FIRST QUARTER 2021 / VOLUME 28

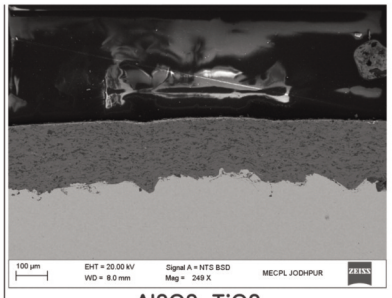
SPRAYTIME

AWS INTERNATIONAL THERMAL SPRAY ASSOCIATION

Cold Spray Restoration of Historical Planes

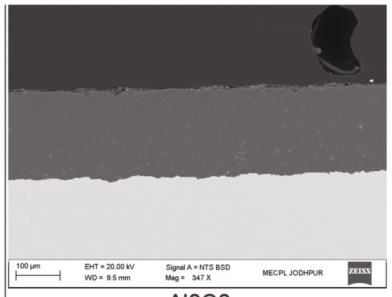
PUBLISHED BY THE INTERNATIONAL THERMAL SPRAY ASSOCIATION,
A STANDING COMMITTEE OF THE AMERICAN WELDING SOCIETY

INNOVATIVE CERAMIC COATING



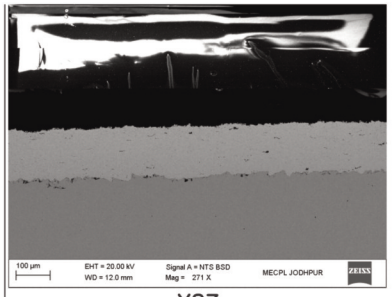
Al2O3-TiO2

POROSITY %	1.0-2.0
HARDNESS $HV_{0.3}$	700-850
ADHESION STRENGTH(MPa)	63.81
AS-SPRAYED Ra (µm)	2.0-4.0



Al2O3

POROSITY %	2.0-3.0
HARDNESS $HV_{0.3}$	750-850
ADHESION STRENGTH(MPa)	61.23
AS-SPRAYED Ra (µm)	3.5-4.0



YSZ

POROSITY %	1.0-2.0
HARDNESS $HV_{0.3}$	550-700
ADHESION STRENGTH(MPa)	39.29
AS-SPRAYED Ra (µm)	2.0-4.0

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On the cover: A historical Lancaster World War II plane flies in the Royal Dutch Air Force Open House on June 18, 2005, in Glize-Rijen, The Netherlands. (Photo by Foto VDW/DepositPhotos.)

Features

Departments

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

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

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By Julio Villafuerte

Cold Spray Technology Keeps Historic Aircraft Airworthy

A Lancaster bomber flying over Shoreham Airfield in Sussex, England. (Photo by phil_bird/DepositPhotos.)

The Lancaster was a successful British heavy bomber aircraft during World War II. The plane emerged as a redesign of the former Avro Manchester aircraft powered by four 1460 hp Rolls-Royce Merlin engines. The Lancaster first flew in January 1941 and entered production in early 1942. All of the almost 7400 Lancasters produced during the war were committed to nighttime strategic bombing. For these missions, the plane's spacious bomb bays typically carried a mixed load of powerful bombs. Most Lancasters were armed with an assortment of machine gun turrets. After the war, surviving Lancasters served in various noncombat roles, including patrol, photo reconnaissance, aerial mapping, flying tanker for aerial refueling, and even as a long range trans-Atlantic passenger and postal delivery airliner until they retired around 1960. Today, there are about 17 planes remaining in historical static displays, mostly in Canada. At least two of those Lancasters have been restored for airworthiness with plans to continue maintaining them this way.

