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SPRAYTIME

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

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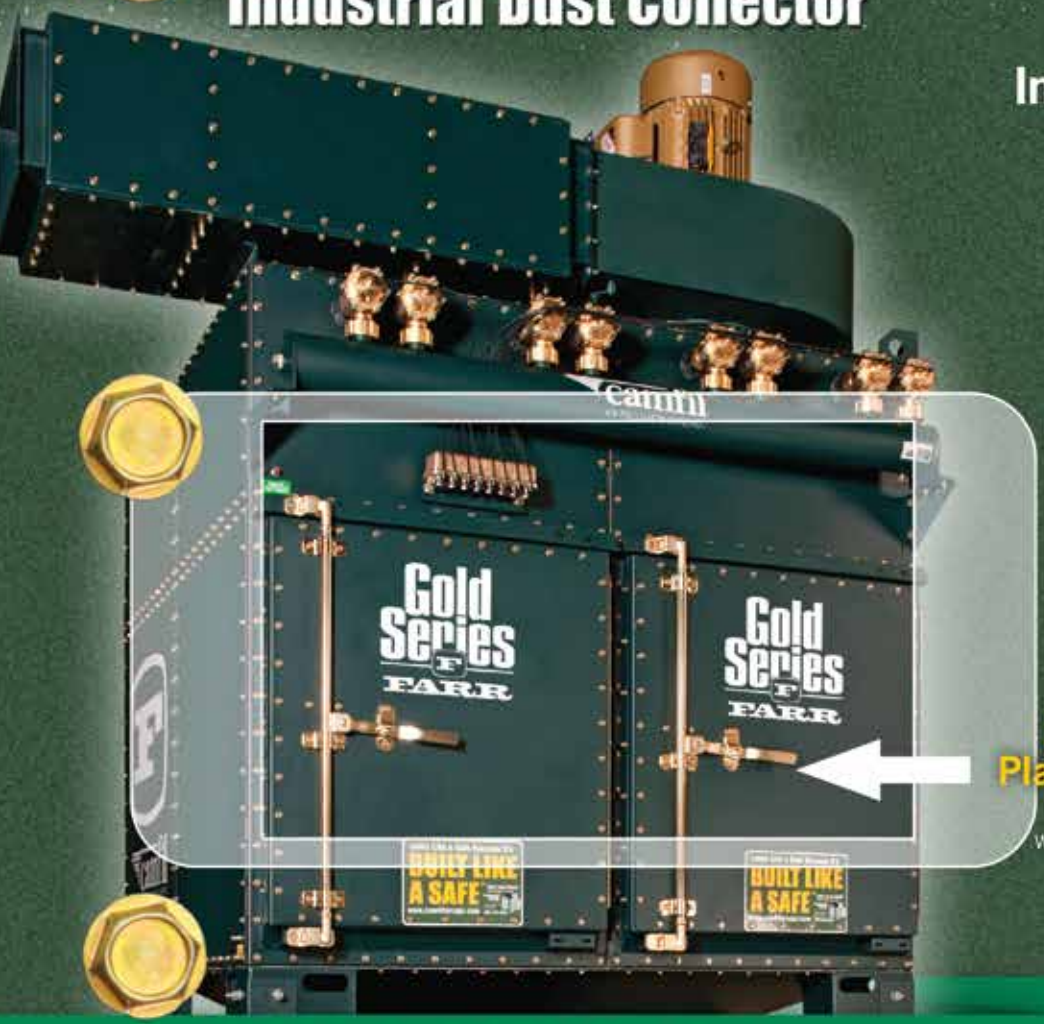

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Published by International Thermal Spray Association
A Standing Committee of the American Welding Society

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

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

Prof. Seiji Kuroda delivering his Plenary Talk

Prof. Changhee Lee inaugurating the Technical Exhibition

SIXTH ASIAN THERMAL SPRAY CONFERENCE

The 6th Asian Thermal Spray Conference (ATSC-2014) was held at Hyderabad, India during November 24-26, 2014. Over the years, the ATSC Conference Series has emerged as a flagship event of the Asian Thermal Spray Society (ATSS) in the Asia-Pacific region, with the previous ATSCs having been held in Japan (twice), Korea, Singapore and China. ATSC-2014 was organised by the International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI), a leading Indian R&D institute with particular expertise in the field of surface engineering, in association with ATSS.

The above first ever ATSC to be conducted in India had an overwhelming response, with nearly 300 people representing 14 countries participating. The presence of a large number of renowned experts from across the globe ensured exciting technical deliberations. Apart from 35 Plenary and Invited lectures delivered by the above experts, over 90 Oral technical presentations spanning various aspects of thermal spraying were made across 15 carefully organized technical sessions. In addition, 20 poster-presentations were made by young researchers and students.

ATSC-2014 was actively supported by thermal spray equipment manufacturers, service providers and users alike, as well as by various funding agencies of the Govt. of India. A Technical Exhibition held concurrently during the conference also attracted immense interest, with all the available exhibition booths being taken and nearly 25 leading companies associated with the field of thermal spraying participating. A 2-day course on Thermal Spraying, conducted by Prof. Christopher Berndt, University of Swinburne, Australia on Nov 23-23, 2014 immediately preceding the ATSC was also a standout success.

Clearly, ATSC-2014 realized the objective of providing an attractive forum for all stakeholders (researchers from industry, R&D institutions and academia; thermal spray practitioners from service providers; capital installations; equipment and feedstock manufacturers as well as OEMs and users) from across the region to network in order to foster a fruitful interaction during and after the conference. It also served as an important step in putting India on the thermal spray map.

Participants at the ATSC-2014

H.C. STARCK'S TANTALUM SUPPLY CHAIN AGAIN DECLARED COMPLIANT WITH CONFLICT FREE SMELTER PROGRAM

H.C. Starck, a leading manufacturer of technology metals and advanced ceramics, announced today that its tantalum supply chain has been again declared free of "conflict minerals" following an independent audit. The audit was conducted by a third party auditor assigned by the Electronics Industry Citizenship Coalition (EICC) and Global e-Sustainability Initiative (GeSI) as part of the Conflict Free Smelter Program (CFSP).

"The procurement and processing of raw materials from conflict-free sources is a core component of our raw material strategy", said Andreas Meier, President and CEO of H.C. Starck. "We are proud of the re-certification because it proves the success of our sustainability efforts in procuring raw materials." At the beginning of 2015, all of H.C. Starck's tantalum processing plants in the United States, Germany, Japan, and in Thailand were audited by independent auditors, assigned by the EICC and GeSI and were found to meet the high CFSP site requirements. To be declared conflict-free, H.C. Starck had to prove that it has documented and integrated a conflict minerals policy into its business operations to avoid the use of ores and metals that finance or benefit armed groups; deploys a system for tracing finished goods back to its mine of origin, and documents that all of its purchased and processed materials are from conflict-free sources.

