FOURTH QUARTER 2024 | VOLUME 31

SPRAYTIME

AWS | INTERNATIONAL THERMAL SPRAY ASSOCIATION

Research and Development at FIU

Crawmer's Laws

IN THIS ISSUE: INDUSTRY NEWS ■ EVENTS CALENDAR ■ MEMBERSHIP DIRECTORY

CONTENTS

[FEATURES]

8 Research and Development on Wire-Arc Directed Energy Deposition Additive Manufacturing at FIU
T. Paul et al.

11 Crawmer's Laws of Thermal Spray
B. Grow

[DEPARTMENTS]

04 ITSA Member News
05 Events Calendar
06 Industry News
13 Product Spotlight
14 ITSA Membership Directory
15 Advertiser Index

On the cover: Thermach AT-400 twin wire electric arc system spraying anti-skid coating for research and development. (Photo courtesy of Thermach.)

Published by the International Thermal Spray Association, a Standing Committee of the American Welding Society

Mission: To be the flagship thermal spray industry publication providing company, event, personnel, product, research, and membership news of interest to industrial leaders, engineers, researchers, scholars, policymakers, and the public thermal spray community.

SPRAYTIME®
Publisher *Annette Alonso* / **Editor** *Cindy Weihl*
Editorial Staff *Kristin Campbell, Roline Pascal, Alexandra Quiñones*
Technical Editor *Daniel Hayden*
Design and Production *Carlos Guzman, Zaida Chavez*
Advertising *Scott Beller, Lea Owen*

SPRAYTIME® (ISSN 1532-9585 Print) (ISSN 2689-0518 Online) is a quarterly publication of the International Thermal Spray Association. Printed on recycled paper.

Article submissions (subject to acceptance and editing), advertising insertions, address correspondence, subscription requests, back issue copies, and changes of address should be sent to:

American Welding Society
Attn: *SPRAYTIME*
8669 NW 36 St., #130, Miami, FL 33166-6672
(800/305) 443-9353 | *spraytime.org*

A subscription to ***SPRAYTIME®*** is free for individuals interested in the thermal spray and coatings industry. Visit *spraytime.org* to subscribe.

Kirk Fick
Chair

It has been a remarkable year in the thermal spray (TS) industry. Not only was 2024 filled with growth in legacy markets but also in emerging markets. It has been exciting to be involved in so many projects that not only benefit from TS coatings but, for some, would not have been possible without them. And 2025 is shaping up to be a great year as well.

Having just wrapped up our 2024 ITSA Annual Business Meeting, held at AWS Headquarters in Doral, Fla., I would like to thank all those who attended, presented, and helped plan this event. The two-day meeting was held in association with AMPP. The first day was filled with informative presentations centered around the theme of corrosion protection. The second day started with an update from the AWS C2 Committee on Thermal Spray presented by C2 Chair Daniel Hayden. It was followed by member company updates, the ITSA Annual Business Meeting, and a tour of the impressive and soon-to-expand Florida International University's Cold Spray and Rapid Deposition lab.

In 2025, ITSA plans to hold a symposium centering around the topics of heavy equipment, mining, agriculture, and overhaul. The location and timing for the symposium will be announced in the coming months.

To help promote the thermal spray industry and increase value to our members, moving into 2025, each member of the ITSA executive board will be chairing subcommittees focusing on the following areas: Membership – Jim Ryan; Planning (events) – Ashley Hunsaker; Governance – Bill Mosier; Education – Ana Duminie (tentative); *SPRAYTIME* – Kirk Fick; and Scholarship – Mollie Blasingame. We welcome and encourage member participation in these committees. If you are interested in participating, please contact any of the chairs or ITSA Program Manager Adrian Bustillo (*abustillo@aws.org*) for additional information.

Finally, I would like to thank all our members for their continued support and wish you all the best for the coming year!

ITSA MISSION STATEMENT

The International Thermal Spray Association (ITSA), a standing committee of the American Welding Society, is a professional industrial organization dedicated to expanding the use of thermal spray technologies for the benefit of industry and society. ITSA invites all interested companies to talk with our officers and company representatives to better understand member benefits.

OFFICERS

Kirk Fick, chair, Cincinnati Thermal Spray Inc.
Ashley Hunsaker, vice chair, HTS Coatings

EXECUTIVE COMMITTEE (above officers plus the following)

Mollie Blasingame, Superior Shot Peening & Coatings
Ana Duminie, North American Höganäs
Jim Ryan, TechMet Alloys
David A. Lee, David Lee Consulting LLC
Bill Mosier, Polymet Corp.

ITSA SCHOLARSHIP OPPORTUNITIES

ITSA offers annual graduate scholarships. Since 1992, the ITSA scholarship program has contributed to the growth of the thermal spray community, especially in the development of new technologists and engineers. ITSA is very proud of this education partnership and encourages all eligible participants to apply. Visit *thermalspray.org* for criteria information and a printable application form.

ITSA *SPRAYTIME*

Since 1992, ITSA has been publishing *SPRAYTIME* for the thermal spray industry. The mission is to be the flagship thermal spray industry publication providing company, event, personnel, product, research, and membership news of interest to the thermal spray community.

JOIN ITSA

Membership is open to companies involved in all facets of the industry — equipment and materials suppliers, job shops, in-house facilities, educational institutions, industry consultants, and others.

Engage with dozens of like-minded industry professionals at the Annual ITSA Membership Meeting, where there's ample time for business and personal discussions. Learn about industry advancements through the one-day technical program, participate in the half-day business meeting, and enjoy your peers in a relaxed atmosphere complete with fun social events.

Build awareness of your company and its products and services through valuable promotional opportunities: a listing in *SPRAYTIME*, exposure on the ITSA website, and recognition at industry trade shows.

