The Plasma Transferred Arc Process (PTA) has been in use since 1962 for surfacing of parts . The applications possible with PTA are hardfacing to protect against extreme conditions in service life like heat , abrasion , corrosion , erosion ,adhesive and abrasive wear etc. It is also use to recondition worn out parts or build up of mis machined parts.

Plasma is a state of matter resulting from the inonisation of gas. It is composed of positive ions and free negative electrons. Its ionized condition enables it to conduct current.

Transformation of gas into plasma requires energy and the ionization level increases according to temperature ranging from 6000 to 20000 degrees centigrade. Since the pressure approximates to that of the atmosphere the impact of the fast moving particles on one another are numerous enough for the transformation of their kinetic energy into heat to result in a considerable rise in temperature.

The plasma torch design as used in surfacing applications is shown below

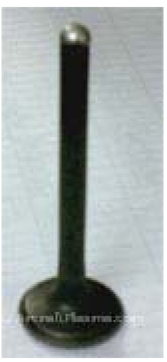
The arc is struck between the Tungsten electrode (Cathode) and the job which is the anode . The fine bore copper nozzle constricts the arc into a fine beam as compared to the open arc of TIG welding. Powder is fed by a powder feeder into the plasma arc through specially drilled holes in the copper nozzle . Torches using external wire feed are also available . It is possible to use both powder and wire feed combination if extra ordinary high deposit rates are required.

Although many consider Plasma Transferred Arc System (PTA) as a Thermal spray process it is a high energy, inert gas welding process rather than a spraying process. PTA deposition is also called PTAW surfacing because the American Welding Society classifies the PTA deposition under Plasma Welding category .

Argon is basically used for arc plasma supply, powder transport and molten material shielding. The coating material is fed into the Plasma arc in either powder or wire form. The plasma torch has to be held at a distance of 3 to 8 mm from the workpiece mostly in 1 G position.

PTA results in a metallurgical bond with a bond strength of 65000 psi while a average NTA (Non Transferred Arc) deposit would feature about 6500 psi . This is because PTA deposits are welded on the substrate.

PTA is suitable for manual, semi or fully automatic operations using manipulators, positioners , oscillators and micro processor controls . It can be used with Robots and adapted with CNC systems. It produces a very high quality deposit offering optimal protection with minimal dilution or deformation of the base material which are relatively low cost surfaces in the case of Hardfacing .



Types of systems availaible

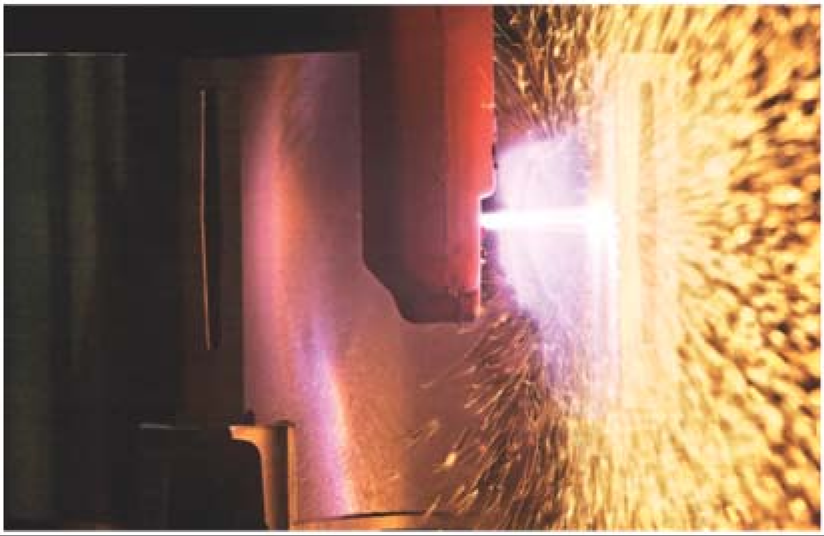
Automated PTA systems

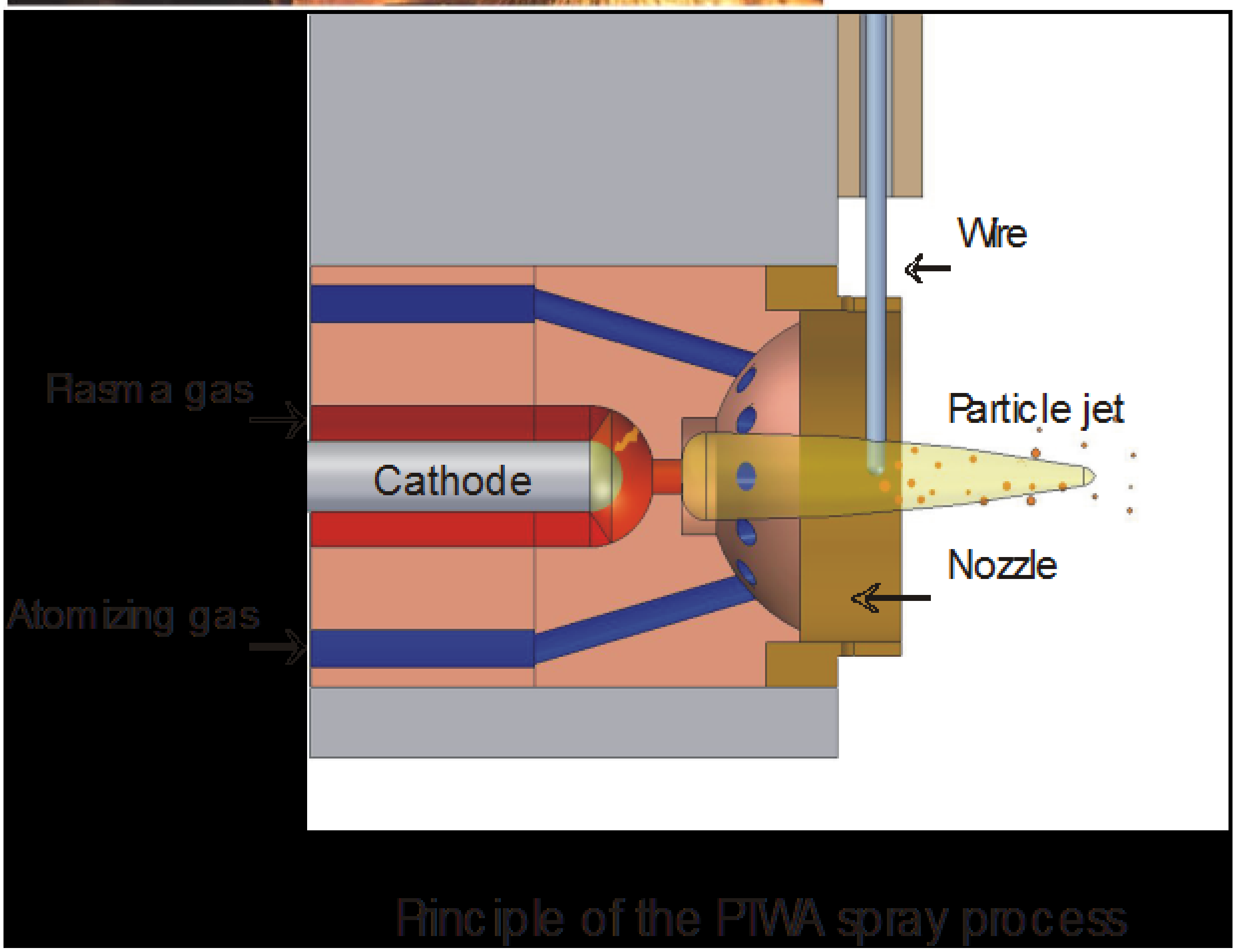
The Main power source itself consist of two power sources for the pilot arc and main transferred arc , Arc starting system , Gas Flowmeters for plasma and shielding gas , Plumbing board for torch connections , Switches and failure indicators .

PTWA (Plasma Transferred Wire Arc)

PTWA (Plasma Transferred Wire Arc) is a rotating spray process designed for the coating of internal diameters. Originally developed to coat automotive cylinder bores, Companies are working to develop non-automotive applications for this commercially proven technology.

PTWA technology is a wire based, rotating spray process which combines a twín arc spray process and an atmospheric plasma spray process. PTWA can deposit a coating on an internal or external surface of a cylinder. Internal diameters as small as 2″ (50mm) or as large as 14″ (360 mm*) can be coated.*

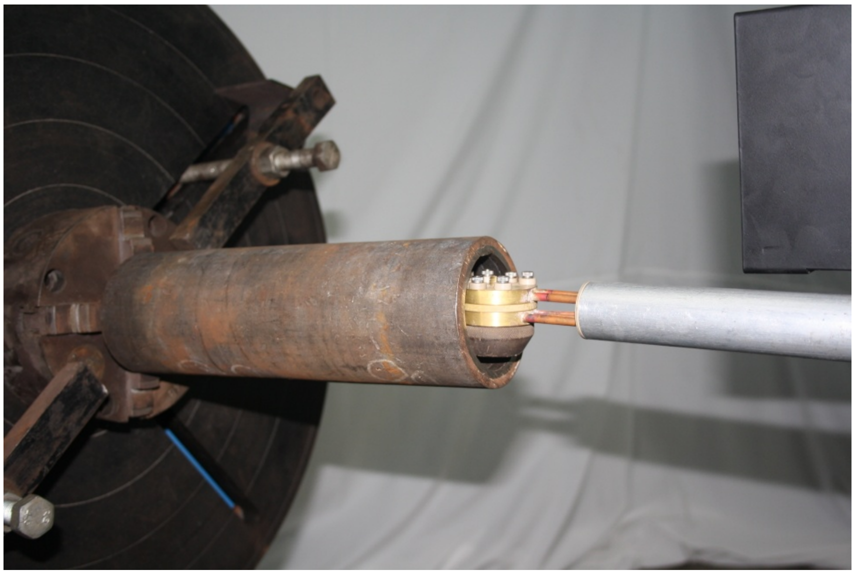




Principle of the PTWA spray process

PTA with powder welding for internal diameters .

. PTA can deposit a coating on an internal or external surface of a cylinder. Internal diameters as small as 2″ (50mm) or as large as 14″ (360 mm*) can be coated. The current capacity is 140 Amps DC giving a max weld bead height of 6mm and width of 16 mm using a oscillator for the Torch* .



Manual Plasma Applications

Manual Plasma torches are available upto 100 Amps DC . Manual plasma torches and portable power sources are ideal for repair shops and site applications .

P.T.A. DEPOSITS SHOW THE FOLLOWING CHARACTERISTICS:

1. An attractive controlled weld bead reducing cost / wastage of consumables with little or no ripple reducing time and cost of post weld machining .
2. Very low dilution with the base metal .
3. High, density bead without porosity , oxidation & inclusions..

Advantages

1. Wide range of deposits: The PTA- applied deposits can be as thin as only 0.5 mm or as thick as 50 or 60 mm. In fact there is no 'upper' limit since the thickness may easily be built up to any desired level by repetition i.e. use of 'multiple passes'.
2. Wide range of materials: The substrate to be coated may be any industrial metal or alloy. Even difficult materials HCHC alloys, die steels, hot-die steels, HSS etc can be easily coated with a wide variety of materials.

