WOMAG

Kompetenz in Werkstoff und funktioneller Oberfläche

Plasma for chrome-free sun shading

Large quantities of chemicals and contaminated wastewater are normally incurred during the precleaning of aluminum strips before coating. For the past 12 years, an atmospheric plasma technology has enabled a leading solar shading manufacturer to avoid using any wet chemicals for fine cleaning their aluminum strips and so set an example in environment responsibility.

Changing from an established industrial process to a completely new one is a huge step which calls for courage and a great deal of patience on the part of an entrepreneur. Griesser AG demonstrated both these virtues when several years ago they set about designing a new coil coating line for aluminum strips that was to be as environmentally friendly as possible. As one of Europe's leading manufacturers of solar shading, the Swiss family business specializes in weather-resistant aluminum roller shutters and external Venetian blinds. In 2007 a cleaning process based on atmospheric Openair-Plasma technology (*Fig. 1*) from system developer Plasmatreat – the first of its kind in the coil coating industry – was introduced at the company's headquarters in Aadorf which eliminated environmentally harmful practices from the outset. But such a revolutionary process change does not happen overnight.

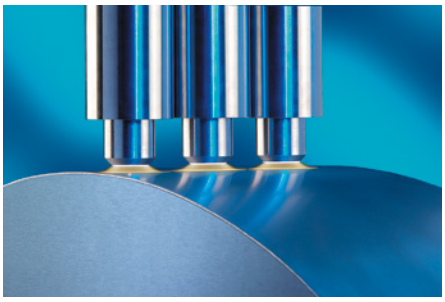

Fig. 1: Fine cleaning an aluminum coil with Openair-Plasma; the environmentally friendly jet technology is a dry, chemical-free process which cleans the strips using nothing other than compressed air and electricity (Photo: Plasmatreat)

The vision

The specialists at Griesser had long been contemplating how a new narrow-band coating line with integrated pretreatment could increase the reliability of the painting process and make it environmentally friendly at the same time. Since there was no integrated pretreatment zone in the old coil coating line, the company used chromatized strips, but this was to change. The speed was also to be increased, in other words, the aim was to achieve the fastest possible throughput of new products while maintaining absolutely consistent paint quality. It was clear that to implement the new system and the desired production volumes using conventional pretreatment methods, they would need a wet-chemical cleaning line over sixty meters long – but there was simply no room for this on the factory premises.

The then project manager came across Plasmatreat Openair-Plasma jet technology – which was still relatively new at the time – when attending a trade show. An in-line cleaning process with atmospheric pressure plasma (AP plasma) which uses no chemicals whatsoever, relying solely on air and electricity (*Fig. 2*). He could not stop thinking about the opportunities and benefits which this plasma technology would bring to his planned project. He was particularly taken with the idea that a future coil-coating process would reduce the number of process steps and significantly increase the level of environmentally friendliness.

Plasma replaces wet chemicals

Aluminum surfaces must be completely clean to ensure good wettability and effective coating. But this is rarely the case at the outset. Instead, the metal surface is contaminated with traces of residue from the production process such as release agents, lubricants, cutting oils and drawing grease or unspecified oxide layers and dirt deposits. These impurities diminish the effectiveness of the surface energy naturally present in the aluminum which is largely responsible for the adhesive strength of a coating. Consequently, the substrate must be thoroughly cleaned before further processing which, in the case of aluminum strip stock, is normally done by the supplier or a specialized external cleaning company using environmentally harmful wet chemicals.

Openair-Plasma, on the other hand, is a dry, environmentally friendly process which is highly effective at fine cleaning. In simple terms, its mechanism is based on the oxidizing ability of the plasma. The nozzles run entirely on compressed air, high-voltage and a process gas if required. During pretreatment, the plasma beam impinging on the surface removes all organic impurities from the material. The pretreatment process is contact-free, area-selective and extremely fast. The surface is cleaned to a microfine level and simultaneously activated at molecular level in a single step (*Fig. 3*).