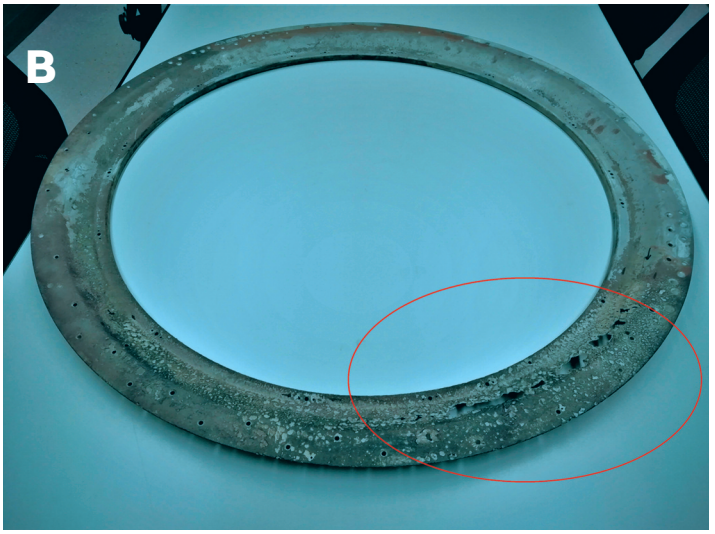
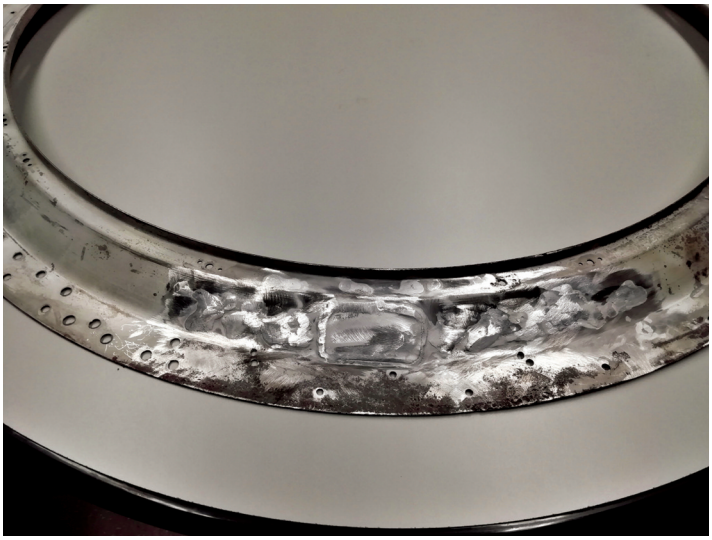


Fig. 1 — A — Rear gun turret (Photo by Paulspixs/DepositPhotos); B, C — part of a heavily corroded turret mounting assembly showing through-thickness corrosion holes. (Photos B and C are courtesy of CenterLine Windsor Ltd.)

Restoration Challenges

Maintaining airworthiness on the Lancaster and other historical airplanes is challenging, at best, due to the lack of spare parts and/or effective repair and restoration processes available. Corrosion typically takes a toll on the aesthetics and functionality of components, many of which are made of treated materials that cannot tolerate elevated process temperatures. One such component is a ring belonging to the mounting assembly of the rear gun turret — Fig. 1. Years of corrosion have created through-thickness holes affecting both aesthetics and the integrity of the assembly. These holes are difficult to restore using conventional thermal processes without affecting the integrity of the part.

Fig. 2 — Commercial SST Series P cold spray manual system. (Photo courtesy of CenterLine Windsor Ltd.)



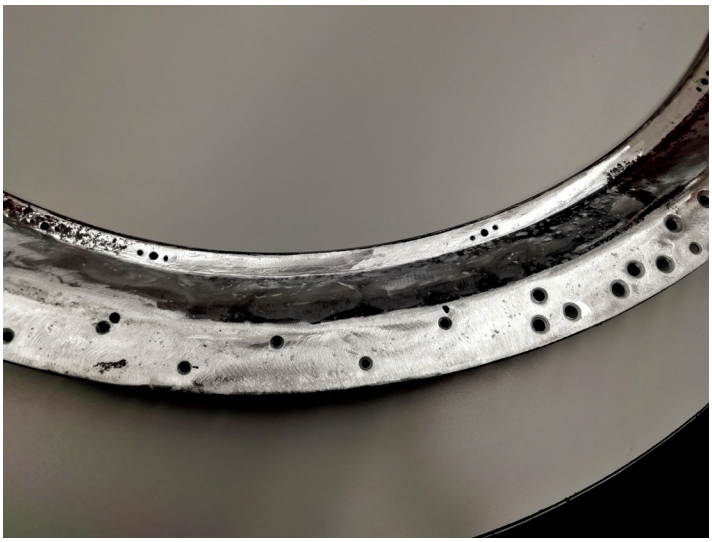


Fig. 3 — The component cold sprayed and grinded. (Photo courtesy of CenterLine Windsor Ltd.)

