Thermal Spray Process | Super D-Gun™

The Super D-Gun™ process is an advanced thermal spray method that yields unique coatings with extraordinary wear and mechanical properties. Super D-Gun particle velocities are higher than traditional thermal spray processes (up to 3000 ft/sec or 900 m/sec). The resulting coatings have a characteristic thermal spray lamellar microstructure, but with a density that is very close to theoretical.

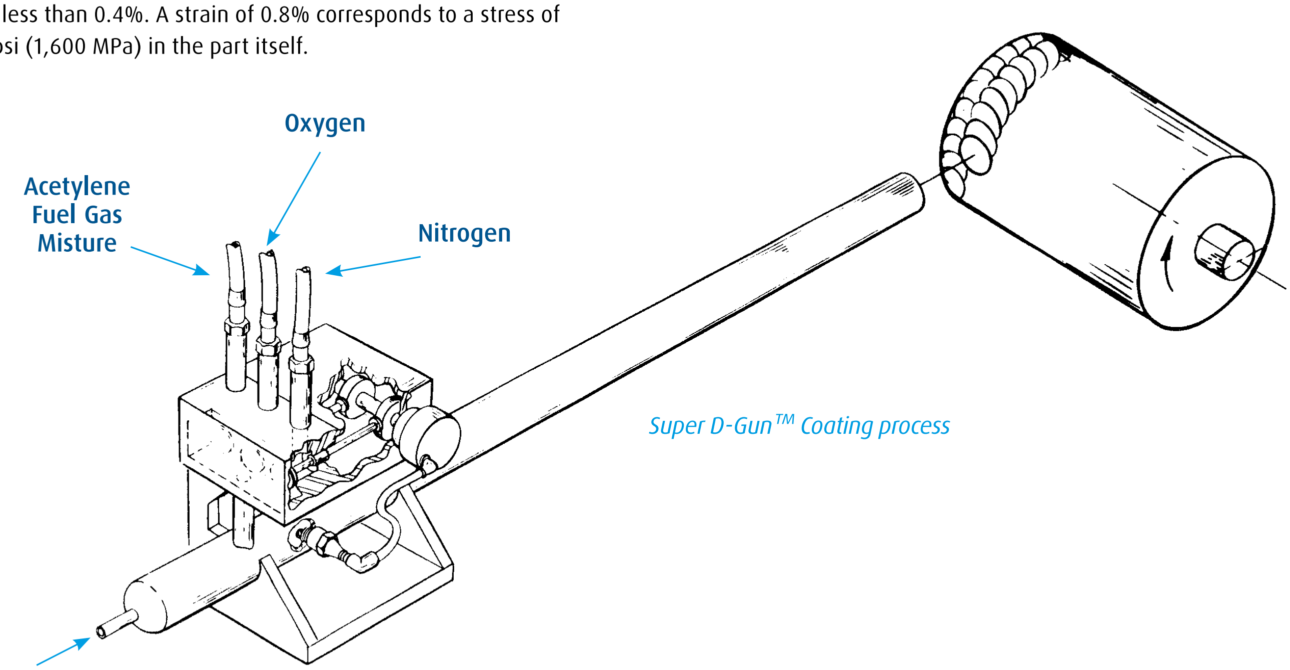
The Coating

The extremely high particle velocities of the Super D-Gun process result in significant advances in coating properties over those of other thermal spray coatings, even over comparable conventional detonation gun coatings. For example, using a modified Ollard test, tensile bond strengths in excess of 30,000 psi (210 MPa) have been measured. Abrasive wear, erosive wear and impact fretting wear have all been substantially improved over comparable conventional detonation gun coatings as well as other thermally sprayed coatings.

Inherent in most thermally sprayed coatings is a residual tensile stress that may substantially reduce the strain-to-fracture of such coatings. This, in turn, may lead to a significant reduction in the fatigue characteristics of coated components. For many of the Super D-Gun coatings, however, a residual compressive stress, in some cases as high as 50,000 psi (340 MPa), is achieved. As a result, strain-to-fracture may be as high as 0.8%, while for most conventional detonation gun coatings it may be less than 0.4%. A strain of 0.8% corresponds to a stress of 240,000 psi (1,600 MPa) in the part itself. Even lower values are common to most plasma-sprayed and other thermally sprayed coatings. The high strain tolerance of coated components permits greater load-carrying capacity in both shock and severe service environments. This high strain-to-fracture tolerance value also strongly influences the effect of Super D-Gun coatings on the fatigue strength of substrates. In some cases, no fatigue debit is measurable. In other cases, the fatigue debit is significantly lower than experienced with conventional thermal spray coatings.

The as-deposited surface roughness of Super D-Gun coatings varies with the type of coating from less than 100 to more than 200 μin Ra (2.5 to 5.0 μm Ra). Although for many applications coating are used as deposited, most coatings are either ground or ground and lapped. Because of the very high density and cohesive strength of Super D-Gun coatings, pit-free surface finishes as low as 0.4 μin Ra (0.01 μm Ra) can be achieved.

Typical coating thicknesses range from about 0.002 to 0.020 inches (0.05 to 0.5mm), but both thicker and thinner coatings can be used depending on the specific application. Because of the unique control of residual stress, Super D-Gun coatings can frequently be used at much greater thicknesses than can be achieved with other thermally sprayed coatings.



Super D-Gun™ Coating process

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The Process

The Super D-Gun process employs a D-Gun as illustrated. Carefully measured gases, usually consisting of oxygen and and acetylene, are fed into the barrel of the gun along with a charge of fine powder. The gas is ignited, and the resulting detonation wave heats and accelerates the powder as it moves down the barrel. The gas velocity and density are much higher than in a conventional detonation gun. The powder is entrained for a sufficient distance for it to be accelerated to its extraordinary velocity. A pulse of nitrogen gas is used to purge the barrel after each detonation.
The process is repeated many times per second. Each detonation results in the deposition of a circle (disk) of coating material a few microns thick. The total coating consists of many overlapping disks. Precise, fully automated disk placement results in a very uniform coating thickness and a relatively smooth, planar surface.

The Super D-Gun process is called line-of-sight because the gun must be able to see the area to be coated. This characteristic is true of all thermal spray coatings. For other thermal spray coatings, the best coating properties are achieved when the angle of deposition is close to 90 degrees to the surface. As the angle of deposition deviates from the optimum, the properties of the coatings begin to degrade. Because of the extremely high powder velocity of the Super D-Gun process, however, little degradation in properties is noted down to at least 45 degrees.

Almost any material that melts without decomposing can be used to make D-Gun or non-transferred arc plasma sprayed coatings. 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 that quickly solidify on the surface; many layers of such platelets form the coating.

A major attribute of this technology is the ability to apply coatings with very high melting points to substrates (workpiece 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 many industries, including steel manufacturing, aviation, paper manufacturing and chemical processing. Their primary purpose is usually to combat wear (abrasive, erosive, fretting or adhesive), often in very corrosive environments.

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