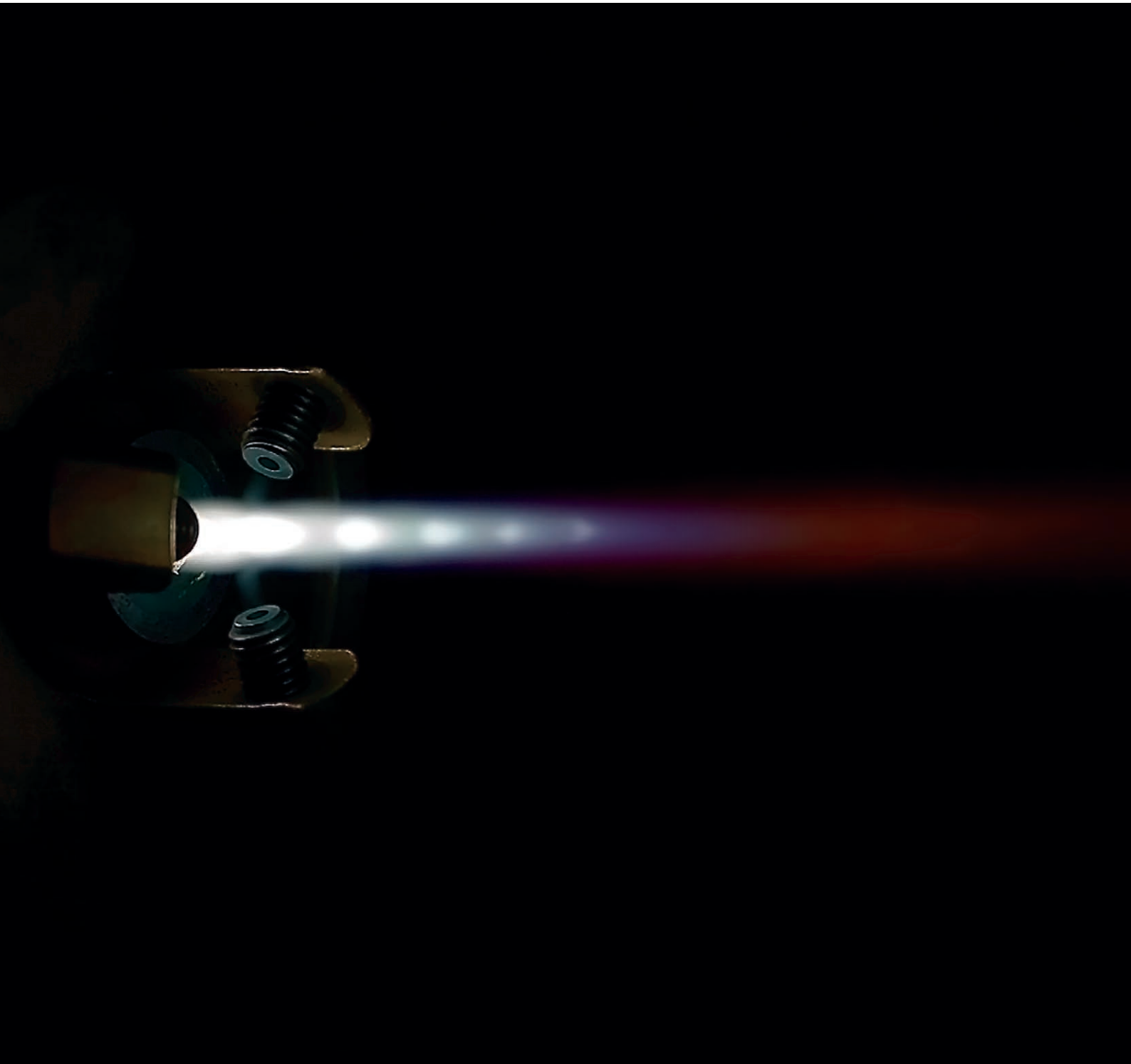


Solutions Flash

Produce excellent quality PWA 257 high-energy plasma sprayed carbide coatings with TriplexPro-210

