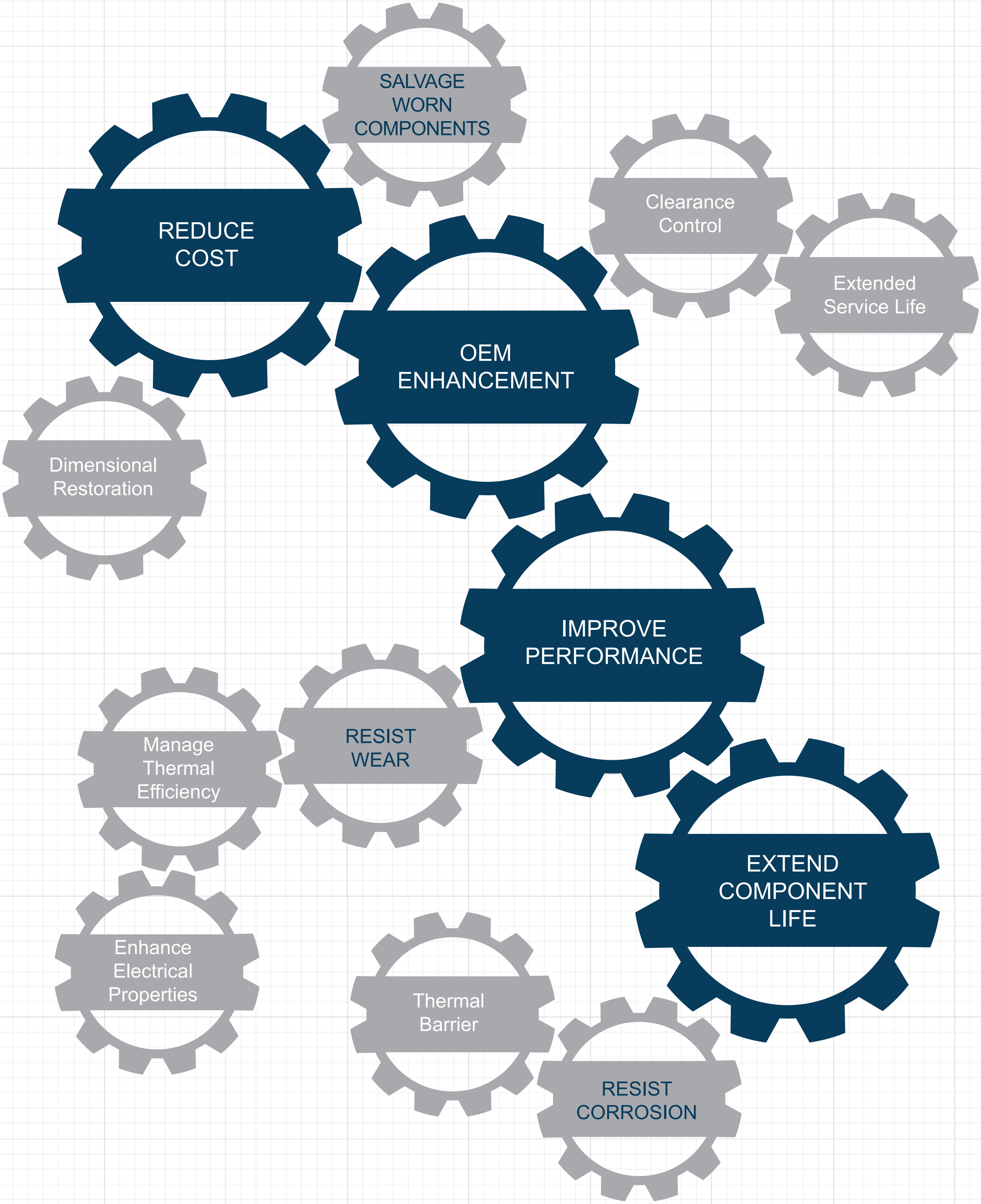
HTS COATINGS

machining & grinding

THERMAL SPRAY FUNDAMENTALS

WHY THERMAL SPRAY?

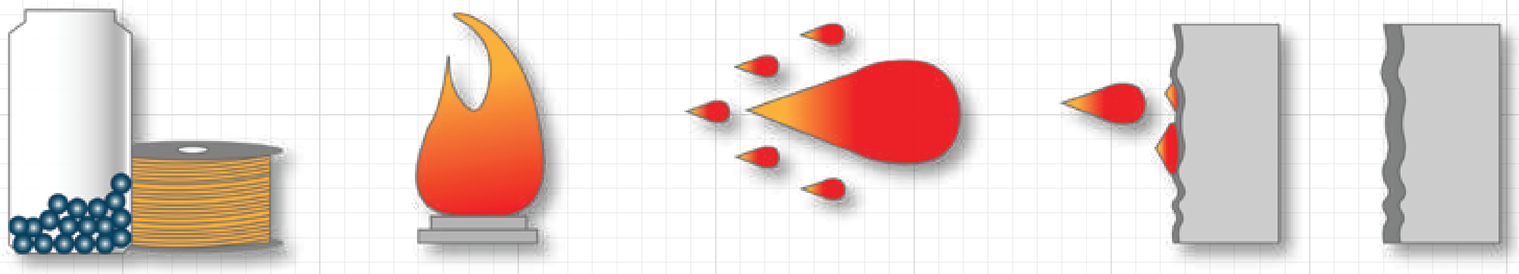


THERMAL SPRAY

Thermal spray, sometimes called metallizing, is a process of melting a powder or wire in a gas stream and applying the semi-molten material to a substrate. The materials that can be sprayed through thermal spray are almost endless. Ceramics, metals, carbides, alloys and even Teflon materials can be applied in this manner.