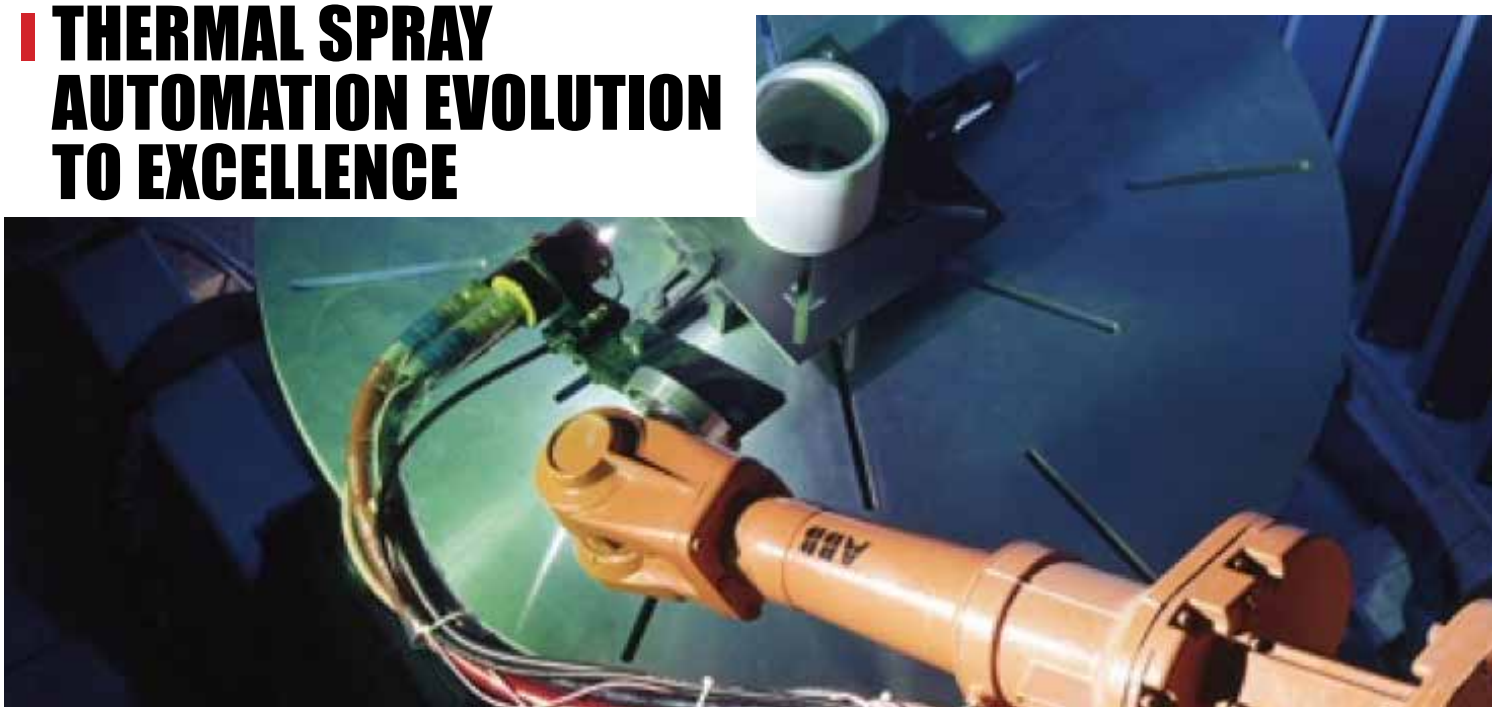
The raw material supply of H.C. Starck rests on two strong pillars: cooperation with established and certified mines as well as increasing recycling activities of secondary materials. "Technology metal recycling is a distinctive competence of H.C. Starck," said Meier. "It helps us to accomplish supply security and it reduces our dependency from volatile global raw material pricing."

H.C. Starck fully supports the position of the EICC and the Organization for Economic Co-operation and Development (OECD) to avoid the use of ores and metals that finance or benefit armed groups. The company is committed to actively supporting its customers with their diligence and disclosure requirements as required by the SEC regulations. H. C. Starck is a member of the ITRI Tin Supply Chain Initiative (iTSCi), which has developed a due diligence system for a transparent raw material supply chain in conflict regions and monitors the implementation of the system in their member companies. In support of government and private initiatives to develop conflict-free supply chain systems, H.C. Starck is a founding member of the Public-Private Alliance for Responsible Minerals Trade (PPA).

About H.C. Starck

The H.C. Starck Group is a leading global supplier of technology metals and advanced ceramics, and serves growing industries such as the electronics, chemicals, automotive, medical technology, aerospace, energy technology, and environmental technology industries, as well as engineering companies and tool manufacturers, from its own manufacturing facilities located in Europe, America, and Asia. In 2013, the company had about 2,800 employees in the United States, Canada, Great Britain, Germany, China, Thailand, Vietnam and Japan. Additional news about the company is available at *www.hcstarck.com*.

THERMAL SPRAY AUTOMATION EVOLUTION TO EXCELLENCE



Thermal spray, in simplest terms, is nothing but a stream of molten particles impinging upon a substrate surface creating coatings that can be tailored to do a variety of things! Ever since Dr. Max Ulrich Schoop identified the opportunity in the early 1900's, vastly different technologies have been implemented to atomize the molten particles. Various sources of energy like gaseous fuel, liquid fuel, plasma and electric arc along with feed stock material in either wire or powder form are used by designers and manufacturers of thermal spray equipment, to produce thermal spray solutions. The function of the desired surface enhancement dictates the choice of thermal spray equipment.

While the chemistry of the thermal spray consumable of choice, for proper surface enhancement is of utmost importance, choice of the thermal spray process to produce the coating needs proper consideration as well. For example, while coating 95/5 Nickel/Aluminum is possible using either plasma or arc spray processes, it is difficult to produce a coating with thickness exceeding 0.040 inch (1 mm) using plasma spray. Or if denser coatings are desired, high velocity oxygen fuel process is better suited than arc spray process. Coatings of Alloy 718 sprayed by combustion wire, arc spray or HVOF are distinctly different with diverse levels of oxides and porosity. Improper choice of the process could lead to an expensive, unprofitable mistake.

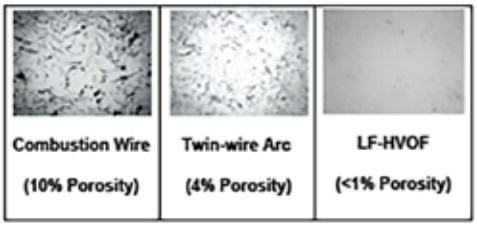


Fig 1. Alloy 718 Coatings by Different Thermal Spray Processes

Excluding twin-wire arc spray systems, a typical spray spot size of a thermal spray torch on a flat surface could range anywhere from 0.375 inch (9.5 mm) to a maximum of 0.5 inch (12.7 mm). The build-up rate of the coating per pass varies with the different thermal spray processes due to coating structure and stress. With the arc spray process, it is generally not recommended to exceed a build-up rate of 0.004 inch (0.1mm) per pass. By nature, as the thermal spray process builds up the coating thickness, it is imperative that there is an overlap of each pass as the coating is laid down. If not, there is a high likelihood of inconsistent thickness or perhaps, exposed substrate with little to no coating coverage which is an unacceptable outcome in any coating application other than those used for sacrificial corrosion protection.

Consistent stand-off, the distance between the thermal spray torch and the surface being coated, plays a very important role in producing a quality thermal spray coating. Simplified, if there is inconsistency in the stand-off distance from pass to pass, the characteristic of the coating put down with every pass vary.

In a nutshell, there are many factors that affect the successful application of a coating. The choice of thermal spray consumable, thermal spray process, consistent overlap between passes, repeatable stand-off from start to finish, torch traverse speed, and reliable part manipulation, all play a vital role in producing an economical, consistent, quality coating!

At their inception, most thermal spray torches were primarily designed as hand-held devices, with the operator working hard to apply coatings with 'some' uniformity. Consistent coating quality depended on having an experienced operator who knew what he was doing and equipment that was operating as designed.
Over time, as the use of thermal spray coating solutions grew to be accepted and spread to more challenging applications with the need for more sophisticated materials, there has been a growing demand by the industry in general, and specifically by the more knowledgeable customers and

end users, for a more consistent, repeatable process to produce higher quality coatings.

