Kunststoffe im Automobil
Hochleistungspolymere in hochbelasteten Anwendungen

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DIE FACHZEITSCHRIFT FÜR DEN LEICHTBAU BEWEGTER MASSEN

LUFT- UND RAUMFAHRT

Atmosphärische Plasmavorbehandlung

Roland Harings
Novelis Switzerland SA.
„Das neue Aluminium"

Fügetechnik
Verbinden im Multi-Material-Design

Aerospace industry

Applications for atmospheric plasma pretreatment

The sparkling high-gloss paints and coatings used on passenger jets are not intended simply to give the aircraft a smart appearance. Their real purpose is to protect the aluminium structure against the tough environmental conditions which the planes are exposed to. The paint must prevent the material from being damaged by corrosion resulting from moisture penetration and by erosion caused by rain, hail and runway dirt. The trend for using modern composites in aircraft presents a number of new challenges for surface pretreatment and coating processes.

The pretreatment of aluminium is generally the first step in the multi-stage coating process, which involves acid etching, conversion coatings, primers and top coats. These standard processes are governed by hundreds of different process specifications. The first step usually consists of washing the components in solvents, media blasting or manual grinding. It is crucial to ensure that the problems caused by solvents, toxic materials and variations resulting from manual processing are avoided altogether or kept to a minimum.

ACTIVATING AND CLEANING SURFACES WITH ATMOSPHERIC PLASMA

Openair plasma technology is a process developed by Plasmatreat from Steinhagen in Germany, which is designed to meet these growing requirements. The high-throughput procedure has a threefold effect. The atmospheric plasma activates the surface extensively as a result of selective oxidation processes, removes static charges and precision cleans the surface, which ensures the optimum adhesion of paints and coatings.

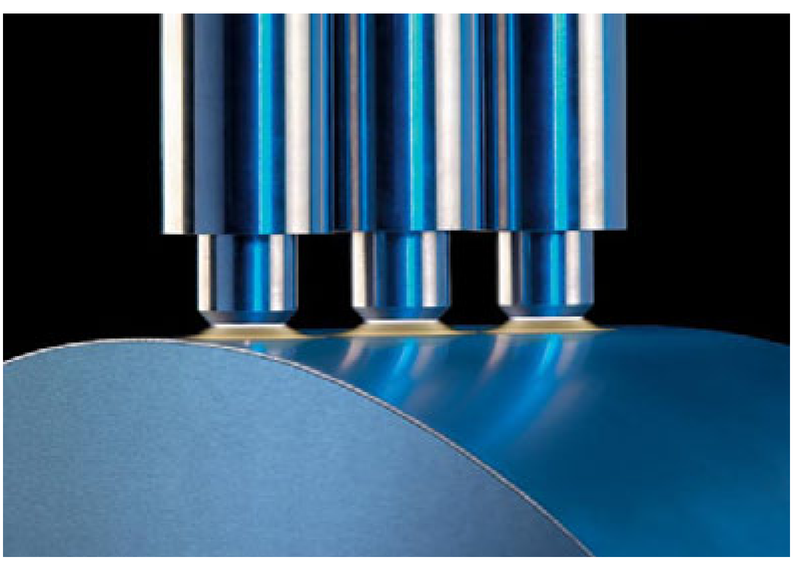

FIGURE 1

In order to provide more effective corrosion protection and ensure the long-term adhesion of paint, aluminium sheet and composites are precision cleaned and their surfaces activated using the Openair plasma process, before the paint is applied.