The benefits of the thermal spray process are the application to almost any substrate. The low temperature of application makes it possible for use on finished parts without causing distortion or changing the properties of the base material. Thermal spray saves you time and money by rebuilding your parts with enhanced materials; leading to less down time and fewer maintenance hours through the life of the part.

THERMAL SPRAY PROCESS



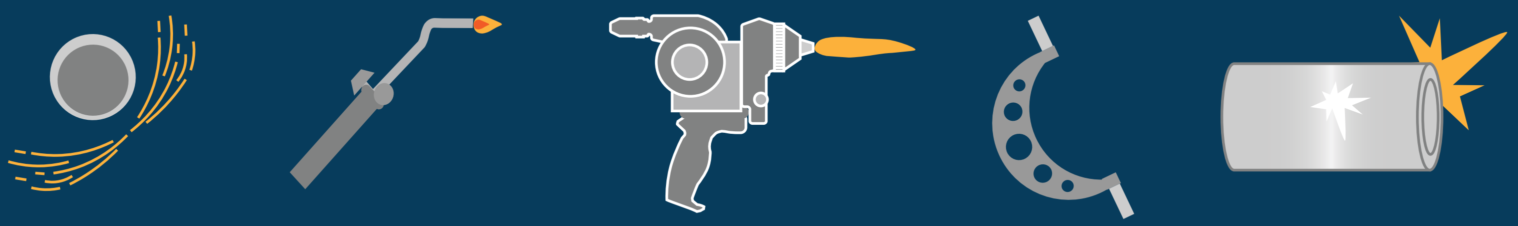
Spray Material | **Melting Spray Material** | **Molten Particle Acceleration** | **Impact Particle/Substrate** | **Coating**

REPAIR & OVERHAUL

One of the primary goals of thermal spray is the repair and overhaul of industrial components. Thermal spray can take parts that are headed for the scrap yard and make them like new. Whether it is a large print roll overhaul or a complex seal sleeve repair; thermal spray can be an economical solution for component failure. It can be used to repair both large surface areas and diameters as well as some inside diameters.

THERMAL SPRAY REMANUFACTURE PROCESS

Remove damaged material | Fill in eroded or damaged areas | Apply thermal spray coating | Finish grind to desired size | Superfinish to desired smoothness (as needed)



Thermal spray can be used for the repair and overhaul of machinie parts, as described above, or to enhance the performance of production parts before installation.

TYPES OF THERMAL SPRAY PROCESSES

FLAME SPRAY

- 1,000-5,000 psi bond
- 5-20% Porosity
- Wear Resistant
- Surface Restoration
- 0.005”-0.250”

ARC SPRAY

- 1,500-9,000 psi bond
- 5-10% Porosity
- Wear Resistant
- Surface Restoration
- 0.005”-0.250”

PLASMA SPRAY

- <10,000 psi bond
- 3-5% Porosity
- Wear Resistant
- Corrosion Resistant
- 0.003”-0.030”

Increasing adhesion, cohesion and decreasing porosity

HVOF SPRAY

- >10,000 psi bond
- 0.5-3% Porosity
- Wear & Corrosion Resistant
- 0.003”-0.030”

HVAF SPRAY

- >12,000 psi bond
- <0.8% Porosity
- Cavitation, Wear & Corrosion Resistant
- 0.002” to 0.050+”

SPRAY & FUSE

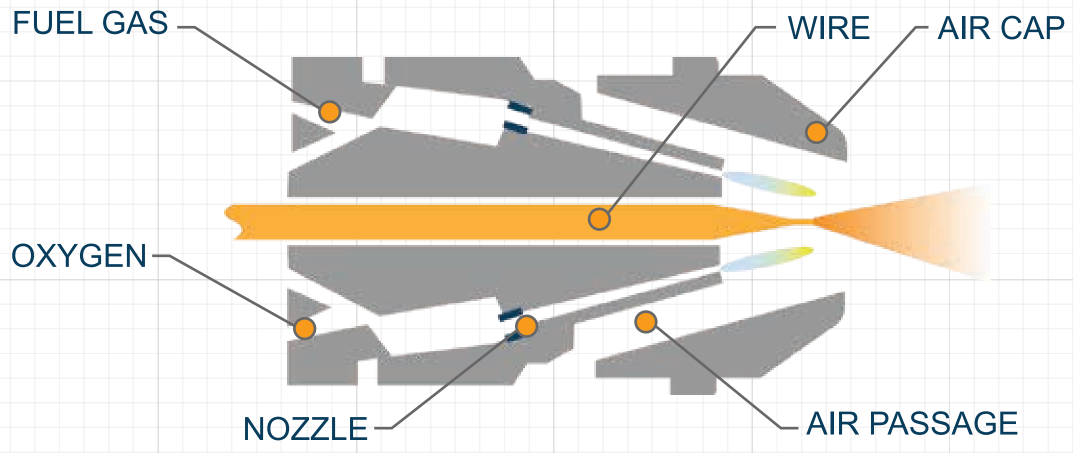
- Metallurgical bond
- <0.8% Porosity
- Extremely Wear & Corrosion Resistant
- Welding bond with ease of thermal spray

