

■ THIRD QUARTER 2015 / VOLUME 22

# **SPRAYTIME**

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



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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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Article submissions (subject to acceptance and edit), advertising insertions, address correspondence, subscription request, back issue copies, and changes of address should be sent to:

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## I SAINT-GOBAIN: 350 YEARS, 350 REASONS TO BELIEVE IN THE FUTURE

**Saint-Gobain** is celebrated its 350th anniversary in 2015. An exceptional anniversary that the Group marked by promoting its history, but with its sights set firmly on the future, 2015 was packed full of events. The celebrations began on the 9th of January in Shanghai (China) and will end in October in Paris (France).

### SAINT-GOBAIN, A GROUP WITH ITS SIGHTS ON THE FUTURE

Since its creation in 1665 by King Louis XIV and Jean-Baptiste Colbert, the oldest company in the Paris Bourse's CAC 40 index, has adapted to the changes in the world and taken up the many challenges it has faced. Backed by this experience and its corporate culture, **Saint-Gobain** has its sights resolutely set on tomorrow, and knows that there are many "reasons to believe" that are based on the six central pillars in its strategy and the Group's values.

**The world has no boundaries:** Since it opened its first establishment outside France, in Germany in the 1850s, **Saint-Gobain** has grown into an international group that is present today in 64 countries.

**Sustainable habitat is within our reach:** **Saint-Gobain** provides sustainable products and solutions to direct the course of habitat in order to reduce its impact on the environment, improve its energy efficiency and occupants' comfort.

**Innovation is transforming the world:** **Saint-Gobain** is one of the world's 100 most innovative companies. Innovation is embedded in its history and its identity. Its products improve habitat and everyday life.

**Talent is infinite:** **Saint-Gobain's** strength is its employees. United behind a foundation of shared values, each day, they take up multiple challenges serving the Group's millions of customers.

**Habitat for everyone is achievable:** **Saint-Gobain** is committed to habitat for everyone by inventing materials adapted to local markets, and through its **Saint-Gobain** Initiatives Foundation.

**Saint-Gobain builds on the past and plans for the future:** For 350 years, the Group has been reinventing itself to adapt to and support the world's changes.

"This anniversary is an opportunity and an occasion to remind everyone of the strength that is acquired through 350 years of history and 350 years of ongoing innovations. Our experience means we understand and focus on the long term. It also gives us the composure and agility to adapt to the ever-changing world. Our history is proof that we are a company that has consistently pushed back boundaries and taken up technological challenges. As we look back over our past and examine today's world and what we do, we are convinced that there are many reasons to believe in the future. So, it is with our sights set on the future and innovation that we are celebrating this anniversary. It is our optimism that we want to share with you in 2015," says Pierre-André de Chalendar, Chairman and CEO of **Saint-Gobain**.

### HIGHLIGHTS OF THE YEAR'S CELEBRATIONS

- Futuristic traveling pavilions open to the public showcased the Group's capacity for innovation and its exceptional expertise in construction materials. They will tour the world and provide a sensory and artistic experience for visitors:
  - In Shanghai (China) in January
  - In São Paulo (Brazil) in April
  - In Philadelphia (United States) in June
  - In Paris (France) in October.
- A virtual exhibition in five languages (French, English, German, Spanish and Brazilian Portuguese) was published online in February. With more than 700 archival documents, **Saint-Gobain** gives everyone the opportunity to explore, or rediscover its history via previously unseen documents and personal accounts. The exhibition will allow visitors to enter a gallery of habitat innovations, to discover six in-depth thematic sections (Transformation of Material; From Advertising to Marketing; **Saint-Gobain** throughout the World; Major Achievements; The Word of Work; Corporate Governance and Culture), and to experience, thanks to a spectacular 3D reconstruction of the Manufacture des Glaces, mirror glassworks as they would have been on the eve of the French Revolution. Visitors will also be able to

contribute to the exhibition by uploading onto the site their own documents and personal experiences.

- An anniversary book, connected to the virtual exhibition with QR codes and translated into five languages (French, English, German, Spanish and Brazilian Portuguese), will be published by Editions Albin Michel in the spring. This book looks at the Group's past and present and will provide an opportunity to learn more about **Saint-Gobain** in a different way.
- The World 350 game was available in the spring as a free download for smartphones and tablets. World 350 enabled players to test their digital skills and to challenge their friends and family to enter an offbeat world where they will come across subtle allusions to **Saint-Gobain**. Their task is to build houses on planet World 350.
- Lastly, an anniversary day that will be celebrated by all Group employees worldwide, on October 15. This anniversary day will exemplify the ties between all **Saint-Gobain** employees.

### 350 YEARS OF HISTORY

**Saint-Gobain's** history is marked by an ongoing movement towards diversification and refocusing. Despite that, the Group has the distinction of having retained its original business – the manufacture of flat glass – even if it now only accounts for 11 percent of its revenue. Other distinctive features include the tradition of innovation and early internationalization.

#### 17<sup>th</sup> CENTURY

Louis XIV, under the impetus of his Minister Colbert, created the mirror glassworks (La Manufacture Royale des Glaces) designed to defy Venice's supremacy for the manufacture of mirrors.

#### 18<sup>th</sup> CENTURY

Mirrors became fashionable and increasingly affordable. Benefiting from royal and personal orders, the Manufacture, which employed more than 1,000 workers, modernized and enjoyed growing prosperity throughout the century.

