

## **Bonding plastics with Openair-Plasma®**

Reliable and long-time stable adhesion on hard-to-bond surfaces

## Environmentally friendly adhesion enhancement

From structural bonding in the automotive and aerospace industry to high-tech adhesive bonding in the electronics industry and even simple wet labelling: Openair-Plasma® pretreats the bond surface with precision, creating an even and process-reliable base for industrial adhesive bonds while at the same time ensuring sustainable process design. The use of cleaners and solvents containing VOCs is eliminated, as is the frequently necessary cleaning and drying of components.

## Plasma

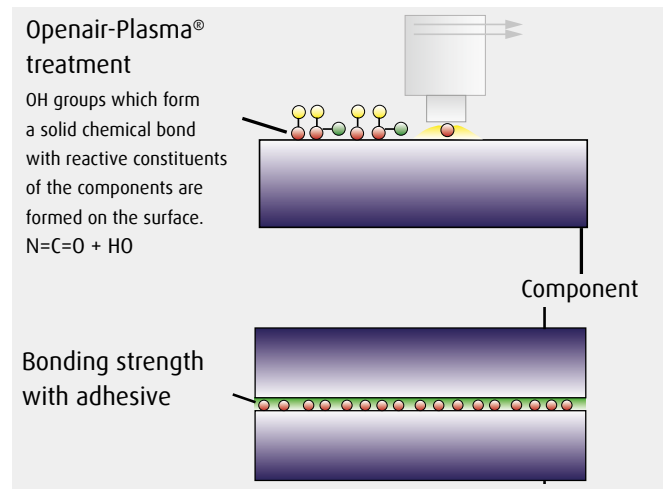
After solid, liquid and gaseous, plasma is often referred to as the fourth state of matter. Plasma is the state a gas assumes when more and more energy is applied to it. The gas is ionised, i.e. electrons are ejected out of the atoms and molecules. An electric charge characterises the remaining species and they are referred to as ions which are very reactive in conjunction with the treated surfaces and/or surrounding gases. Plasmas generated under normal ambient conditions are referred to as atmospheric pressure plasmas.

## In the majority of cases

A polymer surface treated with Openair-Plasma® is reactively modified. Long molecular chains are severed by the energy contained in the plasma while at the same time reacting with oxygen. Often up to 25% of the surface is functionalised. Even hard-to-bond plastics like polypropylene or fluorine compounds clearly exhibit adhesive build-up after plasma activation.

## Surface energy

Using Openair-Plasma® treatment increases the surface energy of the plastic to be treated and significantly improves its wetting behaviour. To do this, an electrical discharge in the plasma generator is used to convert the process gas air to the plasma state. This plasma consists of reactive nitrogen and oxygen species that react with the surface of the plastic and bond fast to it. This gives rise to functional groups which are available on the surface to the reactive components of the adhesive and bond to them with long-term stability.



Plasma pretreatment of polymers such as PA, PC, PE, PMMA and PP results in tensile shear strength and significantly enhanced adhesive bonding compared to surfaces not treated with plasma (Fig. 2). There is also a clear improvement in long-term adhesion.

