Metallisation
Thermal spray equipment and consumables

NAS National Alloy Solutions

An Introduction To Thermal Spraying And Its Applications

Metallisation
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What Is Thermal Spraying ?

- It is a process for applying coating onto a solid substrate
- Thermal sprayed coatings are melted, or softened metallic, ceramic, or polymer materials which are transported by a gas stream to a substrate
- Thermal spray is NOT a welding process

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What Can We Do With Thermal Spray?

- Improve/ change the surface of a material
- Repair and refurbish worn components
- Provide corrosion protection

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History of the Process

- Pioneered by Dr M U Schoop of Zurich in the early 1900's (1st patent 1909)
- Started out by pouring molten metal into a high pressure gas stream
- Developed to depositing coatings from solid wires
- Introduced in the UK in 1922 (foundation year of Metallisation)

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Introduction to Thermal Spraying

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What Are Thermal Sprayed Coatings?

These coatings are typically mechanically bonded to a grit blasted surface

The coatings are similar to the metals being sprayed, however there are some important differences:

1. Particles in the coating create a layered effect within the coating structure
2. Due to the rapid cooling of the metal particles as they adhere to the substrates, thermal sprayed coatings have unique crystalline structures not normally found in wrought metals
3. There are oxide stringers and porosity in the coatings

Almost any material can be thermal sprayed onto almost any substrate

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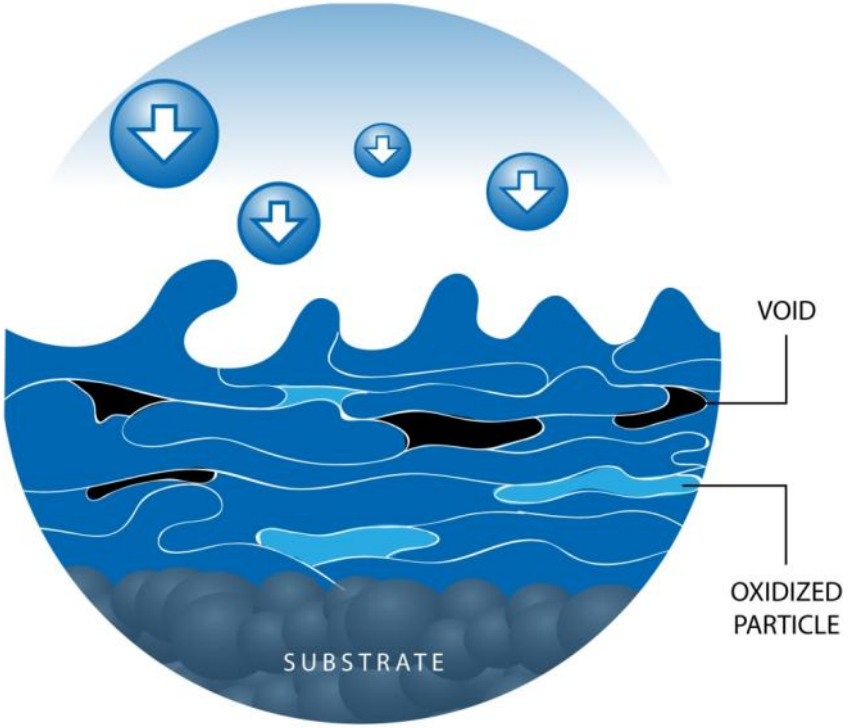
Metal spraying

- Four common processes:
  - Flamespray
  - Arcspray
  - Plasma
  - HVOF



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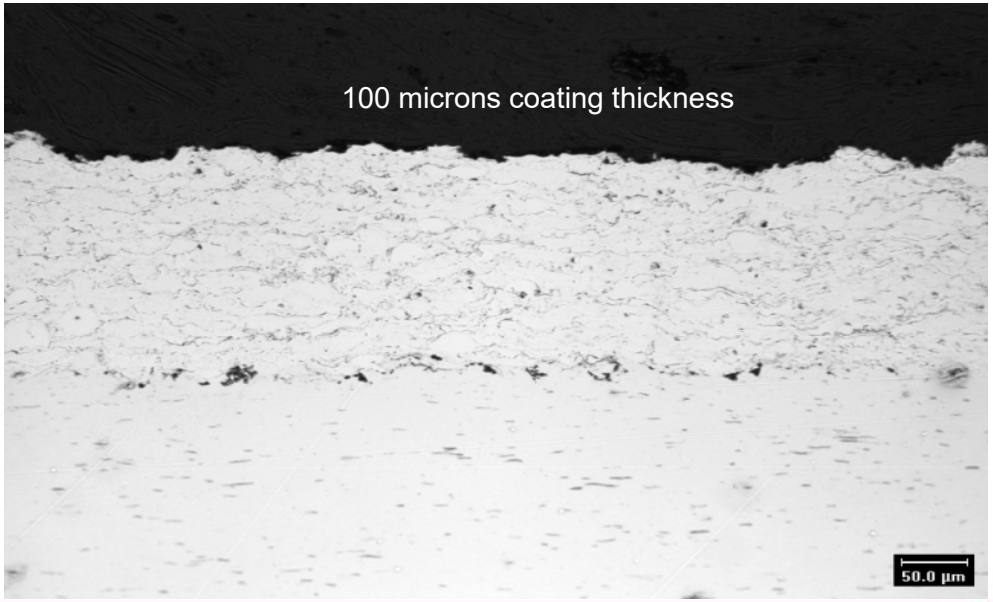
Typical Arc Sprayed Coating

- Metallisation Arc 140
- Material 60E 13%

  chrome steel
- Hardness 35 Rc
- Porosity 3%



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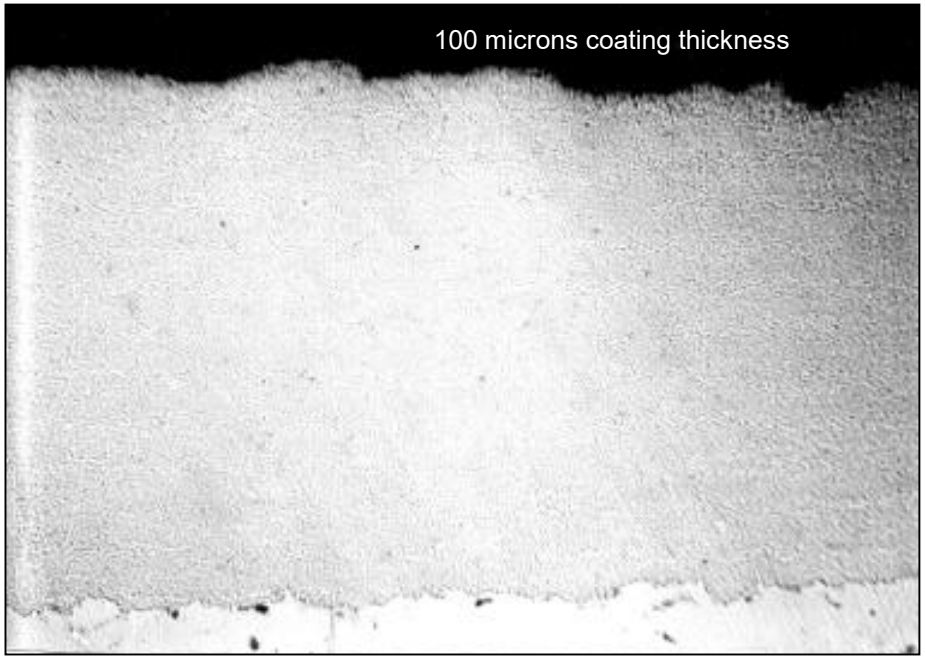
Typical HVOF Sprayed Coating

