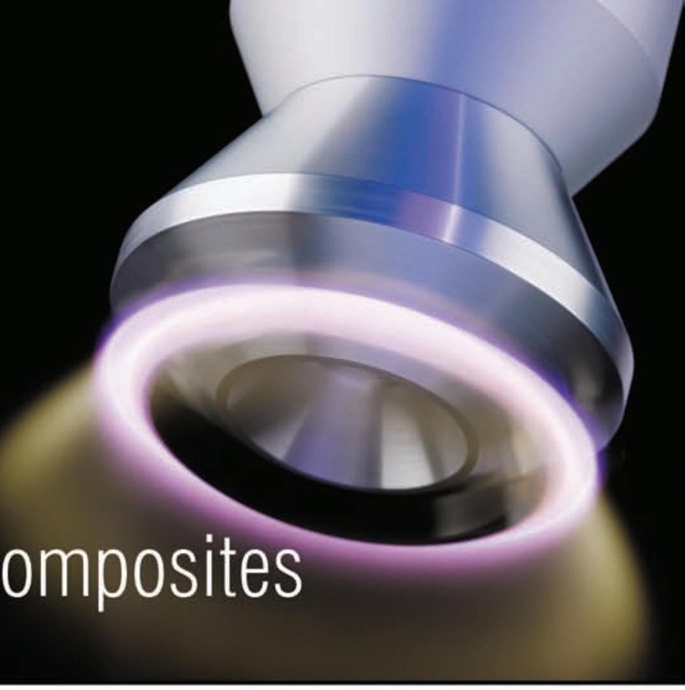

Case study

Plasma activation eliminates masking

and safeguards glass fibre composites

The surface treatment of injection moulded parts prior to the adhesion of an additional layer such as a PUR foam is often performed using a flame torch. For simple and even shapes, the process works and is cost effective. However, for more complex larger parts with intricate design requirements, the process requires labour-intensive masking of areas not to be treated. Also, in the case of fibre composites, the flame treatment of surfaces can damage the fibres rendering it inappropriate for use with composites. In addition, flame torch surface treatment requires a fair amount of care and attention to make sure it is used safely — the torches are gas fired and must be monitored by an operator to prevent fire hazards during operation.

The use of atmospheric pressure plasma to treat the surfaces of moulded parts overcomes these drawbacks. First there is no need for masking whatsoever — the plasma torch can be robot guided to cover precise areas and work on angles to an accuracy of 1 mm, leaving untreated areas untouched. Second, composite parts can be treated without any risk of damage of the fibres thanks to the fact that there is no change in temperature involved during treatment. Third, fire risks are greatly reduced when using the technology — the plasma is generated using electricity rather than natural gas.

These advantages of atmospheric plasma treatment have been capitalised upon by German automotive component supplier Peguform in the production of the dashboard for the Audi Q5 series. The company installed a plasma treatment line from Germany-based plasma technologists Plasmatreat two years ago and have been successfully manufacturing the dashboards ever since.

Peter Langhof, project and market manager at Plasmatreat in Germany tells the story.

Three years ago, German plastic parts supplier Peguform received an order for manufacturing the entire instrument panel for the Audi Q5 series. The dashboard structure is composed of three material layers: a long glass fibre-reinforced plastic structural member, a PUR foam layer, and a so-called slush skin — which is a moulded PVC skin. Peguform produces the structural members in polypropylene (PP) by injection moulding. This type of nonpolar plastic material mandatorily requires pretreatment to allow for the adhesion of the PUR foam. The objective of such a pretreatment is to increase the surface energy. The higher it is, the better the subsequent adhesion to the foam. For manufacturing the Q5 dashboard structural member, the company planned to construct a new pretreatment plant at its factory in Neustadt. After completion of a test phase, the advantages of the plasma-based pretreatment plant — over the previously employed technique which involved a pre-treatment of firing — were quite obvious. Peguform was convinced that a plasma-based approach was worthwhile thanks to the option of a patterned plasma treatment and the resulting elimination of masking tasks combined with the strong adhesion effect due to the high activation energy of plasma.

