THERMAL SPRAY DECODED

What you need to know about the process and the companies that do it for you.

Plasma-Tec, Inc.™

PRECISION TURNING GRINDING THERMAL SPRAY

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What you need to know about the process and the companies that do it for you.

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Stronger, tougher, and an extraordinary ability to tolerate extreme environments – it almost sounds like the description of a super hero. Of course you know what we're talking about are the effects of thermal sprayed coatings. Through an intense process, thermal spray makes an already strong and carefully manufactured part even better. When parts are stronger, tougher, and more abrasion & corrosion resistant, they become more effective, longer-lasting, and suitable for tasks they would otherwise not be capable of.

This paper will provide you with a high level review of thermal spray processes and applications. By reading this paper you will gain a greater understanding - and appreciation - of thermal sprayed components along with the companies that perform this process well.

What is Thermal Spray?

Simply put, thermal spray is the application of a coating onto a base surface. This is done as wire, rod, or powder (known as feedstock) is melted by chemical or electrical means and sprayed onto a work piece. These wires, rods, and powders typically are composed of metals, alloys, ceramics, or composites. As these particles make contact with the base surface they flatten, harden, and form a mechanical bond - first to the substrate, then to each other as thickness increases.

There are several key benefits of thermal spray coatings:

- Thermal spray coatings reduce overall costs of a project because they allow manufacturers to use a low-cost base material while spraying high-performance material on top to improve the overall composition and performance of the part. The process can be highly focused, like in a bearing area on a shaft.
- Thermal spray offers versatility as almost any metal or ceramic can be sprayed.
- As part of this versatility, thickness range of coatings can vary from .001 inch to more than .125 inch thick.

Thermal Spray Processes

There are four key variations of thermal spraying:

- Plasma spraying
- Electric arc spraying (or twin wire electric arc)
- Flame spraying (or spray & fuse)
- High velocity oxy-fuel spraying (HVOF)

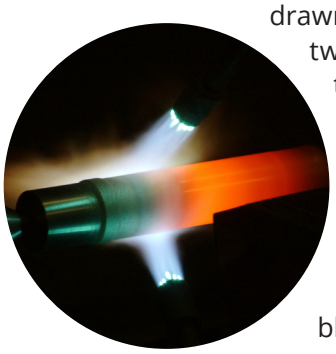
Plasma spray uses a plasma generator as a thermal and kinetic energy source to spray droplets of molten materials against an appropriate substrate. Uniform deposits of rapidly quenched splats are collected to form coatings or structures. Deposits can then be machined to precise dimensions. By eliminating the need for a secondary fusing operation, the sprayed coatings are economical in both initial manufacture and repair.

Typically, plasma spraying is used to apply ceramic coatings. Plasma spray coatings are ideal for applications requiring the highest protection levels such as downhole tools, oil processing equipment,

aircraft engine hardware, agriculture products, mining equipment, engine components, rotary equipment parts, and pump components.

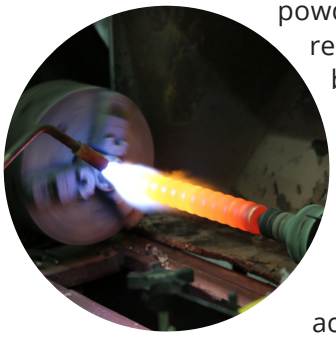
Through application of specific materials, coatings can be applied to resist abrasion, corrosion, erosion, fretting, friction, and galling. Some common applications for plasma sprayed coatings are: pump idler pins, shafts, bushings (ID & OD), pump plungers & sleeves, compressor rods, capstans, and drawing dies.

Wire arc is a method for spraying any metal that can be drawn into a wire. Drive rolls feed two electrically charged wires through the arc metallizing gun to its nozzle. There a short circuit is set up between the wires, creating an arc that melts them at temperatures higher than 7200° F. A compressed air blast atomizes the molten metal and projects it onto a previously prepared surface. The surface is prepared for metallizing by mechanical roughening. When spraying a non-ferrous material, mechanical roughening can be followed by a bond coat of low-carbon steel to increase bond strength.



Wire arc metallizing is excellent for applications that require a heavy coating deposit. The wire arc system produces a highly concentrated spray pattern and can spray at extremely high speeds. This process has flexibility, allowing precise fine-tuning of characteristics such as coating hardness and oxide content. It also allows the creation of a pseudo-alloy (or mixed metal) coating by feeding a different metal through each electrode. This is an excellent process for the repair of shafts.

