

## Plasma Coating Process

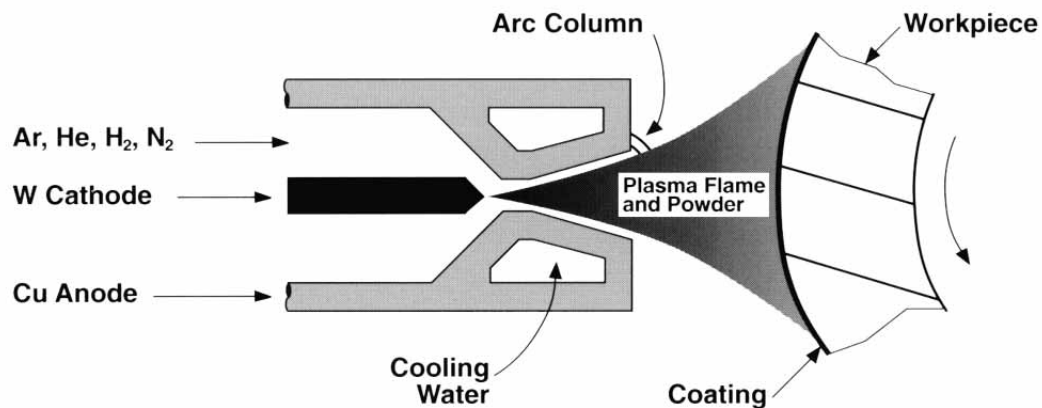


Figure 1

A plasma torch is shown schematically in Figure 1. Gas, usually argon and/or nitrogen, with hydrogen or helium admixed in some cases, flows through a cylindrical copper anode which forms a constricting nozzle. A direct current arc is maintained between an axially placed tungsten cathode and the outer or expanding portion of the anode. A gas plasma (ionized gas) is generated with a core temperature of about 50,000°F (30,000°C). Powder, with a particle size ranging up to about 100 microns, is fed into the plasma stream in a variety of ways and locations. The powder is heated and accelerated by the plasma stream, usually to temperatures above its melting point, and to velocities ranging from 400 to almost 2,000 ft/sec. The actual powder temperature distribution and velocity are strongly a function of the torch design.

The gases chosen for plasma do not usually react significantly with the powder particles; however, reaction with the external environment, normally air, may lead to significant changes in the coating. The most significant reaction with metallic and carbide coatings is oxidation. The unique design of Praxair Surface Technologies torches inherently results in far less oxidation than occurs with most other plasma torches. To reduce degradation during deposition even further, coatings may be produced using either an inert gas shield surrounding the effluent or by spraying in a vacuum chamber under a low pressure of inert gas. Argon is usually used in both cases as the inert gas. A proprietary Praxair gas shroud is extremely efficient in inhibiting oxidation and is less costly than spraying in low pressure chambers.

Plasma deposition is, of course, a line-of-sight process. However, because of the relatively small size of the torch, the inside surface of hollow cylinders (and some other more complex shapes) can be coated with appropriate traversing equipment. Torches have been produced which can coat inside cylinders to substantial depths.

The as-deposited surface roughness of Praxair plasma coatings vary with the type of coating from about 60 to over 300 microinch Ra. Although for many applications the coating is used as-deposited, some are ground or ground and lapped to 1 to 10 microinch, Ra. Typical coating thicknesses range from about 0.002 to 0.020 inch, but both thicker and thinner coatings are used on occasion.

Complete details about specific coatings and design considerations are available from technical field representatives. Contact one of these headquarter locations for the name of the representative in your area. In the United States call toll free: 1-800-822-7284

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*Almost any material that melts without decomposing can be used to make D-Gun™ or non-transferred arc plasma sprayed coatings. Both techniques were invented by our scientists. In both, the coating material in the form of powder is heated and accelerated in a high temperature, high velocity gas stream and projected against the surface to be coated. The molten or semi molten droplets form thin, overlapping platelets which quickly solidify on the surface; many layers of such platelets forming the coating.*

*A major attribute of this technology is the ability to apply coatings with very high melting points to substrates (work piece or part) without significantly heating the substrate. Thus coatings can be applied to fully heat treated, completely machined parts without danger of changing the metallurgical properties or strength of the part and without the risk of thermal distortion inherent in high temperature coating processes.*

*Standard production coatings include pure metals and metallic alloys such as nickel or nichrome, ceramics such as alumina or alumina-titania, and cermets such as tungsten carbide cobalt. These coatings are used in virtually every type of industry-ranging from the space shuttle to submarines, from steel mills to medical instruments, and from gas turbine engines to diesel engines. Their primary purpose is usually to combat wear (abrasive, erosive, or adhesive) often in very corrosive environments.*

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