Exploring new horizons:

Atmospheric pressure plasma under test in aircraft construction

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The shiny, high gloss paint on the commercial airlines are not just for visual appearance. The real purpose of aircraft paints and coatings is to protect the high strength structure from the harsh environmental conditions that the aircraft will face over many years of service. An atmospheric plasma process is currently undergoing intensive testing in the aircraft construction industry for surface preparation of aluminum and composite aircraft parts and structures for painting and coating.

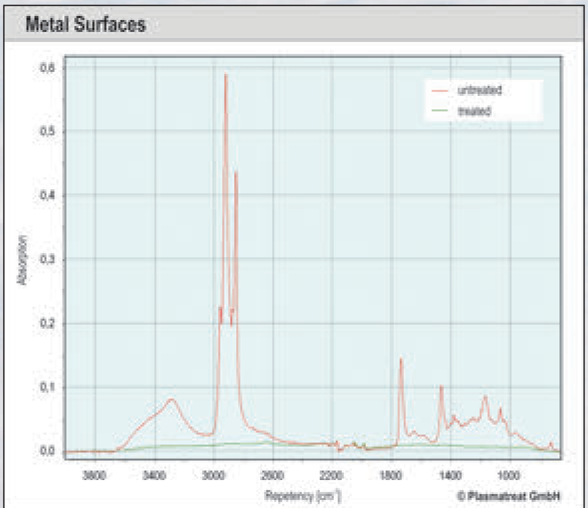
The paint must protect the plane from corrosion caused by moisture ingression and erosion from rain, hail and runway debris.The chemical reaction is insidious; the gradual destruction of the aluminium can develop anywhere at any time. Surface preparation of the aluminium is the first step of a multi-step coating process of acid etches, conversion coats, primers and top coats.

These processes are well established and governed by hundreds of process specifications. Often the first step involves solvent washes, media blasting or hand sanding. There is, however, increasing pressure to eliminate or minimize the use of solvents, toxic materials and the variability of hand labour in the production process.

Jet-plasma surface treatment

Openair-Plasma technology developed by market leader Plasmatreat, Steinhagen, Germany is a process whose use eliminates these problems. The atmospheric pressure plasma jet technology, proven over many years in different industry sectors around the world, is a robust, high throughput processing system. It is characterized by a threefold action: it activates a surface by selective oxidation processes, eliminates static charge and brings about microfine cleaning of surfaces. This in turn promotes optimum adhesion of paints and adhesives. The system can be easily implemented into existing production lines and is compatible without restriction with robots.

In addition, the process is cost-effective in operation and environmentally friendly because the nozzles are operated solely by air and electricity. No toxic emissions or waste materials are produced and the



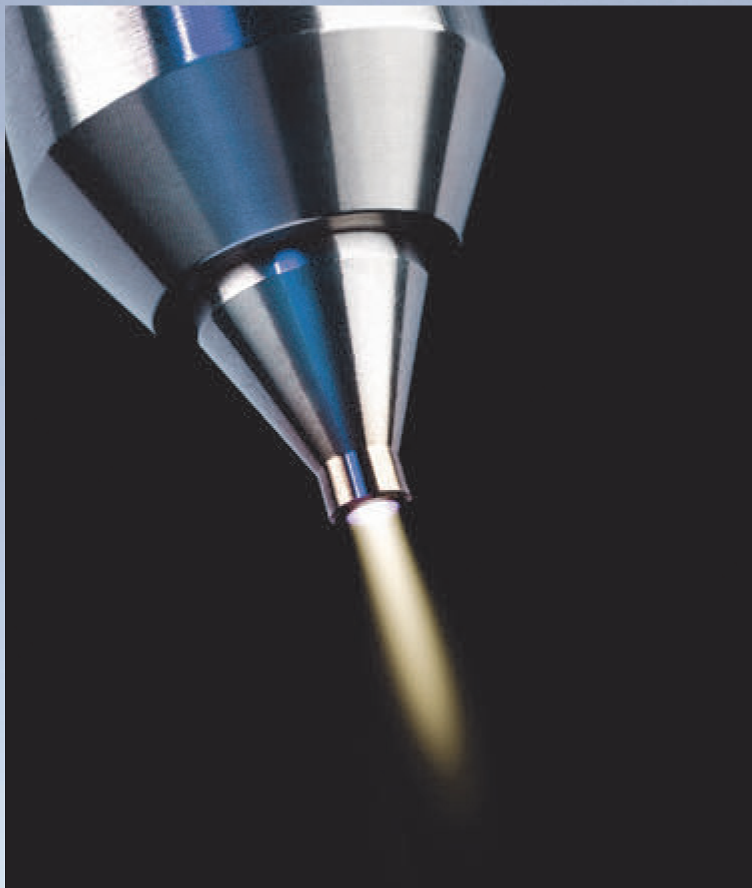
Infrared spectroscopic measurement: By cleaning the metal surfaces to a microfine level Openair®-Plasma eliminates all dirt and organic contaminations such as greases and oils as well as water adhering to the interface.

