Adapted version from German original: “Plasma statt Chemie” published in BBR magazine August 2007

PLASMA REPLACES CHEMISTRY

THE COMPANY PLASMATREAT PROMISES TO BRING ABOUT A REVOLUTION IN COIL COATING WITH ITS “OPENAIR” ATMOSPHERIC-PRESSURE PLASMA TECHNOLOGY. FOR THE PRETREATMENT OF ALUMINIUM STRIP MATERIAL THIS WILL REPLACE CHEMICAL METHODS – COMPLETELY.

Innumerable tons of wet chemicals, millions invested in waste water disposal, – will these soon be things of the past? *Openair* atmospheric pressure plasma technology has made it possible to displace the use of chemicals in the pretreatment of aluminium coils and in doing so has set an example for environmental conservation, while quadrupling the plant capacity. Corrosive attack on surfaces, residual contamination by processing oils and the energy intensive pretreatment processes using environmentally threatening chemicals are the most common problems in the processing of aluminium.

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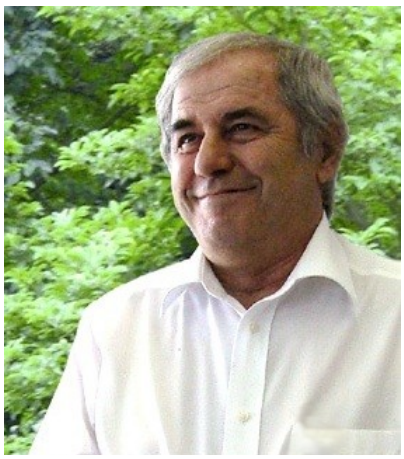
A process, whose application completely eliminates the above problems, has been developed using open air atmospheric pressure plasma technology and brought into production. This has been accomplished through the teamwork of Plasmatreat, based in Steinhagen, Germany, in collaboration with Griesser AG, Switzerland, and the German research institute Nanocraft. This technology brings about the ultrafine cleaning of aluminium coils before the application of the conversion layer (chem-coater) and completely replaces environmentally polluting wet-chemical processes in the cleaning operations.

Fig.1: The new 49 m long coil coating plant at Griesser AG by dispensing with a cleaning line establishes a milestone in process engineering.
Fig.2: The electrically neutral plasma beam allows ultrafine cleaning, high activation and extremely thin coating of surfaces.
Fig.3: By realizing his vision of environmentally friendly precleaning in the coil coating process project leader Branko Vasiljevic achieved a worldwide success. (Photo: Blue Rondo International)



Trailblazing innovations usually originate in the vision of a single person. Five years ago, Branko Vasiljevic, Strip Coating Project Leader of one of Europe's largest manufacturers of aluminium roller shutters, Griesser AG, had already dreamed of the construction of a new, absolutely environmentally friendly coating line. This line should not only be faster than the old one but would also allow the cleaning of aluminium coils in-line and hence save a lot of space.
Vasiljevic was enthusiastic about the possibilities of the relatively young *Openair* plasma technology. In Christian Buske, Managing Director of Plasmatreat, he found an equally committed partner who is ready to examine new approaches and to test in a joint project the integration of plasma pretreatment into Griesser's new coating line.

Plasma the fourth state of matter
Plasmatreat holds a patent on the process which eliminates the usual cost-intensive chemical cleaning processes used to clean the material of oils and greases as well as ensuring good adhesion of the coatings. In this way the coils are cleaned not only in an environmentally friendly fashion but also very economically. All that is needed is air and electric power. Plasma is the name given to matter at a high, unstable energy level. By means of electric discharge, additional energy can be fed into the gaseous matter and an electronically excited state occurs. When this happens the electrons can leave their atomic shells and molecular bonds can be broken.
This results in the formation of free electrons, ions and molecular fragments. Plasmatreat developed and patented the Openair atmospheric-pressure plasma process operating at zero potential about 10 years ago. This technology made it possible to exploit this fourth state of matter for industrial purposes. Through the development and use of plasma jets, atmospheric pressure plasma was successfully used for the first time in production processes, even in-line. The systems, based on a jet principle, operate at atmospheric pressure. With the aid of an electric arc ignited in the jet and the working gas, air, a plasma is generated. The plasma flows without potential onto the product to be treated. It contains particles which are sufficiently excited to initiate selective effects on the surface. The jets are operated with air, possibly also with another desired process gas, and at high voltage.

