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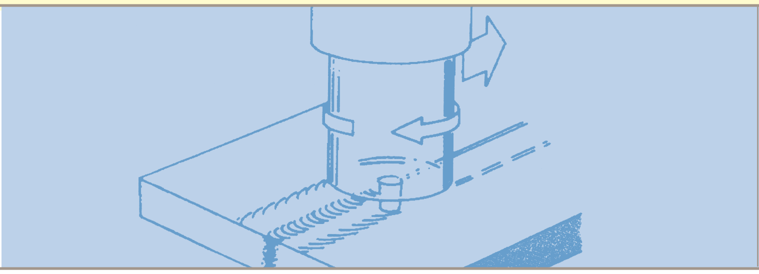
Insights



Schematic representation of the FSW process for welding butt joints. The FSW tool is rotated and traversed along the joint to produce the weld.

Friction Stir Welding and High-Strength Steel Plate and Pipe

Nate Ames | Energy & Chemical Market Leader

Friction stir welding (FSW) is a relatively new addition to the family of joining processes considered for oil and gas applications. FSW has become an accepted joining process for aluminum alloys in other industries due to its ability to produce high quality joints in Al alloys that would otherwise not be considered weldable through conventional arc processes.

During FSW, heat for the creation of joints is generated by rubbing a non-consumable third body on the substrate(s) intended for joining and by the deformation produced by the passage of the tool. The rotating tool creates volumetric heating so, as the tool is progressed, a continuous joint can be created. FSW, as with other types of friction welds, is largely solid state in nature. As a result, friction stir welds are not susceptible to solidification-related defects that hamper other fusion welding processes. Other significant side effects of the 'solid state' nature of friction stir are low distortion and exception fatigue properties due to the high compressive residual stresses.

Recent efforts have focused on applying FSW to high strength steel plate and pipe. FSW offers a number of advantages for steel joining, including lower overall energy inputs, minimization of grain growth, fume reduction and distortion control. FSW of steels generally parallels that of aluminum, but with two notable exceptions. These include the higher temperatures required for forging, and lower thermal conductivities. Given the higher forging temperatures, tool materials are a major concern. Work has been done with molybdenum-, tungsten-, and ceramic-based tools. Temperatures at the workpiece achieve levels of roughly 1300-1400°C (notably below the melting temperature). The resulting joints do show excellent mechanical properties, microstructures, and distortion resistance.

Some of the recently acquired technology at EWI allows for full hardness contouring of a weld specimen. This has been applied to FSW welds on conventional oil and gas grades of carbon steel. This type of information coupled to the boundless data regarding mechanical properties and toughness indicate that FSW welds on steel and similar grades is feasible in the near future. It is believed that, while not yet fully deployable on steels, the FSW process is capable of creating sound repeatable welds on high-strength carbon steel.

For more information on friction stir welding or other oil and gas applications, please contact Nate Ames at 614.688.5135 or nate_ames@ewi.org.

The President's Corner

Henry J. Cialone

Hurricanes Katrina and Rita devastated the Gulf Coast and transformed its landscape. The recovery effort will no doubt be long and difficult. Many of our friends and colleagues in the region were directly affected, and the thoughts of all EWI associates are with them.

The media coverage of the hurricanes' aftermath heightened everyone's awareness of the growing gap between consumption and availability of our world's resources. One visible consequence is the continuing escalation in the price of petroleum. As cost has increased, people and industries have reduced their consumption of petroleum products to a degree. However, there is a limit to what can be accomplished without new technology. Longer term, all industries will need to develop alternatives to traditional fuel sources and find new ways to increase efficiency with conventional fuels.

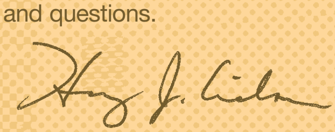
For over 20 years, EWI's accumulated expertise, leading edge facilities and innovative staff have brought next-generation materials joining solutions to our customers. The complex energy landscape—including energy supply, delivery, and conversion, coupled with environmental stewardship, creates challenges for all of our government and industry clients. Meeting those challenges with products that can be manufactured cost effectively requires significant advances in materials fabrication and joining processes. The key hurdle for researchers has been finding ways to introduce promising new technologies that increase our energy supply or make more efficient use of existing sources, while improving reliability at a competitive cost.