Plus, ITSA Membership comes with an AWS Supporting Company Membership and up to five AWS Individual Memberships to give to your best employees, colleagues, or customers. Visit *aws.org/membership/supportingcompany* for a complete listing of additional AWS benefits. For more information, contact Adrian Bustillo at (786) 937-9595, or *itsa@thermalspray.org*.

For an ITSA Membership application, visit the membership section at *thermalspray.org*.

2025

AMPP Annual Conference and Expo
April 6–10
Nashville, TN
ace.ampp.org/home

Powder Coating Week 2025
April 14–16
Orlando, FL
conference.powdercoating.org

Surfaces, Interfaces and Coatings Technologies International Conference
April 23–25
Albufeira, Portugal
setcor.org/conferences/sict-2025

ITSC 2025
May 5–8
Vancouver, Canada
www.asminternational.org/itsc-2025

51st International Conference on Metallurgical Coatings and Thin Films (ICMCTF)
May 11–16
San Diego, CA
icmctf2025.avs.org

Cold Spray Action Team
May 20–22
Worcester, MA
coldsprayteam.com

Coatings Science International Conference
June 30–July 3
Noordwijk, The Netherlands
coatings-science.com

NRL's Thermal Spray Technology Enhances Navy Ship Readiness

Engineers at the U.S. Naval Research Laboratory's (NRL's) Center for Corrosion Science and Engineering, Key West, Fla., have installed an advanced thermal spray nonskid (TSN) coating system on the USS *Kearsarge* with a new thermal spray robotic vehicle (TSRV) to enhance U.S. Navy mission readiness, ensure crew safety, and maintain a fully capable fleet.

"The successful application of TSN using the TSRV on the USS *Kearsarge* marks a significant milestone in the Navy's efforts to modernize its fleet and improve operational readiness," said NRL Center for Corrosion Science and Engineering Branch Head Ted Lemieux. "NRL is committed to developing innovative technologies that support the Navy's mission and enhance the safety and well-being of our sailors."

The USS *Kearsarge* (LHD-3), a Wasp-class amphibious assault ship, is under routine maintenance at the British Aerospace (BAE) Shipyard in Norfolk, Va. During its overhaul, the vessel will undergo multiple repairs and upgrades, including TSN installation for the first time.

"The TSN flight deck nonskid coating system, transitioned to the navy by NRL, offers significant advantages over traditional nonskid coatings," said NRL Materials Research Engineer Jimmy Tagert. "The standard epoxy nonskid requires replacement every two to three years, whereas TSN has proven to last ten years. Therefore, a ship with TSN does not have to include non-skid replacement for three to four repair cycles, reducing the need for shipyard resources." Additionally, TSN is a metallized coating that can withstand harsh shipboard environmental conditions and enhance the long-term corrosion protection of the structure.

The TSRV automates applying TSN, further improving efficiency and reducing costs. The TSRV combines multiple steps of the TSN application process, from deck preparation to spraying the nonskid solution.

"Combining multiple steps of the TSN application process into a single unit helps us get the work done two to three times faster, providing schedule relief during complex maintenance availabilities," Tagert said.

TSN and TSRV technology provides enhanced durability, improved safety, increased efficiency, and environmental

Jimmy Tagert, engineer for U.S. Naval Research Laboratory's (NRL's) Center for Corrosion Science and Engineering, helped install an improved thermal spray nonskid (TSN) system on the USS Kearsarge (LHD-3) with the new thermal spray robotic vehicle (TSRV). (U.S. Navy photo by Mass Communications Specialist First Class Jeff Troutman.)

benefits, all while reducing life cycle maintenance costs and supporting the navy's mission of operational readiness.

NRL strives to continue enhancing this technology to support TSN operations for the Navy. Tagert and his team intend to shape the TSN application process to expand nonskid technology to all ship classes, including smaller vessels.

Hannecard – ASB Adds Thermal Spray HVOF K2 Gun to Production

Hannecard – ASB Industries, Barberton, Ohio, has enhanced its production capabilities with the installation of the advanced GTV K2 HVOF system, a high-performance thermal spray technology. The third-generation kerosene fuel system, widely adopted across Europe, incorporates patented kerosene atomization and an optimized combustion chamber design, providing more-consistent high-quality coatings in a robust, high-production system.

The system delivers higher combustion pressure, providing higher velocity coatings. This leads to improved coatings with higher strain tolerance and optimum coating structure for wear. The system sprays fine powders for smoother as-sprayed coatings. It features multiple gun configurations to spray materials that require high heat input, such as Cr_3C_2/Ni20Cr, and low-melting-point materials, such as copper. Other features include stabilized kerosene flow, efficient carbide spraying, and more-consistent powder feeding.

