The sixth annual TITANIUM EUROPE 2018 Conference and Exhibition, sponsored and organized by the International Titanium Association (ITA), held May 14-16 in Seville, Spain, attracted 371 delegates and featured a tour of the Airbus M400 Plant in Seville. The gathering hosted speaker panelists and industry experts who provided their insights on the titanium global supply chain, near-term business conditions and trends, and emerging manufacturing technologies.

The Airbus A400M Atlas is a multi-national, four-engine turboprop military transport aircraft, designed by Airbus Military (now Airbus Defense and Space) as a tactical airlifter with strategic capabilities. The A400M’s maiden flight took place on Dec. 11, 2009 from Seville.

The ITA’s Women in Titanium (WiT) committee underlined its activities in 2018 and beyond. The mission of the WiT committee is to develop a networking group of collegial women presently in the titanium industry, and to promote, attract and encourage high school and college women to enter the titanium industry. The WiT committee contributes to the growth of the titanium industry through mentoring, collegial and networking opportunities for women within the titanium industry.

Michelle Pharand, vice president, sales and marketing for Astral Air Parts LLC, is the chair of the WiT committee and Holly Both, vice president of marketing for Plymouth Tube Co., is the vice chair.

Albert Bruneau, president of Neotiss, a leading producer of titanium tubing, offered his thoughts on global trends for titanium industrial markets. Bruneau estimated the current level of demand of the worldwide industrial titanium market is 27,000 metric tons. He projected demand would reach 30,000 metric tons in 2021. The industrial market encompasses applications in the process, power generation, automotive and desalination industries, with process accounting for roughly half of the overall sector in terms of titanium volume.

Bruneau said that in recent years desalination has been an erratic and unpredictable market for titanium consumption, with an uncertain status for several desalination facilities in the Middle East. In addition, Bruneau indicated the reverse osmosis desalination
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process, which uses little titanium, has become the favored technology for this industrial market, compared with thermal multi-stage flash distillation, which typically requires a high volume of titanium tubing, pipes and valves. By way of comparison, Bruneau sees the potential for opportunities in power generation, especially in plans for nuclear power projects in India and China.

In a separate presentation, Brian Mercer, global sales and marketing director of Ametek Specialty Metal Products addressed issues regarding “Industrial Applications for Titanium Tubing. Mercer said that while engineers are attracted to titanium’s “natural cache” of properties (strength-to-weight; biocompatibility; and corrosion resistance), “customers often need a solution not a tube dimension. Arriving at a solution needs supportive technical marketing data.

Even though demand growth for titanium tubing is positive, factors that may hinder growth are capacity and lead time (for seamless tubing), sustainable, validated manufactured routes, and seamless versus welded economics and specifications.

Michael Metz, the president of VSMPO Tirus US, estimated that titanium demand for the Russian market, mainly composed of aviation and industrial business sectors, would top 10,000 metric tons this year and will climb to 12,000 metric tons by 2022. Russian titanium sponge producers Avimma and Solikamsk Magnesium had respective 2017 output levels of 40,704 metric tons and 1,880 metric tons. Russian titanium ingot production in 2017, made up of five producers, the largest of which is VSMPO, had an estimated capacity of 80,500 metric tons.

Metz reported that, in 2017, Kazakhstan registered an output of 11,000 metric tons of sponge and 6,240 metric tons of ingots. During the same period, Ukraine’s output of sponge totaled 7 metric tons and 2.5 metric tons for ingots.

Andrea Carolina Clark, titanium product manager, Continental Steel & Tube Co., Fort Lauderdale, FL, shared her perspective on “The Future of the Global Bicycle Industry.” Clark said the global bicycle industry is expected to continue growing as various organizations continue to advocate for a cleaner environment and healthier lifestyles. “Titanium will remain an essential metal for bicycle producers since the costs associated with production has been reduced in the past few years due to new innovative manufacturing technologies,” she said.