Since adhesion of the metal powder to the substrate and deposited material is achieved in the solid state, the characteristics of cold spray deposits are quite unique, making cold spray suitable for depositing well-bonded, low-porosity, oxide-free deposits.

Table 1 — Spray Parameters

Machine: SST Series P, manual gun, 2.0-mm orifice, UltiLife™ nozzle

Spray Powder: SST A0050 (aluminum — alumina)

Substrate: Heat-treated steel

Gas: Nitrogen

Surface Preparation: Grit blasting with Grit 80

Gas Temperature: 400°C

Gas Pressure: 180 lb/in.^{2} (13 bar)

Cold Spray Restoration

Cold spray is a solid-state metal consolidation process that uses a high-speed gas jet to propel metal and other powder particles against a substrate where particles plastically deform and consolidate upon impact. The term cold spray refers to the relatively low temperature involved in the process, which is typically much lower than the melting point of the spray material and substrate. In cold spray equipment, air can be used as a propellant gas and temperatures will be low enough not to thermally disturb the substrate material. After low-temperature dimensional restoration of the area, the new consolidated material can be effectively machined back to tolerance using standard machining techniques. Cold spray technology offers the ability of all-metal consolidation for dimensional restoration of manual or robotic applications — Fig. 2.

The Solution

The steel ring was submitted for cold spray repair. First, surface preparation consisted of cleaning and grit blasting. Then, cold sprayed aluminum composite was utilized to manually fill in all repair areas, including through holes, using the spray parameters shown in Table 1. To successfully fill in through-thickness holes with acceptable adhesion, a qualified cold spray operator used a step process consisting of slow buildup around the edges followed by grinding off to prepare the next buildup. The deposits were gradually bridged to close the hole. By repeating these steps, the good adhesion deposits were warranted for final post-spray grinding — Fig. 3.

Conclusion

Since adhesion of the metal powder to the substrate and deposited material is achieved in the solid state, the characteristics of cold spray deposits are quite unique, making cold spray suitable for depositing well-bonded, low-porosity, oxide-free deposits. These attributes make cold spray uniquely suitable for depositing a range of temperature-sensitive materials in this application.

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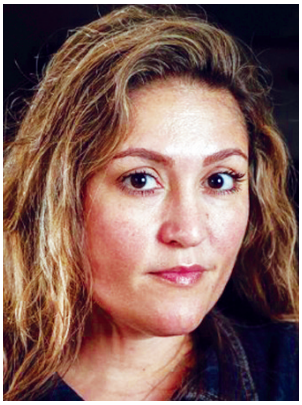

Ana Duminie
Chair

Here we are in the first quarter of 2021. Who would have thought a global pandemic would continue to affect us a year after we first started hearing about it? As a result, so many things have changed in the ways we conduct business. I recently found out ASM International's ITSC 2021 will now be a virtual meeting. I think all of us in the thermal spray community had hoped this would be the first in-person event since COVID-19 halted 2020 plans, but unfortunately, we were all too optimistic. It is obviously in all of our best interests to stay safe until more people receive the COVID-19 vaccine. We commend the organization for making the difficult decision to hold virtual talks instead of an in-person meeting. Personally, I miss seeing my friends, customers, and peers at events like these and look forward to the day when we can all meet again.

