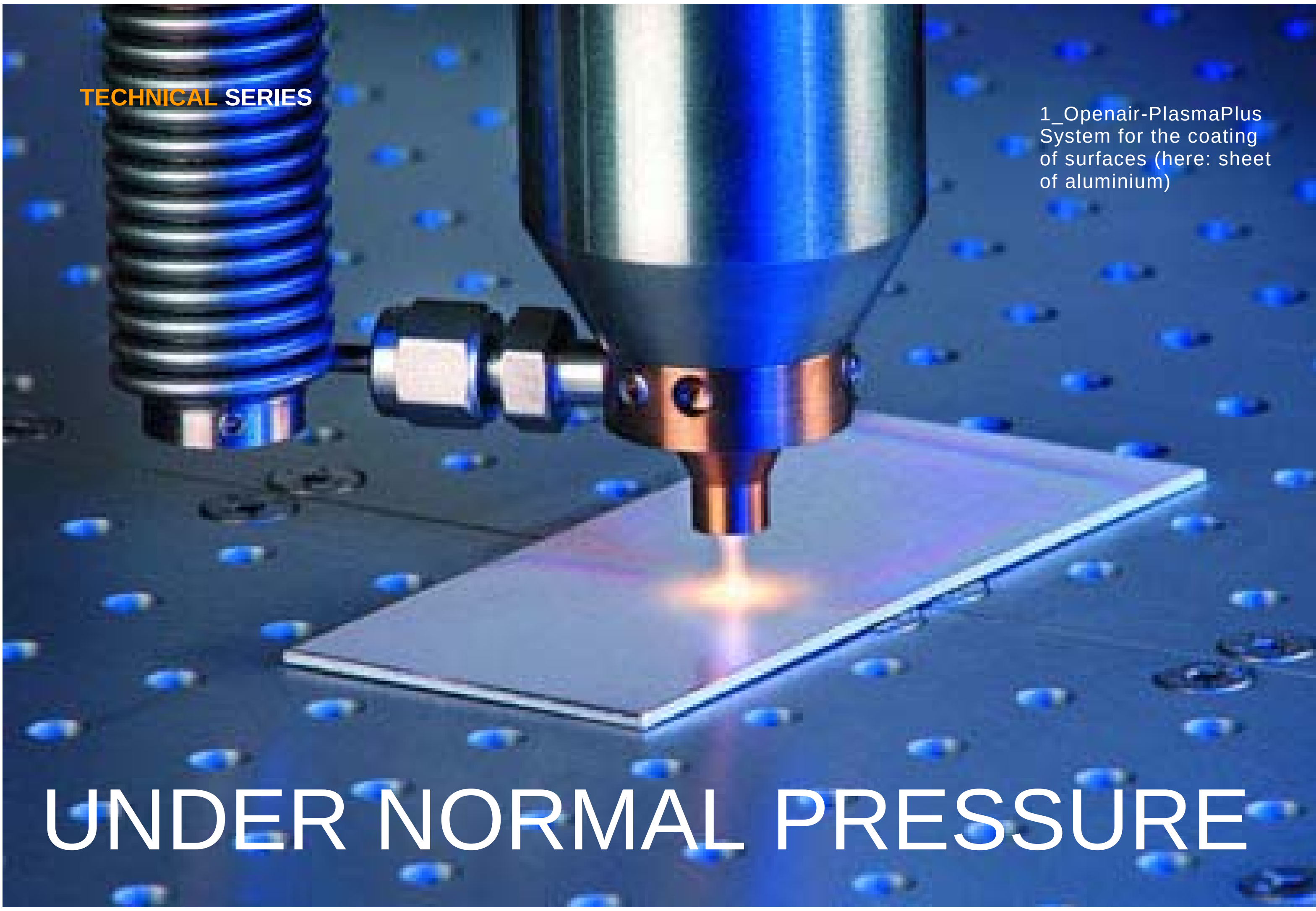


Adapted version from German original: 4/5.2008, www.bbr.de

Series
PART 3

PLASMA POLYMERISATION UNDER NORMAL PRESSURE INSTEAD OF IN VACUUM

A NEW PLASMA TECHNIQUE AFFORDS AN ABUNDANCE OF DIFFERENTLY FUNCTIONALISED LAYERS FOR THE SELECTIVE COATING OF MATERIAL SURFACES

The basis of the new process is the Openair atmospheric-pressure plasma technology from Plasmatreat GmbH, Steinhagen, which has been used throughout the world for over 10 years.

The zero-potential plasma system is characterised by a threefold action: it activates surfaces by selective oxidation processes, discharges them at the same time and brings about microfine cleaning and high activation of the surfaces of metals, plastics, ceramics and glass. Its intensity is so high that treatment rates of several 100 m/min can be achieved. In addition, the plasma energy of this system is exploited for film formation. From the economics point of view the jet systems used can always be integrated in-line by the user, that is to say integrated directly into a new or already existing production line.

