



Extract from the annual report 2016  
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## OXYGEN-FREE PLASMA PRETREATMENT

Plasma cleaning and activation of surfaces in preparation for subsequent process steps is widely used and industrially established. Frequently used process gases are air or gas mixtures containing oxygen. Over-treatments can occur in particular in the pretreatment of plastics. Investigations are going on at the Fraunhofer IST into the use of oxygen-free, nitrogenous process gases with which high densities of nitrogenous chemically reactive groups such as amino groups can be created, especially on organic surfaces.

### State of the art

Conventional plasma pretreatments of plastic surfaces on the one hand creates polar groups on the surface and on the other the highly reactive oxygen species generated in the plasma can damage the polymer, even superficially, which can lead to adhesion problems during subsequent processing. However, since oxygen-free nitrogenous process gases are used during pretreatment, oxidation of the surface of the plastic is avoided. This means that with an appropriate choice of parameters, nitrogenous chemically reactive groups form, which during subsequent coatings have a mostly positive effect on adhesion.

### Surface functionalization

In contrast to a treatment at low pressure, the composition of the process gas is not so easily controlled in the case of pretreatment with atmospheric pressure plasma. Special devices are required, which prevent oxygen from the ambient air getting into the treatment area.

This is why atmospheric pressure plasma processes and the corresponding equipment are being developed at the Fraunhofer IST and being adapted customer-specifically, offering the possibility of treating substrates in a previously defined process gas atmosphere. In addition, methods for surface characterization are under development with which the various chemically reactive groups created can be detected and their density determined. The investigations showed that plastic surfaces which have been treated with process gas mixtures of nitrogen and small quantities of hydrogen contain high densities of chemically reactive groups.

In addition, not only can surface properties be directly detected at the Fraunhofer IST but the adhesion of paints, adhesives or printing inks can also be characterized. In this way, surface pretreatments are being further optimized.



### Treatment of customer samples

In the case of pretreatment with atmospheric-pressure plasmas the substrate geometry plays an important part in the design of equipment. The Fraunhofer IST has various laboratory facilities for very different substrate geometry, such as sheeting or 3D substrates. In addition, plasma systems are also available for a local treatment, such as plasma printing or plasma jets. Due to the wide range of different systems, the processes can be transferred with good results to customer samples and customer requirements fine-tuned. Lambda sensors and optical emission spectroscopy are used for process monitoring, in particular to ensure the absence of oxygen. A final characterization of the surfaces using derivatization, fluorescence labeling, infrared spectroscopy or even XPS makes a comprehensive and promptly surface characterization possible.

**1** *RotoTEC system for the treatment of 3D plastic parts.*

**2** *Pretreatment of substrates for subsequent bonding.*

**3** *Treatment of a plastic sample with a plasma jet in a glove box.*

## CONTACT

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