- Metjet-4L liquid fuel
- Material WC/Co/Cr
- 86/10/4
- Hardness 1360 HV 300
- Porosity 0.1 %



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Thermal spray highlights

- Instant curing
  - No drying or curing time – can be handled straight after application
- Metallurgically cold process
  - Virtually no heat input to the substrate (<80C typically). No distortion.
- Typically mechanical bonding process
  - Normally requires grit blasting (sometimes m/c'ing or preheat)
- Can spray many materials
  - Zn / Al / Cu / Steels / Bronzes / Ceramics / WC / Mo/ Abradables/ Thermal Barriers etc.
- Can be applied at various thicknesses
  - Typically 150-750 microns but can be more
- Line of sight process

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ARC SPRAY

Electric Wire Arc is a cost effective method of applying a wide range of metallic coatings and alloys including

Aluminium
Steels
Stainless steels
Nickel
Copper
Zinc
Bronze

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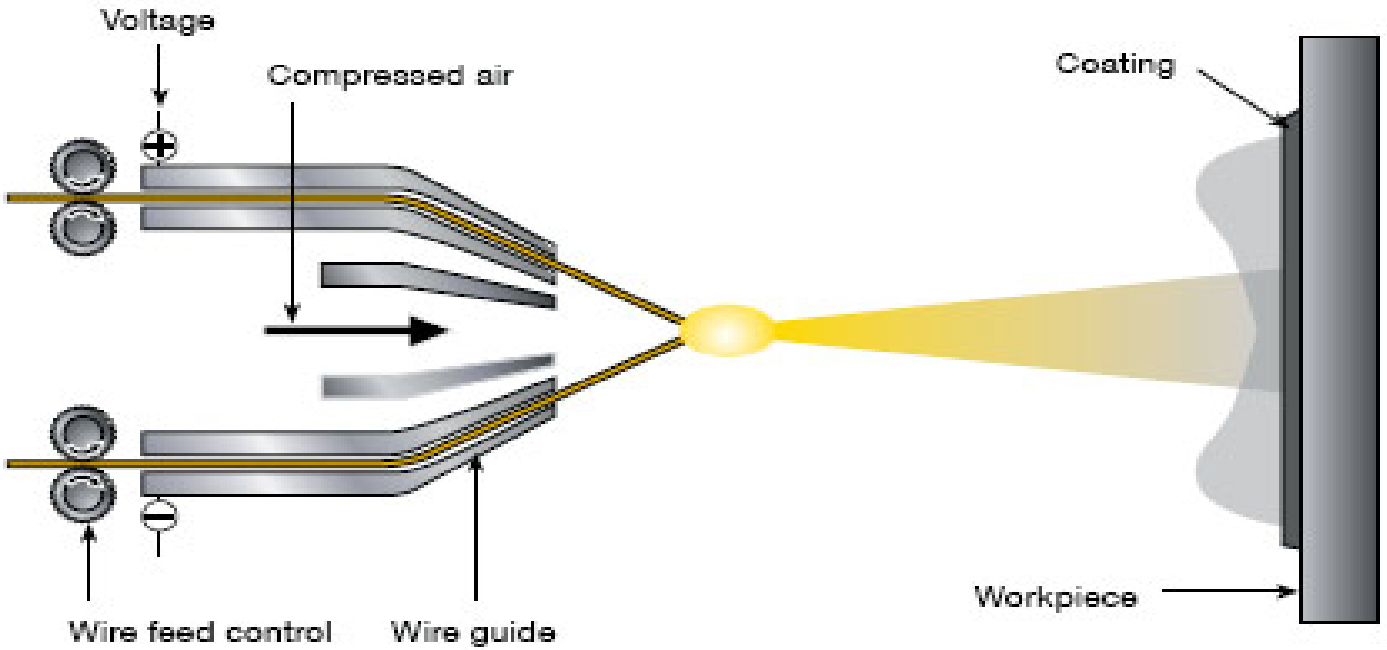
Arcspray Process



- An electric arc is struck between 2 wires
- The wires melt
- The resultant melted particles are atomised by compressed air
- Compressed air projects particles

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Arcspray Equipment

- Metallisation Arc140
  - Lightweight pistol
  - 5-20m wire drive (push/pull)
  - Throughput
    - 8.5 kg/hr (2.3mm Al)
  - Deposit efficiency
    - 65% (Al)
  - Typical bond strength
    - 13.75MPa (Al)

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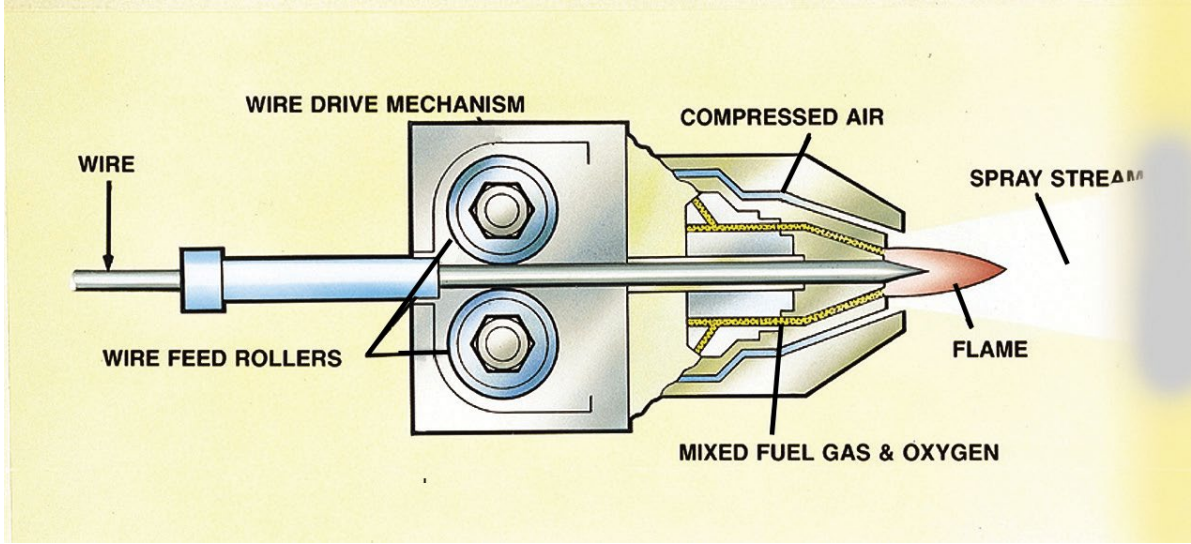
Flamespray process