Bicycle production, based on steady consumer demand and the growth of cycling as a popular international sport, remains strong in North America, Europe, Asia and Australia. “In terms of production of titanium bicycle, China dominated the global market with a share of 41.6 percent in 2017 and is projected to grow up to 43.5 percent by 2025,” she said.
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noting that Grade 9 (Ti3Al-2.5V), Grade 2 and Grade 5 (Ti6Al-4V) remain the most popular titanium alloys for bicycle production.

A presentation by Henry Seiner, vice president of business strategy for Titanium Metals Corp. (Timet), and the chair of the ITA’s board of directors, examined “Commercial Airframes: Trends and Forecasting.” Using a bar chart, Seiner compared the titanium demand forecasts for commercial airframes from aerospace consulting groups Teal and Airline Monitor. By 2026 Teal estimates demand will reach 40,000 metric tons, while Airline Monitor projects demand will reach 50,000 metric tons.

Seiner said overall global airline regional traffic, measured by “revenue passenger miles,” remains strong, even as specific markets are experiencing shifting trends. For example, North America dropped from 80 percent of world traffic in 1980 to 23 percent in 2016. “Asia/Pacific reached the same level of traffic as North America and Europe in 2010 and has exceeded both to date. The Middle East is now nearly 10 percent of global traffic.”

Charles Young, business development manager and metallurgist for Tricor Metals, addressed the topic of “Selling Titanium to the Industrial Market,” declaring in the summary of his presentation that “titanium is still misunderstood by chemical industry engineers and engineering companies.” The titanium industry needs to remain a competitive force in the worldwide industrial market, especially chemical processing, given the market’s project growth rates of 6.8 percent in 2019 and an average of 7 percent in 2020-2022, according to Young.

Young offered a host of points to push back on those who still “misunderstand” titanium’s value and capabilities for industrial applications. Titanium, he said, is “not an exotic metal.” It has a worldwide supply base with stocking distributors that provide quick, on-time material deliveries, along with many knowledgeable fabricators. Fabricators are able to educate the market with regard to quality control and proper welding specifications. Titanium offers a competitive, stable cost structure when compared with stainless steel and copper/nickel alloys as well as effective, long-term life cycle costs.

Guillaume Sana, research and development process manager of ACB, a division of Aries Alliance, discussed “Hot Forming of Titanium Alloys: Industrial Solutions for Efficient Manufacturing.” Based in France, Aries Alliance, an industrial manufacturing enterprise, has 300 employees, four industrial companies and six service companies industrial manufacturing units, all of which focus on business in the aerospace sector.

Sana reviewed the best practices for titanium hot forming, superplastic forming, linear friction welding, and hot-stretch forming. As for future business opportu-
nities, hot-forming technologies are a way forward to meet the increasing demand for titanium parts in aerospace and other industrial markets, Sana said. He also noted that traditional production management is being replaced by new manufacturing technologies that will be housed in factories of the future.

Burghardt Kloden, the group manager of additive manufacturing for the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Bremen, Germany, delivered a presentation on the “Processing of Titanium-Based Alloys by EBM (electron-beam melting): Powder to Component.”

As explained in an online post by Additive Manufacturing Magazine, in the Electron Beam Melting process, an electron beam is used to melt a titanium powder while the additive fabrication process builds parts on a layer-by-layer basis. Titanium wire or powder is placed under a vacuum and fused together from heating by an electron beam. When the high-speed electrons strike the metal powder, the kinetic energy is instantly converted into thermal energy. When the temperature is above the melting point, the electron beam rapidly liquefies the titanium powder. The vacuum supports processing of reactive metal alloys like titanium. After melting and solidifying one layer of titanium powder, the process is repeated for subsequent layers. In his talk, Kloden provided his outlook for EBM research and development and industrialization challenges. Despite current efforts, he said productivity for EBM additive manufacturing remains low, limited by several factors such as beam powder and pre- and post-heating. Build space is limited by beam power and the number of beam sources. As for quality control, current systems use cameras as monitoring devices, but detectors from scanning electron microscopes (SEMs) are not yet implemented.