Increasing adhesion, cohesion and decreasing porosity

FLAME COMBUSTION SPRAY

Flame spray is one of the oldest forms of thermal spray. Typically using oxygen and acetylene, these thermal spray systems melt wire or powder in the combustion stream and apply it to the part. These coatings are great for restoration of old parts. Flame spray systems can spray I.D. and O.D. components.

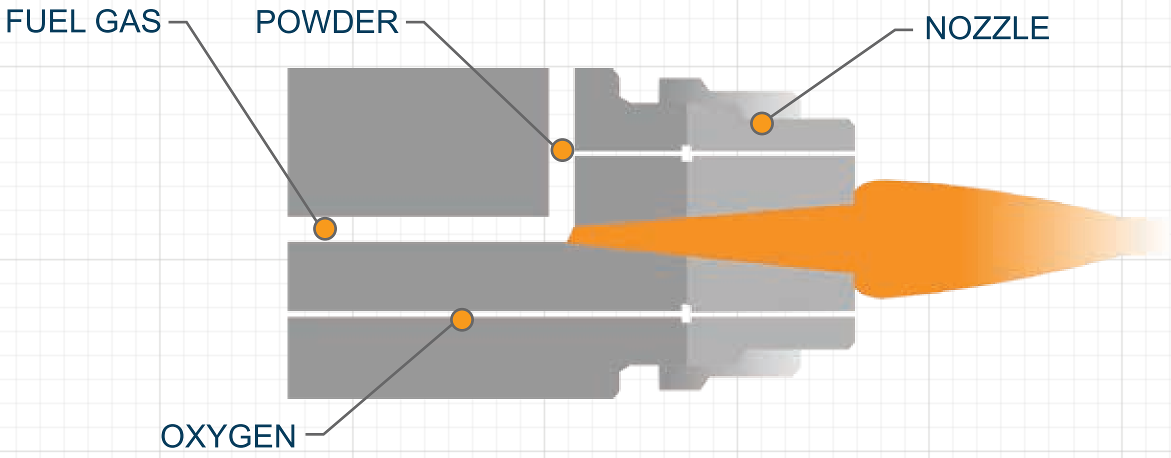
PROCESS OVERVIEW (WIRE)



Process Description	An oxy-acetylene combustion process using wire based coatings
Coating Applications	Stainless Steels, Abradable coatings, Aluminum, Molybdenum, Tin, Zinc, Copper
Operating Cost	Economical Spray
Bond Mechanism	Mechanical (1,000-5,000 psi)
Max Flame Temperature	5,600 °F / 3,100 °C
Particle Velocity	160-300 ft/sec
Max Spray Rate	20 lb/hr (9 kg/hr)
Coating Thickness Range	0.005" to 0.250"
Special Features	Economical, No heat distortion
Wear Resistance	Acceptable
Corrosion Resistance	Poor/Medium
Porosity	High

