TITANIUM NEWS

A concise and timely report on Titanium and Titanium Recycling

SIMS Metal Management Aerospace

MANUFACTURERS OF FINE RECYCLED TITANIUM PRODUCTS

Beautiful Titanium

INTERNATIONAL TITANIUM ASSOCIATION MEMBER

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Editorial

A Tribute to the Pilots of Qantas Flight 32

A collective sigh of relief could be heard throughout the aerospace industry when the extent of the damage to the Number 2 engine on Qantas Flight 32 became known. Only the consummate skill of the pilots prevented a disaster, setting the disabled A380 down safely on the runway in Singapore. It was also a testimony to the aircraft itself, which took a major blow yet held together.

For many people in the titanium industry, it brought back memories of the heroic endeavors of the pilots onboard the United Airlines plane that crashed in Sioux City, Iowa, in 1989. A catastrophic failure of a fan disk in the Number 2 engine sent shrapnel through the structure, causing the loss of hydraulic power. Of the 296 passengers and crew onboard, there were 112 fatalities, a figure that would have been far higher were it not for the crew's skillful adjustments of power of the remaining engines in an attempt to maintain control.

Initial findings on the failure of the Qantas A380 engine are pointing to fatigue cracking caused by a manufacturing error, but whatever the final report reveals, there is a greater truth at work here. Quality is critical, from the smallest titanium fastener to the largest turbine blade. But in the final analysis, an airplane is in the hands of human pilots, who, when the computers go down, alarms are going off and warning lights are blinking, calmly take control and do what their experience and knowledge dictate to the very best of their ability. Ti

(See page 4 for articles related to the A380)

Technically advanced equipment has been installed in the new plant that has 425,000 square-feet of space under one roof.

Sims Metal Management Aerospace Opens State-of-the-Art Facility

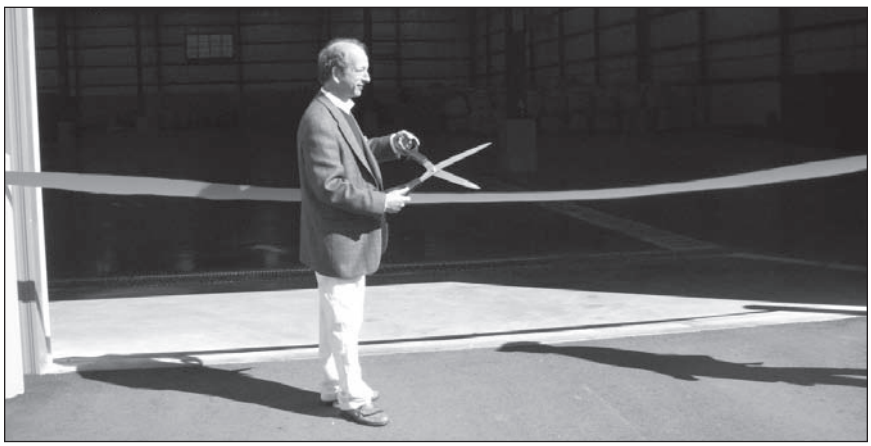
Over 100 guests from 70 different companies attended the open house.

(Photos continued on page 2)

Sims Opens Facility *(continued from page 1)*

Daniel W. Dienst, Group Chief Executive Officer of Sims Metal Management, spoke about the company's commitment to achieving a lean and green recycling facility that is the most technologically advanced in the field.

Sims Metal Management Aerospace staff: Brian Paradis, Maintenance Manager; James M. Nathan, President; Jack Marshall, Vice President Manufacturing; David Borg, Executive Vice President; Dan Mullen, Vice President Technology; Richard Anderson, Laboratory Manager; and Tom Degray, General Manager Turnings.



James M. Nathan, President of Sims Metal Management Aerospace, cut the ribbon with titanium scissors.

The event was capped by dinner and a tour of the Connecticut River on the riverboat the Lady Katharine.

James M. Nathan, President Sims Metal Management Aerospace, explained to the MIT and Polimi group how metal turnings move through the entire plant from arrival to shipping.

