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SPRAYTIME

AWS American Welding Society | International Thermal Spray Association

Thermal Spray Preparation

Florida University Unveils Cold Spray Lab

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On the cover: Preparing the surface for thermal spray using a manual pressure grit blasting process. (Photo courtesy of Oerlikon Metco.)

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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.

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Mollie Blasingame
Chair

It's hard to believe we are in the last month of 2023. This was a great year for ITSA, with the highlight being the return of our face-to-face annual business meeting this past summer in Buffalo, N.Y. A great deal of time was spent planning that gathering, and we are already preparing and looking forward to our next meeting in Miami, Fla.

The American Welding Society (AWS) will be hosting us at their headquarters building, and we will have the opportunity to visit Florida International University's (FIU) plasma lab as well as their new Cold Spray and Rapid Deposition (ColRAD) lab to learn more about the interesting research being done there. FIU recently held a ribbon cutting ceremony to unveil ColRAD (read more about it on page 10), and ITSA Program Manager Adrian Bustillo, *SPRAYTIME* Editor Cindy Weihl, and AWS C2 Committee on Thermal Spraying Program Manager Jennifer Rosario were in attendance. We look forward to sharing more information on the 2024 Miami meeting in the next issue. This year, we also saw the redesign of the ITSA website. I was able to offer input and feedback on new content for the site, and I invite everyone to go visit it at *thermalspray.org*. Lastly, the ITSA Membership Task Group met in the fall, and we received updates on membership and developed a list of initiatives to attract new ITSA members. We are really looking forward to all the new things happening with ITSA in 2024 and are grateful to all our members and readers.

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.

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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.

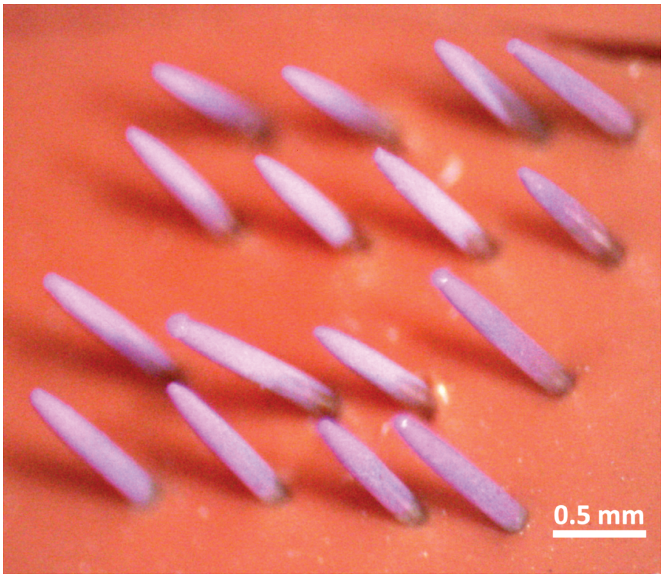
Build awareness of your company and its products and services through valuable promotional opportunities: a listing in *SPRAYTIME*, exposure on the ITSA website, and recognition at industry trade shows.

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*.

Rutgers Scientists Develop Spray Technique for Bioactive Materials



Dyed DNA vaccine coated on a microneedle array by efficient electrospray deposition. (Photo courtesy of Sarah H. Park/Rutgers School of Engineering.)

Scientists at Rutgers School of Engineering, Piscataway, N.J., have devised a more-accurate method for creating coatings of biologically active materials for a variety of medical products. According to researchers, such a technique could pave the way for a new era of transdermal medication, including shot-free vaccinations.

Writing in *Nature Communications*, researchers described a new approach to electrospray deposition, an industrial spray-coating process. Essentially, Rutgers scientists developed a way to better control the target region within a spray zone as well as the electrical properties of microscopic particles that are being deposited. The greater command of those two properties means that more of the spray is likely to hit its microscopic target.

"While many people think of electrospray deposition as an efficient method, applying it normally does not work for targets that are smaller than the spray, such as the microneedle arrays in transdermal patches," said Jonathan Singer, an associate professor in the Department of Mechanical and Aerospace Engineering in the Rutgers School of Engineering and an author on the study. "Present methods only achieve about 40% efficiency. However, through advanced engineering techniques we've developed, we can achieve efficiencies statistically indistinguishable from 100%."