Meeting future global energy demands will require increasing energy supply in many forms. Unconventional oil and gas, including deepwater exploration, coal-bed methane, and oil sands are already being commercially exploited; technology is helping to expand their production and ensure continued safe and reliable operations. New sources like oil shale are under development with promising economics but significant technical barriers. The return of coal is widely discussed, with coal being the cheapest and most abundant fuel source in the U.S. and advanced efficient technologies like ultra-supercritical steam plants and integrated gasification combined cycle systems approaching commercial viability. Advanced nuclear technology offers the prospect for abundant power with no greenhouse gas emissions, and the potential to drive large-scale hydrogen production. And renewable energy is approaching cost competitiveness in many applications. Each of these energy supply options presents its own unique materials processing and joining challenges.

With high energy conversion efficiency and low emissions, fuel cells are expected to become increasingly prevalent for transportation, as well as for portable and stationary power generation. Before achieving mass market penetration, fuel cells must be made smaller, lighter and cheaper, more durable and reliable, and proven to provide power at competitive prices. Fuel cells, along with lighter weight but stronger cars, hybrid vehicles, smart energy management systems, and more efficient appliances can help us better manage our consumption of energy resources.

EWI is exploring ways to improve the manufacturability of fuel cells, fuel cell stacks, and fuel cell system components to decrease cost and improve reliability. Our materials joining, non-destructive evaluation, and manufacturing capabilities will play a significant role in bringing economical fuel cell products to market sooner.

As the energy landscape continues to evolve, EWI is committed to addressing the technical challenges of meeting future energy demands. I invite you to contact me with your thoughts, concerns, and questions.



EWI Names Michael Merlo as Heavy Machinery Market Leader

Michael Merlo

EWI announced that Michael Merlo has been named to the position of market leader for heavy machinery and welding equipment and consumables. Mr. Merlo brings over 30 years of experience.

As a market leader at EWI, Mr. Merlo will focus his experience on solutions to the materials joining challenges facing the heavy machinery industry. He is responsible for business development and related product development activities for EWI.

He previously served as Technical Director with Select-Arc Inc., a manufacturer of tubular welding electrodes. He has a Bachelor of Science degree from Lafayette College in Easton, Pennsylvania, with a major in Metallurgical Engineering.

EWI Hosts Ultrasonic Technology Workshop

EWI is pleased to announce a one-day workshop highlighting the latest developments in the application of ultrasonic metal welding in the field of 'Ultrasonic Additive Manufacturing' - UAM (also identified as 'Ultrasonic Rapid Prototyping' URP) to be held on December 14, 2005 at EWI's headquarters in Columbus, Ohio. Register online for the seminar at www.ewi.org/WorkshopRegistration/20051214_UltraSonics.aspx

During this workshop, experts from EWI and Solidica Corporation will highlight the principles and applications of the rapidly developing technology of ultrasonic additive manufacturing - UAM. Now finding applications in production of tooling and dies, UAM is rapidly being extended to new fields of use, including embedding of temperature-sensitive fibers, optics and electronic devices in metal components for use in smart and reactive structures, development of ceramic-metal matrix composites, and in a broad range of structural repair applications.

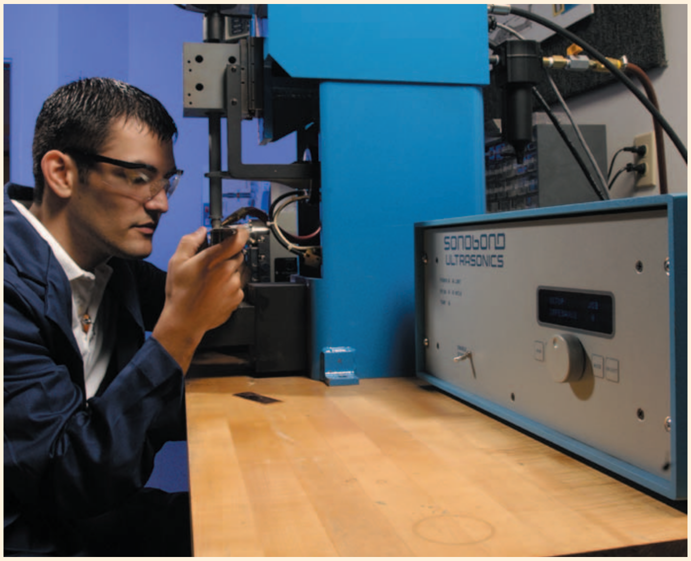
Because ultrasonic metal welding (UMW), is the core technology to the additive manufacturing process, the workshop will also review the basics of the metal welding process and the new range of applications of this process to automotive structures and electrical components arising from development of more powerful welding systems.

