

the SPOTLIGHT

SOLAR ATMOSPHERES' NEWSLETTER **SPRING 2015**



Vacuum Brazing of Lightweight Titanium and Ceramic Structures

Solar California Gains SAFRAN Approval

Solar East Renews Sikorsky Approval

Solar Hermitage Employee Retires

Vacuum Brazing of Lightweight Titanium and Ceramic Structures

contributed by
Alex Shapiro Owner & CEO of Titanium Brazing, Inc

For more information on Solar Atmospheres' titanium brazing capabilities, contact Michael Paponetti, Outside Sales Manager at mikep@solarwpa.com or call 724-982-0660 x2228

Titanium alloys play an important role in many modern industries, particularly in aerospace, due to their highly desirable performance characteristics, such as low density, high strength, fatigue and corrosion resistance, and good strength-to density ratio. Also, more and more, titanium alloys become the main materials for compressors, vanes, and fans of gas turbine engines, as well as for electronics, medical and optical devices.

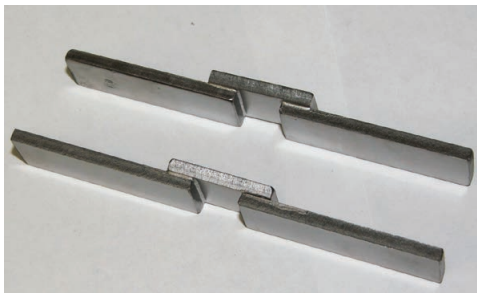


Fig. 1 Ti-6Al-4V alloy brazed in vacuum using amorphous foil TiBraz200 at 920°C

Contemporary brazing technology and filler metals should provide brazements with properties corresponding to the level of the virgin base metals. The nature of titanium alloys determines temperature/time limits of brazing cycles. These limits are a consequence of important changes in the structure and properties occurring above the so-called "beta transus," i.e., the critical temperature for the $\alpha \rightarrow \beta$ phase transformation. Therefore, this should be taken into consideration when dealing with these materials. Basically, there are three types of titanium alloys, according to their predominant phase composition at room temperature: alpha-alloys, alpha-beta alloys, and beta-alloys. Brazing operations may affect each of these alloys differently depending on what class a specific alloy belongs to. However, even more important from the metallurgical point of view is the nature of new phases forming as a result of the reaction between base and filler metals. Unfortunately, many of these Ti-based phases are brittle intermetallics, such as Ti_xNi_y and Ti_xCu_y and their formation negatively affects joint integrity. Still, in general, filler metals with a



Fig. 2 Titanium Grade 2 brazed to copper using amorphous foil TiBraz800 at 830°C

brazing temperature below the beta-transus are preferable because they preserve and provide high mechanical properties of titanium brazed assemblies.

Solar Atmospheres, Inc. together with Titanium Brazing, Inc. successfully tested new brazing technology that allows avoiding all above mentioned problems by using titanium- and zirconium-based amorphous foils as filler metals for brazing titanium alloys. The TiBraz[®]200 (Ti-20Zr-20Cu-20Ni wt.%) and new zirconium-based filler metals TiBraz[®]590 (Zr-17Ti-20Ni-1Hf wt.%) and TiBraz[®]800 (Zr-14.7Ti-12.6Ni-7Cu-1Hf wt.%) can now be used in the form of amorphous foils having thickness in the range of 37-50 microns (0.0015"-0.0020") and width up to 75 mm (3"). Both zirconium-

based filler metals provide brazing below the $\alpha \rightarrow \beta$ transus of α - and ($\alpha + \beta$)-titanium base alloys, and TiBraz[®]800 has a melting range even below phase transition of near- β and β -titanium base alloys. This opens an opportunity to manufacture brazed parts from such alloys as Timet 21S and Ti-3Al-10V-2Fe without affecting mechanical properties of base materials. Also, these foils resolve the problem of furnace brazing of titanium to copper, because brazing temperatures are much lower than the titanium-copper eutectic point 1625°F (Fig. 1-2). Besides, the very thin amorphous foils are characterized by no or low erosion of base metal and lower volume of brittle intermetallics in the joint if compare to traditional titanium filler metals.

continued on page 2

Average Shear Strength of Metal-to-Metal Brazed Joints, MPa

Base metals	Brazing filler metals			
	TiBraz200	TiBraz590	TiBraz800	BTi-1 (Ticuni [®])*
CP Titanium	244.0	217.8	190.4	-
Ti-6Al-4V alloy	276.7	208.2	207.8	223.0
Ti-6Al-4V alloy + 304SS	137.4	80.0	-	-
CP Titanium + Copper	-	97.2	62.5	-
CP Titanium + Ni-plated carbon steel	-	110.0	76.6	-

* BTi-1 (Ti-15Cu-15Ni wt.%) is the conventional filler metal used for brazing most titanium structures

