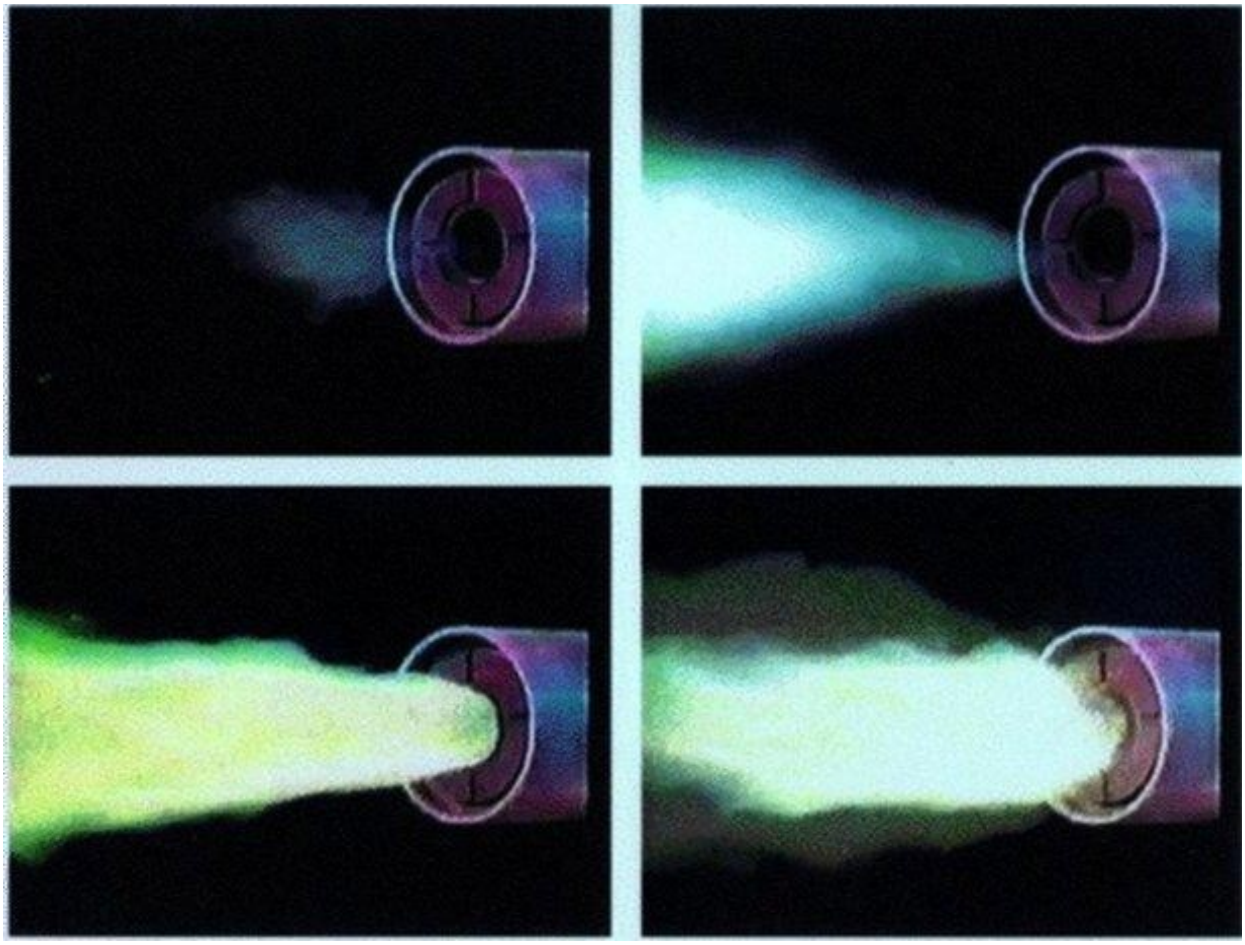
A-Flame Corporation

Detonation Gun

8175 Kroger Farm Road, Cincinnati, OH 45243-1639 USA Tel 1-513-831-4284 Fax 1-513-831-5237

E-Mail: detonation@aflame.com

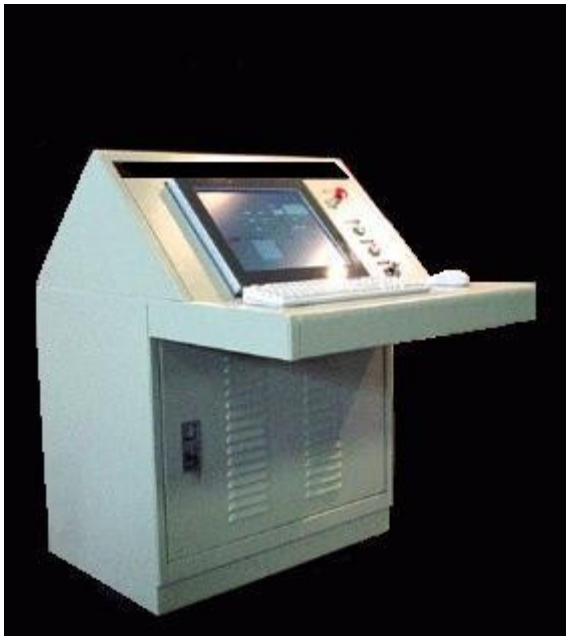


You Can Have It, Too!

The gas detonation coating process is a spraying method aimed at creating a new technological generation of production coatings, or the production of bulk component parts, made from powders. The above images show the flow of detonation products from the Detonation Gun

barrel. Four photographs are taken with a 50-microsecond interval between each. This illustrates the ultra-fast nature of the detonation process.

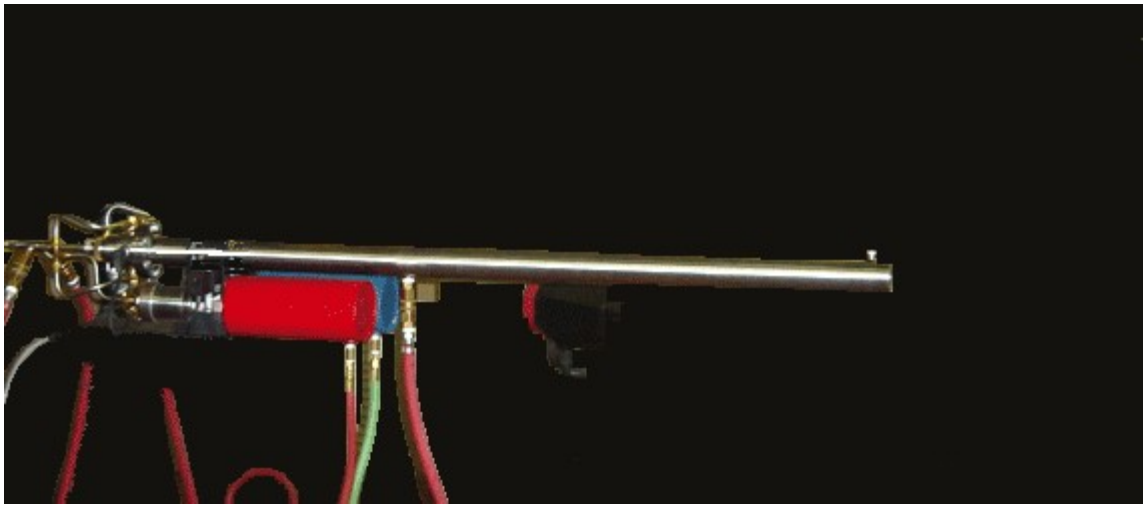
The deposition of coatings is done, by using the energy of the detonation (explosion) of gaseous mixtures to achieve powder acceleration. The effect of gas detonation results in a premium coating quality, the lowest substrate temperature, and a very economical, and safe manufacturing operation. The patented design of the Detonation Gun, uses the gasses' dynamic effects, to prevent a backflash during detonation, which eliminates the need for mechanical valves, makes the apparatus extremely simple and reliable, while substantially raising the operational frequency and productivity. This process uses a wide variety of fuel gases, including propane, methane, and natural gas.



Main Control Console

Gas and Water Control Unit

This process is capable of producing coatings of the following metals: (Al, Zn, Cu, Fe, Ti, V, Co, Ni, etc.), oxides (Al_2O_3, Cr_2O_3, $MgAl_2O_4$, TiO_2, etc.), carbides (WC, Cr_3C_2, 91WC-9Co, 85Cr3C2 - 15[Ni-Cr], etc.), alloys (2OCr-8ONi, 30Al-O.2Fe-69, 8NI, 53Nb-47Ti, etc.) and compounds (lOONi [B, A], etc.) on various metal, dielectric and plastic substrates; including glass, ceramics, etc. The characteristic value of adhesion is as high as a measured 36,250 psi, porosity <1%, layer thickness is unlimited, deposition efficiency up to 80%, substrate temperature during deposition 20^0-150^0 C.