A particular characteristic of the emerging beam of plasma is that it is electrically neutral which greatly extends and simplifies its range of uses. Its intensity is so high that machine speeds of several 100 m/min can be attained. The Openair system is characterized by a threefold action: it activates a surface by selective oxidation processes, discharges static electricity, and brings about ultrafine cleaning and high activation of the surfaces of metals,

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plastics and glass. The economic aspect: users can always integrate the jet systems employed in-line, that is, directly into new or already existing production lines

The Research

The project that Griesser decided to embark upon in 2002, however, required further research work. So the process had to be developed and refined before plasma cleaning functioned just as effectively as the chemical cleaning process employed. The same applied to the reliable adhesion of coatings subsequently applied.

At the first field trials were not successful, with not even any promising results. Vasiljevic then decided to commission a study on the subject of "plasmatreated aluminium sheet metal" from the German company Nanocraft. As an offshoot of the internationally renowned Max Planck Institute and an independent contract research company using expensively developed methods in the field of scanning probe microscopy Nanocraft was capable of imaging surfaces both conventionally, i.e. in terms of topographical elasticity and chemical sensitivity, and on down to molecular resolution.

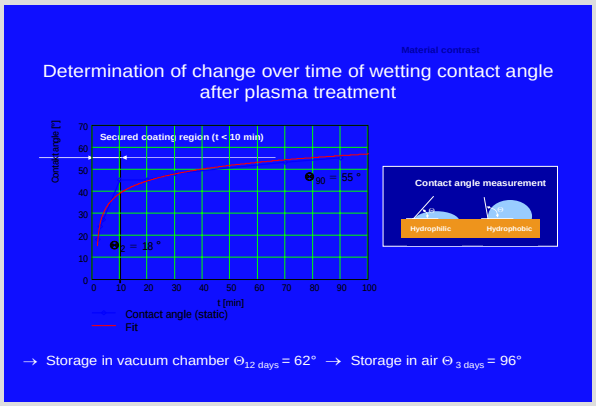

Fig. 4 and 5: The atmospheric-pressure plasma installation only 2 m long replaces a 21 m long cleaning line, i.e. tons of wet chemicals. 2 x 24 plasma jets clean the strip on both sides. Fig.6: At a speed of 40 m/min and a pretreatment width of 6-8 mm individual jets direct the intensive plasma beam onto the strip. (Photos: Plasmatreat)
Fig. 7: By means of Openair plasma a very small wetting contact angle and hence a very good hydrophilic substrate surface is obtained (diagram: Griesser AG)

Nanocraft carried out tests on the systems for cleaning and preparing aluminium coils developed by Plasmatreat for Griesser.

Conclusive Results

Under the leadership of Nanocraft Managing Director, Dr. Sabri Akari, the practicability of atmospheric-pressure plasma in volume production and its efficacy as a pretreatment, i.e. cleaning and activation, of surfaces to be coated as in coil coating was demonstrated.

In the trials, conventional chemical pretreatment was used as the reference system. Taking account of the material-plasma parameters to be optimized (plasma focus, intensity/energy input) it was possible to show a distinct superiority over conventional pretreatment methods. The results obtained proved not only the usability and high effectiveness of atmospheric-pressure plasma, but also that in all areas plasma pretreatment achieves better results than the chemical reference procedure.

Since the aluminium coils are components to be used later on the exteriors of buildings they were exposed to a 1,000-hour acetic acid salt spray test carried out in accordance with GSB at the German *Forschungsinstitut fuer Edelmetalle und Metallchemie* (FEM; Research Institute for Noble Metals and Metal Chemistry). After the test, the plasma-treated coil exhibited no migration under the coating nor the slightest sign of corrosion.

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At the end of December 2006 the construction of the new 49 m long coating line was started. Production commenced in June 2007. Set up in offset fashion 24 jets per side of the coil achieve a hydrophilic, activated surface having a contact angle of 15° - 28°. They clean the aluminium strip over a width of 150 mm (300 mm in total) before the conversion layer is applied. The company processes more than 400 metric tons of aluminium strip per annum and in doing so only two members of staff are needed for operating the entire plant.

The development lead time for the new plant costing over 4 million US Dollar from the initial idea of running the cleaning installation in-line to start-up was about five years. At the same time, due to the use of the Openair plasma process the speed of the plant has quadrupled in comparison with the old plant. The cooling and drying systems in the new plant were developed by the German company Vits Systems GmbH and the construction of the whole plant including transport of the strip and application development was the responsibility of the Swiss company Werner Mathis AG. The plasma plant replaces here an approximately 21 m long cleaning line, but the described jet-system can be implemented in any size of coil coating production. By increasing the number of nozzles, the application can accommodate any coil width. This measure resulting in enormous savings in costs and protection of the environment sets very high standards for the entire coil coating sector.

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