PLASMA COATING UNDER NORMAL PRESSURE

NANOCOATING WITH ATMOSPHERIC PRESSURE PLASMA ENABLES SUBSTANCES TAILORED SPECIFICALLY TO THE APPLICATION TO BE DEPOSITED DEEP DOWN INTO THE NANOSTRUCTURE OF THE MATERIAL SURFACE. AN AWARD-WINNING JET-TECHNOLOGY CREATES A HIGHLY EFFECTIVE FUNCTIONAL COATING THAT CONFERS COMPLETELY NEW SURFACE CHARACTERISTICS ON THE MATERIALS. INÈS A. MELAMIES WRITES FOR BP&R TO FURTHER EXPLAIN THE TECHNOLOGY.

Fig. 1: Locally selective plasma coating under atmospheric pressure: the chemical composition can be varied according to the application to obtain the best results for a variety of different materials. Photo: Plasmatreat

The process is based on the Openair plasma jet technology developed by Plasmatreat GmbH in Steinhagen, which has been used throughout the world for almost 20 years. This 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 of materials such as metals, plastics, ceramics and glass. A particular feature of this technology is that the plasma is potential-free, which greatly increases the range of possible applications. The intensity of the plasma is so high that processing speeds of several 100m/min can be achieved. It also offers economic benefits: the jet systems are designed for in-line integration by the user, i.e. they can be integrated directly into a new or existing production line, and they are compatible with robotic systems.

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In addition to the functions described above, this plasma system is also used for functional coating (Fig. 1). Until recently this coating process could only be performed under vacuum. Plasmatreat, in close collaboration with the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM) in Bremen, has spent the last few years developing an innovative process called PlasmaPlus, which for the first time enables a nanocoating to be applied to material surfaces under normal atmospheric conditions. In recognition of its work in developing this simpler, far quicker and more cost-effective process, the company was granted the Industry Award 2012 in the "Production and Mechanical Engineering" category. Fraunhofer researchers, Dr. Jörg Ihde and Dr. Uwe Lommatzsch, received the Joseph von Fraunhofer Prize at almost the same time.

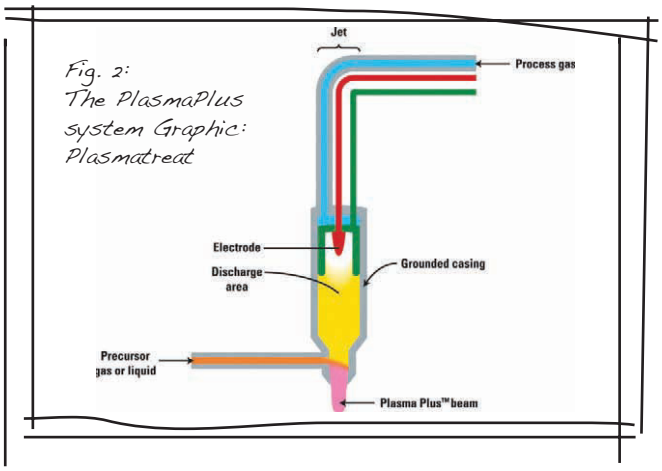

Fig. 2: The PlasmaPlus system Graphic: Plasmatreat

At the heart of the process is a plasma nozzle that conceals a highly complex coating system (Fig. 2). The process is environmentally friendly, needing nothing other than compressed air, electricity and a precursor, which is added to the plasma to create the coating. Due to the high-energy excitation in the plasma, this compound is fragmented and deposited on a surface as a vitreous layer (Fig. 3). The chemical composition can be varied according to the application to achieve the best results on a variety of different materials.

The unique advantage of PlasmaPlus compared with other systems is the locally selective coating technique. Layer deposition can be targeted with millimetre accuracy to a precisely defined location. The use of a plasma jet enables the coating to be applied in this highly targeted manner, which makes efficient use of resources. Processes can be controlled in such a way that coatings which confer different functions, such as adhesion and anti-adhesion, or for example corrosion protection, can be applied using the same nozzle (Fig. 3). This means that only very small quantities of coating material are required, and very varied materials or material combinations can be applied.

Christian Buske, CEO and President of the Plasmatreat Group, points out another important advantage: "The processing speed is extremely high. For example, a 100Nm-thin coating can be deposited in milliseconds. Under vacuum it would take around one to two minutes and localised selection would not be an option."

