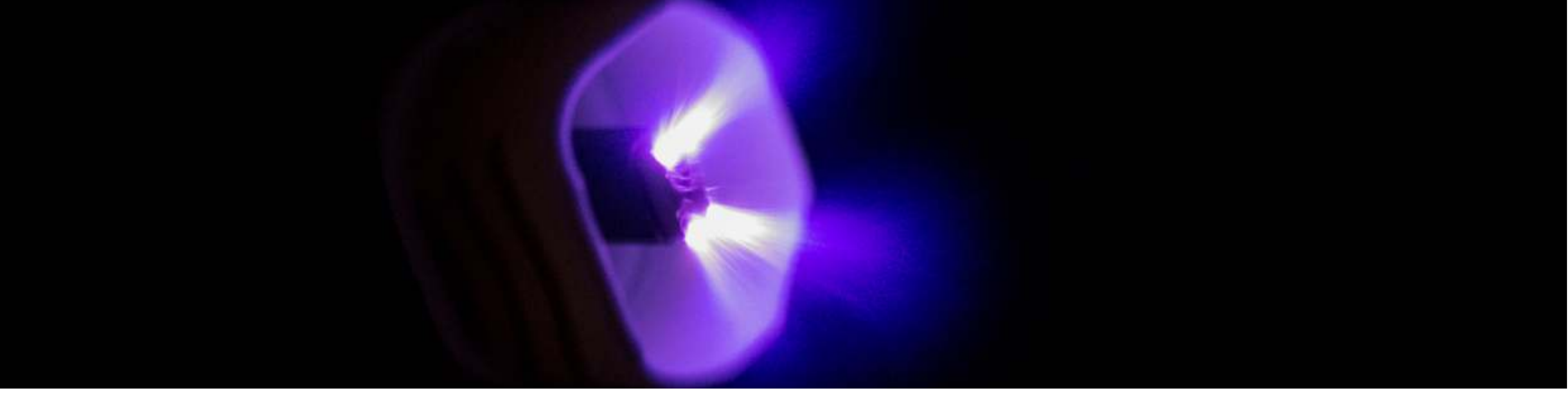
relyon plasma rely on plasma technology

piezobrush® PZ3

Effective plasma handheld device



Effective plasma device for manual use

Piezobrush® PZ3 has been designed as a compact plasma handheld device for use in laboratories, pre-development and assembly of small series. With a maximum power consumption of 18 W, the Piezoelectric Direct Discharge (PDD®) technology is used to generate cold active plasma at a temperature of less than 50°C. Plasma is used to increase the surface energy of many materials with high efficiency, as well as to reduce germs and odors.

Fields of application

◇ Joining technology
◇ Development and optimization of production processes
◇ Research facilities and laboratories
◇ Microbiology, microfluidics and food technology
◇ Medical and dental technology
◇ Prototype and architectural model making
◇ Small-scale production

Technical data

Electrical connection: 110-240 V / 50-60 Hz
Power consumption: max. 18 W
Weight: 110 g
Design: Handheld unit with power supply, integrated fan
Volume: 45 dB
Plasma temperature: < 50 °C
Treatment speed: 5 cm^2/s
Typical treatment distance: 2 - 10 mm
Typical treatment width: 5 - 29 mm