Vacuum Brazing of Lightweight Titanium and Ceramic Structures

continued from page 1

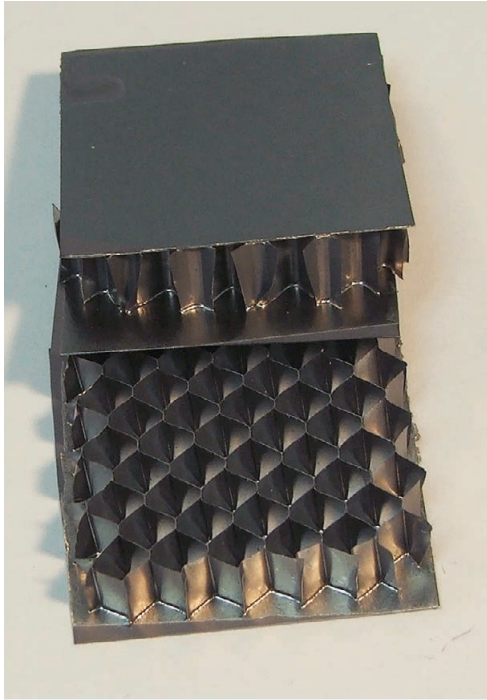


Fig. 3 Sample of a titanium honeycomb panel (Grade 2 and Grade 9) brazed using amorphous foil TiBraze590 at 860°C

These homogeneous and ductile foils have excellent wetting and melting characteristics and good compatibility not only with titanium or zirconium alloys but also with ceramics, graphite, and carbon-carbon composites. When used in a pre-placed preform, these brazing materials supply a minimum and accurate amount of filler metal in the joint clearances, resulting in joint mechanical properties unattainable for filler metals in powder or sintered strip forms. Brazing with low-erosion amorphous foils is ideal for

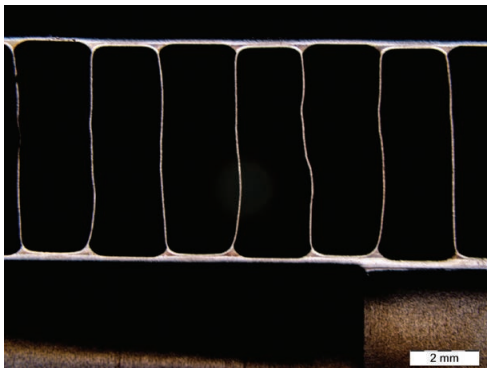


Fig. 4 A section of titanium fin-plate heat exchanger brazed with TiBraze200 amorphous foil at 920°C

joining such thin-wall titanium structures as honeycomb panels and heat exchangers (Fig. 3-4). When used these filler metals result in satisfactory strength in brazed joints of various combinations of base materials and have good compatibility with base materials: specifically, with CP titanium or Ti-6Al-4V alloy, and in joints of dissimilar base material titanium-to-copper, titanium-to-stainless steel or to nickel-plated carbon steel, ceramics (alumina, silicon carbide and boron nitride), and graphite.

Shear strength of graphite-to-titanium and ceramic-to-titanium brazed joints was not measured, because all samples failed in graphite body (Fig. 5), even at the overlap of one or two thicknesses of the graphite parts. Most of alumina-titanium, SiC-titanium, and hBN-titanium joints failed in the ceramic body (Fig. 5), not at the joint. However, these tests at least demonstrate that adhesion of the braze materials to ceramics and graphite is sufficiently strong to resist shear loads, and titanium-to-ceramics brazed joints can respond to the requirements of reliability at larger overlaps.

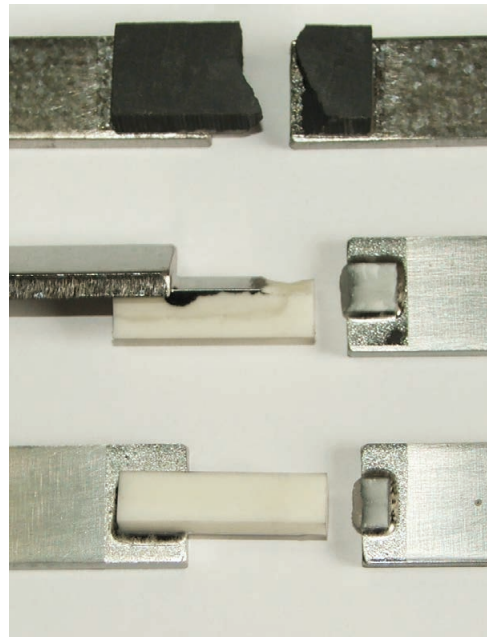


Fig. 5 Brazed joints of titanium-to-graphite and titanium-to-alumina failed in ceramic or graphite bodies during mechanical tests. Brazing with TiBraze200 amorphous foil

Titanium Brazing, Inc manufactures Ti-based, Zr-based powdered, and Al-Mg-based foil and wire brazing filler metals for joining titanium alloys, titanium to aluminum, copper, or steel, titanium aluminides, refractory metals, graphite and carbon-carbon composites in various applications such as heat exchangers, honeycomb structures, compressor vanes, tubing, electronics, medical devices.