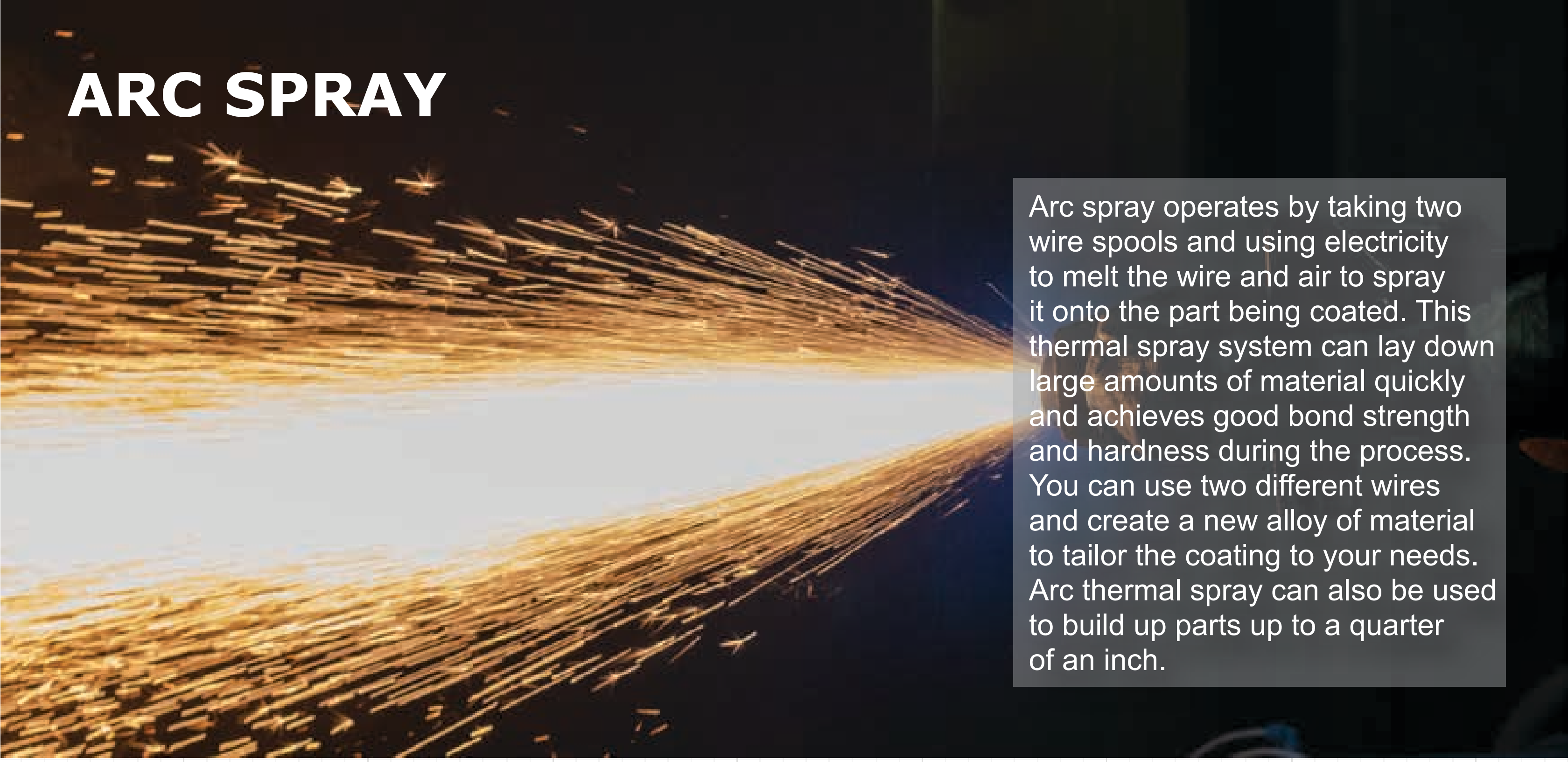
FLAME COMBUSTION SPRAY

PROCESS OVERVIEW (POWDER)



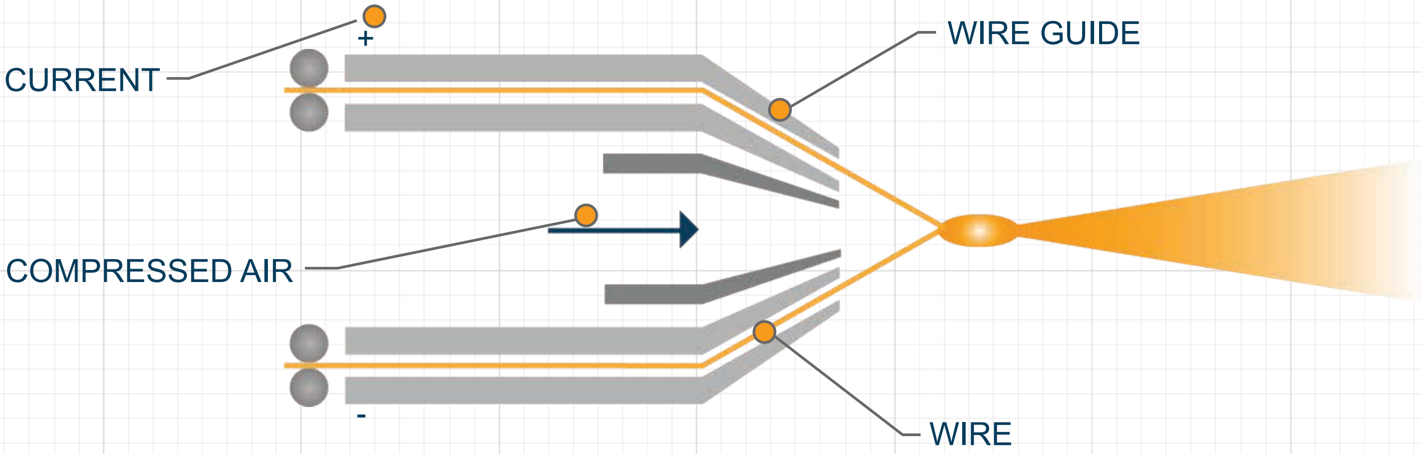
Process Description	An oxy-acetylene combustion process using powder based coatings
Coating Applications	Abradable coatings, Metals, Alloys, Composites, Self-Fluxing, Aluminum Oxides, Cermets
Operating Cost	Economical Spray
Bond Mechanism	Mechanical (1,000-5,000 psi)
Max Flame Temperature	5,600 °F / 3,100 °C
Particle Velocity	160-300 ft/sec
Max Spray Rate	20 lb/hr (9 kg/hr)
Coating Thickness Range	0.005" to 0.250"
Special Features	Economical, No heat distortion
Wear Resistance	Acceptable
Corrosion Resistance	Poor/Medium
Porosity	High