Until recently plasma coating used to be a process that could only be carried out in vacuum. In close collaboration with the Fraunhofer IFAM in Bremen Plasmatreat developed a new process which now for the first time allows nanoscale thin films to be applied to the surfaces of materials at atmospheric pressure.

PLASMA POLYMERISATION UNDER NORMAL PRESSURE

To produce a layer the atmospheric-pressure plasma employed here is admixed with an organosilicon compound. Due to the high-energy excitation of the plasma this compound is fragmented and is deposited on a surface in the form of a vitreous film.

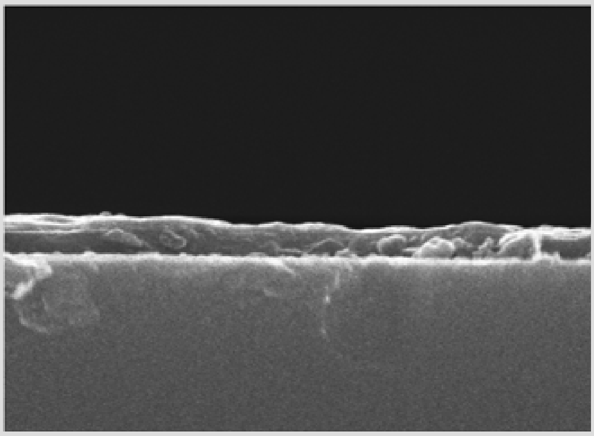
The chemical composition can be varied according to application in order to achieve the best results for the different materials involved. To evaluate the thicknesses of the layers SEM (scanning electron microscope) studies were carried out.

At 50,000 times magnification scanning electron micrographs of coated sample cross-sections reveal a homogeneous and nonporous layer structure. This is very important in corrosion protection since we are dealing here with a passive layer, which means that attack by corrosive media is prevented due to a barrier effect. The material in the coating itself is not sacrificed during the corrosion process, as would be the case, for example, in a zinc-coated or galvanised steel surface (active corrosion protection).

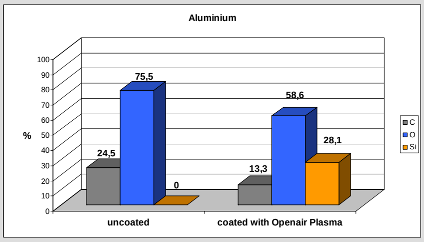
PROTECTING ALUMINIUM AGAINST CORROSION

Apart from its in-line use, the great advantages of ‘PlasmaPlus’ technology compared with other coating techniques lie primarily in the technique of selective coating.

The anticorrosive action is particularly effective in aluminium alloys. The coating is able to protect the aluminium for several days against direct salt spray fog (DIN 50021) without the visual appearance of the metal being affected. To demonstrate the mode of action an aluminium plate (Al 99.5) was partially coated, while the remaining area was left in the unprotected initial state. After 96 hours of exposure to the salt spray test the uncoated aluminium surface was highly corroded (matt area) while the coated area still exhibited its original lustre. The boundary between the corroded and uncorroded areas is clearly discernible in the photomicrograph at 100 times magnification. If plasma coating is used for corrosion



2_The area protected by the PlasmaPlus coating exhibits no sign of corrosion even after exposure for 96 hours to the salt spray test. **3**_ Cross-section through an approximately 100 nm thick Openair PlasmaPlus layer (50,000 times magnification by scanning electron microscope) (Photo: Saint Gobain) protection a thick layer (several hundred nanometres) is advisable since this is more resistant to corrosive media, such as electrolyte solutions, acids and alkalis. When the layer is used as a bonding agent just a few nanometres suffice in principle since this thin film comprises all the important functional groups with which the adhesive can react and undergo strong bonding.



Composition of coatings created by the Openair-Plasma (Plasmatreat)

PLASMA COATING IN THE AUTOMOTIVE SECTOR

The very strong adhesion of the coating to the base material effectively prevents infiltration of the bonded seam (bondline corrosion). In the case of a bonded component, such as a motor or printed circuit housing for example, infiltration would be particularly damaging since then the transmission of force in structural joints would no longer be ensured or, on the other hand, in the case of housings sealed with a jointing compound a leakage could occur. At TRW Automotive, world market leader in vehicle safety systems, motor pump housings are now for the first time being coated by Openair PlasmaPlus technology. Compared to the original process, in which after bonding a fluoropolymer-based anticorrosive agent was sprayed onto the bonded seam from the outside, the plasma-polymerised layer achieved substantially better leak-proofing.

LONG-TERM EFFECT

In an external weathering test the time to "breakthrough" (appearance of first signs of corrosion in the interior of the housing) was increased by about 50 per cent to over 750 hours. Accordingly, coating by means of the new plasma technology provides not only the optimum preconditions for durable adhesion of the adhesive but also simultaneously ensures a long service life for the component.

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