Delegation from MIT and Politecnico di Milano Visit New Facility

On July 23, 2010, seven students and professors from MIT, Cambridge, Mass., and Politecnico di Milano (Polimi), Italy, visited the new Sims Metal Management Aerospace facility to learn first-hand about advanced metal recycling technologies.

James M. Nathan, president, led the in-depth tour of the super-alloy processing plant, explaining the design of the new lean and green technologies. "Our new facility is so advanced, I appreciate the chance to show it to engineers who are involved in studying the efficacy of metal separation," Nathan told the group.

The tour was part of a research collaboration between MIT and Polimi focusing on the recycling of waste materials and specifically modeling the performance and efficiency of separation facilities. According to Malima I. Wolf who helped organize the visit, "We were especially interested in visiting Sims Metal Management Aerospace because it is a one-of-a-kind facility for the area, as well as a state-of-the-art facility, giving us the chance to see technologies in action that we wouldn't be able to see anywhere else." A Ph.D. candidate in mechanical engineering at MIT, Wolf's work focuses on environmentally benign manufacturing.

One example of environmentally benign manufacturing is the 100% water recycling process at Sims Metal Management Aerospace. Nathan explained to the delegates that from the standpoint of customers, this process removes any concern about water-soluble coolants that adhere to the chips.

Stanley B. Gershwin, Senior Research Scientist at the MIT Department of Mechanical Engineering, accompanied the group. Dr. Gershwin teaches Manufacturing Systems Analysis and is a member of the MIT Laboratory for Manufacturing and Productivity. He and his research students have performed research projects and consulted for Boeing, General Motors, and United Technologies.

The delegates from Polimi were: Davide Veroux and Amedeo Grotti, both master's students; Natalia Duque Ciceri, a Ph.D. candidate; Marcello Colledani, research scientist; Tullio Tolio, professor. Colledani and Ciceri were at MIT as Roberto Rocca Fellows, a program that sponsors post-graduate and post-doctoral research fellowships between Polimi and MIT. Ti

As part of their research collaboration, MIT and Polimi have focused on the efficiency of separation facilities, making the tour of the new Sims Metal Management Aerospace facility all the more important.

Unexpected Magnetism Reported in Titanium

Theoretical work done at the Department of Energy's Oak Ridge National Laboratory (ORNL) has provided a key to understanding an unanticipated magnetism between two dissimilar materials: strontium titanate ($SrTi0_3$) and lanthanum manganite ($LaMn0_3$).

Published in *Nature Communications*, the results have special significance for the design of future electronic devices for computations and telecommunications, according to co-author Satoshi Okamoto of ORNL's Materials Science and Technology Division. "What the team found was an unexpected magnetic order among the titanium atoms at an interface between strontium titanate and lanthanum manganite, which are both insulators in bulk," Okamoto said in a news release from ORNL.

The work was performed at Universidad Complutense de Madrid, synchrotron radiation facilities in France and Japan, University of Bristol and University of Warwick. The research was led by Jacobo Santamaria of Universidad Complutense de Madrid.

In the abstract of the paper *Spin and orbital Ti magnetism at $LaMnO_3/SrTiO_3$ interfaces*, the team of scientists wrote that the magnetism "results from charge transfer to the empty conduction band of the titanate and has spin and orbital contributions evidencing the role of orbital degeneracy. The possibility of tuning magnetic alignment (ferromagnetic or antiferromagnetic) of Ti and Mn moments by structural parameters is demonstrated. This result will provide important clues for understanding the effects of orbital degeneracy in superexchange coupling."

Using nano-fabrication tools, scientists can develop artificial materials in which different very thin crystalline layers alternate. The properties of these materials are determined by the interfacial structures and their effect on the interaction of atoms. Interfaces have traditionally been considered sources of disorder, but with complex oxides (such as were used for this study), the result is unique. To better understand the phenomenon, the research team made detailed synchrotron x-ray measurements. They also were able to manipulate the structure of spin, or magnetism, at atomic scale. The theoretical work by Okamoto provided the key to understanding the origin of this novel form of interfacial magnetism.

