Copper as an Antimicrobial Surface

COVID-19's Business Impact
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 American Welding Society
 Attn: SPRAYTIME
 8669 NW 36 St., #130, Miami, FL 33166-6672
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At the American Welding Society (AWS), we are actively following the Novel Coronavirus (COVID-19) outbreak. The welding and fabrication industries have been determined to be an essential business, especially as it relates to repair and maintenance of key infrastructure. The content of the Third Quarter 2020 SPRAYTIME issue is intended to be accurate when published, but we recognize that we are in a rapidly changing situation. For AWS’s official statement on COVID-19, as well as the latest updates and frequently asked questions, please visit aws.org.

Third Quarter 2020 / SPRAYTIME
Copper, the first metal manipulated by humans to make everything from tools to jewelry, is now making headlines for another reason — its antimicrobial properties.

A recent United States government-funded study conducted by researchers at the National Institute of Health (NIH) and the Centers for Disease Control and Prevention (CDC) shows that the SARS-CoV-2 virus, which causes COVID-19, remained viable for up to two to three days on plastic and stainless steel surfaces but only up to four hours on copper (Ref. 1).

Highly effective antimicrobial and antivirus coatings of copper and copper alloys for frequently touched surfaces can be produced by thermal spraying.

Mankind’s First Metal — A Brief History

The Stone Age lasted for more than three million years until around 10,000 years ago when our ancestors began working metals they found on the ground or in ground waters. The three metals were gold, meteoric iron, and copper, and they were easily worked (hammered) to make ornaments and replace tools previously made out of stone. At an archaeological site in what is now Northern Iraq (originally part of Mesopotamia), a pendant was unearthed that was identified as copper. This is the oldest known copper artifact dating to 8700 B.C.E. and as such, copper...
became known as “mankind’s first metal.” The working and use of metal moved our ancestors from the Stone Age to the Copper Age. The Sumerians of southern Mesopotamia (now Iraq) were the first civilization to use copper tools and weapons beginning around 4500 B.C.E. (Ref. 2) — Fig. 1.

At around the same time, rudimentary smelting was developed, and it was discovered that an addition of tin to copper made it stronger such that knives, axes, swords, and spears held their sharpened edges longer. The Vinca Culture in modern-day Serbia is believed to be the first to utilize melting and smelting. The Romans started using smelting around 4000 B.C.E. and mined most of their copper from the Isle of Cyprus. The Latin name for copper is Cyprum/Cuprum, which means Isle of Cyprus.

Bronze and Brass

Bronze dates back to 3500 B.C.E. with artifacts produced by the Sumerians. Some examples of tools from the Bronze Age (approximately 3000 to 1200 B.C.E.) are shown in Fig. 2. Brass was introduced around 500 B.C.E. Metalworkers of the time realized that an addition of calamine (zinc ore) resulted in a golden-colored, tarnish-resistant metal. Since it resembled gold in appearance, it became a less expensive and sometimes devious way to produce “gold” jewelry and ornaments (Ref. 2).

The first recorded medicinal uses for copper were discovered in an Egyptian papyrus written between 2600 and 2200 B.C.E. Now known as the Edwin Smith Papyrus, named after the dealer who purchased it in 1862, the document is the oldest known surgical treatise on trauma. In it is recorded the use of copper to sterilize wounds, cure headaches, calm epileptic seizures, and sterilize drinking water — Fig. 3. Other documents found from this era show writings of soldiers who used shavings from their copper alloy knives and swords in their wounds to aid in healing and prevent infection. By this time, it was known that copper bowls, cups, and pitchers prevented water from getting a green slime on the surface and reduced bouts of diarrhea (Ref. 3).

At around 1000 B.C.E., metallurgy had progressed to the point where iron had become the metal of choice. The Iron Age was born. It was more readily available and superior to copper alloys for swords, knives, spears, and other tools. At this point, copper was primarily used for coinage, ornaments, jewelry, and containers. The medicinal value of copper was still recognized when Hippocrates wrote in 500 B.C.E. of its value in treating wounds.

In the 18th century, the British Navy began sheathing their ship hulls in copper to prevent the growth of algae and the attachment of barnacles, a practice used today with copper-infused hull paints. The 19th century vintners in France used a copper solution to protect their grapes from fungus. This method is also still in use today (Ref. 2).

Antimicrobial Copper

Doctor Victor Burq is credited with discovering copper’s antimicrobial properties during a cholera outbreak in Paris between 1854 and 1855. He observed that significantly fewer deaths from cholera had occurred among jewelers, goldsmiths, or musicians who played brass instruments. Burq later wrote, “Copper or its alloys, brass and bronze, applied literally and pregnantly to the skin in the cholera epidemic are effective means of prevention which should not be neglected.” It would be...
many years later when his studies would be verified by the scientific community (Ref. 4).

Since then, it has been well established that copper has inherent antimicrobial properties that do not diminish with time. An example of this are the brass railings at Penn Station in New York City. The railings were installed in 1910 and even though most of the station was demolished in 1963, a few structures from the original building still exist — Fig. 4. The railings were tested and found to be just as effective as an antimicrobial today as they were in 1910.

Present Day

Currently, the United States Environmental Protection Agency (EPA) has registered more than 500 copper alloys as antimicrobial. There is a strict protocol to follow to register an alloy product or coating as antimicrobial (see epa.gov for details). With this registration comes the responsibility to advertise the antimicrobial products or coatings using required verbiage. An excerpt is as follows:

"Laboratory testing has shown that when cleaned regularly:
[This [product] [surface] continuously reduces bacterial contamination, achieving 99.9% reduction within two hours of exposure.]
[This [product] surface kills greater than 99.9% of Gram-negative and Gram-positive bacteria within two hours of exposure.]
[This [product] surface delivers continuous and ongoing antibacterial action remaining effective in killing greater than 99.9% of bacteria within two hours, even after repeated wet and dry abrasion and re-contamination.]
... The use of a copper surface is a supplement to and not a substitute for standard infection control practices..." (Ref 5).

Copper continues to be incorporated into many forms for various uses. As an example, Cupron Inc., Richmond, Va., has a proprietary and EPA-registered technology for blending copper into polymers and fibers. Some of the products that have been produced are textiles used in various garments, such as anti-fungal socks. Cupron also produces reusable medical textiles, such as patient bed linens, gowns, blankets, and towels, as well as reusable knit and woven face masks — Fig. 5. The Sentara Hospital Group, Norfolk, Va., installed Cupron medical textiles and EOS Surfaces biocidal copper hard surfaces in all 12 of their hospitals over a four-year period from 2013 to 2017 (Refs. 6–9).

