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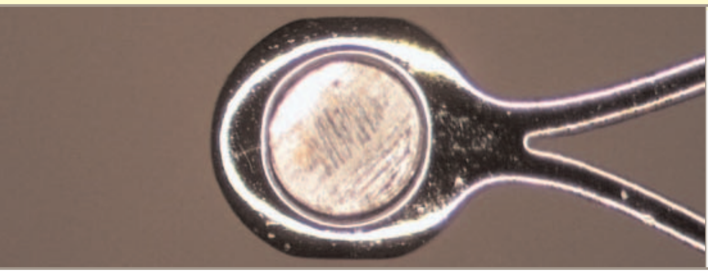
Insights



A typical marker rivet in a stent.

EWI Uses Knowledge of Joining Dissimilar Metals for Minimally Invasive Devices

Candice Mehmetli | Medical & Electronics Market Leader

Medical device manufacturers are driven by patient care concerns as well as device application. Reducing patient trauma has resulted in an increasing trend for minimally invasive surgeries (MIS). MIS requires devices to be smaller, have increased flexibility, and the ability to be tracked through imaging. Increasingly, it is necessary to design devices with radiopaque markers to enhance visibility under fluoroscopy. Radiopaque markers block the passage of x-ray or other forms of electromagnetic radiation and are used to facilitate measurement and placement of medical devices.

Due to the density of some biocompatible materials, marker rings, or bands, are added to increase the visible 'footprint' of the device during surgery or implantation. EWI has provided technical assistance for joining marker rivets to stents and in joining dissimilar metals including stainless steel, nitinol, gold, platinum, and tantalum. In some cases, rivets require fusion welding of nitinol to stainless steel and presents challenges due to brittle intermetallics that form. Solid-state welding, and the location of the weld joint, can minimize the impact on the assembly. Fusion welding of other metals to nitinol is possible if the weld joint is designed correctly.

A typical marker rivet for the end of a stent is shown in the image above. Feasible processes for attaching radiopaque markers are resistance welding, ultrasonic welding, and laser welding.

Resistance welding uses electrical current to heat metals to a plastic state below the melting point of the metals to be welded. Melting of the metals can occur but is not desirable for dissimilar, small-scale welds. For a stent, the rivet can be heated to forge the rivet radially outward to fill the hole in the stent eyelet. The rivet thickness is critical to providing a solid weld without overheating the eyelet and causing a fracture in the loop.

Ultrasonic welding uses high-frequency (20-60kHz) mechanical vibrations and force to flow the rivet outward with a similar action to that of the resistance welding. The heat energy provided by resistance welding is replaced by the mechanical energy of the ultrasonics. The modulus of the metal rivet is critical to providing sufficient metal flow; high modulus metals may not provide sufficient deformation to "lock" the rivet in place.

Laser welding with a pulsed Nd:YAG laser requires contact of rivet to eyelet prior to welding. A gap will cause lack of thermal conductivity between the parts, thereby causing excessive melting. If a zero-gap weld joint is designed, the metals will melt and alloy together for most metal combinations. For a rivet welding application, two or three weld spots provide sufficient strength. Prior knowledge of the weld metal microstructure is important in determining if laser welding is feasible for a particular metal combination.

For more information on joining dissimilar metals, please contact Candice Mehmetli at 614.688.5180 or candice_mehmetli@ewi.org.

The President's Corner

Henry J. Cialone

As 2006 gets started, one of EWI's challenges will be to outpace the accomplishments realized in 2005. While the past year certainly qualified as a transition year at EWI, it didn't lack for notable achievements. From a year-in-review perspective, I'm quite proud of the people, events, and milestones that contributed to a memorable year. Attempting to top 2005 will make 2006 an interesting journey.

The past year ended on a high note for EWI when the United States Department of Defense granted us the Defense Manufacturing Technology Achievement Award for the Navy Joining Center project on composite-to-steel adhesive joints for the DD(X) destroyer. Earlier in the year, our Government Programs Office Vice President, Harvey Castner, was honored as an AWS Fellow and awarded a National Meritorious Award and the Health and Safety Award from AWS. We also hosted several technology workshops on Ultrasonics, Magnetic Pulse, Advanced High-Strength Steel, and a Technology Overview workshop. EWI was issued five patents over the course of 2005 in weldbonding, adaptive and synergic fill welding methods, welding of nitinol to stainless steel, a nondestructive butt weld inspection method, and reduction of distortion by transient thermal tensioning.

