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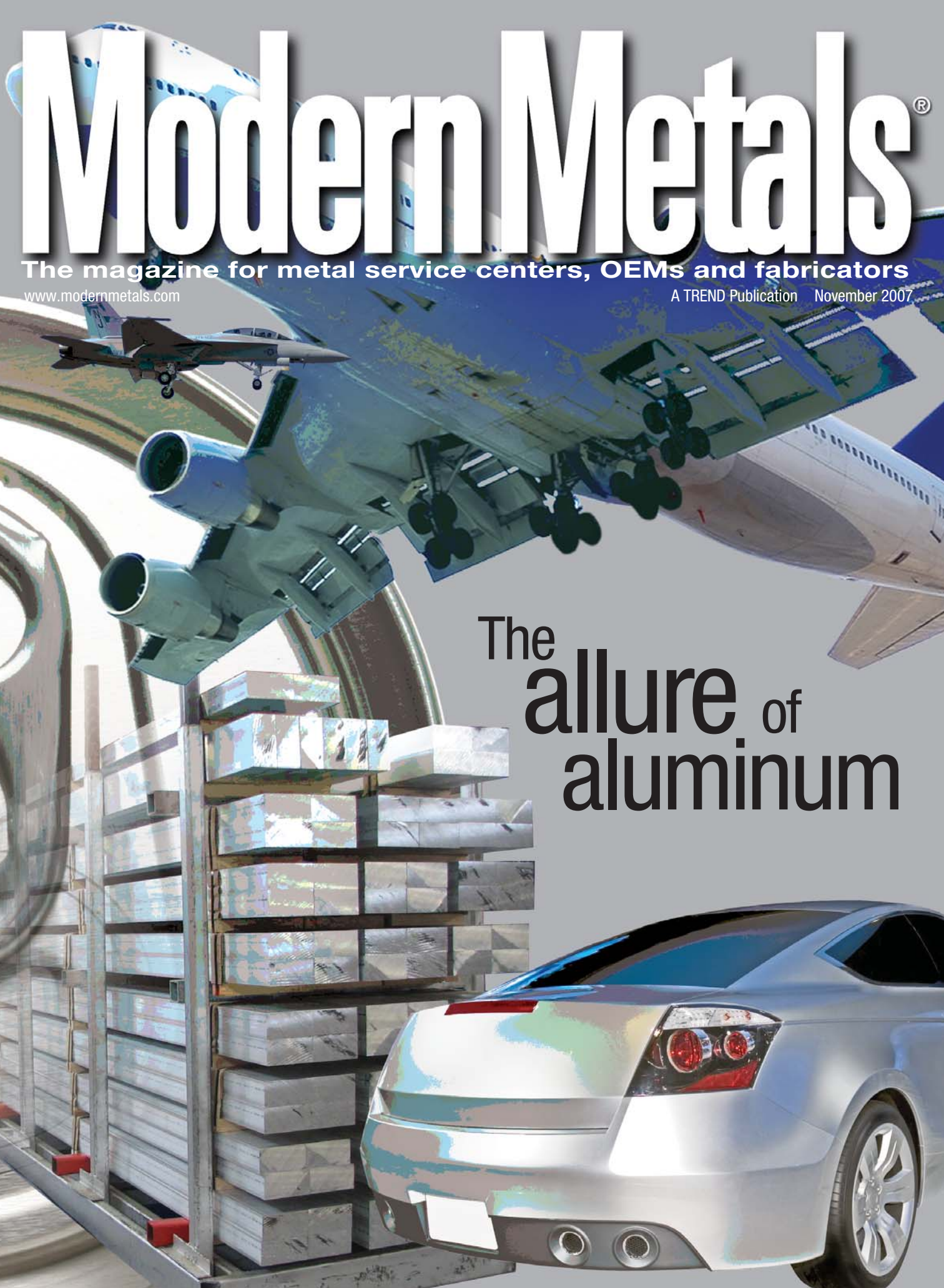


The allure of aluminum

Photographs courtesy of Plasmatreat.

BY JOACHIM SCHUESSLER

Plasma replaces chemistry in the innovative **Plasmatreat** process

Environmental revolution in coil coating

Soon the innumerable tons of wet chemicals and millions invested in wastewater disposal could be a thing of the past because Openair atmospheric pressure plasma technology has made it possible to displace the use of chemicals in the pretreatment of aluminum coils. As a result, the process has set an example for environmental conservation while quadrupling plant capacity.