According to information posted on its website (the English translation: www.ifam.fraunhofer.de/en.html), Fraunhofer IFAM is a leading European research institute with five locations (Bremen, Dresden, Oldenburg, Stade and Wolfsburg). With more than 600 employees, working in 23 departments, Fraunhofer has expertise in seven core competencies: powder technology; sintered, composite, and cellular metallic materials; adhesive bonding technology; surface technology; casting technology; electrical components and systems; and fiber reinforced plastics. Products, processes and technologies developed by Fraunhofer target a variety of business markets such as the aviation, automotive and medical industries.

Edward Jones, technical director, Hangsterfer Laboratories Inc., presented information on “Sustainable Cutting Fluids,” by first defining “sustainable,” which refers to fluids that are not harmful to the environment and that can endure the complexities of modern manufacturing. He pointed out that “lubricants are often the last part of the manufacturing process to be considered, and often the process is engineered to the limitations of the lubricant and not to the limitations of the tools and machine. Sustainable cutting fluids create a better machining environment, easier cleaning of parts, less material handling and improved productivity, according to Jones.

Jones said lubricants containing substances of “very high concern” from an environmental perspective include boric acid, formaldehyde containing biocides, secondary amines, short-chain chlorinated paraffin and medium-chain chlorinated paraffin.

Speaking at the ITA's TITANIUM USA 2017 conference, held last October in Florida, Jones said sustainable cutting fluids and lubricants can increase part surface quality and extend tool life. As an example of this, he said the development of advanced metalworking fluids has led to significant improvements in machining. Hangsterfer’s recently had their advanced metalworking fluid, S-787 independently tested. The results showed that S-787 increased surface quality and reduced cutting forces by at least
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Robert G. Lee, the chair of the ITA’s safety committee, updated the audience on “How Titanium is Affected by the TiO2 Category 2 Inhalable Carcinogen Classification in the EU Under REACH.” REACH is the European Union’s Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals, which was established in June 2007. According to information posted on the website of the European Chemicals Agency (“Understanding REACH; https://echa.europa.eu/regulations/reach/understanding-reach), “REACH was adopted to improve the protection of human health and the environment from the risks that can be posed by chemicals, while enhancing the competitiveness of the EU chemicals industry. It also promotes alternative methods for the hazard assessment of substances in order to reduce the number of tests on animals. REACH applies to all chemical substances; not only those used in industrial processes but also in our day-to-day lives, for example in cleaning products, paints as well as in articles such as clothes, furniture and electrical appliances.”

Lee stressed that the REACH regulations apply across the entire European Economic Area (EEA), which includes the EU Member States, Iceland, Liechtenstein and Norway. It covers all sectors manufacturing, importing, distributing or using chemicals as raw materials or finished products (not only the chemical industry). “It applies to you regardless of your company size and makes you responsible for the safe use of the substances you place on the market or use. REACH requires every actor in the supply chain to communicate information on the safe use of chemicals, and gives consumers the right to ask about substances of very high concern contained in your articles,” he said.

He said titanium’s REACH dossier indicates that data analysis for titanium metal revealed a complete absence of hazard data (environmental and human toxicity). Titanium metal is subject to rapid formation of a stable layer of titanium dioxide when exposed to air, forming in milliseconds.

The REACH focus appears to be on the potential health effects on the inhalation of titanium dioxide particles. Human exposure towards titanium metal is secondary to that of titanium dioxide. Lee said there is continuing discussion as to whether the carcinogenicity of titanium dioxide is cause by the chemistry of the material or the physical characteristic as a PSLT (poorly soluble, low toxicity). Last March it was announced the EU member states support change to the titanium dioxide classification, and that member states said the intend to vote on the classification at the June 2018 EU REACH meeting.

Melissa Allen, an executive with AMG Titanium Alloys and Coatings, GfE Metalle und Materialien GmbH provided information on the production of titanium aluminide (TiAl) alloys. These high-performance alloys are specified on a number of commercial aerospace engines, such as the GE’nx family, the PurePower PW100G family and the LEAP family.
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This year GfE plans to extend the TiAl product portfolio with atomized powders for additive manufacturing technologies. GfE has developed a production process for TiAl ingots based on vacuum arc remelting, plasma arc cold hearth melting and electron beam cold hearth melting. Different applications require specific treatments after the casting process. The capability for the recycling of valuable revert is mandatory for economic and environmental reasons.