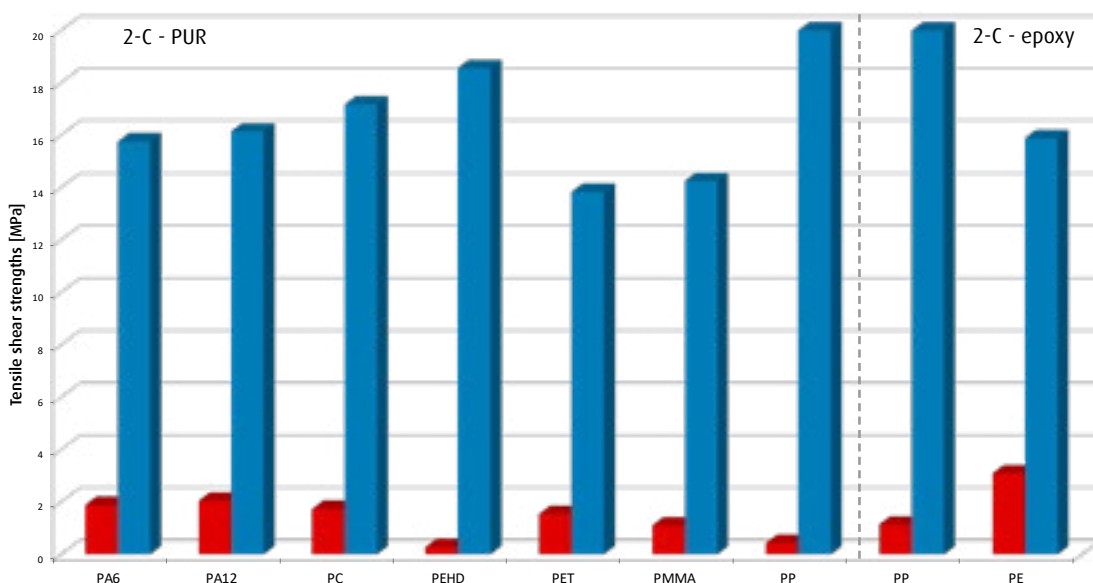
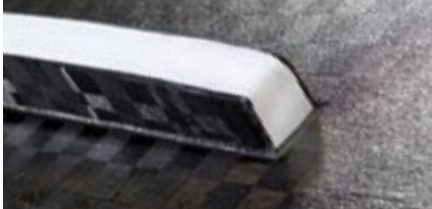


Fig. 2 Tensile shear strengths of plastics treated with Openair-Plasma®

Adhesives:  
2-component polyurethane and  
2-component epoxy

■ without plasma  
■ with plasma

## Application



### Modern headlights, bonded watertight

Modern headlights last the car's lifetime so they have to be protected against moisture ingress. Openair-Plasma® enables:

- a stable, secure and diffusion-tight adhesive bond
- the use of non-polar and sometimes highly filled materials
- the use of new 1-component PUR hotmelt adhesives
- pretreatment immediately prior to final assembly

### Cost-saving assembly of household appliances

Pretreating the bond surfaces with precision enables fast, secure and efficient joining of:

- carbon fibre-reinforced plastics and glass
- polymer cover panels
- plastic-coated housing parts
- balancing weights of polymer concrete
- PlasmaPlus® also enables the deposition of a targeted hydrophobic coating thereby ensuring energy-saving drying

### Secure joints in cars

Pretreatment with Openair-Plasma® is the perfect preparation for bonding the lift gate of a vehicle made of plastic (two-component polyester resin or epoxy resin) to structure-reinforcing elements:

- no additional mechanical or wet chemical pretreatment, roughening and primers are avoided
- fully automatable, process-reliable pretreatment
- immediately bondable
- long-term adhesive surface activation

### High-tech adhesive bonding in electronics

Pretreating the bond surface with precision makes it possible to bond the polycarbonate window in the half shell of the housing without the use of primers.

- use of highly sophisticated UV adhesives, curing by irradiating the bonded component
- increasing the adhesion of adhesive tapes
- no damage to sensitive, electronic components due to electrically neutral pretreatment

### Structurally bonded CFRP, new solution for lightweight automotive construction

For a faster bonding process, optimised adhesion and to save on weight in CFRP components, they are pretreated before bonding using Openair-Plasma®.

