

PYROGENESIS S.A. Advanced Materials Thermal Spray Technologies



THERMAL SPRAY

INDUSTRIAL APPLICATIONS

Applications through Partnership and Innovation



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Thermal Spray principle: Schematic representation





Schematic diagram of spherical particle impinging onto a flat substrate (left) and 3D view of deposited coating (right)









Thermal Spray Technologies

- Plasma Spray (APS and VPS)
- HVOF
- Wire Arc Spray
- Wire and Powder Flame Spray
- Liquid (slurry or solution) Precursor Plasma Spray
- Cold Spraying (exploratory)



FOR

- Protective and Functional Coatings
- Component Restoration
- Net-Shape Spray Forming



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Atmospheric Plasma Spray, APS

Plasma Spray Process













APS layer microstructure



Metallic layer Alloy FeCrMn Hardness 450 HV Porosity <1% Adhesion >55 MPa





Vacuum Plasma Spray (VPS)





High Velocity Oxygen Fuel Spraying, HVOF

High Velocity Oxy-Fuel













HVOF Sprayed Layer Microstructure



Layer WC/12Co Hardness 1200 HV Porosity <0.5% Adhesion >70 MPa





Wire Arc Spraying, WAS





WIRE ARC LAYER MICROSTRUCTURE



Metallic layer With 20-25% oxides Hardness 500 HV Porosity <3% Adhesion >45 MPa





Wire Flame Spray









Powder Flame Spray

Flame Spray coating









Powder Flame Spray







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COLD SPRAY TECHNIQUE

Cold Spray is a materialdeposition process whereby particles of diameters between 1 and 40 microns in diameter are impacted at high velocity onto a substrate. The particles are placed in a gas stream of nitrogen, helium or air. The then stream is heated and accelerated through a **de Laval** supersonic nozzle at speeds ranging from 1000 to 2500 meters per second. The particle stream is directed towards a substrate, where the particles are consolidated in the solid

state 🛛



TURKEYTRIB '15, 1st International Conference on Tribology, 7-9 October 2015, Istanbul, Turkey



TS production booth with robot







Quality Control Laboratory



Optical Microscope with Image Analysis Software



Microhardness Tester



Metallography Preparation Equipment



Portable Pneumatic Adhesion Tester





Component Restoration by Thermal Spray





Train Wheel Shaft restoration 1











Train Wheel Shaft restoration 2





Restoration of Valve Ball - PPC







Restoration of Valve Ball - PPC





Restored crankshaft journal





Gear shaft restoration





Boat Central Shaft Restoration







Small Crankshaft restoration (Air compressor)





Restoration of turbine gas drain (Hellenic Navy)







Patenting Roll before and after restoration







Wear resistant coating on battle tank AI wheel (Hellenic Army)







AL ALLOY NOSE WHEEL RESTORATION

THERMAL SPRAY

SOVENEL

CENSE

120

STUN AROTE

SERTAL NOVES-



Battle Tank Engine Cylinder *ID Plasma Spray* (Hellenic Army)







In-situ restoration of a big industrial shaft (9,5 m in length, 65 cm in diameter) *PPC (ΔΕΗ)*



Power Production *Boiler Wall Protection Coating, PPC (ΔΕΗ)*

HEAT EXCHANGE – ENERGY RECOVERY TUBES

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Coatings on fan blades PPC (ΔΕΗ)

FDF aluminum fan during robot-spraying of particle erosion resistant coating

Coatings on fan blades PPC (ΔΕΗ)

IDF fan with Ni-based coating C-22 for protection from sulfur corrosion

HVOF carbide coatings on piston rings

Carbide coatings by HVOF Coffee Mills, NESTLE

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WC coatings by HVOF, Coffee Mills, NESTLE

Tungsten Carbide coatings on valve balls and seats

Cu coating on AI rolls

Molybdenum (Mo) coatings on synchronization rings

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Ceramic Zirconia Coatings on Turbine Combustion Heads by APS

Ceramic Zirconia Coatings on Piston Heads by APS

TBC on Car Exhaust Systems

CERAMIC COATING ON SLEEVES

Ceramic coatings on pumps

Coatings on Pump components

Ceramic Coatings Repair

Ceramic Coating Restoration

Carbide coatings on turbogharger parts TURBO GENERAL

Corrosion Resistant coatings (Albased) on big steel construction parts METKA

Corrosion Resistant coatings (Al-based) on big steel construction parts *METKA*

Rion-Antirion Bridge, Patras, Greece

Zn-Al coatings for corrosion resistance DESFA-Revythousa

Επικάλυψη με Zn-Al για αντιδιαβρωτική προστασία σε πάνελς αεριοποίησης υγροποιημένου φυσικού αερίου

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Al-based coatings on large steel surfaces (metallurgical furnaces) LARCO SA

In situ Zn Galvanizing LYKOMITROS STEEL

WIND TURBINE APPLICATIONS ROKAS

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WIND TURBINE APPLICATIONS

Thermal spray coatings offer a cost-effective solution, aimed at ensuring long service life. Arcspray zinc and zinc-aluminum coatings are largely used for corrosion protection in both offshore and onshore installations. Coated areas include"

steel towers (inside and outside before painting), foundation plates, slewing rings, the complete machine housing, and the hub.

see separate document

Hydropowder: Tungsten Carbide coating on Kaplan Turbine blade

Hydropowder: Cavitation damage of a Francis turbine

PyroGenesis Hydropowder: Tungsten Carbide coatings on Pelton Wheels

ISO 9001

Dimension Restoration of buses

Αποκατάσταση διαστάσεων σε μπούσες με θερμικό ψεκασμό

Επαναφορά διαστάσεων

Αποκατάσταση διαστάσεων σε στρόφαλο με θερμικό ψεκασμό

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