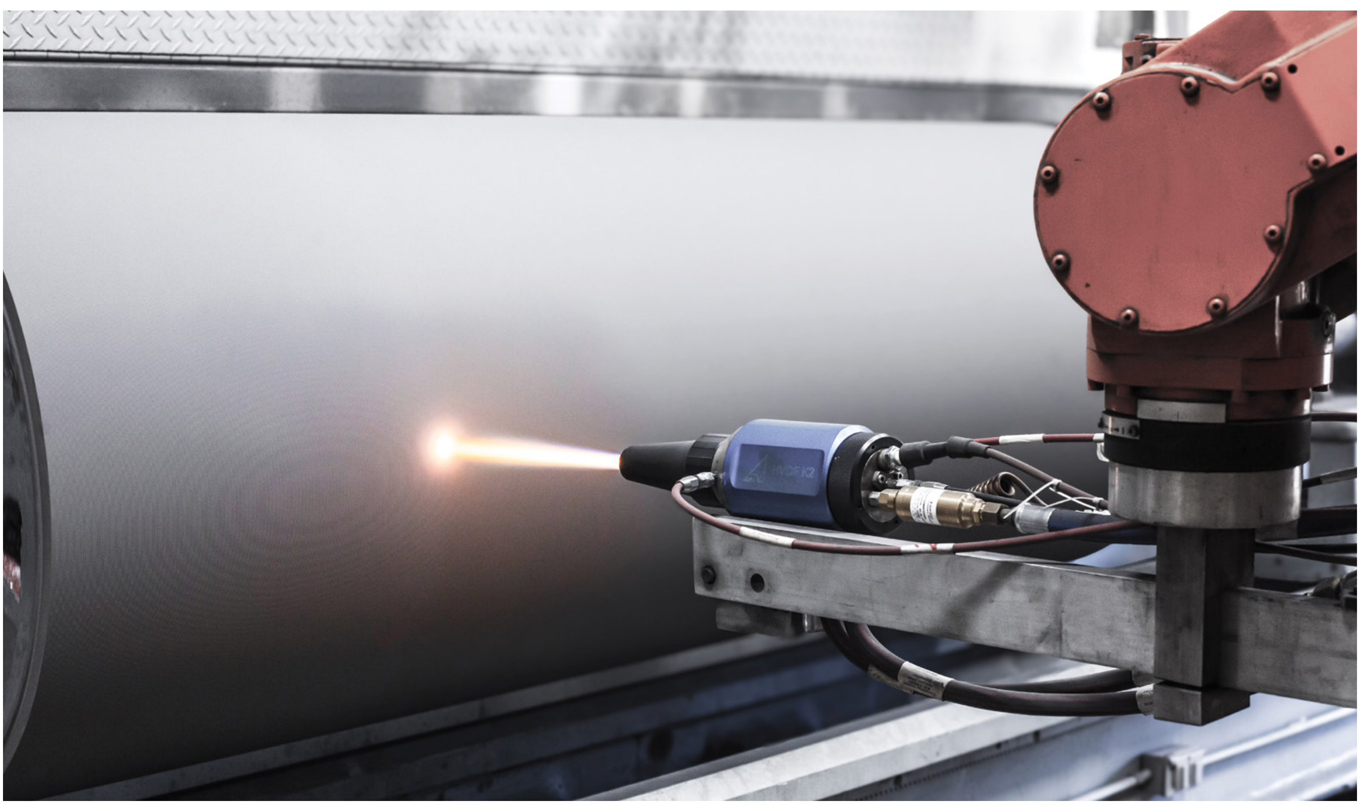
IGS Acquires Thermal Spray Business from Liquidmetal Industrial Solutions

Intergrated Global Services Inc. (IGS), Richmond, Va., a global provider of proprietary, highly engineered asset integrity, environmental, and efficiency technologies, has acquired Liquidmetal Industrial Solutions' engineered coatings and materials business.

The acquired business, based in Chattanooga, Tenn., specializes in high-performance thermal spray application services and materials, including the Armacor® technology line. This addition enhances IGS's comprehensive thermal spray solutions portfolio and expands its ability to serve customers with specialized surface enhancement needs.

"We are excited to welcome the experienced team from Liquidmetal into the IGS family," said Rich Crawford, president and CEO of IGS. "IGS's technology leadership, engineering excellence, and global operating platform — combined with Liquidmetal's innovative material technologies — create compelling opportunities for continued global adoption of HVTS® [high-velocity thermal spray] across a wide range of industries."

The acquisition brings several key personnel from Liquidmetal Industrial Solutions to IGS, ensuring continuity of service and expertise.



Hannecard – ASB Industries operates high-performance production with the upgraded thermal spray HVOF K2 gun, delivering consistent, high-quality coatings for wear resistance in demanding applications.

BY TANAJI PAUL, TYLER DOLMETSCH, AND ARVIND AGARWAL

Research and Development on

Wire-Arc Directed Energy Deposition Additive Manufacturing at FIU

On November 7, ITSA members were welcomed to Florida International University's (FIU) Cold Spray and Rapid Deposition (ColRAD) laboratory in Miami, Fla., for a facility tour and to learn about the school's research and development initiatives, especially those related to additive manufacturing (AM).

Additive manufacturing has rapidly evolved over the last few decades, transforming industries by enabling more efficient production, customization, and material use. Among the various additive manufacturing techniques, wire-arc directed energy deposition (WDED) stands out for its ability to build large, complex metal components with high deposition rates. WDED uses an electric arc as the heat source and metal wire as the feedstock, fusing layers of material to create intricate geometries. As the demand for AM technologies continues to grow, WDED has gained attention not only for its application in industries like aerospace, automotive, and defense but also for its unique potential to reduce material waste and manufacturing lead

