Nature as a Role Model

Innovative solutions are needed to address future strategies such as resource conservation and energy efficiency. By producing ultra-light honeycomb panels and using atmospheric pressure plasma for surface treatment before painting, a lightweight panel manufacturer from Thuringia supplies high quality components to the commercial vehicle industry.

Bionics provided the inspiration for developing lightweight composite panels – the blueprint is honeycomb, whose special hexagonal structure is unique in combining low material requirement and stability with low weight. As the following example demonstrates, the thermoplastic polymer polypropylene (*Figure 1*) provided the technical means.

Plasma technology (*Figure 2*) exploits another natural phenomenon; it produces technical plasmas inspired by natural atmospheric discharges. In industry plasma is mainly used today for pretreatment, i.e. for the ultrafine cleaning, activation and nanocoating of material surfaces.

Often plasma activation – a targeted reactive change at surface molecular level – is often the only way to make a material suitable for an application.

Nature's patents in vehicle construction

So called honeycomb panels are increasingly used as a core or support layer in lightweight sandwich panels because they are invariably water-resistant and have high strength and stiffness. However, the main benefit is undoubtedly their low weight. Manufacturers are particularly interested in reducing the weight of utility vehicles to reduce fuel consumption and cut CO_2 emissions throughout the entire life of a truck or transporter. At the same time, the lightweight panels reduce wear on the vehicle and ensure higher load capacities. The material even offers advantages at the end of the vehicle's life: The recyclable panels can easily be disposed of.

When we succeed in transferring knowledge like this obtained from nature to industrial production processes, we are justified in talking about cutting-edge production. This is what happened at MonoPan Composites (formerly Wihag Composites) in Thuringia, a manufacturer that has been using these two 'patents from nature' in its production system for years. The company founded in 1999 specializes in the production of ultra-lightweight honeycomb sandwich panels made from polypropylene (PP) with a glass fiber-reinforced PP outer skin on both sides. Before being primed and painted in the factory, this skin is pretreated with atmospheric pressure plasma in an environmentally friendly process lasting a matter of seconds.

The lightweight panels are manufactured in various thicknesses in widths of up to 2.75 m and lengths of up to 13.60 m. Their outer skins are primed twice with a 'primer filler' and then given an optional final coat of white paint on a UV roller coating

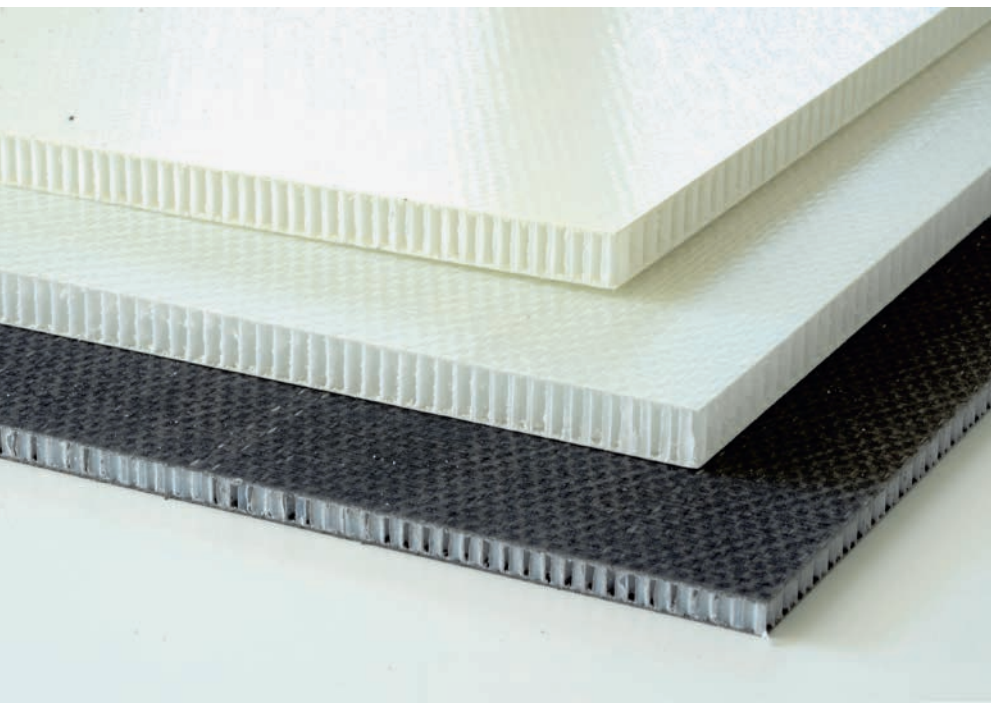

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Figure 1 > Inspired by bionics: Polypropylene honeycomb panels have high stability and low weight.