(Continued on page 7)

The massive damage to the No. 2 engine in the A380, Qantas Flight 32. In its preliminary report, the ATSB suspects a manufacturing defect in a stub pipe that connects HP and IP bearing structures of the engine. (Photo courtesy ATSB)

Manufacturing Defect Leading to Fatigue Cracking Is Suspected In A380 Engine Failure

On December 1, the Australian Transport Safety Bureau (ATSB), which is leading the international investigation into the November 4 engine failure on the Qantas A380, announced that they had found the source of an oil leak that caused the Roll-Royce Trent 900 to blow apart. They suspect a manufacturing defect in a stub pipe that connects the high-pressure and intermediate-pressure bearing structures of the engine. This caused fatigue cracking. Maintenance does not appear to be a factor. In a recommendation issued to Rolls-Royce, Dec. 2, 2010, ATSB wrote:

Further examination of the cracked area has identified the axial misalignment of an area of counter-boring within the inner diameter of the stub pipe; the misalignment having produced a localized thinning of the pipe wall on one side. The area of fatigue cracking was associated with the area of pipe wall thinning.

The ATSB published its preliminary report on December 3. However, it considered the safety issue so significant that it preempted the report by releasing its safety recommendations two days earlier, stating, "The problem relates to the potential for misaligned oil pipe in counter-boring, which could lead to fatigue cracking, oil leakage, and potential engine failure from an oil fire." The ATSB advised airlines using the Trent 900 engines on their A380s to conduct more extensive inspections. It said that any engine that shows signs of the defect should be removed from service.

Prior to the ATSB warning, the three involved airlines (Qantas, Singapore Airlines and Lufthansa) had already conducted inspections in compliance with a November 11th directive from the European Aviation Safety Agency. Some of those inspections had uncovered oil deposits in places where it could catch fire. Modifications were made by Rolls-Royce.

The fire that broke out in the section housing the turbines may have caused the rotor to expand, bringing the titanium turbine blades into contact with the casing. Among the recovered wreckage was a shattered turbine disc that appears to show that the fracture direction was from the bore to the rim. The failure also severed the wiring to the No. 1 engine so that the pilots were not able to shut it down once the plane had landed. It had to be shut down by firemen on the ground. Ti

A Troubled Last Quarter of 2010 for Aerospace

Onboard fires, engine explosions, and chronic supplier problems conspired during the last quarter of 2010 to cause turbulence for the aerospace sector. Adding to the problems were more delays for the F-35 Joint Strike Fighter and uncertainty as to what the political changes in the U.S. Congress will mean to military spending. Steep cuts are a strong possibility. Built by Lockheed Martin, the F-35 is the Pentagon's most expensive program. Another aircraft potentially on the chopping block is the V-22 *Osprey*. Titanium is used extensively in both aircraft.

There were many signs of strength as well, especially in emerging markets, which are in a buying mood. But the emerging markets are also increasing the pressure on the aircraft builders not just to provide superjumbos but single-aisle models with more fuel-efficient engines. Airbus responded positively by announcing in early December that it plans to build an updated version of the A320 single-aisle plane, one of Airbus's workhorses. To provide improved fuel economy, it will have a geared turbo-fan engine built by Pratt & Whitney, the PurePower PW1100G. Customers can also choose CFM International's Leap-X engine.

Boeing is under pressure to upgrade its 737 but is reluctant to do so, preferring to bring out a totally redesigned 737, a ten-year process that would place more stress on an engineering team already overstretched by problems with the Dreamliner.

Boeing and the 787

Boeing has been faced with an epidemic of bad news. In August 2010, a Rolls-Royce engine (Trent 1000) used in one of the 787 test planes failed in a test plant, spewing debris. (Rolls-Royce stated that the failure of that engine was not related to the subsequent catastrophic failure of the Trent 900 engine on the Airbus A380 jumbo jet operated by Qantas. However, the oil system has been implicated in both.) Then on November 9, Boeing halted test flights on the Dreamliner following an onboard electrical fire that occurred on a test plane (ZA002) in Laredo, Texas.