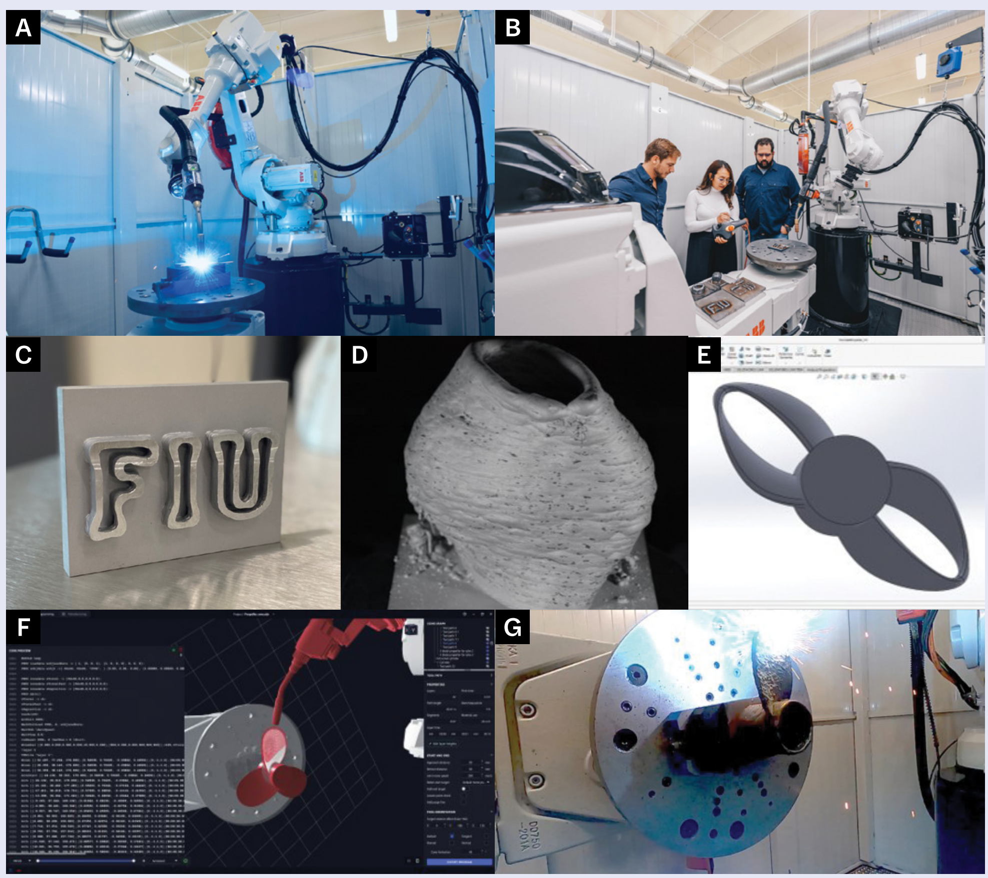


Fig. 1. — Florida International University's wire-arc directed energy deposition (WDED) technology at its Cold Spray and Rapid Deposition (ColRAD) laboratory is an amalgamation of additive manufacturing and design software for rapid prototyping of metallic alloy parts with complex geometries.

times due to supply chain challenges. FIU has emerged as a key player in this field, with its state-of-the-art WDED facility pushing the boundaries of large-scale additive manufacturing research and development at its ColRAD laboratory. The following explores the capabilities of FIU's WDED facility, from the advanced equipment and sensors to the imaging technologies that allow for precise process control. This article highlights parts manufactured at the facility and ongoing efforts to expand research and workforce development initiatives.

Integration of Equipment, Sensors, and Software for WDED Technology

At the heart of FIU's WDED facility is a specialized robotic cell equipped with an ABB IRB 2600 robot, which has a capacity of 20 kg (44.09 lb) and a reach of 1.65 m (5.41 ft) (Fig. 1A). The robot's six degrees of freedom coupled with two additional degrees of the turntable of capacity 750 kg (1653.47 lb) enable intricate movements and large build volumes, ensuring that large additively manufactured parts with complex geometries can be built with exceptional accuracy (Fig. 1B). Central to the system is the Fronius TPS 400i cold metal transfer welding machine capable of depositing wires from 1.1 to 1.6 mm (3.61 to 5.25 ft) in diameter constituted of various compositions, such as aluminum alloys, steels, and novel materials, such as high entropy alloys. This welding machine delivers the necessary energy and material for the deposition process, which, paired with the robot, allows for high-quality builds at an impressive rate (Figs. 1C, D), making it ideal for producing large-scale metal components.

Industry-standard software solutions support the design and manufacturing process. This includes SolidWorks for 3D modeling and topology optimization, ADAXIS for multiaxis non-planar slicing and post-processing, and Siemens NX for streamlining automation from CAD to additive manufacturing simulations (Fig. 1E). These programs enable seamless transition from digital designs to physical parts, ensuring precision in every layer deposited. Efforts are underway to construct digital twins to replicate the complete physical asset of WDED deposition, robotics, and materials that enhance the quality of manufactured parts. Integrating design software with advanced robotic technology allows for rapid prototyping and efficient parts production with minimal material waste (Figs. 1F, G).

To enhance process control, the facility uses thermal sensors for real-time temperature monitoring up to 1200°C (2192°F). These sensors are embedded in the deposited parts and the substrates, allowing for precise control over thermal conditions during the build process (Fig. 2A, B). By closely monitoring temperature variations, researchers can adjust processing parameters quickly, leading to better material properties and overall part quality. These capabilities are further enhanced by advanced imaging systems that provide deeper insight into the process.

High-Resolution Imaging Capabilities and Material Studies

The equipment at FIU's WDED facility is complemented by a suite of imaging tools, which provide critical insights into the deposition process and the resulting material properties. A Blackmagic high-resolution 6K camera is used for imaging the wire-arc deposition process. Additionally, an i-SPEED 7 Series high-speed camera is used to understand solidification mechanisms during bead formation. This camera can acquire up to 1 million frames per second, capturing minute details during the build, allowing researchers to observe the deposition arc, wire feed, and material flow with unmatched clarity. The footage not only aids in identifying potential process anomalies but also serves as a valuable tool for refining and optimizing future builds. The facility also employs a FLIR thermal camera for temperature monitoring from ambient to 2000°C (3632°F) that provides thermal maps of the part being built, allowing researchers to track temperature distribution across the deposited layers (Figs. 2C, D). Temperature distribution information is essential for controlling cooling rates and preventing unwanted thermal effects like cracking or warping. When combined with the data from embedded thermocouples, the thermal camera enables precise heat management throughout the entire process, ensuring uniformity and consistency in part quality.