Copper and Thermal Spray

A critical reason for using copper antimicrobials in the healthcare industry is the reduction of healthcare-associated infections (HAIs). The CDC reports that in 2015, there were an estimated 687,000 HAIs in U.S. acute care hospitals and approximately 72,000 hospital patients with HAIs had died. The cost to hospitals approached $45 billion. In a 2010 to 2011 study funded by the U.S. Department of Defense, copper components were installed at three medical centers — Medical University of South Carolina, the Memorial Sloan-Kettering Cancer Center, and the Ralph H. Johnson Veterans Affairs Medical Center. It was shown that HAIs were reduced by as much as 58%.

Why is it not more prevalent? It is a daunting and expensive task to replace all the plastic and stainless steel handrails, IV stands, door handles, faucets, call buttons, etc. that exist in a hospital environment with copper/copper alloy products. Offering a thermal spray solution could be a less expensive option. To increase the use of thermal spray antimicrobial coatings in healthcare requires proof of efficacy against known pathogens; collaboration with such government agencies as the CDC, NIH, and the U.S. Department of Health and Human Servies; cost comparisons of coatings vs. copper alloy
components; retrofitting costs and time; partnering with component manufacturers and end users; and education and training in the maintenance and cleaning of coatings (Refs. 10–13).

There are numerous publications on the efficacy of copper/copper alloys against various pathogens, as well as the utilization of thermal spray. Some are listed in the references and resources below. Additionally, there are numerous companies that have and continue to thermal spray components with copper and copper alloys. The following are just a few organizations offering and studying antimicrobial coatings for the healthcare industry.

Aereus Technologies, Toronto, Canada offers EPA-registered CuVerro Shield™. It uses a proprietary thermal fabrication technique to heat the copper alloy, permanently binding CuVerro® antimicrobial copper to any shape or form during the manufacturing process, which starts and ends as solid copper (Ref. 14) — Fig. 6.

Bed Techs Inc., Greendale, Ind., and LuminOre®, Nassau Bay, Tex., have partnered to market Bed Tech’s Ever-Clean™ antimicrobial hospital bed utilizing LuminOre’s cold spray copper technology (Ref. 15) — Fig. 7.

In addition, TST Engineered Coatings Solutions, Sun Prairie, Wis., has developed a family of antimicrobial coatings made with elemental alloys of silver, copper, and iodine. The coatings can be applied to most materials, including metals, plastics, and composites (Ref. 16).

The Centre for Advanced Coating Technologies, University of Toronto (Ref. 17), has been studying the antibacterial properties of wire-arc sprayed copper alloy coatings for ten years and it continues to work closely with industry, other universities, and research facilities.

**What about COVID-19?**

Copper has proven to be an effective antimicrobial against such pathogens as Salmonella enterica, Listeria, Influenza A virus, Staphylococcus Aureus, Methicillin-Resistant Staphylococcus Aureus (MRSA), Escherichia coli, and others. But what about COVID-19? There is documented proof that copper is effective against the earlier discovered Human Coronavirus 229E; therefore, it is theorized that copper could be effective against COVID-19.

A recent letter was submitted to the *New England Journal of Medicine* in March 2020 documenting preliminary results to this effect (Ref. 1). The work was jointly undertaken by the NIH, CDC, Princeton University, and UCLA. It compared the time that aerosol COVID-19 remains viable on various surfaces including plastic, stainless steel, cardboard, and copper. The best results were achieved on copper (4 h vs. 24 h for cardboard and one to three days on the other surfaces). It is expected that updates from this promising research will be provided over the coming months.

**The Future of Copper**

Since its discovery 10,000 years ago, copper continues to prove its value as a natural antimicrobial against an ever-growing list of pathogens. It is hopeful then that copper and copper coatings can be added to our toolbox in the fight against COVID-19.

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Jean Mozolic (jean.mozolic@comcast.net), is president, The Mozolic Group, Londonderry, N.H.
Industry Insight Six Months into the COVID-19 Pandemic

In March, businesses and industries were forced to implement operational changes as the COVID-19 virus spread through the United States and abroad. From keeping employees safe to finding new ways to deliver goods and services, no one knew what to expect from such unprecedented times. Now, six months later, SPRAYTIME staff asked several ITSA members how their companies have changed since the start of the pandemic and the impact it has had on the industries they serve.

What industries do you mostly work with/in? How was that industry affected by COVID-19?

Karen L. Sender, manager, marketing and communications, Oerlikon Metco (US) Inc., Westbury, N.Y.: Oerlikon Metco covers a broad range of industries on a global basis. In addition to thermal spray, we market products for brazing, additive manufacturing, weld hardfacing, cladding, and other processes. Obviously, some major industries, such as aerospace and oil and gas, were heavily impacted, while many other industries either had minimal or negligible impact as a result of the pandemic. Some of those industries will continue to be impacted into 2021, with some coming back relatively quickly and others that could take longer to come back to pre-COVID-19 levels.

Bill Mosier, president; and Wes Price, sales manager, Polymet Corp., West Chester, Ohio: The sector most directly affected by COVID-19 has undoubtedly been aerospace. The dramatic fall of in-passenger revenue miles, delivery delays of new aircraft, and the delay of MRO [maintenance, repair, and operations] have adversely affected our aerospace business. With IATA [International Air Transport Association] estimating 2024 for a return to pre-COVID-19 travel levels, the road to recovery for the aerospace industry is looking to be long and slow. Oil and gas, along with petrochemical refining, have also seen a significant downturn since the beginning of the shutdown periods. Power generation and defense remain as bright spots for Polymet during this downturn.

Mollie Blasingame, director of quality, Superior Shot Peening Inc., Cleveland, Tex.: We serve the oil and gas, aerospace, and chemical industries. We are classified as essential and are lucky to have remained open the entire time. No one is traveling; therefore, the demand for gas is at one of the all-time lows. They are calling it a black swan event. Oil and gas [prices] were down before COVID-19, but no one could have predicted a global pandemic combined with it that would shut down the global economy. This situation is unprecedented.

Jeff Fenner, senior sales and marketing director, Fusion Inc., Houston, Tex.: Industries served include petrochemical, refineries, rotating and reciprocating component repair, downhole, and wind turbine. It has caused extreme undue pressure onto employers and their team members, wasted untold amounts of money, and resulted in loss of productivity/growth.