use of solvents is kept to an absolute minimum or can be dispensed with altogether.

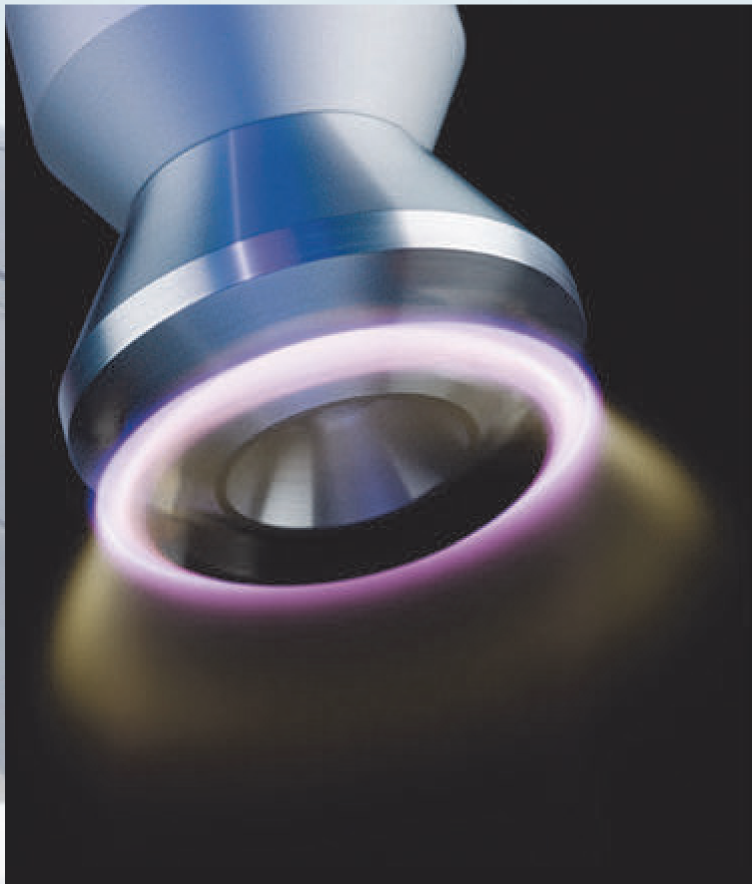
One special feature of the Openair process is that the emergent plasma beam is practically electrically neutral, which greatly extends and simplifies the range of possible applications. Its intensity is so high when using stationary individual nozzles, processing speeds of several hundred metres per minute can be achieved. The plasma beam is formed and focused at the jet outlet and gives up its energy on contact with a surface

Depending on the power of the plasma jet, a single plasma beam can be up to 50 mm long and have a treatment width of 25 mm. The plasma source is moved at a distance of 10-40 mm from the surface and at a speed of 6-600 m/min relative to the surface of the material being treated depending on the treatment power required. By using rotary plasma jets an operating width of up to 130 mm per jet at treatment speeds of up to 40 m/min can even be achieved.