- Oxygen / Propane flame melts wire
- Compressed air projects particles

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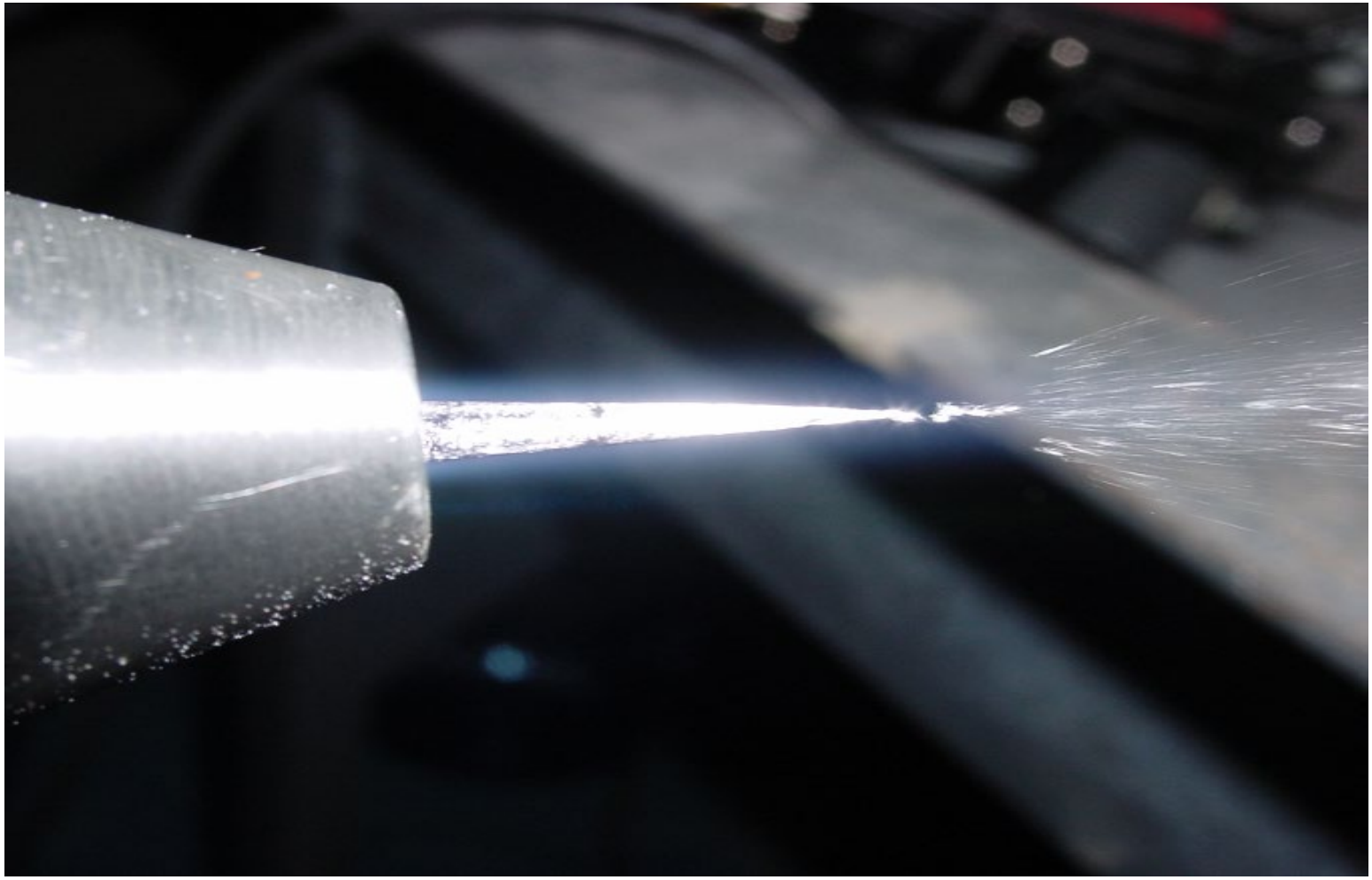

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Flamespray Equipment

- Metallisation MK73
  - Hand held pistol
  - Oxy-propane flame
  - Stop/start function
  - Up to 80m hose length
  - Throughput
    - 7.5 kg/hr (3/16” Al)
  - Deposit efficiency
    - 85% (Al)
  - Typical bond strength
    - 6 MPa approx. (Al)

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Typical Plasma Applications

- Typical applications
  - Gas turbine parts
  - Print industry rolls
  - Aerospace components
  - Seal areas
  - Thermal barrier coatings

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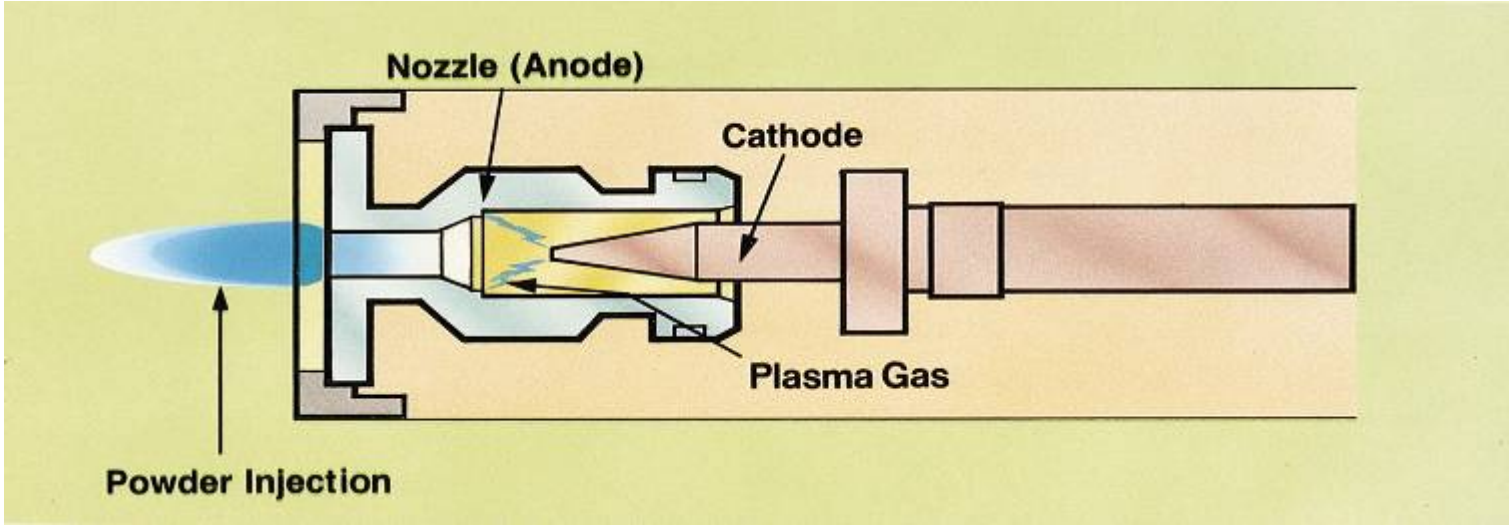
Plasmaspray process



- Plasma jet created by arcing in plasma gas
- Ceramic / metal powder injected into plasma stream
- Particles soften and strike surface at high velocity

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NEW PS50M-PC Controlled System

- Metallisation PS50M-PC
  - PC / Touch screen control
  - Powder feeder
  - 50kW Plasma system
  - Mass flow control (repeatability and quality coatings)

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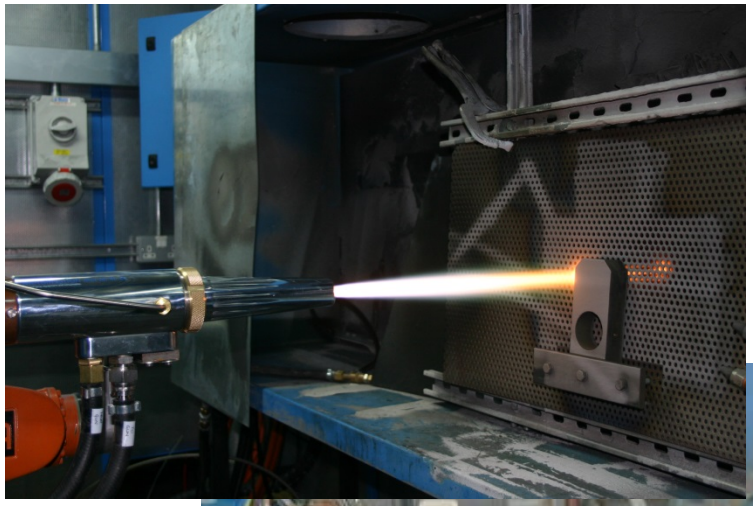
Typical HVOF Applications