#### 19<sup>th</sup> CENTURY

Confronted with strong international competition, **Saint-Gobain** diversified into chemicals. By the end of the century, its business was split evenly between chemicals and glassmaking. The Manufacture then benefited from the rapid



rise in a new form of architecture based on iron and steel, mainly for large public buildings: markets, stations, arcades, etc.

## 20<sup>th</sup> CENTURY

By now, **Saint-Gobain** had turned its attention to all types of glass products (bottles, optical glass, glass fiber, etc.). The automobile revolution and modern architecture with its vast expanses of glazed surfaces provided the company with new outlets. In 1970, **Saint-Gobain** merged with cast iron pipe manufacturer Pont-à-Mousson. This led to a new style of management, nationalization (1982) followed by privatization (1986), increased efforts in research, the arrival of new countries, and a time for divestitures and

acquisitions. Major acquisitions included Norton in 1990, which positioned **Saint-Gobain** in high-technology-content materials (abrasives, ceramics and plastics). The acquisition of Poliet (Point.P, Lapeyre and Weber) in 1996 allowed the company to enter the world of building distribution materials (45 percent of its net sales in 2013).

## 21<sup>st</sup> CENTURY

**Saint-Gobain** has focused its strategy on sustainable habitat while continuing to serve its many industrial markets. Leveraging its many sites around the world, the Group is continuing to grow in emerging countries, and it is making significant acquisitions to extend its building materials distribution

network in Europe and to complete its product portfolio (the acquisition of British Plaster Board in 2005 - gypsum and plasterboard - and Maxit in 2007 - industrial mortars). ▲

For more information about **Saint-Gobain**, visit [www.saint-gobain.com](http://www.saint-gobain.com)

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## I OERLIKON METCO'S ELDIM FACILITY CELEBRATES 45 YEARS OF OEM PARTNERSHIP FOR SUPPLY OF CRITICAL GAS TURBINE COMPONENTS

**Oerlikon Metco's** Eldim facility in Lomm, Netherlands, marks its 45th anniversary with strong OEM and sup-plier relationships and a proactive approach to the creation of customer value.

Forty five years ago, the Eldim facility was founded in the Netherlands by visionaries who set out to provide electrical discharge machining (EDM) services. From its inception, the facility focused on using superior manufacturing processes, solving the hardest problems, and delivering products that gave their customers' a competitive ad-vantage

Today, the company's innovative solutions positively impact the world's premier aero and IGT OEMs, delivering a unique scope of in-house manufacturing capabilities and managing the total value chain. With new competences such as automated production cells, self-steering teams, highly qualified employees and a passion for process optimization, Eldim remains a trusted partner for development and production of aircraft and industrial gas turbine components. Its sheet metal and machined components such as honeycomb seals, inserts, and compressor vane assemblies improve aircraft engine efficiency and performance.

"Our long-term customer relationships are a testimony to the value we add as an industry leader," states Head of Sales and Marketing Richard Van Den Dungen. "In 1970, the Eldim facility opened with the mindset that it would be successful and attract the most talented people in the industry by building superior EDM technology, nurturing an environment of partnership and innovation, and customer commitment to a high standard of quality. We have demonstrated this over 45 years and we look forward to continuing that culture of innovation and our unyielding pursuit of excellence."

Since the foundation of the initial facility in the Netherlands, **Oerlikon Metco's** Eldim business line has expanded to include honeycomb design, manufacture and logistics in Stockport, UK as well as an additional component produc-tion facility in Debrecen, Hungary.

**Oerlikon Metco** employees in the Netherlands, celebrate the company's milestone with gratitude for their great clients, partners, colleagues and families. ▲

For further information, please visit [www.oerlikon.com/metco](http://www.oerlikon.com/metco).



## I FORGOTTEN THERMAL SPRAY AUTOMOTIVE APPLICATIONS

THIS HISTORICAL ACCOUNT DETAILS HOW THERMAL SPRAY COATINGS WERE USED BY TWO MAJOR AUTOMAKERS IN THE EARLY 1950S BY JAMES K. WEBER

As part of this “lost in time” thermal spray coatings article, an array of automotive applications is explored. Perhaps these provided solutions to problems that no longer exist today or for products that are no longer needed; nevertheless, they are interesting and readers may even find that these thermal spray remedies fit difficulties encountered today.



Fig. 1 — In the foreground are front sections of two crankshafts that have been coated. Between and behind them is a crankshaft yet to be repaired with scoring visible on the surface that will be restored by thermal spray.

### DEFINING THERMAL SPRAY CHARACTERISTICS

What is thermal spray? Briefly stated, thermal spray is a process where a heat source heats a material, such as a wire or powder, and then propels this material by a high-velocity gas toward the surface that will be coated.

Thermal spray is not spray welding, as it is sometimes called, because the coating particles are not welded to the surface. The major factor affecting the coating's adhesion is a strong mechanical bond. This does not make the coating inferior to welding, just different than welding.

Thermal spray coatings may have some of the following attributes compared to welding:

- Usually thinner, with the 0.003- to 0.025-in. range being most common.
- Depending on the materials and

process, they may have porosities ranging from <0.1% to >10%.

- Oxides may be present.
- May have very low heat input into the base material.
- May be applied very quickly.

Let's see how some of these attributes helped out Ford and Chevrolet during the early 1950s.