Other topics to be presented:
Fundamentals of ultrasonic metal welding
Fundamentals of ultrasonic additive manufacturing
Advanced applications of ultrasonic additive manufacturing
Applications of ultrasonic additive manufacturing

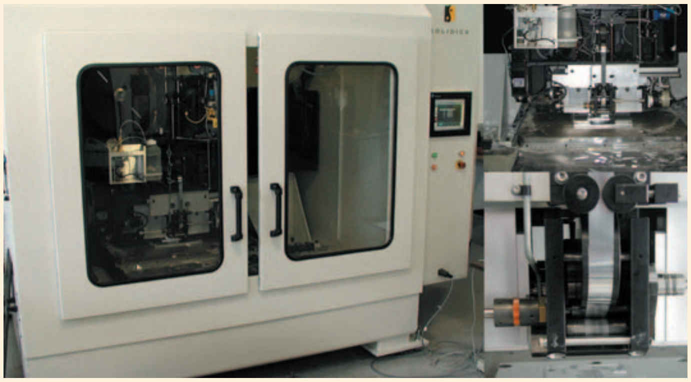
Laboratory demonstrations of the UAM process will be a key part of the workshop, as will demonstrations of high power spot, seam, and torsion welding systems.

The workshop cost is $75 for EWI members and $125 for non-members. If you are interested in attending, please complete the registration form by November 30, 2005, as seating is limited. The registration form is available online at www.ewi.org/events/seminars.asp#ULTR

We hope you will take advantage of this opportunity and join us in Columbus in December.



Ultrasonic welding of aluminum



Developed with assistance from EWI, Solidica's Form-ation rapid prototyping machine can produce articles of almost any shape and size.

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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EWI Programs Provide Support for the Fuel Cell Industry

Amid the fervor and exuberance of the 1990s technology boom, there was considerable attention given to fuel cells. Companies were quick to claim fuel cell activities, and their stock prices soared.

The apparent basis for this enthusiasm was the belief that these new power sources would run on an unending supply of the most plentiful element in the universe, hydrogen. Few enthusiasts stopped to ask the tough questions about actual hydrogen availability and fuel cell manufacturing costs. Instead, the technical dialogue and promotional frenzy focused on the amazing chemistry and physics that allowed hydrogen to be converted to electricity. Federal and state government research programs were initiated, and universities across the country and around the world established fuel cell centers, departments, and programs. Then the "tech bubble" burst and other sobering realities of the new millennium deflated the intense interest in fuel cell companies and their technologies.

The relative quiet time that followed in the past few years has provided a much needed breather for the fuel cell development community. Every level of research program now has more concise objectives. Government and private research funding is much more aligned with cost targets and potential products. The investment community is evaluating fuel cell companies with a much better understanding of market potential as well as obstacles. Hydrogen generation and distribution have been clearly identified as critical contributors to the future of fuel cells. Finally, the potential impact of a "hydrogen economy" is now being enunciated.

In a February 2005 address, U.S. Energy Secretary Spencer Abraham noted that, "The day of the hydrogen economy, while not eminent, is now within sight…It promises the kind of transformation not seen since the nineteenth and early twentieth centuries, when the world experienced the last energy revolution."