As a result, Boeing announced changes for power distribution panels as well as updates to the systems software that manages and protects the power distribution. In a press release, Scott Fancher, vice president and general manager of the 787 program, said "We have successfully simulated key aspects of the onboard event in our laboratory and

are moving forward with developing design fixes. Boeing is developing a plan to enable a return to 787 flight test activities and will present it to the FAA as soon as it is complete." On Dec. 23, Boeing announced resumption of test flights.

Separate from the engine failures, Boeing has admitted that it outsourced too much design and production work, essentially losing control of the process. Quality has been such an issue that Boeing has had to rebuild some crucial parts itself, leading one analyst to quip that the Dreamliner was "being hand-built." During 2010, Boeing was forced to tell suppliers several times to halt parts deliveries. The third time was because Alenia Aeronautica, a unit of Finmeccanica of Italy, could not deliver the Dreamliner's horizontal tails on time. Of necessity, Boeing pulled inhouse some of the engineering on the 787-9. This did not include the wing work being done by Mitsubishi, a company that is performing very well, according to Boeing sources.

Ancillary to regaining control, on November 22, Boeing announced that it had agreed to acquire Summit Aeronautics Group in Helena, Mont. According to a company press release, Summit currently performs hard metal machining on 747-8 fail-safe bars, which allow the flaps to move on the wings; 787 edge frames that fit around the doors; and 767 main-landing-gear beams, which facilitate the landing gear rotation. In the future, Summit will continue its work on these programs but will also manufacture parts for the 787.

Boeing had expected to deliver the first Dreamliner in February 2011. Already three years behind schedule, the company announced on Dec. 2 that the first delivery to Japan ANA would be further delayed. This will reduce the number of Dreamliners produced in 2011 and will change the projections for the number of Dreamliners produced in 2012.

The repeated delays have led to cancelation of some orders. China Eastern Airlines announced in December that it is considering the cancelation of its order for 15 Dreamliners. But ANA, although disappointed, is standing firm in its commitment to the Dreamliner. Shinichiro Ito, chief executive of ANA, said that his top priority is to have an excellent fleet.

Rolls-Royce and the Trent 900

The spectacular problem for Rolls-Royce that triggered a global safety review was the disintegration of a Trent 900 engine on a Qantas A380, November 4, 2010. (See box.) The uncontained engine failure was the first of its kind since the A380 went into service in 2007.

What most troubled aviation safety experts was that the Trent 900 engine is designed to contain a blowout inside the engine's casing thereby preventing broken parts from puncturing the fuselage or the wings where the fuel tanks are located. But on the Qantas plane the blowout was not contained and there was severe collateral damage. Fortunately the plane, carrying 450 passengers, landed safely in Singapore.

Subsequently Qantas, known for its safety record, grounded its six A380s. It did not return any of them to the air until November 27 when Alan Joyce, Qantas CEO, took to the skies on a flight from Sydney to Singapore. "We are 100 percent comfortable with it," he told reporters. "If we weren't, we wouldn't be restarting the operations today."

The A380's four engines are either from Rolls-Royce or Engine Alliance, a joint venture between General Electric and Pratt & Whitney. Qantas, Lufthansa and Singapore Airlines use A380s with the Trent engines. Emirates Airline and Air France use the GE and Pratt & Whitney engine.

Some analysts contend that Rolls-Royce has narrowed the tolerances too much in trying to build a more fuel-efficient engine. Besides problems with the Trent engine for commercial aircraft, there have been difficulties with the engines for military aircraft. With General Electric, it has built an alternate engine for the troubled F-35. But in September the company disclosed that the airfoils of one of the engines had been damaged. Furthermore, funding is highly uncertain for the alternate engine, which is seen by many in Congress to be a waste of government money.