### EXPLORING VARIOUS PROCESSES TO USE ON AUTOMOTIVE PARTS

In 1951, at the Ford Motor Co.'s River Rouge plant in Dearborn, Mich., the Ford flathead V8 engine was being built at a rate of around 2200/day.

At that time, the machine tools used for manufacturing the cast steel crankshafts were still quite primitive. Also, the automaker found it was generating mismachined crankshafts at a rate averaging 24–36 per shift.

The major tolerance problems were undersized outside diameters on the flange where the flywheel mounts, on the front of the crankshaft where the camshaft drive gear mounts, and on the front of the crankshaft where the accessory drive pulley mounts.

With the retail cost of each crankshaft at \$47.65 (equivalent now to \$435.82), the cost to scrap was quite high.

### WHY WELDING DIDN'T WORK AT THE TIME

Welding buildup with subsequent machining was tried as a method to reclaim these parts. However, the problems listed were encountered.

- The high heat input and stress in the cooled weld metal often warped the crankshaft, which then necessitated a further straightening step in a hydraulic press.
- Most mismachining errors called for only 0.025 in. or less to be built up, and

it was not possible to add weld cladding much less than 0.250 in. Grinding off all this extra metal took time and wasted materials.

- Porosity was sometimes found between weld beads after grinding, requiring additional welding and rework.

Unfortunately, welding was not the ideal solution. It took more than an hour to complete, involved many steps by several people and machines, and sometimes the repair cost would add up to more than the crankshaft value if any additional rework (discovered weld porosity and hydraulic straightening) was caused by welding.

### THERMAL SPRAY BENEFITS

Maintenance personnel at the River Rouge plant had been using the thermal spray process to repair machinery there since the early 1930s, especially on shafts.

At some point, it was thought to use these methods for repairing the mismachined crankshafts, which led to astonishing results — Fig. 1. Each repair took one man 5–10 min to complete with the crankshaft rotating 30 rev/min in a dedicated spray lathe. Due to the low heat input and low coating stress buildup of the thermal spray process, there was never any warping of the crankshaft, and therefore no hydraulic straightening was ever needed. Very thin coatings could be applied when the mismachining was only slight and thicker coatings could also be done when needed. The ability to tailor coating thickness to the job at hand reduced



Fig. 2 — A Ford employee mechanically cleans the area to be coated by holding a coarse emery cloth against the rotating crankshaft that was previously solvent wiped.



post grinding by a factor of 10.

Ford used the flame spray wire process for this repair with the consumable wire being molybdenum. Known as SpraBond™ in the thermal spray industry, molybdenum thermal spray wire coatings are distinguished as self bonding due to molybdenum's high melting point of 4753°F.

The spray particles do not leave the consumable wire until they reach near this temperature, and these very hot particles to some extent spot weld to the steel surface, forming an extremely strong bond to the crankshaft without the abrasive blasting surface normally needed for other thermal spray materials.

The process used was very simple and time tested.

- To remove grease and oil, the repairer solvent wiped the 30 rev/min rotating surface to be repaired.
- He then used an emery cloth to roughen and mechanically clean the surface — Fig. 2.
- Next, he preheated the surface with the flame of the thermal spray gun for about 30's.
- Finally, he turned on the wire feed and applied the white hot particles of firmly bonded molybdenum for 1 to 5 min, depending on how much thickness he needed to build up.

Another added benefit was that the coating surface was harder and more gall resistant than the cast steel beneath it, but somewhat self-lubricating and easy to grind. A repaired and coated crankshaft may, in some ways, have been a better product than a nonrepaired part.

## HARD-CHROME PLATING DIFFICULTIES

At this same period, General Motors' Chevrolet and Pontiac divisions were also using thermal spray molybdenum to repair mismachined parts.

However, prior to thermal spray, Chevrolet was not using weld cladding to repair these parts. Instead, the automaker was using hard-chrome plating to refurbish the same mismachined crankshaft areas as at Ford and also camshaft journals that were undersized.

Hard-chrome plating is an excellent structural repair material for these surfaces. However, its application caused Chevrolet many problems that prompted the automaker to look into a thermal spray system and then put it into operation.

Following are some of the challenges encountered with the hardchrome plating



Fig. 3 — A Chevrolet employee mechanically cleans the area to be coated by holding a coarse emery cloth against the rotating camshaft.

process:

- Hard-chrome plating builds up thickness very slowly, about 0.012 in./day. Quite often, 0.040-in. buildups were needed so that a repaired part could be ground concentric with no shallow areas. Parts often spent more than 80 h in the plating tank.
- For parts that needed less than 0.040 in., frequent removal and checking of plating thickness was required.
- Parts being selectively plated had to have a masking compound applied to all areas that would not be receiving plating. A crankshaft is a complex item to mask.

- Hard-chrome plating is very hard, in the 65–69 HRC range, and required a more expensive grinding method than the original part or molybdenum coating that took its place.
- The sheer volume of mass production and the amount of rework needed caused an expensive bottleneck in the company's plating department. Each day, it was reported that an average of 120 crankshafts and 100 camshafts were pulled off the line by quality inspectors and sent off to be repaired by plating.

## RECLAIMING CAMSHAFTS AND CRANKSHAFTS QUICKER

Chevrolet reported that with the flame spray molybdenum process, it was able to reclaim camshafts and have them ready for regrinding at a rate as fast as 30/h, a vast improvement in productivity over hardchrome plating — Figs. 3, 4. Similar improvements were seen with crankshafts, running in the 20–25/h range depending on the thickness of the coating required.