One of the standout materials being investigated at ColRAD is commercially pure titanium, a highly sought-after material in industries such as marine, aerospace, and biomedical engineering. Single-phase titanium parts with excellent microstructure (Fig. 2E) and mechanical performance of up to 80% of that of conventionally cast titanium demonstrate the capability of WDED to manufacture high-quality components. Currently, ColRAD is studying the deposition of novel iron-based cored wires for manufacturing bulk HEA large-scale components. Novel microstructures with heterogeneous precipitation are observed. These successes pave the way for further exploration into more advanced alloys and complex materials.

Upcoming Expansion and Workforce Development

The WDED facility at FIU has successfully manufactured a range of metal components, leveraging the versatility of wire-arc technology. Among the notable achievements are aluminum and steel parts and the previously mentioned titanium components. These parts are designed for industries that require lightweight yet durable materials, such as aerospace and automotive, where the ability to customize designs and reduce material waste provides a significant competitive advantage. FIU is poised for an exciting expansion of its WDED capabilities. Plans are in place to integrate a laser-based WDED instrument where the 450 nm wavelength blue light brings in improved energy absorption and printing efficiency across the metallic alloy spectrum. The introduction of this cutting-edge technology will allow for greater control over material properties and expand the range of metals and alloys that can be used in the manufacturing process. This expansion will significantly increase ColRAD's capacity for research and development, positioning FIU at the forefront of advanced manufacturing technologies. In parallel with these technical advancements, FIU has made significant strides in workforce development. Recognizing the growing demand for skilled professionals in additive manufacturing, the facility offers hands-on training programs that expose students to real-world applications of WDED technology. A particularly inspiring success story is that of a student who began as a high school summer researcher at FIU. Starting with introductory training in WDED, this student

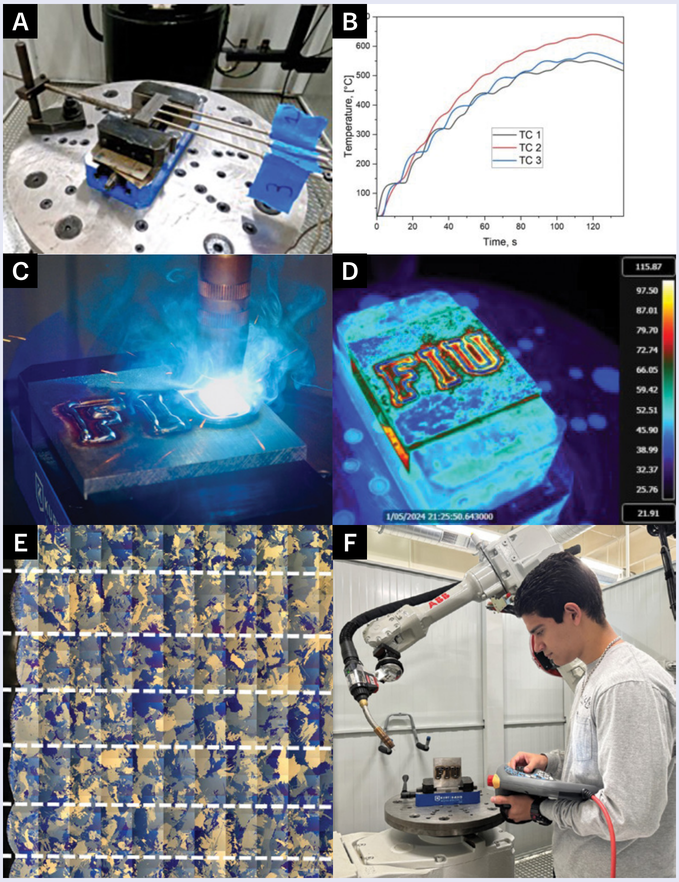


Fig. 2. The integration of sensors such as thermocouples, high-resolution cameras, and thermal imaging technologies provide a comprehensive understanding of processing fundamentals and success in the development of advanced materials and opportunities for training the next generation of STEM workforce in the global additive manufacturing ecosystem.

transitioned into an undergraduate research role focused on wire-arc additive manufacturing. After gaining significant experience, the student can manufacture WDED parts (Fig. 2F) independently, showcasing the facility's ability to nurture talent from an early stage and develop the next generation of STEM experts in this field of additive manufacturing.

Conclusion

Upcoming expansions at FIU, including the integration of laser-based instruments, will further enhance the precision and scope of the research. At the same time, ColRAD's commitment to workforce development equips the next generation of skilled professionals with the expertise to drive the future of this technology.

References

1. Palacios, B., et al. 2024. Role of crystalline orientations and additive layers on the bulk tensile response of wire-arc directed energy deposited (WDED) single phase titanium. *Materials Science and Engineering: A* 911(9): 146921.
2. Mohammed, S. M. A. K. et al. 2023. Exploring the potential of wire fed direct energy deposition of aluminum-boron nitride nanotube composite: microstructural evolution and mechanical properties. *Advanced Engineering Materials* 25(20): 2300770.
3. Paul, T., et al. Aluminum boron nitride nanotube composites and methods of manufacturing the same. U.S. Patent US 11780023B2, filed Dec. 14, 2022, and issued Oct 10, 2023.
4. Palacios, B., et al. 2023. Role of structural hierarchy on mechanics and electrochemistry of wire arc additive manufactured (WAAM) single phase titanium. *Journal of Manufacturing Processes* 93(5): 239-249.