Questions are also being asked about the A350, Airbus's newest plane under development, due out in 2013. Unlike the A380 and the Dreamliner, the A350 is not being configured for a second engine option. As of this moment, the only engine offered is the Trent XWB, but there are indications from Airbus that this may change.

Emirates is the largest buyer of A380s although they use the Engine Alliance engine. Even so, in a news conference, Emirates President Tim Clark expressed confidence in Rolls-Royce stating that the problems were serious but that "in the end Rolls-Royce will get a fix on this."

Airbus, A380 and A320

In January 2010, Airbus delivered its 6,000th aircraft, an A380 for Emirates. At the ceremony President and CEO Tom Enders said, "It took 19 years for Airbus to produce its first 1,000 aircraft and just two years for the latest 1,000." The rest of the year continued apace with Lufthansa Group ordering 40 aircraft worth $4.3 billion in September. Lufthansa Group is Airbus's biggest operator worldwide with 325 Airbus aircraft in service of which 12 are A380s. But the engine checks required on the A380s following the Qantas engine failure dashed Airbus's hopes of delivering 20 superjumbos before year-end.

EADS, Airbus' parent, posted a third quarter profit but Louis Gallois, chief executive, used the opportunity to stress that he expects aerospace growth not to come from Europe and the U.S. but from emerging markets including China. "Now we are in a new world. We know growth in our company will not come from Europe or the United States." As if to prove Gallois's

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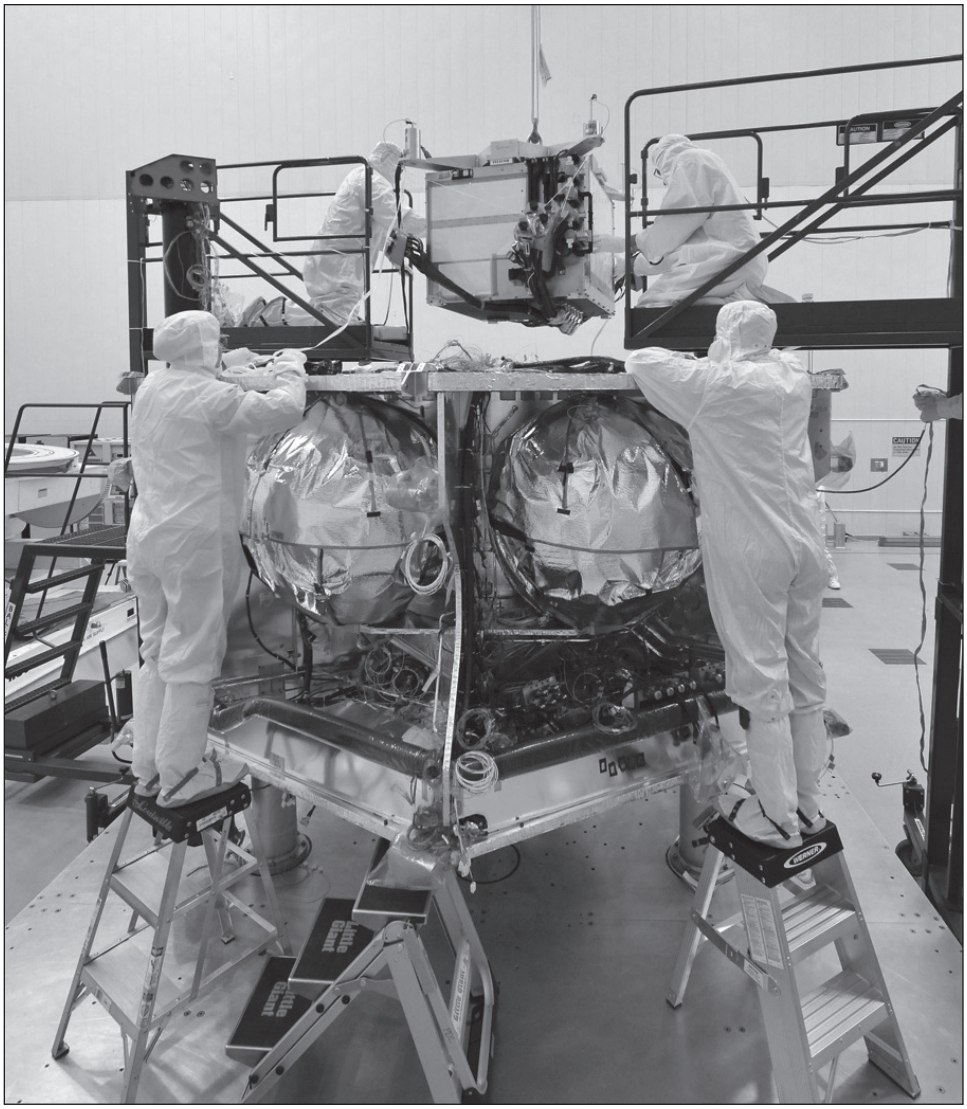
Rolls-Royce Trent engine under construction. (Photo courtesy of Rolls-Royce).