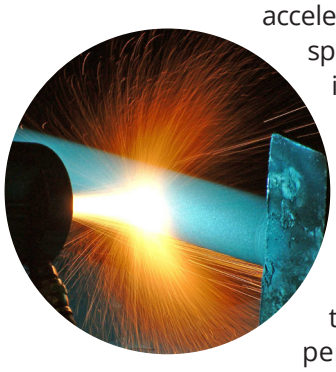
Flame spray is separated into three subcategories depending on the feedstock material – powder, wire, or rod. Flame spray relies on a chemical reaction between oxygen and a fuel of combustion to produce a heat source capable of melting the feedstock. As the material is melted, compressed air is used to atomize the material and accelerate it onto a substrate.



Flame spray is common in the oil exploration and agriculture industries. The technique is used in these industries to provide wear resistance as well as impact resistance. Other industries that utilize flame spray technology are aerospace, construction equipment, oil & gas processing, and machine repair.

The biggest advantage of flame spray is its ability to reduce porosity in the coating, resulting in a dense, well-bonded coating.

High Velocity Oxygen Fuel spraying (HVOF) generates its gas stream from mixing and igniting oxygen and fuel in a combustion chamber, allowing this high pressure gas to accelerate through the nozzle of the spray gun. Feedstock for HVOF is powder, and the resulting coating consists of thin overlapping platelets. This thin coating is extremely dense & very low in porosity.



HVOF is a cost-effective technique that improves performance properties of the workpiece. The technique is also beneficial for enabling components to operate in higher or lower temperatures, as well as in harsh chemical environments. Typical applications for HVOF coatings include subsea pump internals, impeller wear rings, slurry pump internals, wire drawing equipment, and many other instances to protect components from wear and corrosion. Hexavalent chrome replacement is an excellent application for HVOF.

What does thermal spray do, and when should it be used?

Thermal sprayed coatings are an effective alternative to surface modifications like nickel and chrome plating, nitride or heat treat processes, anodizing, and weld overlay. Thermally sprayed coatings can be used to give a workpiece wear resistance, heat resistance, oxidation resistance, corrosion resistance, electrical resistance, electrical conductance, and restoration of size. Thermal spray allows designers to use low cost or light weight base materials and still create a high performance part with a functional surface.

These coatings impart significant enhancements to

parts and components, but no amount of coating can make up for a poorly manufactured part. There is an art to balancing the machining, turning, and grinding of the part with the coating of the part; parts need to be made with the coating process in mind.

Can any part or material be thermal sprayed?

In short, any material that can be melted can be sprayed by thermal spraying. Depending on the variation of thermal spray, material can be heated in a gun up to as hot as 14,000° C. However, the benefit of plasma & HVOF spraying is that these high temperatures stay inside the gun, transferring very little heat to the substrate itself. Substrate temperature rarely exceeds 300° C so coatings can be applied with little to no pre- or post-heat treatment while component distortion is minimal. With plasma and HVOF spraying, coatings can be applied to thermal sensitive substrates like low melting point metals and plastics.

What is the difference between a thermal spray part and a non-thermal spray part?

Thermal spray coatings can be used as protection from heat, chemicals, molten metal, abrasion, adhesive wear, galling, fretting, and weathering. Thermal spray coatings can also be used to repair and renew worn components that would otherwise be too costly to replace. Non-thermal spray parts will generally be made with more expensive base materials in order to provide as many benefits in surface properties from the start of the process. While this non-thermal spray base material should be high quality, without a proper coating it will be subject to natural wear and corrosion, as well as any environmental factors that could expedite damage to the part. It also will be more expensive.

Is one thermal spray source as good as the next?

When deciding on a thermal spray provider, it is best to look for a company that also machines & finishes the parts that are being coated with thermal spray. It is important to remember that the coatings only make the base material better; a coating can make a sturdy part harder, but it can't make a weak part strong. As mentioned earlier, parts should be made with the coating process in mind, as there is an art to balancing the machining, turning, and grinding of a part with the coating.

How important is base material?

The integrity of the base material is critical to how a component is manufactured and ultimately performs. For this reason, it is absolutely necessary that you ask a provider where their base materials are sourced from. Base materials from China and Russia (for instance) have been known to be inferior in quality. Seek out manufacturing partners that source their raw materials from North America and Europe. If you have any hesitation about whether or not your manufacturer is telling the truth about where their raw materials come from, ask to see the documentation. Ultimately a good partner knows that your name is on the line too, so they'll do what they can to give you assurances of the quality you can expect. Using inferior raw materials is not being cost-efficient - it is compromising the integrity of the part and the integrity of your operation. That is why it is so important to ask your provider where they source their raw materials.

What can the right thermal spray company do for your parts, your business, and your bottom line?

Thermal spray coatings increase component life and value, decrease machinery downtime, and improve overall component performance. The right thermal spray company will provide you with parts that are harder, more durable, and more wear resistant. When critical parts are properly protected, you can be confident that they will perform longer and more consistently, saving your customers money by reducing downtime and maintenance costs. Reduced costs obviously add immediate improvements to their bottom line, but parts that perform better allow you to offer superior products which results in significant return on investment. //