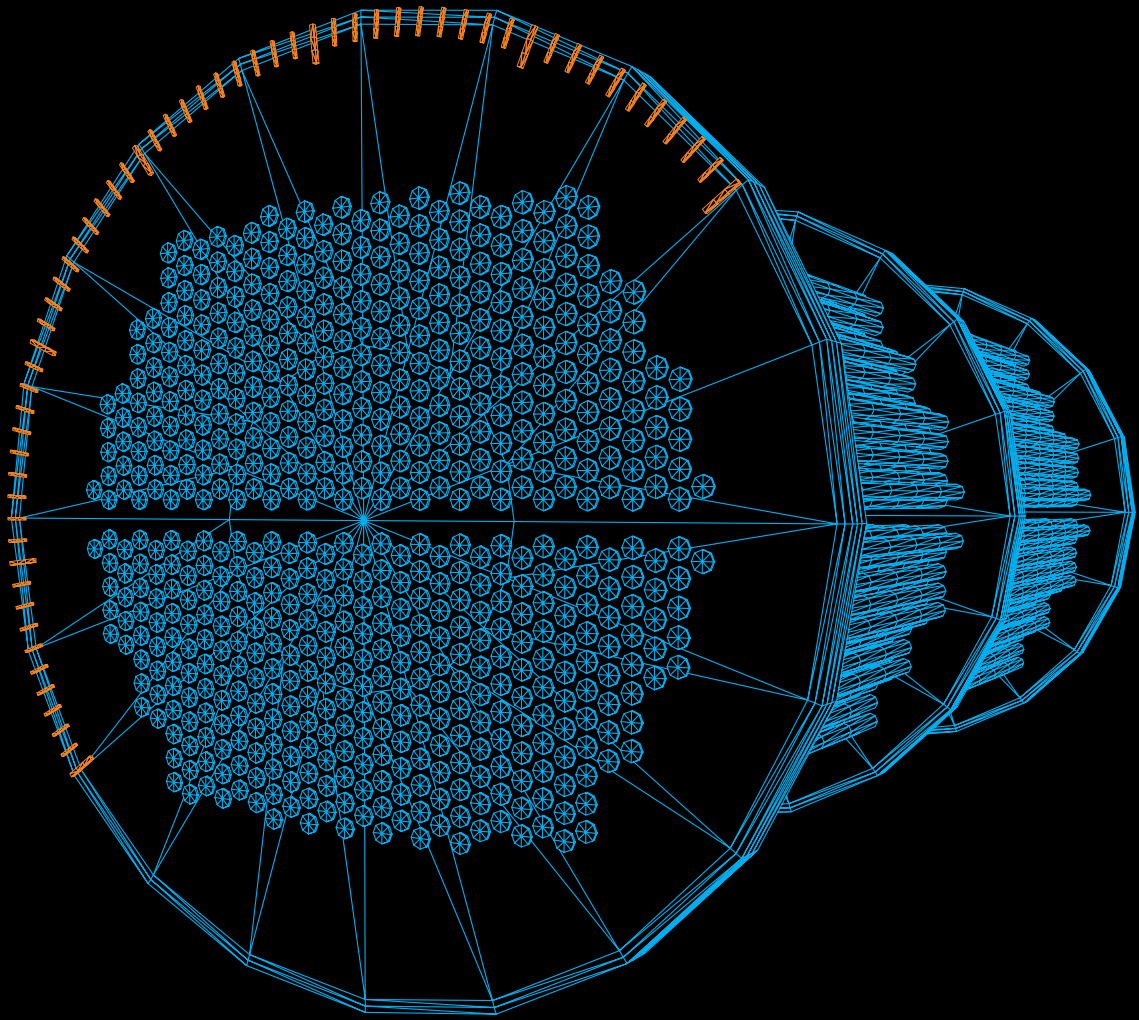
ZTMC Zaporozhye Titanium & Magnesium Combine

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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 renowned 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 Standards ISO 9001:2008 and EN 9100:2009".

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