## CONCLUSION

Nowadays, with enormously improved manufacturing techniques, materials, quality methods, and other mass production improvements, these types of repairs are no longer needed. However, these methods still exist, and molybdenum flame spray coatings are still used in the automotive industry on some piston ring wear surfaces and synchronizer rings among other parts. ▲

*This "Forgotten Thermal Spray Automotive Applications" article by James K. Weber on pages 32–35 of the August 2015 Welding Journal is copyright of the American Welding Society, and it's also being republished with permission of the American Welding Society.*

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Fig. 4 — A Chevrolet employee works hard to keep up with the camshafts racked up behind him. (Note: In current safety practices, protective gear would've been worn.)

## DEADLINES FOR YOUR NEW RIGHT-TO-KNOW PROGRAM

BY SHANNON DECAMP

Some regulatory deadlines for the new Hazard Communication Standard are upon us, so heads up! If you use even a single hazardous chemical in your workplace, this affects you! Thermal spray processes may use compressed gases to heat and fuse fine particles into coating substances. Coating substances can include a wide variety of metals and ceramics, and new substances may be introduced in your workplace as these products continue to evolve. Other operations that you may perform at your facility, such as grinding and lapping may generate waste particulate.



### HAZARD COMMUNICATION AND THE GHS

The Globally Harmonized System of Classification and Labeling of Chemicals (GHS) is an internationally agreed upon system that replaces the various classification and labeling standards used in different countries. The OSHA Hazard Communication Standard was revised in 2012 to conform to the GHS. The revised regulation established four deadlines as a phased approach to meet various requirements of the new standard – two of which have already passed.

### WHAT HAS CHANGED?

The old standard allowed chemical manufacturers and importers to convey hazard information on labels and material safety data sheets in whatever format they chose. The modified standard provides a single set of criteria for classifying chemicals according to 10 health and 16 physical hazards, and specifies hazard communication language for both labeling and safety data sheets (SDS).

**Pictograms:** Labels now contain pictograms to alert users to the chemical hazards to which they may be exposed. Each pictogram consists of a black symbol on a white background framed within a red border. The pictogram on the label is determined by the chemical hazard classification.

Pictograms alert users to the chemical hazards to which they may be exposed. Each pictogram consists of a black symbol on a white background framed within a red border. The pictogram on the label is determined by the chemical hazard classification.



**Labels:** The new requirements for labeling offer workers better protection from chemical hazards, while also reducing trade barriers and improving productivity for American businesses that regularly handle, store, and use hazardous chemicals.

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Chemical manufacturers and importers must provide a label that includes a product identifier and supplier information, a signal word, pictogram(s), hazard statement(s), and precautionary statement(s) for each hazard class and category.



**Safety Data Sheets:** SDSs now replace MSDSs. The new format requires 16 specific sections, ensuring consistency in presentation of important protection information. Employers must ensure that SDSs are readily accessible to employees.

- Section 1: Identification
- Section 2: Hazard identification(s)
- Section 3: Composition/information on ingredients
- Section 4: First-aid measures
- Section 5: Firefighting measures
- Section 6: Accidental release measures
- Section 7: Handling and storage
- Section 8: Exposure controls/personal protection
- Section 9: Physical and chemical properties
- Section 10: Stability and reactivity
- Section 11: Toxicological information
- Section 12: Ecological information (non-mandatory\*)
- Section 13: Disposal considerations (non-mandatory\*)
- Section 14: Transport information (non-mandatory\*)
- Section 15: Regulatory information (non-mandatory\*)
- Section 16: Other information including information on preparation and revision of the SDS

*\*Note: Since other agencies regulate this information, OSHA will not be enforcing sections 12 through 15*

#### WHICH DEADLINES HAVE ALREADY PASSED?

##### GHS requirements in effect as of December 1, 2013

You should have already trained your employees how to read the new GHS labels and Safety Data Sheets – that deadline was December 1, 2013.

##### GHS requirements in effect as of June 1, 2015

As of June 1, 2015 manufacturers and importers are providing all new products with the new GHS labels and SDS (Safety Data Sheets) in GHS format. Suppliers may still ship existing stock with old labels and SDS until December 1. As noted above, your employees should know to expect these changes and must know how to read the new labels and SDS.

#### WHAT DO I STILL NEED TO DO?

##### GHS requirements in effect as of December 1, 2015

Beginning December 1, chemical manufacturers, importers and distributors may only ship containers with GHS labels, and all Safety Data Sheets will be in GHS format. At this point, every new product you receive should conform to the new standard.

##### GHS requirements in effect as of June 1, 2016

The deadline for full compliance with the new Hazard Communication and other standards affected by the GHS is June 1, 2016. After meeting all of the previous compliance deadlines, by this date you must update your hazard communication program as necessary, and provide additional employee training for newly identified physical or health hazards. If you provide alternative workplace labeling of chemicals, these must also comply with the new label standards. ⚠️

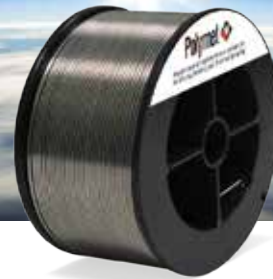


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# SIX WAYS TO OPTIMIZE FILTER PERFORMANCE IN THERMAL SPRAY DUST COLLECTORS

BY GREG SCHREIER AND TAYLOR MORGAN,  
CAMFIL AIR POLLUTION CONTROL



*A pair of cartridge dust collectors with vertically-installed filters serve two metal spray booths for spraying zinc and aluminum in the manufacture of electronic components. The units successfully replaced previous dust collectors with horizontally-mounted filters that were performing poorly.*

Thermal spray involves many processes using different equipment, materials, gases, powders and wires. High efficiency cartridge-style dust collectors are the technology of choice for controlling harmful particulate emissions generated during thermal spray operations. Each process has a different dust-loading volume going into the dust collector based on the thickness of the coating, hours of operation and the properties of the powders/wires being used, which may react differently in the dust collector. You must fully understand all of the moving parts involved in the process to engineer the correct dust collection solution for the application.

