Plasma processes reduce costs in automotive manufacturing

Automotive manufacturers can replace costly and time-consuming processes with plasma surface treatments. The technology facilitates the production of strongly bonded composite materials and new material combinations.

Almost all the components making up the interior of a modern car are now made from plastic materials or metal-plastic compounds. These materials require careful surface treatment to obtain strong adhesive bonds and durable coatings. Conventional surface treatment processes are not only technically laborious; they can also have undesirable side-effects. With flame treatments, for example, which are widely used on plastic components, there is a risk of deformation if the flame temperature is too high. Furthermore, overtreatment of the material may result in a loss rather than gain of adhesive properties. And finally, areas that do not require treatment must be masked with flame-retardant material, which is particularly laborious. There are drawbacks with other conventional surface treatments too. They may be very time-consuming or involve the use of solvent-based adhesion promoters (primers) which are harmful to the environment.

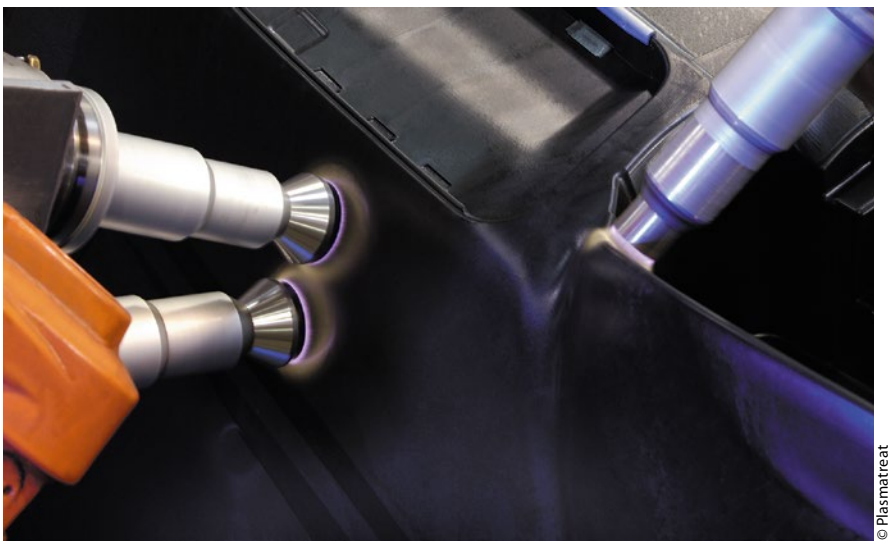
Modifying the surface characteristics of solid materials

Plasma technology is a far more efficient, highly effective and environmentally friendly alternative to the treatment processes referred to above. Plasma is generated by harnessing the energy in gaseous matter through the removal of individual electrons from the electron shell surrounding the gas atoms. This produces a highly unstable energy level which modifies the surface characteristics of solid materials such as plastics, for example. Plasma pretreatment creates the optimal conditions for producing a permanent bond between materials which were previously thought to be virtually or entirely incompatible.

When plasma has been used in the past for the surface treatment of industrial components, it was almost invariably in the form of low-pressure plasma. This meant that the parts had to be placed in a separate pressure chamber which was not part of the main production line. Consequently, the process was very time-consuming – and quite unsuitable for treating large volumes of parts. The development of Openair-Plasma technology in the 1990s made it possible to integrate plasma treatment into the production line. It works under atmospheric pressure, so there is no need for a separate chamber. With this technology, car parts, to give just one example, can now be treated inline to create the optimal surface characteristics for strong adhesive bonds and flawless finishes.

Reducing costs with lean production processes

Well-known automotive manufacturers and their suppliers have been using Plasmatreat technology for several years now. The benefits of plasma processes for the cleaning, activation and coating of material surfaces are particularly apparent in the production of assemblies for vehicle interiors.



The surface of the instrument panel blank is micro-cleaned and activated with plasma to ensure strong, long-time stable adhesion of the foamed thermoplastic front which is subsequently applied.

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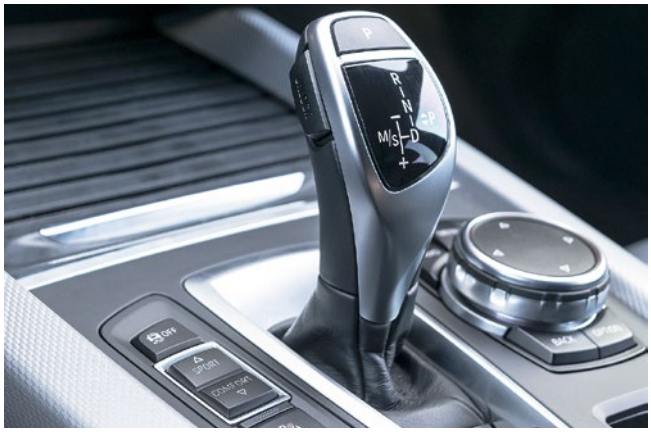
Plasma processes are often used to manufacture the displays of driver assistance systems which are now a standard feature in almost all modern cars.