Advantages Of Gas Detonation Coating Technology

Gas detonation is capable of producing the highest pressure, velocity, and density in the gas flow, which is not achievable by all other spraying techniques. As a result, the detonation coatings are characterized by **extremely high density, microhardness, and low porosity**, and are suitable for applications requiring very high standards, such as aircraft engine components. An example would be production of WC-9Co coatings on the high strength alloy gears of turbines, for helicopter engines, with 0.3% porosity, 250 MPa adhesion and 1392 HV average microhardness. This allowed a 7-fold increase in the operational lifetime of this part.

A great variety of materials can be sprayed by using the detonation technology and a broad selection of base substrates can be coated. In addition to premium coating quality, the use of the gas detonation coating process, provides the following benefits:

- **Low Substrate Temperature:** Due to the intermittent nature of the process, the amount of heat transferred to the substrate stays very low. The substrate temperature, during spraying, does not exceed 150 C and **can be maintained at room temperature**, if necessary. This makes possible the spraying of precision components such as crankshafts, or turbine blades, without the danger of causing thermal deformations, or chemical changes. It is also possible to spray low melting point materials, such as plastics.

- **No Use of Nitrogen:** The use of Nitrogen changes the properties of the detonation wave, particularly its velocity, degrading the quality of the coating. This new gas supply system completely excludes the use of Nitrogen, as a protective gas. A significant feature is that the gases are fed continuously into the combustion chamber and backfiring is prevented by the **special design**

of the gas supply unit. This **eliminates the need for a buffer gas**, as well as mechanically moving valves in the gas supply system, making the process much simpler and more reliable.

- **Low Cost of Operation:** The manufacturing experience of our customers, demonstrates that the use of the detonation coating process, in production, is very cost-effective; and, it results in substantial operational and maintenance cost reductions, as compared to the typical HVOF and plasma spray systems. This is due to the following five principle factors:

  - **Less Gas Used:** A high-pressure fuel and oxygen supply is not needed. The gases are fed into the combustion chamber at low pressure, slightly exceeding atmospheric pressure. The total amount of **gases consumed**, per unit mass of powder sprayed, is about **10 times less** than the typical HVOF system.

  - **Less Water Consumed:** Due to the low amount of heat transferred to the gun barrel, a **special cooling system is not needed**. **Water consumption is very low**.

  - **Less Electrical Energy Consumption:** Very effective electric **power consumption** - the unit consumes a total of **200W of electrical power**, which is comparable to a regular electric bulb. A water chiller is not needed, which requires a lot of electricity.

  - **Less Downtime:** The process is very **simple to operate** and very **reliable**. There are literally **no components that can wear out**, similar to Laval nozzle in the HVOF gun.

  - **Less Scrap:** There are no nozzles that can melt, or disintegrate, and spit copper on the expensive part being sprayed.

The gun barrel can be mounted at any angle, or can be fixed in the arm of a robot-manipulator. Multiple gun barrels can be installed to satisfy process requirements for high volume.

The gun design allows you to use the same unit as a grit blaster, without modifications of the barrel, or the gas supply system. This eliminates the need for a separate grit blasting booth, and it allows for a combination of surface grit blasting and further spraying, in one continuous operation.

COMPARISONS OF DIFFERENT METHODS OF THERMAL SPRAY

Type of System	**Flame or Plasma Exit Temperature**	**Heat Transfer to Substrate**	**Particle Impact Velocity**	**Oxide Content**	**Porosity**	**Adhesion (Bond**

	(^{0}C)	(^{0}C)	(M/S)	(%)	(%)	Strength)
Detonation Gun	3000	20-150 MAX	800-1000	0.1	0.1 - I	Extremely high
Plasma Jet (HVOF)	2500-3100	500-700	500-800	0.2	1 - 10	Very High
Plasma Spraying	5500-8300	700-1000	200-600	0.1-1	1 - 10	Very High
Wire Arc	4000-6000	500-800	240	0.5-3	10-20	High
Flame Spraying	2500-3000	500-700	30-180	4-6	10-30	Low

These are generic examples - your exact results will depend on spray duration, spray distance, process settings, and the substrate material

For More Information, please phone, fax, or e-mail a note of inquiry to:

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