ITSA is also facing the same decision about our annual meeting. Should we hold an in-person meeting, a virtual event, or a combination of the two? ITSA members have recently received a survey about travel for the 4th Annual Advanced Coating Symposium and Annual ITSA Membership Meeting. We are looking to get the pulse of the membership to decide how we will proceed for our meeting later this year. We are in a better situation because our meeting is not until the second half of 2021, but there is still concern about the virus and the ability to travel. We look forward to receiving the survey responses that will help the ITSA board make the best decision for our members. I hope everyone stays safe, and I look forward to seeing you all again sooner rather than later. Maybe the next time we meet will be at our ITSA 2021 annual meeting. Fingers crossed!

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 SCHOLARSHIP OPPORTUNITIES

The International Thermal Spray Association 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, the International Thermal Spray Association 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, USA.

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 worldwide industry collection, and we welcome donations from the entire thermal spray community.

ITSA SPRAYTIME

Since 1992, the International Thermal Spray Association 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.

JOIN THE INTERNATIONAL THERMAL SPRAY ASSOCIATION

ITSA is a professional, industrial association dedicated to expanding the use of thermal spray technologies for the benefit of industry and society. 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

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Zircotec Helps Deliver a Carbon-Zero Truck Engine

Zircotec, a heat management specialist in Abingdon, UK, has announced its involvement with Dolphin N2, now owned by FPT Industrial, and Brighton University on a project to develop a new internal combustion engine (ICE) with near-zero emissions.

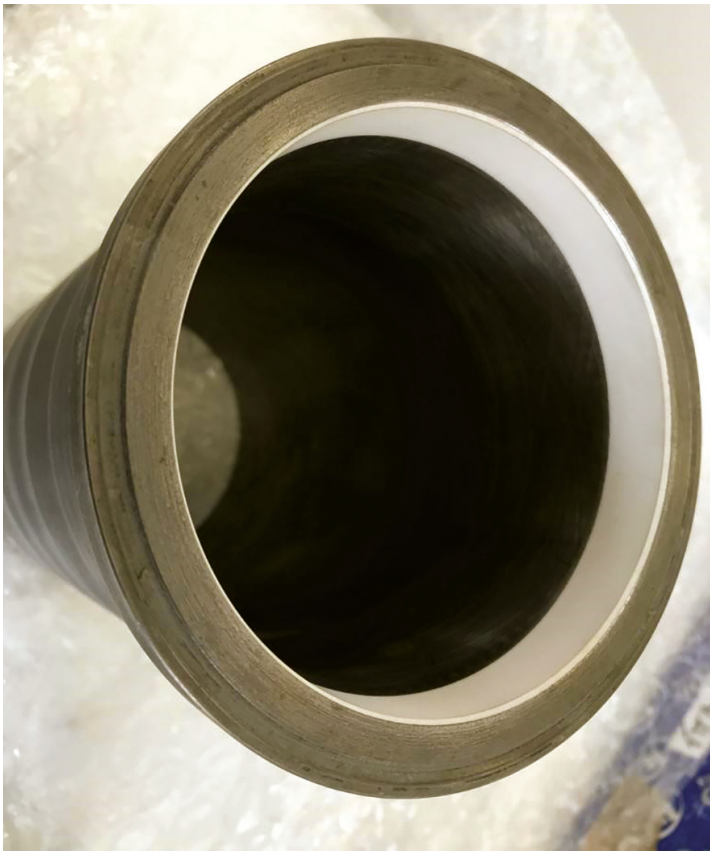
Zircotec provided thermal coatings and precision ceramically coated components, along with its patented encapsulated heat shields that meet the demands of this next-generation recuperated split-cycle engine.

"This technology is perfect for long-haul trucks, agricultural vehicles, self-powered railway traction, and even ships — engines that are, at present, not suitable for battery-electric propulsion," said Graeme Barette, sales and marketing director, Zircotec. "We're seeing the electrification of personal vehicles, but for something like a long-haul truck or ships, they would lose a chunk of their cargo space to house the batteries required to propel them, and that makes the electrification of these unviable."

Two versions of the recuperated split-cycle engine are being developed, called ThermoPower and CryoPower. Likely to run on diesel at first, the technology is expected to reduce the amount of fuel consumed. The collaborative project, called Recuperated Engine — Advanced Route to Market Demonstrator will show that the engine can also run on carbon-free hydrogen fuel.