The most common problems that companies face when processing aluminum are a corrosive attack on surfaces, residual contamination by processing oils and the energy-intensive pretreatment processes using environmentally threatening chemicals.

Plasmatreat, Steinhagen, Germany, in collaboration with Griesser AG, Aadorf, Switzerland, and the German research institute Nanocraft, developed and holds a patent on a process that completely eliminates environmentally polluting wet-chemical processes in cleaning operations. The technology allows the ultra-fine cleaning of aluminum coils before the application of the conversion layer (chemcoater). In this way the coils are cleaned not only in an environmentally friendly way but also economically. All that is needed is air and electric power.

A vision becomes reality

Five years ago, Branko Vasiljevic, strip coating project leader at Griesser AG, one of Europe's largest manufacturers of aluminum roller shutters, had already begun thinking about building a new, environmentally friendly coating line. This line would not only be faster than the old one but would also allow the cleaning of aluminum coils inline and, as a result, save space.

In 2002, the dream began to take

shape. 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 was ready to examine new approaches and to test in a joint project, the integration of plasma pretreatment into Griesser's new coating line.

The fourth state of matter

Plasma is the name given to matter at a high, unstable energy level. By means of an 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.

The Openair atmospheric-pressure plasma process 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.

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 and plasma is generated. The plasma flows onto the product to be treated. It contains particles that are sufficiently excited to initiate selective effects on the surface. The jets are operated with air (or possibly another process gas) and at high voltage.

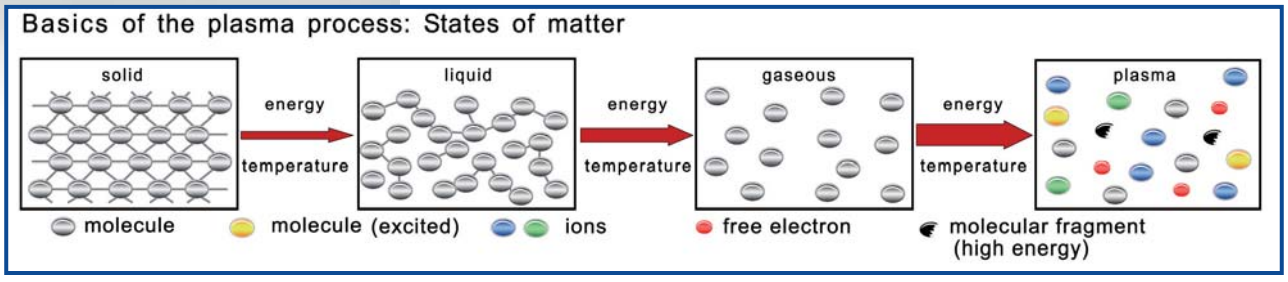
A particular characteristic of the emerging beam of plasma is that it is electrically neutral, which greatly extends and simplifies its range of uses. Its intensity is so high that machine speeds of several hundreds of meters per minute can be attained. The Openair plasma system is characterized by a threefold action: It activates a surface by selective oxidation processes, discharges static electricity and brings about ultra-fine cleaning and high activation of the surfaces of metals, plastics, ceramics and glass. For additional economy, users can always integrate the jet systems into new or already-existing production lines.

Refining the process

Before plasma cleaning functioned just as effectively as the chemical cleaning process, especially when it came to the reliable adhesion of coatings, the process had to be developed and refined. The first field trials were unsuccessful, yielding no promising results. Vasiljevic then decided to commission a study on plasma-treated aluminum sheet metal from Nanocraft. An offshoot of the internationally renowned Max Planck Institute and an independent contract research company using methods in the field of scanning probe microscopy, Nanocraft was capable of creating images of surfaces both conventionally (in terms of topographical elasticity and chemical sensitivity) on down to molecular resolution.

And, under the leadership of Dr. Sabri Akari, managing director of Nanocraft, the practicability of atmospheric-pressure plasma in volume production and its efficacy as a pretreatment of surfaces to be coated was demonstrated.

The trials used conventional chemical pretreatment as the reference system. By taking account of the material-plasma parameters to be optimized, it was possible to show a distinct superiority over conventional pretreatment methods. The results proved not only the usability and



Plasma technology doesn't stop at the gaseous state of matter: If by means of electric discharge additional energy can be fed into the material, the electrons gain more kinetic energy and leave their atomic shells.

high effectiveness of atmospheric-pressure plasma but also that in all areas, plasma pretreatment achieves better results than the chemical procedure that was used as the reference.

Since the aluminum 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 the GSB at the 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.