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A plasma treatment enhances the durability of coatings and printed lettering on the control elements in the vehicle interior.

They enable interior components to be manufactured in a more affordable way, and to a higher quality. The cost savings stem from lean production processes and savings on chemicals and other auxiliaries. Quality improvements arise from the fact that the intensity of plasma activation can be tailored precisely to the requirements of the respective application. This level of adjustment makes it possible to create the optimum conditions for a strong adhesive bond between two material surfaces. This is what sets plasma processes apart from surface treatments involving primers, where such fine tuning is not an option.

More reliable processes

To ensure high process reliability and continuous availability, the systems can be equipped with three-fold process monitoring for optimum protection against system failure. For example, spectral monitoring of the plasma beam ensures that plasma quality is consistently high: a sensor in the plasma nozzle measures the light emitted by the plasma using a single-channel optical detection system. The amplitude of the emitted light in the relevant spectral range is continually analyzed. A motion control system also monitors the forward and rotational speed of the plasma nozzle. This ensures reliable production processes and consistent product quality.

It is also important to monitor the media supply, since the process-specific plasma characteristics (temperature and intensity) must be reproducible at any time to ensure that the process can be used for mass production on an industrial scale. For this reason, Plasmatreat offers monitoring units to suit all areas of application.

Surfaces must be clean

Material surfaces must be ultra-clean before they can be bonded or coated. Vehicle interiors contain numerous different plastics and plastic-metal hybrid structures which must be bonded together and coated to give a durable finish. For example, loudspeakers and displays, leather covers and trims, and control elements such as switches. A process known as optical bonding is used in the production of displays to enhance the output of the backlight and significantly reduce reflection. During optical bonding a transparent 2-component silicone adhesive (RTV) is applied to the polymethyl methacrylate (PMMA) display in a defined pattern using a special dosing system. With loudspeakers, it is important to obtain a strong bond between the housing and the membrane. Thorough surface cleaning is also a prerequisite for subsequent coating and printing of control elements such as switches. Otherwise there would be no guarantee that the coating or printing inks would bond reliably to the surfaces.

Microfine cleaning for durable adhesive bonds

The Openair-Plasma process can be used to clean material surfaces. During cleaning, the high energy level of the plasma fragments the structure of chemical and organic substances on the surface of the material in a targeted manner. Furthermore, the deionizing effect of the plasma beam neutralizes loose particles of dust and removes them from the surface of the material. Cleaning results in precisely defined surfaces which ensure optimum adhesion of adhesives and coatings. Unlike other processes such as blast cleaning, the plasma technology cleans the material at structural level. Furthermore, it does not require the costly consumables needed by other cleaning processes since it relies solely on air and electricity.

Activation increases adhesion capacity

During cleaning, the material surface is simultaneously activated. Activation increases the surface energy to enhance the adhesive characteristics. This is particularly important for the plastics used in vehicle interiors, since they are non-polar and would otherwise be very difficult to bond or coat. Functional groups containing oxygen or nitrogen which are incorporated into the polymer matrix during plasma activation are responsible for increasing the surface energy of the treated materials. Surface wettability is significantly enhanced if the surface energy of the solid material is higher than that of the liquid applied (e.g. adhesive or paint).

Plasma treatment instead of primers

The use of plasma treatment in the production of loudspeakers eliminates the need for wet-chemical primers which are not only expensive but also harmful to the environment. To ensure reliable paint adhesion, control elements were cleaned by CO_2 (dry ice) blasting before the advent of Openair-Plasma. Innovative plasma technology al-

The plasma coatings also provide corrosion protection.

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lows manufacturers to dispense with this costly process in some cases, and also to replace solvent-based coatings with water-based coatings.

Functional surface coatings

In addition to the cleaning and activation of material surfaces, Plasmatreat also offers a third plasma process – PlasmaPlus coating. With this system, functional plasma-polymer layers are deposited on material surfaces – for example corrosion protection layers for metals or adhesion promoters for bonding plastics or for metal-plastic hybrid components. The surface characteristics of these functional coatings can be tailored to each application. Plasma processes offer numerous benefits to the automotive industry and their suppliers: they streamline manufacturing processes, reduce production costs and protect the environment. Furthermore, the processes are fully automatable and can be integrated into existing production lines. Carefully matched system components and the transmission of process data via open interfaces offers extensive opportunities for process control and traceability. Many car manufacturers have already recognized the enormous potential of plasma technology. It significantly increases efficiencies within the industry and offers the promise of material combinations which we can only guess at today. //

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