- less weight = lower energy consumption
- bonding instead of lamination
- long-time stable adhesion of adhesive bonds
- high process reliability and efficiency due to automated pretreatment

### Structural bonding of truck bodies

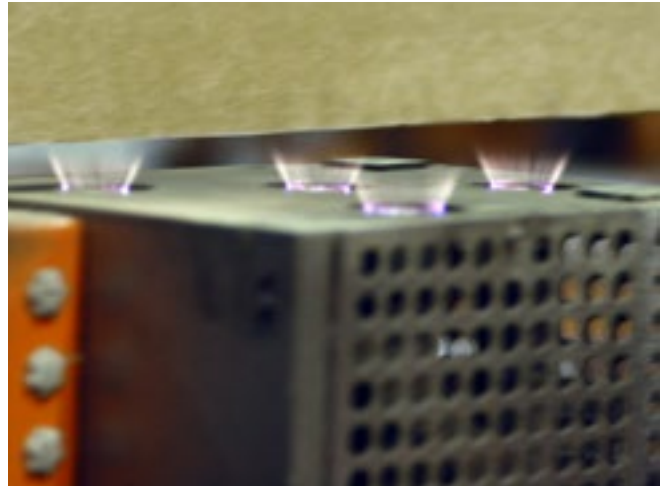
- truck bodies for frozen and chilled transportation achieve their stability due to bonding of the plastic-coated wall and roof elements
- process-reliable pretreatment is absolutely crucial
- no need for additional pre-cleaning or roughening
- process reliability due to comprehensive plasma process monitoring
- pretreatment using plasma units, each with four rotary nozzles max. 200 mm wide on each panel side

## Bonding plastics with Openair-Plasma®

One of the criteria for bonding plastics in the automotive industry is cleanliness of the parts.

Every pre-cleaning and pretreatment process requires an individually tailored solution. The key factors here are material, type and level of surface impurities, component geometry, surface energy and desired adhesion. Efficient parts cleaning and activation using plasma as an adhesion enhancer is essential for avoiding increasing cost pressure.

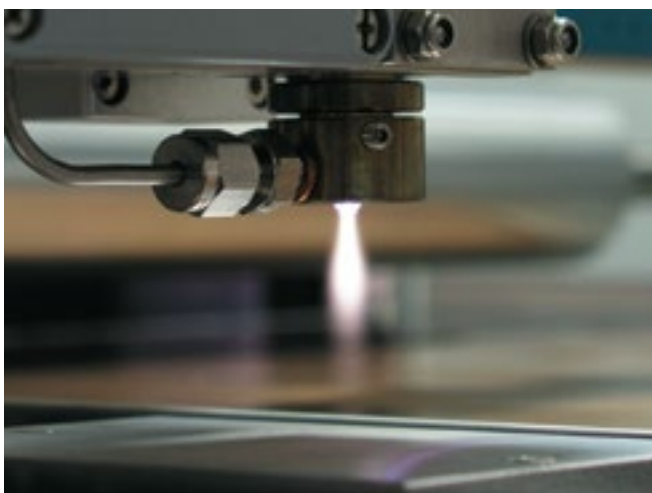
Plasma technology enables effective treatment of manufactured parts of different materials, such as steel and plastics, in the inline process, reliably removing surface impurities at the same time. Openair-Plasma® pretreatment significantly enhances the bond between the material and subsequent adhesive.



Plasma production process for high throughput of components in the automotive industry.



Car door lock showing the effect of plasma pretreatment on a POM adhesive bond.



PlasmaPlus® process for applying an adhesion promoter.

## Outlook

The Openair-Plasma® process has been used successfully for years as an affordable and environmentally friendly means of pretreating plastic surfaces with plasma in diverse industrial production processes. However, high-performance plastics such as POM (polyoxymethylene) require a more extensive plasma treatment. The **PlasmaPlus® process** developed by Plasmamatreat now makes it possible to apply a plasma polymer adhesion-promoting layer to hard-to-bond plastics. This is achieved by continuously injecting the plasma with a chemical additive which is deposited on the surface in the form of a reactive plasma polymer to produce a cross-linked layer. This process enables the creation of adhesive bonds which remain stable and do not migrate under even the most adverse conditions. The entire Openair-Plasma® system is fully compatible with robotic applications and suitable for integration into inline processes. This makes it a versatile tool for the fine cleaning and activation of polymeric surfaces.

Experienced Plasmamatreat engineers are on hand throughout the world to solve your adhesion problems.