Coatings are increasingly critical for a variety of medical applications. They are used on medical devices implanted into the body, such as stents, defibrillators, and pacemakers. And they are beginning to be used more frequently in new products employing biologicals, such as transdermal patches.

"Being able to deposit with 100% efficiency means none of the material would be wasted, allowing devices or vaccines to be coated in this way," said Sarah Park, a doctoral student in the Department of Materials Science and Engineering who is the first author on the paper. "We anticipate that future work will expand the range of compatible materials and the material delivery rate of this high-efficiency approach."

In addition, researchers allege that unlike other coating techniques used in manufacturing, the new electrospray deposition technique is characterized as far field, meaning it doesn't need highly accurate positioning of the spray source. As a result, the equipment necessary to employ the technique for mass manufacturing would be more affordable and easier to design.

DeWys Metal Solutions Acquires Shoreline Powder Company and Initiates Expansion Plans

DeWys Metal Solutions, a custom metal fabricator located in Marne, Mich., is increasing its local presence with an acquisition and the expansion of two facilities.

Shoreline Powder Coating, Grand Haven, Mich., was added to DeWys's ReFab Metal Fab business to provide customers with a broader range of finish options and faster turnaround times.

"Having in-house powder coating capabilities will significantly reduce lead times, make us more competitive with cost, and allow us to quickly respond to customer needs," explained ReFab President Andrew DeWys. "It also expands our portfolio of painted and assembled products for current and future customers."

DeWys Metal Solutions is growing its business with improved facilities and an acquisition.

Additionally, the company will add to its existing location in Marne and has acquired a new facility for its DeWys Stainless Solutions division in Walker, Mich. The additions will create more job opportunities, further strengthening the local economy.

Airbus Selects Titomic as Supplier of Cold Spray Equipment for Aerospace Applications

The Airbus Group, Blagnac, France, a commercial aircraft manufacturer, has chosen Titomic Ltd., Mount Waverly, Australia, an additive manufacturing company, as its supplier for cold spray additive manufacturing, repairs, and maintenance equipment.

As part of the agreement, Airbus has issued a purchase order for two kinetic fusion systems. One of the systems, a D623 medium-pressure cold spray system, will be installed onsite at Airbus, enabling coatings and repairs capabilities. The second larger system will be installed at Titomic's European facility. The Titomic-based system will facilitate the development of aerospace applications tailored to Airbus's specific needs. The two companies will work together to develop and refine cold spray processes and equipment to meet the stringent requirements of the aerospace industry.

PPG Invests $44 Million to Boost Global Powder Production

PPG, a supplier of paints, coatings, and specialty materials based in Pittsburgh, Pa., will invest $44 million to upgrade five powder coating manufacturing facilities in the United States and Latin America. The projects are part of the company's efforts to expand its powder coatings offerings and increase global production for sustainably advantaged products.

Collectively, the investment — $30 million for U.S. plants and $14 million for facilities in Latin America — is expected to increase overall capacity; add production capabilities for bonded metallic powders; improve processing times with automated packaging; and advance production for small, medium, and large batches. Enhancements and expansions are already completed or underway at powder production facilities in Brazil, Ind.; Gainesville, Tex.; Greensboro, N.C.; San Juan del Rio, Mexico; and Sumaré, Brazil. The company expects to complete these total projects by the end of the year.

"Focusing on powder coatings is a win-win for PPG and our customers as we are able to offer greater access to sustainably advantaged products," said Marizeth Carvalho, PPG global director, powder coatings, Industrial Coatings business. "Powder is the fastest growing coatings technology in the world, and PPG's goal is to lead that charge through innovation and production advancements."

The growth of PPG's powder coatings business will help meet customer demand. (Photo courtesy of Business Wire.)

One outcome of this work is the inclusion of Titomic's equipment and technology within Airbus maintenance protocols. As a result, all Airbus maintenance, repair, and overhaul (MRO) facilities planning to utilize cold spray applications will be required to use Titomic equipment and technology, ensuring consistency and adherence to Airbus standards across its MRO operations.