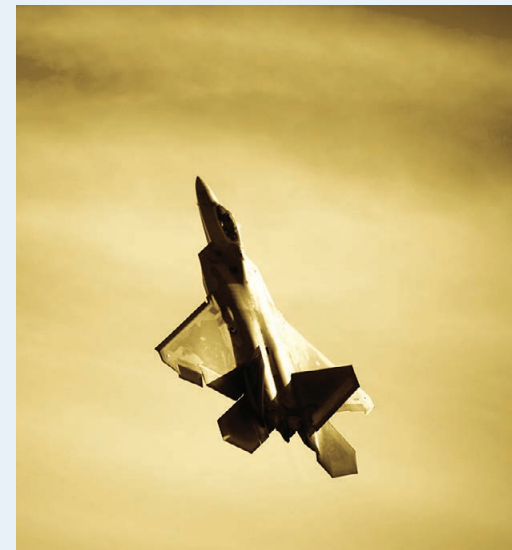
www.titanium-brazing.com

Solar California Gains SAFRAN Approval



Solar Atmospheres of California (SCA) announced today that it has attained an approved supplier status for SAFRAN/SNECMA. SCA has received approval for the heat treatment processes of stress relieving, solution heat treatment, normalizing, homogenization annealing, aging process, stabilization process, sub-zero HT process, and austenitizing quenching for steel, nickel base alloys, and cobalt base alloys. There are a limited number of companies in the U.S. with the SAFRAN/SNECMA approved supplier status.

Derek Dennis, President of Solar Atmospheres of California states, "I'm very pleased to add SAFRAN/SNECMA approval to our growing list of quality approvals. Along with expanding our current capacity, our dedicated quality department continues to work diligently on obtaining new approvals to support our customer's new programs coming online in 2015. This approval was a long time in the making; Solar's internal quality system was capable of meeting all the detailed requirements of this world class aerospace supplier. SCA is committed to providing a quality service, continuously improving with a customer service second to none."



Solar East Renews Sikorsky Approval



Solar Atmospheres, Inc. announced today that it has renewed an approved supplier status with Sikorsky Aircraft Corporation with a 2-year certification. Solar is approved to provide heat treatment of titanium, and carburizing grade materials and aircraft grade steels in accordance with various AMS and Sikorsky specifications. In addition to maintaining current approvals, Solar also gained full approval for laboratory testing, metallography and micro hardness testing for Sikorsky products.

Mike Moyer, Director of Sales at Solar Atmospheres, Inc. states, "Solar Atmospheres Inc. has been Sikorsky approved since the 1990s. Over the years, Solar's investment in R&D and process development has gotten the attention of Sikorsky and other prime aerospace companies, resulting in an expansion of our work scope. Solar's Low Pressure Vacuum Carburizing process is a perfect example of our ever-expanding capabilities and subsequent approvals."

Solar Hermitage Employee Retires



Solar Atmospheres of Western PA recently experienced their second retirement of service within their short yet productive 15 year history. James "Jimmy" Reinhart, who was with SAWPA for 13 of those 15 years, was one of the main reasons for the company's success.

Jimmy conscientiously led SAWPA's third shift for the majority of those years. He was always the first person to report to work and often the last to leave. The time clock never meant a thing to Jimmy – just getting the job done was more imperative in his eyes.

On December 17th, a retirement breakfast was held to celebrate Jimmy's years of dedicated service. With approximately 25 coworkers in attendance, along with Jimmy's lovely wife Debbie, Bob Hill, president of SAWPA presented Jimmy with a gift certificate to Thunder Harley Davidson of Sharon, PA. Bob sincerely thanked Jimmy for making his retirement date a second priority, noting that his first priority was always to be sure the company had the proper replacements in place prior to his departure.

Jimmy was the epitome of a "Company Man". As he rides off into the sunset on either his prized Harley or his restored Chevy Nova, SAWPA wishes Jimmy good health and all the best in future endeavours.

Solar Atmospheres, Southeast Now Open!

We have brought our first furnace online the first week of May and we are now officially open for business. Other furnaces will continue to be delivered and brought online over the summer months and we will be notifying customers as we gain sufficient capacity and capability to serve them from our newest facility in Greenville, SC.

Upcoming Trade Shows



Space-Tech Expo
May 19-21, 2015
Long Beach, CA



Blade Show
June 5-7, 2015
Atlanta, GA



D2P Minneapolis
June 10-11, 2015
Minneapolis, MN

This newsletter is published by Solar Atmospheres, a leader in world-class vacuum heat treating.

Lori Atkinson Editor
Keith Reim Corporate Marketing Manager
Andrew Nagy Graphic Designer

 solaratm.com
 **1-855-WE-HEAT-IT**

If you no longer wish to receive *The Spotlight*, would like a co-worker to receive it, or need to update your address, please email us at marketing@solaratm.com