Both our virtual "front door" and our bricks-and-mortar front door were recently spruced up to better welcome website and building visitors to EWI. I hope you've had an opportunity to visit www.ewi.org and "surf" the newest version of the site. With better organization of information and navigation, and new content additions, we think you'll find the site both practical and pleasing. And, while we realize that not all of our members can visit us on a regular basis, we think those who are planning a visit to Columbus in the future will be equally impressed by the enhancements made in our lobby and meeting spaces.

The year also brought about changes to the EWI Code and our Board of Directors. We simplified the Code and streamlined the Board, changes which were passed unanimously at a special meeting of Members on December 12. The Board was reduced from 16 to 9 members and the Executive Committee was eliminated, while regular meeting frequency was increased from 4 to 6 times per year. Our overall objectives were to improve the corporate governance of EWI and make EWI a more effective service provider for its Members, able to adapt more rapidly to changing market demands and Member needs. I invite you to contact me directly with your comments as to how well we are meeting that standard of performance.

The past year has been a time of accomplishment and progress. In the new year, we look forward to building on our successes and embracing the challenges and opportunities ahead. And, as always, we encourage you–our membership base–to continue to let us know how we can better meet your needs.

EWI Names Mark Matson as Human Resources Director

Mark Matson

EWI announced that Mr. Mark Matson joined EWI as Human Resources Director. Mr. Matson's responsibilities include the development and implementation of all phases of talent management practices as well as the alignment of those practices with business strategies.

Mr. Matson is certified by the Society for Human Resource Management (SHRM) as a Senior Professional in Human Resource Management (SPHR). He received his Master's degree in Labor Relations and Human Resource Management from the Fisher College of Business at The Ohio State University. He holds a Bachelor's degree in Urban Studies from The Catholic University of America in Washington, D.C.

Mr. Matson has been an active leader in community and professional organizations. He has served on the Advisory Board for the Institute for Management Studies based in Reno, NV and the National Certification Standards Committee for the Society for Human Resource Management in Washington, D.C. He is an active community leader with the Central Ohio United Way, most recently serving on their Race and Diversity Vision Council. He has served as a Trustee for the Columbus Literacy Council, as a Trustee and President for Rebuilding America/Ohio, and as a community educator for the Columbus AIDS Task Force.

Congresswoman Deborah Pryce Visits EWI

Visit Focuses on EWI's Advanced Welding Technology Deployment Initiative

Ohio Congresswoman Deborah Pryce recently visited EWI to review the innovations in advanced joining processes brought about by the $3.8 million contract awarded to EWI in early 2004 to establish the Advanced Welding Technology Deployment Initiative (AWTDI).

The visit, which took place on Monday, December 12, included remarks by Congresswoman Pryce, a tour of EWI's manufacturing lab area, and a ribbon cutting ceremony for EWI's new flexible manufacturing cell.

Matt White, Market Leader for EWI's Government Programs Office, stated, "Through the funds provided by AWTDI, EWI has procured a flexible fabrication cell capable of combining several joining processes with rapid design and tooling. EWI will make extensive use of its modular tooling, computer modeling, and offline programming capabilities to meet a range of defense applications."

White continued, "In the case of the Army's upcoming Future Combat System, the flexible fabrication cell will be used to incorporate low-density, high-performance materials such as aluminum, titanium, and composites into advanced structural designs to reduce weight. Combining these materials to produce hybrid structures requires a number of advanced joining technologies including friction stir welding (FSW), hybrid gas metal arc/laser welding, pulsed gas metal arc welding (GMAW) of titanium, adhesive bonding, and active brazing/soldering."

The AWTDI program provides cutting edge welding and joining techniques to rapidly produce improved armored vehicle armor systems using composites, ceramics, titanium, and aluminum and improve the manufacturability and repair of current systems. It was initiated to assist the Army and its manufacturing base in responding to changing threats to U.S. forces in Iraq and Afghanistan, as well as the need for lighter-weight, rapidly deployable weapons systems to meet the challenges of the war on terror.

For more information on the AWTDI, please contact Matt White at 614.688.5241 or matt_white@ewi.org.

Deborah Pryce Visits EWI

Flexible Fabrication Cell at EWI

Insights is produced four times per year. Please direct general questions and comments to Lisa McClintock, Marketing Communications Manager, at 614.688.5130 (lisa_mcclintock@ewi.org). Questions relating to an article may also be directed to the contact listed in the article.