So, what is it about fuel cells that appeals to industry and government alike? There are many answers to that question; the one that seems to be at the core of U.S. interests is energy independence. The Department of Energy has frequently highlighted the gap between U.S. energy production and U.S. energy demand, particularly as it relates to transportation costs. The importance of this message has been demonstrated convincingly for all Americans with the dual impacts of hurricanes Katrina and Rita, as well as the ongoing unrest in oil-producing centers of the world. The promise of a hydrogen economy in the transportation scenario is that the hydrogen could be produced from coal, gas, nuclear, and renewable resources — all of which the United States has within its grasp.

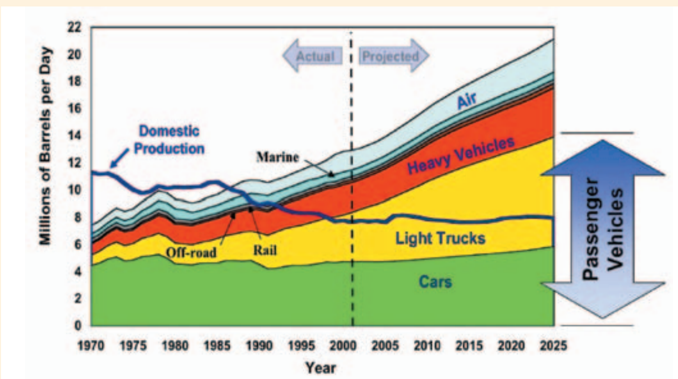
A multitude of other attractive fuel cell benefits can be identified. Fuel cells are efficient, quiet, non-polluting, and range in power from milliwatts to megawatts. They can be designed to run on pure hydrogen, methanol, diesel, or a number of other hydrocarbons. The diversity of potential fuel cell applications is wide and growing but they are often grouped into three broad categories: stationary power, portable power, and transportation. Fuel cell designs for laptops, households, automobiles, soldiers, and cities are all being evaluated and developed. Dozens of fuel cell types have been created to address this wide range of applications and they are typically described by their acronyms, such as PEM (proton exchange membrane), SOFC (solid oxide fuel cell), DMFC (direct methanol fuel cell), or MCFC (molten carbonate fuel cell), among the most common. The physical differences among the various designs are vast and defy simple descriptions or images.

So, given the breadth of opportunity and the variety of technical solutions, why haven't fuel cells become a bigger part of everyday life? The simple answer is cost. Although there are a host of other obstacles including reliability, safety concerns, regulations, and hydrogen availability, cost truly is the main obstacle. An unfortunate irony of fuel cell development is that design diversity is inhibiting cost reduction. There is little component commonality among the multitude of fuel cell designs. Further, fuel cell designers have historically been reluctant to expose their designs to potential competitors. Thus, potential suppliers of components to the fuel cell industry have not had visibility to the developers' needs. Fortunately, this is beginning to change. Department of Energy-sponsored fuel cell research is starting to focus on manufacturability by attacking those generic manufacturing challenges that can be identified. Many of these challenges are related to sealing and joining of the multitude of components that make up a fuel cell stack and its related elements.

State governments are also stimulating the fuel cell economy through a variety of efforts including demonstration grants, centers of excellence and tax abatements for fuel cell industries. According to Dr. Mark Williams of the D.O.E's National Energy Technology Laboratory, "Ohio leads the way" in the promotion of fuel cell technology, through grants, loans, and research sponsorship.

The Ohio Department of Development (ODOD) and the Ohio Fuel Cell Coalition are active in attracting fuel cell business to the state. The ODOD also supports EWI's internal research efforts in fuel cell manufacturing and Ohio's Wright Centers program has helped EWI acquire equipment that is uniquely suited to fuel cell manufacturing investigations.

EWI's member companies include many fuel cell developers and potential suppliers to the fuel cell industry. In the past few years, we have been privileged to have some "first looks" at a number of candidate fuel cell-related components and we have conducted many confidential research projects for our member companies. These projects have dealt with a host of joining challenges and materials and no two components have been the same. However, there is one generic challenge that appears in many fuel cell system designs. Specifically, there is a frequent requirement to join thin, stainless steel sheet for a variety of components including bi-polar plates, recuperators, reformers, cassettes, and other heat exchangers—all publicly disclosed.



Petroleum consumption in the United States.

