Selective cleaning and coating

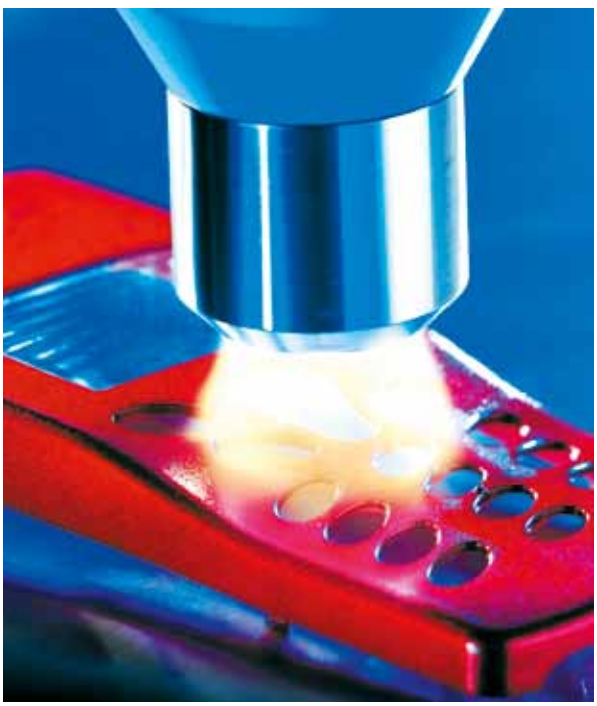
Atmospheric plasma replaces chemicals

Atmospheric plasma technology has already proven itself many times as an environmentally friendly alternative to wet chemical cleaning and pre-treatment. The technology ensures reliable cleaning and activation as well as a long-term stable adhesion of coatings on aluminium, plastics and glass.

Prerequisites for the reliable adhesion of a coating on metals, plastics or glass are firstly that the material surface is very clean and secondly that the surface energy of the solid, if possible, is greater than the surface tension (mN/m) of the liquid adhesive or paint. Wet chemical processes are usually used for this.

Plasmatreat's Openair technology is an alternative to this wet chemical pre-treatment. This process ensures microfine cleaning, high activation and nano-coating of material surfaces and therefore a long-term stable adhesion of paints and adhesives.

The plasma process may be used in fully-automated and continuous production processes. Pre-treatment takes place in-line under normal air conditions and in an environmentally-friendly manner: only air pressure and electrical energy is needed for operation. VOC emissions are avoided.



The atmospheric plasma technology provides environmentally friendly microfine cleaning, activation and nano-coating of material surfaces for subsequent processes such as painting, printing, adhesive bonding and coating

Electrically neutral plasma jet

Gas converted into plasma is electrically conductive. A particular feature of the Openair process is the almost electrically neutral plasma jet, which makes the process easier to use and more versatile. When the electrically neutral plasma hits the surface, the electrical charge carriers of the statically charged component can flow to earth. This causes a static discharge of the surface.

The intensity of the plasma jet is so high that processing speeds of more than 100 m/min can be reached. In addition, by adding a precursor, selective nano-coating is also possible, which enables, among other things, an individual adaptation of the surface qualities according to the demands of the later product. This enables metals to be equipped with adhesive-enabling and corrosion-reducing coatings.

Cleaning, activation, coating

Without the high activation that for example a non-polar plastic such as polypropylene experiences during the plasma process, there may be wetting problems that would make coating impossible. During plasma pre-treatment, the surface energy of the plastic is significantly increased, meaning that polar groups such as hydroxyl functions are generated on the surface. This not only

enables the entire surface to be wetted with paint but it also allows the creation of a covalent bond, which is a very stable atomic bond to the surface. The consequences are homogeneous paint levelling and long-term stable adhesion of even the most demanding coatings. Research has shown that with plasma pre-treatment of plastics, surface energy values of more than 72 mJ/m² become possible.