Workers place the special radiation vault for NASA's Juno spacecraft onto the propulsion module. The vault has titanium walls to protect the electronics from Jupiter's harsh environment. (Photo courtesy of NASA.)

Juno Spacecraft Armored with Titanium

When NASA's *Juno* spacecraft begins to orbit Jupiter in 2016, its sensitive electronics will be protected from massive radiation bombardment by a unique titanium shield. "Without its protective shield, or radiation vault, *Juno's* brain would get fried on the very first pass near Jupiter," explained Dr. Scott Bolton, principal investigator and director of the Space Science Department at the Southwest Research Institute (SwRI), San Antonio, Texas. He compared *Juno* to an armored titanium tank designed to withstand an environment with more radiation than any encountered by a NASA spacecraft, except the environment of the sun. Titanium will not prevent all radiation from hitting the electronic components, but it will dramatically slow down the radiation aging effect for the duration of the mission.

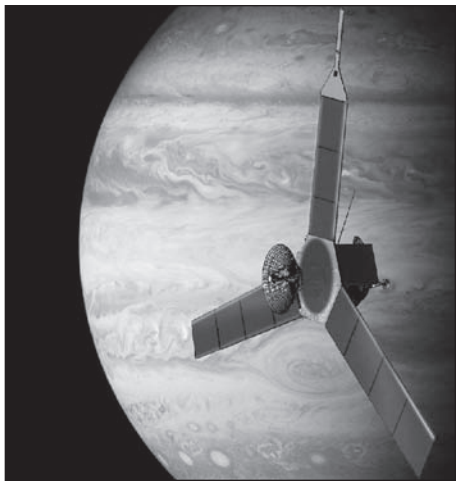
If all goes according to plan, *Juno* should be launched on its five-year journey in August 2011. It is a joint effort of SwRI, NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., and Lockheed Martin Space Systems, Denver, Colo. The vault was built by Lockheed Martin and is the first of its kind. It was lifted into *Juno's* propulsion module on May 19, 2010 at Lockheed Martin's high-bay cleanroom in Denver. Testing of the entire spacecraft is now underway, with completion expected in late spring 2011.

Early in the design process, other materials that are good radiation blockers were considered for the vault, including aluminum, lead, tantalum, and tungsten. Factors in the decision to use titanium included launch-weight, a radhard to 50krad minimum, availability, machinability and producability. JPL tested pieces of the vault in a radiation environment similar to Jupiter's, according to William McAlpine, *Juno's* radiation control manager.

Each titanium wall measures nearly a square meter in area, about one centimeter in thickness, and 18 kilograms (40 pounds) in mass. The entire vault weighs about 200 kilograms (500 pounds) and encloses *Juno's* command and data handling box, power and data distribution unit, and about 20 other electronic assemblies.

To further protect the electronics from radiation, NASA has mapped a route that will take *Juno* around Jupiter's poles away from the radiation belts at its equator. Some of the electronics are made from radiation-resistant tantalum and tungsten. Other assemblies that require extra protection have their own mini-vaults.