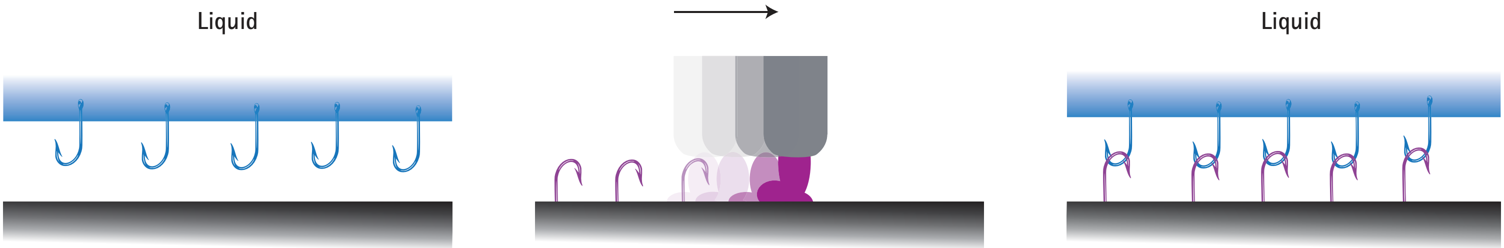
Possible use cases

◇ Activation and functionalization of surfaces of various materials
◇ Improvement of wettability
◇ Optimization of bonding, painting, printing and coating processes
◇ Surface treatment of plastics, glass, ceramics, metals, semiconductors, natural fibres and composite materials
◇ Ultra-fine cleaning
◇ Germ and odour reduction

Introduction to surface treatment

For processing and end use of materials, their surface properties are of vital importance. These can be positively influenced by selective surface treatment with plasma to achieve an ideal end result. For example, the cleanliness and wettability of a surface are of decisive importance for adhesion in bonding, printing, painting or coating processes.

Even in a clean state, many surfaces exhibit insufficient wettability, which is further worsened by contamination. As a result, liquids such as glue or ink will bead off and cannot adhere. This state is referred to as a low surface energy state of the solid. If this surface energy is lower than the surface tension of the liquid, the wetting and thus the adhesion is insufficient. Plasma activation of a surface increases its surface energy and molecular anchor groups are formed which react with those of the liquid. This leads to improved wetting and consequently to an optimized adhesion of suitable liquids.



Contact angle analysis as a method to determine the effectiveness of plasma treatment

To prove the effectiveness of plasma treatment, a contact angle analysis is often performed: A drop of a liquid with known surface tension is applied to the surface before the plasma treatment and the contact angle between liquid and solid is measured with a contact angle measuring device. The surface is then treated with plasma and a contact angle measurement is carried out accordingly. By determining the contact angle of a polar and a non-polar liquid, the surface energy is calculated and thus the effectiveness of the plasma treatment is quantified.

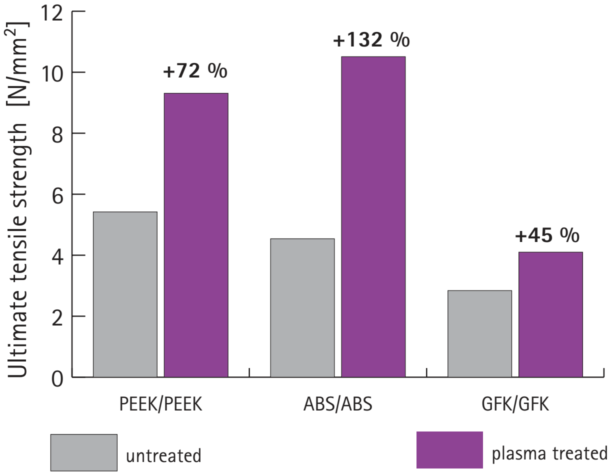
- ◇ Round droplet
- ◇ Low surface energy
- ◇ Insufficient wettability of liquids
- ◇ Poor adhesion of glue, inks, etc.

- ◇ Very flat droplet
- ◇ High surface energy
- ◇ Increased wettability of adhesives
- ◇ Strong adhesion and bonding