TANAJI PAUL (*tpaul@fiu.edu*), is a research assistant professor, **TYLER DOLMETSCH** is a research scientist, and **ARVIND AGARWAL** is a distinguished university professor and principal investigator at Cold Spray and Rapid Deposition Laboratory (ColRAD), Florida International University, Miami, Fla.

CRAWMER'S LAWS OF THERMAL SPRAY

As many in the industry know, thermal spray is a finicky game. With dozens of variables and delicately balanced material phase changes, much can go wrong. Through decades of experience, one man was able to refine most of his knowledge into two laws to govern the entirety of thermal spray. He has contributed countless innovations and insights to the industry. He was even able to share some of his knowledge in the classroom as an adjunct professor at the University of Wisconsin-Madison. His name is Daryl Crawmer.

The Thermach SG100 plasma torch prepares to spray coating samples for a customer.

Rule #2

Crawmer had two laws of thermal spray. I am going to list his laws out of order for reasons that will soon become apparent. Crawmer's second law is "There are no small carrier gas leaks." In other words, "All carrier gas leaks are bad." With so many variables to consider, this one can be easily overlooked. A carrier gas leak anywhere from the point of control to the point of injection into the plasma or flame can cause a multitude of problems, from inaccurate feed rates to powder injection problems, which can cause downtime or produce a coating that is out of spec. This seemingly small factor leads to rework and costs going through the roof.

Carrier gas leaks can also lead to inconsistent feed rates. A consistent feed rate is key if you want to produce a consistent coating. Inconsistent feed rates lead to rework and rising costs. Aside from feed rate issues, carrier gas leaks can result in plugs in the powder port or the production of "berries." This is due to inconsistent powder penetration at the boundary layer of the plasma or flame. If the carrier gas flow is too high, berries can start forming on the torch opposite the side of the powder injection port. If the flow is too low, the powder will not penetrate the boundary layer, and the powder port will get plugged or berries will form on the same side as the powder port. Another issue with leaks is the aspiration of air or other gases that might not be process gases. This can lead to rapid hardware failure and oxides or other impurities in the coating, and it can alter the spray parameters. All three scenarios lead to excess material costs and, of course, more rework. For these reasons, we urge our customers to perform periodic 15-minute leak checks on all powder feeders, hoses, and tubes used in the process. A 15-minute test could save you hours of troubleshooting and rework.

Rule #1

Crawmer's first law is "The only absolute in thermal spray is that there are no absolutes." You might be wondering why this law is here and out of order. Well, let's look at Crawmer's second law again. Just because you have a carrier gas leak does not mean you cannot produce the desired coating. You can certainly produce a coating that is well within spec; it is just going to be more difficult and costly.

Another example is with feedstock: the powder and wire used to spray. You can use the same powder from the same vendor in the same spec, and it will work beautifully for your process. Then one batch comes in, and it doesn't work. The vendor insists that the powder is within spec, but it isn't working as nicely. Maybe that specific cut has a slightly different shape to the particulates. Maybe the particulate size variation is off ever so slightly to interfere with the standard process. With so many variables in thermal spray, changing even one variable — no matter how small it may seem — can cause a lot to go wrong.

The optimistic side of this law is that thermal spray, like many processes, has its limits. But these limits are meant to be pushed. New things are meant to be tried, failed, and retried.

The Thermach AT-1200 rotary powder feeder for high-velocity oxygen fuel, high-velocity air fuel, plasma, flame, and laser cladding applications.

Conclusion

For the past century, thermal spray has been the hidden backbone of many influential industries like gas and oil, military, aerospace, and automotive. Today, new industries, such as electric vehicles, sustainable energy, commercial space travel, and artificial intelligence and quantum computing will need that hidden backbone to help prop them up as they get legs and start to run. Thermal spray now faces more opportunities to push the boundaries of physics and materials engineering than ever before.

BENJAMIN GROW (*benjamingrow@thermach.com*) is operations manager, Thermach, Appleton, Wis.

Thermal Spray Control Console Provides Remote Support Capabilities

The AT-3200 mass-flow control console for high-velocity oxygen fuel (HVOF) or plasma can quickly automate the thermal spray process. The system, which is entirely recipe-based, allows operators to select recipes for process controls quickly. This eliminates the need for operator input and related errors. Operations can leverage greater process reliability and remote monitoring for quality assurance. The console has an easy user interface with a large touchscreen human-machine interface. A programmable logic controller-based system allows for communication and integration with other components. Additional features, including data acquisition, maintenance scheduling, and monitoring, are readily available.

Thermach
thermach.com / (920) 779-4299

Report Predicts $17 Billion Growth in Thermal Spray Equipment Market

Thermal Spray Coating Equipment and Services Market by Product (Material, Equipment & Services), Process (Combustion Flame & Electrical), End-Use Industry (Aerospace, Automotive, Healthcare, Energy & Power), and Region — Global Forecast to 2030 reports the market is projected to grow from $14 billion in 2024 to $17.8 billion by 2030 with a compound annual growth rate of 4.1% over the forecast period. The increasing industrialization across various sectors, such as automotive, aerospace, energy, and healthcare, is a significant driver for the market. These industries require coatings to enhance their equipment's performance, durability, and protection. In the market for thermal spray coating equipment and services, the services segment has the largest market share. This is because there are many special-use spray coatings applications as well as technical support, maintenance, and repairs in industries such as aerospace, automotive, and energy. Therefore, these tasks tend to be outsourced so that quality and precision can be ensured and handled by individuals who know how to do it.