These applications present a competitive situation for brazing and laser welding technologies and EWI routinely investigates both. Because of this recurrent challenge, EWI is expanding our technical capability in laser welding with the addition of a 600 watt fiber laser and high speed motion system, a combination ideally suited to this common demand among fuel cell components.

In summary, the applications and importance of fuel cell technologies are increasing, and the emphasis is shifting toward manufacturing challenges and cost reduction. EWI's strong membership involvement and our affiliation with Ohio's aggressive fuel cell programs provide a solid foundation for our support of this important, emerging industry.

For more information about Fuel Cell projects at EWI, log on to the Members Only portion of the EWI web site where the latest Fuel Cell CRP reports have been posted on your personalized homepage. You may access the members only site at http://www.ewi.org/members/ or contact Stan Ream at 614.688.5092 or stan_ream@ewi.org.

Upcoming EWI Tradeshows & Presentations

Dates	Event	Host	Location	Web Site
11/13 -11/16/05	FABTECH International and The AWS Welding Show	FABTECH and AWS	Chicago, IL	http://www.aws.org/expo/
11/28-12/4/05	Defense Manufacturing Conference	ManTech	Orlando, FL	http://www.dmc.utcdayton.com/
11/29-12/1/05	2005 USAF Structural Integrity Program (ASIP) Conference	USAF	Memphis, TN	http://www.asipcon.com/pages/invite.htm
2/12-2/16/06	Space Technology and Applications International Forum Conference	Univ. of New Mexico	Alberquerque, NM	http://www.unm.edu/~isnps/staif/2006/main.html

EWI Assists Duracell with Weld Quality

Challenge

Duracell contacted EWI for assistance in analyzing quality issues at their Lexington, North Carolina facility. The site was experiencing resistance weld quality issues on a tab-to-can weld for a prismatic cell.

Production problems included weak welds and missed welds. EWI sent a senior engineer to the Duracell Lexington plant to analyze the problem and provide recommendations for improvement of resistance weld quality for the prismatic cells.

Solution

Senior Engineer Tim Frech was on-site at the Lexington plant for one day. A thorough review of the welding process was conducted, followed by on-line trials to improve current weld quality. Recommendations on weld process improvements for future tab welding processes were also given.

Results

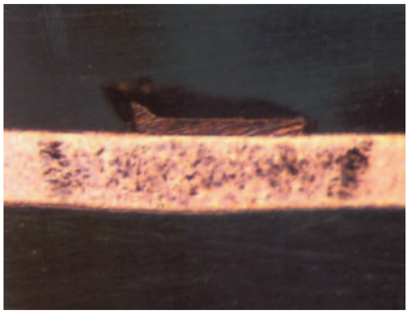
A weld “pre-pulse” was used to identify and analyze the problem condition of the plastic separator in the weld area. Electrode damage caused by arcing around the plastic was prevented. Due to the inductance in the secondary circuit of the welding system, the weld current pulse output was variable, and caused variability in the weld input power. This variability is what initiated the inconsistent weld quality in terms of strength and button size.

A written report was provided to Duracell with findings and recommendations. The findings included analyzing and utilizing the equipment and electrodes used for the tab-to-can weld. Semi-automatic weld tooling was designed to address the weak weld and missed weld concerns.

About Duracell

As part of The Gillette Company, Duracell is the world's leading manufacturer and marketer of high-performance alkaline batteries. Duracell also markets primary lithium and zinc air batteries as well as rechargeable nickel-metal hydride batteries.

For further information on analyzing quality issues or electronic materials joining issues, please contact Candice Mehmetli at 614.688.5180 or candice_mehmetli@ewi.org.



Large heat affected zone in can material caused by low tab-to-can weld strength.

Heat affected zone closer to the weld interface with improved button size and strength.

EWI’s Stan Ream Chairs Session at Recent Fuel Cell Summit

Stan Ream

EWI’s Stan Ream recently chaired a session at the Fuel Cell Summit held October 23-25 in Connecticut. The event was hosted by the Society of Manufacturing Engineers and the Connecticut Clean Energy Fund.

Attendees represented stakeholders throughout the hydrogen and fuel cell value chain including fuel cell producers, end users, researchers, suppliers, manufacturers, and professional service individuals.