In addition, and rightly so, there has been increasing visibility and attention towards the hazards associated with any thermal spray process. Potential hazards associated with the process stem from;

- the nature of the energy sources used to melt the consumables (i.e.: highly explosive Hydrogen or the asphyxiates Nitrogen and Argon),
- overspray dust (Co, Ni, hexavalent chrome (Cr6)),
- gaseous emissions (CO, CO2, NOx, SOx, and VOC's)
- UV radiation,
- noise levels (>85 dBa)

Knowing these associated hazards, businesses have to give serious consideration to the safety of the operator in an unsafe environment.

With the increasing complexity of the actual thermal spray control systems, serious consideration of all the numerous and convoluted elements involved to produce repeatable, quality coatings have pushed the thermal spray industry to move more and more towards implementing thermal spray automation.

A growing transition to the use of industrial robots in thermal spray operations for torch, or in some instances part manipulation, to remove operators from potentially dangerous and unhealthy environments is being pushed by the growing number of and more strict standards mandated by organizations such as OSHA. The use of integrated part manipulators like lathes or turntables, coupled with industrial robots, has helped mitigate most of these safety concerns. Too, the implementation of complete safety interlock packages further enhances safety and adds the highest level of redundancy in helping to avoid the risk of injury and mitigate the health hazards inherent to the thermal spray process. In summary, an integrated thermal spray cell, designed to meet OSHA standards for operator safety, ANSI standards for technical expectations and ISO for consistency and reliability, helps institute sustainable solutions in a safe production environment.

Fig 2. Elements of a Complete Automated Thermal Spray Solution

Over the past century, the seemingly simple thermal spray process has evolved into a complex system going beyond just the choice of thermal spray equipment. The fundamentals of a complete thermal spray solution package have to include:

•Environmental, Health and Safety,

•Thermal spray equipment: Combustion gas, Plasma, RF Plasma, Arc, HVOF, HVAF, PTWA

- Quality feed-stock material: Wire or Powder
- Part manipulation devices,
- Torch manipulation equipment,
- Acoustical enclosure,
- An adequate exhaust system design,
- An appropriate dust collection system,

Optional:

- Master control center,
- Process data acquisition package,
- Part temperature monitoring,
- In-flight particle analysis

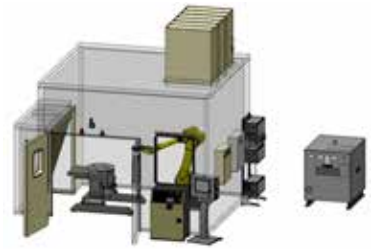


Fig 3. Typical Automated Plasma Spray Cell

Every component of the thermal spray solution package needs appropriate attention to detail and evaluation thereof, for proper design to consistently produce quality coating solutions.

Acoustical booth design and size is dependent on the thermal spray process being used, the part being sprayed, the size of the part manipulator and the device being used to move the spray torch. Thereafter, evaluation of air flow requirements to capture the dust and fumes generated during the process is of equal importance. Negligence in this regard could leave overspray dust uncollected on the floor and in the air which could lead to health hazards and poor coating quality or even failure. Therefore, proper sizing of exhaust system, make up air, and dust collector is of critical importance.

The benefits of automating certain thermal spray applications are obvious. Safety, Quality and Productivity improve along with coating consistency from part to part. In addition, the need to mitigate risks associated with direct operator contact with the spray operations supports the trend toward automated turnkey thermal spray cells. Effective thermal spray automation requires a fine balance of the correct equipment, process parameters and materials.

Fig 4. Complete Automated Arc Spray Cell

Improving Safety, Quality, Cost, Delivery and Performance have always been key deliverables for all successful business models. Using integration experts to help design and build the proper infrastructure for these sophisticated thermal spray application requirements, proves to be the desired approach, to establish sustainable processes.

TAFA Incorporated, a wholly owned subsidiary of Praxair Surface Technologies Inc., has been applying our unique blend of thermal spray expertise and systems engineering to develop thermal spray cells for more than 35 years. We understand the equipment, the materials, and the processes—and we marry that knowledge to a commitment to safety in order to develop customer-specific automation and integration solutions.

For more information,
TAFA Incorporated

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Arc and Ancillary Product Manager,
Manish_Bhusari@praxair.com and

Richard Thorpe,
Standard Products Manager,
Richard_Thorpe@praxair.com

Metallisation
Thermal spray equipment and consumables

METALLISATION LAUNCHES NEW HVOF SYSTEM

Metallisation has launched a new Met-PCC HVOF system. This is the latest development in its range of liquid or gas fuelled High Velocity Oxygen Fuel (HVOF) systems.

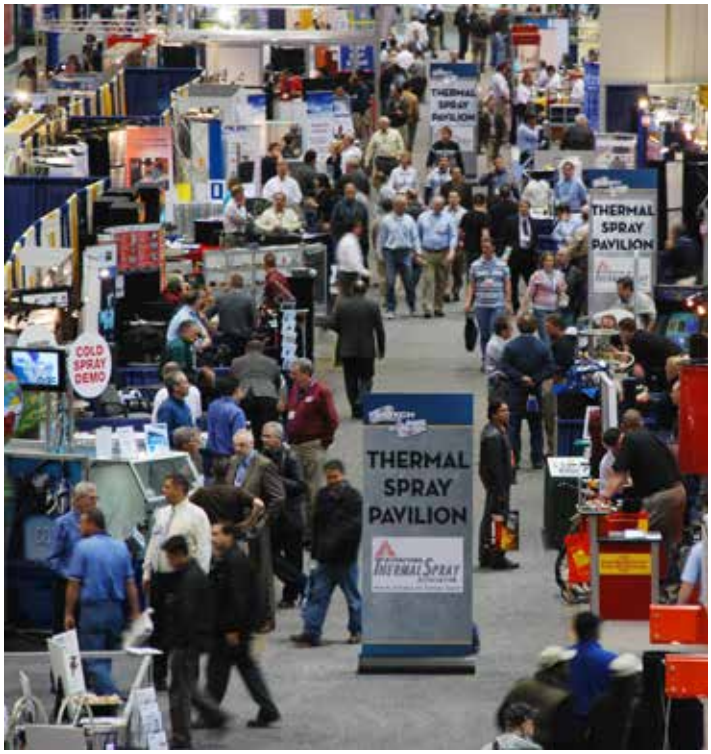
The new Met-PCC HVOF system retains all of the simple control and operator interface features of the previous HVOF system and is available in two versions: The Met-PCC HVOF-L (liquid fuel), and the Met-PCC HVOF-G (gas fuel).

The Met-PCC HVOF-L system is designed to work with the MET-JET 4L pistol, but can also operate other pistols such as the JP5000. Metallisation is happy to technically review pistols from other manufacturers for suitability. The Met-PCC HVOF-G system has been interfaced with the Oerlikon Metco Diamond Jet (hydrogen) pistol and the Deloro-Stellite Jetkote (hydrogen) pistol and, again, other pistols could be technically reviewed for suitability.

For the Met-PCC HVOF-G, the supplies package to each of the pistols is bespoke to the specific system, as the hose requirements will vary more with gas fuelled systems. For systems using the Jetkote pistol, a 5m input and 10m output supplies pack for gas fuel systems is supplied.

As the operator interface is PC based it is extremely flexible to control. The functionality can be as complex or as simple as needed. As standard, the system can run in three modes of operation, manual recipe or external interface. With some additional hardware, the control system can be interfaced with an external robot/automation. If the robot is programmed in such a way, the spray system can select the appropriate robot program and number of passes for the robot to make for a given spray job. Alternatively, the entire robot programming can be included within the robot only. In this case, just the robot start sequence will be controlled by the spray controller.
The new Met-PCC HVOF is a truly unique, compact, flexible, easy to operate system, backed by Metallisation's 90 plus year industry experience, knowledge and customer support.