This article will focus on the heart of a dust collection system – the filter components – and will provide some general strategies for optimizing filter performance in thermal spray dust collection systems.

## 1. USE CONSERVATIVE AIR-TO-CLOTH RATIOS.

Air-to-cloth (A/C) ratio refers to the amount of air or process gas in cubic feet per minute (cfm) entering a dust collector, divided by the square feet of filter media in the collector. A higher A/C ratio allows the use of a smaller dust collector with lower initial cost, but it will likely result in performance problems and shorter filter life. Overly high A/C ratios can also cause dust to by-pass the filters and be released into the atmosphere.

As a result, conservative A/C ratios are recommended for cartridge dust collectors in thermal spray operations. Electric

arc (twin wire arc) spray generally produces a high volume of fumes, smoke and overspray. Lower A/C ratios are required in order to properly handle these conditions without blinding or plugging the filters. If filters are blinded by excessive dust and fumes produced in any thermal spray process, the air volume will decrease as well as the carrying velocity in the ductwork.

## 2. USE A SYSTEM WITH VERTICALLY MOUNTED FILTERS.

Some dust collectors are designed with horizontally mounted filter cartridges. These designs can cause dust to become entrained at the top of the filters and do not allow pre-separation of heavy or abrasive particles from the air stream. This situation can shorten filter life and provide a dusty surface for sparks to ignite. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Handbook states that horizontal cartridges present challenges because dust tends to collect on the top side of the cartridges.

To prevent these problems, dust should enter the collector from a side inlet with vertical filters that create manageable air patterns within the system. There are multiple advantages to this design. It slows down the velocity of the dust, allowing heavier particulate to drop directly into the hopper and drum below without ever touching the filter media. It reduces the load on the filters and also allows more efficient pulse cleaning that extends filter service life between change-outs. There are documented cases in which vertical filters have lasted 10 times longer than horizontal filters for identical applications.



*Horizontally mounted filter cartridges can cause dust to become entrained at the top of the filters, shortening filter life and providing a dusty surface for sparks to ignite.*

## 3. SELECT PRIMARY FILTERS WITH NANO FIBER MEDIA.



*Filters with nano fiber media are recommended because the fine-pored nano fibers act as a pre-filter to the base media, capturing dust at the surface before it imbeds in the filter. This technology increases dust capture efficiency while enhancing cleaning ability and service life.*

Over the past decade, nano fiber filter media that combine high performance with long life have come into widespread use. Fine-pored nano fibers act as a pre-filter to the base media, capturing most of the dust at the surface before it imbeds in the filter. This technology further increases a filter's dust capture efficiency while also enhancing cleaning ability and service life. For thermal spray applications, nano fiber media filters with an efficiency of 99.995 on 0.5 microns and larger by weight are recommended in order to meet EPA, state, and local regulations on industrial plant emissions. The filter media should also be fire retardant.

## 4. CONSIDER A CYCLONE OR DROP-OUT MODULE FOR PRE-FILTRATION.

Cyclones/drop-out modules can be used in addition to dry media filters to enhance cleaning efficiency by enabling the capture of larger amounts of dust entrained in the air stream before it reaches the primary dust collector. These pre-filter modules can also function as a spark arrestor by trapping large and/or hot particles that could otherwise damage the primary filters or send an ignition source into the collector.

A cyclone works by swirling the dirty air in a downward direction around the outside of a spiral path and then pulling the air straight up the middle. Large particles are forced down into a collection drum, unable to travel upward with the air. The overall efficiency of dust removal is rather low, but these devices excel at removing large amounts of particulates and can be used for product reclamation.

A drop-out module attached to the collector or positioned before the collector





*A drop-out module slows down the velocity of the air stream before it enters the dust collector. This can extend the life of the primary filters, reduce fire risks and aid in product reclamation.*

offers similar benefits to a cyclone. Drop-out modules tend to have a lower pressure drop and slow down the velocity of the air stream before entering the dust collector. They also can reduce the total cost of ownership of a collector by extending the life of the filter cartridges. Drop-out boxes before the collector take up minimal space and are easy to install and add on to existing modular-design dust collectors, but they must be maintained regularly.

Though cyclones and drop-out boxes can extend the life of the primary filters, reduce fire risks and aid in product reclamation, they may also increase fan horsepower requirements for a subsequent trade-off in energy costs.

#### 5. USE A SAFETY MONITORING FILTER.

A safety monitoring filter, sometimes called an after-filter or final filter, is often recommended for use downstream of the primary filtration system; and when handling certain hazardous powders and metals such as nickel and chromium, these filters are required when discharging exhaust air to the

atmosphere.