Herbert Koeck, managing director of Titomic, commented, "This is a significant development for us at Titomic, and we are excited to embark on this strategic partnership with Airbus, further expanding our presence in the aerospace sector . . . With demanding regulations and requirements, the aerospace market is difficult to enter. We are grateful to Airbus, our investors, and suppliers for supporting us in reaching this important milestone."

ASG AMF Engineering Buys New Factory

ASG AMF Engineering, Bromborough, Wirral, England, a precision engineering company that manufactures components and assemblies for research facilities and the semiconductor industry, has invested in an additional factory. It will continue to retain the existing premises for machining.

The new factory has enabled the company to increase the size of its clean assembly facility while providing more room for its chemical cleaning and welding capabilities. The facility has also allowed the company to invest about £400,000 ($497,000) in automated thermal spraying equipment and the expansion of its ultrahigh vacuum cleaning facility. A £500,000 ($621,000) investment in an additional large 5-axis machining center with a pallet loader will enable fully automated lights-out machining. These investments will increase production capacity.

Zack Kirkman of ASG AMF Engineering programs the new thermal spray robot.

The new factory unit will also facilitate the creation of new jobs, contributing to the local economy and offering employment opportunities within the Wirral community.

SPEE3D's 3D Printers to Aid Japan's Military Operations

The Japanese Ground Self-Defense Force (JGSDF) will receive two 3D printers from SPEE3D, Melbourne, Australia.

WarpSPEE3D is a large-format metal 3D printer able to produce large metal parts in minutes or hours. The XSPEE3D offers a metal additive manufacturing capability with SPEE3D's patented cold spray 3D printing technology and auxiliary equipment integrated within one shipping container unit.

SPEE3D CEO Byron Kennedy (left) next to Ground Staff Office Ministry of Defense Major General Norimichi Shirakawa.

With this technology, the JGSDF will be able to manufacture critical replacement parts in minutes or hours, on demand, in a wide range of materials, including but not limited to aluminium 6061, aluminium bronze, copper, and stainless steel.

The company will provide the JGSDF with comprehensive training, support, and maintenance for both printers, including field exercise programs with the XSPEE3D.

"We are grateful for the opportunity to expand our presence into Japan and the APAC [Asia-Pacific] region," said SPEE3D CEO Byron Kennedy. "It is indeed an honor to collaborate with the Japanese military. Our aim is to train and prepare their forces to use the XSPEE3D printer in the field to address their most-urgent supply chain issues through quickly manufactured on-demand parts."

Fume Extraction Hood Adds Capabilities and Multiple Configurations

The Torit® fume hood provides fabricators with additional fume extraction capabilities. Designed for robotic or manual welding applications, the hood's low profile allows for a more flexible installation than traditional canopy-style hoods. When paired with the optional weld curtains, it can be sized to reduce airflow requirements, ultimately lowering the overall cost of a dust collection system. The hood can also be easily integrated with an existing system or paired with the company's cartridge collector for enhanced filtration. It comes in multiple sizes and is available in freestanding and ceiling-mounted configurations for better integration into facility workflows.

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Projected Revenue Surge in Thermal Spray Powder Market Expected to Propel Industry Growth through 2030

Thermal Spray Powder Market: Industry Trends, Share, Size, Growth, Opportunity and Forecast 2023–2030 provides a comprehensive analysis of the thermal spray powder market, including market size, trends, drivers and constraints, competitive aspects, and prospects for future growth. It shows why the thermal spray powder market has been growing significantly in recent years, driven by several key factors, such as increasing demand for its products, expanding customer base, and technological advancements. The more-than-115-page research report includes an updated list of tables and figures. Additional key data covered in this report includes the market compound annual growth rate throughout the predicted period, comprehensive information on the aspects that will drive the thermal spray powder market's growth between 2023 and 2030, calculation of the size of the thermal spray powder market and its contribution to the market, forecasts of future trends and changes in consumer behavior, and a complete examination of the market's competitive landscape, as well as extensive information on vendors.