Plasma activation with piezobrush® PZ3

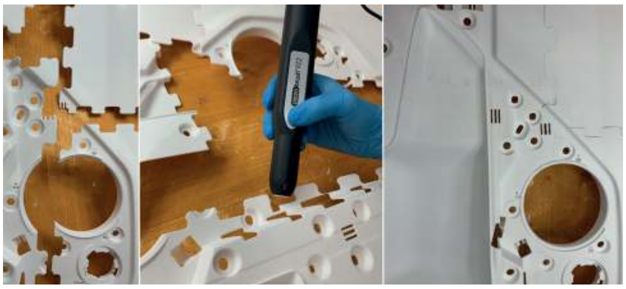
Optimized adhesive bonding with plasma

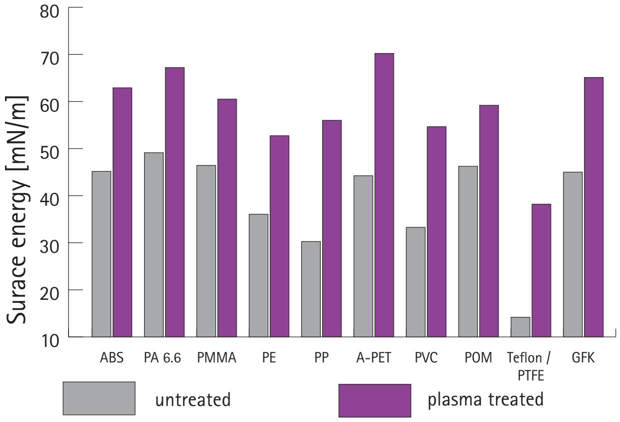
If a surface is functionalized with plasma before bonding, the following bonds show a significantly improved adhesion. Plasma can be used on a variety of materials: Metals, glass, ceramics and even natural materials such as wood, natural fibres and textiles react very well to plasma treatment. The adjoining table shows a comparison of the ultimate tensile strength of 2K epoxy bonds between untreated plastics and bonds between the same plastics with previous plasma treatment. The comparison shows a significantly improved adhesion.



Application example: Bonding of PA 12

In 3D printing, large parts are often manufactured as individual parts made of PA 12 and subsequently bonded - however, often with considerable adhesion problems. By means of a plasma pre-treatment, up to three times the strength of the adhesive joints is achieved without the use of environmentally harmful chemical primers.





Improved wettability by plasma treatment

For many industrial processes it is important that materials, e.g. plastics, have a specific surface energy in order to achieve a certain quality of the subsequent processes. For this reason, plasma is often used as a pre-treatment to remove the finest contaminants and also to compensate any differences between material batches. The chart shows that the surface energy of the various plastics can be increased significantly.

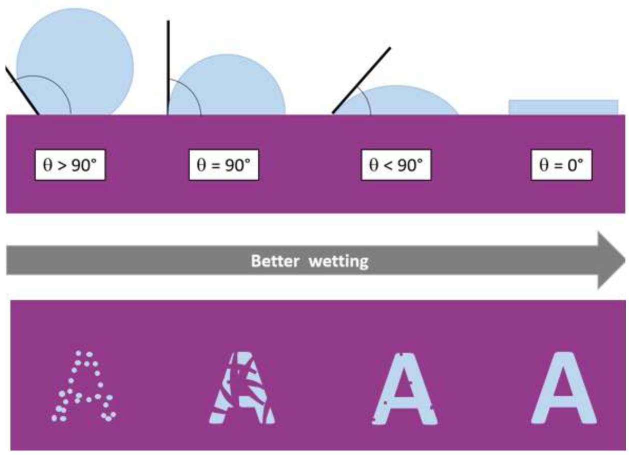
Application example: Dental implants

For the healing process after a dental implantation it is important that implants are easily wettable with blood to accelerate ingrowth. Therefore, the wetting behaviour of titanium implants before and after plasma treatment was investigated to show the effects. The wettability has been significantly optimized, the surface is now hydrophilic.

Plasma activation with piezobrush® PZ3

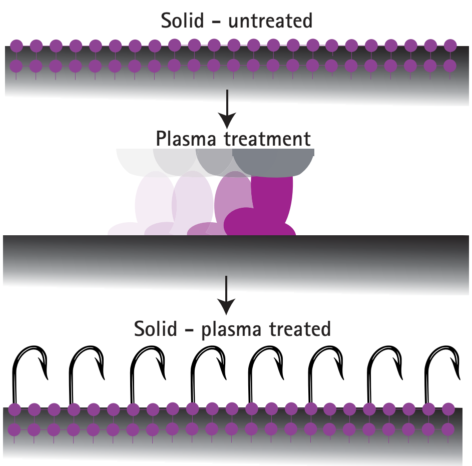
Plasmatreatment prior to printing

Plasma treatment improves adhesion of printing inks and varnishes on the surface, thus significantly enhances the print quality. The illustration shows a droplet of ink applied to a surface and below the subsequent print result. The first droplet has a high contact angle of more than 90° and therefore wets the surface poorly, which causes the ink to contract on the surface and is not destributed evenly. The best result is achieved when the contact angle is 0° - the ink wets the surface optimally and creates an even print image.