Traditionally, ductwork and a transition section have been required to connect this secondary filter module to the dust collection system. More recent integrated designs are available in which the safety filter is mounted on top of the collector so that no additional floor space is required. Some newer designs have also been proven through testing to function as flame arrestors for combustible dusts.

Safety monitoring filters use high efficiency particulate air (HEPA) filters to enhance the dust capture efficiency of dry systems and provide backup protection if there should be an air leak through the primary filters. Air is passed through the media to capture 99.97 percent of fine particles as small as 0.3 microns. These units must be used in conjunction with regular dust collectors, as they are not designed to handle large volumes of particulate and fumes.

Due to the gaseous by-products such as ozone, carbon monoxide and nitrous oxide generated by thermal spray processes, air recirculation downstream of the dust collector is not recommended as a general practice. However, in special circumstances, the use of a safety monitoring filter system might allow air to be recirculated through the facility to reduce heat loss and save on energy in cold climates. Such systems require careful design and close operational monitoring to ensure safe operation.

#### 6. GET A WRITTEN GUARANTEE OF FILTER EFFICIENCY AND EMISSIONS PERFORMANCE.

There are many different methods used to measure filtration efficiency. Sometimes a dust collector supplier may state that a system offers 99 percent filtration efficiency at a certain particle size, or that it uses MERV 15 filters. These ratings are useful for comparing different systems, but mass density efficiency, defined as the weight per unit volume of air, is the best predictor of a filter's compliance. The EPA, OSHA and other regulatory bodies don't care



*Used on a spray and fuse application, this dust collector has been in operation for nearly two years with no issues or maintenance needed. Benefits include low pressure drop for energy.*

about percentage efficiency claims: They want to know that emissions will be at or below required thresholds, typically stated as grains per cubic foot or milligrams per cubic meter.

To make sure your bases are covered, verify that the supplier will provide a written guarantee of performance stating that the dust collector filters you select will satisfy applicable emission requirements.

Choosing the right dust collection equipment for thermal spray is a complex challenge that includes many other factors in addition to filter selection. These factors include hazard analysis/risk assessment, overall system design considerations, dust testing. ▲

*Greg Schreier is director of metalworking market/OEM sales and Taylor Morgan is a sales engineer with Camfil Air Pollution Control (APC). Camfil APC is a leading manufacturer of dust collection equipment and is part of Camfil, the largest air filter manufacturer in the world. The authors can be reached at 1-800-479-6801, 1-870-933-8048, or filterman@camfil.com.*



*A safety monitoring filter system is integrated on top of the collector to enhance dust capture efficiency and provide backup protection. These filters are required before discharging exhaust air to the atmosphere when handling hazardous powders and metals such as nickel and chromium.*



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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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## MEMBERSHIP



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](http://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.

### OFFICERS

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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](http://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](http://www.thermalspray.org).





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## GRAND VIEW RESEARCH MARKET ANALYSIS PREDICTS THERMAL SPRAY COATINGS MARKET TO REACH \$12 BILLION BY 2022

### INDUSTRY INSIGHTS

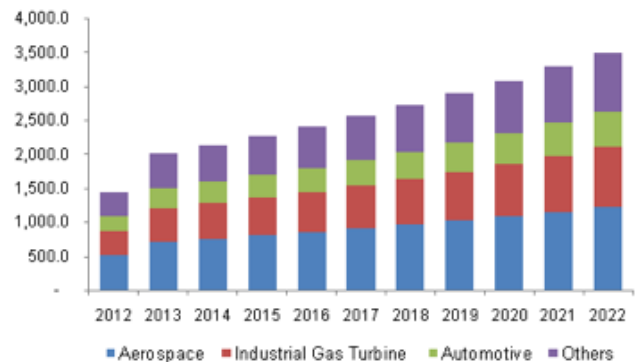
Global thermal spray coating market size was estimated at USD 7.41 billion in 2014. Rising demand in various applications including automotive and aerospace is expected to be one of the key market drivers.

Increasing application scope, owing to advantages such as wear and corrosion protection, low toxic gas emissions, thickness capability and electrical resistance is expected to fuel thermal spray coating market growth. However, low degree of adhesion on small substrates is expected to challenge industry growth over the next seven years.

Key applications include aerospace precision parts, automotive, medical instruments and industrial gas turbines. Use of these coating for biomedical and medical instruments to improve wear resistance and boost biocompatibility of prosthetics and dental implants is expected to augment growth.

Metal, ceramic, intermetallic and polymer are the most prevalent

North America thermal spray coating market revenue by application, 2012-2022 (USD Million)



products in the thermal spray coating industry. They are applied to various surfaces in order to achieve longer life spans under severe operating conditions. They are extensively used in manufacturing high strength low alloy steels for LPG tanks to prevent stress corrosion cracking. Expansion of the oil & gas industry particularly in North America and Middle East is expected to have a positive impact on demand over the forecast period.

Increasing application scope in engineering coating, wear resistant coating, automotive & aerospace, biomedical, food processing, electronics, semiconductors and energy are further expected to promote demand.

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Shifting consumer trend from hard chrome to thermal spray in order to comply with stringent environmental standards particularly in North America and Europe is expected to be one of the primary drivers. Technological upgradation to reduce overall cost is expected to be another key factor for growth over the next seven years.