Markets and Markets
marketsandmarkets.com / (888) 600-6441

Thermal Spray Coatings Market Report Projects Robust Growth to 2031

According to *Thermal Spray Coatings Market Size, Share, Growth Analysis, By Process (Combustion flame (wire flame spraying, powder flame spraying, detonation gun spraying, ceramic rod spraying), By Material (Metal and Alloys, and Ceramics), By End User (Aerospace (flame tubes, turbine blades, landing gear), Automotive (suspension parts), By Region - Industry Forecast 2024-2031*, the thermal spray coatings market has experienced robust growth over the past decade and is projected to continue expanding. The market size was valued at $11.3 billion in 2022 and is poised to grow from $11.87 billion in 2023 to $17.53 billion by 2031, growing at a compound annual growth rate of 5.0% during the 2024–2031 forecast period. This growth is driven by several factors, including an aging global population, increasing prevalence of advancements in technology, and rising global expenditure. The 184-page report offers a thorough analysis of the market, competitor and geographical analysis, and a focus on the most recent technological developments. It also demonstrates existing and upcoming opportunities, profitability, revenue growth rates, pricing, and scenarios for recent industry analysis. The report can be segmented based on several factors, including product type, application, end-user, and distribution channel, for companies looking to target specific markets and tailor their offerings to meet consumer needs.

SkyQuest Technology Group
skyquestt.com / (351) 333-4748

JOB SHOP MEMBER COMPANIES

Accuwright Industries Inc.
Gilbert, AZ
David Wright | *dave@accuwright.com*
(480) 892-9595 | *accuwright.com*

Atlas Machine & Supply Inc.
Louisville, KY
Richie Gimmel | *richie@atlasmachine.com*
(502) 584-7262 | *atlasmachine.com*

Bender CCP
Vernon, CA
Doug Martin | *dmartin@benderus.com*
(323) 232-2371 | *benderccp.com*

BryCoat Inc.
Oldsmar, FL
Kevin Smith | *ksmith@brycoat.com*
(727) 490-1000 | *brycoat.com*

Cincinnati Thermal Spray Inc.
Cincinnati, OH
Kirk Fick | *kfick@cts-inc.net*
(513) 793-0670 | *cts-inc.net*

Exline Inc.
Salina, KS
Brent Hilbig | *b.hilbig@exline-inc.com*
(785) 825-4683 | *exline-inc.com*

Fusion Inc.
Houston, TX
Jeff Fenner | *jfenner@fusionhouston.com*
(713) 691-6547 | *fusionhouston.com*

Hayden Corp.
West Springfield, MA
Dan Hayden
daniel.hayden@haydencorp.com
(413) 734-4981 | *haydencorp.com*

H&M Plating Co. Inc.
Houston, TX
Kevin Crenshaw | *kcrenshaw@hmplating.com*
(713) 643-6516 | *hmplating.com*

Kermetico Inc.
Benicia, CA
Andrew Verstak | *averstak@kermetico.com*
(707) 745-3862 | *kermetico.com*

Linde Advanced Material Technologies Inc.
Indianapolis, IN
Michael Brennan
michael.brennan@linde.com
(317) 240-2500 | *linde-amt.com*

Metcut Research Inc.
Cincinnati, OH
Triratna Shrestha | *tshrestha@metcut.com*
(513) 271-5100 | *metcut.com*

Nation Coating Systems
Franklin, OH
Pat Pelzer | *patp@nationcoating.com*
(937) 746-7632 | *nationcoatingsystems.com*

Spraywerx
North Vancouver, BC, Canada
Alan Burgess | *aburgess@spraywerx.com*
(604) 306-2061 | *spraywerx.com*

Superior Shot Peening Inc.
Houston, TX
Mollie Blasingame
mmb@superiorshotpeening.com
(281) 449-6559
superiorshotpeening.com

SUPPLIER MEMBER COMPANIES

Alloy Coating Supply
Spring, TX
Jeffrey Noto | *jnoto@alloycoatingsupply.com*
(281) 528-0980 | *alloycoatingsupply.com*

Ametek Inc.
Eighty Four, PA
Cindy Freeby | *cindy.freeby@ametek.com*
(724) 225-8400 | *ametekmetals.com*

ARC Specialties
Houston, TX
Daniel Allford | *dan@arcspecialties.com*
(713) 631-7575 | *arcspecialties.com*

Ardleigh Minerals Inc.
Beachwood, OH
Ernie Petrey | *epetrey@ardleigh.net*
(216) 464-2300 | *ardleigh.net*

Arzell Inc.
Cypress, TX
Michael Gray | *mike@arzell.com*
(281) 213-4085 | *arzell.com*

Carpenter Technology
Philadelphia, PA
Jason Simmons | *jsimmons@cartech.com*
(610) 208-2000 | *carpentertechnology.com*

CenterLine (Windsor) Ltd.
Windsor, ON, Canada
Julio Villafuerte
julio.villafuerte@cntrline.com
(519) 734-8464 | *supersonicspray.com*

DeWAL Industries Inc.
Narragansett, RI
Rebecca Auger
rebecca.auger@rogerscorp.com
(401) 789-9736 | *rogerscorp.com*

Donaldson Torit
Minneapolis, MN
Paul Richard | *paul.richard@donaldson.com*
(603) 343-2448 | *donaldsontorit.com*

Global Tungsten & Powders Corp.
Towanda, PA
Laura Morelli
laura.morelli@globaltungsten.com
(570) 268-5000 | *globaltungsten.com*

Haynes International
Mountain Home, NC
Brandon Furr | *bfurr@haynesintl.com*
(828) 692-5791 | *haynesintl.com*

IKH USA-Inc.
Wellford, SC
Richard Bajan | *richard.bajan@ikh-usa.com*
(864) 431-4134 | *ikh-usa.com*

Imerys Fused Minerals
Greeneville, TN
Mitch Krieg | *mitch.krieg@imerys.com*
imerys.com