Juno will investigate whether the planet has an ice-rock core, measure the amount of water and ammonia in the atmosphere, study atmosphere convection and deep wind profiles, investigate the origin of the magnetic field, and examine the polar magnetosphere. "As the largest planet in the solar system, Jupiter contains more matter than all the other planets combined," explained Bolton. "By determining how much water is in the planet, we complete the inventory of the key ingredients that make up the planet, and that will allow us to figure out the billion-year-old recipe that made the first planets in our solar system." Ti



Artist's rendition of Juno entering Jupiter environment.

Condolences on Death of Ronald Foertch

Ronald "Ron" J. Foertch, 76, of Albany, Oregon, passed away August 12, 2010, after a courageous battle with cancer. Ron was born in Liverpool, NY, April 27, 1934, the son of Leonard and Florence Foertch. He entered the U.S. Air Force at the age of 17 and retired as a technical staff sergeant after serving for 22 years. Ron was employed at Oremet for 18 years, retiring in 1991. He is survived by his wife Marty, his children and grandchildren. Ti

Ti Magnetism *(continued from page 3)*

This work is important for the development of what is known as spintronic devices, which stands for spin transport electronics, aka magnetoelectronics. An example would be a tunneling magneto-resistance junction that could be used as a head of a hard-disc drive. Electronic devices now in use are based on the transfer of electrical charge between two materials, but spintronic devices would also use the magnetic moment, or spin, of electrons in addition to their charge. Therefore, they would be more efficient for sending or storing information as an electric signal.

[The paper *Spin and orbital Ti magnetism at $LaMnO_3/SrTi0_3$ interfaces* was published Sept. 21, 2010 in *Nature Communications*. Funding was provided by the Spanish Ministry of Science and Innovation. Work at ORNL was supported by DOE's Office of Basic Energy Sciences. ORNL is managed by UT-Battelle for DOE's Office of Science.] Ti

Strontium Titanate

Titanium is paramagnetic, meaning its attraction is weak. However, in bulk $SrTi0_3$ is non-magnetic. Synthetic $SrTi0_3$ was created by National Lead Co. in the early 1950s. It was not found in nature until 1982 when crystals were discovered in Siberia and named tausonite. $SrTi0_3$ is superconducting below 0.35K. Ti

Carpenter Technology Plans Expansion

Carpenter Technology Corp. announced in November an expansion of its Dynamet titanium wire and bar facility in Clearwater, Florida. Dynamet, a wholly-owned subsidiary, is a leading producer of titanium wire feedstock for the aerospace fastener industry. The facility expansion is expected to cost in excess of $5 million.

"This investment will include construction of a new building and installation of proprietary manufacturing facilities to produce close tolerance, high performance wire for manufacturing titanium aerospace fasteners," said William Kent, Vice President, Dynamet & Carpenter Powder Products (CPP). "The capacity increase will address our customers' increasing demand for titanium aerospace fastener wire, which is projected to escalate with the introduction of new airframes and the increase in wide-body aircraft production during the next decade." Ti

Dynamet Technology, Inc. Produces Prototype Sprocket Carrier for Marine Corp

Dynamet Technology, Inc., Burlington, Mass., has successfully produced prototype sprocket carriers for the Marine Corps' Expeditionary Fighting Vehicle (EFV) manufactured from titanium alloy recycle supplied by Sims Metal Management Aerospace. The resulting mechanical properties for both strength and ductility are superior to typical specification minimum values for conventional cast Ti-6Al-4V alloy product. Moreover, the test results to date indicate that tensile properties are consistent with typical Ti-6Al-4V wrought annealed material. The sprocket carrier components have been machined and assembled and slated for on-vehicle performance testing.

The program is targeted to provide lower cost titanium components with properties equivalent or superior to wrought properties. This will permit increased usage of titanium components for light-weighting of combat vehicles. The technology being developed for specific military components can be applied to a wide variety of titanium components for diverse applications where the energy efficient, economic, clean manufacturing technology will offer greater affordability of titanium components.