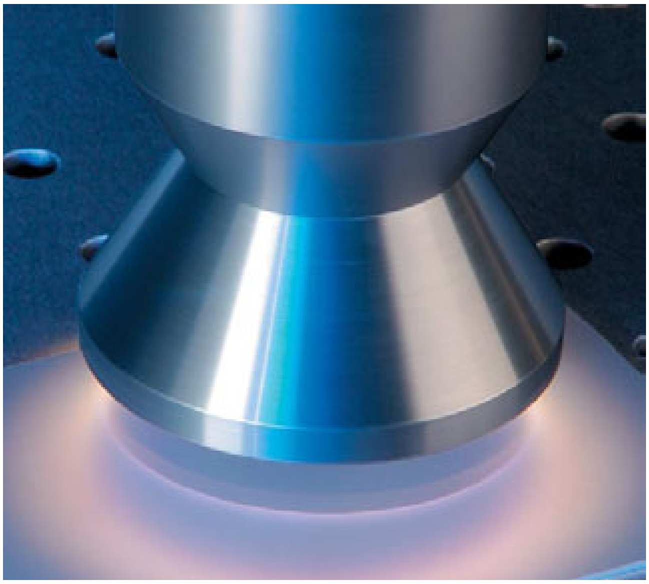

FIGURE 2 The non-contact plasma jet reaches the plastic surface at almost the speed of sound. The surface only heats to around ΔT < 20°C.

FIGURE 3 Source: Rokit/www.photocase.de

The system is ideal for use with robots and can be incorporated into existing production lines. In addition, the process is cost-effective and environmentally friendly, because the plasma nozzles are operated using only electricity and air. No toxic emissions or waste materials are produced and the use of solvents is kept to a minimum and can in some cases be dispensed with altogether. One special feature of the process is that the plasma jet is electrically neutral, which makes it much simpler to use and extends the range of possible applications. The jet is so intense that when individual fixed nozzles are used, processing speeds of several hundred metres per minute are possible. The plasma jet is generated and focused at the nozzle aperture and releases its energy when it reaches the surface.

Depending on the performance of the nozzle, a single plasma jet can be up to 50 mm long and 25 mm wide. In order to meet different processing requirements, the plasma source can be between 10 and 40 mm away from the surface of the material being treated and can have a speed of 6 to 600 m/min relative to the surface.

If rotating plasma nozzles are used, an area up to 130 mm wide can be treated by each nozzle at speeds up to 40 m/min. Complete rotary systems are available for treating larger areas. In addition, depending on the application, several plasma generators which rotate at a very high speed can be used. By choosing plasma nozzles of a suitable diameter and arranging them appropriately, surfaces up to 2000 mm wide can be treated in one pass.

The plastic surfaces of composite materials are often chemically inert, because their long polymer chains have a low surface pressure and contain few or no functional groups. As a result, they form a poor adhesive bond with paints or coatings. The ions and free electrons in the plasma jet cause nitrogen and oxygen to integrate functional groups, such as –OH and –NH, into the surface of the polymer. In this case the plastic surface heats to around ΔT < 20°C during the treatment. The process can be used to treat the surface of metals, plastics, ceramics and glass.

APPLICATIONS IN AEROSPACE ENGINEERING

The Openair procedure has proved its value over a number of years in different sectors of industry and is currently undergoing intensive testing in the aircraft industry for the surface treatment of aluminium and composites, before the application of a paint or coating. The basic parameters of the process are the distance between the nozzle and the surfaces and the speed of the plasma jet. The plasma system can be controlled by robots to guarantee a reproducible cleaning and activation process. The variations in the results caused by manual grinding or media blasting and the additional costs incurred can also be avoided.

Openair technology is ideal for the rapid treatment of large components, such as aircraft wings or fuselage assemblies, and for the precise treatment of smaller areas, including parts with complex shapes. As the system operates under normal atmospheric conditions, there is no need for the large vacuum chambers and pump systems which are required for low-pressure plasma processes.

Because this system does not generate electric potential, the process can be used to treat the surfaces of mixed materials. Both carbon composites and metals can be processed without electric arcs occurring, as is the case in the corona treatment process.