ARC SPRAY



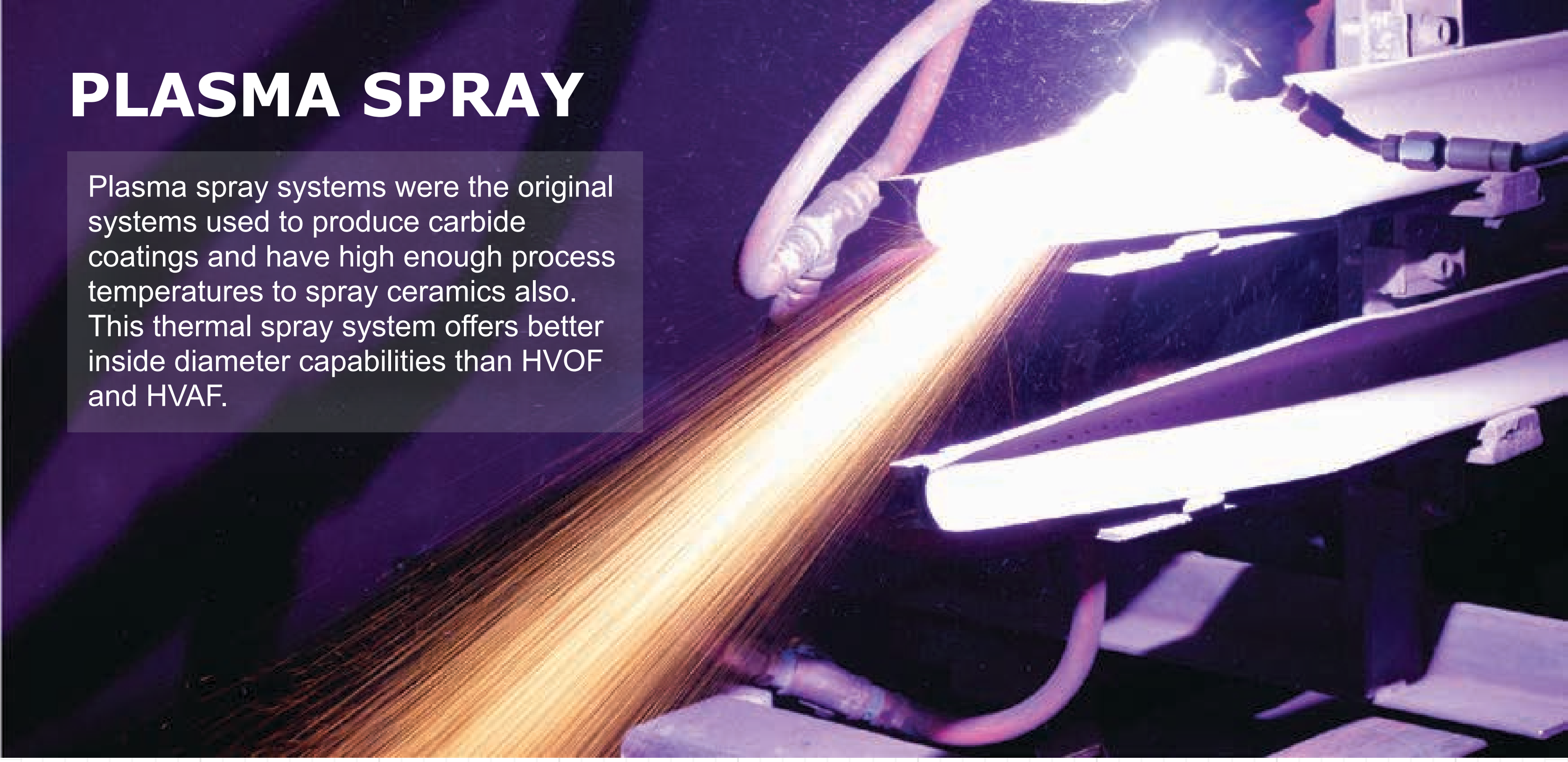
Arc spray operates by taking two wire spools and using electricity to melt the wire and air to spray it onto the part being coated. This thermal spray system can lay down large amounts of material quickly and achieves good bond strength and hardness during the process. You can use two different wires and create a new alloy of material to tailor the coating to your needs. Arc thermal spray can also be used to build up parts up to a quarter of an inch.

