



Plasma Treatment: Dropping the Failure Rate

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Whether in daily manufacturing or the development of new processes and products: surfaces and their properties play an increasingly important role in nearly all industrial areas. The surface of materials often have to be pretreated to prepare them for processes that will follow.

Openair plasma is a method of producing new surface properties and optimizing other manufacturing processes. This atmospheric plasma, applied by special nozzles, results in micro-fine cleaning and extensive activation of surfaces — necessary for optimum adhesion of coatings, paints and adhesives, such as the epoxy adhesives and hotmelts frequently used in electronics.

Openair is the key technology developed and patented in 1995 by Plasmatreat GmbH, and today is used worldwide in a wide variety of industries. It permits continuous in-line application to all or selected parts of the surface at high speeds. If the nozzle is guided by a robot, high-precision localized effects can be obtained and the finest contours cleaned, activated and coated. Quite often, a material cannot be used at all until its surface has been custom treated with atmospheric pressure plasma.

Neutral Plasma Beam

The systems work at atmospheric pressure and produce a plasma with the aid of an arc ignited in the nozzle and the air which serves as working gas. The plasma then flows potential-free onto the product to be treated. It possesses sufficient numbers of excited particles to introduce targeted effects onto the surface.

The emitted plasma beam is electrically neutral, and this

greatly extends and simplifies applicability. Its intensity is so high that processing speeds of several hundred meters/min are possible. During treatment, the heating typically undergone by plastic surfaces is less than 30°C. The Openair system works in three ways: it prepares the surface targeted oxidation processes, discharging the surface at the same time and leading to micro-fine cleaning.

Surface discharge means that the Openair plasma system offers cleaning effects which far exceed those of conventional systems. The high electrostatic discharge effect of a free plasma beam is boosted by the very high emission speed of the plasma. Very effectively removal of any loosely adhering particles is the result.

Protection by Encapsulation

Electronic components are typically protected against adverse environmental effects by encapsulating or sealing them using suitable materials. In doing this it is important to plan the encapsulation process so that there are no weak spots. This means that there must be no air

occlusions, cracks or irregularities in the encapsulation. Successful encapsulation, however, depends not only on the encapsulating material or the encapsulation installation, but also on the surface of the component on which the material is to be applied.

The plasma consists of ionized air composed to a large extent of extremely reactive oxygen ions and radicals. These particles react at the surface with the plastic and the workpiece and alter them both physically and chemically. First, these ions



Openair plasma provides microfine cleaning and surface preparation which ensures long-term adhesion of encapsulating hotmelt.

increase the surface tension to such an extent that the encapsulating material flows into each tiny cavity on the surface of the workpiece. Then the surface becomes highly reactive so that firm chemical bonds can be established between it and the hardening encapsulating material. Both effects together ensure an intimate bond between the encapsulating material and the base that is being treated so that the bonding between these two different materials is just as great as the cohesion within the encapsulating material itself. Whether of metal or plastic, the geometries of work pieces are becoming increasingly complex. The tip of the Openair plasma nozzle can be readily adapted to the work piece geometry, important for pre-treatment of highly complex, three-dimensional geometries with a large number of undercuts.

Automotive Electronics

Electronic components and circuits are playing an ever-increasing role in automotive manufacture. Major automotive subcontractors use open-air plasma to protect their highly sensitive sensors and control elements. The IEC standard and the IP degrees of protection stipulate that the sensors and control elements must be protected against penetration by moisture and contamination.

Because automotive electronics are exposed to such serious environmental risks, they are usually placed inside a protective plastic box or housing. The physical demands placed on the integrity of the protective plastic housing are extreme; the electronics must withstand temperature fluctuations of -40 to +140°C in the test process and all moisture, liquids and chemicals must be kept locked out of the protected enclosure. To obtain the best possible seal, it is standard practice to treat the sealing surfaces with plasma before applying the adhesive. This pre-treatment cleans and activates the housing surfaces to provide increased adhesion properties of the subsequent bonded joint that will guarantee a seal against penetration of any harmful environmental hazards — virtually eliminating the risk of short-circuits, malfunctioning and pos-

sible long-term destruction caused by environmental incursions.

Clean Displays

Wherever vibrations occur — in cars, car radios, on-board computers, mobile telephones, pocket calculators or computer monitors — displays are coated with a heatsealed film. The film provides the flexible connection between the printed circuit board and the contact surface or display, which usually consists of two thin glass panes. The foil is bonded to the pane, which has been coated with indium tin oxide (ITO). Glass surfaces, however, get dirty easily, whether during packaging, storage, handling or transport. Fingerprints or dust on the glass surfaces are difficult to avoid and require additional cleaning.



Pretreatment and activation of the housing before adhesive application.

This contamination can result in segment errors; particles that are present cause short-circuits.

Most manufacturing processes today still employ conventional manual cleaning of the display glass with the aid of a cotton bud and solvents. The average fail rate of 12 percent is common. The situation is totally different for those manufacturers who clean the displays with atmospheric plasma pre-treatment; here the fail rate sinks to below 1 percent. In addition, the protective plastic film, ITO layer and pole filters are not damaged by the careful, ESD-free treatment. The entire in-line process is environmentally sound, monitorable and reproducible, as is also the case during circuit board cleaning.

Protection Guidelines

Outdoor electronics require high levels of protection, since they are perma-

nently exposed to the weather. Novar GmbH, Albstadt, Germany, a security systems manufacturer affiliated with Honeywell Security AG, attaches special importance to Openair plasma treatment during the manufacture of its high-quality alarm systems. Unlike the case for control elements in cars, which must be accessible at any time and therefore are packaged in a sealed housing, the soldering process for alarm systems is followed by electronic encapsulation with the aid of a hotmelt adhesive to safeguard the mounted boards from moisture and/or mechanical damage. Without pre-treatment, however, the adhesive either does not stick to the substrate or detaches itself after a while.

Here, too, Openair plasma cleaning pre-treatment is the answer. The plasma nozzle leads the jet across each square centimeter of the plate. The result: when the hotmelt is applied, it adheres so well that it reaches the highest international degrees of protection (IP 68) and even the relatively new IP 69K. IP 69K is aimed particularly at the stability of electrical components during high-pressure jet cleaning. After completion, the printed circuit board is inserted into an additional housing where it serves as a keyboard in the outer entrance area of a complete, highly complex intruder alarm system. Failure of this keyboard could lead to a malfunction of the security system, which is why Honeywell goes far beyond the requirements of the standard, subjecting each individual board to a 12-hour underwater functionality test.

Openair plasma technology is a new pretreatment process used in the electronics industry to process parts and circuits during production and/or assembly. High purity requirements are met along with potential free treatment, i. e. the circuits do not make contact with electrical voltage during plasma treatment. The entire process is environmentally friendly, monitorable and reproducible.

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