SF-0006.2 – October 2014



Today's situation

Many spray shops have a need to apply quality carbide coatings using an air plasma spray system. While application of carbide coatings is best performed with an HVOF spray system, high energy plasma is considered an acceptable substitute and is often specified on critical components by turbine engine manufacturers. Examples of such specifications include Pratt Whitney PWA 257-1 for tungsten carbide coatings and PWA 257-2 for chromium carbide coatings.

In the standard high-energy plasma process using a conventional gun, the plume temperature rapidly decays after exiting the nozzle as the plasma gas expands. Because the gas is heated by the arc, there is no continued heat generation

The Oerlikon Metco solution

The Oerlikon Metco TriplexPro™-210 plasma spray gun equipped with the 5 mm high velocity (convergent/divergent configuration) applies PWA 257-1 and 257-2 high energy carbide coatings of excellent quality when used with a Oerlikon Metco TriStar IPS 500/200 V Power Supply. This configuration permits gun power levels of up to 90 kW with operation in the high velocity (supersonic) regime. The coatings produced are hard, dense and exhibit a homogeneous microstructure.

TriplexPro-210 maintains coating quality at high-energy spray conditions for extended periods of time without the need to change gun hardware. It can do so at elevated spray rates and at high deposit efficiencies.

Solution description and validation

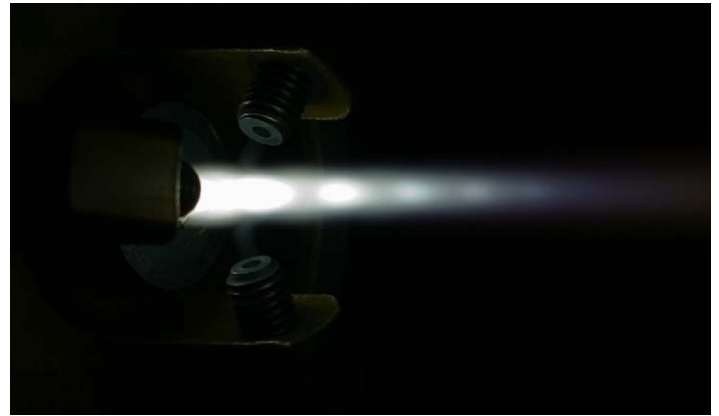
TriplexPro-210 Plasma Spray Gun

The Oerlikon Metco TriplexPro-210 Plasma Spray Gun is capable of a much broader operating regime than conventional plasma spray guns. The triple cathode, cascading anode design of the TriplexPro-210 produces a very stable plasma plume with highly efficient heating. The design also extends the service life of the internal gun components and long spray runs with little or no process drift.

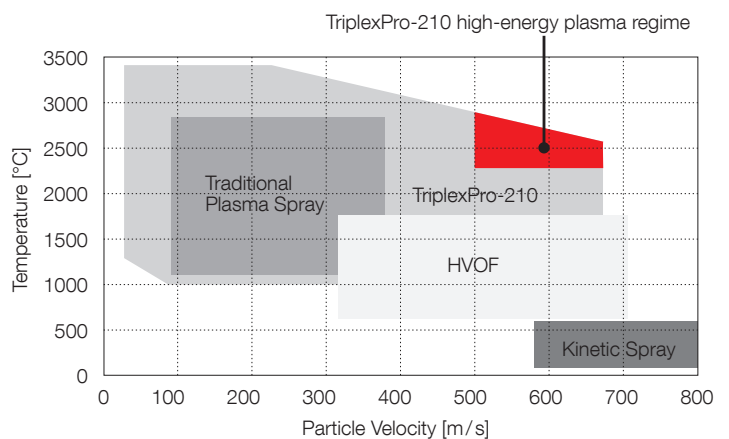
To achieve high velocity conditions in a plasma spray gun, it is necessary to raise the internal gas pressure. However, increased pressure constricts the arc root attachment at the nozzle. In the TriplexPro-210, an electrically neutral stack between the electrode and the nozzle forces long arc lengths, which allows regulation of voltage independently of pressure. This permits the TriplexPro-210, to operate at high voltages, thus producing a high energy flux density at lower amperages.