RESEARCH GOALS AND APPLICATIONS

WATER AND DIRT REPELLENT

The company's plasma coating process currently makes it possible to create hydrophobic surfaces that repel water. Surfaces treated in this way are also dirt-repellent and self-cleaning without requiring any mechanical cleaning action.

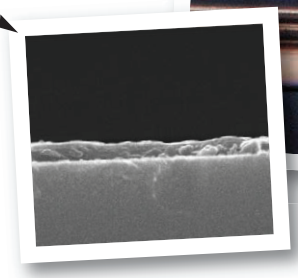

Fig. 3: The image shows a cross-section through an approximately 100 nm thick PlasmaPlus coating (SEM 50,000× magnification). Photo: Saint-Gobain

BARRIER COATINGS

Barrier or diffusion coatings created using plasma are an important focus of research. They are considered a reliable protection for food, beverage and medicinal packaging and provide an effective barrier to carbon dioxide, oxygen and water. They can be applied to all types of plastics and enable the production of barrier films or PET bottles with a CO_2 barrier.

MEDICAL DEVICES

The PlasmaPlus process can already be used to apply photocatalytically-active titanium-dioxide coatings. When exposed to sunlight and moisture, these coatings have a self-cleaning and germicidal effect. This application is of particular interest for coating medical and sanitary products since it allows manual cleaning intervals to be extended or omitted altogether. Another Plasmatreat research topic is the deposition of antimicrobial coatings containing silver.

2C-INJECTION MOULDING

Plasmatreat is also intensively researching and developing techniques to improve rubber-to-metal and plastic-to-metal bonding in hybrid injection moulding. This involves applying nanocoatings with active adhesion to the metal surface, then moulding the plastic component onto the surface. In the future, depositing adhesion-promoting coatings with the PlasmaPlus process will provide an alternative to solvent-based primers in automobile manufacturing.

RELEASE COATING INSIDE THE STEEL MOULD

The plasma ant-adhesion coating developed by Plasmatreat has been successfully used as a universal release treatment for injection moulding tools for the past two years. It provides exceptional release characteristics for a variety of different polymer and rubber-based mould materials. This anti-adherent effect is due entirely to plasma polymerisation on the mould surface. Thanks to this environmentally friendly process, wet chemical release agents are no longer required, nor is it necessary to demount moulds for re-coating, since old coats no longer have to be removed. New coatings can now be applied directly to the mould in situ. (Fig. 4)

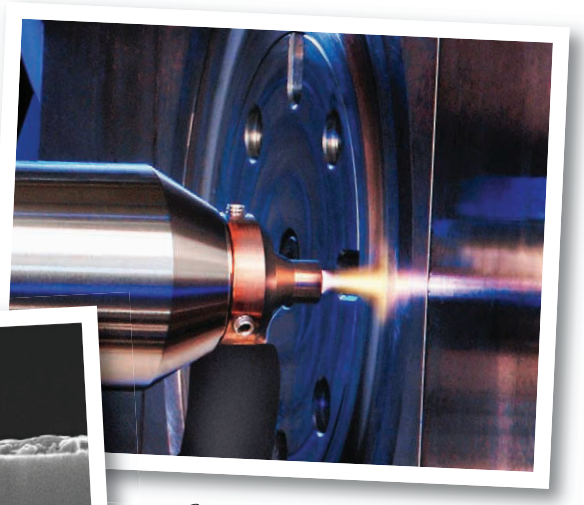

Fig. 4: PlasmaPlus in-mould coating and in-mould regeneration. Photo: Plasmatreat

NANOCOATING OF 3D COMPONENTS

It is also possible to apply atmospheric plasma coatings to complex 3D components using the PlasmaPlus process based on Openair plasma technology. The coating material even reaches areas that are difficult to access like deep groove geometries or undercuts. This makes it possible to completely coat populated circuit boards on or under the components.

SUMMARY

PlasmaPlus nanocoating under atmospheric pressure allows for substances tailored to specific applications to be deposited deep into the nanostructures of the material surface. This produces a highly effective functional coating and gives the materials completely new surface characteristics. The ability to manufacture products with selectively functionalised surfaces has added an entirely new dimension to innovation capability.

FURTHER INFORMATION:
WWW.PLASMATREAT.CO.UK