Julio Villafuerte, corporate technology strategist, CenterLine (Windsor) Ltd., Windsor, Ontario, Canada: With a focus on the automotive industry, upon the start of the pandemic in March, the industry plummeted by about 40%. However, around June, things started improving as new business models popped up in an attempt for the industry to adjust to the new economy. Our sales pretty much followed these trends.
What changes took place at your company in the early days of the pandemic? Are those changes still being implemented?

Karen L. Sender, manager, marketing and communications, Oerlikon Metco (US) Inc., Westbury, N.Y.: COVID-19 prevention activities started at Oerlikon Metco in early March with company-wide travel restrictions and changes at our facilities. As our business was considered essential by the authorities, our plants and facilities remained open with very few intermittent exceptions. Having logistic and manufacturing facilities around the globe, Oerlikon Metco rigorously followed all local and WHO [World Health Organization] regulations and recommendations. As such, our production, HSE [health, safety, and environment], and facilities personnel took on the complex task of making necessary changes at our facilities to ensure social distancing and proper sanitation to keep our employees productive and safe. Task force groups were quickly set up so that all facilities could share their experiences and best practices.

Bill Mosier, president; and Wes Price, sales manager, Polymet Corp., West Chester, Ohio: Our first few days into the pandemic were dictated by maintaining our employees’ safety as well as following CDC [Centers for Disease Control and Prevention] and local guidelines. Polymet quickly moved to enact remote working for those able to do so. Polymet was deemed an essential business due to the many critical infrastructure industries we serve and the government contracts going through our facility. In remaining fully operational, it was critical we quickly implemented social distancing, sanitizing, and training measures. These safety practices and measures are still in place and will continue to be a part of our everyday operations beyond the pandemic.

Mollie Blasingame, director of quality, Superior Shot Peening Inc., Cleveland, Tex.: We qualified for the PPP [Paycheck Protection Program loan] designation and have not had to lay off [employees] since it was granted. We implemented procedures to mitigate the occurrence of COVID-19 being spread throughout the facility. Every morning, we have temperature checks at the gate before employees enter the facility. We have limited clocking in and out to socially distance. We have sanitizing stations in each warehouse. Per Texas mandate, employees are required to wear masks. We sanitize frequently used areas three times a day. There are no visitors allowed in the warehouses. These mitigating procedures are still implemented because of the spike of positive cases in Texas.

Jeff Fenner, senior sales and marketing director, Fusion Inc., Houston, Tex.: There are many changes in place. We have stopped all nonessential travel via public transportation, including flights; greatly reduced customer visits unless asked by our customer specifically; work space distancing; masks; added disinfecting practices; two-week paid stay/work from home after any travel; and testing before returning to work if close contact with someone with systems that tested positive.

Julio Villafuerte, corporate technology strategist, CenterLine (Windsor) Ltd., Windsor, Ontario, Canada: Our business was deemed essential so we did not have to shut down. At the beginning of the pandemic, we put a percentage of the workforce on furlough leave as there was not enough work. A small percentage remained in the office following social distancing and wearing masks/face shields. The balance of the workforce continued to work from home. Because of the slight improvement in sales since June, we have been able to bring back much of the workforce under the new precautionary measures (masks, face shields, distancing). Roughly 30% of employees remain working from home.

How has your job/workload/operations changed since March?

Karen L. Sender, manager, marketing and communications, Oerlikon Metco (US) Inc., Westbury, N.Y.: In many instances, office workers were asked to work from home — a measure easily and instantly made possible by the excellent IT infrastructure that Oerlikon already had in place. This allowed us to continue to network and carry out our tasks as a company, and stay in close touch with our customers. Keeping our customers informed of any situation that could impact their business in such a fluid situation is paramount for Oerlikon Metco. While in many locations office workers have now returned to the office, the changes to ensure social distancing and sanitary conditions remain in place.

Bill Mosier, president; and Wes Price, sales manager, Polymet Corp., West Chester, Ohio: With the changes coming quickly in the first few days of the pandemic, we all began to wear very different hats. Many of us received a hasty dissertation in human resources, legal, and even virology matters. We, like many others, went through our Zoom and Microsoft Teams training to begin our era of the video conference. The installation of Teams and online collaboration has been an unforeseen positive that emerged from this current situation. We are now able to quickly communicate better, organize shared information, and increase transparency across departments. We will continue to embrace these applications far beyond the lasting effects of COVID-19.

Mollie Blasingame, director of quality, Superior Shot Peening Inc., Cleveland, Tex.: The workload has been slow but stayed steady. We are currently only running one shift.

Jeff Fenner, senior sales and marketing director, Fusion Inc., Houston, Tex.: Our workload has decreased substantially due to the panic and fear created over this new disease.
Julio Villafuerte, corporate technology strategist, CenterLine (Windsor) Ltd., Windsor, Ontario, Canada: The workload has improved as automakers’ sales appear to have picked up since June.

How do you think what we’re currently living through will affect the future of your work and the industry?

Karen L. Sender, manager, marketing and communications, Oerlikon Metco (US) Inc., Westbury, N.Y.: As some 95% of planned trade shows were cancelled or postponed around the world, we looked to other technologies to reach out to customers, including stepping up our social media presence as well as public and private webinars. These programs have proven quite successful, and we will continue to expand them into the future.

Bill Mosier, president; and Wes Price, sales manager, Polymet Corp., West Chester, Ohio: Manufacturing companies will still rely heavily upon their employees and the safety of these employees. Companies will begin to reassess their safety protocols and procedures from a disaster recovery standpoint. Lastly, companies will take a long, hard look at their current supply chains to identify and eliminate risk, while holding those suppliers with financial strength and stability in high regard.

Mollie Blasingame, director of quality, Superior Shot Peening Inc., Cleveland, Tex.: As a business, we have seen the worst of oil prices in the 1980s and lived through it. The oil industry by nature is cyclical. The issue is not if the industry is coming back, the unknown is when the industry is coming back. We do not need $100 a barrel of oil to be successful. We need people to get back to their daily lives and routines to get the global economy running again.

Jeff Fenner, senior sales and marketing director, Fusion Inc., Houston, Tex.: There will be permanent/lingering damage to most of the industries we service, as well as across the board. One just needs to follow LinkedIn to understand the devastating amount of employment losses to these industries and how many will choose another career path and not return to oil and gas.

Julio Villafuerte, corporate technology strategist, CenterLine (Windsor) Ltd., Windsor, Ontario, Canada: The industry will adjust to new business models driven not only by the pandemic, but also by the trends imposed by the new generations, namely the shared economy. For the automakers, there are trends such as car subscriptions instead of traditional sales and leasing.