For metals, cleaning and coating with atmospheric plasma creates the crucial prerequisites for the subsequent painting process or high corrosion protection. The treatment is very uniform, the pre-treatment results are reproducible and the selected parameters are monitored using a computerised process control. Using this plasma technology totally eliminates the need for additional pre-treatment with the aid of solvent-containing primers or by brushing and rinsing the surfaces.

Wide range of uses

Solvent-free coating of plastics

The Openair plasma treatment in the plastics industry is aimed at two-component injection moulding as well as upstream and downstream processes such as painting, adhesive bonding, printing, foaming and coating plastic surfaces. Due to the high activation ability of the plasma, substrates that were previously incompatible can now be bonded. Another essential aspect is that adhesion of water-based painting systems to nonpolar plastics becomes possible.

Metals: replacing chromating

Conventional, automated chromating processes treat the entire component. Areas not being coated must be covered with masks, or the coating must be removed afterwards.

Selective plasma polymerisation under normal pressure is an environmentally-friendly and efficient alternative. PlasmaPlus, a technology developed in close cooperation with the Fraunhofer Institute IFAM, Bremen (Germany), enables the selective, nanothin coating of material surfaces under normal air conditions for the first time. The anti-corrosive adhesive agent coating achieves not just a high level of prevention against corrosion, but is also an excellent adhesive base. To produce a coating, the atmospheric plasma is mixed with an organic silicon compound. Due to the high-energy excitation in the plasma, this compound is fragmented and deposited on a surface as a vitreous layer. The chemical composition can be varied depending on the application.

PlasmaPlus technology is already being used for aluminium surfaces in solar energy technology and in vehicle construction. Apart from its in-line use, the important advantages in comparison with other coating methods lie primarily in its capability of selective coating. The anti-corrosion effect is particularly effective on aluminium alloys. The coating can protect the aluminium for several days against direct salt spray (DIN 50021), without affecting the visual appearance of the metal.

Plasma in car production

TRW Automotive, the world market leader for vehicle safety systems, has used PlasmaPlus technology for motor pump housings since 2007 for power steering systems. To avoid corrosion in these safety-relevant components, the adhesive seams of metallic component surfaces are selectively coated under atmospheric pressure. The coating is applied in-line and assures the highest possible protection against invasive moisture. Coating with atmospheric pressure plasma plays an essential role here. The SWAAT Test (Sea Water Acetic Acid Test) showed that the adhesive seams of plasma-protected aluminium die-cast housings were infiltrated by corrosion ten times more slowly than untreated components. The time until the onset of corrosion inside the housings was increased by about 50 % to more than 750 hours (see Table).

The Fraunhofer Institute IFAM is intensively researching the replacement of chromating with plasma. In the AIF Research Project No. 14240N/1 ‚Prevention of Corrosion of Aluminium using Plasma Coatings' it is explained: ‚By plasma coating aluminium surfaces, it can be shown that chromium 6 and solvent-based primer systems can be replaced by chromium and solvent-free systems.'

Chromium-free aluminium sections

For decorative purposes, aluminium sections for interiors, such as door sections or window trim, are mainly painted or wrapping with foils. The wrapping

SWAAT-Test	Testing time [hours]			
	50	250	500	750
without corrosion protection	sealed	unsealed	unsealed	unsealed
sprayed with corrosion protection grease	sealed	sealed	sealed	unsealed
Coating with PlasmaPlus	sealed	sealed	sealed	sealed

Duration in SWAAT test up to the onset of corrosion inside the aluminium die-cast housing

takes place with high-quality printed paper or special plastic foils and gives the sections a sophisticated look. In the outdoor area, it is products such as window sills and fence posts which come with wrapping foil. Adhesion to aluminium, however, is quite challenging, due to the tendency of the material to form oxides on the surface. Such oxides infiltrate the bonding and lead, under long term weather and temperature changes, to a need for replacement. For this reason, the application of a protective layer is required, and here chromate coating technology for surface treatment of aluminium profiles is standard practice. The process takes place in chromium-containing baths and leaves waste water behind, which must be treated in a time-consuming process.