Fig. 2: The use of AP plasma on the new coating line installed by Griesser 12 years ago dispenses with the need for a wet-chemical cleaning line (Photo: Plasmatreat)

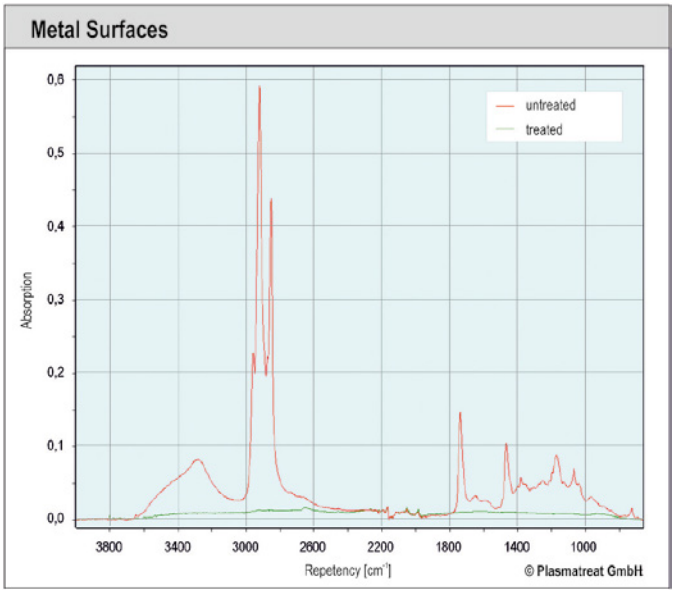

Fig. 3: As the infrared spectroscopic measurement shows, impurities on the metal surface are broken down and removed by the high-energy atmospheric plasma (Photo: Plasmatreat)

In the case of aluminum and other metals, the surface energy present in the substrate is restored by intensive plasma cleaning to ensure complete and homogenous surface wettability. Designed for fully automated, continuous production processes, the Plasmatreat systems are computer-controlled, screen-monitored and fully compatible with robotic applications, while the pretreatment processes themselves are robust and one hundred percent reproducible.

Griesser was excited about the possibilities afforded by the innovative technology. In Plasmatreat the company had found an equally enthusiastic partner who was immediately willing to work with Griesser to explore ways of integrating the plasma pretreatment into their new coating line.

The research

However, the solution that Griesser had decided on still required further research, so there was a long way to go before constructing the new plant and implementing the new process. Although the very first tests had shown that plasma technology could be used as an alternative to wet-chemical cleaning, the process still had to be developed and refined before it would work at least as effectively as the chemical cleaning process previously used by the supplier. The same applied to the long-time stable adhesion of the downstream conversion and paint coating.

Griesser decided to commission research company Nanocraft to undertake a study on the subject of *plasma-treated aluminum sheets*. As a spin-off of the Max Planck Institute and independent research services provider, Nanocraft was able to use elaborate methods developed from scanning probe microscopy to create surface images at molecular level to reveal both conventional, i.e. topographic, and chemically sensitive data.

Nanocraft successfully demonstrated the suitability of AP plasma for use in series production and its effectiveness for cleaning and activating surfaces before painting processes, such as coil coating. The conventional chemical pretreatment was used as a reference system during the tests. The plasma treatment was found to be vastly superior to conventional pretreatment methods in terms of the material plasma parameters that were to be optimized (focus, intensity, energy input). The results did not simply prove that AP plasma was a suitable alternative – in fact, the plasma treatment significantly outperformed the chemical reference system in all areas. Because the aluminum strips are intended for subsequent external use on the building facade, the Research Institute for Precious Metals and Metal Chemistry (fem) additionally performed a 1000-hour acetic acid salt-spray test in accordance with the GSB standard.

A milestone in systems engineering

Work began on constructing the new 49 m long coating line at the end of 2006, and at the start of June 2007 it was commissioned.

At first, Griesser continued to purchase the coils as roughly pre-cleaned sheets, but soon decided to carry out this initial cleaning stage themselves for cost reasons. Since then, the integrated preliminary cleaning stage has been performed in an environmentally friendly way using a pressure washer. The only cleaning medium used is demineralized water, which is recycled after use.