Figure 1: The atmospheric Openair plasma beam operates in a patterned manner and brings about microfine cleaning and strong activation of the polypropylene surface of the dashboard.

PLASMA ACTIVATION

The atmospheric plasma process, developed by Plasmatreat in 1995 and nowadays in use all over the world, is based on a nozzle principle for the most varied component geometries. The systems work under normal ambient conditions and are solely operated with compressed air and high voltage. The plasma strongly activates the surfaces of metals, plastics, glass or ceramics by selective oxidation processes whilst simultaneously discharging the former and bringing about microfine cleaning of the surfaces (see figure 1). The surface energy is the most important measure for evaluating the probable adhesive strength of an adhesive layer or coating. Tests on nonpolar thermoplasts, such as PP, indicate low surface energies, mostly between 28 mJ/m² and 32 mJ/m². But good conditions for adhesion can only be obtained by experience from 38 to 42 mJ/m² onward. A plasma treatment, i.e. a strong activation of the material surface, can bring about a distinct increase in surface energy. Trials at Plasmatreat have revealed that values up to over 72 mJ/m² become possible for most plastic materials (see figure 2). The system excels by its high process safety which in turn has a positive effect on the adhesion and the product quality.

PATTERNED PRETREATMENT

The plasma system equipped with three rotary nozzles operates with an emission speed of approximately 250 m/s. The activation is therefore also effective in the case of complex geometries — such as small recesses and undercuts. The working range of the plasma is close to the nozzle so that variations in distance due to different tolerances on components and tools hardly become noticeable in the pretreatment track width. One of the positive effects is the true-to-contour scanning of the plastic surface. The plasma nozzle can make changes in direction over the component and is capable of passing over tracks, not only over lines, without imparting treatment. This contrasts strongly with conventional flame treatment, in which major changes in direction must be made outside the component to avoid burns on the surface.

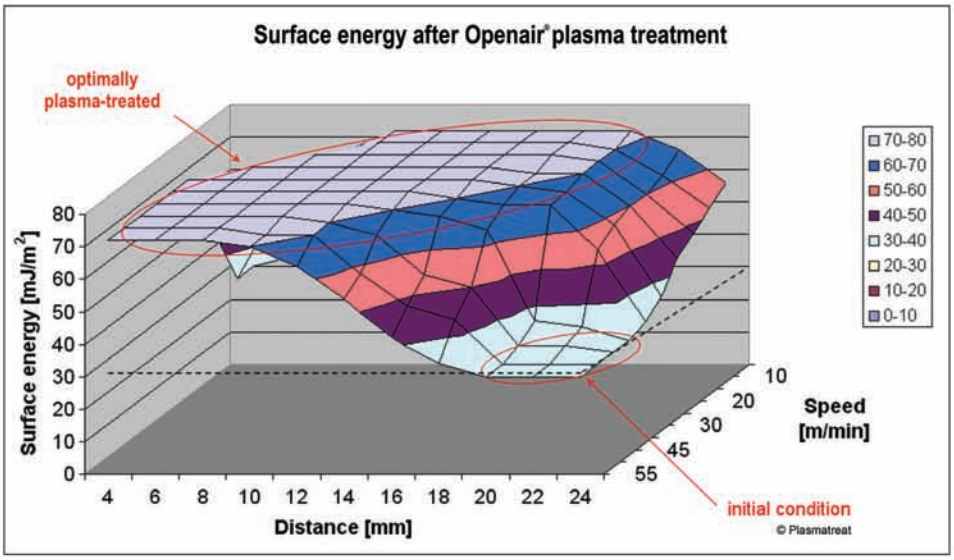

Figure 2: Illustration of a plastic surface that was pretreated with plasma, as a function of distance and speed. Treatment renders the surface polar, and the surface energy rises to >72 mJ/m² with a large process window.

