

The reason why adhesive or paint does not readily adhere to clean plastic surfaces is generally because the surface energy is too low. Plasma can quickly remedy this problem. For years the automotive industry has been using an atmospheric plasma technology from Westphalia in Germany as an environmentally friendly and particularly cost-effective means of satisfying the industry's strict technical and quality requirements.



Author:
Inès A. Melamies
Specialized Journalist
Facts4You
53586 Bad Honnef
www.facts4You.de

With the development of its atmospheric plasma jet technology over twenty years ago, the systems engineer Plasmatrete created a solution which the industry had long been seeking: an alternative to wet-chemical pretreatment processes for material surfaces. Growing demands in the nineties for environmentally friendly, safe processes called for new methods which did not require wet chemicals and were at the same time cost-effective and process-reliable. Now used throughout the world, »Openair«-Plasma technology offered a highly effective pretreatment process based on jet technology that enabled the area-selective pretreatment of mass-produced components in a continuous production process.

Non-polar plastics require an essential pre-

It's all about surface energy

To enable mask-free pretreatment, the polypropylene plastic surface is pretreated with an area-selective »Openair«-Plasma system. The robot-controlled rotary nozzles ensure that even complex geometries are effectively activated.
Images: Plasmatrete

treatment before downstream processes such as bonding, painting, printing or foaming. This is because their lack of polarity causes them to have low surface energy. Reliable adhesion is conditional on the surface energy (mJ/m^2) of the solid material being higher than the surface tension (mN/m) of the liquid applied, such as adhesive, paint or ink. Plasma has the power to activate a non-polar plastic surface by making it polar and so increasing its surface energy. The result is homogeneous wettability of the substrate and a long-time stable adhesive bond or coating even under challenging load conditions. The rise in temperature of plastic surfaces during this type of plasma treatment is typically just $\Delta T < 30^\circ\text{C}$.

»Openair«-Plasma is generated without a vacuum chamber, so under normal production conditions, and performs three operations in a single step lasting only a matter of seconds: The plasma emitted from the nozzle at extremely high speed simultaneously brings about the microfine cleaning, electrostatic discharging and activation of the plastic surface – a reactive change at molecular level. Activation is achieved through 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.

Mask-free pretreatment of instrument panels

Pretreatments using flame technology require labor-intensive masking of instrument panels before they can be filled with foam. The use of the plasma technology by automotive component supplier SMP Deutschland for the cockpit of the Audi Q5 showed that it could be done without masking. This instrument panel is composed of three layers of material: a long-glass-fiber-reinforced plastic substrate, a PUR foam layer and a molded PVC skin, known as a 'slush skin'. The structural parts are made from injection-molded polypropylene (PP). Pretreatment is essential with this type of non-polar plastic to facilitate subsequent adhesion processes.

The plasma system equipped with three robot-controlled rotary nozzles operates at a flow rate of approximately 250 m/s. As a result, even complex geometries such as tiny recesses and undercuts can be effectively activated. A particular benefit is the true-to-contour scanning of the plastic surface. For the manufacturer, the advantages of the plasma process were clear: The area-selective application was a key deciding factor; pinpoint precision meant that masking was no longer required. The fact that the »cold plasma« does not damage the long-glass-fiber-reinforced polypropylene surface, the system is highly process-reli-

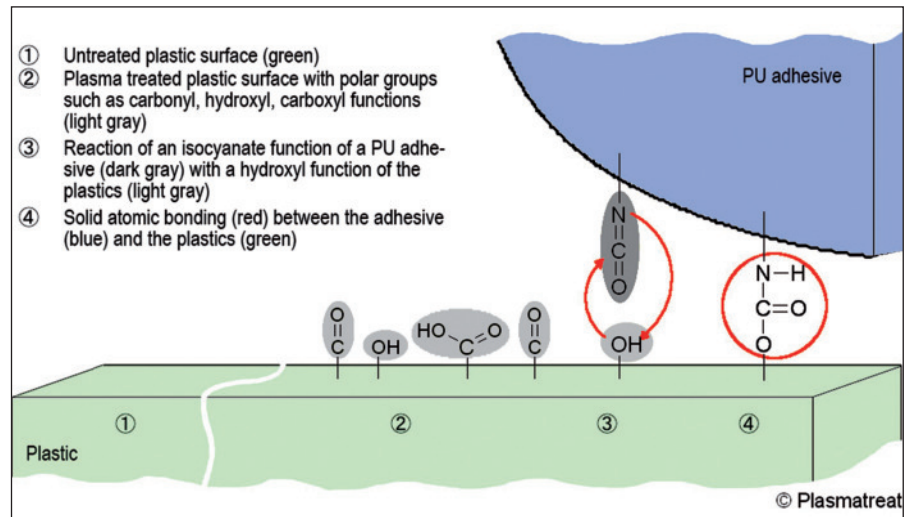
able and reproducible and the technology as a whole significantly reduces operating costs were further plus points.