- Typical applications
  - Hard chrome replacement
  - Ball/Gate valves oil industry
  - Suspension components
  - Automotive valves
  - Aerospace landing gear

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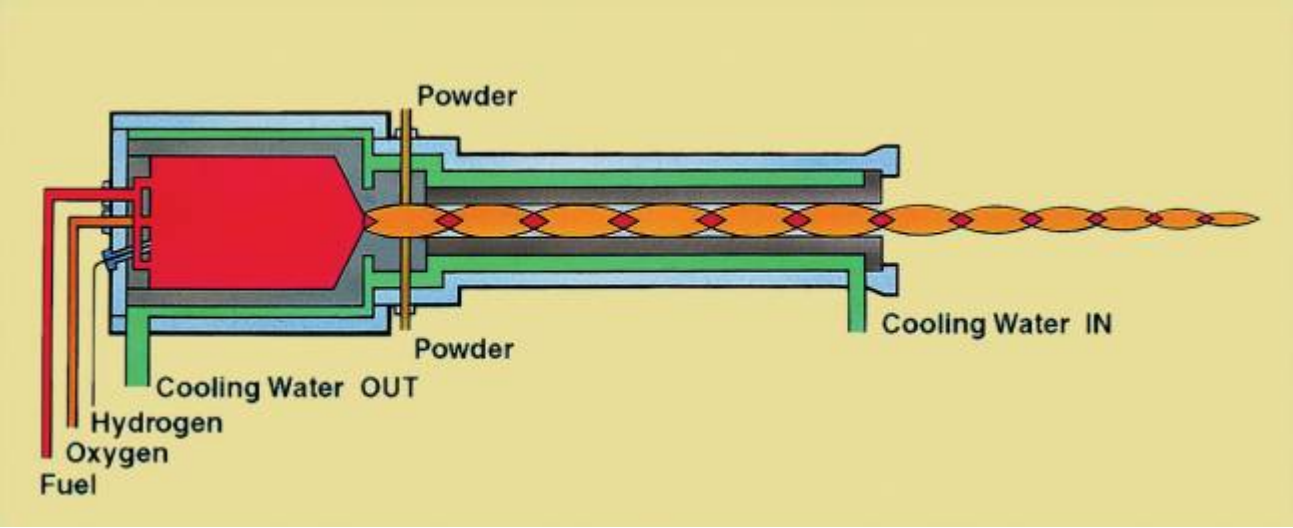
HVOF process



- Oxygen / liquid fuel (kerosene) ignites in chamber
- Combustion gases accelerated through nozzle (Mach 2+)
- Powder injected into gas stream
- Particles soften and impact substrate at high velocity

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MET-JET 4L System

- Metallisation MET-JET 4L (Liquid)
  - PC / Touch screen control
  - Clean burn / simple nozzle
  - Rotating disc Powder feeder
  - Oxy/Kerosene system (high density, thick coatings)
  - Mass flow control (repeatability and quality coatings)

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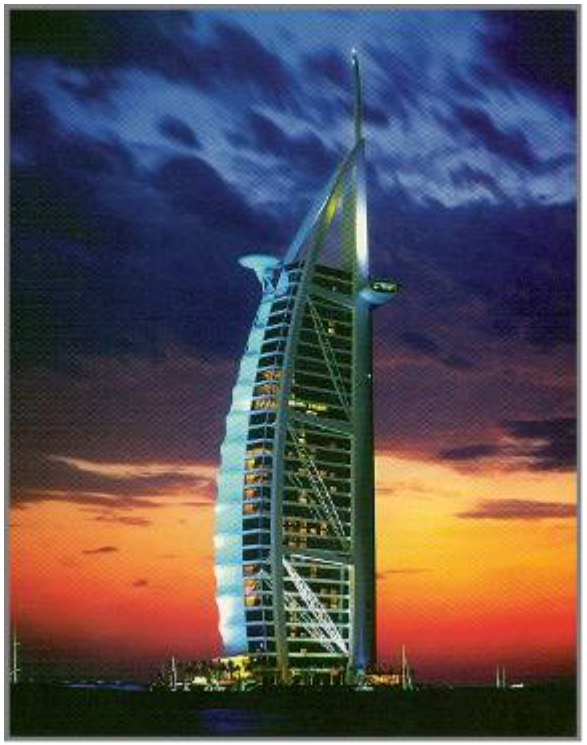
Anti-corrosion



Burj Al Arab Hotel, Dubai. TSA 10,000m^2 150µm

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Anti corrosion

Vessels and Pipework (internal TSA), Gas Plant, UAE

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Anti-corrosion

Concrete bridge sprayed to give galvanic protection to reinforcing bars

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Anti-corrosion

- Forth Road bridge sprayed by Metallisation 1963. Original zinc still excellent and being re-painted

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Anti Corrosion. Moana III

Being Arc Sprayed on a blasted SA3 surface with Zinc at 100µm using Metallisation Arc Spray 234 system

After more than 20 years, the vessel has been repainted on the hull, but no corrosion is apparent in areas where the Zinc Arc Spray was applied

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Anti-corrosion.

Automated LPG bottle coating, Luxembourg. Twin Arc 528 pistols

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Tungsten Carbide Cobalt
Extreme Hardness
HVOF Sprayed
To Diverter Valve
Body Internals.

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Print, Packaging & Paper

- Ink Rollers, Copper, Ceramic, Steel
- Ceramic Anilox Rollers
- Anvil Cylinders
- Litho Cylinders
- Path Rollers
- Feed Rollers
- Yankee Dryers
- Chrome Replacement

Repair
Refurbish
OEM

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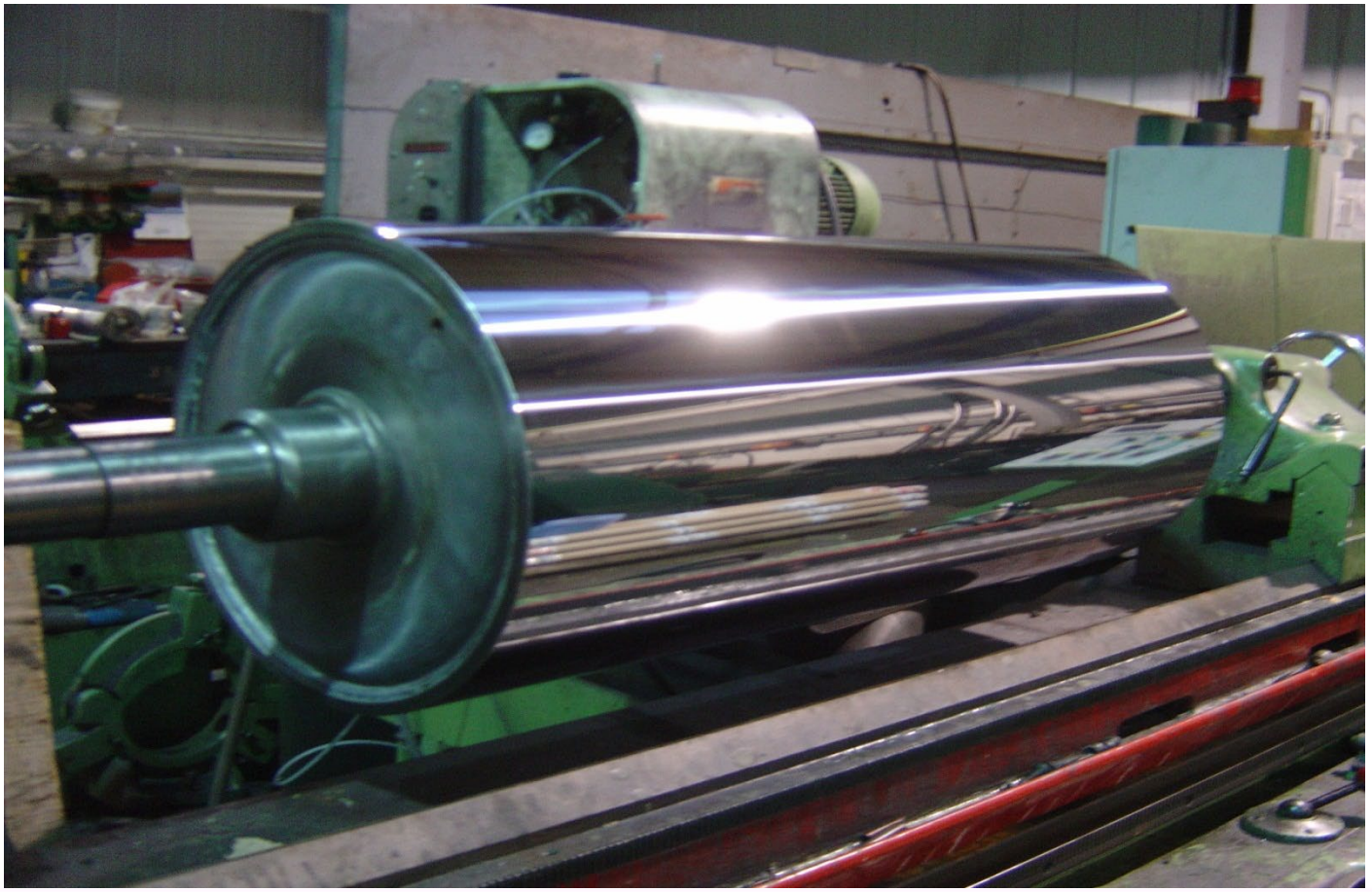
HVOF Sprayed NiCrBSi Water Cooled Print Roll



