

Environmentally friendly and efficient – plasma replaces solvent and keying processes

Today's vehicle superstructures are assembled using adhesive bonding throughout to ensure greater inherent strength and improved durability of joints, with lower production costs. In addition, this joining technique increases the payload and reduces the weight of the semitrailer, which in turn cuts down on fuel consumption and reduces CO₂ emissions throughout the vehicle's lifetime. The requirements for structural bonding are high and can only be achieved with a reliable pretreatment process.

There are various means of cleaning and activating material surfaces, including the widespread use of wet chemicals, which are harmful to the environment and to health. However, refrigerated trailer manufacturer Schmitz Cargobull shows that it can also be done in an environmentally friendly and far more efficient way.

Europe's leading trailer manufacturer gave up using organic solvents for pretreating the sandwich panels of large refrigerated superstructures several years ago (Fig. 1). Over 16,000 new refrigerated semitrailers roll out of the factory gates at Vreden in North Rhine-Westphalia each year. Prior to structural bonding, Openair-Plasma technology is used for the environmentally safe, fast and reliable pretreatment of the walls and ceilings of the 13.50m long, 2.60m wide and 2.80m high semitrailers.

New adhesive properties

The atmospheric plasma process developed in 1995 by Plasmatrete from Steinhagen in Germany and now used throughout the world performs a number of key tasks for the trailer manufacturer: Integrated into the production process, it brings about the microfine cleaning and simultaneous activation of the surfaces to be bonded (Fig. 2 and 3). During plasma activation, the surface is selectively modified at molecular level. This gives the material completely new adhesive properties and significantly increases the surface energy and ensuing uniform wettability of the substrate – without the need for additional chemicals or keying processes.

The plasma treatment enables Schmitz Cargobull to use solvent-free adhesives and ensures particularly strong, long-time stable adhesive bonds. All the jet-based systems used here work in-line. The process is reliable and reproducible. Compu-



Fig. 1. Photo Schmitz Cargobull AG

Nowadays modern refrigerated semitrailers are structurally bonded. Europe's leading manufacturer gave up using organic solvents for pretreating sandwich panels prior to bonding several years ago.

ter-controlled, it operates at high speed and under normal ambient air conditions – unlike low-pressure plasma (vacuum chamber). The only consumables needed to operate these systems are electrical energy and compressed air, avoiding environmentally harmful VOC emissions from the outset.

Pretreatment in a single step

"Plasmatrete technology came to our attention at an international conference some 15 years ago", reports Reinhard Beelmann, who has worked at Schmitz Cargobull for 25 years and as Technical Director of the Vreden plant for over 10 years. "The performance parameters of this pretreatment process, which at the

time was still new, precisely matched what we wanted to achieve in the construction of a new bonding station." The primary goal was to dispense entirely with the organic solvents used in the bonding process, and thus eliminate the potential risk of environmental pollution right from the start. At the same time, the company wanted to replace the current practice of manual surface cleaning and manual keying with an automated process. The provision was that the new process would have to satisfy both requirements in a single step.

There then followed an initial six-month test phase in collaboration with the University of Kaiserslautern. The metallic outer skin of the sandwich panels has

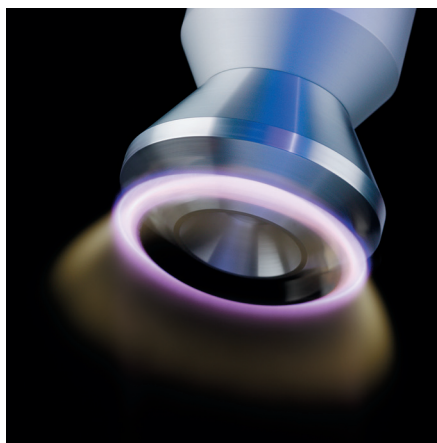


Fig. 2 + Fig. 3. Photos Plasmatrete

Schmitz Cargobull uses rotating plasma nozzles with wide coverage (left), as well as contour-precise, static plasma nozzles (right) for the microfine cleaning and simultaneous activation of the panel outer skins.