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Thermal Spray Market Is Set to Reach Impressive Growth in Years to Come

Global Thermal Spray Market Research Report 2023 provides an in-depth look at the prominent aspects of the thermal spray market landscape, such as revenue projections, production growth, compound annual growth rate (CAGR), consumer trends, profit margins, and pricing dynamics. The thermal spray market size, estimations, and forecasts are provided in terms of output/shipments and revenue, considering 2022 as the base year, with history and forecast data for the period from 2018 to 2029. The global thermal spray market was valued at $14,670 million in 2022 and is anticipated to reach $22,410 million by 2029, witnessing a CAGR of 6.1% during the 2023–2029 forecast period. The influence of COVID-19 and the Russia-Ukraine War were considered while estimating market sizes. Additionally, this report segments the global market comprehensively. Regional market sizes, concerning products by type, by application and by players, are also provided.

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By Cindy Weihl

FIU President Dr. Kenneth A. Jessell; Dr. Arvind Agarwal, chair of FIU's Department of Mechanical and Materials Engineering at the College of Engineering and Computing; and FIU Board Chair Roger Tovar had the honor of cutting the ribbon to unveil the new FIU Cold Spray and Rapid Deposition Laboratory.

FIU Cold Spray Center OPENS ITS DOORS

Florida International University (FIU), Miami, Fla., officially unveiled its Cold Spray and Rapid Deposition Laboratory (ColRAD) with a ribbon-cutting ceremony on October 11. University and community leaders gathered at the new facility, which will advance techniques in the repair, design, and durability of high-performance materials.

At the lab, more than two dozen researchers are developing groundbreaking technology for 3D printing using powder, wire, and rods. These techniques will aid defense forces in the repair, design, and durability of high-performance materials used to manufacture next-generation vehicles and munition. The materials will also help defense forces quickly manufacture parts in the field and repair them while in combat zones.

The lab is led by Distinguished University Professor Dr. Arvind Agarwal. He is also the chair of FIU's Department of Mechanical and Materials Engineering at the College of Engineering and Computing (CEC) and a renowned expert on advanced additive manufacturing techniques. Additionally, the lab is supported by a five-year, $22.9 million grant from the U.S. Army Combat Capabilities Development Command (CCDC) Army Research Laboratory.

Florida Congresswoman Debbie Wasserman-Schultz, ranking member of the Military Construction and Veterans Affairs subcommittee of the House Appropriations Committee, was not able to attend the ceremony but was instrumental in helping the school win the grant. Via video, she said, "I am so proud I was able to help secure the funding supporting the innovative solutions that FIU is developing, in this case, helping to ensure our defense systems are agile and meeting the needs of our troops while also bolstering the manufacturing ecosystem in South Florida."

Special guests at the ceremony included Dr. Kenneth Jessell, president, FIU; Dr. Elizabeth Bejar, provost, executive vice president, and chief operating officer, FIU; Roger Tovar, FIU Board chair; Dr. Victor Champagne, team lead, U.S. Army CCDC Army Research Laboratory; Dr. Michael Nicolas, U.S. Army Research Laboratory; Dr. John Volakis, dean, computer & engineering, FIU; Dr. Andres Gil, senior vice president for research and economic development, FIU; and Gloria Oliveros, district director, Congressman Mario Diaz Balart's office.

Jessell told the crowd gathered for the ceremony how research at the lab stands to benefit the local industry and community.

"FIU's commitment to innovation and impact is on full display today as we celebrate the opening of this lab," he said. "We show the world today that we are a leader for Army Research Lab cold spray technology and an influential partner, together with our congressional delegation, in building up Miami's tech, innovation, and manufacturing ecosystem."

FIU is now the first university in Florida to have an advanced cold spray facility dedicated to the 3D printing of large-scale metal and composite structures. The opening of the lab also positions FIU as a key provider of research and talent for the Department of Defense and industry partners, particularly due to the increased demand for electronics and the expansion of both the aerospace and defense industries.

"We have a large group of more than 25 researchers working on cold spray and rapid deposition technologies here at the College of Engineering and Computing," said Ines Triay, interim dean of CEC. "This state-of-the-art lab, the only one of its kind at a Florida university, will allow us to not only augment our research capabilities, but also equip the next-generation workforce with critically important skills."

CINDY WEIHL *(cweihl@thermalspray.org)* is editor, *SPRAYTIME*.

FIU research students (in white shirts) joined FIU dignitaries, community leaders, and representatives from the Army Research Lab for the unveiling of FIU's new lab.