The aluminum strips are fine-cleaned with AP plasma. In total, 48 offset rotary plasma nozzles per 150 mm width clean both sides of the aluminum sheets before applying the chrome-free conversion layer (no-rinse process) (*Fig. 4*). The plasma nozzles produce a hydrophilic surface with a consistent contact angle of 20 to 30 degrees. The increased wettability ensures that the subsequent conversion coating bonds optimally to the surface. Griesser's computer-controlled plasma unit, with a footprint of just 2 m x 1.50 m (*Fig. 5*), replaces a cleaning line that would otherwise be over 60 m long. The environmentally friendly cleaning system saves large quantities of chemicals and thousands of tons of wastewater each year, depending on the degree of soiling of the strips. And since the pre-cleaning process does not generate any waste, there is no need for the usual neutralization measures that would otherwise be required, i.e. wastewater treatment. Large

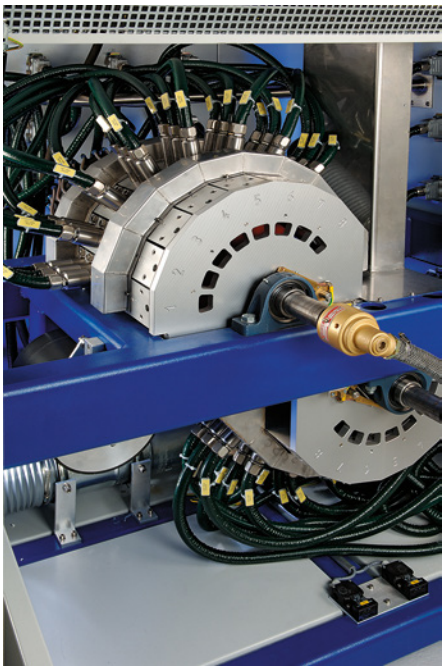

Fig. 4: In total, 48 offset rotary plasma nozzles per 150 mm width clean both sides of the aluminum sheets before applying the chrome-free conversion layer and the coating (Photo: Plasmatreat)

quantities of filter cake which would have to be disposed of as hazardous waste are thus avoided.

Not only has the plasma process enabled us to increase the production rate from 10 m/min to 40 m/min, reports Emanuel Kissling, overall production manager at the Aadorf plant, it also gives us greater flexibility, allowing us to coat small volumes and thus increase our in-house manufacturing output. Griesser's vision of avoiding chemicals altogether in the precleaning process has been fulfilled. The entire coil coating production of aluminum blinds is now a chrome-free process. The cost-saving, environmentally friendly measures serve as a blueprint for the coil coating industry. Inès A. Melamies

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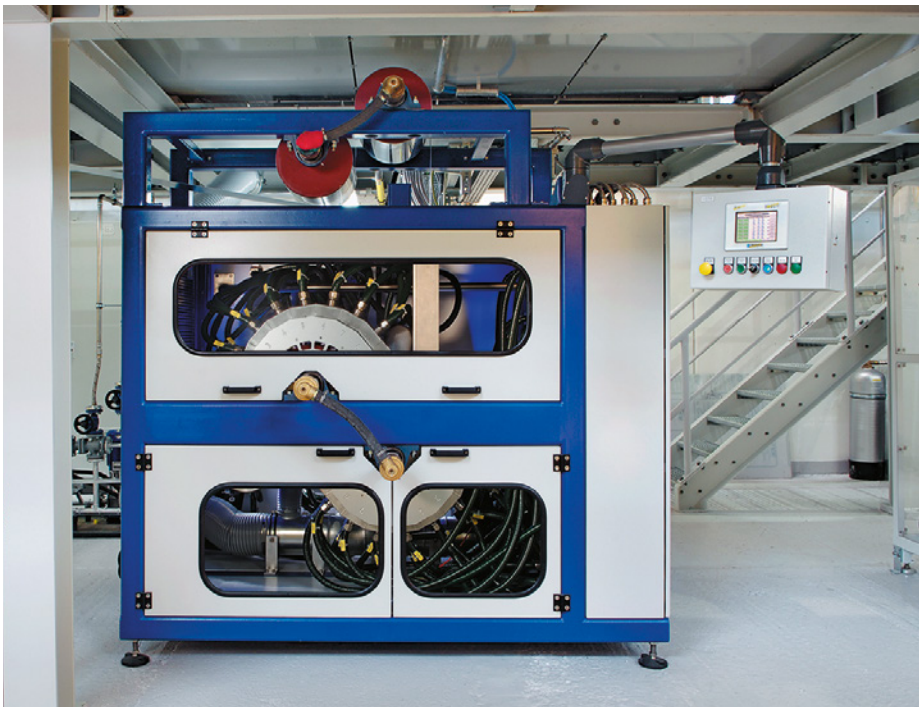

Fig. 5: With a footprint of just 2 m x 1.50 m, the computer-controlled plasma unit at Griesser brought about a fourfold increase in the production rate (Photo: Plasmatreat)