SBIR Grant for Automotive Components

In December, Dynamet Technology also received a National Science Foundation Phase I Small Business Innovative Research (SBIR) Grant to develop titanium automotive powertrain components for increased fuel efficiency and reduced emissions. The program will apply Dynamet's advanced titanium powder metal manufacturing technology and its innovative wear resistant lightweight titanium alloys. Susan M. Abkowitz, Vice President Technology & Operations, is principal investigator. Ford Motor Company will participate with Dynamet on the testing and evaluation of the novel materials and critical components.

Dr. Anthony Walters, NSF Program Officer, indicated that the broader/commercial impact of the project will be reduced weight parts, particularly in reciprocating applications, at a lower cost than conventional titanium parts. Reducing the weight of specific reciprocating parts can allow weight reduction of other components as well as reduced bearing stress and friction. Glen Weber, Technical Specialist, Engine Metals for Ford Motor Company, indicated that the Dynamet technology is compelling and with further development has a strong potential to contribute to the production of increasingly energy efficient vehicles.

An 84-pound sprocket carrier was cast using Dynamet's feedstock electrode produced from 100% Ti-6Al-4V.

Stanley Abkowitz, CEO of Dynamet Technology, stated that the grant recognizes NSF appreciation of the importance of implementing near-term improvements in the efficiency of today's combustion engine, enabling the automotive industry to continually increase its government-mandated CAFE requirements. Ti

The expansion at Perryman Co. will increase capabilities in titanium bar finishing.

Perryman Begins $10 Million Expansion

Perryman Co. is expanding its capabilities in titanium bar finishing at its Houston, Penn., campus. The project will enable the company to finish larger diameter titanium round bar product up to four inches (102mm) in diameter in a wide range of alloys. Completion is targeted for September 2011.

"The expansion of our bar capabilities is a natural extension of our existing bar products supported by the integration of our melting and breakdown operations," said Frank Perryman, President and CEO. With this investment, Perryman will be in position to better serve customers in both the aerospace and medical markets as well as recreational and industrial markets. "We see continued growth and opportunity in a range of sectors, particularly in aerospace for the airframe and engine segments and in forging bar for the medical market," stated Perryman. "Consistent and reliable supply to our customers, regardless of market conditions, remains as our core goal." Ti

Troubled Last Quarter *(continued from page 5)*

point, when President Hu Jintao of China visited France in November, he brought with him an $8 billion order for 66 Airbus jets for China. But orders from emerging markets may also bring with them the pressure to actually produce the planes in whole or in part in those countries, a possibility from which Gallois does not shy away.

Airbus ended the year with its announcement that it would invest approximately $1.3 billion in the new A320. The engine is expected to burn 15% less fuel, reduce engine noise and lower operating costs. Pratt & Whitney was a clear winner with a 15-year contract for its Pure Power engine.

F-35 Cost Overruns

The national's most expensive arms program is on the verge of getting even more expensive – a stratospheric $55 billion for development alone. Bloomberg estimated in November that the overruns could be as high as $5 billion more than previously estimated, which is on top of a $2.8 billion increase in the spring of 2010. In response, Robert J. Stevens, CEO of Lockheed Martin, confirmed in November that the development program needs more resources for software and flight tests.

Already five years behind schedule, the F-35 fighter is about to slip even further because Pentagon officials believe more flight tests are needed on the Marine version of the plane. That particular version, which has the capacity for short take-off and vertical landing (STOVL), has suffered from failures of the engine fan and hydraulics. More tests could delay it two to three years. The less-troubled Navy and Air Force versions are on schedule. Ti

Titanium News is published by Sims Metal Management Aerospace, manufacturers of fine recycled titanium products.

239 West Service Road Hartford, CT 06120
Telephone: 860-522-3123
Fax: 860-724-9245

Pratt & Whitney's PurePower engine was chosen by Airbus for the updated A320. It is expected to burn less fuel, reduce engine noise, and lower operating costs. (Photo courtesy Pratt & Whitney.)