FIU Research Associate Tyler Dolmetsch (right) presented FIU President Dr. Kenneth A. Jessell with an FIU plaque created during a live demonstration of the lab's wire arc additive manufacturing capabilities.

An overhead view of the new lab.(Photo courtesy of Florida International University.)


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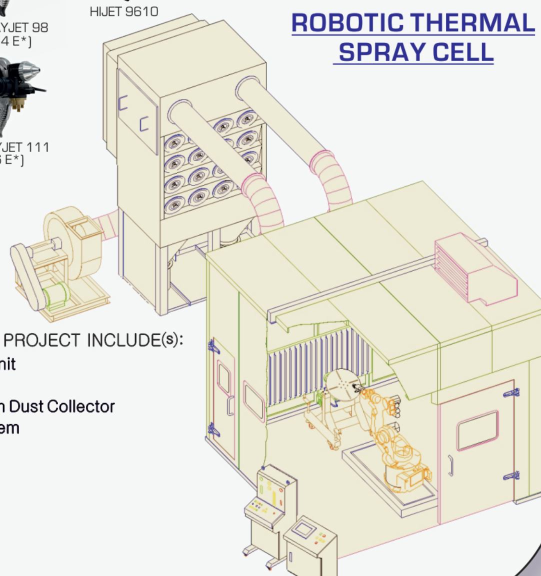

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BY STEVE BOMFORD

PREPARATION — THE KEY TO THE THERMAL SPRAY PROCESS

As with most things, preparation is the key to making sure you achieve a good bond between a coating and a substrate. I always say that you can have the very best coating in the world, but if it is not satisfactorily adhered to your component, then it really is of no use to anyone.

This article will review the primary preparation methods for providing a mechanically activated surface and share some insights into a robust and repeatable preparation process.

Why Do We Need to Prepare Properly?

As a general rule, most thermal spray processes create a stream of molten or semimolten particles that impact onto the surface to be coated — Fig. 1. Adhesion and buildup of the subsequent deposit relies on a combination of kinetic and thermal energy to ensure conditions are right to create a well-bonded coating. This is part of the adhesion equation, but equally important are cleanliness and surface activation.

A Clean Surface

I am not going to concentrate too much on cleaning methods in this article, but it is definitely true to say that "cleanliness is next to godliness."

A suitable degreasing process will remove contamination on the surface. Any contamination can directly affect bonding. Proper cleaning will also prevent indirect contamination of the activation process media, which could, in turn, recontaminate the surface to be coated.

Degreasing methods employed will vary depending on the material composition and geometry of the part to be coated.

Typical methods include:

- Local swab and brush
- Vapor (reduced in use due to environmental legislation)
- High temperature burn-out
- Aqueous (detergent-based systems)

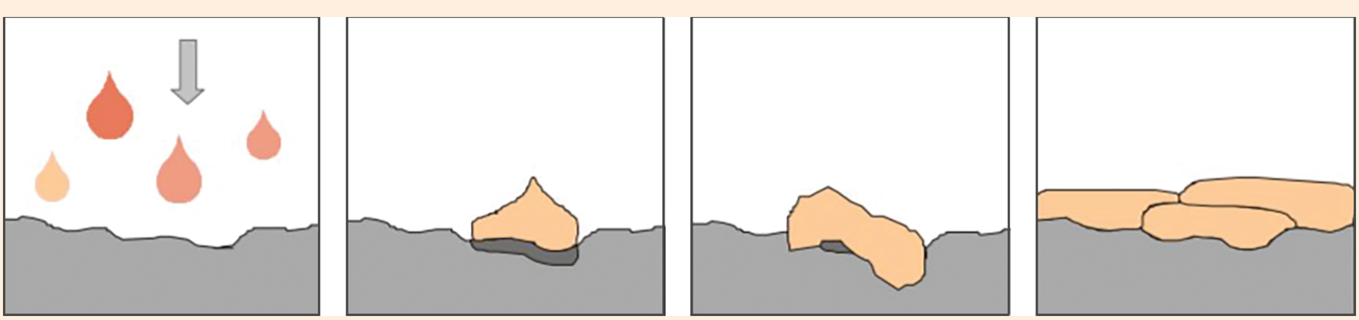

Fig. 1 — Heated particles from the thermal spray process strike the surface, flatten, and form thin splats that adhere to irregularities on the prepared surface and to each other.