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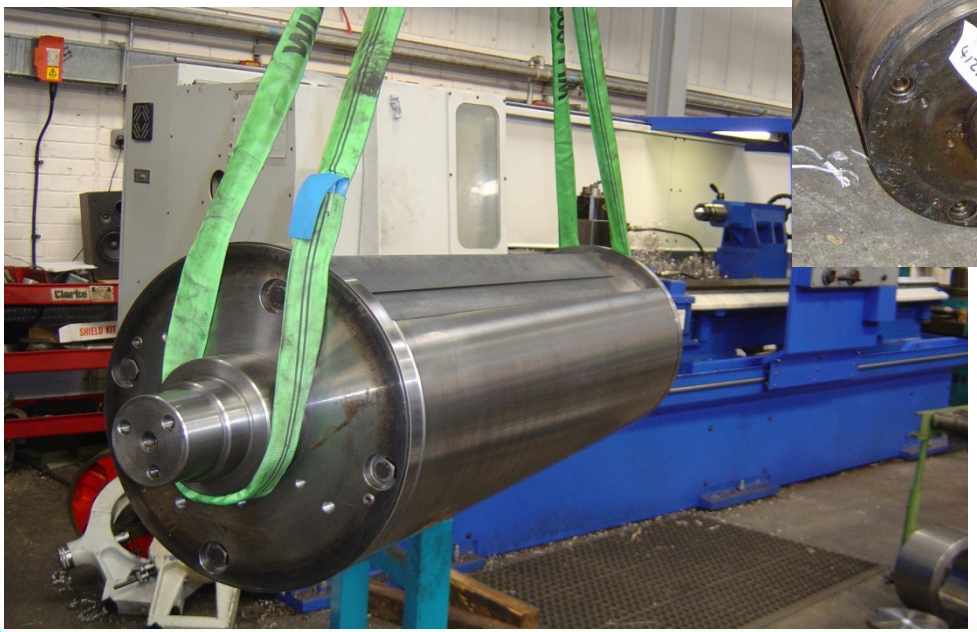
Offset Litho Print Cylinders Refurbished in Arc Sprayed 60E 13% Chrome Steel

Before

After



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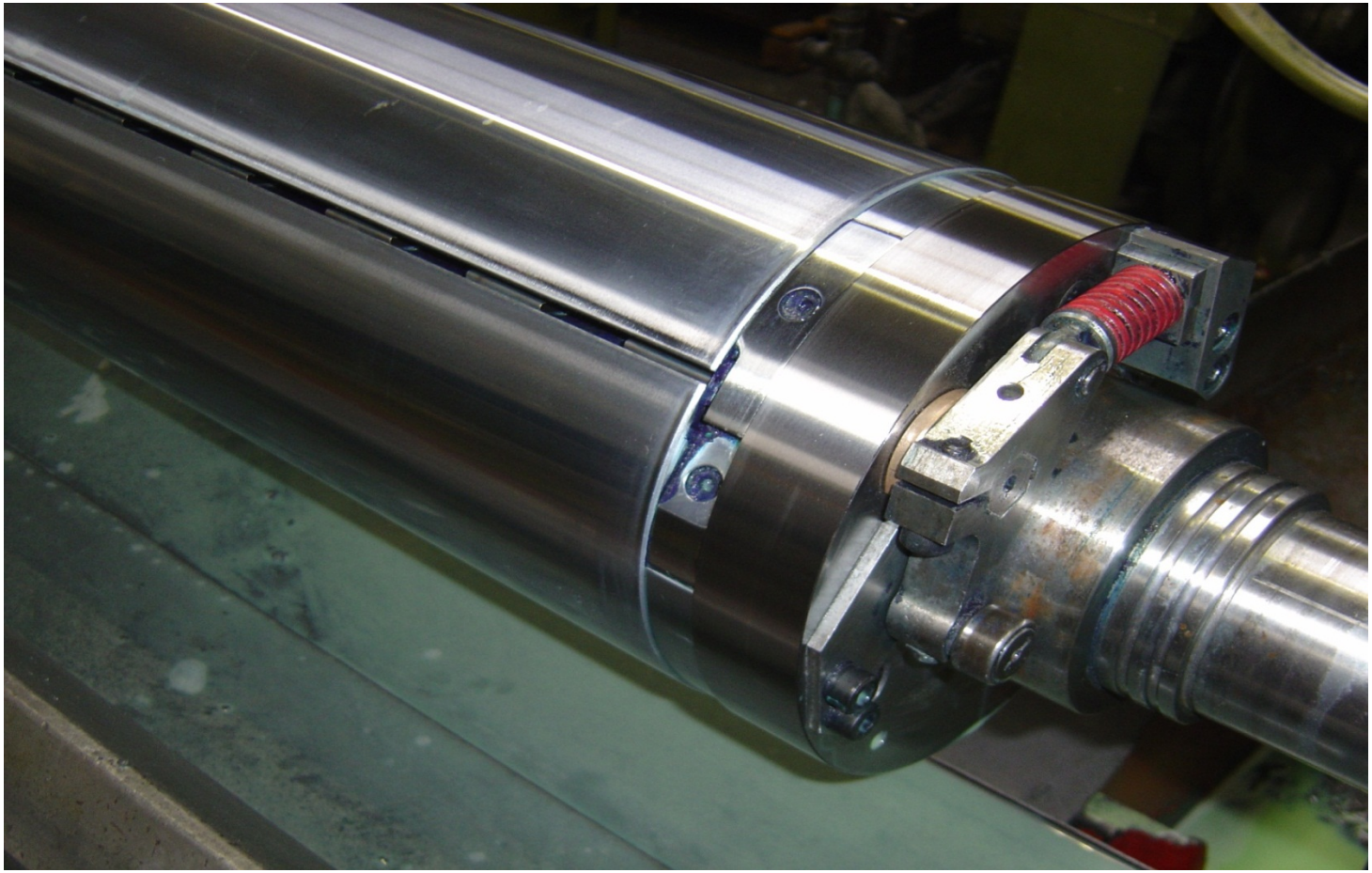
HVOF Sprayed NiCrBSi Web Printing Cylinder