“EWI participated in the conference to expand its relationship with the growing number of firms working to develop manufacturable fuel cells,” said Stan Ream, EWI Fuel Cell Technology Leader. “We believe our expertise in materials joining makes us an attractive research partner for fuel cell companies.”

Over 100 of EWI’s member companies manufacture products and components that are used or can be used in fuel cell systems. As North America’s largest engineering and technology organization dedicated to welding and materials joining, EWI is positioned to develop and deploy critical technologies required to move fuel cells from the research laboratory to the manufacturing floor.

NJC Provides High Productivity Welding Technology for Next Generation Surface Combatant

The Navy Joining Center is participating with shipbuilders and other Navy ManTech Centers of Excellence in several technology development projects for the U.S. Navy's next generation multi-role surface combatant—DD(X). One such project that has just been completed addresses a design concept that includes a number of large structures fabricated from thick section, high-strength steel.

Construction of the DD(X) with high-strength steel structures requires welds that are of the highest integrity. Fabrication of these structures to meet design requirements was previously limited to manual welding practices and procedures. Welders were required to deposit many layers of weld metal while working in tight spaces as the base material is preheated to minimize risks of hydrogen cracking. Use of manual welding procedures for these structures requires thousands of production man-hours per ship. Manufacturing cost estimates determined that the expense to fabricate these structures would be excessively high with long production cycles without replacing the manual welding procedures.

This ManTech project was performed to meet the need for improved welding technology to reduce the construction cost and enhance the survivability of the DD(X) multi-mission destroyer. As such, it was necessary to optimize the deposition rate, increase the allowable heat input limits, decrease the joint volume, mechanize or automate the process, and utilize filler material systems with reduced cracking sensitivity.

The project evaluated alternative welding processes and procedures to replace the baseline manual gas metal arc welding approach. These alternatives included submerged arc and flux cored arc welding procedures to increase weld deposition rates and mechanized welding procedures to cut manual labor content. Weld joint designs were reconfigured to reduce the angles of weld grooves and thereby reduce the volume of weld metal that must be deposited. The procedures were modeled through computer simulations and optimized for minimum distortion. The fabrication of several full scale test modules applied these developments to produce more than 50 percent of the welds with mechanized procedures. The combination of mechanization and reduced joint volume contributed to a 25 percent reduction in welding labor hours and a 15 percent increase in first-time weld acceptance.

The newly developed mechanized welding procedures and joint configuration have been successfully transferred to Northrop Grumman Ship Systems (NGSS) and Bath Iron Works (BIW). Both shipyards have been trained in the use of these procedures and have completed welding qualifications. NGSS used this technology to fabricate a full-scale peripheral vertical launch system (PVLS) test module that successfully passed a Maximum Credible Detonation Event explosion test. The new weld joint configuration and welding procedures are the new baseline manufacturing process for the PVLS. These developments also are applicable to the fabrication of other thick-section, high-strength steel ship structures.

For more information on high productivity welding, please contact Larry Brown at 614.688.5080 or larry_brown@ewi.org.

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New EWI Members

ESI, Klamath Fall
Klamath Fall, OR
Business: Manufacturer of electronic component systems and tooling for machines

Guild International
Bedford, OH
Business: Designer and manufacturer of shear welders, horizontal strip accumulators, and complete entry systems

HC Starck, North America
Cleveland, OH
Business: Manufacturer of metal powders, semi-finished and finished molybdenum, tungsten, tantalum, niobium, titanium, zirconium, and nickel products and their alloys

Imalux Corporation
Cleveland, OH
Business: Producer of medical imaging equipment and devices

Obara Corporation
Erlanger, KY
Business: Manufacturer of resistance welding products

Pressure Tube Mfg. LLC
Bridgewater, NJ
Business: Manufacturer of high quality welded corrosion resistant tube

Spirit Aerosystems, Inc.
Atlanta, GA
Business: Supplier of structures for commercial aircraft

TRW Automotive, Steering & Suspension, North America
Sterling Heights, MI
Business: Manufacturer of power rack and pinion steering gears for passenger cars and light trucks

Veri-Tek International Corp.
Wixom, MI
Business: Manufacturer of machinery that is used to inspect automotive and heavy equipment parts