The Zircotec coatings decrease the temperatures in the areas of the engine where heat is not wanted, reducing heat transfer and keeping the heat in the hot part of the engine. Through the retention of heat in the combustion cycle, less energy is lost through the cooling system, so a high-performance efficiency is produced. The heavy-duty thermal propulsion system offers fuel-cell levels of efficiency (55% brake thermal efficiency) and near-zero emissions (5% EuVI NOx).

"Our high-end simulation capabilities are being exploited to overcome the enormous thermal challenges faced in reaching such superior performance," Barette explained. "Working with commercial and university project partners, this development phase is poised to deliver a running demonstrator engine delivering the next-gen performance levels. Our engineering team will also be focusing on process technologies, refinements, and automation to prepare for vehicle integration."



Zircotec's fully structured ceramic inliners used in the production of a new internal combustion engine with near-zero emissions.

Camfil Group to Build Manufacturing Facility

Camfil Air Pollution Control (APC), a manufacturer of industrial dust, fume, and mist collection systems, is constructing a new manufacturing facility in Jonesboro, Ark., to replace its previous building that was destroyed by a tornado in March 2020. The factory and office space will be located at Craighead Technology Park. The target date for completion is early 2022.

Since the tornado, the company has been conducting manufacturing operations out of a rented local facility. Sales offices, filter cartridge production, warehousing, and shipping were not damaged. All these functions will move to the new facility.

"We are grateful to everyone who has helped us move forward and make this new production facility possible, especially our parent company, Camfil Group, for committing the resources to help us rebuild, "said Graeme Bell, vice president of Camfil APC Americas. "We also thank the city of Jonesboro, the Jonesboro Chamber of Commerce, architects Fisher Arnold, our dedicated employees, our extremely supportive customers, and the people of Jonesboro."

Camfil APC, whose previous building was destroyed by a tornado, will begin construction on a new facility.

PRL Merges with Compass Partners

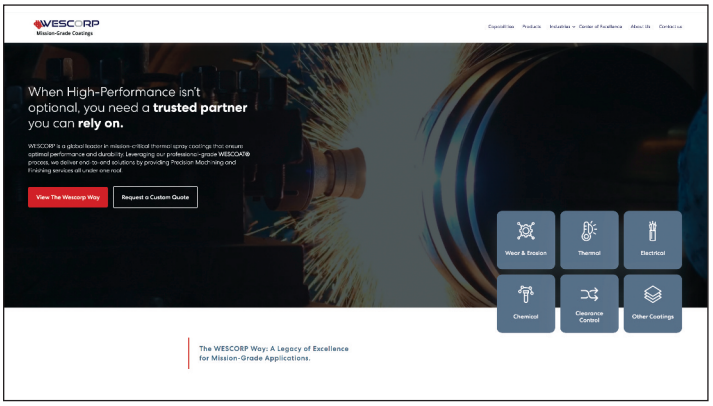
Compass Partners Capital LLC, an investment firm based in Stamford, Conn., acquired PRL Inc., Cornwall, Pa., a manufacturer of high-tech alloy castings. PRL will be combined with Micro Precision Inc. (MPI), a Compass portfolio company, to create an enterprise serving the U.S. Navy, nuclear power, and railroad industries. Vice Admiral John Morgan, president and CEO of MPI, will serve as the CEO of the combined platform.

Headquartered in South Windham, Conn., MPI is a tier-one, Level 1/SUBSAFE supplier of critical components and assemblies for the U.S. Navy's Virginia and Columbia-class submarines.

"We have no greater priority than our nation, our customers, and our employees," said Admiral Morgan. "This combination demonstrates our steadfast commitment to all three with a concerted focus on the U.S. submarine programs. We are building a trusted one-stop shop for critical components . . . These companies can and will grow as we serve the top priority programs in the Pentagon."

Family-owned since 1972, PRL comprises PRL Industries, Regal Cast, and Lebanon Tool Co. A vertically integrated enterprise, the company and its subsidiaries have capabilities to pour a variety of ferrous and nonferrous alloy castings, conduct conventional to close tolerance machining on small to large components, and provide in-house nondestructive examination and upgrading services.

