Quality boosting plasma

The automotive industry relies on robust, coordinated processes to ensure the consistently high quality and adhesion of coated products. Atmospheric pressure plasma meets the stringent requirements for long-time stable adhesion in the pretreatment of material surfaces. Furthermore, it is an environmentally friendly option which also enhances product quality.

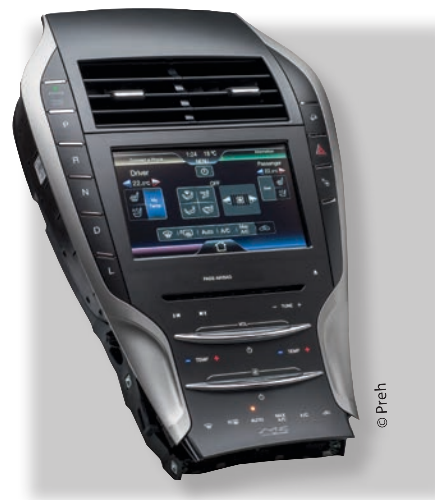

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Fig. 2 >
The polycarbonate panel on the center stack of the Ford Lincoln MKZ is pretreated with Openair plasma to obtain a bubble-free touch foil bond.

The invention of a plasma jet technology some twenty years ago proved a ground-breaking advance for developer and systems engineer Plasmatreat. Growing demands in the nineties for environmentally friendly, safe surface treatments called for new methods which did not require wet chemicals and were at the same time cost-effective, process-reliable and suitable for continuous processes.
With the development of special plasma nozzles and an in-house plasma technology called Openair plasma, the company succeeded in integrating a state of matter rarely ever used on an industrial scale into in-line production processes, making the use of plasma under atmospheric pressure feasible on a large scale for the area-selective pretreatment of material surfaces for the first time.

Reliable cleaning of headlamp housings

Hella, a leading automotive component supplier for lighting technology and electronic products, was the first customer to purchase the plasma system for pretreating their vehicle headlamps. With these components, the adhesive bond between the polycarbonate lenses and their polypropylene housings must satisfy extremely strict sealing requirements. Even the slightest leak would result in moisture penetration leading to impairment of the headlamp lens, which in turn would adversely affect the beam angle of the light. Hella uses the plasma to clean the grooves in the polypropylene (PP) housing before applying a 2-component silicone adhesive and to activate the non-polar material at precisely defined locations *(Fig. 1)*. This increases the surface energy of the PP from 35mJ/m² to over 72 mJ/m². This has the effect of improving the adhesive characteristics of the subsequent bond to ensure total seal tightness.

Corrosion protection for aluminum

In 2008 Plasmatreat and the Fraunhofer IFAM announced the joint development and world's first industrial use of a functional plasma nanocoating under normal pressure. A ground-breaking innovation, because until then plasma coatings had been possible only under low-pressure plasma.
The first company to use the new plasma polymerization technology Plasma-

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Fig. 1 > Vehicle headlamps must satisfy extremely strict sealing requirements. To prevent moisture penetrating the housing, the plastic grooves are cleaned and activated with atmospheric pressure plasma prior to bonding.

Fig. 3 > The robot-controlled plasma rotary nozzles carry out an area-selective treatment. By scanning the geometry of the instrument panel true-to-contour, they eliminate the need for masking before foaming.

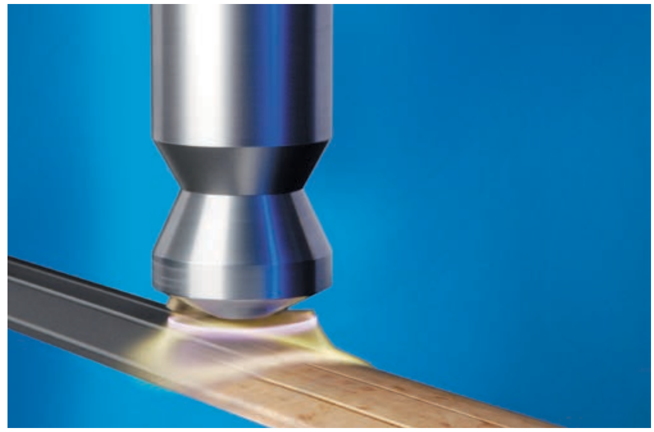

Fig. 4 > The Openair process facilitates the chrome-free pretreatment of aluminum profiles. An additional plasma polymerization coating is applied to profiles used on the vehicle exterior.