UNMASKED

The foam injected by the foaming installation between the PP structural member and the slush skin for the soft touch of the instrument panel must adhere at certain places but not at others. Areas not to be treated include, for example, bolt-on points or add-on parts or — in the case of higher end designs — places where the back-foamed slush skin is to be replaced by real leather later on. For flame surface treatment applications, all areas where no foam adhesion is desired must be masked with thermally stable masks to protect the surface from change. The Plasmatreat technique, known as the Openair process, eliminates

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the need of masking, since the robot-guided plasma beam operates in a patterned manner. Unlike the flaming process, it is capable of following the component geometry with millimetre precision. In the untreated areas, the spot-faced slush skin with the back-foamed PUR foam can be easily peeled off (see figure 3). Areas where complete openings of the structural member are to be provided for instrument installation, are milled out separately (see figure 4).

LONG GLASS FIBRE REINFORCEMENT

If the "distance from the component" or "duration of the flaming" parameters deviate from the specification, even if only for a very short period of time, a 1000°C hot flame can become detrimental to the thermally sensitive polymer. And this is especially true when a long glass fibre-reinforced plastic material is involved, as is the case with the Audi G5 dashboard. Should the reinforced PP melt due to overheating, the fibres would lie loosely on the surface which would result in extremely poor adhesion to the PUR foam. Also, a heat accumulation could occur in the area of the deeper concave recesses of the display instruments during flame treatment because the heat cannot dissipate, leading to the same result. The Openair technique excludes these risks. The atmospheric plasma, also known as "cold" plasma, does not heat the plastic material to a temperature over 30 °C during the treatment.

CONCLUSION

Peguform's experience with the stable pretreatment process from Plasmatreat proved to be successful. Not a single field failure was recorded since the start of production of the Audi Q5 dashboards. The decisive advantages include, among others, the reliability and high effectiveness of the Openair method in the production process. Adding to this are the ease of integration into automated process operations and the higher cost effectiveness compared to conventional methods.

For more information about Plastmatreat systems, contact Graham Porcas at Plasmatreat (UK). For more information about the Audi G5 dashboard production process, contact Oliver Berger at Peguform, Neustadt, Germany.
www.plasmatreat.co.uk
www.peguform.de

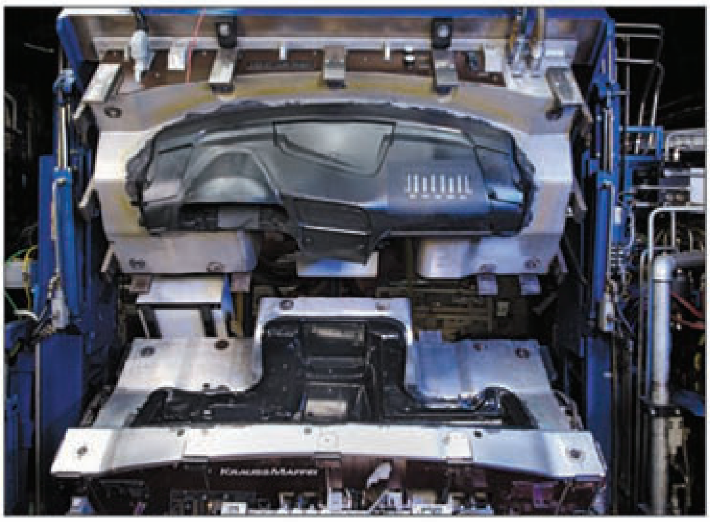

Figure 3: The foam installation appears like a giant sandwich toaster when opened. The PUR foam will be applied on top of the slush skin in the lower mould. After closing the installation the foam spreads equally between the PP-board (top) and the skin, bonding both together.

Figure 4: A milling system provides for the instrument openings. The back-foamed slush skin can be easily manually removed from the non-plasma-treated areas.