For more information on the new Met-PCC HVOF systems, please contact Stuart Milton, Sales Director, on +44 (0) 1384 252 464 or visit ***www.metallisation.com***.



JOIN ITSA AT FABTECH 2015

FABTECH brings a wealth of innovation and technology solutions to Chicago, Illinois November 9-12, 2015. The four day show will cover 550,000+ net square feet of floor space at McCormick Place. More than 40,000 attendees and over 1,500 exhibiting companies are expected to gather once again celebrating metal manufacturing at its best.
The event also provides learning opportunities beyond the show floor with over 100 educational sessions which include a full-day Thermal Spray Conference, a half-day "What Is Thermal Spray?" symposium, a Thermal Spray Pavilion and a LIVE Thermal Spray demonstration throughout the exhibition.

Visit the 2014 **"Live Demo"** movie at ***www.thermalspray.org***

Join the International Thermal Spray Association with your Company booth at the Fabtech Thermal Spray Pavilion this year in Chicago.

To reserve your booth space, contact

Joe Krall,
800.443.9353 x297 or
email jkrall@aws.org

For event information,
visit ***www.fabtechexpo.com***

OERLIKON METCO HAS BEEN AWARDED "TRANSMISSION TECHNOLOGY" OF THE YEAR

Oerlikon Metco has been awarded special jury recognition for "Transmission Technology of the Year 2014" by India's Auto Tech Review magazine.

Oerlikon Metco's friction systems solutions were recognized for their advanced and innovative carbon synchronizer products in the Indian automotive manufacturing environment. These synchronizer friction systems products provide one-stop solutions for transmission synchronizer rings. The exceptional features and benefits of these carbon coated synchronizer rings are: tight tolerances, lightweight, high strength and excellent wear resistance. The carbon friction material on steel synchronizer rings pro-vides superior friction behavior and a constant friction coefficient over lifetime, resulting in a high level of shift comfort in manual transmissions.

Innovative carbon synchronizer products from **Oerlikon Metco**.

Auto Tech Review is India's first and only automotive magazine with a core focus on technology. This magazine takes a 360-degree approach to automotive journalism and propagates knowledge and information on the sector through its initiatives in print, online, digital and events.

Auto Tech Review magazine annually invites OEMs and OEM suppliers to present their implemented innovation technologies. The award is well known as IATIA (Indian Automotive Technology and Inno-vation Awards) in the Indian market. The various award categories include engines, transmissions, safety, conventional technology, environment, technology innovations, innovations by students and readers' choice technology of the year. The jury members are eminent personalities from various fields such as R & D, automotive consultants, management service providers, government agencies and top-notch leaders in the auto OEMs.

"We are proud of being recognized and awarded for our innovative products and services in the fast growing Indian automotive market." says Dietmar Koester, Head Business Line Friction Systems.

About Oerlikon Metco

Oerlikon Metco enhances surfaces that bring benefits to customers through a uniquely broad range of surface technologies, equipment, materials, services, specialized machining services and compo-nents. The surface technologies such as Thermal Spray and Laser Cladding improve the performance and increase efficiency and reliability. Oerlikon Metco serves industries such as aviation, power gen-eration, automotive, oil & gas, industrial and other specialized markets and operates a dynamically growing network of more than 40 sites in EMEA, Americas and Asia Pacific. Oerlikon Metco, together with Oerlikon Balzers, belongs to the Surface Solutions Segment of the Switzerland-based Oerlikon Group (SIX: OERL).

For further information, please see: ***www.oerlikon.com/metco***

About the Surface Solutions Segment

The Oerlikon Surface Solutions Segment includes the two brands Oerlikon Balzers and Oerlikon Metco. Oerlikon Balzers is one of the world's leading suppliers of surface technologies that significant-ly improve the performance and durability of precision components as well as tools for the metal and plastics processing industries. Extremely thin and exceptionally hard coatings reduce friction and wear. Under the technology brand ePD, the company develops integrated services and solutions for the metallization of plastic parts with chrome effects. Oerlikon Metco enhances surfaces with coating solutions and equipment. Customers benefit from a uniquely broad range of surface technologies, coating solutions, equipment, materials, services, and specialized machining services and components. The innovative solutions improve performance and increase efficiency and reliability. Oerlikon Metco serves industries such as power generation, aviation, automotive, and other specialized mar-kets. The Surface Solutions Segment operates a dynamically growing network of currently more than 130 facilities with over 110 coating centers in 35 countries in Europe, the Americas and Asia, employ-ing around 6 000 people. The Surface Solutions Segment is part of the Switzerland-based Oerlikon Group (SIX: OERL).

Polymet

POLYMET CORPORATION INVESTS IN INNOVATION

Cincinnati, OH – Polymet Corporation (http://www.polymet.us/) is and has always been recognized as a leader in innovation within the industries their wires are used. There are no plans to let this position of leadership slip. Polymet is excited to step into 2015 with some big plans to support innovation and excellence.
For starters Polymet has made some big upgrades and developments in their R&D department. Both staff and technical capabilities have grown considerably this past year. “We’ve are excited to be growing our R&D efforts here at Polymet, we’ve always been dedicated to innovation and it is one of our biggest focus areas for 2015” Says President Bill Mosier. “We are lucky to have a team of very bright engineers who are passionate about their work and dedicated to our mission.”

In the past year Polymet brought several new, game-changing alloys to market. An example being Vecalloy Readable, from their Vecalloy Product Line (all one of a kind alloys meticulously engineered to combat the most extreme wear in their respective applications). Vecalloy Readable is the only Fe-based twin wire arc spray which is readable as-sprayed and after exposure to high temperatures. Polymet is confident and excited to bring the same kinds of developments to market this year.
About Polymet

Polymet Corporation is a world-class manufacturer of high performance wire for hardfacing, welding, and thermal spraying. We produce high quality products used in aerospace, power generation, nuclear, lumber, mining, and many other industries. Our wires are ideal for demanding applications such as metal to metal, metal to earth, high impact, high abrasion, corrosion and high temperature wear factors.

Polymet Corporation
www.polymet.us

PTMAT
Plasma Technology Automation & Materials
855.782.6285 www.ptamaterial.com

PTA-MAT ANNOUNCES LARGE ROBOTIC PTA SYSTEM

After delivering several smaller PTA integrated robotic systems, PT-MAT has completed its first Larger Robotic PTA Platform.

This system features a welding grade 6-Axis ABB Robotic arm coupled with a 7th axis 6000# capacity servo controlled Headstock with 10.5” through hole 25” chuck, to allow pass-through of larger parts such as drill collars.

Two support rollers are mounted on a rail system for ease of adjustment to the length of part to weld. Two powder feeders were selected on this system to allow welding of powder feeder A on a part; then purging and switching to powder feeder B and welding. This is a great feature to utilize when applying coating to components, such as non-mag, that can require two different layers of coating.

The PTA welding cell comes pre-programmed for most common oil field components (stabilizers, top subs, kick pads, bearings, etc.). Operation is very user friendly and features a teach point interface where the operator jogs the torch to the corner of the coating area and starts the overlay process.

Our PT-MAT 400A PTA welding system with 400A machine torch are all mounted on a 7’ x 12’ skid. Visitors are welcome to stop by our Conroe, TX facility and see manufacturing first hand.

To request more information go to:
www.ptamaterial.com/contact-us.html

EXPANDING ITS CAPABILITIES SIMULENT INC. LAUNCHES SIMCOAT: A NEW COATING SIMULATION SOFTWARE

Simulent Inc., a leading Computational Fluid Dynamics (CFD) software development and engineering consulting company, launches their newest software tool, SimCoat™. The new software is relevant to Thermal Spray Coating in a number of industries such as: Aerospace, Oil and Gas, Automotive, Pulp and Paper, Pharmaceutical, Medical and many more.

This unique product allows users to model spray coating on any surface and provides essential information on the microstructure of the coatings. Additionally, it allows the simulation and analysis of coatings prior to the application of any coating materials. The coatings materials range from high temperature molten metals of Thermal Sprays to water.

For the user's convenience, **SimCoat™** calculates the coating layer thickness, roughness and porosity at any desired location on the substrate for a stationary or moving spray gun. It can also calculate the initial velocity, size and temperature distribution for the injected powder.

SimCoat™ and its sister software, **SimDrop™** are the only software products available in the market for simulating thermal spray coating. The product has been extensively tested and has proven to be efficient, fast and accurate. The founder and owner of Simulent Inc., Dr Javad Mostaghimi is enthusiastic about the launch of SimCoat™: "I believe this is an important tool for the industry as it will help companies save money and time when deciding what type of coatings to use on various substrates"

About Simulent Inc.

Simulent Inc. is a leading multidisciplinary Computational Fluid Dynamics (CFD) software and engineering consulting company delivering award winning innovative solutions to the market place for the design and testing of thermo-fluid systems.

Based in Toronto, **Simulent Inc.** is affiliated with the Centre for Advanced Coating Technologies (CACT) at the University of Toronto. It is also a member of Consulting Engineers of Ontario and a member of the Professional Engineers of Ontario. For more information, please visit ***www.simulent.com***.

To Learn More About **SimCoat™**
Jimmy Scott
Vice President Business Development
jcs@simulent.com

Where is your article? We encourage you to send articles, news, announcements and information to
spraytime@thermalspray.org

CURTISS-WRIGHT ACQUIRES BOLT'S METALLIZING, INC.

Leading Supplier of Thermal Spray Coating Applications for Aerospace Customers

Curtiss-Wright Corporation (NYSE: CW) today announced that it has acquired certain assets and liabilities of Bolt's Metallizing, Inc. (Bolt's). Bolt's is a leading provider of thermal spray coatings for critical aerospace applications, including high velocity oxygen fuel (HVOF) and plasma spray coating capabilities. The acquired business will operate within Curtiss-Wright's Commercial/ Industrial segment and will be accretive immediately.

"The acquisition of Bolt's is complementary to our existing engineered coatings offerings, adding high-technology services to our Surface Technologies business," said David C. Adams, Chairman and CEO of Curtiss-Wright Corporation. "This is consistent with our stated acquisition strategy of targeting strategic bolt-on companies and is expected to support our objectives of margin expansion, cash flow generation and solid return on invested capital. Further, it reinforces Surface Technologies' strategic objective to advance up the technological chain and expand the breadth of their technology and customer bases. Bolt's is located in a major US aerospace manufacturing area where we do not currently maintain a coatings presence, and this acquisition is expected to generate significant opportunities for technology transfer within our worldwide services network."

Bolt's specializes in the application of oxidation resistant and abradable coatings for turbine engines and HVOF wear coatings for landing gear components. In addition to thermal spray coatings, the business has onsite capability for welding and brazing, which enables turnkey repairs of turbine engine components. Bolt's operates out of a 20k ft2 facility in Phoenix, AZ, and is NADCAP and ISO 9001 accredited. Bolt's has approximately 25 employees and generated sales of approximately $6 million in 2014.

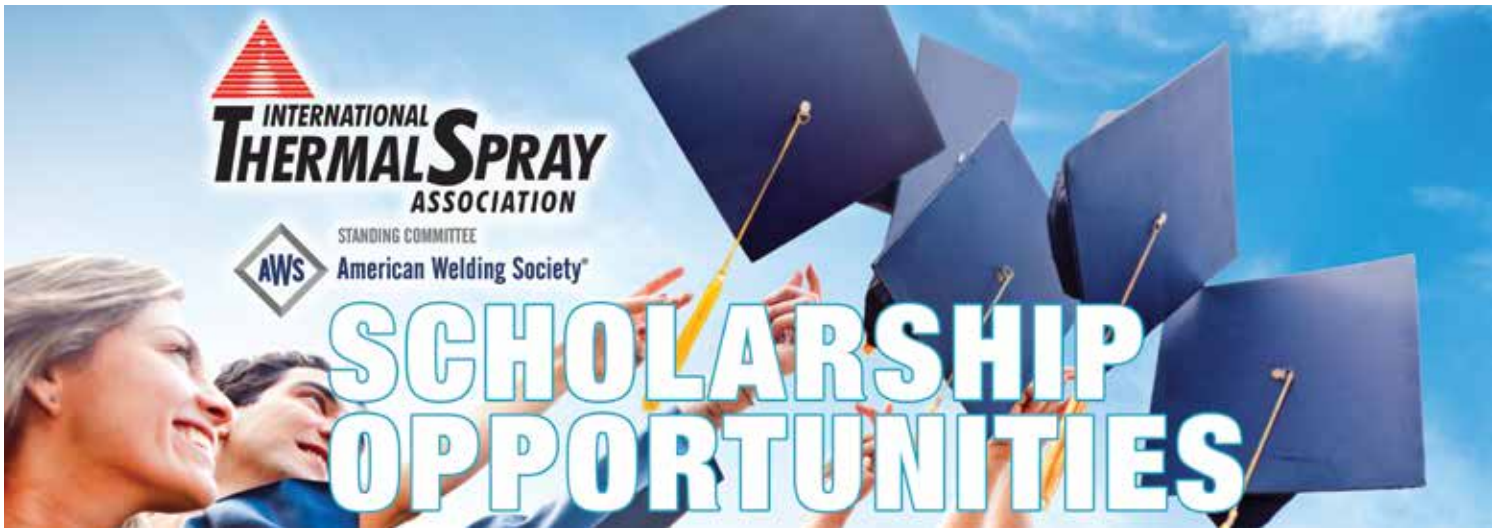
About Curtiss-Wright Corporation

Curtiss-Wright Corporation (NYSE:CW) is a global innovative company that delivers highly engineered, critical function products and services to the commercial, industrial, defense and energy markets. Building on the heritage of Glenn Curtiss and the Wright brothers, Curtiss-Wright has a long tradition of providing reliable solutions through trusted customer relationships.

The company employs approximately 9,000 people worldwide.

CURTISS-WRIGHT

For more information, visit ***www.curtisswright.com***.



International Thermal Spray Association

Up to three (3) Graduate scholarships worth $2,000.00 each to be awarded each calendar year.

Since 1991, the **ITSA** Scholarship Program has contributed to the growth of the Thermal Spray Community, especially the development of new technologists and engineers.

The International Thermal Spray Association is very proud of this education partnership and encourages all eligible participants to apply.

NEW APPLICATION DATES:
Scholarship applications are now accepted annually April 15 through July 15 ***ONLY*** for the Graduate scholarships.

Please visit the Scholarship area at
www.thermalspray.org

FUSION, INC. HAS JOINED THE INTERNATIONAL THERMAL SPRAY ASSOCIATION

Fusion, Inc. is a coating & grinding facility offering HVOF, plasma and electric twin arc wire coating capabilities and is known for quick-turn repairs on rotating and reciprocating components such as turbine rotors, shafts, piston rods, impellers and crankshafts to name a few. Fusion has also become recognized for the application and finish polishing of carbide on downhole mud motor rotors and drill cones.

For more information, visit website ***www.fusionhouston.com*** or contact **ITSA** company representative Jeff Fenner, JFenner@FusionHouston.com

Journal of Thermal Spray Technology®
A publication of the ASM Thermal Spray Society

Processing Conditions Affecting Grain Size and Mechanical Properties in Nanocomposites Produced via Cold Spray
P. Cavaiiere, A. Perrone, and A. Silvello

Cold spray is a coating technology based on aerodynamics and high-speed impact dynamics. In this process, spray particles (usually 1-500 μm in diameter) are accelerated to a high velocity (typically 300-1200 m/s) by a high-speed gas (pre-heated air, nitrogen, or helium) flow that is generated through a convergent-divergent de Laval-type nozzle. A coating is formed through the intensive plastic deformation of particles impacting on a substrate at a temperature below the melting point of the spray material. In the present paper the main processing parameters affecting the microstructural and mechanical behavior of metal-metal cold spray deposits are described. The effect of process parameters on grain refinement and mechanical properties were analyzed for composite particles of Al-Al2O3, Ni-BN, Cu-Al2O3, and Co-SiC. The properties of the formed nanocomposites were compared with those of the parent materials sprayed under the same conditions. The process conditions, leading to a strong grain refinement with an acceptable level of the deposit mechanical properties such as porosity and adhesion strength, are discussed.

Read the entire article in the October 2014 Issue

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Chairman Mosier

The ***International Thermal Spray Association*** is closely interwoven with the history of thermal spray development in this hemisphere. Founded in 1948, and once known as Metallizing Service Contractors, the association has been closely tied to most major advances in thermal spray technology, equipment and materials, industry events, education, standards and market development.

A company-member association, **ITSA** invites all interested companies to talk with our officers, and company representatives to better understand member benefits. A complete list of ITSA member companies and their representatives can be found at their website ***www.thermalspray.org***

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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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 www.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 which 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 over 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 NEWSLETTER

Since 1992, the International Thermal Spray Association has been publishing the SPRAYTIME newsletter for the thermal spray industry. The mission is to be the flagship thermal spray industry newsletter providing company, event, people, product, research, and membership news of interest to the thermal spray community.

BECOME A MEMBER OF THE INTERNATIONAL THERMAL SPRAY ASSOCIATION

Your company should join the **International Thermal Spray Association (ITSA)** now! As a company-member, professional industrial association, our mission is dedicated to expanding the use of thermal spray technologies for the benefit of industry and society. **ITSA** members invite and welcome your company to join us in this endeavor.

NEW – *All **ITSA** company members are now also Supporting Members of the **American Welding Society**.*

Whether you are a job shop, a captive in-house facility, an equipment or materials supplier, an educational campus, or a surface engineering consultant, **ITSA** membership will be of value to your organization.

Our annual membership meetings provide a mutually rewarding experience for all attendees - both business and personal. Our one-day technical program and half-day business meeting balanced by social activities provide numerous opportunities to discuss the needs and practices of thermal spray equipment and processes with one another.

As an **ITSA** member, your company has excellent marketing exposure by being listed centerfold in the ***SPRAYTIME*** newsletter.

ITSA member companies are also highlighted in the **ITSA** booth at several trade shows throughout the year.

For more information, contact Kathy Dusa 440.357.5400 or visit the membership section at ***www.thermalspray.org***.

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PROSPECTING ISN'T AN EVENT; IT'S A CAMPAIGN

Bill is responsible for sales at his company and considers himself a tenacious worker. Whenever he discovers a new prospect, he enters him or her into the system. From there, he will attempt to contact that person by phone, through email and even via office visit if possible. However, after a number of failed attempts, Bill is likely to toss the person into the sea of dead prospects.

Does this sound familiar at all to you? This is the typical approach to prospecting. Besides being disorganized and tedious, the process yields less than stellar results because it inhibits prospects from becoming familiar with the salesperson's organization.

Instead of adopting the common haphazard approach to prospecting, it's time to think of every outreach effort as part of a larger campaign to engage prospects.

Meet Laura. Before implementing the campaign approach, she employed a strategy similar to Bill's, usually attempting to reach prospects seven or so times before giving up. Now, she uses the campaign approach to reach prospects. Here is what her new process looks like:

IDENTIFY: Once she identifies a prospect, she adds him or her to her CRM system along with all the relevant information she can find.

OUTREACH 1: She attempts to call the prospect. In the likely event that she doesn't reach the prospect, she leaves a message saying that she is going to send over a letter with best practice case studies that highlight how she could add value to the prospect's organization. She reiterates this information in an email.

SEND LETTER 1: She sends a letter containing best practice case studies.
Follow up on Letter: She now attempts to contact the prospect at different times of the day over the course of a week or two without leaving a voicemail.

ANNOUNCE PACKAGE: She leaves a voicemail and email explaining that the prospect will be receiving a package with some ideas for a new program.
Send Package: She sends a big package with more high-value ideas to help the prospect.
Follow Up on Package…
Send Letter 2…
Follow Up on Letter…
And so on…

She uses this same campaign for each new prospect. Yes, it is more labor-intensive than the haphazard approach, but it slowly builds a connection with the prospect even in the very likely event that she can't get through. Of course, if she does connect with the prospect, she simply references the last letter or package sent and then goes into her call script.

Here are a few key techniques from Laura's process that can translate into a successful prospecting campaign for any salesperson:

1. Create multiple steps. Plan out ahead of time what your campaign will look like and what you will send to the prospect at each step. Make sure that everything you send over is of actual value to the prospect. Brochures don't cut it! Instead, create 3-5 different pieces to send the prospect, which can each serve as a legitimate reason to connect. Even in the event that you don't hear back after step 2, you are still slowly making yourself known to the prospect, which makes him that much more likely to take your call the next time.

2. Call and email in between steps. Since you've sent something of value to the prospect, you now want to follow up to learn what matters most to her. The goal of any campaign is to simply get through to the prospect. By having a consistent process, you simply follow directions and let the campaign do the real work. As soon as you actually reach the prospect, you start the selling process.

3. Warm them up with personal touches. People still open mail, especially when it's personal, so don't just send boilerplate letters and packages to prospects. Make them personal with handwritten notes and individualized gestures. One step in your campaign could be to send a letter with a business article that may be highly relevant to the prospect based on his current situation. The key is to show that you've done your homework and see the prospect as more than just a number.

Remember, developing a prospecting campaign can be a bit of work up front, but once you have it laid out, all you have to do is follow the steps. By taking every prospect through this same campaign, you slowly build connections in a world where it is increasingly difficult to get through the barrage of voicemail, gatekeepers, and other barriers. So give it a shot. Lay out your campaign, and take your next series of prospects through the steps. The more prospects you have in a particular campaign, the easier it is to implement a systematic approach.

Have you ever used a campaign for your prospecting? Please share your results below in the comments.

ABOUT THE AUTHOR: Marc Wayshak is the bestselling author of two books on sales and leadership, Game Plan Selling and Breaking All Barriers, as well as a regular contributor for Fast Company, Entrepreneur Magazine and the Huffington Post Business section. As a sales strategist, Marc created the Game Plan Selling System to revolutionize the way salespeople, entrepreneurs and companies approach selling. Marc's sales strategy is based upon his experiences as an All-American athlete, Ivy League graduate, startup entrepreneur and years of research, training and selling. He holds an MBA from the University of Oxford and a BA from Harvard University. Get his free eBook on 25 Tips to Crush Your Sales Goal at GamePlanSelling.com.

You can call him at (617) 203-2171 or email him at ***Info@MarcWayshak.com***.
(Twitter: @MarcWayshak)

IN MEMORIUM

We are all saddened by the passing of

Warren Mickle

on January 12, 2015

■ In the early sixties, Warren served his Country in the U.S. Army as an Intelligence Analyst, with the 7th Army. After his Honorable Discharge he began his long and distinguished career with Union Carbide Coating Service now known as **Praxair Surface Technologies, Inc**.

In his twentynine years with Praxair he worked in many capacities such as: Assistant to the Regional Sales Manager in North Haven, Connecticut, Sales Engineer in Westboro, Mass., Account Manager for the Westboro Plant, Area Sales Manager and Regional Sales Manager at the New Castle Pennsylvania plant.

In the mid 90's Warren accepted a management position dealing with both domestic and international customer sales and remained in that position until his retirement in 1993.

However, retirement didn't last long. He accepted the position of Vice President of Sales and Marketing with **Plasma Technology, Inc.** that same year and continued in that position until his retirement in 2006.

He and his wife Linda subsequently moved to New Castle, Pennsylvania, until 2014 when they purchased second home in Florida.

Warren held a B.S. in Marketing Science from Quinnipiac College and attended over twenty Industrial Training programs at MTI Northwestern Butler. Warren was a member of the Society of Plastic Engineers, American Society of Metals, International Thermal Spray Association and a member of the New Castle Country Club.

He is survived by his wife, Linda, his son Todd who resides in California and his daughter Jennifer who resides in New Jersey, and several grandchildren.

All of us at PTI have fond memories Warren participating in our golfing activities and being entertained by Warrens singing at company dinners and other events. We will miss him greatly.

camfil
AIR POLLUTION CONTROL

TOMM FRUNGILLO PROMOTED TO VP, CAMFIL APC AMERICAS

■ Jonesboro, AR, December 16, 2014 – Camfil Air Pollution Control (APC), a leading global manufacturer of dust, fume and mist collection equipment, has promoted **Thomas (Tomm) Frungillo** to the position of vice president, Camfil APC Americas. "Tomm Frungillo has been a key player in the growth of Camfil APC since he joined the company in 2000," states Alan O'Connell, executive vice president in charge of global operations for the company. "He will assume full responsibility for the Jonesboro manufacturing facility as well as sales operations in North and South America for all Camfil APC products, including the full line of products resulting from the Handte acquisition earlier this year."

Frungillo has more than 20 years' experience in the dust collection and air filtration industries. Since joining Camfil APC as a regional sales manager, he has held a succession of posts in sales management as well as special market management in the pharmaceutical, mining and thermal spray industries. More recently his duties expanded to include responsibility for Latin American and Asian sales operations. Frungillo is a member of the International Society for Pharmaceutical Engineering (ISPE) and the International Thermal Spray Association (ITSA). He holds a Bachelor of Science degree in business administration from the University of North Carolina at Greensboro.

CAMFIL APC PROMOTES FOUR TO SALES MANAGEMENT POSTS

Camfil Air Pollution Control (APC), a leading global manufacturer of dust, fume and mist collection equipment, has promoted four members of its sales management team to new positions.

■ **John Dauber,** who joined the company in 1998 and most recently headed up the U.S./Canada sales team, is taking on the role of Handte product manager for the Americas. Last year Camfil APC acquired Handte, a German manufacturer of dust collectors, oil and emulsion mist collectors, wet scrubbers and ancillary items that strategically complement the **Farr Gold Series®** dust collection line. The Handte acquisition has greatly expanded the size of the company as well as the depth and breadth of product offerings. Dauber will oversee integration of these products into the Americas market.

■ **Matt Caulfield**, a 7-year veteran of Camfil APC, has been named director of sales – USA/Canada. Caulfield brings several years of sales management experience to this role, having most recently led the growing northeast U.S. territory and Canadian sales team. He will work closely with Dauber on the Handte product integration and will also have involvement in key OEM accounts.

■ **Rick Kreczmer**, an 8-year veteran of Camfil APC, has been promoted to director – aftermarket sales and corporate training. In this expanded role, Kreczmer will continue to manage the highly successful aftermarket filter

sales group while having global responsibility as cartridge product manager. Additionally, Kreczmer will supervise the corporate technical and sales training program for company employees.

■ **Greg Schreier**, who has served for three years as Camfil APC metalworking market manager with 13 prior years as a sales representative, will now have a dual role as director – OEM accounts/ metal and thermal spray market manager. Schreier and his team have spearheaded recent growth in these markets and have also expanded the company's OEM account base.

All four managers will report to **Thomas (Tomm) Frungillo**, who was recently appointed vice president, **Camfil APC Americas.**

For further information, contact
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LEE MORGAN NAMED PRESIDENT OF THE SYSTEMS GROUP

El Dorado, AR, December 9, 2014 – The Systems Group (TSG), (www.tsg.bz), a diverse group of companies engaged in fabrication, plant maintenance and construction for steel mills, foundries, metal processing plants, petrochemical plants and manufacturing facilities, announces that Lee Morgan has joined the company as its new president.

Company CEO Chuck Hays comments: "Lee Morgan has significant experience in leading and growing businesses, which will help us continue to expand all of our business units." Morgan will oversee all three companies that comprise the privately-held group: Systems Contracting Corporation, one of the nation's top-ranking specialty contractors in the industrial, municipal and commercial construction markets, whose numerous specialties include process piping, structural concrete, and structural steel erection; American Steel Company, an AISC Certified Fabricator with the experience and capabilities to handle all types of fabrication projects both in the U.S. and internationally; and Systems Spray-Cooled Inc., which manufactures a line of patented equipment for extreme heat load applications in the global metal and mineral industries.

Morgan comes to TSG after 17 years at Camfil Air Pollution Control, a leading manufacturer of dust, fume and mist collection equipment. As general manager and later president of the company, Morgan developed Camfil APC from a small business into a highly successful global operation. He holds six patents and has published multiple papers in the field of industrial air cleaning. Morgan holds a Bachelor of Science degree in mechanical engineering from South Dakota State University.

For further information,
The Systems Group
P.O. Box 11390, El Dorado, AR 71731; phone 870-862-1315; email info@tsg.bz,
www.tsg.bz

NEW HEAD OF SALES AMERICAS AT OERLIKON METCO

Oerlikon Metco appoints Steven Ort as Head of Sales Americas.

Steven joined Metco in June 2008 as Head of Equipment Marketing during which he strongly influenced the Oerlikon Metco's cascading arc plasma portfolio. Recently, Steven served as Integration Project Manager for sales and marketing during the acquisition of Metco by Oerlikon. In addition to his time with Metco, he has over twenty years of experience in sales and marketing management positions within the welding and cutting industry. He holds a Bachelor of Science in Business Administration from Central Michigan University and an MBA from The University of Michigan Ross School of Business.
About Oerlikon Metco

Oerlikon Metco enhances surfaces that bring benefits to customers through a uniquely broad range of surface technologies, equipment, materials, services, specialized machining services and components. The surface technologies such as Thermal Spray and Laser Cladding improve the performance and increase efficiency and reliability. Oerlikon Metco serves industries such as aviation, power generation, automotive, oil and gas, industrial and other specialized markets and operates a dynamically growing network of more than 40 sites in EMEA, Americas and Asia Pacific. Oerlikon Metco, together with Oerlikon Balzers, belongs to the Surface Solutions Segment of the Switzerland-based Oerlikon Group (SIX: OERL).

For further information,
www.oerlikon.com/metco

MANUFACTURER PLASMA-TEC PROMOTES BRYAN DEGROOT TO GENERAL MANAGER

The manufacturer of coated and uncoated wear components appoints DeGroot to the position after 7 years of service with the company

As a successful and growing manufacturing company, Plasma-Tec continually strives to provide customers with high-quality parts and exceptional personal service. Talented team members who believe quality & service are an integral part of the success for both Plasma-Tec and their customers are critical to its success. Based on technical competence, managerial capabilities and a client relationship focus, Bryan DeGroot has been promoted in recognition of his hard work, talent, and commitment.

