AUSGABE 2018

Fundamentals of Surface Technology Edition 2018

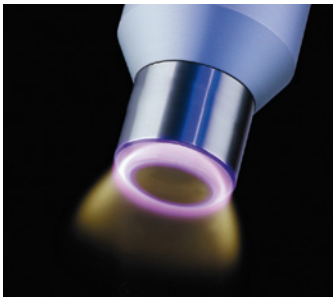
»BASISWISSEN

Prozesskette Oberflächentechnik

WOTECH
Kompetenz in Werkstoff und funktioneller Oberfläche

USING ATMOSPHERIC PRESSURE PLASMA – *environmentally friendly cleaning, activation and coating*: Through the development of plasma nozzles in 1995, Plasmatreat GmbH from Steinhagen in Germany has established an atmospheric pressure plasma technology (name: Openair-Plasma) in manufacturing technology which can be integrated into continuous, fully automated production processes. The particular appeal of the technology is that it operates under normal atmospheric conditions, paving the way for widespread applications for the pretreatment of material surfaces using simple, in-line technology. The process is now used worldwide in virtually all sectors of industry. The supplied energy is transferred to the surfaces of metals, plastics, glass or ceramics on contact with them, and then used to drive subsequent reactions. This produces surfaces with the ideal characteristics for coating, printing, bonding or foaming.

Cleaning and activation in a single step: The pretreatment process is very fast and particularly environmentally safe, using nothing other than compressed air and high voltage. A notable feature of the technology is the use of special nozzles which emit a plasma beam that is virtually potential-free. This ensures that even sensitive electronic components are not damaged by the plasma. The intensity of the plasma is so high that processing speeds of several 100m/min can be achieved when using static fine nozzles. Different levels of surface activation can be produced, depending on the speed of the plasma and its distance from the material being treated. Fine nozzles with relatively small outlet angles are suitable for treating narrow profiles and complex geometries, whilst patented rotary nozzles can treat areas up to 50 mm wide or up to

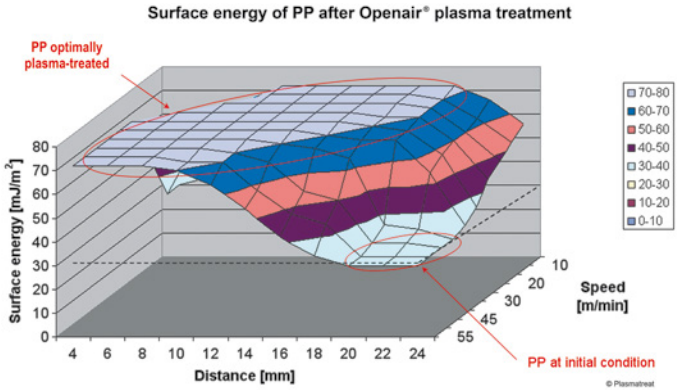


Environmentally friendly pre-treatment in seconds. Openair plasma brings about micro-fine cleaning, simultaneous activation and functional coating of materials surfaces (Source: Plasmatret)

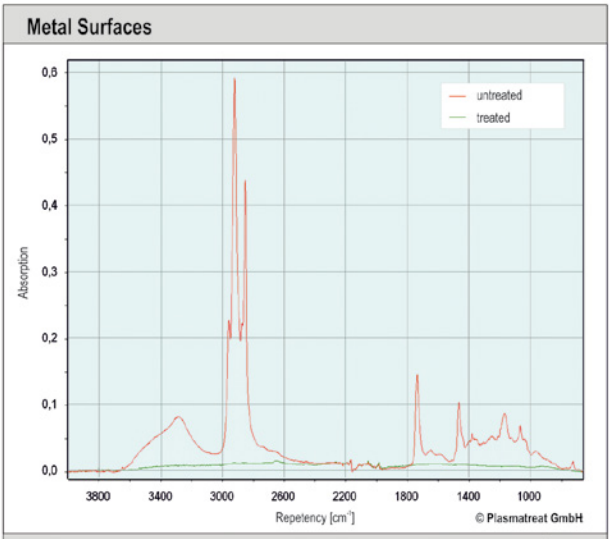
100mm when used as a double nozzle. Several plasma nozzles are combined to treat larger working widths.

The plasma system features a threefold action: It brings about the microfine cleaning, electrostatic discharging and simultaneous area-selective activation (modification) of a surface in a single operation lasting only a few seconds.

To increase the surface energy, the surface is activated by the chemical and physical interaction of the plasma with the substrate. When the plasma hits a plastic surface, groups containing oxygen and nitrogen are incorporated into the mainly non-polar polymer matrix. The area-selective plasma treatment renders the non-polar substrate polar at this place, thereby increasing its surface energy. This can produce surface energy values in excess of 72mJ/m² (72 dyne). Aluminum and glass have naturally polar surfaces, but this



Treatment renders the plastic surface polar and increases the surface energy to >72mJ/m² (72 dyne) with a large process window (Source: Plasmatreat)



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. (Source: Plasmatreat)

surface energy which gives them their adhesive characteristics can be compromised by layers of oxides, dust deposits, grease and oils or other contaminants. This is where the microfine cleaning action of the plasma comes into play, revealing once again the high level of surface energy already present in the substrate. Materials can be further processed immediately after cleaning and activation with AP plasma.