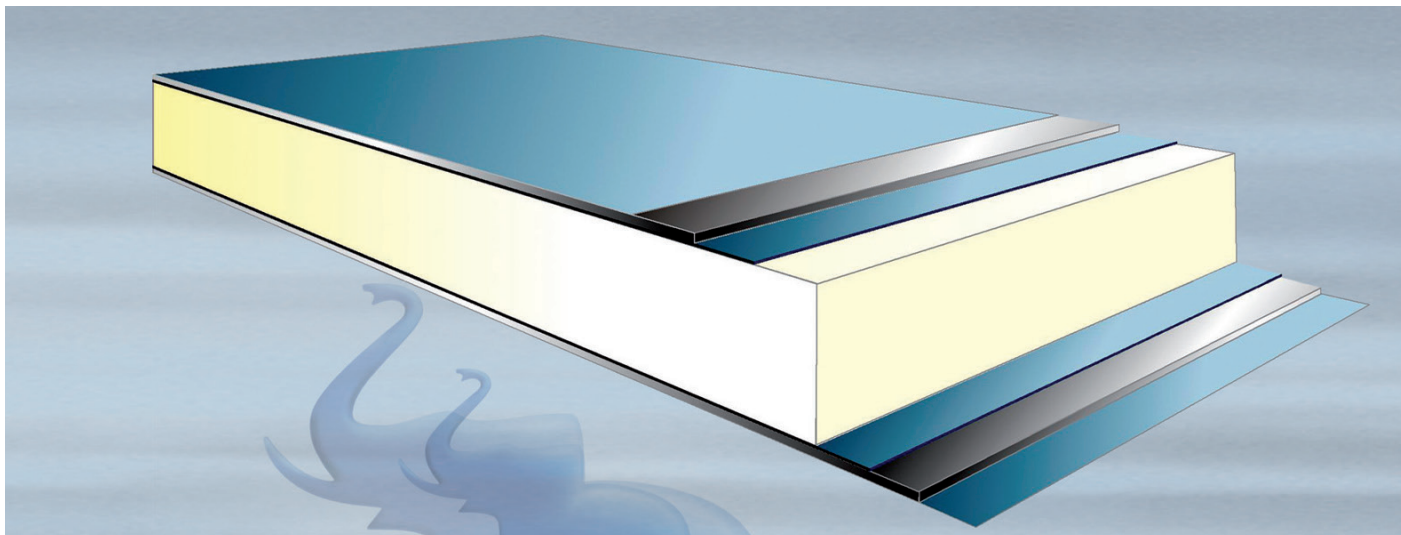


Fig. 4. Photo Schmitz Cargobull AG

The coated steel outer skins of the semitrailer's patented wall and ceiling panels are pretreated with atmospheric pressure plasma before bonding.

a protective coating of polyester or polyurethane paint. Test ink measurements revealed that the surface tension of 32 - 34mN/m in the untreated state increased to 42 - 44mN/m after plasma activation. The surface tension of the hard PVC foil coating the steel inner skin of the wall and ceiling panels increased to the same degree. The interactions between the atmospheric pressure plasma, 2-component adhesive and material were tested, as well as the potential extent of emissions, since the aim was to use several plasma systems simultaneously.

Streamlining the production process

After the satisfactory test results, it was time to design the entire systems engineering, including the in-line plasma station and the adhesive bonding process. Schmitz Cargobull's commissioning of the first industrial plant with integrated plasma pretreatment for the structural bonding of refrigerated semitrailers in 2003 marked a revolutionary streamlining of the production process in this field. Whereas beforehand individual workstations were required, now pretreatment and adhesive coating are combined in a single process step, since the plasma system has been integrated into the gantry of the adhesive, mixing and dispensing station. Beelmann: "The space-saving design and high level of process reliability are not the only advantages of the plasma technology. The major benefit is that fine cleaning and strong activation with plasma has dispensed with the need for wet degreasing and keying. We have also made our employees happier by getting rid of the solvents." Just one year later, the manufacturer installed plasma units in a second bonding station.

Plasma on large areas

The refrigerated semitrailers manufactured by Schmitz Cargobull are self-supporting systems - the entire modular structure is assembled without bolts and rivets. The adhesive bonding technology creates friction and positive locking joints without costly thermal bridging. Walls and ceilings are constructed from patented vapor-permeable Ferroplast panels, which consist of a high-density polyurethane foam core sandwiched between two coated sheet steel skins (Fig. 4). By bonding the large-format panels in aluminum profile rails, the system becomes self-supporting. The areas of the panel surface to which the adhesive is applied are pretreated with atmospheric pressure plasma to ensure an extremely durable, tight adhesive bond.

Of the four plasma treatment stations currently deployed at the Vreden plant, which are equipped with either rotary or static plasma jets, 32 in total, the first is used exclusively for pretreating wall and ceiling panels. The three-axis system containing the integrated plasma unit as well as the mixing and dispensing head for applying the adhesive runs completely automatically. The plasma unit consists of two jet systems mounted one on the left and the other on the right outer edge of the same traversing unit which holds the adhesive mixing and dispensing head.