#### APPLICATION INSIGHTS

Aerospace was the largest application segment, accounting for 34.4% of global revenue share in 2014. Various aeronautic components require hard, wear resistant coating that can withstand temperatures in excess of 800°C. Expansion of the aerospace sector particularly civil aviation in Asia Pacific particularly in India and China on account of increasing disposable income of consumers is expected to have a positive impact on the market over the next seven years.

Industrial gas turbine (IGT) was the second largest application segment, and was valued over USD 1.80 billion in 2014. Rising application scope of gas turbines in ships, locomotives, tanks, helicopters and motorcycles is expected to augment demand over the forecast period.

Automotive application was estimated over USD 1.20 billion in 2014. India is expected to witness high demand for automobiles due to industrialization coupled with government support for vehicle manufacturing. "Make in India" policy introduced by the government is expected to encourage domestic production of all kinds of automobiles and components. This in turn is expected to have a positive impact on the thermal spray coating market over the next seven years.

#### PRODUCT INSIGHTS

Ceramics accounted for a significant share with revenue exceeding USD 2.20 billion in 2014. These are primarily employed in biomedical industry. HVOF technology is used to spray these products on to substrates which are further used in the medical sector for the manufacturing of dental implants. Expansion of this sector is expected to have a positive impact on growth over the next seven years.

Metals accounted for 22.4% share of the overall market in 2014. Wide range of microstructures, speed of coating deposition and feedstock flexibility make these coating a lucrative option for a use on metals and hence will be a key market driver over the next seven years. Stringent regulations by EPA and AFSP have led to the use of these products in automobile sector on account of increasing consumer safety and environment protection.

#### REGIONAL INSIGHTS

Asia Pacific accounted for over 21.2% of global revenue share in 2014. Rapid industrialization leading to establishment of numerous automotive manufacturing units particularly in India and China is expected to have a positive impact on growth over the next seven years.

North America dominated the market and was valued at USD 2.14 billion in 2014. Growing aerospace sector has resulted in rising demand for coating pre-

cision aero-engine parts thus influencing overall market growth over the forecast period.

#### COMPETITIVE INSIGHTS

Although numerous companies are engaged in production and distribution of thermal spray coating equipment as well as formulation, the industry is dominated by larger firms that procure low-cost raw materials and gain share by pricing below their competitors. ▲

For more information on this research data and publication availability, visit [www.grandviewresearch.com/industry-analysis/thermal-spray-coatings-market](http://www.grandviewresearch.com/industry-analysis/thermal-spray-coatings-market)



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**Quality Approvals:** GE, Pratt & Whitney, Rolls Royce, etc.

# NEW CARBIDE SPRAY POWDERS FOR HVOF AND HVAF

BENNO GRIES, H.C. STARCK GMBH, GOSLAR, GERMANY

## 1. INTRODUCTION

While the HVAF spray process is at the beginning of its commercial life cycle, kerosene fired spray processes have finally reached the mature phase after three decades. Typically during mature phases, processing costs need to improve in order to remain competitive. Costs for thermal spray powders normally account for the largest portion of coating production costs as well as employee costs. This is especially valid for highly dense tungsten carbide based coatings due to their highly bulked density. The broad utilization of these coatings in wear protection is directly linked to the spread of the HVOF spray processes.

There are different strategies to improve the profitability of coating production, e.g.

- increase deposition efficiency and productivity,
- use alternative materials or
- abstain from coating properties in view of coating applications or to abstain from post treatments, e.g. sealing.

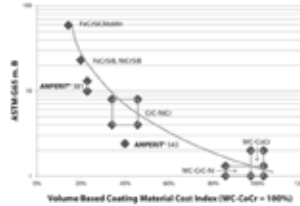
Cooperation with the spray powder or equipment producer is always helpful in order to find the best solution. This article illustrates several results for each of the above-mentioned strategies.

## 2. ALTERNATIVE MATERIALS

In recent years, interest in the development of new materials for thermal spraying has declined (see /1). On the other hand, there is a significant gap in the portfolio of common carbide spray powders. Picture 1 shows the volumetric ASTM G65 wear rate of kerosene HVOF sprayed wear resistant coatings as a function of the coating material cost index (the latter contains spray powder market prices, deposition efficiencies and bulk densities). Thus, it is possible to compare different wear resistant materials regarding their cost/performance ratio. There is a significant gap between, on the one hand, the two tungsten carbide based coatings WC-CoCr (index set to 100%) and WC-CrC-Ni and CrC based coatings on the other. This gap is related to the material properties of the different carbides and their elastic modulus. The two iron based materials FeCrSiB and FeCrSiC-MoMn are the most economical materials. However, they are not corrosion resistant in aqueous media, whereas NiCrSiB can be considered as corrosion resistant in most applications.

By accepting slightly higher coating wear costs, Amperit® 543 offers an economic alternative to WC-CoCr and WC-CrC-Ni. An additional advantage that this material provides are coatings that are comparatively dense and do not need sealing. Furthermore, the atomized alloy FeCrVCmSi (Amperit® 381) provides a significant improvement in wear compared to NiCrSiB and other iron based alloys. Corrosion in aqueous media is a disadvantage, so these coatings are only suitable for a dry or lubricated application. In combination

with common grey cast iron GG25, coatings made from Amperit® 381 are characterized by particularly favorable tribological properties (friction coefficient  $\mu$ , wear) under dry conditions. Moreover, they offer an economic/competitive alternative to electrolytic hard chrome.