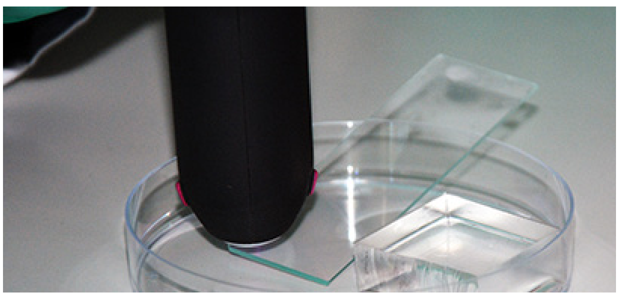
Application example: Printing on PTFE

Many plastics such as Polytetrafluoroethylene (PTFE) are difficult to print on. In the photo only the right side has been treated with plasma before printing. The comparison clearly shows that the plasma pre-treatment of the substrate not only leads to an even print image, but also to a considerably better adhesion of the ink.



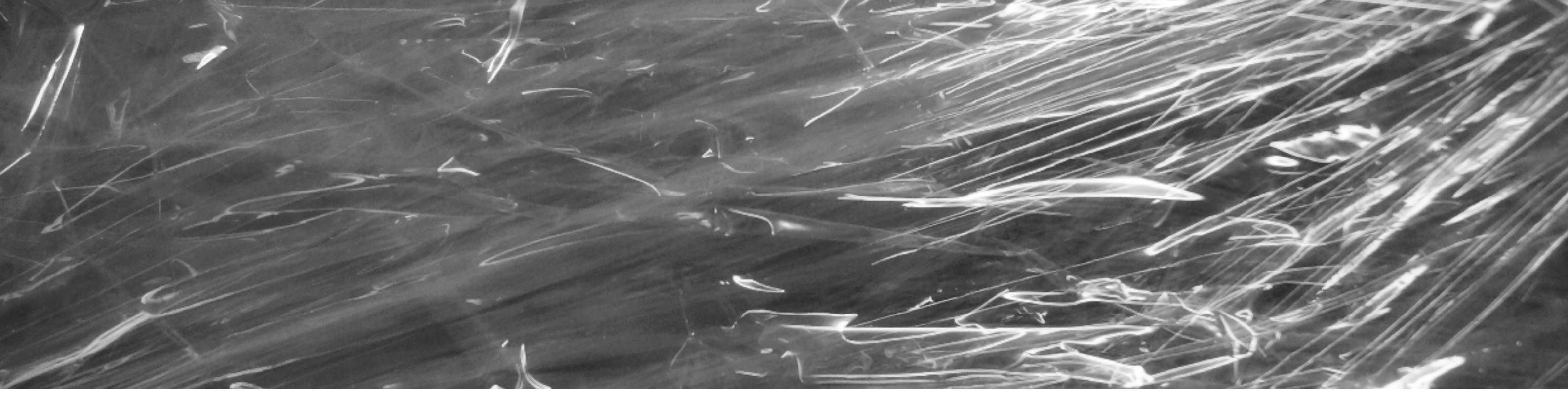
Activation with plasma

The plasma activation of a surface increases its surface energy and polar molecular end groups are generated. These act as deposition sites for liquids applied to the surface and ensure that they can adhere better. Plasma activation modifies the surface and increases surface energy, resulting in a significantly better wettability.



Application example: PDMS and glass

In microfluidic chip manufacturing, PDMS chips are often connected to glass carriers, which is not possible without pre-treatment. Only through plasma pre-treatment of the surfaces of both materials a bond can be formed between PDMS and glass. With the piezobrush® PZ3 the treatment is simple, fast and straightforward.