Both jet systems are fitted with four offset rotary nozzles. When the transport crane has deposited the panel, the axis with

Fig. 6. Photo Schmitz Cargobull AG

The plasma pretreatment must be carried out on a minimum width of 300mm across the entire length or width of the panel.

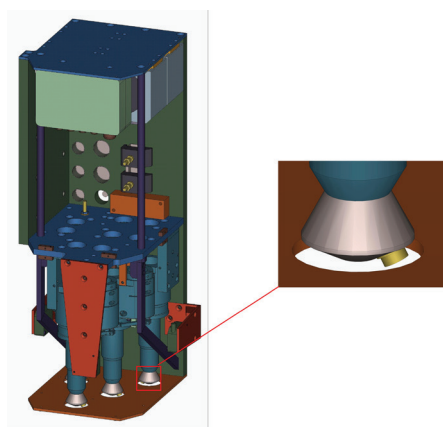
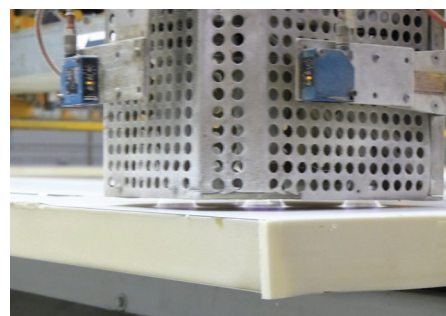


Figure 5. Figure: Plasmamatreat

Designed specifically for large-area application: Plasma system with four offset rotary nozzles dispenses the plasma at an angle of 45° and a treatment width of 47mm per nozzle.

the now active plasma nozzles starts to travel at a speed of 20m/min along the outside edge of the panel. The rotary systems designed specifically for large-area applications dispense the plasma at an angle of 45° and a treatment width of 47mm per nozzle (Fig. 5). Depending on the direction, 150-180mm of the surface can be cleaned and activated in a single pass. Beelmann: "Our main concern when pretreating the plastic-coated sheet



Subject: Structural bonding in vehicle manufacturing



Fig. 7. Photo Blue Rondo International
The load securing rails are flush-mounted in the metal outer skins of the panels. Plasma pretreatment ensures strong adhesive bonds.

steel skins is to produce a predefined reference status because we cannot rule out the fact that the components may be slightly contaminated during transportation. Then they would no longer correspond to the reference requirements.”

The pretreatment must be carried out on a minimum width of 300mm across the entire length or width of the panel (Fig. 6), which amounts to 32.60m per wall panel. Three beads of 2-component PU (polyurethane) adhesive are then applied to this pretreated area immediately afterwards. Generous overlaps are factored into the pretreatment process for reasons of safety. The plasma system makes a total of three passes across the surfaces to be bonded. Once the adhesive has been applied, a transport crane picks up the large

panels and inserts them in the aluminum profiles waiting alongside.

Working round the clock

In response to the growing demand for refrigerated vehicles, Schmitz Cargobull has recently built a further production hall. Mechanical engineer Beelmann designed the continuous production line on two superimposed levels to save space, with components transported automatically from one level to the other. The company operates a three-shift system. In a new manufacturing process, the inner skins of the panels are bonded to the galvanized steel load securing rails and double decker system on the ‘sheet line’. Static plasma nozzles work round the clock at high speeds to pretreat eve-

ry contour of the adhesive surfaces with millimeter precision immediately before the adhesive is applied. With these semi-trailer components too, the plasma treatment produces a predefined reference status. The purpose of this is to ensure that during subsequent processing the adhesive bond of the formed steel, which is flush-mounted to the metal outer skin of the panel, safely satisfies the requirements (Fig. 7).

Based on an average installation rate, the total length of plasma-treated surfaces is approximately 4.2 km per day in this production area alone. Plasmamatreat Key Account Manager Leonhard Enneking, who has assisted with this plasma application from the start, is full of praise for Schmitz Cargobull: “They have brilliantly mastered the integration of our technology straight from the process development stage into their sophisticated series production lines.”

Summary

In vehicle manufacturing, the requirements for structural bonding are high and can only be achieved with a reliable, reproducible pretreatment process. Atmospheric plasma treatment has successfully replaced conventional pretreatments such as mechanical keying or activation with environmentally harmful solvents in this industry. Schmitz Cargobull has made an impressive contribution to environmental protection in their refrigerated semitrailer production process: They have saved at least 20 tonnes of wet chemicals per year by using Openair technology. Furthermore, the fact that the plasma systems are integrated into the production process has made the pretreatment not only more reliable, but also extremely effective and economical.

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