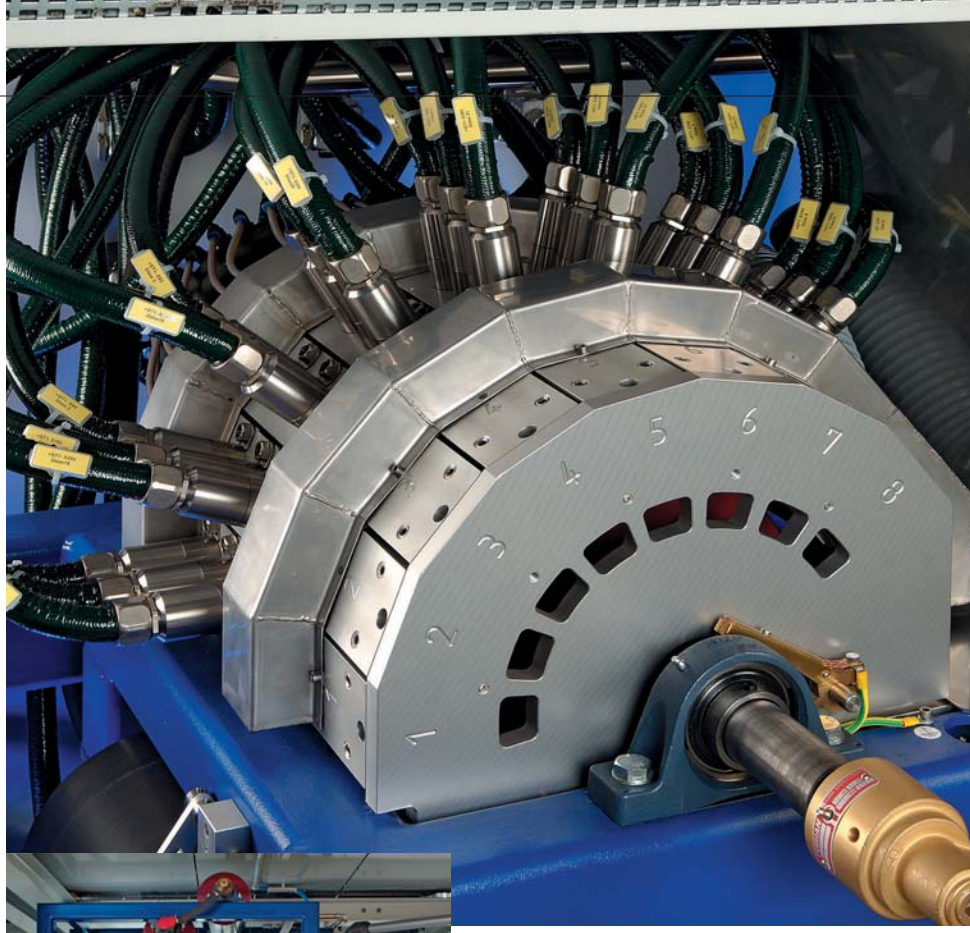
A milestone in industrial engineering

At the end of December 2006, the construction of a new 49-meter-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 that has a contact angle of 15 degrees to 28 degrees. The jets clean the aluminum strip over a width of 150 millimeters (300 millimeters in total) before the conversion layer is applied. The company processes more than 400 metric tons of aluminum strip per year, and only two staff members are needed for operating the entire plant.

The development lead time for the new plant, with a price tag of more than $4 million, was about five years—from the initial idea of running the cleaning installation inline to startup. At the same time, because of the use of the Openair plasma process, the speed of the plant has quadrupled in comparison with the old plant. The plasma plant replaces an approximately 21-meter-long cleaning line, which means that, depending on the grade and contamination of the strips, between 150 tons to 180 tons per year of chemicals and waste process water are eliminated.

The jet system can be implemented in any size coil coating operation. By increasing the number of nozzles, the application can accommodate any coil width. This results in enormous cost savings, as well as protecting the environment and setting a high standard for coil coating.

Openair atmospheric plasma processes are effective for surface preparation, including critical cleaning, activation for improved bonding and coating adhesion and deposition of thin-film coatings. Materials that can be modified include metals, polymers, composites and glass. The most important advantages of this technology include the reliability and quality it provides in the production process. Accordingly, the requirements of high-performance finishing manufacturers can be met. The robust, high-throughput processing system is readily integrated into existing manufacturing lines offering cost-effective solutions with absolutely no adverse effects on the environment. ■



A total of 48 plasma jets, found within the 2-meter-long installation, ensure ultra-fine cleaning on both sides of the aluminum sheet.

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