Which materials can be treated?

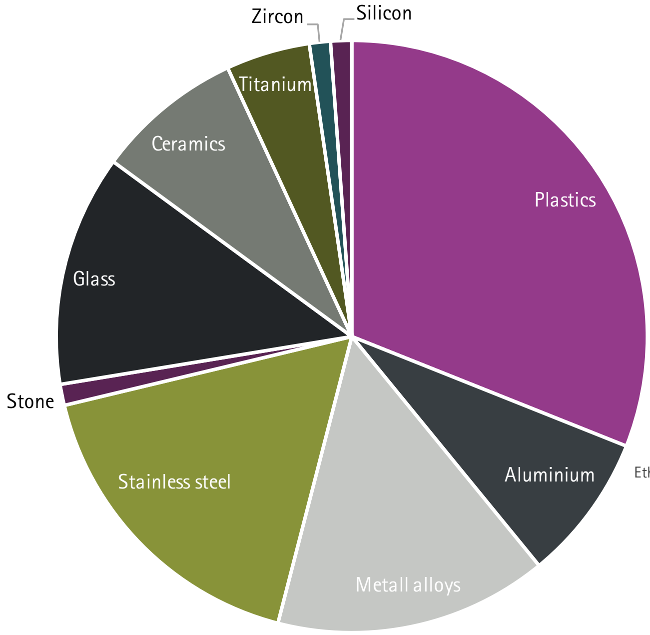
In principle, all materials can be treated with atmospheric pressure plasma from the piezobrush® PZ3 handheld plasma device. This surface treatment with atmospheric-pressure plasma hardly causes any temperature input on the material, which also has the advantage that there is no risk of overtreatment even with temperature-sensitive materials such as plastics.

Typical materials

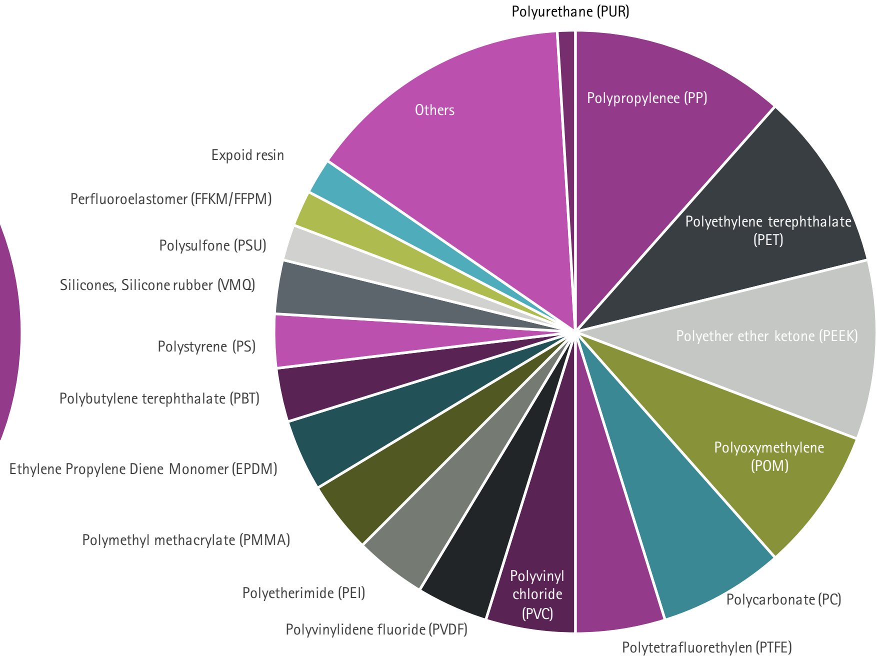
- Plastics and composites
- Metals and metal alloys
- Glass, ceramics, natural stone
- Natural leather, artificial leather
- Natural fibre, wood, paper

The following diagrams give an overview which materials are typically treated with piezobrush® by our customers.