beyond the final point of the arc attachment in the nozzle. To generate the necessary thermal and kinetic energy, the use of high current parameters with high argon, argon/helium or argon/nitrogen/hydrogen gas flows are used. These parameters are aggressive on gun hardware, thermally inefficient and typically have a narrow window of operation.

Often, these conditions lack the duration requirements necessary to effectively coat components that require long run times. Coating application is limited to short runs to compensate for this lack of consistency and rapid deterioration of coating quality.

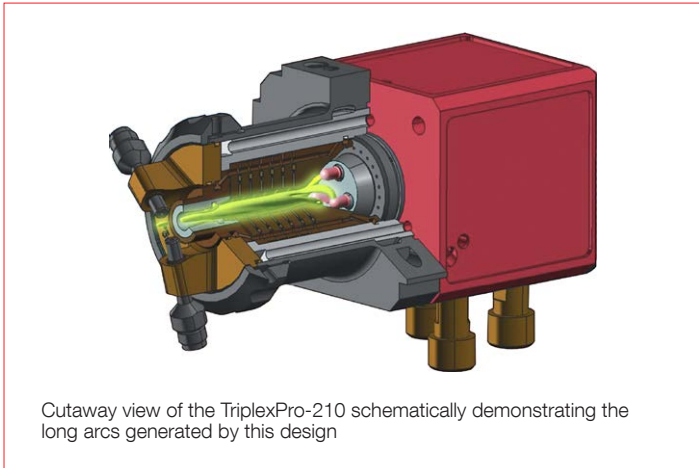


The Oerlikon Metco TriplexPro-210 plasma spray gun with high velocity, supersonic plume.



Particle velocity vs. particle temperature diagram that shows the broad application range of the Oerlikon Metco TriplexPro-210 plasma spray gun compared to other thermal spray processes and traditional plasma spray.

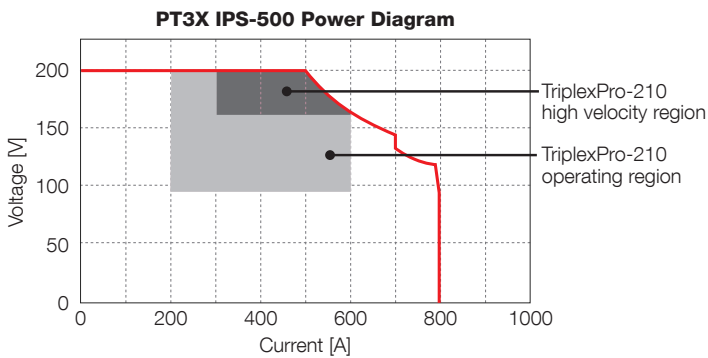
Because the total arc current is divided across the three electrodes, the flux density for each individual arc is far lower than the single arc of a traditional plasma spray gun operating at comparable power levels. This design produces a very stable plasma plume, even at high gas velocities and power inputs, but with far less damage to gun components. As a result, gun components last far longer compared to traditional plasma guns, even at high velocity conditions.