Directly after the cleaning process has been completed, there is often a masking requirement to protect areas that are not to be coated. A grease-free surface also has the added benefit of improving the adhesion of any masking tape subsequently employed.

Surface Activation

Once the part to be coated has been degreased and masked, there will be a need to activate the surface to ensure the deposit has the required level of adhesion. Coatings can be applied to several accepted types of activated surfaces, including those created by mechanical roughening, laser ablation, water-jet stripping, and blasting — Fig. 2. It is the grit-blasting process that we will be concentrating on in this article.

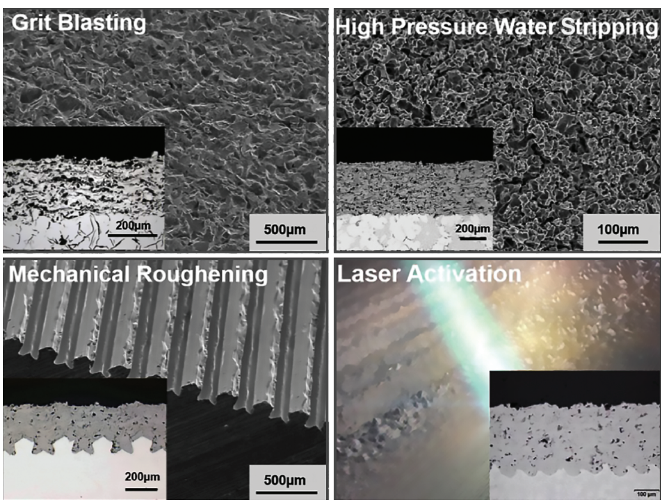

Fig. 2 — Unique topographies created as a result of surface-preparation techniques prior to thermal spray.

Fig. 3 — Manual and semiautomated grit-blasting processes.

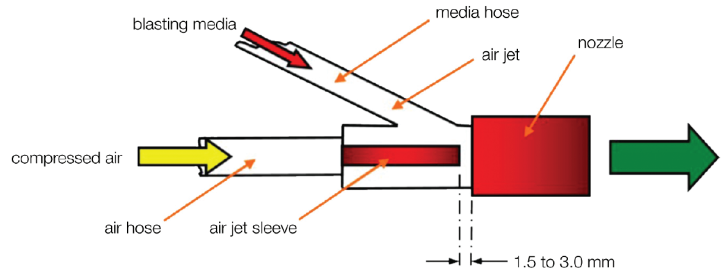

Fig. 4 — Suction blast head schematic.

Grit blasting can be a manual, semiautomated, or fully automated process — Fig. 3. My experience suggests that when preparing for thermal spray, the vast majority of grit-blasting applications are manual. It's nice to think that the more automation is involved, the more reproducible the process becomes. This is true, but automating an aggressive blasting procedure can be difficult. Quantity of parts and complexity of their shape are often also a deciding factor.

The grit-blasting technique involves abrasive particles that are fired through a nozzle using compressed air. Methods of propelling the particles can vary, but the usual method employed is via the use of suction (vacuum) or pressure blast systems. Figure 4 shows the principle of operation of a suction-type grit blasting unit. Control over the blasting process is vitally important to create a reproducible surface profile. Significant control variables include but are not limited to blast distance, air pressure, nozzle diameter, blast angle, and motion profile. I would recommend the creation and use of a properly toleranced parameter sheet for any grit-blasting procedure.

Handling the Media

Of course, choosing the right grit-blast media for the job is another very important part of the equation. The choice should be made on technical as well as commercial grounds. For example, a cheap steel grit may cut well, but steel remaining at the interface between the substrate and the coating could corrode in an aqueous environment and result in coating failure.

The media most often used in engineered thermal spray coatings is one primarily made up from fused aluminum oxide (alumina). Typically, this can be a 99% or more white alumina or alumina/3% titania (titanium oxide), so-called brown alumina. The added titania provides a little more toughness. Alumina cuts well, remains sharp as it breaks down, is chemically inert, and has high temperature capabilities. The latter two points are significant in relation to trapped grit, which I will be covering later in this article.

