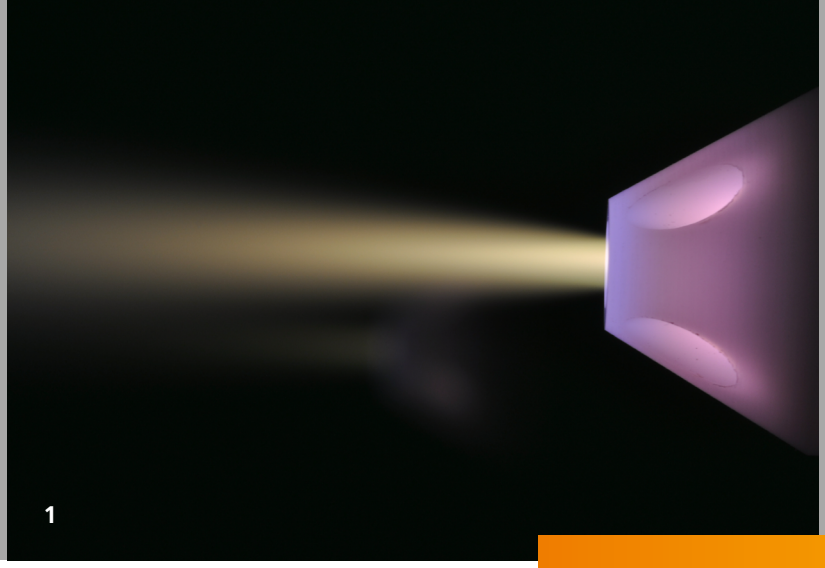

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Extract from the annual report 2015
To the website: www.ist.fraunhofer.de/en.html

PRETREATMENT OF HIGH-PERFORMANCE PLASTICS

New plastics deploy their excellent material properties under high thermal and chemical stresses and are therefore used increasingly in the most varied fields of machine and plant construction. One challenge here is the high-strength bonding of components. Atmospheric-pressure plasma pretreatment for high-strength plastics has been optimized at the Fraunhofer IST.

State of the art

Despite enormous advances in the development of adhesives and in surface pretreatment, many plastics continue to be considered very poorly bondable since durable connections can only be secured with a limited number of adhesives. In many cases these adhesives have to be modified, with the consequence that requirements relating to mechanical, thermal, and/or processing properties are not longer satisfied.

In recent years it has been possible to considerably expand the range of usable plastics and adhesives by means of suitable pretreatment methods. While chemical methods such as pickling or etching are now only rarely used due to poor environmental compatibility and questions of occupational physiology, in many companies physical or chemical pretreatment processes are in service. Here plastic surfaces are cleaned, roughened or activated by flame treatment, the use of low-pressure plasmas and in particular the inexpensive applications of atmospheric-pressure plasmas, such as, for example, corona treatment, dielectric barrier discharges (DBD) or a treatment with a plasma jet. This makes the surface better wettable and in many cases also leads to an improvement in the adhesion of the adhesives.

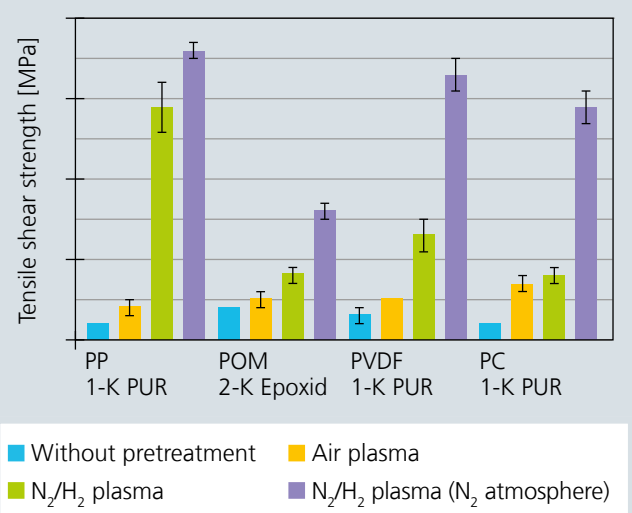
Surface functionalization

At the Fraunhofer IST atmospheric-pressure plasma processes and the corresponding installations are being developed which offer the possibility of functionalizing plastic surfaces under a controlled atmosphere. It is possible with the equipment available to give surfaces selective chemical functionalizations. This might be, for example, groups containing nitrogen generated by plasma treatment in nitrogen/hydrogen mixtures or ammonia. However the creation of functionalizations on the basis of coatings with carboxylate or epoxy groups is even possible by using suitable precursors such as maleic anhydride or glycidyl methacrylate.

The »KovaPlas« project

The aim of this AiF project was to optimize existing atmospheric-pressure plasma processes such that low-energy plastics would due to pretreatment adhere much better to adhesives. With the use of polyurethane and epoxy adhesives in particular, high-strength covalent and durable bonds can thus be obtained in the area of substrate strength between the adhesive and the surface of the bonded component. Here the greatest number possible of chemically reactive groups adhering firmly to the surface was created and bonded with amine-curing adhesives. The figure below shows tensile shear tests with various treated plastics.

Adhesion results for different plastics.



1 *Plasma jet for pretreatment.*

2 *Glove box with plasma jet for oxygen-free nitrogen functionalization.*

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