Conclusion

The COVID-19 pandemic has shown us just how much can change in six months. As industries continue to grapple with the “new normal,” they are finding ways to evolve and adapt. 

Cindy Weihl (cweihl@thermalspray.org) is editor of SPRAYTIME.
Cold Spray Repair Completed at Norfolk Naval Shipyard

Norfolk Naval Shipyard, Portsmouth, Va., has claimed it developed and completed the first organic cold spray repair of the U.S. naval shipyards.

Cold spray is an additive repair process where the expansion of a compressed and heated gas is used to accelerate metal powder to sufficient velocity to cause the powder to deform and create a mechanical bond upon impact with a base material. The cold spray process occurs at significantly lower temperatures than traditional repair methods.

This process was applied to USS George H. W. Bush after the discovery of damage to a water pump motor shaft in March 2020.

"In order to execute this repair with cold spray, we had to utilize the recently published Uniform Industrial Process Instruction (UIPI) for cold spray and prove through a battery of required tests that cold spray would be a valid repair for the specific component," said Code 265 Submarine Mechanical/Piping Branch Head Daniel Stanley, Norfolk Naval Shipyard transformation manager for cold spray.

As this was the first cold spray repair performed at the shipyard, there was some initial hesitation to perform this process on the component. Stanley explained the Bush project was hesitant to accept the risk of utilizing a technology that had never before been completed organically at Norfolk Naval Shipyard, taking into consideration their overall tight project schedule.

"With the first-time execution of this process, as expected, we had encountered a number of situations we had not previously envisioned and gained many lessons learned," said Stanley. "Even though the UIPI for cold spray was approved by both the shipyard and the Naval Sea Systems Command, this was the first time it was tested/executed in a shipyard environment. As issues arose, the Norfolk Naval Shipyard team was able to leverage relationships with the cold spray team at Puget Sound Naval Shipyard and Penn State Applied Research Laboratory to overcome the barriers encountered and provide ways to better improve our processes for the future."

Another unexpected challenge was the safety precautions being put in place to combat COVID-19. "It was when we sent the cold spray repair coupons to the Code 134 lab for testing that the first high-risk guidance was established at the shipyard," said Stanley. "This greatly reduced the ability of the lab to complete testing as well as the number of production resources capable of doing the pre-machining for the component, cold spray repair itself, and the post-machining."

In those times of uncertainty, Stanley and his team sought answers for how to perform the work safely and ensure the mission was upheld. "With the lab aspect complete, the team was able to obtain some assistance from Code 200 and Code 930, providing the necessary personnel to be put in place to support the pre-post-machining of the component. Meanwhile, Code 265 assisted Code 930 with execution of the cold spray application of the component," said Stanley. Final machining of the component took place April 1. The component is currently being assembled for shipboard use.

"Having a cold spray facility in place at Norfolk Naval Shipyard allows other shipyards and Department of Defense facilities to establish a roadmap in respect to developing their own cold spray capabilities," Stanley added. "In contrast to other technologies, cold spray’s primary challenges have been the facilities to support the operation. A running facility at Norfolk Naval Shipyard also gives a conduit for organizations such as Penn State Applied Research Laboratory or the Army Research Lab to transition some of their technology from the lab into a real-world application."

Stanley explained this is only the beginning for cold spray being utilized directly at America’s Shipyard. "The cold spray team at Norfolk Naval Shipyard has spent the last year renovating, upgrading, and designing the facilities that are capable of supporting the operation of cold spray, driven mostly by the premise of a technology that would directly result in better repairs," he said. “In respect to the shipyard, it has required a high level of support both with funding and assistance in overcoming obstacles to get the facilities where they are today. As a result, we have nitrogen-generation capabilities, two large rooms to perform cold spray operations, two robotic arms, a large array of workstations to handle a variety of components, and an exterior work cell with on-site machining capabilities.”
ITSA Hosts Thermal Spray Seminar

The International Thermal Spray Association (ITSA) held its first-ever webinar on August 13, aimed at providing a historical and practical overview of the thermal spray industry. Titled, “Thermal Spray: The Industry, Technology, Applications and Careers,” the webinar was moderated by American Welding Society (AWS) Content Manager Trish Claussen and hosted by Jim Ryan, ITSA executive committee member and director of business development at TechMet Alloys LLC; and Daniel C. Hayden, president of Hayden Corp.

Topics covered included an introduction to ITSA and thermal spraying, as well as thermal spray uses, processes, coatings, applications, and careers paths available within the industry.

To watch the recording, as well as view other recent AWS webinars, visit aws.org/webinars.

University West Begins Research on Thermal Spraying to Improve Bone Implants

University West, Trollhättan, Sweden, has started a joint research project with the Vellore Institute of Technology (VIT), Vellore, India, using thermal spraying to develop a new type of bone implant that can be integrated and healed together with the rest of the existing bone. The research project will run from 2020 to 2021 and is funded by the Swedish Research Council within the framework of their research collaboration between India and Sweden (the Indo-Swedish Joint Network).

Thermal spraying is often associated with industrial applications. For many years, researchers at University West have focused on gas turbines in aircraft engines, power plants, and automotive engines. But thermal spraying can also improve product properties in several other areas. New suspension plasma spraying technology opens up additional possibilities in areas such as biomaterials.

The researchers at the Center for Biomaterials, Cellular and Molecular Theranostics at VIT have expertise in the biomaterials research area. In this project, their knowledge is linked to the proficiency in thermal spraying found at University West.

“We got in touch several years ago during a visit at VIT,” said Nicolae Markocsan, professor of production technology at University West. “VIT was willing to test some of our suspension plasma-sprayed samples, and due to the excellent results, they became very interested in moving on to a joint research project.”

Researchers in India will produce 3D-printed titanium implants that can be customized for various types of injuries. The porous implants are coated with a thermally sprayed, nanostructured layer of biomaterial and filled with a mixture of collagen
and stem cells. This filling helps to better integrate the bone implant with the body. The task of University West is to give the implant a biocompatible surface layer that improves mechanical functionality and is also antibacterial.

With the aid of suspension plasma spraying, University West will test different nanostructured layers consisting of hydroxylapatite, silver, and graphene. Hydroxylapatite is a well-known biomaterial that is often used for various types of implants. Silver has antibacterial properties, and graphene can help increase the mechanical properties of the implant. Combinations of these three materials in one layer can give the improved properties mentioned above.

The goal is to emulate the components of the human bone, speed up the formation of bones, and prevent infections.