Oerlikon Metco PT3X IPS-500 Plasma Power Supply

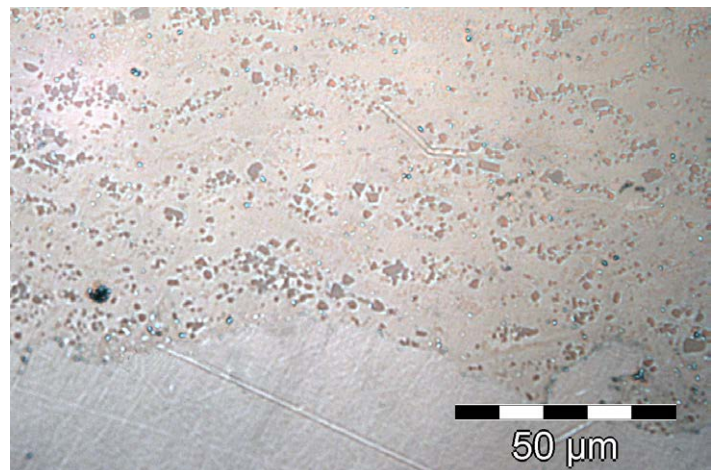
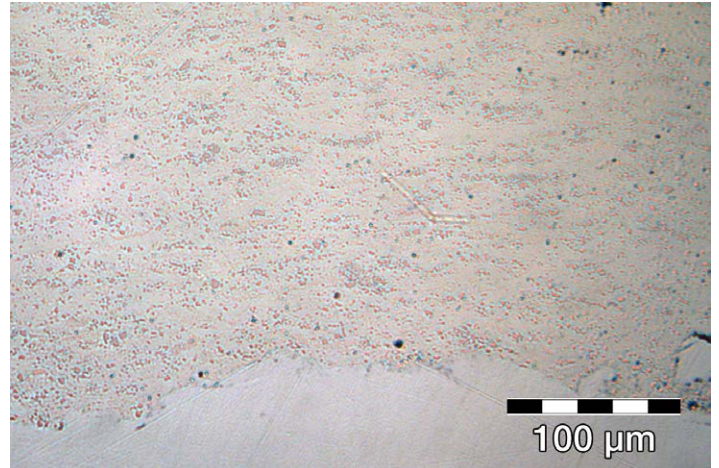
The Oerlikon Metco PT3X IPS-500 is an advanced plasma power supply developed specifically to utilize the full capabilities the TriplexPro-210, including high velocity parameters. This power supply produces a nearly ideal DC waveform, which is free of residual ripple, to stabilize the spray process. It has a power factor $\cos \phi$ approaching unity.

The PT3X IPS-500 is rated for 100 kW at 100% duty cycle. When used with a TriplexPro-210 plasma spray gun, high voltage (greater than 130 volts) and high power levels (greater than 60 kW) can be consistently maintained.



PWA 257-1 tungsten carbide coating

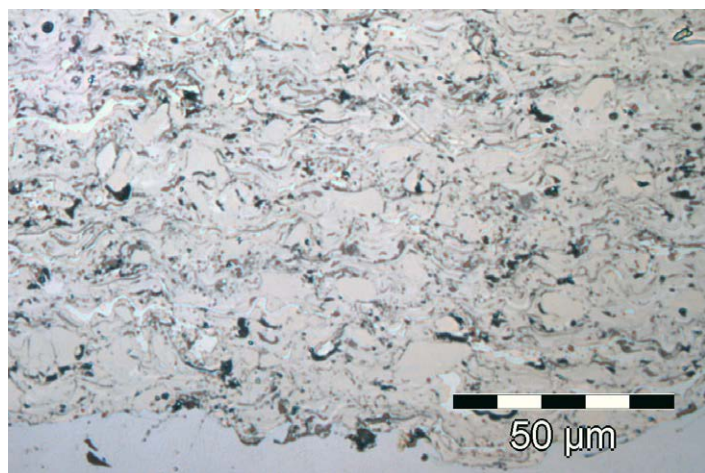
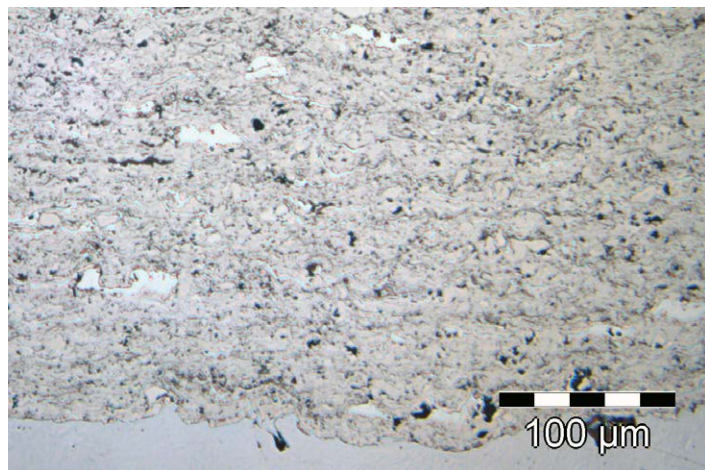
The Pratt Whitney PWA 257-1 coating specification uses a tungsten carbide [88WC/12Co]. PWA 257-1 coatings applied with the TriplexPro-200 and Metco 71VF-NS-1 powder are very dense, have good hardness, does not exhibit splat layers and the carbides are fully dispersed. They fully meet the PWA 257-1 specification.