Functional plasma coating under normal pressure: In close cooperation with the Fraunhofer IFAM in Bremen, Openair plasma technology has been further refined through the addition of special nozzle systems and a precursor. This new nanocoating technology (brand name: PlasmaPlus) is used in a variety of industry sectors to functionalize surfaces through layer deposition.

The process can be used to produce thin plasma polymer layers under atmospheric pressure – and thus under normal production conditions. The coating enables substances tailored specifically to the application (precursors) to be deposited deep into the nanostructure of the material surface. For instance, a coating like this one, with a selected adhesive-promoting function, can entirely replace the use of solvent-based primers in the automotive industry. High-energy excitation within the plasma fragments the precursor, causing it to be deposited on the substrate surface in the form of a vitreous layer. The highly effective functional coating gives materials completely new surface characteristics.

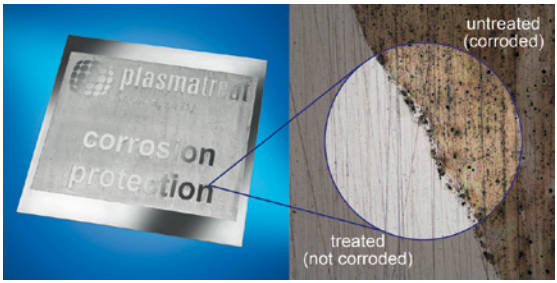
Research and application: The universal application of atmospheric plasma technology is virtually limitless. Apart from existing uses, as in injection molding or extrusion processes, for aluminum components, in electronics, medical engineering and packaging or in the automotive sector, shipbuilding and the aerospace industry, the technology provides a simple and effective solution for use in virtually any kind of product and solid material.

Water and dirt-repellent: PlasmaPlus renders surfaces hydrophobic, i.e. water-repellent. Since these surfaces are inherently dirt-repellent too, they acquire a simple self-cleaning function without any mechanical action.

Barrier coating: Barrier or diffusion layers produced with the aid of plasma are an important research goal. They provide an effective barrier against carbon dioxide, oxygen and water and reliably protect packaging for food, drinks and pharmaceuticals. They can be applied to a wide variety of plastics and make it possible, for instance, to produce barrier films or PET bottles with a CO_2 barrier.

Medical engineering: One benefit of atmospheric pressure plasma is that it enables the deposition of photocatalytically-active titanium-dioxide layers

The PlasmaPlus process makes use of a precursor to apply area-selective, nanofine functional coatings to material surfaces (Source Plasmatreat)



The corrosion protection provided by atmospheric plasma polymerization is particularly effective on aluminum alloys (Source Plasmatreat)

which have a self-cleaning and germicidal effect when exposed to sunlight and moisture. This application is of particular interest for coating medical and sanitary products, since it allows manual cleaning intervals to be extended, or omitted altogether.

Hybrid injection molding: Practical experience shows that even an injection-molded bond that was originally tight can become untight over time, lose cohesion and ultimately lead to the functional failure of the components. In many cases, premature adhesive failure is caused by the absorption of moisture in combination with oxygen, which results in subsurface migration at the interface. After intensive research, a new coating technology has been developed (tradename: Plasma-SealTight) which not only improves plastic-to-metal bonding significantly in hybrid injection molding processing, it also creates media-tight bonds. This allows an adhesion-promoting and anti-corrosion nanocoating to be applied to the metal surface which is then overmolded with a customized plastic compound to which it bonds covalently.

Anti-adhesion coatings: The plasma coating can also be used as a universal release layer for injection molding tools. It offers outstanding release properties for a wide range of polymer and rubber injection molding materials. The anti-adhesion effect is due solely to plasma polymerization on the tool surface. The process entirely eliminates the need for wet-chemical release agents. And since there is no need to remove the old coats, the mold no longer needs to be removed for recoating either. The new coat can be applied in-mold.

Solar energy: Whereas in the past corrosion protection was provided by polymer coatings in the micrometer range, today atmospheric plasma polymerization delivers the same degree of protection with an ultra-thin coating in the nanometer range, which substantially reduces the amount of light absorbed by the coating.

Nanocoating of complex three-dimensional components: The PlasmaPlus technology based on the Openair process also makes it possible to coat more complex 3D components with atmospheric pressure plasma. Even hard-to-reach areas such as the deep grooves and undercuts found on the top and underside of assembled circuit board components can be fully coated using this method.

Corrosion protection for aluminum: The corrosion protection provided by atmospheric plasma polymerization is particularly effective on aluminum alloys. The coating is capable of protecting aluminum from direct salt spray (DIN 50021) for 100 h or more without impairing the visual appearance of the metal. The nozzle system applies the corrosion protection to the aluminum surface via the plasma in a contact-free process.

Direct glazing: Plasmatreat has worked with Ford Automotive to develop an environmentally friendly pretreatment for direct glazing that totally eliminates VOC emissions.

Outlook: Significant benefits of the Openair plasma process include reliability and reproducibility in the production process and in particular, its area-selective application. The PlasmaPlus-process has made it possible to manufacture products with selectively functionalized surfaces and in so doing, has opened up a completely new dimension in innovation capability. All systems are fully compatible with robotics and designed for both in-line and external use. Further benefits include simple integration into process flows, savings on material and process costs compared with conventional methods and outstanding environmental compatibility.