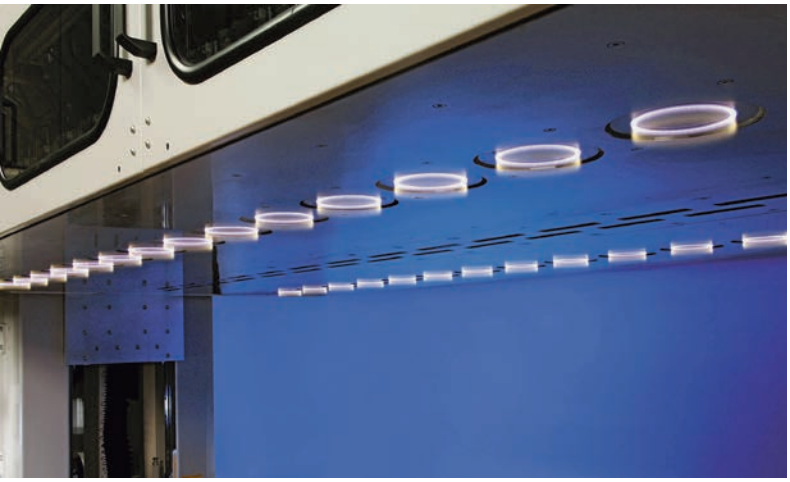

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Figure 2 > Modeled on natural atmospheric discharges, this technology generates plasma by high voltage. This means that it can be used for pretreating material surfaces.

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Figure 3 > Before priming with filler and painting, the large PP sandwich panels at MonoPan are pretreated with atmospheric pressure in a fully automatic process lasting just 20 to 40 seconds.

station in a continuous production process. Before each individual coating stage the plastic surfaces are micro-cleaned and activated with plasma (*Figure 3*).

The honeycomb core and outer skins are heat-sealed in the patented manufacturing process to create a combined positive and friction fit which prevents delamination. The panels made entirely from polypropylene feature high mechanical strength and low weight.

MonoPan panels are used mainly for box bodies in vehicle construction, for example, at Rapid-Leichtbau in Saxony Anhalt. The specialist in lightweight box bodies (*Figure 4*) welds the mass-produced honeycomb panels to create a cargo box for vans and light trucks made by automotive manufacturers such as MAN, VW, Mercedes, Ford, Opel and Peugeot. The lightweight box design reduces the weight by over 500 kg, which can increase the payload by around 30 %, depending on the chassis and size of the box.

Effective change

However, it's when the component manufacturing process is efficient, environmentally friendly and low-cost in equal measure that this innovative panel technology really comes into its own. Ten years ago, when MonoPan was planning the construction of a new coating plant and production facility, the company was keen to prioritize these aspects. Since an effective pretreatment is essential to ensure full-surface wettability of the non-polar PP plastic and long-term adhesion of the coating, a suitable pretreatment concept had to be included at the start of the planning process.

Various pretreatment methods were discounted right from the start due to the component geometry and the required production rates. However, the in-line use of Plasmatreat's environmentally friendly atmospheric plasma process was included in the evaluation from the outset.

MonoPan's requirements for the new pretreatment system for their painted sandwich panels were challenging. Not only did they specify the continuous pretreatment of different geometries, they also wanted high production rates and, of course, homogenous wettability of large plastic surfaces and optimal adhesion of filler and paint. Plasmatreat were satisfied that they could meet these conditions by constructing a new plasma unit tailored specifically to these requirements.

Optimum paint adhesion guaranteed

Although MonoPan was familiar with the Plasmatreat technology, it now was necessary to meticulously evaluate its relevance before deciding to actually use it. In preliminary tests the AP plasma process already proved to be an effective method of increasing the surface energy of the non-

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Figure 4 > The plasma-treated, pre-painted sandwich panels are used to construct low-weight box bodies for light trucks made by leading automotive manufacturers.

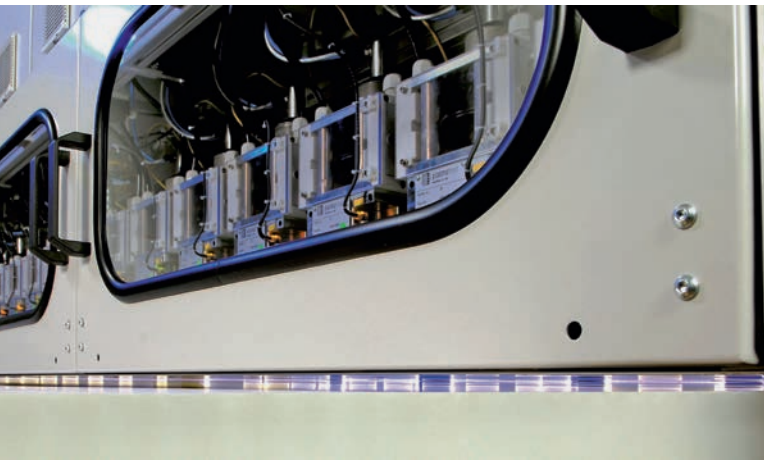
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Figure 5 > 28 Openair-Plasma rotary nozzles carry out the microfine cleaning, static discharging and simultaneous activation of the PP panels. The plasma effect ensures full-surface wettability and significantly increases the adhesive characteristics of the plastic surface.