WESCORP Reveals Updated Website



WESCORP's upgraded website showcases the next generation of mission-grade industrial surface coatings with new branding.

White Engineering Surfaces Corp. (WESCORP), Philadelphia, Pa., has unveiled its newly launched website at *wescorp.us*. The company is a supplier of thermal spray coatings, precision machining, and precision finishing in industries such as aerospace

Welder Larry Missimer works on a part for the U.S. military at PRL Inc.

and defense, energy, electronics, automotive, and healthcare.

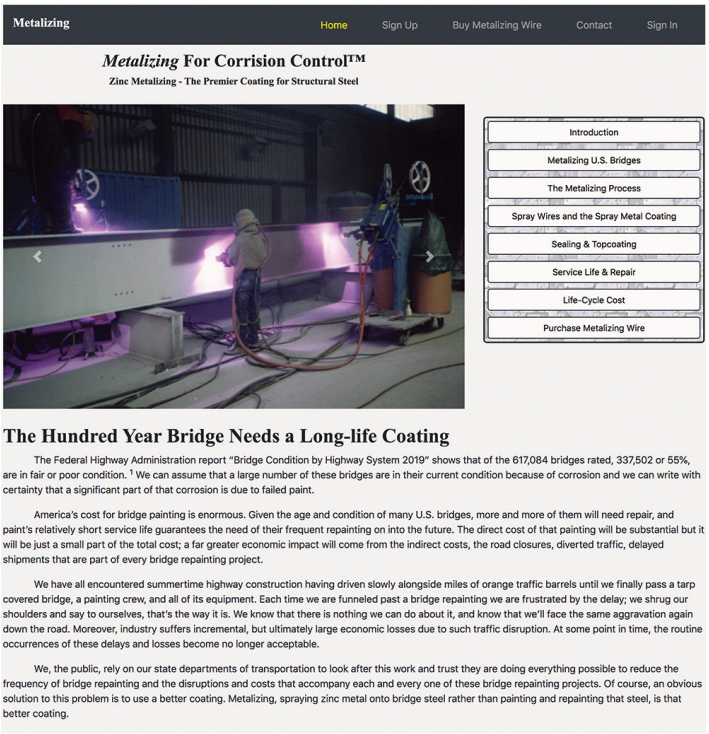
The site features a solution-based approach reflective of the expanded capabilities that the company offers critical manufacturers in need of high-performance components.

"Our new website reflects our strategic corporate expansion through new branding, new logo, corporate identity, and tagline — 'Mission-Grade Coatings,'" said Colby Nyland-Elliott, WESCORP vice president.

The company worked with creative agency partner Borenstein Group, a business-to-business technology marketing agency, to craft its new brand image in the thermal coatings industry.

Website Offers Metalizing Details

Metalizing For Corrosion Control™, Wadsworth, Ohio, has revised its website, *metalizing.com*. The website presents information gathered from several industry and national standards, reports, and other resources to address frequently asked questions about metalizing structural steel. These sources include the British Standard 5493, *Code of practice for protective coating of iron and steel structures against corrosion*; Canadian Standards Association G189, *Sprayed Metal Coatings for Atmospheric Corrosion*; and joint standard American Welding Society C2.23M, NACE No. 12, The Society for Protective Coatings CS-23, *Specification for the Application of Thermal Spray Coatings (Metallizing) of Aluminum, Zinc, and Their Alloys and Composites for the Corrosion Protection of Steel*.



The updated Metalizing For Corrosion Control website discusses metalizing structural steel. In addition to public articles, visitors can access more information by registering for free.

The website covers basic details including the definition of metalizing and the specific spray wires that protect steel from atmospheric corrosion, as well as more complex topics such as sealing and how it can improve the appearance and performance of sprayed-metal coatings. Other subjects include the cost of corrosion, U.S. bridge metalizing, and the maintenance and repair of sprayed-metal coatings.

To access all of the information on the website, register for free at *metalizing.com/identity/account/signup*.