Today’s implants are expensive and involve risks of various kinds, explained Markocsan. But suspension plasma spraying has advantages. Because the coating material is mixed with liquid, it is easy to test different mixtures. In addition, it’s possible to spray very thin layers with good adhesion and high crystallinity and density — that is, the layer becomes stronger and more durable.

Tests for this project have been promising. University West hopes the new type of implant will greatly facilitate the healing process for patients who are recovering from a lost or damaged bone.

**In the future, damaged bones can be rebuilt with 3D-printed implants that have thermal sprayed surface layers so they are more readily accepted by the human body.**

Wall Colmonoy Expands Pontardawe Research and Development Lab

As part of its efforts to improve product development, technical support, and advancement, Wall Colmonoy has recently invested approximately $650,000 in its Research & Development (R&D) Laboratory at its Pontardawe-based European headquarters.

The R&D Lab has developed into a suite of analytical equipment for characterizing powders, including laser diffraction, chemical analysis, dry powder and fluid rheometry, and optical and electron microscopy. With a recent move into materials for additive manufacturing, where powder properties such as particle shape and size are often more critical, there was a need to expand analytical capabilities.

Morphologi 4 is used for optimizing atomization conditions and evaluating the impact of process changes on powder properties. (Credit: Jordan Brace.)

--- continued on page 20 ---
Industrial Dust Collector Reduces Costly Compressed Air Usage

The Gold Series X-Flo industrial dust collector lowers compressed air consumption up to 70% because it provides more airflow and usable filter media. Its individual modules handle airflow up to 6000 cfm using four Gold Cone X-Flo (GCX) filter cartridges, which contain more pleated media to move more air and process more dust without increasing the dust collector’s overall footprint. The dust collector also creates a more uniform airflow to extend the life of the filters. Additionally, the GCX filter cartridges feature inner cones with more downward-facing media than traditional filters. These cones evenly distribute the pulsed air along the outer pack of the filter and through the inner cone, ejecting more dust straight into the hopper. The result is a more thorough cleaning with each pulse, and the vertical filters are cleaner, safer, and easier to change out.

Camfil APC  
camfilapc.com / (800) 479-6801

Vacuum Casting System Allows Users to Set Multiple Cycles Automatically

The SimpliVac™ digital vacuum epoxy casting system expedites the making of cold-mounted samples (usually in a materials, inspection, or quality-control environment) through programming and automation. These samples, which are from delicate materials, rely on thermal spray coatings or innovative materials. Using a compressed air source, this system pulls a vacuum to evacuate trapped air from any porous sample, resulting in optimized edge retention and additional support for processing delicate samples. It is easy to operate with an intuitive interface that can be set for multiple cycles. Additionally, the system optimizes sample impregnation in a quicker, more automated way and allows lab technicians to set multiple cycles to complete the mounting process faster. It can also accommodate larger samples due to its oversized chamber and sample tray insert, which creates a large, flat surface for bigger mounts. The integrated turntable allows for bi-directional movement of the samples when aligning, and seeing within the chamber is easy due to its large, clear lid, thus allowing for simple alignment of samples when pouring. It also has locking controls that prevent inconsistent samples due to user error. Accessories are available and depend on the process, as the product can also be used without pouring under vacuum. A compressed air source is required for operation.

Buehler Ltd.  
buehler.com / (800) 283-4537

Report Projects Thermal Spray Coatings Market to Register a CAGR of $13.6 Billion

Thermal Spray Coatings Market Size, Share & Trends Analysis Report by Product (Metal, Ceramic, Intermetallic), by Technology (Plasma Spray, Cold Spray, Flame Spray), by Region, and Segment Forecasts, 2020–2027 reports the global thermal spray coatings market size was valued at $10.1 billion in 2019 and is expected to grow at a compound annual growth rate (CAGR) of 3.9%. Increasing demand from the aerospace, industrial gas turbines, and a few other application industries is expected to propel market growth. The aerospace application segment led the market, accounting for a revenue share of 32.3% in 2019, and is projected to maintain its dominance during the forecast period. Moreover, the growing demand for corrosion-resistant coatings from these sectors is expected to be a key driver for the market. Asia Pacific is predicted to be the fastest-growing regional market on account of increasing vehicle production along with rapid economic growth in China, India, Japan, Indonesia, South Korea, and Thailand. Furthermore, the recent outbreak of COVID-19 has disrupted supply chains and sharply curtailed product demand. Restrictions in transportation and supply due to a slowdown or halting of factories and partial or nationwide lockdowns in several countries to restrain the spread of the pandemic is expected to negatively impact market growth. The 180-page report forecasts revenue growth at global, regional, and country levels and provides an analysis of the latest industry trends in each of the subsegments (product, technology, application, and region) from 2016 to 2027.

Grand View Research  
grandviewresearch.com / (888) 202-9519

Third Quarter 2020 / SPRAYTIME 15
In the last issue of SPRAYTIME, I mentioned ITSA's intention to hold a virtual annual membership meeting for all of our members to participate in since we could not meet in person this year. I am happy to announce that our first-ever virtual annual meeting on June 25 was a success, with more than 30 member companies joining in the discussions. We tackled all the topics we would normally cover in our face-to-face meetings, such as membership, financials, and the direction of the association. Additionally, we heard from a few member companies on how the pandemic has affected their businesses and day-to-day lives. In my opinion, our in-person meetings are the most ideal setting for the topics covered, but I was very pleased with the membership turnout and participation as well as the demonstration of our member's commitment to the association and industry. For those who were unable to attend, you can find the recorded meeting on the ITSA website (thermalspray.org).

On behalf of the ITSA executive committee, I wish to thank all annual membership meeting participants as well as the American Welding Society (AWS) staff and the ITSA meeting/symposium planning committee for their efforts in planning this year’s meeting. I know this is not what anybody expected for 2020, but I applaud our flexibility in dealing with the unforeseen issues associated with the pandemic.

ITSA members voted to postpone the 2020 meeting until the fall of 2021 and it will be held on the West Coast. Additionally, the membership voted to form a small subcommittee to explore the possibility of participating, or having a presence, at the International Thermal Spray Conference and Exhibition in May 2021 in Quebec City, Canada. The committee held its first meeting in August, and the membership will be updated on the results of the discussions.

Lastly, I want to mention that the fourth quarter/winter issue of SPRAYTIME will focus on safety and feature guidance materials for facilities looking to add or improve thermal spraying capabilities. Spraying involves a good deal of specialized equipment and utility support, and this reference issue is intended to help shop owners make safe and effective plans for their facilities. If anyone is interested in supplying articles pertaining to the subject matter or advertising in the last issue of 2020, please reach out to Cindy Weihl at cweihl@aws.org.

