

International Surface Technology



JOT – Germany's leading magazine for surface technology
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IN-LINE COATING WITH ATMOSPHERIC PLASMA

Selective Corrosion Protection for Aluminium Housings

A major supplier to the automotive industry has recently begun using plasma technology to pretreat pump housings. With the new process, the surfaces of metallic components can be selectively coated in-line at atmospheric pressure to prevent bond line corrosion.



The system uses the jet principle to activate and coat surfaces.

Whether the aim is to provide protection against corrosion, to apply a bonding agent or to simplify the process of cleaning surfaces, the PlasmaPlus technology, newly developed by Plasmamatreat GmbH in collaboration with the Fraunhofer IFAM in Bremen, offers a wide range of different functionalised layers for selective coating.

The new process is based on the Openair atmospheric plasma technology which is already in use throughout the world. One large supplier to the automotive sector began using the new technol-

ogy earlier this year to protect steering system components against corrosion.

Glass-like passive coating

In order to create a coating, an organosilicon compound is added to the atmospheric plasma. The high-energy excitation in the plasma causes the compound to become fragmented and it is deposited onto a surface in the form of a glass-like layer.

The chemical composition can be modified depending on the application in order to achieve the best results on dif-

ferent materials (for example, metal, plastic, glass or ceramics).

The films can be examined under a scanning electron microscope (SEM) to measure their thickness. At a magnification of 50,000x, the SEM images of cross-sections of coated samples reveal a homogeneous film containing no pores. This is very important in corrosion protection as it indicates a passive protection layer. In other words, corrosive agents are prevented from attacking the material by a barrier. The coating itself is not sacrificed during the corrosion process as would be the case on a galvanised steel surface (active corrosion protection).

Particularly effective for aluminium alloys

In addition to the option of in-line use, the major benefit of PlasmaPlus technology when compared with other coating methods is the selective coating technique. The anticorrosive action is particularly effective for aluminium alloys. The coating can protect aluminium for several days against direct salt spray (DIN 50021) without any changes occurring in the visual appearance of the metal.

In order to demonstrate the effects of the coating, part of an aluminium sheet (Al 99.5) was coated and part was left in its original unprotected state. After being exposed to the salt spray test for 96 hours, the uncoated aluminium was heavily corroded (matt surface), but the coated area retained its original shine. The transition between the corroded and non-corroded areas can be clearly identified in the photomicrograph at 100x magnification.

If the plasma coating is to be used for corrosion protection, a thick layer (several hundred nanometres) is advisable since this will be more resistant to corrosive agents, such as electrolyte solutions, acids and alkalis. Where the plasma coating is to act as a bonding agent, a layer only a few nanometres thick is sufficient. Thin layers have all the important functional groups with which the adhesive can react and form a strong bond.

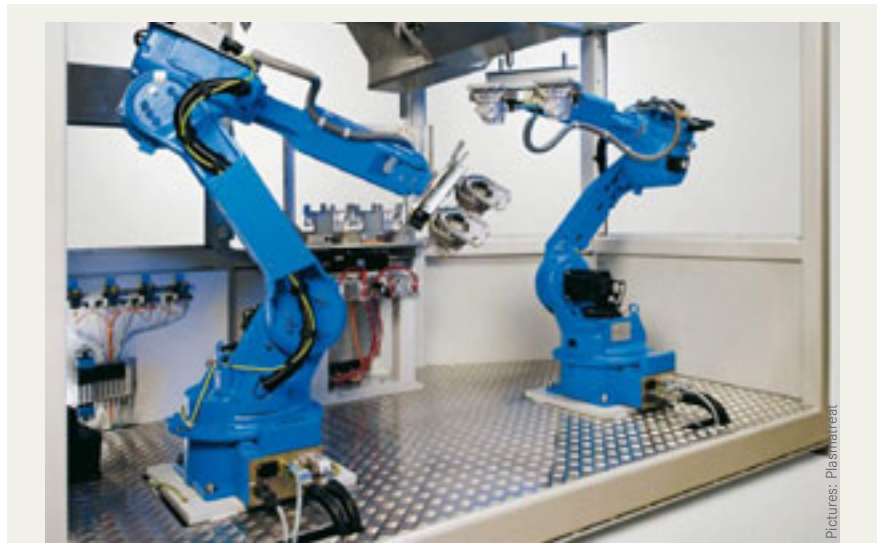
The highly effective bond between the coating and the substrate prevents any infiltration of the bond line (bond line corrosion). Infiltration is particularly harmful to bonded components, such as motor or printed circuit board housings for the automotive industry, because the transmission of forces in structural bonds can no longer be guaranteed or because leaks may occur in housings sealed with adhesive.

Plasma improves the moisture barrier

TRW Automotive, a world market leader in vehicle safety systems, began coating pump housings for steering units using an Openair PlasmaPlus system last year.

The coating process is carried out in-line and ensures the best possible protection against the penetration of moisture. Even microscopic leaks resulting from corrosion can lead to short circuits and the failure of the power steering system. Coatings using plasma at atmospheric pressure play a crucial role in this respect.

The parts are fed into the system on a turntable. The first stage of the process involves two robots subjecting the parts to an identification check with a barcode scanner and checking their dimensional accuracy. After this the flange surfaces that are to be bonded are thoroughly cleaned using plasma to remove organic impurities, such as minute residues of milling and drilling emulsions, which helps to ensure that the organosilicon layer that is applied afterwards forms a strong bond with the aluminium housing.



Robot system which applies a plasma coating to pump housings for the automotive industry.

After a thin coating has been applied, the housing parts are put back onto the turntable and can be removed by the operator. The next stage of production involves applying the adhesive and fixing the housing cover in place. The process ensures that the bond line is effectively protected against infiltration and the housing material in the area of the flange is protected against corrosion.

The mechanical stresses and, in particular, the corrosive stresses that the component is subjected to during its service life must not cause the bond to fail, as otherwise there would be no protection for the electric motor and the electronic parts. These environmental effects can be simulated by exposure to the SWAAT test (sea water acetic acid test).

The plasma-polymerised coating provides significantly better protection against moisture penetration than the original process, which involved manually spraying a fluoropolymer-based anticorrosion agent onto the outside of the bond line after bonding. During the exposure test, the period before the breakthrough, in other words, the appearance of the first signs of corrosion in the interior of the housing,

increased by around 50% to more than 750 hours.

It is clear that coatings using the new plasma technology not only create the ideal conditions for a lasting bond, but also ensure that the component has a long service life.

Ease of use

The Openair PlasmaPlus system can be used in-line in any production process and can be applied by robots. It produces a highly effective anticorrosive coating or layer of bonding agent on a wide variety of substrates and is therefore a versatile system for cleaning and coating aluminium surfaces.

As the chemicals used are non-toxic and are applied in small quantities, the process has little impact on the environment and no additional solvents are needed. The coating does not have to be removed before a component is recycled, as it contains no harmful compounds. The coating can be recycled together with the substrate.

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