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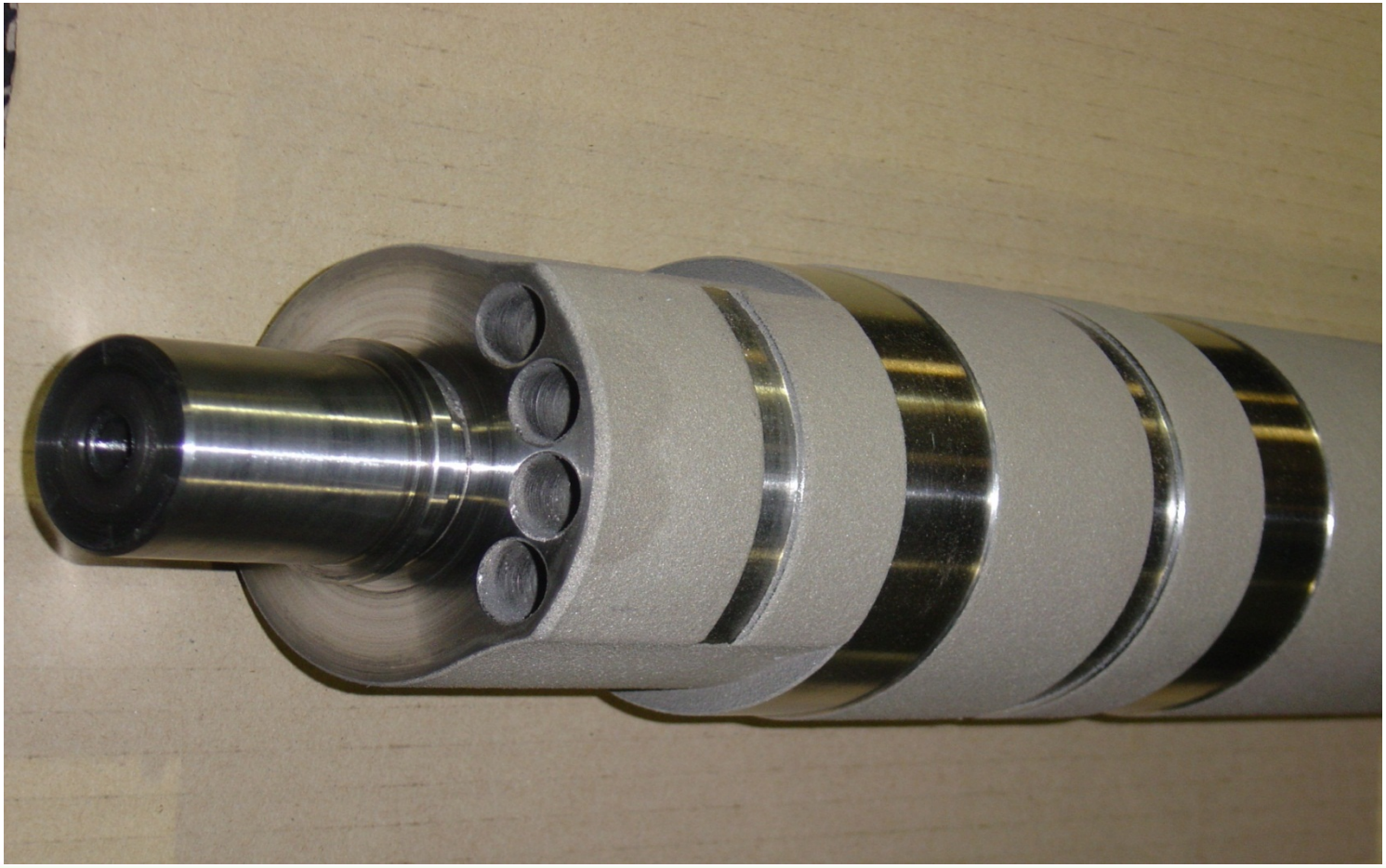
Arc/ HVOF Combined Coating on Traction Infeed Roll



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Blast Furnace Fan

Blade Leading Edges
HVOV Tungsten Carbide Coated

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Oil & Gas

Extreme Hardness Coatings On
Down Hole Tooling,
Valves,
Sensors.

Anti-corrosion Coatings On Offshore Structures

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Anti-corrosion. Offshore Oil and Gas

- Marathon Brae B, flare boom, jacket, cellar decks all sprayed with aluminium.
- All flare booms and almost all jackets and cellar decks in North Sea are sprayed

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Chistmas Tree Of Gate Valves

Most Gate Valves Use Carbide Coatings
to Resist abrasive Wear, Corrosion, Heat And
Pressures Up To 30,000 p.si.

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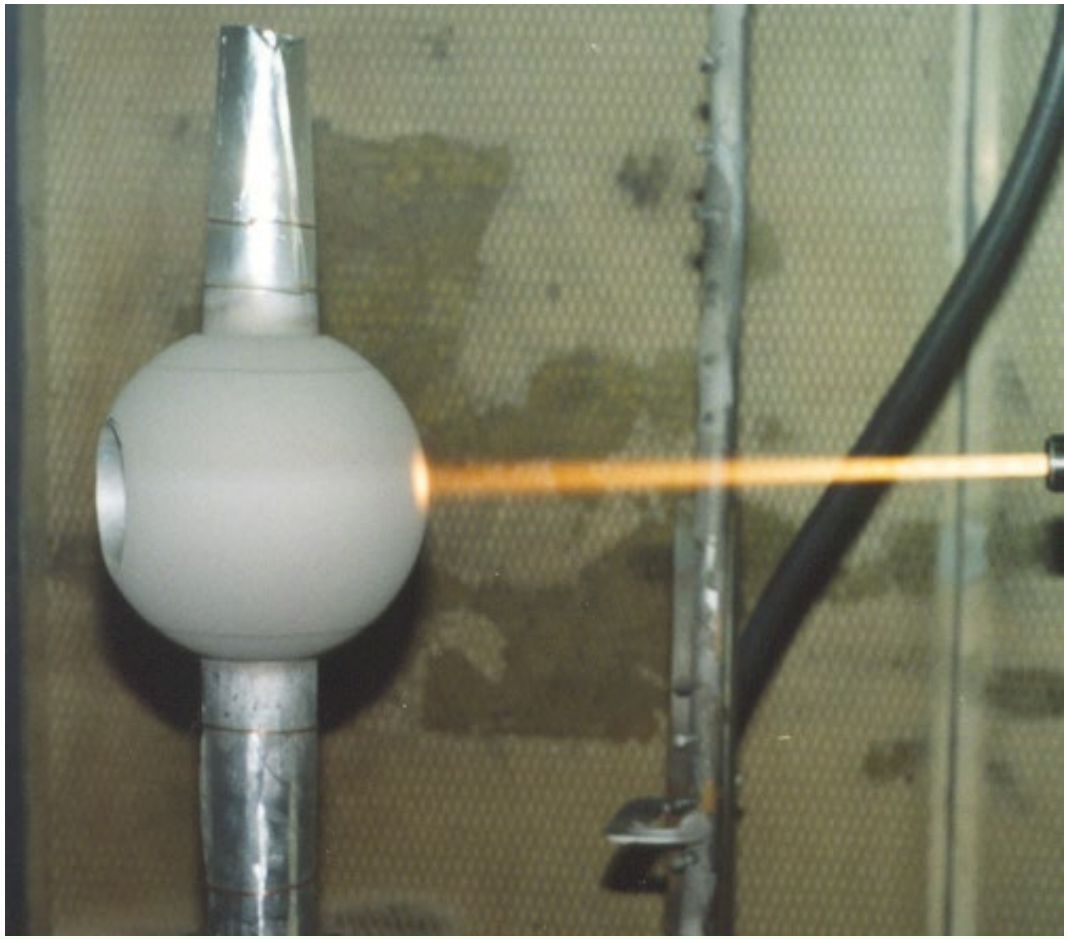
HVOF Carbide Coated Ball & Gate Valves