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

Chair: Ana Duminie, North American Höganas
Vice-Chair: Mollie Blasingame, Superior Shot Peening & Coatings

EXECUTIVE COMMITTEE

(above officers plus the following)
Jim Ryan, TechMet Alloys
David A. Lee, David Lee Consulting LLC
Bill Mosier, Polymet Corp.
Peter Ruggiero, Curtiss-Wright Surface Technologies

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. Please visit thermalspray.org for criteria information and a printable application form.

ITSA THERMAL SPRAY HISTORICAL COLLECTION

In April 2000, ITSA announced the establishment of a Thermal Spray Historical Collection that is now on display at the State University of New York at Stony Brook in the Thermal Spray Research Center.

Growing in size and value, there are now more than 30 different spray guns and miscellaneous equipment, a variety of spray gun manuals, hundreds of photographs, and several historic thermal spray publications and reference books.

Future plans include a virtual tour of the collection on the ITSA website for the entire global community to visit. This is a world-wide industry collection, and we welcome donations from the entire thermal spray community.

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, people, product, research, and membership news of interest to the thermal spray community.

— continued on page 21
### October 2020

- **Euro PM2020 Congress & Exhibition**  
  October 5–7 / Virtual Congress  
  europm2020.com
- **AVS 67 Virtual Showcase**  
  October 27–29 / Virtual Showcase  
  avs67.avs.org

### November 2020

- **ISTFA 2020**  
  November 15–19 / Pasadena, CA  
  asminternational.org/web/istfa

### February 2021

- **Coatings+**  
  February 1–4 / Phoenix, AZ  
  sspc.org/event/coatings
- **Powder Coating Week 2021**  
  February 23–26 / Orlando, FL  
  conference.powdercoating.org

### March 2021

- **EuroBLECH 2020**  
  March 9–12 / Hanover, Germany  
  euroblech.com

### April 2021

- **CORROSION 2021**  
  April 18–22 / Salt Lake City, UT  
  nacecorrosion.org
- **47th International Conference on Metallurgical Coatings and Thin Films (ICMCTF)**  
  April 25–30 / San Diego, CA  
  icmctf2021.avs.org

### May 2021

- **64th Annual Society of Vacuum Coaters Technical Conference — TechCon 2021**  
  May 1–6 / Nashville, TN  
  svc.org
- **Offshore Technology Conference (OTC)**  
  May 3–6 / Houston, TX  
  2021.otcnet.org
- **FABTECH Mexico**  
  May 4–6 / Monterrey, Mexico  
  fabtechmexico.com
- **ITSC 2021**  
  May 24–27 / Quebec City, Canada  
  asminternational.org/web/itsc-2021

### June 2021

- **PowderMet2021**  
  June 20–23 / Orlando, FL  
  mpif.org
- **16th Coatings Science International 2021**  
  June 28–July 2 / Noordwijk, The Netherlands  
  coatings-science.com

### September 2021

- **FABTECH**  
  September 13–16 / Chicago, IL  
  fabtechexpo.com

### October 2021

- **AVS 67th International Symposium & Exhibition**  
  October 24–29 / Charlotte, N.C.  
  avs.org/symposium

### December 2021

- **ASM Global Materials Summit**  
  December 7–9 / Naples, FL  
  asminternational.org/web/asm-global-materials-summit

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**Note:** Due to COVID-19, these events are subject to change.
### Job Shop Member Companies

<table>
<thead>
<tr>
<th>Company</th>
<th>Address</th>
<th>Contact Person</th>
<th>Email</th>
<th>Phone</th>
<th>Website</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuwright Industries Inc.</td>
<td>Gilbert, AZ</td>
<td>David Wright</td>
<td><a href="mailto:dave@accuwright.com">dave@accuwright.com</a></td>
<td>(480) 892-9595</td>
<td>accuwright.com</td>
</tr>
<tr>
<td>Atlas Machine &amp; Supply Inc.</td>
<td>Louisville, KY</td>
<td>Richie Gimmel</td>
<td><a href="mailto:richie@atlasmachine.com">richie@atlasmachine.com</a></td>
<td>(502) 584-7262</td>
<td>atlasmachine.com</td>
</tr>
<tr>
<td>Bender CCP Inc.</td>
<td>Vernon, CA</td>
<td>Doug Martin</td>
<td><a href="mailto:dmartin@benderus.com">dmartin@benderus.com</a></td>
<td>(323) 232-2371</td>
<td>benderus.com/index.html</td>
</tr>
<tr>
<td>Byron Products</td>
<td>Fairfield, OH</td>
<td>Keith King</td>
<td><a href="mailto:kking@byronproducts.com">kking@byronproducts.com</a></td>
<td>(513) 870-9111</td>
<td>byronproducts.com</td>
</tr>
<tr>
<td>Cincinnati Thermal Spray Inc.</td>
<td>Cincinnati, OH</td>
<td>Kirk Fick</td>
<td><a href="mailto:kfick@cts-inc.net">kfick@cts-inc.net</a></td>
<td>(513) 699-3992</td>
<td>cts-inc.net</td>
</tr>
<tr>
<td>Curtis-Wright Surface Technologies</td>
<td>Windsor, CT</td>
<td>Peter Ruggiero</td>
<td><a href="mailto:peter.ruggiero@cwst.com">peter.ruggiero@cwst.com</a></td>
<td>(860) 623-9901</td>
<td>cwst.com</td>
</tr>
<tr>
<td>Ellison Surface Technologies Inc.</td>
<td>Mason, OH</td>
<td>John Langello</td>
<td><a href="mailto:jlongello@ellisonsurface.tech.com">jlongello@ellisonsurface.tech.com</a></td>
<td>(513) 770-4928</td>
<td>ellisonsurface.tech.com</td>
</tr>
<tr>
<td>Exline Inc.</td>
<td>Salina, KS</td>
<td>Brent Hilbig</td>
<td><a href="mailto:b.hilbig@exline-inc.com">b.hilbig@exline-inc.com</a></td>
<td>(785) 825-4683</td>
<td>exline-inc.com</td>
</tr>
<tr>
<td>Fusion Inc.</td>
<td>Houston, TX</td>
<td>Jeff Fenner</td>
<td><a href="mailto:jfenner@fusionhouston.com">jfenner@fusionhouston.com</a></td>
<td>(713) 691-6547</td>
<td>fusionhouston.com</td>
</tr>
<tr>
<td>Hayden Corp.</td>
<td>West Springfield, MA</td>
<td>Dan Hayden</td>
<td><a href="mailto:daniel.hayden@haydencorp.com">daniel.hayden@haydencorp.com</a></td>
<td>(413) 734-4981</td>
<td>haydencorp.com</td>
</tr>
<tr>
<td>HFW Industries Inc.</td>
<td>Buffalo, NY</td>
<td>Matt Watson</td>
<td><a href="mailto:mwatson@hfwindustries.com">mwatson@hfwindustries.com</a></td>
<td>(716) 875-3380</td>
<td>hfwindustries.com</td>
</tr>
<tr>
<td>Kermetico Inc.</td>
<td>Benicia, CA</td>
<td>Andrew Verstak</td>
<td><a href="mailto:averstak@kermetico.com">averstak@kermetico.com</a></td>
<td>(707) 745-3862</td>
<td>kermetico.com</td>
</tr>
<tr>
<td>Metcut Research Inc.</td>
<td>Cincinnati, OH</td>
<td>Tiratna Shrestha</td>
<td><a href="mailto:tshrestha@metcut.com">tshrestha@metcut.com</a></td>
<td>(513) 271-5100</td>
<td>metcut.com</td>
</tr>
<tr>
<td>Nation Coating Systems</td>
<td>Franklin, OH</td>
<td>Pat Pelzer</td>
<td><a href="mailto:pat@nationcoating.com">pat@nationcoating.com</a></td>
<td>(937) 746-7632</td>
<td>nationcoatingsystems.com</td>
</tr>
<tr>
<td>Praxair Surface Technologies</td>
<td>Indianapolis, IN</td>
<td>Michael Brennan</td>
<td><a href="mailto:michael.brennan@praxair.com">michael.brennan@praxair.com</a></td>
<td>(317) 240-2500</td>
<td>praxairsurface.tech.com</td>
</tr>
<tr>
<td>Sulzer</td>
<td>La Porte, TX</td>
<td>Garret Haegelin</td>
<td><a href="mailto:garret.haegelin@sulzer.com">garret.haegelin@sulzer.com</a></td>
<td>(281) 848-3700</td>
<td>sulzer.com</td>
</tr>
<tr>
<td>Superior Shot Peening Inc.</td>
<td>Houston, TX</td>
<td>Mollie Blasingame</td>
<td><a href="mailto:mmb@superiorsshotpeening.com">mmb@superiorsshotpeening.com</a></td>
<td>(281) 445-6559</td>
<td>superiorshotpeening.com</td>
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### Supplier Member Companies