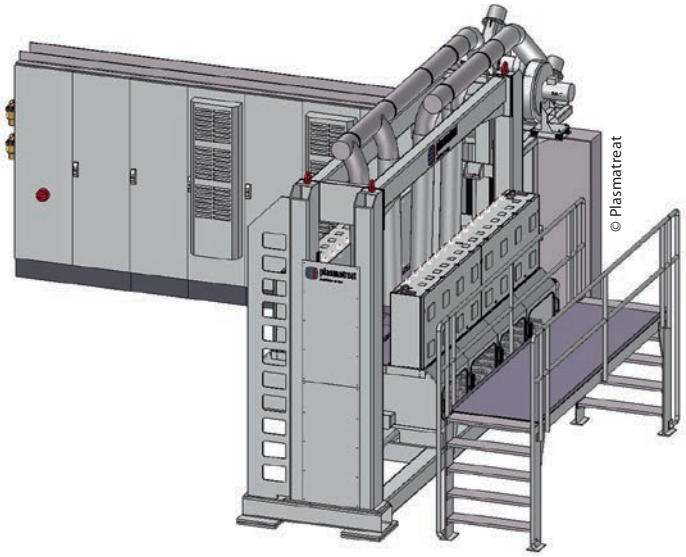
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Figure 6 > The large-panel plasma unit is designed to be maintenance friendly, so the plasma nozzles can be raised to the desired height for servicing and accessed quickly via two walkways.

polar plastic prior to subsequent painting, and thus ensuring optimum paint adhesion. Testing the activation of the PP surface with test inks showed that the surface tension before plasma treatment of approximately 18 mN/m to 20 mN/m rose to 34 mN/m to 36 mN/m after successful plasma treatment.

It subsequently became clear that the new technology would not only simplify in-line integration compared with other methods, it also offered a high level of process reliability. Another deciding factor was that the system allowed the pretreatment process to be adjusted rapidly and flexibly to suit different panel thicknesses. Against this background and the positive results from the one-year test phase, the decision was finally made in favor of the plasma process.

Tailor-made plasma system

Openair plasma technology– now used throughout the world in virtually all sectors of industry – can entirely replace wet-chemical and mechanical pretreatment processes in most cases. The technology features a threefold action: The material surface is activated by selective oxidation processes, electrostatically discharged and cleaned to a microfine level all at the same time (*Figure 5*). The high outflow rate of the free plasma beam also ensures that any particles loosely adhering to the surface are effectively removed.

In 2009, the tailor-made 2.80 m wide plasma system was integrated into the manufacturing process. Straightaway the in-line system was used to pretreat panels up to 2.75 m wide and 17 mm to 30 mm thick in a dry, environmentally friendly process. Panels are processed at a feed rate of 8 m/min, although this can be increased as required. Twenty-eight type RD1010 Openair rotary nozzles arranged in two staggered rows each with a pretreatment width of 100 mm clean and activate the entire panel width. Plasma pretreatment takes only 20 to 40 seconds, depending on the size of the panel.

The entire unit is preset to the required panel thickness. Panels are transported through the pretreatment system on a vacuum conveyor belt and the plasma unit is designed to ensure that height differences can be specified to an accuracy of 1 mm. As Dipl.-Ing. Winfried Meyer, who was the Plasmatreat project manager at the time, explains: "The system automatically recognizes the width of panel to be pretreated and activates only the requisite number of plasma nozzles." The unit is designed to be maintenance friendly, so the plasma nozzles can be raised to the desired height for servicing and accessed quickly via two walkways (*Figure 6*).

Summary

Today MonoPan Composites pretreats more than 120,000 m² of panel material per year. For the panel manufacturer, the process is a highly significant means of ensuring consistent product quality. "Plasmatreat's plasma jet technology has proved the perfect solution for the rapid, reliable pretreatment of our large-format, glass fiber-reinforced polypropylene panels before coating", emphasized managing director Fabian Reich. With nearly ten years' experience of using atmospheric pressure plasma, says Reich, the process will enable them to continue supplying the growing market segment of dry box bodies under 3.5 t with optimum quality. // *Inès A. Melamies, Specialized journalist, Bad Honnef*

Contact

Plasmatreat GmbH
Steinhagen
www.plasmatreat.de

MonoPan Composites GmbH & Co. KG
Königsee-Rottenbach
www.monopan.de