Plus wasTRW Automotive (now ZF TRW), world market leader in the development of integrated safety systems for the automotive industry. The plasma technology is used here to prevent corrosion of die-cast aluminum motor-driven pump units. These units are integral components of servo steering systems for a multitude of vehicles and subject to high reliability requirements in regard to corrosion, thermal and spray water resistance.

At TRW, the bonded joints of the aluminum component surfaces are first cleaned to a microfine level with AP plasma, and then a functional PlasmaPlus nanocoating is applied. Plasma polymerization provides the greatest possible protection from moisture ingress. A significant improvement in environmental stability was achieved with the plasma-polymer coating compared with uncoated components.

Bubble-free touchscreen bonding

The production of touchscreens is another field-tested example of the plasma process in action. 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, which is part of Joyson Electronics, found that Openair plasma also satisfied the requirements in the production of a central console control system for the Ford Lincoln MKZ *(Fig. 2)*. 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 has multiple layers of screen-printed electronic circuitry containing all the specific electrical functions. Bubbles forming between the foil and the carrier during the climatic test were successfully removed by pretreating the PC panel with atmospheric pressure plasma.

No masking required

Pretreatments using flame technology require labor-intensive masking of instrument panels before they can be filled with foam. The use of the plasma process by automotive component supplier SMP Deutschland for the cockpit of the Audi Q5 showed that it could also 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/sec. 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 *(Fig. 3)*. For the manufacturer, the advantages of the plasma process were clear: The area-selective application afforded by the plasma nozzles was a key 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-reliable and reproducible and the technology as a whole significantly reduces operating costs were further plus points.

Pretreatment of plastic car body assemblies

The pretreatment of plastic body assemblies indicates the sheer diversity of atmospheric plasma coating applications in the automotive industry. Nowadays in vehicle body construction, individual assemblies are made from high-performance plastics rather than steel or aluminum plate in order to save weight. As part of the assembly process, the individual components of assemblies such as the inner wing are bonded together in an automated joining process.

The plasma treatment not only replaces conventional methods of preparing the SMC (Sheet Molding Compound) – such as sanding or cleaning with acetone – it also produces superior bonding results. After assembly, the high-performance thermoplastic and thermoset components meet all the requirements in terms of lightweight construction, passive safety, mechanical properties and a “Class A finish”. The technology can be used as a pretreatment process both for bonding and painting these assemblies, as several automotive manufacturers have been doing for years.

Chrome-free aluminum profiles

For decorative reasons, aluminum profiles used in the vehicle interior, for example door profiles and window surrounds, are generally painted or foil-coated. High-grade printed decorative paper or special plastic foils are used to give the profiles a high-quality appearance. However, since aluminum tends to form oxides at the surface, bonding to aluminum is particularly challenging. These types of oxide migrate beneath the adhesive bond, eventually leading to delamination due to the exposure to weather and fluctuating temperatures. A protective coating must be applied to prevent this happening, with a chromate coating currently representing the state-of-the-art for the surface pretreatment of AL profiles.

The Openair process allows for chrome-free pretreatment of aluminum profiles *(Fig. 4)*. And since the plasma nozzles are easy to integrate, the process can take place directly inside the coating machine. If stricter environmental and temperature-related requirements are needed, an additional PlasmaPlus coating can be carried out. Plasma polymerization fulfils two functions: The coating offers an optimal substrate for the foil adhesives while at the same time providing the necessary corrosion protection.

Conclusion

There are virtually no limits to the versatility of the plasma technology described here, which is now used by all reputable automotive manufacturers. Whether at Volkswagen or with the BMWi3 for the long-time stable adhesive bonding of battery housings, at Ford for the direct glazing of front and rear windshields or at FCA, where the plasma process is used in the engine compartment to guarantee seal tightness before bonding and to replace the wet-chemical cleaning of aluminum components.

Apart from the triple action effect – ultrafine cleaning, static discharging and area-selective activation – and the possibility of functional nanocoating, other factors which have won over users include process speed, high process reliability, robot compatibility and total process reproducibility. It also satisfies demands for ease of integration into process flows, signal chaining to higher and lower-ranking control systems and complete environmental compatibility. //

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