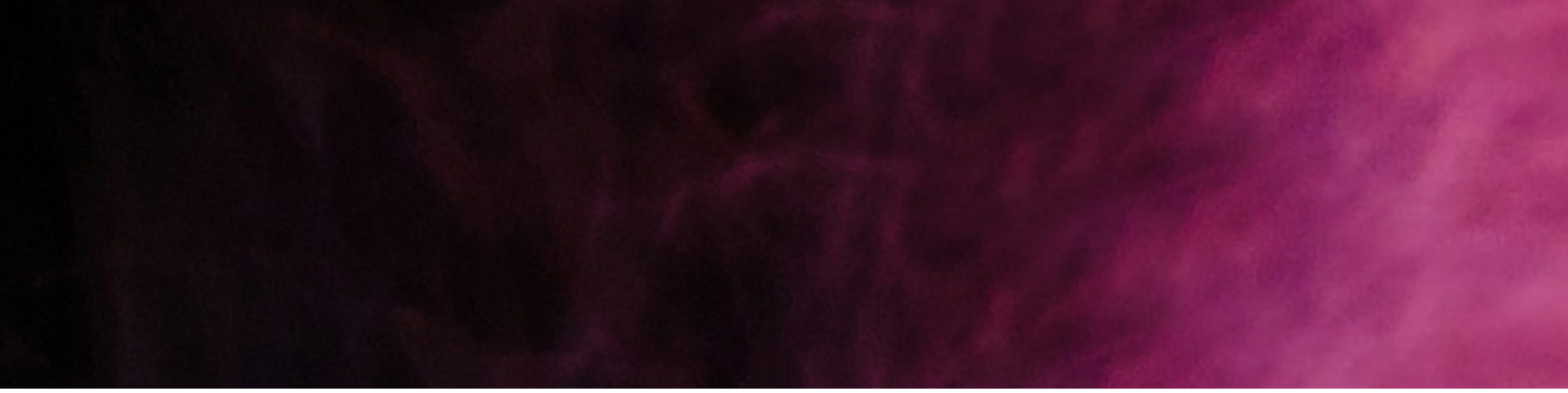
Materials



Plastics



The first diagram shows that plastics represent the majority share of materials treated with the plasma handheld device. Since there is a large variety of plastics, the second diagram shows the different types of plastics that are typically treated with this cold atmospheric pressure plasma.



Exchangeable modules and display

Different surfaces have to be activated with the appropriate accessories to achieve an ideal result. Currently two different exchangeable modules are available for the piezobrush® PZ3 plasma handheld device. The PDD technology used to generate the cold plasma in piezobrush® PZ3 is based on the discharge of high electric fields. Therefore, the electrical conductivity of the component to be treated is of decisive importance when choosing the modules.

Exchangeable module Standard

This module is designed for the surface treatment of non-conductive substrates such as plastics, ceramics or glass. For effective treatment, a module-substrate-distance of 1 to 5 mm is recommended. If uncontrolled arcing occurs on the substrate during use, the device switches off automatically. In this case the surface is at least partially conductive and should therefore be treated with the Nearfield module.

Exchangeable module Nearfield

This module is used to treat (partially) electrically conductive materials such as metals, CFRP, lead glass or conductive plastics. However, this module may also be necessary for the ideal treatment of materials with conductive coatings or assemblies with conductive components. With this module, the plasma only ignites when it is close enough to a conductive surface (this may also be hidden under a thin insulating layer). At a distance of a few millimeters, a violet glow is visible in the gap between module and substrate indicating that the treatment is being performed.

The device automatically detects which module is currently in the device and automatically adjusts the parameters accordingly.

Display

For process control of plasma treatment, the piezobrush® PZ3 is equipped with various features that can be selected and modified via the display.

- Process control:
  - **Stopwatch:** For monitoring the treatment time
  - **Countdown:** Time setting with automatic switch-off function
  - **Metronome:** Acoustic feedback after defined treatment time
- Power adjustment: Reduction of plasma power in several increments

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Do you have questions about our products or about plasma technology in general?
Our team will be more than happy to help you with support and advice.

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More application examples:

Application videos: