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## History and Development of Modern Thermal Spray Guns

*By James Browning*

Prior to the 1950s, metallizing was done using spray gun devices with compressed air as the accelerants of the particles. Both flame-spray and twin wire-arc methods were patented in the early 1900s by Mr. Shoop. The break came in the 1950s with the development of the detonation gun by Union Carbide. The D-Gun speeds the particles to impact velocities several times those previously available.

Merle Thorpe, while a graduate student at Dartmouth's Thayer School of Engineering, worked on a government-sponsored program studying the combustion of small solid fuel particles with air. He won a national student research paper competition held at MIT and sponsored by the ASME; the title "Lateral Blow-Off of Bunsen Flames". Some years later he returned to New Hampshire, and in 1958, he joined three of us in founding Thermal Dynamics Corporation.

Thermal Dynamics was interested in electric arc heating devices for producing supersonic jet streams. Metco, who was aware of our work, invited us to Westbury to discuss an important problem that had developed.

Soon after arriving in Westbury we were in Rae Axline's office with Herb Ingham. Their problem was a drop in sales levels of their flame-spray products – particularly, the spraying of tungsten-carbide. The cause of the drop was the D-Gun's ability to spray improved coatings of that material. After a long period of discussing this matter, all four of us agreed "Let's try plasma as the spraying medium".

The arrangement set up a Research and Development program sponsored by Metco, but carried out at Thermal Dynamics under the leadership of Merle Thorpe. Merle developed and patented the device[1]. In our contract with Metco, they (Metco) would have sole rights (resulting from

Continued on page 4.

## Thermal Spraying Engineering Coatings Using Silver

RFI Screening Limited, specialist surface treatment engineers, has opted for Metallisation MK61 Flamespray equipment to thermal spray a 40 ton generator rotor with fine silver.

The generator rotor, which is a combination of electrical, mechanical and manufacturing components, is regularly exposed to hard mechanical stress and high temperatures, while being subjected to electrical voltage and current. Over time this stress can lead to breakdown, costly repair and maintenance and possibly inconvenient downtime. To maximize the lifetime of the generator rotor, RFI Screening was contracted to thermal spray it, using the flamespray equipment.

Prior to thermal spraying the generator rotor, the surface was grit blasted, to Standard SA 2.5, to clean and prepare the shaft. The shaft was also pre-heated by induction to

Continued on page 11.

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## INDEX

### *INDUSTRY NEWS*



### *APPLICATION HIGHLIGHTS*



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**History continued from page 1.**

the program) within the metallizing field. Thermal would have sole rights for applications outside metallizing. A jointly-owned corporation, PlasmFlame, was established to formalize this arrangement. It became evident that the Thorpe gun was useful, as developed, for uses in addition to metallizing.

And then, Sputnik went up! The rush was on for materials and re-entry testing equipment. It was found that only two companies were marketing the new plasma equipment which proved qualified for this high-temperature test work. "BOOM", Plasmadyne and Thermal sales soared. Each sold general-purpose plasma guns which could also spray metals and ceramics. A possible conflict with Metco arose for us, but it was easily solved. Thermal could include metallizing as a use of general purpose equipment up to the time Metco commenced marketing their own equipment. Thermal would then drop out of the metallizing field for equipment operating under the Thorpe patent. (In fact, Thermal never developed a gun specifically designed for spray use.) Thermal sold several plasma systems operating at 1mw, or above with the highest powered installation using 7mw to Stanford University for studies in magnetohydrodynamics (MHD). (It should be mentioned that Thermal's designs of such high-powered arc guns relied heavily on the past Metco program. This is also true regarding our plasma cutting spray guns.) We learned later that Union Carbide had built a 20 mw unit – presumably for MHD studies.



### Increased Plasma Spray Power Levels

Years after leaving Thermal Dynamics, Richard Whitfield and I began work on a 200 kw plasma spray gun designed to extend HVOF type spraying to much higher jet velocities and temperatures. We settled on purchasing 200 kw Thermal Dynamics metal cutting system using their inexpensive power supplies, controls, and the like. The major change was attaching the spray gun in place of the cutting torch. The system ran fine with an estimated 12,000°F peak temperature and a jet velocity of about 9,000 ft/sec. We sold several of these systems. An offer from a Japanese firm for exclusive world-wide rights to the controlling patents was too favorable to turn down. We went on working, I believe on high-pressure HVOF designs.

The Japanese firm that continued making these units ran into real estate speculation difficulties and, to make ends meet, sold their exclusive patent rights and designs to an established thermal spray firm in the United States. The power level had been increased to 250 kw. The United States firm made and sold five complete systems to an aircraft engine manufacturer for the main purpose of spraying ceramics on gas turbine engine parts. To my knowledge, the new manufacturer discontinued making this outstanding equipment.

### High Pressure HVOF Spray Apparatus

The early HVOF spray guns operated at inlet oxygen pressures below 100 psig. Over a several year period, the pressure rose to 200 psig for the J-Gun which Dick Whitfield and I commenced selling in the middle 1980s. This gun, after extensive improvements by TAFA, who had taken over its manufacture, has been very successful over the past many years providing a superior gun, the JP-5000. Much of this success has been due to its ability to impact un-melted particles against the work piece at velocities so great that the heat-of-impact produced fusion coatings. Events in HVIF spraying (High Velocity Impact Fusion) happen so rapidly that oxidation levels are nearly zero. Metco, at a later date, commenced the sale of HVIF units capable of operating at over 300 psi.

The operating pressure increases led to much higher coating quality. Pondering this fact, the HVOF operating oxygen pressures were raised to 1,000 psi. Again, major improvements resulted in coating quality (see figures 2 and 3). Boundary lines between contact particles in the coatings are difficult to detect. No decarburization of the tungsten carbide is evident. The accelerating jet temperature is so low due to the high expansion level, that these adverse effects were minimized.

The results of the 1,000 psig operation were so good that a 4,000 psi liquid oxygen pump was purchased with its water-heated high strength evaporator. Before using this really high pressure apparatus, I presented the 1,000 psi results at a meeting in Quincy, MA. The audience (at least

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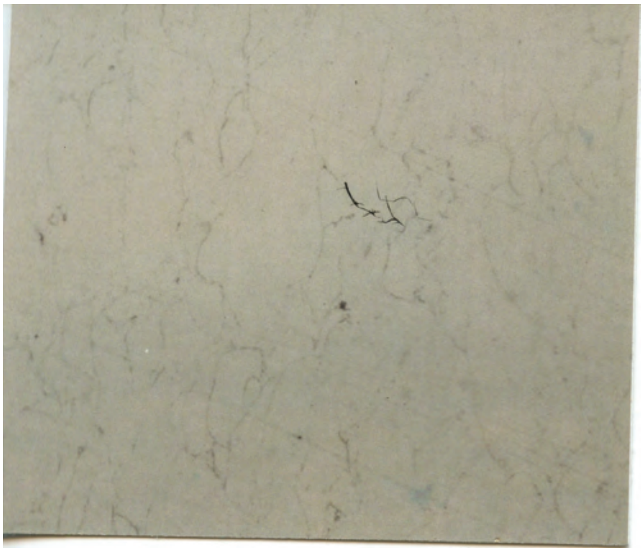

**Figure 2. Photomicrograph of powder-sprayed Stainless Steel using 1,000 psig oxygen pressure using a water-cooled spray gun with 18 in long nozzle length.**

**Figure 3. The spray gun of Fig (2) used to spray tungsten-carbide/cobalt powder using 1,000 psig Oxygen.**

in my interpretation of statements made) would never accept the use of such high oxygen pressures. The device was not marketable. Why go on with this work? I never made use of the liquid oxygen apparatus. (To this day, my belief is that HVOF spraying could in many cases compete with fusion welding and "printing" in applications for forming structures.)

### HVAF – Its Success and Sudden Demise

The high-velocity air-fuel thermal spray equipment was designed after several years of experience gained using much larger air-fuel burners in other applications. A dramatic use of a high-output air-fuel unit was successfully used to drill a hole 1,100 feet deep in the Conway, NH Granite for the purpose of measuring the temperature gradient in this formation containing radio-active Thorium. (The gradient found – 30°C per kilometer of depth.) The flame-drill was provided with 1,200 scfm of compressed air at 900 psig! The hole produced averaged 10 inches in diameter – the drilling rate a bit over 100 ft/hr!

The exclamation points above were purposely included to dramatize how much less complex the air-fuel units designed for thermal spray would be. Their design utilized regenerative air-flow cooling of the combustion device which operated at about 120 psig at the compressed air inlet, with flows up to 150 scfm.

These HVAF units had several advantages over their HVOF competitors. First, costs for similar heating levels are greatly reduced to those for oxygen. Secondly, the peak combustion temperature, prior to expansion to the atmosphere, is about 3,400°F versus over 5,000°F for pure oxygen. Expansion to atmospheric pressure produces a jet temperature below that of stainless steel's melting point of about 2,700°F. No melting of stainless particles being sprayed was the result. In fact, the phenomenon of "impact fusion" was discovered when test-spraying using early HVAF designs. The high-velocity particles forming the exiting plume were barely visible with a much brighter circular glow evident on the work piece surface. For discussions of HVAF operation, see references (2), (3) and (5). Professor Horst Richter, co-author of (2) has recently retired from the Thayer School of Engineering. His advice in ways to reduce oxidation in coatings is to provide peak combustion temperatures near, or below, the dissociation temperatures of such flame species as CO, OH, and O which are intensely oxidizing. This advice has been followed in HVOF cases by burners using additions of non-combustibles such as nitrogen or, even, small flows of water.

The demise of HVAF in this country is a sad and tragic story. The most recent marketer of HVAF equipment had sold a European-made HVOF systems which is comprised of a console containing both oxygen and fuel flow instrumentation with a safety bulkhead separating the two reactants. The customer, without the knowledge of the marketing firm, had drilled hole(s) through the bulkhead. The technician sent to start-up the device was, tragically, killed by the ignition of the pre-mixed reactants. The marketer was so overwhelmed by this event that it terminated activities in thermal spray equipment sales, including HVAF which had not been involved.

### Why Not Use HVOF Advantages For Spraying Wire?

We can. With the aim of eliminating water cooling of HVOF equipment, it was found that a strong oxygen vortex flow along the bore wall could stretch the hot flame well along the bore's length before over-heating the the barrel. For maximum bore lengths, the fuel is injected axially into the low pressure vortex "eye" passing centrally along the bore's axis. This effect was studied carefully and it was found that the exiting supersonic jet does a beautiful job using wire introduced into the jet just beyond the bore exit. The advantages of spraying with uncooled HVOF is that the penalty of a heat loss of up to 25% when water cooling is required, is avoided. Simplicity of construction is remarkable – only one, or two, small pieces of copper required, and, for most designs, total weights under one

**History continued from page 5.**

pound even for units consuming up to 3,000 scfh of oxygen. United States patent No. 7,628,606,issued in 2009, covered the design of such systems, both for heating and propulsion purposes. The single claim of the patent limits the L/D ratio of the bore to a minimum of 6. (L is the bore length, D its minimum inner diameter.) The experimental work on this vortex application dates back 6 years to before 2008 (See fig. 1 for a typical wire-made coating.) Short length guns, at that time, were of little interest.

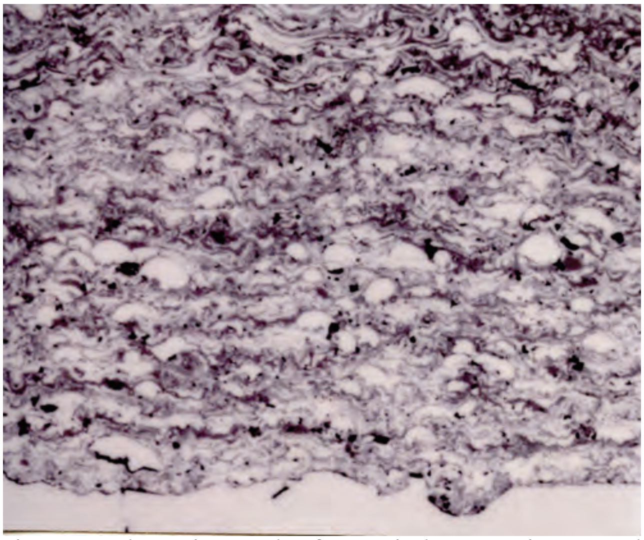

**Figure 1. Photomicrograph of a typical HVOF wire-sprayed coating of a 316 Stainless Steel using a non-water cooled gun.**

With the growing interest of HVOF coating on the inner walls of small diameter pipes and automotive cylinders, the restriction requiring relatively long nozzles began to be seen as a problem under '606. A continuing research program to lower the L/D ratio to under 2 had proven successful. United States Patent No. 8,455,056 issued in June 2013 reduced this minimum useful ratio to under 3. Patent '056 simply moves the fuel entry holes into the bore away from the stagnant "eye" to the vortex high-velocity gases immediately surrounding the "eye". What produced a diffusion flame under '606 became a pre-mixed flame under '056. The older patent technology produced the highest possible jet velocities. '056 has a lower velocityj, but a higher temperature, and an "L" about half as long for the same bore diameter.

At this writing, a new patent application is under examination. It reverses the fuel and oxygen flow positions with the fuel flowing adjacent to the bore wall — the oxygen along the bore axis. It was determined that L/D ratios as low as 2 are possible. This third step in the geometry of the flows of reactants allows burner bore lengths as short as ¾ in. for small bore diameters.

A recent improvement in short burner lengths utilizes vortex flow of each of the reactants into the bore. The mixing of these reactants is so rapid that the bore length for a 3/8 in. ID bore is only 5/8 in. The L/D ratio is about 1.7. This allows a burner length of only ¾ in. Such small length burners, arranged to impact their supersonic jets radially against the inner wall, show promise of being able to produce coatings in pipes down to 2 in. diameter.

In closing this section, a major advantage found for HVOF wire spraying is the ability to use large wire or rod diameters. Spray gun V 1/8 sprays rods up to 5/16 in. diameter. The increased area of the rod surface exposed to flame-jet heating allows for better hear transfer. Nearly straight rods are required with less than ¼ in. cast deflection per foot of rod length. Alternatively, up to three wires, twisted together to form a straight length, may be used to an advantage. The smaller the wire diameter, the greater the surface area-to-mass becomes.

## For Those Desiring "Cold Spray", HVOF-Powered Equipment

Using vortex-stabilized units, as described above, cold-spray, warm-spray, and hot-spray, each producing impact-fusion, are possible. It is not the same though. Outside water cooling is necessary with nozzle lengths up to 16 in. long using ½ in. bores. The principle is simple. The first couple of inches after the reactants have been introduced into the bore, may be un-cooled. When the flame within the bore is fully stabilized, a small flow of quench water is introduced. Allowing time for a sufficient amount of evaporation of this water to begin limiting the jet stream temperature within the bore — about 6 inches



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—, then add the powder. Adjust the quench water flow so that the powder being accelerated never melts. It has more than 8 in., or so, to travel to the exit. Arrange the total bore length to produce impact fusion of the lowest melting point of the metals required; while reducing the quench water exiting the bore to about zero. In some cases a small amount of liquid water may be an advantage — particularly, when it is fully vaporized by the jet a small distance beyond the exit. Maximum flows of quench water used is about 30 gallons per hour, using a ½ in. diameter bore.

Recently, powder has been used in both the '606 style burner and the double-vortex short spray gun. The injection-point is about 1/8 in. prior to the bore exit (similar to plasma spraying). The coatings included such materials as aluminum, Ni-Al, chrome-carbide, tungsten-carbide/cobalt, and Ni-Cu. The coatings look excellent. The heated particle plumes within the accelerating jets were barely visible in a lighted-room. It is possible that open-air, high-velocity jets are better for accelerating particles than for heating them. It may be that these coatings were produced by "impact fusion" (but, just a guess). Figure 4 is a view of a possible arrangement of such a double-vortex set-up.

## The Substitution of Thin Metal Strips in Place of Wires

The advantage of this is the nearly doubling of the heat transfer area of the heat-exposed metal surface of a strip over that of wire weighing the same per unit of length. (See Figure 6 of reference (4) on page 8.) Although higher spray rates and finer spray particles are obtained, I don't believe any manufacturer, or user, would chose to use it. See Figures (5), (6), and (7) on page 8. The question is, "Is the high spray rate shown in (6) too much for the job?" (It is about 30 lb/hr.) If so, just reduce it by the correct amount.

A more detailed sketch is shown of this enlarged zone to about 6 in. beyond the spray gun exits of Figures 5, 6, and 7. In this view, shown in Figure (8), a visual depiction is attempted. The spray guns illustrated are 1 in. long with a 1 in. diameter. The added length of the support may be eliminated by connecting the tubes delivering the reactants radially to the spray guns within the boundaries of their 1 in. lengths.

## Other Applications of Burner Types Discussed To Now

Important uses for this technology other than thermal-spray exists. Rock drilling has been discussed and demonstrated. In spallable-rock drilling, solid chips are separated from the rock mass by stresses set-up using the intense temperature gradient imposed at the surface where the flame-jet impinges. The best types of rock are, basically, quite hard. Included are sandstone, granite, dolomite, dolomitic marble, some basalts, and taconite. Drilling to deep depths is complicated by having to provide an upward assist for chip removal. Holes to about one mile in depth may escape this complication. Included uses, to a mile in depth, include general heating purposes. For the Concord, New Hampshire Granite the rock temperature at the one-mile depth adds a near-surface temperature of

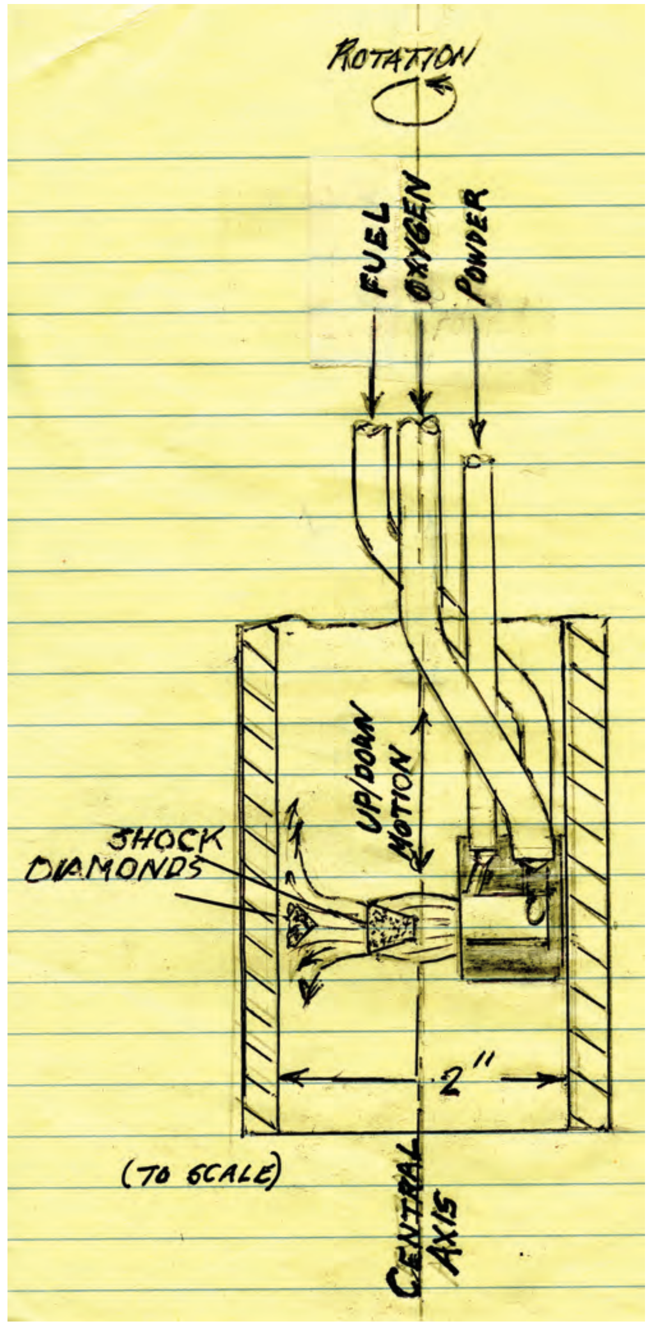


**Figure 4. Sketch of apparatus using a 2V 3/8-3/4 spray gun to powder-spray inside diameters of pipes and automotive cylinders. Combustion-bore 3/8 in. diameter with 5/8 in. length. L/D = 1.7.**

**History continued from page 7.**

55°F to that of the temperature-gradient produced 80°F, for a total of 135°F. Holes of less depth (up to about 600 ft) are used for heat-pump installations. Water wells, of course, require random depths. Returning to the high temperature-gradient granites, depths to two miles can produce temperatures of around 200°F— capable of producing electrical energy (geo-thermal heating).

Other uses include abrasive blasting, heat-treating, steam cleaning, and the like.

**Figure 5. A ½ in. wide by 0.025 in. steel strip being sprayed by a V 1/8-3/4 burner using 500 scfh of Oxygen with a spray rate of about 20 lb/hr.**

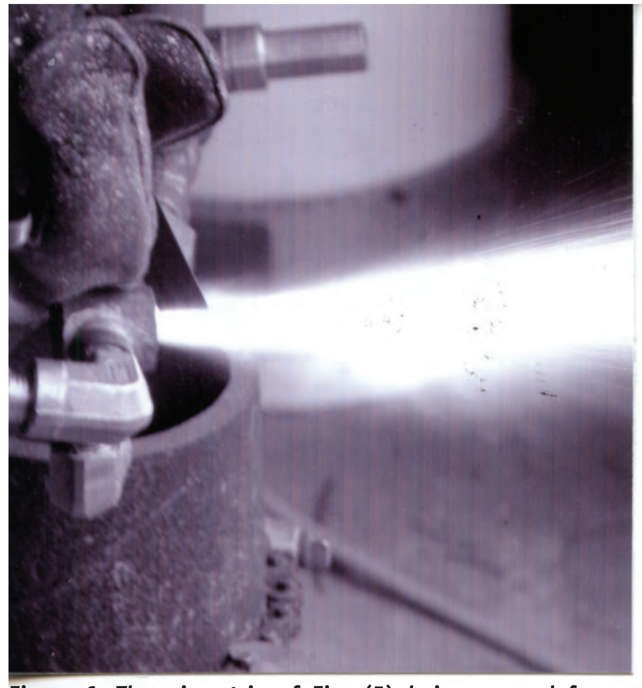

**Figure 6. The wire strip of Fig. (5) being sprayed from a nearly vertical path into the jet from a 2V 3/8-3/4 spray gun at a spray rate of about 30 lb/hr using about 2,000 scfh of Oxygen.**

**Figure 7. A 1 in. wide by 1/8 in. thick zinc strip using the V 1/8-3/4 burner — spray rate, "very high".**



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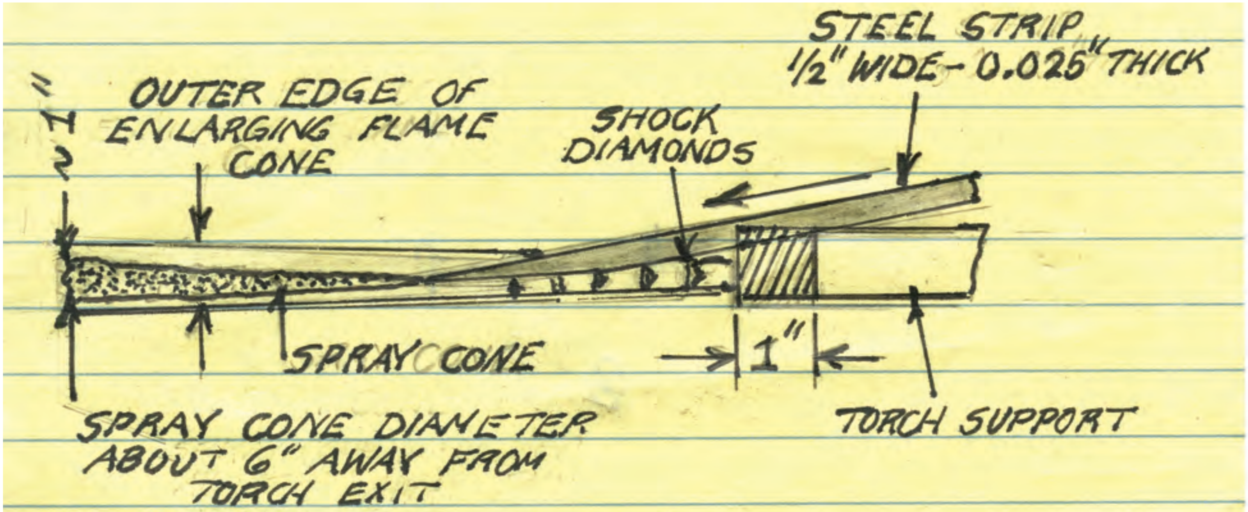


**Figure 8. Sketch showing photographically hidden zones of Fig. (5).**

## Random Views and Comments

Early in this report four "experts" in the metallizing business produced a plasma spray application theory which soon was to be proven quite wrong. Plasma-jet temperatures are so high that tungsten-carbide particles are badly decarburized reducing wear life to nearly 50% of those for the D-Gun. Luckily, plasma has worked well for nearly everything else. (Perhaps the D-Gun is really the first to produce impact fusion, and possibly even before the Russians.)

I wish to thank Professor Heinrich Kreye, Universität Der Bundeswear Hamburg, for the important help he has given me. He has been responsible for most of the photographic examination of the many different wire coatings. In particular, I learned that 8% content of oxygen in molybdenum is optimum. He, very generously, gave me a large amount of the slippery metal (to put on thebottom of my ski s). I never did. I later learned the price of the wire — nearly $100 per pound.

Figure 7 shows a strip of zinc, measuring 1 in. wide by 1/8 in. thick, being sprayed by the V 1/8-3/4 double-vortex device. This use of the HVOF process has an

**History continued from page 9.**
important advantage over zinc arc-melting spray processes. The arc actually vaporizes up to 10% of the zinc being sprayed. This vapor cools rapidly and oxidizes in the surrounding atmosphere resulting in clouds of white dust composed of nano-sized, dangerous-to-breathe, particles. No such clouds result using HVOF.

In my opinion, both thermal spray users and their suppliers of the equipment are responsible for the slow progress being made using the many new processes that could advance the quality of modern coatings. Higher impact velocities are needed. Jet heating must be correct to maximize the properties of the impacting particles. I can understand the decisions of both parties. The users do not want to take a chance using new technology when present coatings are acceptable to their customers. The manufacturers do not wish to jeopardize the continuing sale of its presently well-operating products.

Foreign-made equipment has not been discussed. I know very little about them.

These double-vortex units do a superb job spraying molybdenum wire — better than the single vortex, probably due to the exit jet's higher temperature.

A good question for thermal spray users to ask their equipment manufacturers is, "Why don't you provide us with equipment that makes the best-possible coatings?"

A good question for equipment manufacturers of thermal spray apparatus is, "If we provide equipment capable of producing optimum coatings requiring 500 psig inlet oxygen pressure, will you use it?"

In closing, I must quote the following from Section 5 of Reference 5, "The HVOF-sprayed Wc-Co-Cr coatings showed a wear rate that was an order of magnitude higher than that of the HVAF Wc-Co-Cr coatings".

**REFERENCES:**

(1) United States Patent No. 2,960,594 issued in 1960 to Merle L. Thorpe and assigned to the Plasma Flame Corporation.

(2) M.L. Thorpe and H.J. Richter, "A Pragmatic and Comparison of HVOF Processes", 1992, Hobart TAFA Technologies, Inc., Concord, NH

(3) T.C. Hanson and G.S. Settles, "Particle Temperature and Velocity Effects on the Porosity and Oxidation of an HVOF Corrosion-Control Coating", ASM TSS Journal of Thermal Spray Technology, SEP 2003, p. 403.

(4) United States Patent No. 4,788,402.

(5) L. Jacobs, M.M. Hyland, and M. DeBonte, "Study of the Influence of Microstructural Properties on the Sliding-Wear Behavior of HVOF and HVAF Sprayed WC-Cermet Coatings", ASM TSS Journal of Thermal Spray Technology, MAR 1999.

***For more information,*** contact author Jim Browning via phone at 603.448.4729.

Thermal Spraying Silver continued from page 1.

prevent coating shrinkage issues and enhance the adhesion of the thermal spray. The generator rotor was then sprayed with a 25 micron coating of Molybdenum, which is a bonding material, to optimize the adhesion of the top coat of silver. A final coating of silver was then added to achieve the specified outside diameter on the shaft. Silver is chosen due to its high levels of conductivity compared to other materials such as steel and even copper. In a typical application, a coating 250 microns thick of silver would be sprayed.

The flamespray system was chosen instead of arcspray due to the higher efficiency that can be achieved with a more controllable application process. The flamespray system with small diameter wire will also produce a fine, close structured coating that will maximise the conductivity of the applied silver, which is the main purpose of the coating.

The Metallisation MK61 is an oxygen-acetylene fuelled flamespray system, primarily for spraying engineering coatings of steels, bronzes, copper and molybdenum. The lightweight, robust pistol offers the possibility to reclaim damaged parts for small to medium sized applications, as it has a continous nozzle set up, ideal for engineering coatings. Molybdenum can also be sprayed with the MK61 as a soft bond coat through to a very hard, wear resistant coating.

The MK61 is also ideal for use with RFI Screening's mobile thermal spraying unit, as, although the pistol is lightweight, it is robust, sturdy and well balanced making it very easy to handle. Requiring only gases and compressed air, it also lends itself to site applications where 3-phase electricity may not be available. It comes with a variety of hose lengths to suit a wide range of applications where difficult access may be an issue.

RFI Screening was established in 1982. At its industrial site in Ware in Hertfordshire it has five blast rooms, five cabinets to cover most blasting processes, as well as its mobile blasting and thermal spraying unit. RFI Screening's expertise in applying surface treatments to a wide range of ferrous and non-ferrous substrates has resulted in the company doing projects overseas, as well as in the UK. The most recent thermal spraying job was completed in Saudi Arabia on a Saudi Naval vessel.

Steve Noble, Owner of RFI Screening, says: "We choose Metallisation equipment because the company is very customer focused and were very professional in their dealings with us. We were also thrilled with the quality of the service and speed of delivery of the equipment. The equipment is reliable, easy to use and complements our services perfectly. I would happily recommend Metallisation to any company looking for good quality

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**Thermal Spraying Silver continued from page 11.**
equipment and excellent knowledge and understanding of thermal spraying."

Metallisation provides thermal spraying equipment, consumables and expert advice to industries around the world and has been doing so since 1922. Its equipment has been designed for a wide range of uses, from universal corrosion protection of steel fabrications, to engineering coating applications, such as the one described in this feature. Engineering application include work within the automotive, aerospace, oil and gas and manufacturing industries.

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Vishay Components India Pvt. Ltd. (Pune, India) is one of the largest manufacturers of semiconductors and passive components in the world, with several plants spread across the Americas, Europe and Asia. In India, Vishay has been manufacturing these electronic components with a production set-up that included thermal spray booths served by dust collectors containing horizontally-mounted filter cartridges.

**Both GS32 dust collectors are in place after replacing two horizontal filter-mount collectors at Vishay Components.**

Vishay used two of these collectors imported from Europe for their two thermal spray booths for spraying zinc and aluminum, and a locally supplied dust collector for their epoxy coating application. Vishay was concerned with two main issues: dust spreading in their thermal spray and epoxy coating booths; and higher emission levels, which the old dust collectors were not able to handle to Vishay's satisfaction. To address these concerns, they approached Camfil India for a possible solution.

Camfil India and Camfil APC Malaysia cooperated in this project to provide the customer with sales, marketing and technical support. After a series of surveys and presentations, Vishay placed an order for two Farr Gold Series® GS32 dust collectors for the thermal spray booths. Each collector handles system airflow of 7500 m3/hr and is equipped with 32 high efficiency filter cartridges. Vishay simultaneously ordered a smaller Gold Series GS6 collector containing six cartridges for the epoxy coating machines. All units were equipped with explosion vents and mechanical isolator dampers. Manufactured at Camfil APC's headquarters plant in Jonesboro, Arkansas, they reached the customer in January 2013.

**Gold Series GS6 dust collector for epoxy coating fumes/dust capture application.**

In addition to the new dust collectors, Camfil provided a design plan for replacing all the existing ductwork. The dust collectors were installed and commissioned in June 2013 under Camfil APC Malaysia's supervision.

Notable improvements documented by Vishay include:

- They have nearly eliminated the spread of dust in booths due to suction velocities being almost doubled. The results are cleaner booths and rooms – and happier employees.
- Electrical energy costs are lower due to energy-efficient 10 HP motors for blowers, instead of 20 HP motors used in the previous dust collectors.
- The new dust collectors operate at a very low noise level compared to the previous equipment.

The Farr Gold Series dust collector is popular for a range of thermal spray applications because of several design features that contribute to greater reliability and reduced maintenance. A high entry cross flow inlet eliminates upward can velocities that can hold fine powder up in the filters, reducing re-entrainment of the fine particles. Vertically arranged filters shed all the metal particulate, unlike horizontally mounted filters which allow the metal to build on top of the filter. The high efficiency filters capture 99.99% of particulates at 0.5µ or larger. Special treated filter media and an open-pleat media design contribute to lower pressure drop operation and long filter service life.

**For more information**, contact Camfil APC at (800) 479-6801 or (870) 933-8048; email filterman@camfil.com, web www.camfilapc.com.

## 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 which includes five individual AWS memberships.***

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.

As an ITSA member, your company has excellent marketing exposure by being listed centerfold in our SPRAYTIME newsletter and many other benefits.

*Visit www.thermalspray.org.*

***Thermal Spray Jobs listed at "For Hire" www.thermalspray.org***

## NEW "Supporting Societies" Membership

The International Thermal Spray Association now has a "Supporting Societies" membership category to establish communication with other associations/societies involved in thermal spray and surface engineering activities worldwide.

***See the Supporting Societies listing on page 17.***

This is ideal for membership exchange between organizations. Contact Kathy Dusa at the headquarters office email to itsa@thermalspray.org

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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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**Visit us at www.thermalspray.org**

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.

**Chairman Falzon**

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 www.thermal-spray.org

## ITSA Mission Statement

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### Officers

Chairman: ***Jason Falzon***, FW Gartner Thermal Spraying
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***David Wright***, Accuwright Industries, Inc.

## 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 industrial leaders, engineers, researchers, scholars, policy-makers, and the public thermal spray

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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.

One valuable member asset is our annual membership meetings where the networking is priceless! Our 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 (International Thermal Spray Conference ITSC, Fabtech Thermal Spray Pavilion and Conference, FAbtech Canada, Power-Gen, Society of Vacuum Coaters (SVC), TurboMachinery, NACE and TurboExpo).

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

## Masan Group and H.C. Starck to Establish Tungsten Chemical Joint Venture

H.C. Starck, a leading worldwide manufacturer of technology metals and one of the biggest companies in the global tungsten industry, and Nui Phao Mining Company (Nui Phao), a subsidiary of one of Vietnams largest private sector business groups, Masan Group Corporation (HOSE: MSN, Masan Group), have announced the signing of definitive agreements to establish a joint venture for the production of value-added tungsten chemicals in Vietnam.

Nui Phao and H.C. Starck will own 51% and 49% respectively of the joint venture, which will process all of Nui Phaos tungsten concentrate into higher value-add tungsten chemicals, including ammonium paratungstate (APT) and blue tungsten oxide (BTO). The joint venture company will have an installed capacity of 6,500 tons tungsten trioxide per annum. H.C. Starck will manage the joint venture and has committed to buy a significant share of the production for its own internal use. The company will also support marketing of the remaining product through the joint venture.

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

Andreas Meier, President and CEO of H.C. Starck said, Masan has developed a world-class mining operation and the Nui Phao mine will be a stable source of material for the joint venture. For H.C. Starck this joint venture strengthens our leading position as a global tungsten producer and increases our manufacturing footprint in Asia. Based on the secured supply of tungsten concentrate and our recycling capabilities, we can provide our customers long-term supply security independent from regulatory restrictions and we expect less price volatility for the mineral.

H.C. Starck has significant experience in the tungsten processing business, which is a niche and technologically intensive industry, and will therefore be responsible for the industrial management of the joint venture.

Dominic Heaton, CEO of Masan Resources, a subsidiary of Masan Group and the parent company of Nui Phao, commented, H.C Starck has world-class expertise in the processing of tungsten chemicals and oxides. With H.C. Starcks specialized know-how and technology, Masan Group is able to contribute to Vietnams objective of becoming more of a manufacturer of value-added products.

Madhur Maini, CEO of Masan Group, said: H.C Starck is the technology leader in the production of several high-technology metals. The partnership with H.C. Starck, one of the worlds largest tungsten players, will help Masan capture more of the tungsten value chain and is a

**Continued on page 28.**

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## American Roller Celebrates 75 Years in Business

American Roller Company proudly announces its 75th Anniversary, the launch of a new website, and a new location. Founded in Chicago, IL in 1938, American Roller has built an industry-wide reputation for quality, responsive service, innovation, dependability and superior value, and has consistently earned the confidence of original equipment manufacturers and end-users in a wide variety of markets.


Over the years, as manufacturing has evolved, struggled, and dissipated, American Roller has managed to not only stay relevant, but to expand. During 2012, American Roller Company opened a new location in Houston, TX. The Houston facility aids in the capacity to produce, manufacture, and most importantly exceed customers' needs, requirements, and expectations. It provides the opportunity to utilize technological advances, in turn, allowing them the capabilities to produce products with extremely tight tolerances. Additionally, 2013 plans include the opening another new facility in Shanghai, China.

In conjunction with the anniversary, American Roller would also like to announce the launch of a brand new website at www.americanroller.com. This new site allows ease of navigation while gaining knowledge on all that American Roller has to offer. While browsing through products and services, learn how the company can help increase productivity. Find plant locations, fill out a request for quote, and read about current news within the company.

American Roller Company (www.americanroller.com), with its Plasma Coatings Division (www.plasmacoatings.com), has manufacturing facilities throughout the United States and international licensees around the world. American Roller currently manufactures a full range of synthetic rubber, polyurethane, ceramic and metal matrix coatings, hard coats, nylon, heated rollers, steel and composite cores and shafts, bowed rollers, and chilled rollers for the converting, metals processing, business machine, graphic arts, pulp and paper and non-woven markets. Founded in 1938, American Roller is committed to providing its valued customers ever-improving roller performance.

***For more information***, visit www.americanroller.com and www.plasmacoatings.com



## Watson Coatings Laboratory Announces A2LA Accreditation

The Watson Coatings Laboratory, a division of Watson Grinding and Manufacturing announces its A2LA Accreditation ISO 17025:2005.

A2LA Accreditation ISO 17025:2005 is used by testing and calibration laboratories that produce testing and calibration results. The standard is specific in requirements for competence. Accreditation is a formal recognition of a demonstration of that competence. A prerequisite for a laboratory to become accredited is to have a documented quality management system. Laboratories use A2LA Accreditation ISO 17025:2005 to implement a quality system aimed at improving their ability to consistently produce valid results.

In recognition of the successful completion of the A2LA evaluation process, accreditation is granted to this laboratory to perform the following tests on metal powders and thermal spray coatings:

- Metal Powders - apparent density, flow rate, sieve analysis
- Hardness - Knoop & Vickers, Rockwell (B and C)
- Thermal Spray Coatings - adhesion, area percentage porosity, metallographic preparation, bondline contamination, coating thickness.

All QSLP test methods are in-house procedures.

Watson Grinding and Manufacturing is a full-scale machine shop, offering specialty carbide and ceramic thermal spray coatings via HVOF and Plasma application. Manufacturing and servicing a wide variety of parts, including shafts, valves, rotating and pump components, the company specializes in turning, milling, coating and grinding exotic alloys, hard metals and large parts.

Strategic investments and technical innovations have consistently enhanced Watson Grinding's capabilities. The addition of a robotic thermal spray facility and an on-site metallurgical laboratory in recent years have made Watson Grinding a leader in the precise application of thermal spray coatings, dramatically extending the service life of parts in highly corrosive or wear intensive environments. Machined parts are used in a variety of severe service processes and in various applications. The Watson Coatings Laboratory is a division of Watson Grinding and Manufacturing in Houston, TX.

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

## Cold Spray Enables Welding of Crack-Sensitive Alloys Case Study

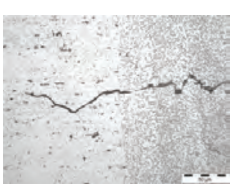
Authors: V. Juechter, T. Mitchell, T. Marrocco, and M. Nunn

Susceptibility to cracking is well known issue when power beam welding 6xxx series aluminium alloys. To prevent cracking the weld metal composition is often modified by addition of 4xxx series filler in wires or foil form. When welding complex assemblies conventional fillers may be difficult to introduce due to limited access. The cold spray technique offers the opportunity to coat all kinds of irregular shapes with a buttering layer prior to welding. TWI has successfully investigated this new way of adding filler material to overcome weld cracking issues.

### Principles and Processes

The cold spray process is used for coating applications where lower thermal spray temperatures are beneficial. The main advantages over conventional thermal spraying include: the powder remains in the solid phase, lower substrate surface temperatures, less oxidation of the powder and the substrate material, no metallurgical transformations and reduced residual stress formation. The powder is accelerated and impact on the surface where deformation, local heating and a bond occur. By repeating this process a near dense layer of increasing thickness is built.

Introduction of a cold sprayed layer may be the solution for many welding challenges. In the case of electron beam (EB) welds only thin layers of filler material are needed to modify the composition of the weld pool as the weld is narrow. Electron beam welding locally melts the material at the interface of two parts, forming a high integrity, normally autogenous, joint after solidification. EB welding takes place in a clean vacuum environment, can work from long stand-off distances and with a wide range of materials and thicknesses. The process produces a relatively narrow single pass weld and is often chosen where thermal damage excess distortion must be avoided. The process is ideal for many aluminium alloy applications such as complicated heat exchanger assemblies.



**Crack in EB welded aluminim alloy 6061 Crack-free EB weld in 6082 alloy made using cold sprayed buttering layer. (weld metal, right; parent material, left)**

**Crack-free EB weld in 6082 alloy made using cold sprayed buttering layer.**

**Crack-free EB weld in alloy 6061 alloy made using foil filler material.**

### Proof of Feasibility

Aluminium alloys 6061 and 6082 are representatives of materials which are crack sensitive when EB welded without the addition of appropriate filler material. The use of aluminium alloy 4047, introduced into the weld as wire or foil, can eliminate liquation cracking in these alloys due to the high silicon content. Where assemblies are complicated it may not be viable to introduce 4047 filler as a foil or wire. Deposition of a buttering layer by cold spray has been successfully demonstrated by TWI. Welded circular patch test coupons were used to test for crack susceptibility. The welds were evaluated by radiography and metallography to show that the approach was practical to apply, to ascertain the overall quality achieved and to check for cracking.

### Results

The cold spray process easily deposits layers of sufficient thickness to act as a buttering layer; the bond strength is adequate to allow subsequent pre-weld machining if required to ensure a good fit between parts. Welds made without filler material exhibited cracks, and the 6061 alloy appeared to be more crack sensitive than the 6082 alloy when EB welded. By adding filler material, using the cold spray process, the crack sensitivity decreased. The hardness profile of the welds was very promising, as nearly no hardness reduction was evident. Comparison of welds made with more conventional foil fillers showed similar results.

### Conclusion

The feasibility of using a cold sprayed buttering layer to locally alloy weld metal and enable EB welding of crack sensitive aluminium alloys has been shown. Besides very promising hardness results, the cold spray process also opens opportunities for viable application onto complex geometries and is suitably robustness to allow handling and machining, where required, before welding. The process may be adopted for other materials and welding processes (such as laser welding) to prevent cracking, or to change mechanical or metallographic properties of the weld zone. This new technique of adding alloying filler material into welds shows significant promise.

***For further information***, visit website http://www.twi.co.uk/technologies/welding-coating-and-material-processing/surface-and-coating/cold-spraying/ or contact TWI Head Office, Phone: +44 (0)1223 899000 Fax: +44 (0)1223 892588 or email Catherine Condie MCIPR AWeldI, Senior Project Leader, Marketing/PR Manager catherine.condie@twi.co.uk

### Scholarship Opportunities

Since 1991, the ***International Thermal Spray Association Scholarship Program*** has contributed to the growth of the thermal spray community. ITSA offers up to three Graduate Scholarships of **$2,000.00 each**.

***Applications accepted April 15 through July 15 ONLY.***

Visit www.thermalspray.org scholarship area for details.

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

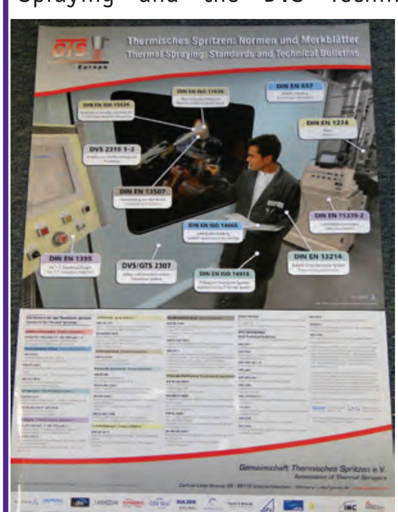

## Free Poster

From Linde and the GTS (Association of Thermal Sprayers) illustrates the different thermal spray processes (suitable for framing). Send request for poster via email to itsa@thermalspray.org

## Free DIN Standards Poster

GTS – the Association of Thermal Sprayers – has produced this spectacular new poster of "***Thermal Spraying: Standards and Technical Bulletins***".

The poster identifies DIN Standards for Thermal Spraying and the DVS Technical Bulletins. The standards/bulletin names are in German and in English.




The poster provides contact information for obtaining the complete version Standards and Bulletins.

The International Thermal Spray Association is proud to be one of the sponsors of this project.

## *Journal of Thermal Spray Technology®*

A publication of the ***ASM Thermal Spray Society***

### *Determination of Thermal Spray Coating Property with Curvature Measurements*

***Gopal Dwivedi, Toshio Nakamura, and Sanjay Sampath***

Real-time curvature measurement of a coating-substrate system during deposition has facilitated the monitoring of coating stresses and provided additional insights into thermal spray deposition mechanisms. However, the non-equilibrium state of coating formation along with harsh spray booth environment introduces complexity not only in data interpretation but also in the coating properties estimation. In this paper, a new procedure is proposed to estimate the elastic modulus of thermal sprayed ceramic coatings using in situ curvature and temperature measurements. In order to correlate the measurable parameters to coating elastic modulus, a systematic study is conducted to develop a suitable methodology. First, various finite element model analyses are carried out to formulate suitable relations between the measurements and elastic modulus. Subsequently, experiments are conducted to validate the procedure to estimate coating moduli. The results are compared with more accurate measurements obtained from post-deposition characterization technique under low temperature thermal cycles. The comparison suggest that the moduli estimated using the proposed procedure are in good agreements with those obtained from the post-deposition technique. Further, the nonlinear response of coatings are evaluated from the estimated moduli during deposition and cool down, which offer additional information on the characteristics of thermal spray coatings.

**Read the entire article in the December 2013 Issue**

Visit www.asminternational./tss



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## Become a Member of the International Thermal Spray Association

Your company should join the International Thermal Spray Association (ITSA) now! ITSA is now a Standing Committee of the American Welding Society expanding the benefits of company benefits. 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 your company to join us in this endeavor. See pages 16-18.***

# CALENDAR OF EVENTS

# 2014

## MARCH 2014

**9-13 San Antonio, TX USA** *Corrosion 2014* - visit www.nace.org

**12-13 Houston, TX USA** ***6th Annual LAM Laser Additive Manufacturing Workshop and Conference***- visit www.lia.org/conferences/lam/conference

**17-19 Cape Town, South Africa** *Power-Gen Africa* - visit www.powergenafrica.com

**18-20 Toronto, Canada** *Fabtech Canada* - visit www.fabtechcanada.com

## APRIL 2014

**10-12 New Delhi, India** *FABTECH India and Weld India -* visit http://www.fabtechexpo.com/fabtech-india

**23-26 Tokyo, Japan** *Japan Int'l Welding Show* - visit www.weldingshow.jp/english

**24-26 Savannah, GA USA** Int'l Thermal Spray Association Annual Membership Meeting - contact Kathy Dusa itsa@thermalspray.org

## MAY 2014

**5-7 New Delhi, India** *Power-Gen India and Central Asia with Renewable Energy World India, HydroVision India and DistribuTECH India* **-** visit www.power-genindia.com.

**5-8 Chicago, IL USA** *57th SVC Annual Technical Conference* - visit www.svc.org

**5-8 Indianapolis, IN USA** *2014 Iron and Steel Technology Expo* - visit www.aistech.*org*

**6-8 Hartford, CT USA** ***MFG4 Manufacturing 4 The Future Aerospace, Defense, Medical, Micro*** - visit mfg4event.com

**6-8 Mexico City, Mexico** *FABTECH Mexico* - visit www.fabtechmexico.com

**18-21 Orlando, FL USA** *2014 World Congress on Powder Metallurgy and Particulate Materials* - visit www.mpif.org

**21-23 Barcelona, Spain** *Int'l Thermal Spray Conference ITSC 2014* - visit www.itsc2014.com

## JUNE 2014

**16-19 Orlando, FL USA** *AeroMat* - visit www.asminternational.org

**16-20 Dusseldorf, Germany** ASME *TurboExpo* - visit www.turboexpo.org

**17-19 Houston, TX USA** *NACE Bring On the Heat 2014* - visit www.nace.org

**17-19 Bremen, Germany** *WindForce 2014* visit www.zinc.org

**25-27 San Diego, CA USA** *Mega Rust 2014 Naval Corrosion Conference* - visit navalengineers.org/MegaRust2014

## SEPTEMBER 2014

**15-19 Garmisch-Partenkirchen, Germany** *14th Int'l Conference and Exhibition on Plasma Surface Engineering* - visit www.pse-conferences.net/pse2014.html

**18-22 Orlando, FL USA** *PM2014 World Congress* - visit www.mpif.org

**22-25 Houston, TX USA** *43rd TurboMachinery and 30th Pump Symposia* - visit turbolab.tamu.edu.

## OCTOBER 2014

**8-9 Hartford, CT USA** *Aerospace Coatings Conference and Exposition* - visit aerospacecoatings@asminternational.org

**28-31 Medellín, Colombia** *LATINCORR 2014 IX Latin American Congress of Corrosion* – visit www.latincorr2014.org

## NOVEMBER 2014

**11-13 Atlanta, GA USA** *FABTECH* ***with a Thermal Spray Pavilion and Conference*** - visit www.fabtechexpo.com

# 2015

## FEBRUARY 2015

**TBD Doha, Qatar** *Middle East TurboMachinery Symposium METS 2015* **-** visit middleeastturbo.tamu.edu

## APRIL 2015

**25-30 Santa Clara, CA USA** *58th SVC Annual Technical Conference* - visit www.svc.org

**26-29 Helsingør, Denmark** *JOM-18 18th Int'l Conference on Joining Materials* - contact jom_aws@post10.tele.dk

### Scholarship Opportunities

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# MAYO 6 AL 8, 2014

*May 6th-8th, 2014*

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- 15,000 METROS CUADRADOS
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H.C. Starck continued from page 19.
testament to the quality of Nui Phaos tungsten deposit and processing plant.

H.C. Starck is a leading global manufacturer for technology metals. Besides being one of the largest global tungsten companies in the world, it also holds top market positions with its tantalum, molybdenum, niobium, and rhenium products. All of these metals require advanced technology and know-how to process.

Nui Phao, the tungsten concentrate supplier of the joint venture, has developed one of the largest known tungsten deposits outside of China with an expected mine life of more than 15 years. The construction of the tungsten chemical plant that will be part of the joint venture is in progress. The first stage of the tungsten chemical plant started in August, with further stages expected to be completed in 2014.

Tungsten is one of the hardest metals and has the highest melting point. As a strategic resource, it is used in a variety of applications requiring high strength. APT and BTO are intermediary chemicals used for the production of high speed cutting and drilling tools which are in high demand from growing industries such as mining and mechanical engineering, medical technology, and the automotive and energy industries. APT is also used for catalyst production in the chemical industry. The European Union identified tungsten as one of the critical raw materials that have high strategic value and yet for which there are only limited natural resources.

The establishment of the joint venture and closing of the definitive agreements are subject to customary corporate and regulatory approvals.

**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 14 manufacturing facilities located in Europe, America, and Asia. In 2012, the company employed approximately 3,000 employees in the United States, Canada, Great Britain, Germany, China, Japan, and Thailand.

***For more information***, visit www.hcstarck.com/press.

**About Mason Group Corporation**

Masan Group is one of Vietnams largest private sector companies with a market capitalization of over US$3 billion, focusing on consumption and resources sectors. Masan is committed to executing shareholder value, through building market-leading businesses with a professional management team and global partners.

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

**About Masan Resources Corporation**

A subsidiary of Masan Group, Masan Resources Corporation (Masan Resources) is the owner of Nui Phao Mining Company Limited, the developer of the Nui Phao project in Thai Nguyen province, located to the north of Hanoi. Nui Phao owns one of the largest tungsten mines in the world. In steady-state operations, the mine will also be one of the largest single point producers of bismuth and acid-grade fluorspar in the world. Mining will be by open-pit methods with overall production unit costs projected to be in the lowest cost quartile relative to the world's current tungsten producers. The mine started production in March 2013. The Nui Phao mine is expected to accelerate Masan Resources' vision to become Vietnam's largest private sector resource company.



## Offshore Wind Energy: Life Cycle Cost Reduction Through Thermal Sprayed Zinc Coatings

Offshore wind energy structures are exposed to the most severe climate conditions experienced by engineered structures. Additionally access is often difficult, making maintenance efforts a sizeable challenge. The cost for correcting failure in offshore protection systems is 75 to 100 times higher per m² than onshore, having the potential of placing the long-term economic viability of the entire project at risk. Therefore a highly protective coating system is required that provides a 25 year service life with minimal maintenance.

The magnitude of costs for maintenance of offshore corrosion protection is often not sufficiently known to decision makers in the wind energy industry. What is planned on paper often looks completely different offshore, in the rough open sea. The lack of experience is not surprising because the industry is young and the extensive experience with oil and gas can often not be translated directly. Consequently, the existing standards and norms for

Continued on page 31.

Offshore Wind Energy continued from page 28.
offshore corrosion protection are not tailor-made for this industry and do not satisfactorily meet the specific requirements allowing for a 25 year service life without extensive maintenance. If this 25 year lifetime cannot be achieved, the cost of corrosion maintenance alone will add $0.0137 USD (1 Euro cent) per KWh, for every KWh of electricity produced over the entire life of the offshore wind energy structure.

To highlight the significant cost savings of using corrosion protection systems of sprayed zinc alloys the International Zinc Association (IZA) has developed a life cycle cost comparator for the wind industry and will organize a seminar on corrosion protection for offshore wind structures:

### CorrWind: a life cycle cost comparator for the wind energy industry

The Excel-based cost model CorrWind, designed by IZA, calculates the life cycle costs for different existing corrosion protection systems such as thermally sprayed Zn15Al including organic coatings (as duplex systems), thermally sprayed Zn coatings and pure organic coatings.

Users can determine the sensitivity of life cycle cost results to input factors like labour and materials costs, rates of inflation over the expected service life of the structure, financial discount rate and the relationship of initial and maintenance costs to the cost per KWh of the wind energy unit, including the capacity factor of typical wind power units. The results of the comparison show that the use of thermal spraying in combination with properly selected and applied zinc-based paint systems provides the lowest-cost combination of first cost and periodic maintenance costs during the expected 25 year service life.

CorrWind provides the wind industry with an advisory tool for reducing costs; supports an increase in transparency of analysis; and provides data for developing corrosion protection standards, tailor-made for the wind energy industry.

CorrWind will be accessible on the IZA website www.zinc.org as of November 2013 and will be highlighted as part of a poster presentation during EWEA Offshore in Frankfurt, Germany, on 20th of November 2013 from 5:30 through 7:00 p.m.

### Windforce 2014, 17-19 June 2014, Bremen, Germany

As part of the conference program IZA will organize a morning session on corrosion protection comprising seven

30-minute presentations on topics including:

- Corrosion protection for offshore wind energy installations: expectations versus reality
- Different corrosion protection systems and their life-cycle cost analysis
- Thermal zinc spraying: information about the process and experience from operators (lessons learned)
- Combination thermal spray-paint systems to achieve 25 year lives with routine maintenance
- Standardizations of norms and specifications for corrosion protection systems as basis for warranty and modularization including cost saving potential.

**IZA invites interested parties to participate in the seminar organization.**

***For further information,*** please contact Dr. Frank Goodwin, Director Technology and Market Development, International Zinc Association phone: +1 919 287 18 78, email fgoodwin@zinc.org,

This article is a follow up on earlier in SPRAYTIME published articles related to the “Thermal Spray Program for Marine Structures”.

### About IZA

The International Zinc Association (IZA) is a non-profit organization founded in 1991. IZA is dedicated exclusively to the interests of zinc and its users and helps sustain the long-term global demand for zinc and its markets by promoting key end uses as corrosion protection for steel, die casting, brass, oxide and sheet; and the essentiality of zinc in human health and crop nutrition. IZA’s main programs are Sustainability and Environment, Technology and Market Development and Communications.

***For further information***, visit http://www.zinc.org

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