<table>
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<tr>
<td>AAF International</td>
<td>Louisville, KY</td>
<td>David Kolstad</td>
<td><a href="mailto:dkolstad@aafintl.com">dkolstad@aafintl.com</a></td>
<td>(800) 477-1214</td>
<td>aafintl.com</td>
</tr>
<tr>
<td>Alloy Coating Supply</td>
<td>Spring, TX</td>
<td>Jeffrey Noto</td>
<td><a href="mailto:jnoto@alloycoatingsupply.com">jnoto@alloycoatingsupply.com</a></td>
<td>(281) 528-0980</td>
<td>alloycoatingsupply.com</td>
</tr>
<tr>
<td>Ametek Inc.</td>
<td>Eighty Four, PA</td>
<td>Cindy Freeby</td>
<td><a href="mailto:cindy.freeby@ametek.com">cindy.freeby@ametek.com</a></td>
<td>(724) 225-8400</td>
<td>ametekmetals.com</td>
</tr>
<tr>
<td>Arc Specialties</td>
<td>Houston, TX</td>
<td>Daniel Allford</td>
<td><a href="mailto:dan@arcspecialties.com">dan@arcspecialties.com</a></td>
<td>(713) 631-7575</td>
<td>arcspecialties.com</td>
</tr>
<tr>
<td>Ardleigh Minerals Inc.</td>
<td>Beachwood, OH</td>
<td>Ernie Petrey</td>
<td><a href="mailto:epetrey@ardleigh.net">epetrey@ardleigh.net</a></td>
<td>(216) 464-2300</td>
<td>arleigh.net</td>
</tr>
<tr>
<td>Carpenter Powder Products</td>
<td>Pittsburgh, PA</td>
<td>Jason Simmons</td>
<td><a href="mailto:jsimmons@cartech.com">jsimmons@cartech.com</a></td>
<td>(412) 257-5102</td>
<td>carpenterpowder.com</td>
</tr>
<tr>
<td>Centerline (Windsor) Ltd.</td>
<td>Windsor, ON, Canada</td>
<td>Julio Villafuerte</td>
<td><a href="mailto:julio.villafuerte@cntrline.com">julio.villafuerte@cntrline.com</a></td>
<td>(519) 734-8464</td>
<td>supersonicspray.com</td>
</tr>
<tr>
<td>Dewal Industries Inc.</td>
<td>Narragansett, RI</td>
<td>Rebecca Auger</td>
<td><a href="mailto:rebecca.auger@rogerscorp.com">rebecca.auger@rogerscorp.com</a></td>
<td>(401) 789-9736</td>
<td>rogerscorp.com</td>
</tr>
<tr>
<td>Donaldson Torit</td>
<td>Minneapolis, MN</td>
<td>Paul Richard</td>
<td><a href="mailto:paul.richards@donaldson.com">paul.richards@donaldson.com</a></td>
<td>(603) 343-2448</td>
<td>donaldsontorit.com</td>
</tr>
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</table>

**ITSA Mission Statement**
The International Thermal Spray Association, 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.
Global Tungsten and Powders Corp.  
Towanda, PA  
Laura Morelli  
laura.morelli@globaltungsten.com  
(570) 268-5182 | globaltungsten.com

Haynes International  
Mountain Home, NC  
Brandon Furr | bfurr@haynesintl.com  
(713) 937-7597 | haynesintl.com

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

Imperial Systems  
Jackson Center, PA  
Jeremiah Wann | jwann@isystemsweb.com  
(724) 992-1721 | isystemsweb.com

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

Lineage Alloys  
Baytown, TX  
Scot Miller | smiller@lineagealloysllc.com  
(281) 426-5535

Metallisation Ltd.  
Dudley West Midlands, United Kingdom  
Stuart Milton | sales@metallisation.com  
+44 1384 252464 | metallisation.com

North American Höganäs  
Hollspoolle, PA  
Andy Hoffman | andy.hoffman@nah.com  
(814) 361-6875 | hoganas.com

Oerlikon Metco (US) Inc.  
Westbury, NY  
Karen Sender | karen.sender@oerlikon.com  
(516) 334-1300 | oerlikon.com/metco

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

Praxair Surface Technologies  
Concord, NH  
Richard Thorpe | richard_thorpe@praxair.com  
(603) 224-9585 | praxairsurfacetechnologies.com

Rockwell Carbide Powders  
Ontario, Canada  
Frank Shao | sales@rockwellpowders.ca  
(905) 470-8885 | rockwellpowders.ca

Saint-Gobain Ceramic Materials  
Worcester, MA  
Shari Fowler-Hutchinson  
shari.fowler-hutchinson@saint-gobain.com  
(508) 795-2351 | coatingsolutions.saint-gobain.com

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

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

Third Quarter 2020 / SPRAYTIME  19
“We know that particle shape directly influences additive manufacturing performance, and our customers expect a high-quality product with the correct size distribution and a spherical morphology,” said Tom Roblin, process engineering manager. “We have manual microscopy and electron microscopy, which allow us to qualitatively check the products we manufacture, but we also needed a technique that could provide quantitative data on a statistically representative sample.”