Update Made to SSPC-PA Guide 11

The Society for Protective Coatings (SSPC), Pittsburgh, Pa., has revised standard guide SSPC-PA Guide 11, *Protecting Edges, Crevices, and Irregular Steel Surfaces by Stripe Coating*.

This guide discusses the technique called stripe coating or striping as a way of providing extra corrosion protection measures on edges, outside corners, crevices, bolt heads, welds, and other irregular steel geometries, including optional techniques that can be used to improve coating performance.

The 2020 revision adds definitions for some previously undefined terms and provides guidance to specifiers for the following:

• Determining when the stripe coat is applied (before or after a full-coat application);

• Determining suitability of a coating for use as a stripe coat (cumulative dry film thickness, compatibility);

• Preparing outside corners and edges for application of a stripe coat; and

• Treatment of flame-cut edges prior to application of stripe coat.

Additional changes include examples of specification language in a nonmandatory appendix and illustrations of areas that may be considered for stripe coating.

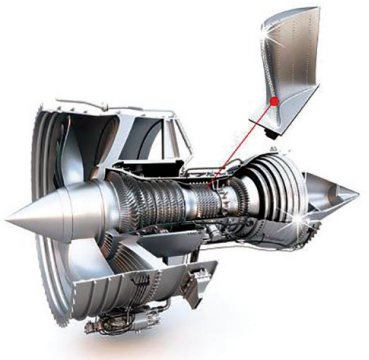
ASB Industries Integrates with Hannecard

ASB Industries, Barberton, Ohio, and Hannecard, Ronse, Belgium, joined forces in January to operate under the name Hannecard Roller Coatings Inc. ASB Industries will benefit from Hannecard's R&D, and Hannecard will expand ASB's technology throughout Europe, Asia, and Africa.

ASB Industries is an industrial coatings service provider. It will continue its existing services with growth to include a broad range of rubber and polyurethane coatings for rollers in many industries. Hannecard, run as a family business since 1929, specializes in industrial rubber, polyurethane, and thermal spray roller coatings and services. It has a worldwide presence in 16 countries and five continents. The acquisition will create a broader product and service offering for both companies.

High-Density Coatings Prevent Oxidation and Corrosion

The BALORA™ PVD MCrAlY, the next generation of MCrAlY coatings based on physical vapor deposition (PVD) arc technology, offers excellent substrate adhesion, and it can be applied up to a thickness of 100 µm without porosity. The composition can be tailored to produce dense coatings, which form a barrier against oxidation and hot corrosion inside turbine blades and vanes in aerospace and power generation markets. This improves system efficiency, extends service life, reduces maintenance, and increases service intervals. The coating design process, a matter of a few steps, takes into account the individual requirements of the application and base material. High-performance targets are developed from the powder material provided by the company and used to deposit an ultra-dense coating on the components in its arc evaporation coating systems.



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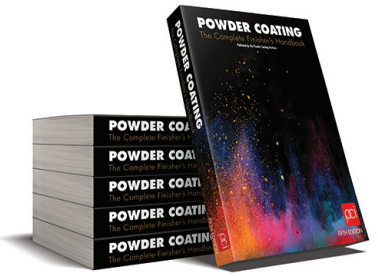
Powder Coating Handbook Covers the Latest Trends and Technologies



Powder Coating: The Complete Finisher's Handbook provides a comprehensive guide for users performing powder coating operations and for those interested in learning more about powder coating technology. This 485-page handbook offers an update to every chapter covering the latest trends and technologies.

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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.

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Product Spotlight — *continued from page 12*

The chapters are assembled in the order that the powder coating system operates. It contains 21 chapters that cover topics including powder coating materials, production analysis, surface preparation, application methods and equipment, powder recovery, curing, maintenance, quality testing, troubleshooting, and more. The handbook also contains appendices with technical briefs and recommended test procedures along with a system troubleshooting guide and a maintenance checklist. The book guides the reader in specifying and selecting equipment and powder materials that best meet the reader's needs and provides assistance in the powder coating process.

Powder Coating Institute
powdercoating.org/store
(859) 525-9988

ITSA Member News — *continued from page 7*

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.

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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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