Apart from the single jets whole rotary systems are also available for pre-treating relatively large surface areas. Depending on the application they contain a number of plasma generators which rotate at very high speed. Depending on the diameter and arrangement of the plasma jets areas up to 3 000 mm wide can be treated in a single pass. This process can be particularly effectively applied to surfaces made from metals, plastics, ceramics and glass.



Fine nozzle for small areas (Photo: Plasmatreat)



Rotating nozzle for large-area cleaning and activation (Photo: Plasmatreat)

Potential applications in aviation and aerospace engineering

The plasma technology is currently undergoing intensive testing in the aircraft construction industry. The process is suitable for both rapid treatment of large area parts such as aircraft wings or fuselage assemblies and precise treatment of small areas. Complex geometries can be easily accommodated. Because the primary parameters are proximity to the surface and speed of treatment, the plasma jet can be robotically controlled to provide repeatable cleaning and activation of the surface. The variability and costs associated with hand sanding and media blasting can be eliminated.

Anti-corrosion primers are often applied to interiors of aircraft fuselage and wing structures with reinforcements and fasteners. They are also found on flush-riveted sheet metal. All of these areas are often difficult to clean and pre-treat. With the ultra-fine cleaning of metal surfaces, the jet plasma removes all impurities and organic contamination such as greases, oils and water adhering to the boundary surface. Rivet edges are susceptible to damage and form the easiest entry point for corrosion. As the plasma beam can reach these very small areas without physical contact, reliable coating adhesion can be attained in these corrosion prone areas.

Compared to other plasma pre-treatment techniques, atmospheric jet plasma is easy to install and easy to handle. A normal sized system takes very little space and as the system operates in-line under normal air conditioning, it is self-evident that there is no need for large vacuum chambers and pumping systems required by low pressure plasma technology.

In addition, since Openair plasma works at nearly zero potential, it is suitable for the surface preparation of sensitive electronic parts and of mixed materials. Both carbon composites and metals can be treated without the electrical arcing associated with methods such as corona treatment.

Removal of mould release agents

Modern long-distance aircraft are built with completely novel materials and combinations of different materials, otherwise known as advanced composites. This trend brings a new set of challenges to surface preparation and paint and coating performance. These composites are layered materials usually composed of carbon-fibre reinforced plastic built up in moulds and cured or hardened at relatively high temperatures. Due to the potential for lighter weight, increased fatigue performance and corrosion resistance, there is a growing use of such advanced composites in aircraft.

Starting with fibreglass composites in secondary structures such as fairings and covers, carbon fibre composites are being used in the primary structures such as wings, control surfaces and the fuselage. These moulded parts are contaminated with mould release agents, often containing silicones. For reliable bonding, coating or painting, these contaminants need to be completely removed. The current surface preparation method usually involves solvent wiping and hand sanding. Besides being variable and difficult to inspect, this method is slow and expensive.

Atmospheric plasma, in contrast, is a highly effective method of removing mould release agents after completion of the corresponding processes. In addition to the cleaning, the reactive elements of the plasma interact with the composite and activate it for true chemical bonding to the paint or coating system. This mechanism is a major reason for improved adhesion.

Aircraft interior surfaces

But not all aircraft components require the application of paint or liquid coatings. Many interior surfaces are finished by laminating easy-to-clean plastic foils to the composite interior parts. Bulkheads, luggage bins, the walls and ceilings are often decorated by this method. Atmospheric plasma could be used to increase the adhesion of these laminates.

Conclusion

The decisive advantages of using this technology include its reliability and quality in the production process. Accordingly the stringent requirements of aircraft manufacturers can be met. Furthermore the user benefits from the simple integration into process flows, higher economic efficiency and environmental friendliness compared to conventional methods.

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