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Rock Drilling Bit HVOF Tungsten Carbide Coated

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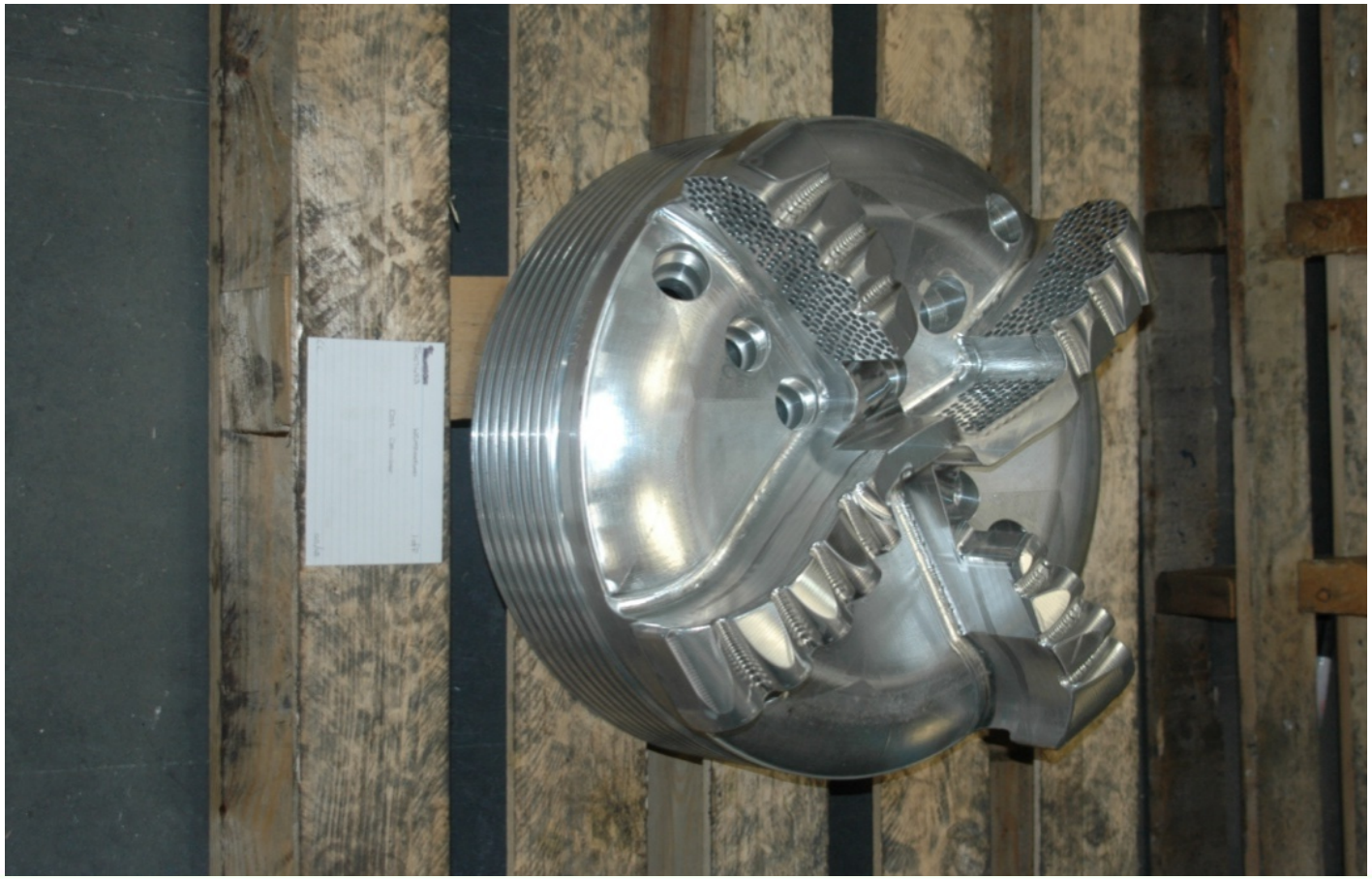
Aluminium Sand Drilling Bit For HVOF Tungsten Carbide Coating



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Oil & Gas Riser Pipes
Anti-corrosion & HVOF
Carbides

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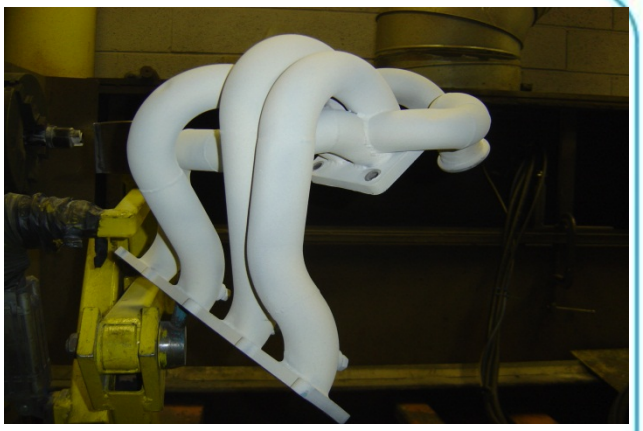