Imperial Systems
Mercer, PA
Tomm Frungillo
tfrungillo@isystemsweb.com
(724) 662-2801 | *imperialsystemsinc.com*

Lincoln Electric
Cleveland, OH
Thomas Brown
thomas_brown@lincolnelectric.com
(216) 383-2951 | *lincolnelectric.com*

Lineage Metallurgical LLC
Baytown, TX
Landon Hendricks | *lhendricks@lineagemet.com*
(281) 426-5535 | *lineagemet.com*

North American Höganäs
Hollsopple, PA
Ana Duminie | *ana.duminie@hoganas.com*
(814) 361-6875 | *hoganas.com*

Oerlikon Metco (US) Inc.
Westbury, NY
Daniel De Wet
daniel.dewet@oerlikon.com
(516) 334-1300 | *oerlikon.com/metco*

Polymet Corp.
West Chester, OH
Bob Unger | *runger@polymet.us*
(513) 874-3586 | *polymet.us*

Saint-Gobain Ceramic Materials
Worcester, MA
Shari Fowler-Hutchinson
shari.fowler-hutchinson@saint-gobain.com
(508) 795-5264
coatingsolutions.saint-gobain.com

TechMet Alloys LLC
Sealy, TX
James Ryan | *j.ryan@techmet-alloys.com*
(979) 885-7180 | *techmet-alloys.com*

Thermach LLC
Appleton, WI
Tim Vanden Heuvel
timvandenheuvel@thermach.com
(920) 779-4299 | *thermach.com*

Thermion
Silverdale, WA
Dean Hooks | *dhooks@thermioninc.com*
(360) 692-6469 | *thermioninc.com*

ASSOCIATE MEMBER ORGANIZATIONS

David Lee Consulting
Ligonier, IN
David Lee | *dlee@daltsc.com*
(574) 849-3636

Florida International University
Department of Mechanical and
Materials Engineering
Miami, FL
Arvind Agarwal | *agarwala@fiu.edu*
(305) 348-1701 | *mme.fiu.edu*

Mason Global Management LLC
Killingworth, CT
Richard P. Mason
rmason@masonglobalmanagementllc.com
(724) 554-9439
masonglobalmanagementllc.com

State University of New York at
Stony Brook
Stony Brook, NY
Sanjay Sampath
ssampath@ms.cc.sunysb.edu
(631) 632-8480 | *ctsr-sunysb.org*

The Mozolic Group
Londonderry, NH
Jean Mozolic | *jean.mozolic@comcast.net*
(508) 254-4375

SUPPORTING MEMBER SOCIETIES

DVS, The German Welding Society
Jens Jerzembeck
jens.jerzembeck@dvs-hg.de
dvs-home.de/en

GTS E.V., The Association of
Thermal Sprayers
Werner Kroemmer
werner.kroemmer@gts-ev.de
+49 89 31001 5203 | *gts-ev.de*

Institute of Materials, Malaysia (IMM)
Johar Juhari | *johar_juhari@petronas.com.my*
+6018 911 3480 | *iomm.org.my*

Japan Thermal Spray Society (JTSS)
Nick Yumiba | *jtss@mb8.seikyou.ne.jp*
+81 6 6722 0096 | *jtss.or.jp*

Metal Powder Industries
Federation (MPIF)
James R. Dale | *jdale@mpif.org*
(609) 452-7700 | *mpif.org*

Surface Engineering for Advanced
Materials (SEAM)
Christopher Berndt | *cberndt@swin.edu.au*
+61(0)4 28 237 638 | *arcseam.com.au*

Thermal Spraying Committee of
China Surface Engineering
Association (TSCC)
Huang Xiao | *xiaoou@chinathermalspray.org*
+86 10 64882554 | *chinathermalspray.org*

ADVERTISER INDEX

Your *SPRAYTIME*® publication is provided to you at no charge by our advertisers. We encourage you to thank these advertisers by using and referring their products and services at every opportunity.

Alloy Coating Supply **2**

Arzell Inc. **16**

Thermach Inc. **5**

VETERAN OWNED BUSINESS

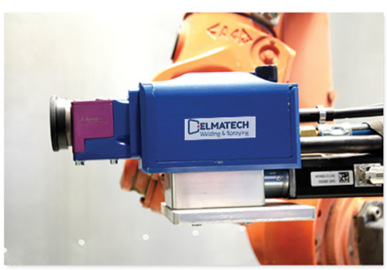
Arzell, Inc.

THERMAL SPRAY INTEGRATION & ROBOT AUTOMATION

NEW OFFERING

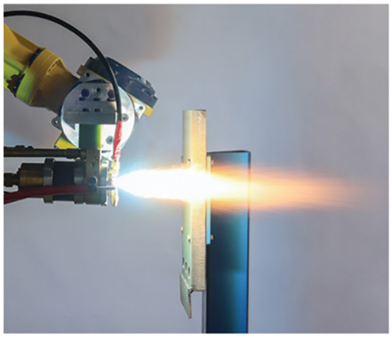
In addition to our in-house manufactured Multus combustion, plasma and HVOF systems, Arzell is proud to announce that we are the exclusive US distributor of the highest technology arc spray system available, the Elmatech MIDI LDS 400.

The standard package is PPG (Push Pull Gun), but can be configured as a pull system, or push with individual pull motors. Additionally, we can update existing SmartArc systems while maintaining the original torch. A PPG ID torch is also available.



Elmatech TWAS Torch & ID Torch

Arzell Multus C+



CALL US TODAY
281 213 4085

13622 KLUGE RD. CYPRESS, TX 77429
WWW.ARZELL.COM

ELMATECH Welding & Spraying

SCAN ME