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Adhesive Bonds and Titanium

For many years, the use of expensive materials such as titanium has been limited to high performance aerospace applications where the performance justifies the high raw material cost. More recently, performance requirements in other applications have led to increasing interest in titanium alloys in the automotive, heavy manufacturing, and medical industries.

To form a durable adhesive bond to titanium, the surface must be treated to produce a strongly bound, stable oxide layer. Traditionally, this was done using either strong acid or strong base often in an electrochemical cell (anodization). These treatments are relatively slow and require the use of hazardous chemicals. In order to broaden the use of titanium in non-aerospace industries, the development of an effective, user-friendly, environmentally benign pretreatment will be required. As part of a new transportation program, EWI has recently revisited several simple surface treatment options for titanium bonds to aluminum.

The stiffness of titanium and its alloys coupled with its excellent heat resistance made it an attractive component of airframe structure for more than 40 years. During the development of the high speed commercial transport in the 1970s and 1980s, a substantial effort was invested in developing bonding technologies for titanium and its alloys, especially titanium 6/4 (6% aluminum: 4% vanadium). While anodization and acid treatments such as Pasa-Jell (PRC-DeSoto) were frequently used, it has since been found that the solubility of the titanium oxide in the bulk metal increases at high temperatures so the oxide surface has a tendency to disappear into the bulk under use conditions. This has necessitated the development of several plasma deposition treatments to produce a heat stable bonding surface on titanium. For applications which do not require high temperature durability, anodization and strong acid pretreatments have remained the standard for preparing titanium surfaces although the best surface preparation seems to vary depending on the particular adhesive composition employed.

Since the use of environmentally friendly processes is increasingly attractive in most industries, we undertook an investigation of more benign surface treatment options for titanium 6-4. This desire led us to look at the performance of alkaline hydrogen peroxide as a pretreatment. Peroxide had been one of the first surface treatments used on titanium and its alloys, but its use has not been recently investigated. We also found that dental fluoridating gel might provide a safer alternative to aggressive phosphate fluoride treatments.

Several surface treatment options were screened using the wedge test ASTM 3762. All of the surfaces were primed with BR 127NC

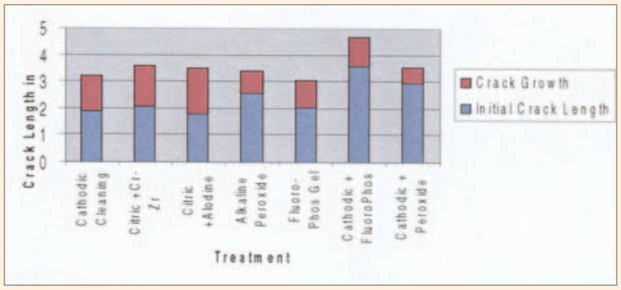


Figure 1. Wedge Test Results for Ti-Ti Bonds with Different Surface Treatments.

after the pretreatment. Two adhesive cure schedules were examined: 30 days at room temperature and 14 days at room temperature followed by a 70ºC post cure for 60-90 minutes. Crack growth was measured initially and after seven days at both normal room conditions and under 60ºC/100% relative humidity exposure. The results are shown in Figure 1.

From these experiments, it was clear that both the alkaline peroxide and the dental fluoro-phos gel performed well. Both the initial crack length and the growth after seven days were low for both treatments. Both of these treatments were further investigated by preparing type A double lap shear specimens according to ASTM D 3528. For these specimens, the outer plates were treated titanium while the inner plate was aluminum. The thicknesses of the plates were adjusted to compensate for the stiffness of the titanium. The strength of these samples was determined at both room temperature and upon moisture saturation after aging 60 days at 60ºC and 100% RH. The strength results are shown in Figure 2. The strength and environmental resistance of the bonded joints was comparable to that of a soldered joint as shown in Figure 3.

Both alkaline peroxide and dental fluoro-phos gel performed well as pretreatments for titanium 6-4 under these testing conditions. The relative success of the treatments appears to vary depending on the cure of the adhesive. Since the properties of the bond adhesive appear to depend on the interaction of the adhesive with the surface treatment, further investigation of these simple surface preparations with other adhesive formulations would be useful.

For more information about adhesive bonding at EWI, log on to the Members Only portion of the EWI web site where the latest adhesive/bonding reports have been posted on your personalized homepage. You may access the members only site at www.ewi.org/members/ or contact George Ritter at 614.688.5199 or george_ritter@ewi.org, or contact David Speth at 614.688.5162 or david_speth@ewi.org.