Wide range of coating materials: The coating materials may be elemental metals from aluminium upto zirconium (only solids), or their alloys , cermets e.g. nickel-aluminide, tungsten carbide mixed with ferrous or non ferrous metal powder. A wide range of proprietory overlay alloys are available for practically any part. Some alloys are very hard; others are softer with hard abrasion-resistant particles dispersed in a matrix. Certain alloys are made to rebuild a part to a required dimension while others are designed to be a final overlay that protects the work surface. Soft alloys, medium and high hardness materials, and carbide composites can be deposited on a variety of substrates to achieve diverse properties such as mechanical strength, wear and corrosion resistance, and creep

3. Narrow range of parameters: As compared to the more famous and established NTA (non transfer arc) option the PTA variation offers a smaller number of parameters to be controlled. The main parameters are arc current, arc voltage (indirectly controlled by arc length), plasma gas flow , shield gas flow , carrier gas flow rate and welding speed. Controlling these requires no special skills and an average welder can confidently yield good deposits. In automated welding the parameters of speed of job movement and speed of oscillation of torch are added.
4. Adaptability: The PTA option is basically simpler, and hence easy to be adapted for semi-or –fully automatic manipulators or programmable electronic or computerized devices.
5. Precision: It is possible to sustain a plasma arc with arc currents as small in magnitude as only 1 Amp DC. Hence the heat content of the flame can be controlled with extremely high precision. When other parameters are also duly controlled, it is possible to deposit very highly controlled quantities of coating material.

6. Heavy deposition: It is possible to increase the high deposition rates of the PTA deposition even further than 10 kgs/Hr. For instance wire feeders can be used in conjunction with the powder feeder, stepping up the deposition rate from as little as one kilogram/ minute upto several Kgs/mm.

7. Added sophistication: It is possible to apply advanced computerized numerical controls or even robotics to PTA deposition process with relative ease.

Applications

The PTA deposition or Surfacing process is one of the most versatile and useful techniques used for what are generally referred as surfacing or overlaying processes.

Following are a few applications to which PTA Deposition has been applied successfully on an international scale.

Hardfacing: Most of the industrial components in an enormous range of wear applications benefit from application of a hand overlay. A variety of nickel-base alloys are available for specific hardness, or a number of other properties combined.

Salvaging/Reclamation: An amazing bulk of all types of industrial components made from simple or complex alloys (e.g. nickel-chromium alloys) are now being dumped as scrap. PTA deposition offers reliable method for salvaging and reclamation .

Application of Special Materials: Sometimes it is a must to apply an overlay deposit of special materials e.g. molybdenum or tungsten etc for lending resistance to elevated temperatures (these are 'refractory' materials).. or in the case of industrial valves Stellite equivalent for impact resistance .

Minute Repairs: There are sometimes defects in parts made from difficult-to-weld-materials which cause them to be scrapped. The PTA deposition process can easily build up the missing portion. Such defects are cracks, notches, dents, cavities, deep scratches or scoring marks etc.

A comparison with another surfacing method such as the GTA process, which in principle bears a resemblance to the PTA process, clearly shows the advantages of the latter. The advantages of the PTA process over the GTA process are:

1. The performance of a 30A operating PTA is equivalent to that of a 100A operating GTA.
2. In the PTA process, the shorter weld time is associated with lower amperage, hence a lower operating cost.
3. The coating properties are not much affected by torch height variations.
4. The cathode is by its very location, protected against any kind of contamination and the service life of the electrodes is much longer.
5. The thinner work pieces are more easily surfaced and the execution of fine beads is easier.
6. The quantity of rejects is quite small. And
7. Since the plasma arc is very well guided, there is a sharp localization of the heat release, the width and depth of the heat affected zone are smaller and the dilution quite limited.

Comparision between TIG and PTA process

A precise example will illustrate the comparison between these two processes, namely surfacing using Stellite grade F or equivalent for Renault internal combustion engine valves (Table 1).

Dilution:

GTA: 8 to 13 percent

PTA: 2 to 3 percent

Deposited material per pass:

GTA: 7.5 g

PTA: 4.5 g

Temp	GTA	PTA
20°	440	420
725°	235	275
800°	140	205

Table 1: Hot Hardness (HV)

Since 700,000 valves are hardfaced every year, the saving on material amounts to 700,000 x 3g = 2.1 metric tons per year . At a average cost of INR 4000 per kg this works out to a saving of INR 8400000 (INR 8.4 million)

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