We also need to consider the size of the grit being used. There are certainly differing opinions within the thermal spray industry as far as the preferred size of media to be used. There are also many factors that define an acceptably bonded coating. Within reason, the controlling factor is the surface finish achieved after blasting. However, common grit sizes used range from 20 to 120 ASTM mesh (850 to 90 µm) sieve size. The choice of size used is often led by customer specification.

Thermal spraying is characterized as a metallurgically cold process. This means that heat transfer to the substrate is low; therefore, concerns over part distortion and negative effects on material properties are minimized. The coating bonds to the substrate via a mechanical adhesion process, so suitable substrate preparation via a roughening process is typically required.

Fig. 5 — Typical appearance of a test panel grit blasted with 20 mesh alumina.

It's All About Having the Right Profile

Having established our blast parameters and media, we need to make sure we create the correct surface finish to allow our coating to adhere to the best of its ability. Ideally, we should create a profile of peaks and valleys rather than hills and vales. A good blasted surface should twinkle in the light as the part is moved — Fig. 5.

Having the right amount of twinkle is subjective, so a common method of verifying surface finish is via the use of a surface profilometer. Surface roughness requirements are often specified as a minimum Ra figure with results presented in microinches or micrometers. Ra is perhaps not the most useful of reporting methods as it provides limited information on surface topography (mountains/valleys vs. hills/vales), but it is regarded as a standard within thermal spray processing.

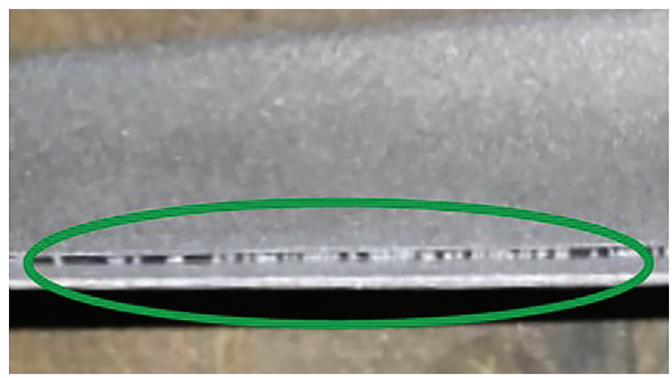

Fig. 7 — 20 mesh alumina grit trapped in a turbine blade trailing edge cooling slot.

Figure 6 provides some guideline surface roughness requirements for different deposition processes (note that 1 µm converts to approximately 40 µin Ra). Nominally, the higher the kinetic energy of the particles in the system, the lower the level of surface roughness required to provide an adequate bond. Again, customer requirements for preparation techniques and

Selected Spray Process	Typical Activation Process	Typical Surface Roughness [µm Ra]
Combustion Spray	Grit Blasting	15 to 75
HVOF	Grit Blasting	3 to 8
Electric Arc Wire Spray	Grit Blasting	5 to 15
Atmospheric Plasma Spray	Grit Blasting	5 to 10
Laser Cladding	Degreasing	Not Applicable
Cold Spray	Soft Grinding or Grit Blasting	1 to 5

Fig. 6 — Typical surface roughness requirements for a range of deposition processes.

acceptable bond strengths will often overrule general guidelines (but they do help).

I've already mentioned the need for visual and measurable quality control techniques to make sure we have our required mountains and valleys, but how about other things to watch out for to ensure we have a robust blasting process?

Feeling Trapped?

Grit entrapment can be a major issue when blasting. It will affect coating quality and performance in a number of ways. Figure 7 shows the trailing edge of a turbine blade after blasting. As can be seen, the blast media has become trapped in the cooling slot. This must be removed by mechanical means as a compressed air blow would not be successful. If it was left in place, it would affect coating adhesion and reduce air flow through the blade. It could also become dislodged in service, causing serious damage to the engine.

The other form of entrapped grit that can cause issues is the type that is incorporated at the interface between the coating and the substrate.

When grit blasting a surface, it is in the nature of the process for some of the grit to become embedded in the material to be coated — Fig. 8. If the coating builds up on top of the grit, the end result will be areas of weakness, which can affect deposit bond strength.

