

Environmentally Friendly and Process Reliable

# Plasma for Aviation and Aerospace Industries

To achieve the required corrosion protection and long-term stable adhesion on aircraft surfaces there is an environmentally friendly and process reliable method. Atmospheric pressure plasma is currently undergoing intensive testing in the aircraft construction industry.

The shiny, high gloss paints and coatings on the commercial airlines are not just for visual appearance. Their real purpose is to protect the high strength aluminum structure from the harsh environmental conditions that the aircraft will face over many years of service. The paint must protect the plane from corrosion due to moisture ingress and erosion due rain, hail and runway debris. The trend towards use of advanced composites in aircraft brings a new set of challenges to surface pretreatment and coating performance.

Surface pretreatment of the aluminum is the first step of a multi-step coating process of acid etchings, conversion coatings, 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 labor in the production process. The use of atmospheric pressure plasma is an environmentally safe alternative, suitable for both large-area parts as well as for precise treatment of small areas.

## Cleaning and activation

Openair Plasma technology developed by system constructor Plasmatrete, Steinhagen, is a process aimed to eliminate these problems. This technology – a robust, high throughput processing system – is characterized by a threefold action: the atmospheric plasma activates the surface by selective oxidation processes, eliminates static charge and



Corrosion protection and paint adhesion: plasma treatment is suitable for both large-area aircraft parts as well as for precise treatment of small areas

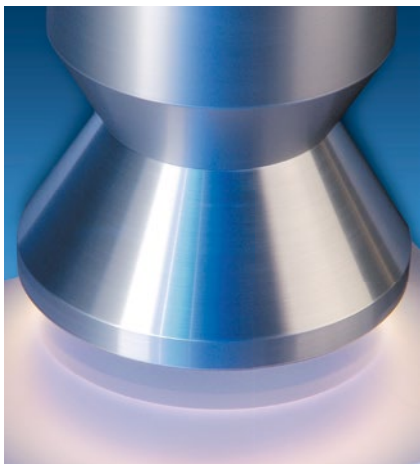
brings about microfne cleaning. This in turn promotes optimum adhesion of paints and adhesives. The system can be implemented into existing production lines and is compatible without restriction with robots.

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

One special feature of the process is that the emergent plasma beam is electrically neutral, which greatly extends and simplifies the range of possible. Its intensity is so high that when using sta-

tionary individual nozzles, processing speeds of several hundreds meters per minute can be achieved. The plasma beam is formed and focused at the jet outlet and transfers its energy on contact to the 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 to 40 mm from the surface and at a speed of 6 to 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.



Rotary nozzle for large area cleaning and activation. The plasma beam hits the plastic surface at high speed, heating it up with less than 30°C.

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.

The plastic surfaces of composite materials are often chemically inert because their long polymer chains have a low surface energy and either contain no or only few functional groups. As a result, they form a poor adhesive bond with paints or coatings. The ions and free electrons in the plasma beam cause the attachment of nitrogen and oxygen to the surface of the polymer so that

functional groups such as –OH and –NH are formed.

“Heating up of the plastic surfaces during treatment in this case is typically  $\Delta T < 30$  °C. Plasma not only cleans the surface to an ultrafine level but also strongly activates it at the same time which distinctly enhances the adhesion of paints and coatings”, comments Christian Buske, CEO at Plasmatreat. This process can particularly effectively be employed on surfaces made from metals, plastic materials, ceramics and glass.

### Potential applications

In different industries aluminum sheets and composites are currently cleaned with atmospheric pressure plasma in order to enhance corrosion protection and for long-term stable paint adhesion. Now the plasma process, proven over a number of years in the most different applications, is also undergoing intensive testing in the aircraft construction industry for surface preparation of aluminum and composite aircraft parts and structures for subsequent painting and coating processes. Since proximity to the treated surface and speed of treatment are the fundamental parameters the plasma jet under robot control can ensure reproducible cleaning and activation. The variability and costs associated with hand sanding and media blasting can be eliminated. The technology is suitable for both rapid treatment of large area parts such as aircraft wings or fuselage assemblies and precise treatment of small areas.