PROCESS OVERVIEW



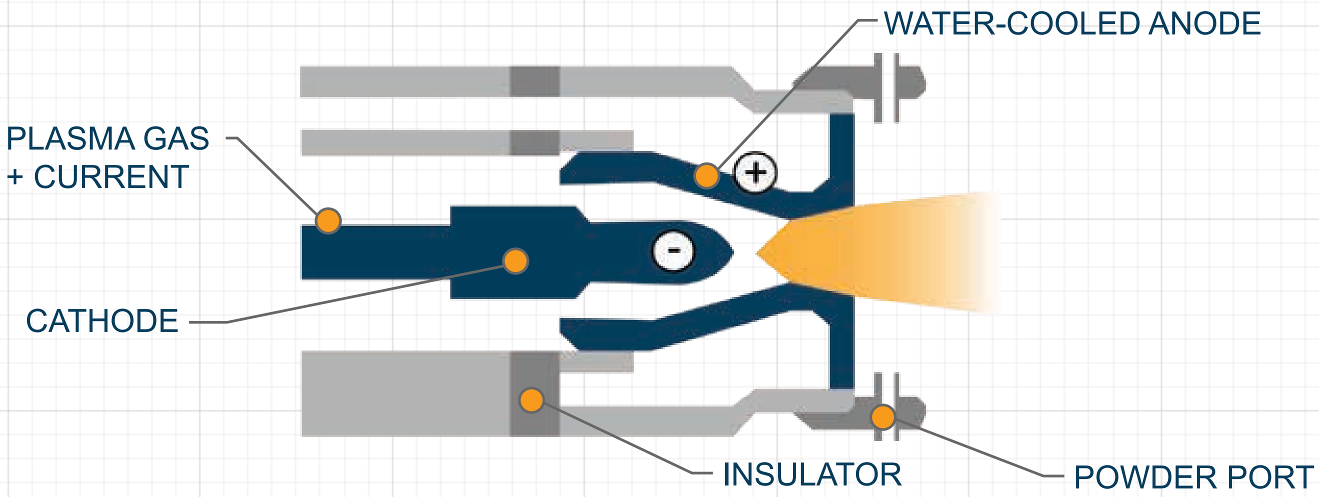
Process Description	An electric arc process creating an arc by combining two wires and propelling the droplet to the part via an air jet
Coating Applications	Monel, Inconel, Stainless Steels, Hastelloy, Zinc, Aluminum, Tin, Copper
Operating Cost	Economical Spray
Bond Mechanism	Mechanical (1,500-9,000 psi)
Max Flame Temperature	Up to 7,000 °F
Particle Velocity	160-300 ft/sec
Max Spray Rate	10+ lbs/hr/100 amps
Coating Thickness Range	0.005" to 0.250"
Special Features	Economical, No heat distortion
Wear Resistance	Average
Corrosion Resistance	Acceptable
Porosity	Medium

PLASMA SPRAY



Plasma spray systems were the original systems used to produce carbide coatings and have high enough process temperatures to spray ceramics also. This thermal spray system offers better inside diameter capabilities than HVOF and HVAF.

PROCESS OVERVIEW



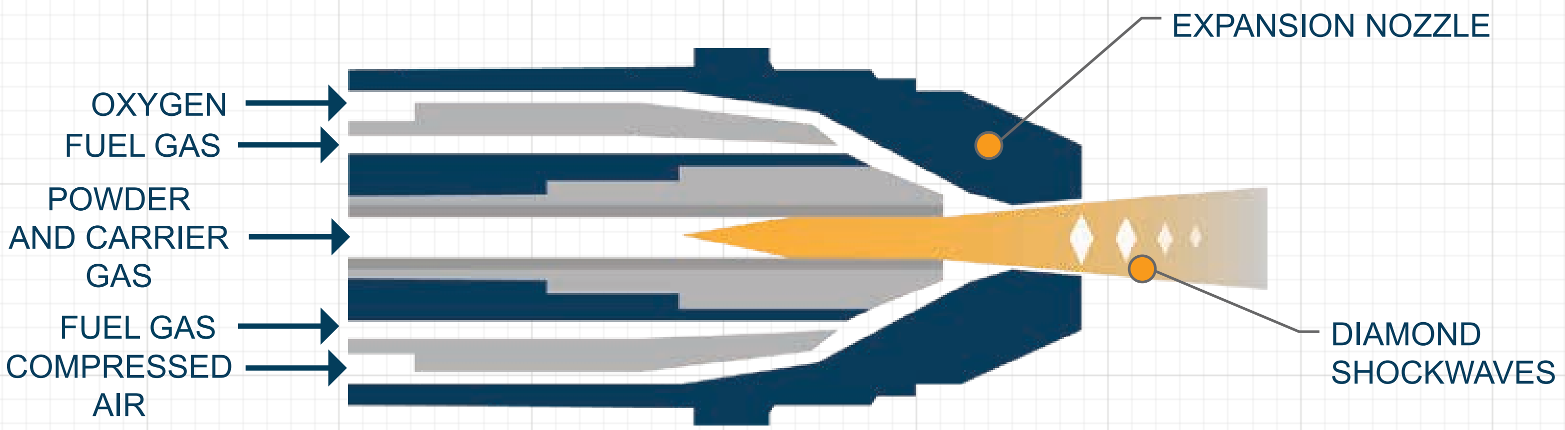
Process Description	An electric arc dissociates & ionizes the gases (Ar, N_2) & passes through the torch. Powder coating is injected externally to the torch into the plasma stream.
Coating Applications	Thermal Barrier Coatings, Abradables, Cermets, Ceramics, Nickel and Cobalt Based Alloys
Operating Cost	Upgraded Spray
Bond Mechanism	Mechanical (<10,000 psi)
Max Flame Temperature	12,000 °F to 35,500 °F
Particle Velocity	1,500-2,600 ft/sec
Max Spray Rate	18 lbs/hr
Coating Thickness Range	0.003" to 0.030"
Special Features	Capable of applying highly corrosion reistant ceramic coatings, no heat distortion
Wear Resistance	Excellent
Corrosion Resistance	Very Good
Porosity	Low