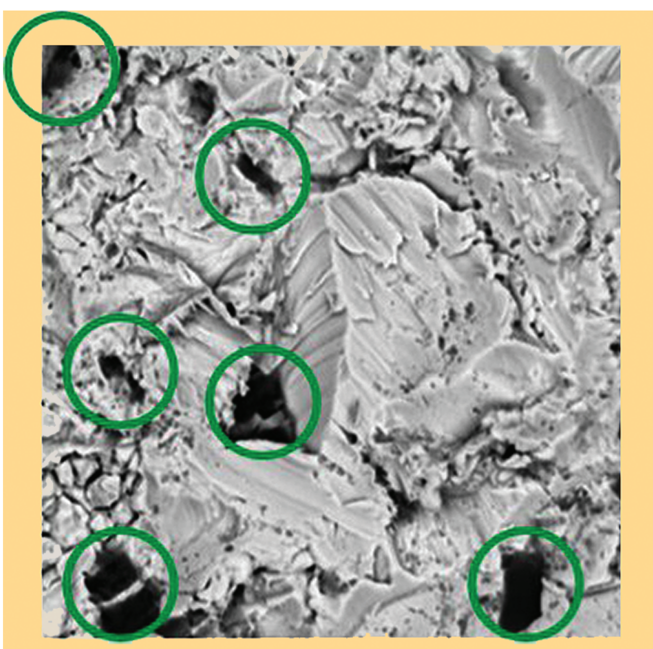

Fig. 8 — Scanning electron microscope image of a blasted steel substrate. Circled areas are embedded alumina grit particles.

The level of entrapment can be somewhat reduced by cleaning the blasted surface with a jet of clean, dry compressed air immediately prior to coating. Perhaps more importantly, control of grit break down levels during routine blasting, in combination with a defined maintenance program for the activation equipment, will create a much more repeatable process where grit entrapment levels will be to defined expectations.

The usual method for measuring entrapped grit is on a polished cross section via a method of line intersections — Fig. 9. Each piece of grit is measured in a defined number of fields of view and an average value calculated over a sampling line length.

Again, acceptable values are often customer specific, but a typical maximum value would be 20% of the interface contaminated with blast media. Values above this tend to compromise the ability of the coating to adhere adequately to the substrate.

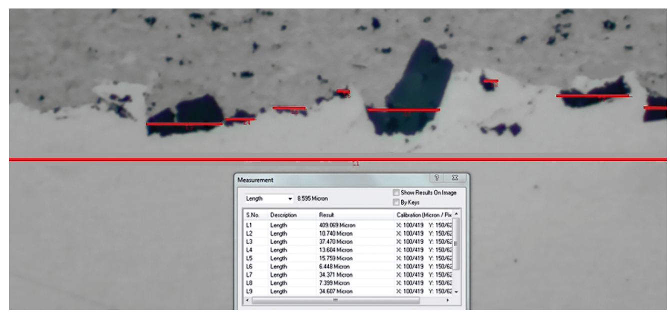

Fig. 9 — Measurement process for grit entrapment levels.

Conclusion

Of course, there is still more to say on the subject of preparation, and this article is just a glimpse at its importance. Close control is necessary at each stage of the cleaning and activation procedure to ensure that an adequate bond is created and that any contamination is kept to a reduced level.

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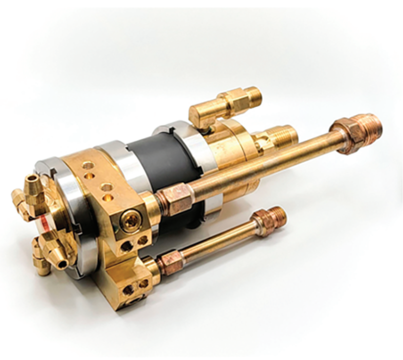

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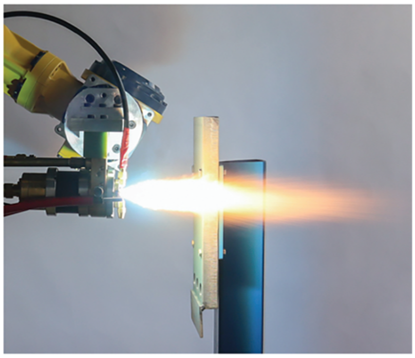

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