Argon	160 NLPM	(365 SCFH)
Helium	200 NLPM	(457 SCFH)
Water flow	22 l/min	(350 gal/h)
Current	450 A	
Voltage (total, at gun)	190 V	
Power	86 kW	
Spray rate (3 ports)	25 g/min	
Spray distance	130 mm	(5.125 in)
Deposition per pass	< 5.1 µm	(0.2 mils)
Deposit efficiency	50 – 55 %	
Micro hardness	1180 HV300	
Porosity	< 1 %	
Bond strength	> 69 MPa	(10,000 psi)

PWA 257-2 chromium carbide coating

The Pratt Whitney PWA 257-2 coating specification is a chromium carbide [83Cr₃C₂ 7(Ni 20Cr)]. PWA 257-2 coatings applied with the TriplexPro-210 and Metco 82VF-NS powder are dense, exhibit high hardness and the microstructure easily meets specification requirements.



Argon	70 NLPM	(160 SCFH)
Helium	70 NLPM	(160 SCFH)
Water flow	21 l/min	(333 gal/h)
Current	550 A	
Voltage (total, at gun)	129 V	
Power	71 kW	
Spray rate (3 ports)	25 g/min	
Spray distance	120 mm	(4.75 in)
Deposition per pass	< 19 µm	(0.75 mils)
Deposit efficiency	55 – 60 %	
Micro hardness	925 HV300	
Porosity	< 1 %	
Bond strength	> 69 MPa	(10,000 psi)

Note: Coating results are reported for the photomicrographs shown. Customers' results will show some variation depending on specific spray conditions.

Information is subject to change without prior notice.

SF-0006.2 – TriplexPro™-210 High Energy Coatings
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Customer benefits

Effective

- Produce quality high-energy plasma coatings with low porosity, high hardness and good homogeneity.
- Highly stable process ensures coating specification requirements are met with little or no process drift during spray campaigns. (Note: gun component service life with high energy parameters is substantially less than with standard parameters)
- Low temperature parameters prevent distortion of critical and thin-walled components
- Can apply coatings in smaller bores than HVOF guns.

Efficient

- Significantly increase production throughput with higher deposit efficiencies and/or spray rates.
- High energy configuration is quickly achieved with a simple nozzle change

Economical

- Save material costs with higher deposit efficiencies.
- Save production time with higher spray rates, higher throughput and a stable process that does not require constant adjustment.
- Save on spray run qualification costs resulting from higher process reproducibility.

Environmental benefits

- High deposition efficiency reduces waste.
- Low gun decibel level reduces shop noise levels.
- No thoriated tungsten components

Contact your Oerlikon Metco Sales representative for more information about the benefits of TriplexPro-210 to apply high-energy carbide coatings to meet aerospace specifications.

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