Bubble-free touchscreen bonding

The touchscreen provides the driver with information about the vehicle, navigation system, GSM data and much more besides. The potting between the glass cover and the TFT screen must be completely bubble-free and have good adhesive characteristics. This calls for a very clean surface with extremely high surface energy. Bavarian automotive component supplier Preh from Bad Neustadt an der Saale found that patented plasma rotary nozzles satisfied these requirements in the production of their central console control systems. A laminator is used to bond the PET touch foil complete with adhesive backing to the back of the injection-molded polycarbonate panel of the center stack. The foil is supplied with multiple layers of screen-printed electronic circuitry. Bubbles forming between the foil and the carrier during the climatic test were successfully removed by pretreating the PC panel with »Openair«-Plasma.

Pretreatment of plastic body assemblies

In order to save weight in vehicle body construction, individual assemblies are now made from high-performance plastics which are glued together. The plasma treatment not only replaces conventional methods of pretreating the SMC (Sheet Molding Compound) – such as sanding or cleaning with acetone – it also produces superior bonding results. After assembly, the plasma-treated high-performance thermoplastic and thermoset components meet all the requirements in terms



The surface is activated through the chemical and physical interaction of the plasma with the substrate.

of lightweight construction, passive safety, mechanical properties and a »Class A« finish.

The plasma process is also particularly effective on fiber composite materials such as CFRP (carbon fiber-reinforced plastic) or GFRP (glass fiber-reinforced plastic). Nowadays automotive parts such as vehicle roofs, trunk lids or hoods are molded from CFRP. Release agents are required to remove the complex individual parts safely from the molds after production. After demolding, components from these release agents remaining on the surface must be laboriously removed. With plasma cleaning, on the other hand, any residual release agents are completely broken down and eliminated in seconds before bonding.

Dispensing with adhesive primers before painting

TRW Automotive Electronics & Components in Radolfzell, Germany, pretreats mil-

lions of switches for car interiors a year with atmospheric pressure plasma prior to painting. A high degree of process reliability is top priority and this is achieved through the computer-controlled and screen-monitored system provided by the Westphalian systems engineer. Throughput has tripled since the company started using a new painting line with integrated plasma system and stopped using primers completely. Furthermore, not only has a complete run incorporating six operations been dropped, according to TRW, they have also been able to save a great deal of time and 90% of the energy costs compared with the previous cleaning systems and a primer activation.

Conclusion

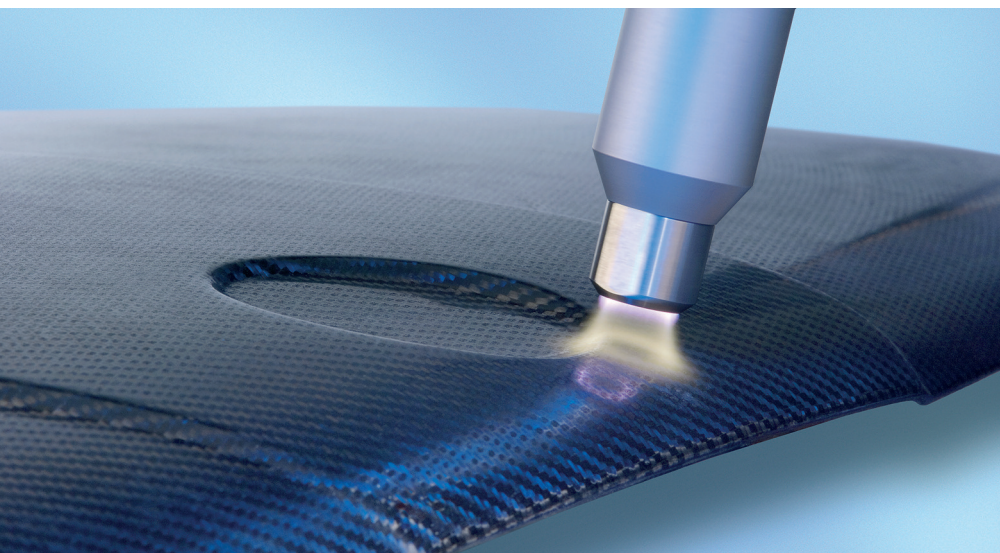
Apart from its effectiveness, other factors which have persuaded users to switch to plasma technology include high process speed, high process reliability, robot compatibility and accurate process reproducibility. The technology provides other desirable features such as easy integration into process operations and signal chaining to higher and lower-ranking control units, as well as satisfying requirements for total environmental compatibility.

■ Details of the companies referred to in the article:
Plasmatrete GmbH
33803 Steinhagen, Germany
www.plasmatrete.de

Preh GmbH
97616 Bad Neustadt a. d. Saale, Germany
www.preh.de

SMP Deutschland GmbH
93333 Neustadt/Schwaig, Germany
www.smpautomotive.com

TRW Automotive Electronics & Components GmbH
78315 Radolfzell, Germany
www.zf.com



Plasma cleaning eliminates in seconds any release agents remaining on the surface after demolding a CFRP component.