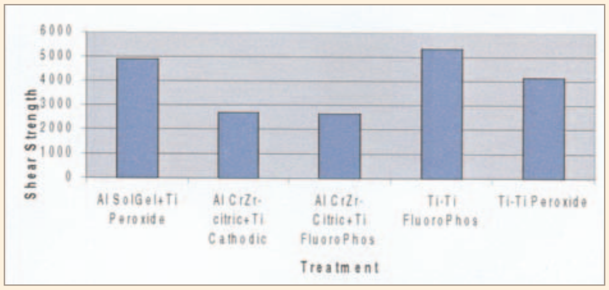


Figure 2. Double Lap Shear Strengths for Al-Ti and Ti-Ti Bonds.

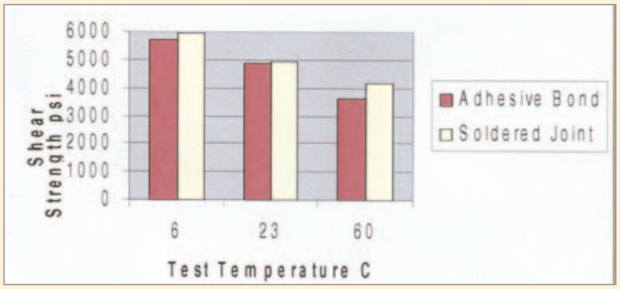


Figure 3. Comparison of Strength between Adhesive Bond and Soldered Joint

Upcoming EWI Tradeshows & Presentations

Dates	Event	Host	Location	Web Site
3/29 - 3/30/06	Automotive Laser Applications Workshop	Univ. of Michigan	Plymouth, MI	http://cpd.engin.umich.edu/
4/25 - 4/27/06	Maintenance, Repair & Overhaul Conference and Exhibition	Aviation Week	Phoenix, AZ	http://www.aviationnow.com/conferences/mromain.htm
5/9 - 5/12/06	Sheet Metal Welding Conference XII	American Welding Society	Detroit, MI	http://aws.kukausa.com/
5/15 - 5/18/06	Aeromat Exposition	ASM International	Seattle, WA	http://www.asminternational.org/seattle/index.htm
5/23 - 5/24/06	Ohio Fuel Cell Symposium	Ohio Fuel Cell Coalition	Canton, OH	http://www.fuelcellsohio.org/pages/831560/index.htm

EWI Helps U.S. Bridge Retain Employees

U.S. Bridge is the largest manufacturer of permanent steel truss bridges for secondary roads in the country. In 2002, U.S. Bridge observed a crack in one of its trusses after hot-dip galvanizing. A thorough inspection of other trusses returned from the galvanizer as well as trusses recently erected disclosed that the problem began to occur that summer. This was a highly unusual condition not previously experienced, and the company's engineers were unable to determine the cause. Had the source of this problem not been identified, the survival of U.S. Bridge, together with 150 much needed local jobs, would have been in jeopardy.

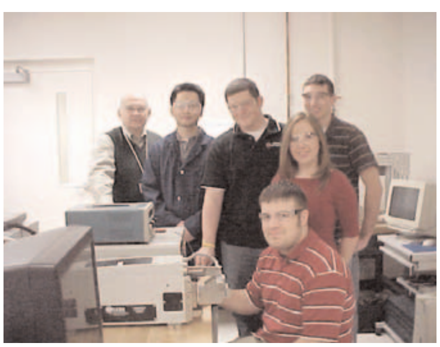
Having nowhere else to turn, the company consulted EWI, where it is a long-standing member. After a methodical laboratory analysis, EWI's engineers identified the cause to be the presence of tin in the zinc ingots recently purchased by the galvanizer. This caused liquid metal embrittlement. Armed with that study, U.S. Bridge required its galvanizer to change its zinc bath and the problem did not recur.

EWI also provided U.S. Bridge with a process for repairing the existing cracks. As part of this process, an updated inspection procedure was developed so that U.S. Bridge could more effectively inspect its galvanized trusses to catch any future problems prior to installation. By identifying a systemic problem, the results of this work greatly benefited the entire bridge construction industry, not only U.S. Bridge.

Arthur Rogovin, President of U.S. Bridge, has stated that EWI's expertise saved his company from likely disaster and preserved 150 local jobs. The savings represented an over 15:1 return on the money invested in the project.

For more information on U.S. Bridge analyzing and repairs, please contact Mike Merlo at 614.688.5149 or mike_merlo@ewi.org.