HIGH VELOCITY OXY-FUEL SPRAY

(HVOF SPRAY)

HVOF is short for High Velocity Oxy-Fuel. This system has been one of the major thermal spray systems in use for many years. It offers hard materials such as carbides but can also spray many different metal-based materials.

PROCESS OVERVIEW



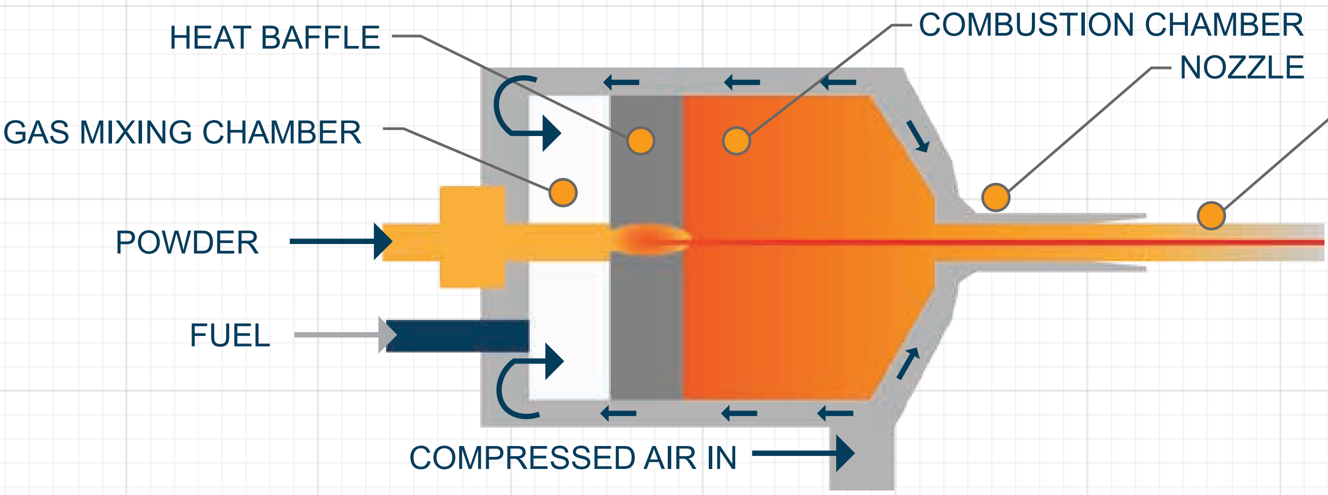
Process Description	Combustion of either, Hydrogen and Oxygen or Kerosene and Oxygen, to produce a high velocity jet in which coating material is injected.
Coating Applications	Tungsten Carbide, Chrome Carbides, Stainless Steel, Hastelloy, Inconel, Monel
Operating Cost	Premium Spray
Bond Mechanism	Mechanical (>10,000 psi)
Max Flame Temperature	5,600 °F
Particle Velocity	2,000 - 3,300 ft/sec
Max Spray Rate	30 lbs/hr
Coating Thickness Range	0.003" to 0.030"
Special Features	Capable of applying high corrosion & wear coatings, no heat distortion
Wear Resistance	Excellent
Corrosion Resistance	Very Good
Porosity	Very Low

HIGH VELOCITY AIR FUEL SPRAY

(HVAF SPRAY)

HVAF is short for High Velocity Air Fuel. This thermal spray system offers higher densities and bond strength than HVOF on some materials. It also allows for thicker thermal spray buildups than HVOF without the cracking issues due to its lower spray temperatures and higher velocity. HVAF thermal spray also offers the ability to spray in smaller I.D. areas than HVOF.