Therefore, the company purchased the Malvern Panalytical Morphologi 4 to measure particle shape and size. It provides an automated optical imaging platform capable of analyzing a large number of particles and image analysis capabilities that automatically quantify the shape and size distribution of those particles.

Morphologi 4 is used to quantitatively measure the particle shape of our atomized alloy powders. By investing in this measurement equipment, we can benchmark and improve our current processes and products,” said Roblin. “It will also aid in the development of a new range of Wall Colmonoy powders for additive layer manufacturing. For us, it is a valuable tool that provides clear images, quantitative analysis, and consistent results.”

The product reports shape information using parameters such as elongation, circularity, convexity to quantify particle irregularity, and surface roughness. It has aided in the development of a new range of Colmonoy® (nickel-based) and Wallex® (cobalt-based) powders for additive manufacturing.

Newly Formed Center for Advanced Coatings Finds Solutions to Industry Issues

At Florida Tech, Melbourne, Fla., the research group formerly known as the National Center for Hydrogen Research has reorganized into the Center for Advanced Coatings (research.fit.edu/coatings/).

Through the development and testing of thermal barrier coatings, researchers explore ways to make parts work better and last longer. The three primary laboratories for this research are the Plasma Spray Thermal Lab, the High Heat Flux Laser Test Lab, and the Material Science Analysis Lab, all located at the Florida Tech Applied Research Lab in Melbourne.

Mary Helen McCay is the director of research and principle investigator. She is joined by Pei-Feng Hsu, codirector; Ilya Mingareev, assistant professor; Frank Accornero, thermal spray specialist; Edward Croy, laser specialist; and Yingsang Wu, program coordinator.

“It is unique in our nation to have a lab that provides all these services in one location,” said McCay.

Launched in part with equipment donated by Siemens, the lab is seeking new industry partners to support.

“We have a range of services we can offer,” McCay said. Those include plasma spray, laser processing and optics, metallurgical and failure analysis, protective coatings, industrial robotics, and training.

McCay and her colleagues are already working with groups, including Rolls-Royce and Siemens Corp., and recently began collaborating with Larsen Motorsports on ways to improve the function of their jet dragsters.

For example, in the thermal lab, researchers create a specialized environment to apply and then test various coatings in extreme heat.

The first stage of testing occurs in the Plasma Spray Thermal Lab in a self-contained booth, where an industrial-sized, bright orange plasma spray gun melts a ceramic powder onto test material at high speed. Nitrogen and argon gases are joined with hydrogen and helium, which increase the heat and velocity of the plasma.

After the test material is coated, it moves down the hall to the High Heat Flux Laser Test Lab. Using a high-powered laser, the test material is heated to extreme temperatures from above and cooled from below with circulating air. A network of thermal sensors, cameras, and computers collects data as the material is pushed to temperatures above 3000°F.

McCay, who holds a PhD in metallurgical engineering and was a decorated NASA engineer early in her career, said this type of testing is ideal for turbine blades that might be used in industrial equipment, or even on airplanes. But there are many other applications as well, from automobiles to prosthetics to shipbuilding.

“These critical services are available right here on the Space Coast,” McCay said. “We welcome the opportunity to talk with local companies, no matter the size, about ways in which this unique research group can do testing that would assist them in their business.”
Bodycote to Open New Illinois Heat Treatment Facility

Bodycote, Macclesfield, UK, a provider of heat treatments and specialist thermal processing services, will open a new facility in Elgin, III.

The space has been designed as a replacement for Bodycote’s aging facility in Melrose Park, Ill. The Elgin facility has been operational since June 2020. It supports manufacturing supply chains in the Midwest region. The Melrose Park facility will be closed once the transfer of customers’ work has been completed.

Tom Gibbons, president of Classical Heat Treatment, North America, commented, “I am delighted to be able to announce the opening of our plant in Elgin, Ill. Our investment in the new facility enables us to expand our capacity and improve our ability to deliver high-quality heat treatment capabilities to our customers.”

Bodycote has more than 70 facilities in North America.

Oerlikon Metco, Westbury Receives Second Certification Under New Quality Standard ISO 9001

SAI Global, Chicago, Ill., a provider of integrated risk management solutions, assurance, and property services, has awarded Oerlikon Metco recognition for achieving their second ISO 9001:2015 certification of their Quality Management System for the equipment business line at the company’s Westbury, N.Y., facility.

Oerlikon Metco produces thermal spray equipment at this location, which requires complex precision-machining capabilities and detailed assembly procedures for the parts and components it designs, manufactures, and sells to markets requiring critical surface engineering. Through continuous improvements in production processes and attention to quality details, the company received a completed audit with no nonconformances reported for seven years straight. The audit, completed by SAI Global, included five years under ISO 9001:2008 standards and Oerlikon Metco’s transition to the new quality standard ISO 9001:2015.

“The successful completion of our ISO 9001:2015 certification by SAI Global is another milestone in our timeline of planned achievements. In addition, close cooperation between our management team, production personnel, quality team, and customer services has done a great job reducing the number of customer complaints and returns to significantly low levels. Satisfying these industry standards is a trait we have developed over the recent years,” stated Michael Tobin, president and head of equipment products, Oerlikon Metco US Inc.

Oerlikon Metco achieved its seventh straight year of ISO 9001 audits without nonconformities. This includes their second certification at the company’s Westbury, N.Y., location, which manufactures thermal spray equipment.

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For more information, contact Alfred Nieves at (800) 443-9353, ext. 467, or itsa@thermalspray.org. For an ITSA Membership Application, visit the membership section at thermalspray.org.
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(609) 452-7700 | mpif.org

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