EWI and OSU Collaborate on Ultrasonic Weldability Study



As part of a year-long senior project, a group of Ohio State University Welding Engineering students have teamed with EWI to better understand the weldability of materials when using the ultrasonic metal welding (UMW) process. Working on a senior year "Capstone" project, OSU students Matthew Bloss, Jeremy Brooks, Matthew Pischel, and Kerry Shook are coordinating their efforts with Haiping Shao and Karl Graff, Senior Engineers at EWI.

Ultrasonic metal welding is finding increased applications, or potential applications, in automotive and aerospace structures and medical and electronic products, as well as in emerging technologies such as ultrasonic additive manufacturing. In all of these areas, the continued drive is to weld materials, combinations and thicknesses that have not previously been welded, or for which there is no reliable welding data. Existing ultrasonic metal weldability charts provide, at best, an uncertain starting point as to materials and combinations that might be weldable, and provide no guidance as to weld process parameters. The weldability study, expected to extend for several years, is intended to remedy these problems.

The first year of this program will focus on determining the weldability of a number of Al (e.g. 2024, 3XXX, 5XXX, 6XXX and 7XXX) alloys, as well as Cu and Mg alloys. The program will also establish standardized welding procedures (e.g. ultrasonic parameters of vibration amplitude, energy and clamping force), surface conditions and tooling, as well as mechanical and metallurgical test procedures. Testing will progress to increasingly difficult-to-weld materials, including stainless steels, titaniums, and various advanced aerospace alloys.

Initial testing will be done using EWI's 20 kHz AmTech Ultraweld 20 ultrasonic metal welder. It is anticipated that welders of increasing power levels, exceeding 5kW, will be used as testing of more challenging alloys is undertaken.

Dr. Graff, overall project leader, believes the benefits of the work will have far-ranging impact, providing the basis for wider use of the ultrasonic metal welding process. "It's an ideal example of OSU-EWI cooperation, generating needed data for our industrial customers, and also providing a valuable training ground for some of the next generation of welding engineers."

Virtual Reality Welding Training Demonstrated at Defense Manufacturing Conference

The Navy Joining Center (NJC) recently demonstrated an innovative approach to welder training at the Defense Manufacturing Conference. The first-of-a-kind virtual reality welder training system permits the trainee to hold an actual welding torch while seeing and hearing a virtual weld being created. The virtual reality training system was developed to train welders for submarine construction, but the technology is immediately transferable to other shipbuilders and defense manufacturers. The project team includes EWI, General Dynamics Electric Boat, and VRSim.

An aging workforce is opening a gap in the availability of skilled welders for ship construction. Virtual reality technology is already being used for training in medicine, aviation, law enforcement, and the military. The virtual reality welder training tool created in this project will drive down training costs and improve training efficiency.

The project created a prototype system, comprised of a head-mounted 3-D display and welding torch attached to a force feedback device. The simulation of the welding process is based on numerical models validated with actual welds made with shipyard welding procedures. The welding process and resultant weld bead are displayed in a virtual environment and on a separate monitor for the welding instructor. Weld quality and recorded process parameters are displayed after welding for critique and instruction.

Evaluations of the system by more than 100 users confirmed that it is easy to use and provides a reasonably realistic experience. The system is already being commercialized by VRSim and their partner Silicon Graphics Inc. (SGI).

For more information on virtual reality welder training, please contact Nancy Porter at 614.688.5194 or nancy_porter@ewi.org.

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Windsor, CT
Business: Manufacturer of power plant equipment, boiler-steam generators & turbines

Conor Medsystems, Inc.
Menlo Park, CA
Business: Developer of vascular drug delivery technologies

Fuel Total Systems California Corp. (FTSCA)
Lathrop, CA
Business: Manufacturer of plastic fuel tanks

Hughes Christensen Co.
Houston, TX
Business: Manufacturer of drill bits for the petroleum industry

Kensey Nash Corp.
Exton, PA
Business: Design, development, and manufacturing of absorbable medical devices

Kiswel Co., Ltd.
Duluth, GA
Business: Manufacturer of welding consumables

M.K. Morse Company
Canton OH
Business: Manufacturer of saw blades and accessories

The NanoSteel Company
Maitland, FL
Business: Manufacturer of steel products

Pemery Corp.
Broadview Heights, OH
Business: Developer of fuel cell technology

Tracewell Systems, Inc.
Westerville, OH
Business: Electronics and systems integration