Bryan DeGroot has worked for **Plasma-Tec** since May, 2007. He was hired as a Manufacturing Leader, and was soon promoted to the position of Plant Manager. In 2010, Bryan's responsibilities expanded as he became Plasma-Tec's Operations Manager. Along the way he has fulfilled many vital responsibilities for Plasma-Tec, ranging from business development to operational leadership. His character, values, skills and experience allow him to serve as a liaison between customers and the shop operations.

Chris Wysong, Vice President of **Plasma-Tec**, had the following to say about promoting DeGroot: "Bryan has been a fantastic part of the Plasma-Tec team and he really lives out our values in a practical way. At Plasma-Tec it is our goal to demonstrate Love, Honor, and Respect to every person we come in contact with, Bryan does that. He is a great leader for the crew on the floor, and excellent at helping customers identify the right technology, processes, and solutions for their components. His leadership is best demonstrated by this quote from one of our OEM customers: 'Plasma-Tec as a whole is a very tight company, very involved in their worker's lives and they care about each other that makes for a stronger company I believe.' I am thrilled to see Bryan take on this role."

Plasma-Tec, Inc. is a precision machining & grinding and wear and corrosion coating services provider. The company produces round, turned, and ground components of medium-to high-precision of 1 in. to 8 in. in diameter. The manufacturing processes and thermal spray coatings utilized by Plasma-Tec make them a preferred source for wear components for companies in the oil and gas, food, chemical and pharmaceutical industries.

For further information,
YPlasma-Tec
1-800-643-6030
www.plasma-tec.com

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Send calendar notice to spraytime@thermalspray.org

MAY 2015

5-7 | Monterry, Mexico – **FABTECH Mexico**
www.fabtechmexico.org

8 | Miri, Sarawak Malaysia – **5th REGIONAL MATERIALS**
Conference by IMM Institute of Materials Malaysia
karen@mte.com.my

11-14 | Long Beach, CA USA – **ITSC 2015**
Int'l Thermal Spray Conference co-located with Aeromat 2015 and Microstructural Characterizatrion of Aerospace Materials and Coatings Conferences and Expositions
www.asminternational.org/web/itsc-2015

28-29 | Tampere, Finland
3rd INTERNATIONAL SEMINAR ON ADVANCES IN SURFACE ENGINEERING (ASE 3)
Special Focus on Thermally Sprayed Coatings and Their Applications
www.tut.fi/ase3

JUNE 2015

1-4 | Shanghai, China
BEIJING ESSEN WELDING AND CUTTING
www.beijing-essen-welding-cutting.com

2-4 | Detroit, MI USA
BIG M MANUFACTURING CONVERGENCE
www.bigmevent.com

15-19 | Montreal, Canada – **TURBO EXPO 2015**
www.asmeconferences.org/TE2015

23-25 | Newport News, VA USA
MEGARUST2015 NAVAL CORROSION CONFERENCE
www.navalengineers.org/megarust2015

JULY 2015

15-17 | Cape Town, South Africa
POWER-GEN AFRICA
www.powergenafrica.com

20-22 | Niagara Falls, Canada
GO CARBON FIBER NORTH AMERICA
cpickard@smithers.com

SEPTEMBER 2015

6-10 | Graz, Austria
EUROCORR2015 EARTH, WATER, FIRE, AIR, CORROSION BY EUROPEAN CORROSION CONGRESS
www.eurocorr2015.org

10-12 | Sule Shangri-La, Yangon, Myanmar – **MYANMAR 2015**
3TH ANNUAL SOUTHEAST ASIA OFFSHORE SUMMIT
www.seaoffshore2015.org

14-17 | Houston, TX USA
44TH TURBOMACHINERY AND 31ST PUMP SYMPOSIUM
www.pumpturbo.tamu.edu

29-10/1 | Mississauga, Ontario Canada
CMTS CANADIAN MANUFACTURING TECHNOLOGY SHOW
www.cmts.ca

OCTOBER 2015

1-3 | New Orleans, LA USA
INT'L THERMAL SPRAY ASSOCIATION ANNUAL MEETING
itsa@thermalspray.org

4-6 | Abu Dhabi, UAE
POWER GEN MIDDLE EAST CONFERENCE
www.power-gen-middleeast.com

7-9 | Delhi, India
12th INT'L SURFACE ENGINEERING, PAINTS AND COATINGS
www.surface@tafcon.com

20-23 | São PauloBrazil – **BRAZIL WELDING SHOW**
www.brazil-welding-show.com

NOVEMBER 2015

1-5 | Portland, OR USA
ISTFA 2015 INT'L SYMPOSIUM FOR TESTING AND FAILURE ANALYSIS
www.asminternational.org

9-12 | Chicago, IL USA
FABTECH WITH A THERMAL SPRAY LIVE DEMONSTRATION AND CONFERENCE
www.fabtechexpo.com

DECEMBER 2015

8-10 | Las Vegas, NV USA – **POWER GEN 2015**
www.power-gen.com

2016

FEBRUARY 2016

2-3 | Houston, TX USA
THERMAL SPRAY OIL AND GAS SYMPOSIUM
itsa@thermalspray.org

MARCH 2016

6-10 | Vancouver, Canada – **CORROSION 2016**
www.nace.org

22-24 | Toronto, Canada – **FABTECH CANADA 2016**
www.fabtechcanada.org

APRIL 2016

25-29 | San Diego, CA USA
ICMCTF'16 - INTERNATIONAL CONFERENCE ON METALLURGICAL COATINGS & THIN FILMS
pgreene@mrl.uiuc.edu

MAY 2016

May | St. Petersburg, Russia
ESSEN WELDING PAVILION AT SVARKA
www.svarka.de

NOVEMBER 2016

16-18 | Las Vegas, NV USA
FABTECH – THERMAL SPRAY LIVE DEMONSTRATION AND CONFERENCE
www.aws.org


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ACCIDENTS ONLY HAPPEN TO IDIOTS, RIGHT?

Consider the accident that happened on March 13, 2009 in Hamburg Germany. A researcher at the prestigious Bernhard Nocht Institute of Tropical Medicine accidently pricked her finger with a needle used to inject the deadly Ebola virus into lab mice.

There is no known cure for Ebola. It is mostly confined to Africa. Ebola hemorrhagic fever begins with flu like symptoms followed by bloody diarrhea and vomiting. During the later stages of the virus victims begin bleeding through the nose, mouth, and eyes. It is a bloodborne pathogen that spreads through direct contact with the blood or body secretions of an infected person. Depending on the strain of virus it can kill up to 90 percent of victims.

Fortunately for this scientist she was a member of a tightly knit worldwide community who, only hours after reporting the incident to her supervisor, were in communication via teleconferencing trying to figure out how to save her life. Less than 24 hours later an experimental vaccine was on its way to Germany from Canada and she was injected with the vaccine.

It's not clear that the researcher was actually infected. She was wearing personal protection equipment that included three layers of protective gloves, and though she felt the needle pierce her, the plunger on the syringe was not pushed, so it's not certain that the virus entered her bloodstream.

If she was infected, the vaccine seemed to work, because news reports said that she recovered nicely. Yet, we may never really know the extent of her injury or the effectiveness of the vaccine. Nevertheless, everyone is better safe than sorry, and this incident epitomizes the need for an effective Bloodborne Pathogen Program.

Charlie Howes is a semi-retired safety consultant, licensed private investigator, and technical writer with over 20 years of experience in the welding & thermal spray industries.

Contact Charlie Howes at
www.charleshowes.com or
Twitter: @cphowes.

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