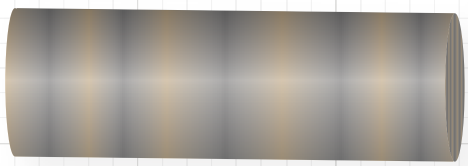
PROCESS OVERVIEW



Process Description	Combustion of Propane in a compressed air strem to produce a high velocity jet in which coating material is injected.
Coating Applications	Tungsten Carbide, Chrome Carbides, Stainless Steel, Hastelloy, Inconel
Operating Cost	Premium Spray
Bond Mechanism	Mechanical (>12,000 psi)
Max Flame Temperature	3,560 to 3,650 °F
Particle Velocity	3,300 ft/sec
Max Spray Rate	73 lbs/hr
Coating Thickness Range	0.002” to 0.050+“
Special Features	Capable of applying high corrosion & wear coatings, no heat distortion, ductile coatings
Wear Resistance	Excellent
Corrosion Resistance	Very Good
Porosity	Very Low

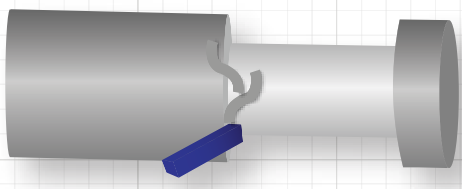
THERMAL SPRAY REPAIR PROCESS

Workpiece



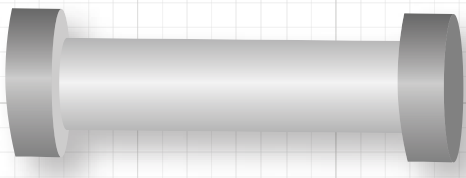
Undercutting

Workpiece is machined to ensure proper coating thickness and to remove damaged material.



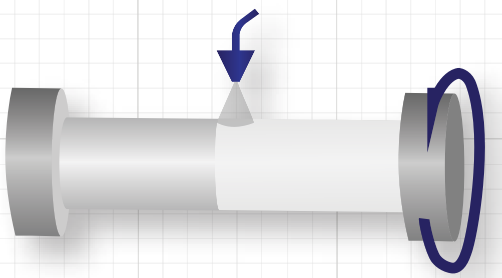
Preparation

Workpiece is prepped through degreasing, masking and/or pre-heating.



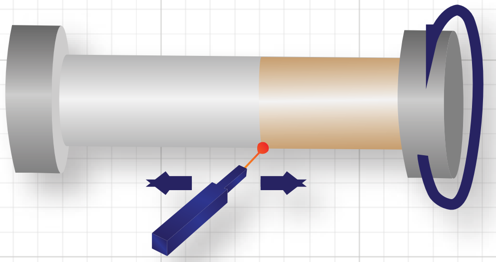
Blasting

Workpiece is blasted to clean part and reinforce coating particle adhesion.



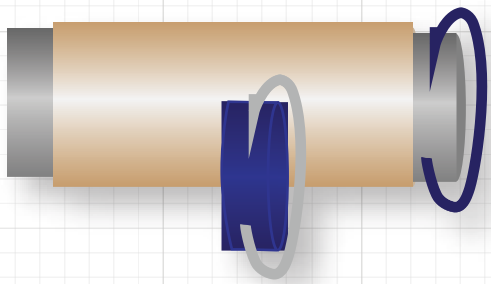
Thermal Spray

Workpiece is coated with selected material and thermal spray process.



Finishing

Workpiece is sealed if necessary then surface is finished to desired roughness.



Completion

Workpiece undergoes final inspection and is ready to be reintroduced into production environment.

Thermal spray repair typically begins with the removal of existing surface material. This ensures that any previous corrosion is removed; as well as produces an even surface to apply the coating. When a component has deep gaugues or missing sections, a weld repair can fill in those areas to build up the surface. Once the component is structurally prepped, most parts will be blasted to ensure a strong mechanical bond. Once the component is fully prepped it is ready for thermal spray. During thermal spray the coating is built up and then machined back down to the desired component dimensions. If a specified roughness is required, superfinishing can be used. Every component is different and our team can design the proper process to ensure a quality repair solution.

COATING CHARACTERISTICS

POROSITY

Porosity is present in most thermally sprayed coatings

- 0.2 to 25 % is normal
- Depends upon process and material

Porosity can be reduced by:

- Increasing kinetic energy - velocity, particle size, mass and morphology
- Reducing turbulence
- Decreasing contamination potential - housekeeping and masking

Porosity can be detrimental in coatings with respect to:

- Corrosion (sealing of coatings is advised)
- Achieving surface finish
- Strength
- Macro hardness

Porosity can be helpful in coatings with respect to:

- Retaining lubrication
- Minimizing stress
- Reduction in crack formation

OXIDES

Chemical interactions occur during spraying:

- Most occur in spraying in air
- Metallic particles oxidize over their surface

Oxides can be reduced by:

- Use of reducing flame parameter (fuel rich)
- Using an inert environment
- Reduce stand off distance
- Compressed air cooling

Oxides in coatings can increase:

- Hardness
- Wear resistance

Oxides can be detrimental in coatings with respect to:

- Corrosion
- Strength
- Machinability

NOTES

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