Another AMG/GfE executive, Peter Baumeister, declared development of master alloys supplier base is essential for global titanium industry growth. In his presentation, “Critical Materials for the New Millennium,” Baumeister defined a master alloy as containing two or more alloying elements for a final titanium alloy, with a defined composition. Titanium master alloys are designed to meet the performance targets of the final tailor-made application; improve the mechanical properties, the heat and corrosion resistance of base the titanium; and improve and allow subsequent process steps (forging, forming, rolling). Vanadium, molybdenum, niobium and chromium are among the typical metals used in titanium master alloys.

Baumeister said master alloy producers must “balance the expectations of our customers and the capabilities of our raw material suppliers while taking into consideration our own constraints, provide our products to specification and on time, and be innovative in developing technical solutions for present and future master alloy requirements as well as leading cost reduction programs.”

Meanwhile, master alloy customers should balance purchasing orders within the approved and certified supplier base, understand and accept market influences (currency exchange rates, raw material situations), intensify cooperation by providing early involvement in research and development activities and reliable mid/long term forecasts, and establish a position of adjusting capabilities and capacities at the right time,” according to Baumeister.

“A master alloy is not a commodity,” he declared. “Master alloys are essential for the titanium industry. The titanium industry requires a healthy master alloy supply base.”

Neill McDonald of MetaFensch, Uckange, France, reported on “Titanium Remelting Studies Using a Semi-Industrial PAM-CHR” (plasma arc melting-cold hearth melting). McDonald explained that MetaFensch is a French publicly funded research and development platform, which serves markets such as aerospace, biomedical and automotive, “whose goal is to help industrial actors bring their innovative metallurgical products and processes to market.” Titanium represents 80 percent of MetaFensch’s activities in three cross-sectional domains: melting, casting and powder metallurgy; metal recycling and process energy efficiency; and upscaling industrialization via semi-industrial pilot furnaces.

In his concluding remarks, McDonald said a semi-industrial scale PAM-CHR has been installed in France with the objective to carry out studies on titanium scrap melting, alloy development and powder recycling. The PAM-CHR program is compatible with an electrode induction melting gas atomizer (EIGA) installed at the same location.

Werner Penkert, the manager of solutions engineering for global aerospace projects for Kennametal Share Services GmbH, said Kennametal has unveiled its Harvi Ultra 8X and Harvi III Aerospace Range cutting tools for enhanced metal-removal productivity. The Harvi Ultra 8X insert has eight cutting edges and features a new edge shape, geometry and design. The Harvi III has a proprietary core design to improve tool stability, an unequal flute spacing that reduces vibrations and improves the surface finish of parts, and a Safe-Lock™ shank that prevents end mill pullout and enables higher feed rates. Kennametal is based in Pittsburgh and holds
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Ron Adams, vice president of additive manufacturing for Bodycote Thermal Processing, shared his company’s insights of a study on the “Removal of Additive Manufacturing Processing Defects and Improving Material Properties in Titanium.” Bodycote is a leading provider of heat treatment and specialist thermal processing services. Adams said the study involved titanium part production using Arcam additive manufacturing equipment. “It’s well known that defects can and still do occur even using the most robust processing parameters,” he explained. “It’s been widely published that HIP (hot isostatic pressing) is recommended to improve properties, but how well? Can we validate the effectiveness of the HIP process? Can we detect defects?”

Cylindrical parts were produced and then tested via a CT scanning X-ray. Adams said the results indicated that small sporadic defects can be detected, and that even the largest defects were completely eliminated via the HIP process. He said HIP with a large production, rapid-quench unit is about to start up, which will help determine whether commercially available HIP capacity will create relevant improvement in material properties.

Thomas L. Christiansen, the Technical University of Denmark (DTU) examined “Future Trends in Gaseous Surface Hardening of Titanium and Titanium Alloys.” Christiansen said controlled gaseous surface hardening of titanium is possible and surface properties can be tailored to boost wear performance.

Michael Mathes, Access e. V., discussed four approaches for TiAl LPT (low-pressure turbine) aerospace engine blade production. He compared blade production via machining from a solid titanium block; isothermal forging; investment casting; and additive manufacturing. He said machining from a solid block offers a stable process and lean supply chain.

Isothermal forging yields the highest mechanical properties and a streamlined manufacturing process through pre-shaped cast blanks. Investment casting delivers the lowest buy-to-fly ratio and reduced material and machining costs due to the use of near-net shape parts. Electron beam additive manufacturing achieves the highest recycling share and high geometric design freedom.

Sylvain Gehler, UKTMP chairman, addressed the “World Titanium Sponge Supply Situation,” indicating that global titanium sponge production is expected to rise after a four-year lull due to aerospace demand. “The increase of build rates of long-range aircraft, the strong demand for engines as well as the growth of the Chinese domestic market has helped to decrease the high inventory of sponge which was overhanging in the market.

“Demand for the aerospace industry remains very strong, the ramp up of the long range planes B787 and A350 is ongoing,” Gehler continued. “Single-aisle planes at Boeing and Airbus are being ramped up to historical high build rate. Backlog is still strong in spite of new orders decreasing, representing nine years of guaranteed work. The backlog is made up on 80 percent of single-aisle planes at Boeing and 85 percent at Airbus. Both Airbus and Boeing are ramping up gradually their single-aisle pro-
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duction and both should reach 60 planes per month.”

Regarding industrial markets, Gehler said volume and pricing remain depressed but future outlook is improving. The shipbuilding industry in China and Korea is picking up with already $16.8 billion of orders book in 2017 compared with $6.8 billion in 2016. Meanwhile, oil and gas prices are increasing, which could spur producers to consider new capital investments. Demand remains strong from China’s energy and chemical markets, he said.

Gehler estimated that world titanium sponge production will reach 195,000 metric tons in 2018, up from 187,400 metric tons in 2017. North American titanium sponge production is expected to drop to 7,000 metric tons, compared with 9,000 metric tons in 2017 and 22,600 metric tons in 2008. As for titanium sponge capacity, China has the highest level at 93,000 metric tons, followed by Japan at 65,200 metric tons and Russia with 46,500 metric tons.

Rang Qi Lei, a representative from BAOTi estimated that in 2017 China had an output of 73,000 metric tons of titanium sponge and 55,000 metric tons of mill products. The acceleration of the Chinese aerospace industry will drive the titanium supply chain. For civil aircraft, the ARJ21 regional jet built by Comac (the state-owned Commercial Aircraft Corp. of China Ltd.) needs 1.3 metric tons of titanium, while Comac’s narrow-body C919 requires nearly four metric tons of titanium. Industrial demand for titanium in China, in sectors such as nuclear power, desalination, and chemical processing should remain strong in 2018, and the ship building market will continue to show strong demand for titanium.

Seung Eon Kim, Ph.D., principal researcher of the titanium department for the Korea Institute of Materials Science, shared information on surface treatment techniques to improve porous titanium medical devices. Compared with conventional pore structures, porous structure medical implants produced via the additive manufacturing process offers good tissue ingrowth, on-demand shaping and process reliability.

TITANIUM EUROPE 2019 will be held May 13-15, 2019 in Vienna, Austria. To register or for more information on this event, contact the ITA, based in Northglenn, CO, USA, at (303) 404-2221 or visit the association’s website (www.titanium.org). Established in 1984, the ITA's main mission is to connect the public interested in using titanium with specialists from across the globe who may offer sales and technical assistance. The ITA strives to advance ideas in research, design, metallurgy and engineering, and serve as the leading forum to cultivate the exchange of ideas and support a diverse global industry. Current ITA membership is comprised of more than 200 organizations and over 1,500 individual members worldwide.
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