Picture 1: ASTM G65 wear (mm³) against coating material cost index for selected wear resistant HVOF coatings materials

Table 1: Results of modified ASTM G99 test, Friction Coefficient / Height of Wear Calotte (mm)

Table 2: Results of modified ASTM G99, lubricated (Shell Tellus S2 M68), Friction Coefficient / Height of Wear Calotte (mm)

Ball Material	Elongation Limit (g)	WC-CoCr	WC-CoCr (FeNi-MC)	CrC-NiCr	Amperit® 543	Hard Chrome
GG25	0.3 - 0.8	0.000000	0.000000	0.000000	0.000000	0.000000
GG40	10	0.000000	0.000000	0.000000	0.000000	0.000000
GG45	5 - 10	0.000000	0.000000	0.000000	0.000000	0.000000
GG50	5	0.000000	0.000000	0.000000	0.000000	0.000000
GG55	5	0.000000	0.000000	0.000000	0.000000	0.000000
GG60	4 - 5	0.000000	0.000000	0.000000	0.000000	0.000000

\*Targeting testing wear

Table 1: Results of modified ASTM G99 test, Friction Coefficient / Height of Wear Calotte (mm)

Ball Material	WC-CoCr	WC-CoCr (FeNi-MC)	CrC-NiCr	Amperit® 543	Hard Chrome
GG25	0.110000	0.120000	0.180000	0.180000	0.110000
GG40	0.120000	0.110000	0.180000	0.180000	0.180000
GG45	0.180000	0.120000	0.180000	0.180000	0.180000
GG50	0.110000	0.110000	0.180000	0.180000	0.180000

Table 2: Results of modified ASTM G99, lubricated (Shell Tellus S2 M68), Friction Coefficient / Height of Wear Calotte (mm)

The content of Table 1 and Table 2 is very complex and partly difficult to understand. However, we are able to draw some conclusions:

- A low friction coefficient does equate to low ball wear.
- Apparently, the elongation limit of the ball material has a strong effect on wear; this is probably why GGG40 is more problematic compared to GG25.
- The use of hydraulic oil in the tribological system results in a major change; In comparison to all other pairings, the two WC-CoCr coatings perform best.
- The pairing of bronze with hard chrome is even more problematic.

## 3. "DENSE" WC-CO-CR COATINGS

In practice, many coating specifications set up by OEM's contain a porosity requirement (e.g. a maximum of 1.0%). The idea behind this is the following: Dense coatings must protect the substrate against corrosion in order to limit the extent of crevice and undercorrosion. Production of dense coatings, i.e. isolating against corrosion, is state of the art, but requires precise adoption of spray powder and spray process.

## 4. INCREASE OF PRODUCTIVITY AND DEPOSITION EFFICIENCY

The increase of deposition efficiency is the most frequent objective of programs which are set up for the development of spray parameter sets or spray powders. There is a simple reason for this: the deposition efficiency is found in the denominator when calculating the material costs of the coating production. In practice, deposition efficiency and productivity (At this point, the latter is to be understood as the deposition rate) cannot be increased without accepting any compromises regarding coating properties.

The best way to increase productivity and deposition efficiency is to either increase the nominal power of the spray system or choose a more powerful one. As a result, we expect an increase of the total energy (kinetic and thermal) of the powder jet.

Apparently, the different spray systems and processes must be quite different in terms of their energy efficiency and are different by feed rate ranges. It is a well-known fact that there is a higher kinetic energy (particle speed) contribution in HVAF systems rather than in HVOF systems while thermal temperature (flame temperature) changes in the opposite direction. In any case, the system immanent water cooling of the kerosene fired HVOF systems results in an unfavorable total energy efficiency. The HVAF systems allow a very high productivity, but coating metallurgy deviates from the one obtained by HVOF.

Although gas fired HVOF systems represent the first generation of HVOF guns, they are still in use in many spray shops and even new ones are installed. Compared to kerosene fired HVOF systems, they achieve 20%-points to higher deposition efficiencies, but only allow 60% of their feed rates /2/. These statements suggest that their limit is at feed rates of about 70 g/min with deposition efficiencies of about 70%.

With an adoption of spray powder parameters, feed rates up to 100g/min with a deposition efficiency of up to 50% were achieved while the resulting coatings were dense without a sealant, according to the salt spray test. This result is at least comparable to state of the art coatings made with a kerosene spray gun.

In most cases, the economic improvement potential can only be realized by larger experimental designs, which need to consider the underlying physics and metallurgy. They should not be restricted to mere combinatorics, which appears to be the case for many recent publications from the non-industrial area. ▲

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- /2/ R. Schmid et al., Tagungsband „9. Kolloquium Hochgeschwindigkeits-Flammspritzen“, S. 185, Erding (2012)

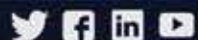


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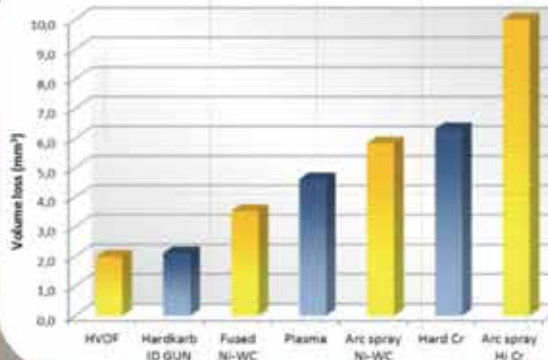
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