Motorsport
Thermal Barrier Coatings
Plasma Sprayed

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Aerospace

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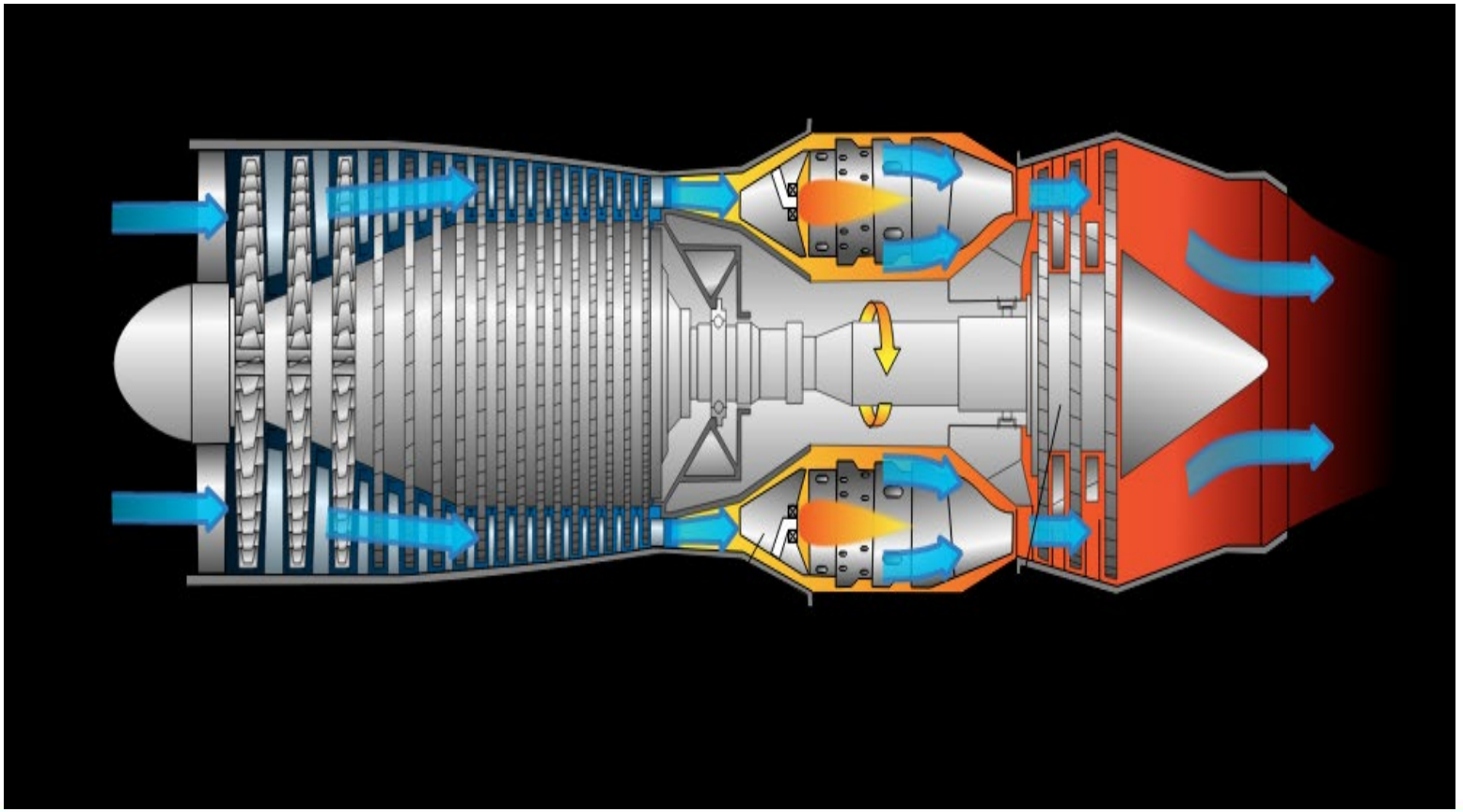
Gas Turbine.
Extensive use of Plasma Sprayed Thermal Barrier Coatings & Abradables



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Aircraft Landing Gear
Hard Chrome Replacement. Carbides or NiCrBSi HVOF Sprayed

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Hard Chrome Replacement. Carbides or NiCrBSi HVOF Sprayed

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Hard Chrome Replacement. Carbides or NiCrBSi HVOF Sprayed

Hydraulic Ram Piston Rod

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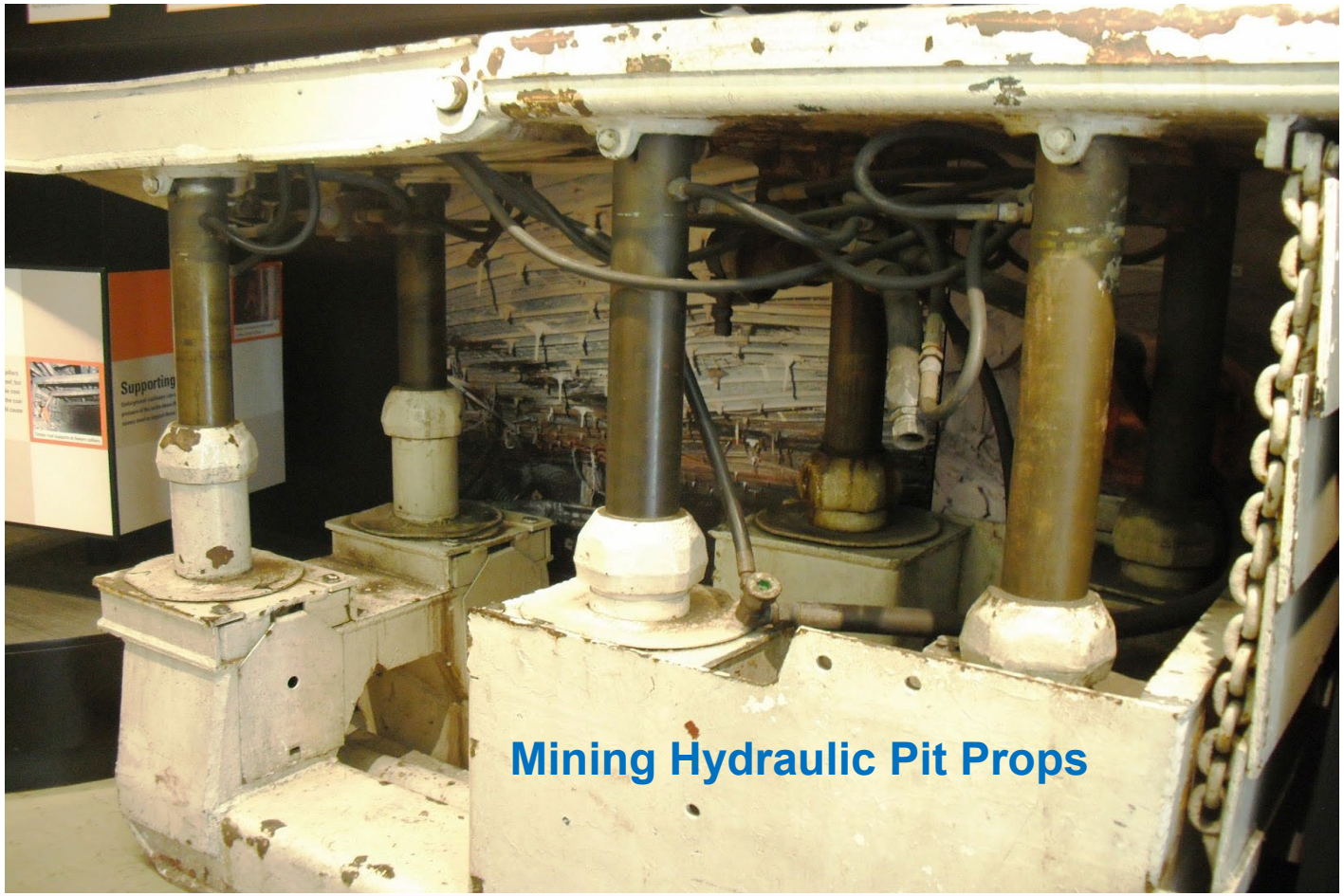
Hard Chrome Replacement. Carbides or NiCrBSi HVOF Sprayed



Mining Hydraulic Pit Props

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Medical Implants

Plasma sprayed coatings of **hydroxyapatite** are often applied to metallic implants to alter the surface properties.

The body sees hydroxyapatite-type material which it is happy to accept.

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PROCESS	TEMP ˚C	PARTICLE VELOCITY m/s	BOND STRENGTH MPa	POROSITY %	TYPICAL MATERIALS SPRAYED	TYPICAL APPLICATIONS
Wire flame spray	3000	50-100	5-27	10-15	Aluminium Zinc Molybdenum Other Metals	Anti-corrosion coatings
Arc Wire	4000	50-100	14-50	10-15	Aluminium Zinc Engineering metals	Anti-corrosion coatings, Engineering reclamation
Powder flame spray	3000	20-50	14-34	5-15	Metals Ceramics Carbides	Engineering reclamation, Jobbing work
Plasma	15000	50-150	34-68	<1-5	Ceramics TBCs Metals Abradables	Aerospace, gas turbines, medical implants, print rollers, thermal barrier coatings ,
HVOF	2500	300-700	41-95	<1	**Carbides** **Metals**	Oil & gas industry components, extreme wear applications, hard chrome replacement, aircraft landing gear

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Quick quiz – is thermal spray a hot or cold process?

- Test piece
  - 1 x tech service engineer
  - Coating – flame sprayed aluminium
- Don’t try this at home – just for demonstration purposes only

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