In manufacturing logistics, chromate is used as an additional processing step prior to wrapping. It makes a big difference in the production of larger, more complex profiles with costs of up to 30 cents/metre. Since typical wrapping speeds are around 20-30 m/min, the desire to reduce this part of the costs is understandable. Besides the demand for cost reduction, an environmentally friendly method free from heavy metals is also required.

The Openair process takes account of both concerns. The pre-treatment of aluminium sections can take place directly in the wrapping machine, due to the ease of integrating the plasma nozzles. The nozzles are positioned in an overlapping pattern on the surfaces to be wrapped and enable good pre-treatment, particularly for sections used in interiors. Additional requirements regarding the environmental and thermal influences are satisfied by the PlasmaPlus process that provides an optimal adhesive surface for wrapping adhesives.

Pre-treatment in the coil coating process

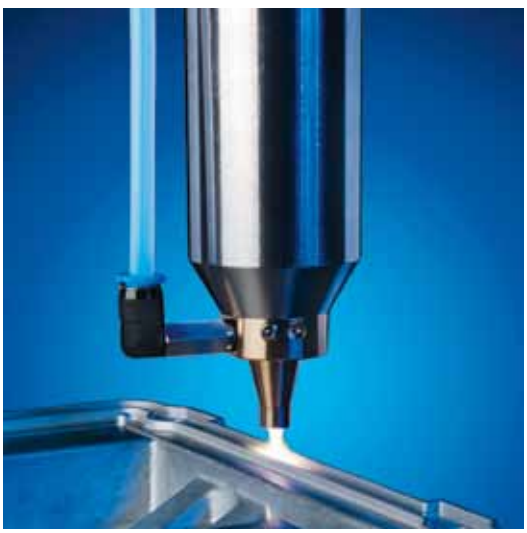
In 2007, much attention was given to the first use of plasma in the coil coating process of Griesser AG in Switzerland, one of Europe's leading manufacturers of aluminium shutters for façade construction. Here, the entire wet-chemical pre-cleaning process was replaced by the Openair process. By using the plasma system for pre-treatment of aluminium prior to painting, the speed of the plant could operate four times faster than the previous one. In addition, the need for large quantities of chemicals and thousands of tons of waste is avoided.

Aluminium strips before wrapping chromating is completely replaced by atmospheric plasma treatment

Environmentally friendly pre-treatment of glass

For years, direct glazing has been state of the art in automotive construction. It is used to bond windshields and rear windows directly to the car body. For reasons of safety, reliable bonding is extremely important. The PUR adhesives used must be protected against environmental factors, such as ultraviolet rays for example, in order to bond reliably. This is usually done using a baked with ceramic enamels, applied by screen printing. This coating differs depending on the manufacturing method achieved in the reduction of ultraviolet transmittance. These effects are partially improved by an additional black primer coating. Modern screen printing processes already offer an excellent ultraviolet block, so this step has already been removed from many production lines.

To develop a good bonding of the adhesive to the screen printed ceramic, it is also state of the art to use primers. These are mainly solvent-based and modified with silane. The job often takes place manually or using automated wiping systems. The glass panes can these primers be further processed after dry-



The anti-corrosive adhesion promoter layer provides not only a high corrosion protection, but is also a good tie coat for many adhesives

Environmentally friendly pre-treatment with no VOC emissions, used in the automotive industry before direct glazing

ing out. During drying, VOC emissions are released, which in automotive manufacturing are often dispersed throughout the entire production facility.

The Plasmatreat Group, together with the American company Ford Automotive, has developed a solution that uses the atmospheric Openair technology for direct glazing and allows environmentally friendly pre-treatment without VOC emissions. The plasma is used in two stages: a) to remove any hydrocarbon residues from the surface and b) to produce using the PlasmaPlus coating technique, a silane modification of the surface by applying a nano-coating. The overall process has been extensively tested by Ford on various screen printed ceramics and has, even under extreme desert conditions, produced the desired results. As the icensee of this new technology, Plasmatreat is able to use this automated application from 2011.

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