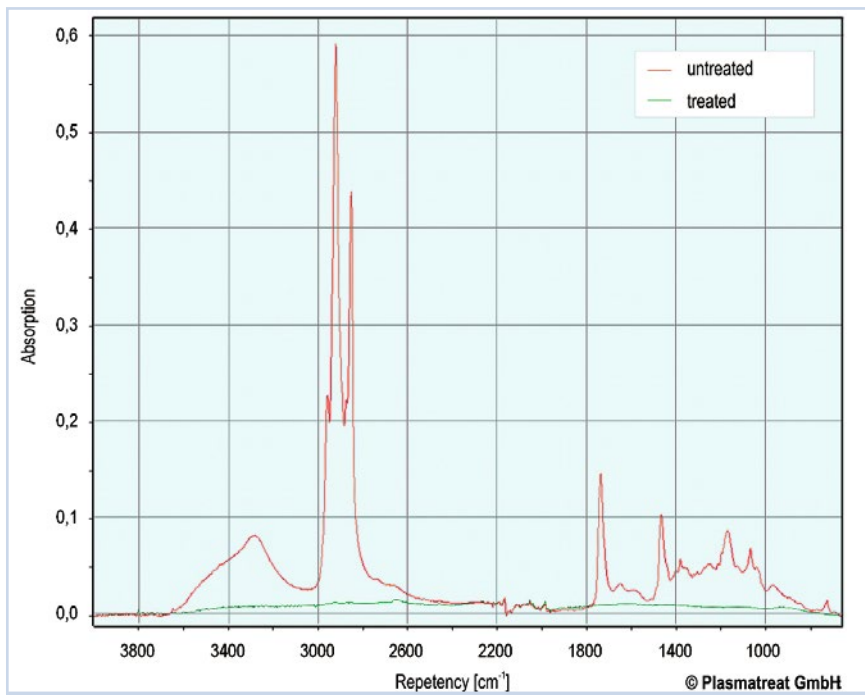
Proximity of the nozzle to the treated surface and speed of treatment are the fundamental parameters of the plasma process.

Complex geometries can be easily accommodated.

As the system operates under normal air conditions, there is no need for large vacuum chambers and pumping systems required by low pressure plasma processes. Since the plasma is potential free, it is especially suitable for the surface pretreatment of mixed materials. Both carbon composites and metals can be treated without the electrical arcing associated with methods such as corona treatment.

### Cleaning of aluminum before coating

Anti-corrosion primers are often applied to interiors of aircraft fuselage and



Infrared spectroscopy measurement. During the precision cleaning of metal surfaces, Openair plasma removes all impurities and organic contamination such as greases, oils and water adhering to the boundary surface

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 pretreat. With the ultrafine cleaning of metal surfaces, the plasma removes all impurities and organic contamination



Fine nozzle for small areas: AP-Plasma works without physical contact ensuring reliable coating adhesion also in small corrosion prone areas.

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 can reach these very small areas without physical contact, reliable coating adhesion can be attained in these corrosion prone areas.

#### Removal of mould release agents

Modern long-distance aircraft are built with completely novel materials and combinations of different materials, otherwise known as composites. These are layered materials usually composed of carbon-fibre reinforced plastic built up in molds 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 advanced composite in aircraft. Starting with fiberglass composites in secondary structures such as fairings and covers, Carbon Fiber composites are being used in the primary structures such as wings, control surfaces and the fuselage.

These molded parts are contaminated with mold 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 mold release agents after completion of the corresponding processes. Only after complete removal of the contaminants is it guaranteed that subsequent painting or bonding tasks will meet the highest standards of quality. 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. Openair atmospheric plasma could be used to increase the adhesion of these laminates.

#### Conclusion

The decisive advantages of using this technology include its reliability and reproducibility 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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