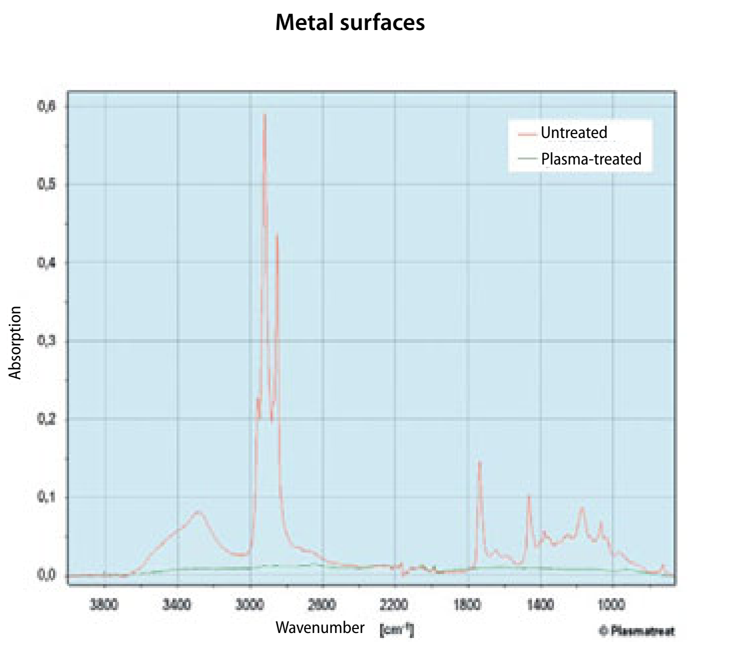

FIGURE 4

4 Plasmatreat graph: Infrared spectroscopy measurement. During the precision cleaning of metal surfaces, Openair Plasma removes all impurities and organic contamination, such as greases, oils and water on the surface (red = untreated, green = pretreated with plasma).

CLEANING ALUMINIUM BEFORE COATING

Anti-corrosion primers are often used on the inside of aircraft fuselages, on wings with stiffeners, on fasteners and on flush riveted sheet metal. All of these areas are often difficult to clean and pretreat. The edges of the rivets are easily damaged and frequently form the starting point for corrosion. As the plasma can reach these very small areas without physical contact, they can be prepared for the coating with no risk of damage.

REMOVING MOULD RELEASE AGENTS

The latest long-haul aircraft are constructed from new types of materials and from combinations of different materials, in other words, composites. These are layered products that are generally manufactured in casting moulds from carbon-fibre-reinforced plastics and cured at relatively high temperatures.

Because of their light weight and improved resistance to material fatigue and corrosion, increasing amounts of advanced composites

English abstract

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Quality Assurance

Aviation and Space Industry
Possibilities for atmospheric-pressure plasma pretreatment

The high-gloss paintwork and coatings on passenger aircraft not only provide an attractive appearance. Their main purpose is to protect the aluminium structure from the aggressive environmental conditions to which the aircraft is exposed. The coating must protect the aircraft against corrosion caused by the penetration of moisture as well as against erosion due to rain, hail and dirt on runways. The trend towards the use of modern composite materials in aircraft makes numerous new demands on the surface pretreatment and coating.

are used in the aerospace industry. Initially, secondary structures, such as cowlings and covers, were made of fibre glass composites. Now, carbon-fibre composites are being used in primary structures, such as wings, control surfaces and aircraft fuselages. These cast components are contaminated with mould release agents, which frequently contain silicones. In order to ensure that a reliable bond, coating or painted surface is created, this contamination must be completely removed. Current surface treatment methods include wiping with solvents and manual grinding. In addition to being inconsistent and difficult to verify, these methods are relatively slow and costly. In contrast, atmospheric plasma is a highly effective method of removing mould release agents. Only when the contamination has been fully removed is it possible to guarantee the quality of the subsequent paint or coating application. As well as providing precision cleaning, the reactive elements of the plasma interact with and activate the composite material to allow it to form a chemical bond with the paint or coating for improved adhesion.

AIRCRAFT INTERIOR SURFACES

Some aircraft components do not require the application of paint or liquid coatings. Many internal surfaces are covered with easily cleaned plastic film, which is laminated to the inside of the composite. This method is frequently used on partitions, luggage lockers, walls and ceilings. In these cases, the Openair process can improve the adhesion of the laminations.

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