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PiezoBrush PZ3

Cold Plasma Pretreatment Portfolio

TDK Electronics AG
Piezo & Protection Devices Business Group
Product Marketing Piezo Automotive Electronics/Industrial Electronics
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PiezoBrush PZ3
A Handy Plasma Source

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Function

PiezoBrush PZ3 generates highly efficient cold plasma by the piezoelectric direct discharge (PDD) technology.

Low input voltage is transformed into a dielectric barrier discharge process on the output electrode.

The ambient process gas (typically air) is dissociated and ionized, **all controlled by your fingertip in a practical, easy-to-use handheld device.**

Key benefits

- Generates highly efficient cold plasma to **optimize adhesion processes like gluing, printing, and bonding**
- Compatible with a variety of materials like plastic, metals, glass, ceramics, semiconductors, natural materials, etc.
  (2 modules are included to treat different types of materials)
- Integrated display for process control and power settings
- Easy, safe, and intuitive plug-and-play technology

World's smallest plasma handheld device with PDD technology

PiezoBrush PZ3 professional set

- Handheld device
- Standard module for non-conductive substrates/materials
- Nearfield module for conductive materials

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The Technology Behind the Scenes
CeraPlas

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Piezoelectric direct discharge (PDD)

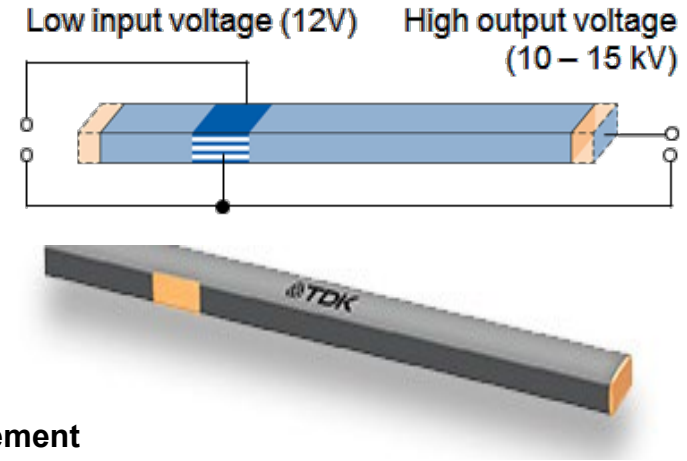
Generation of a voltage sufficiently high for an electrical breakdown in the air by use of a piezoelectric transformer (PT).

Operating principle

A combination of two physical effects (direct and indirect piezoelectric effect) in a two-zone material block.

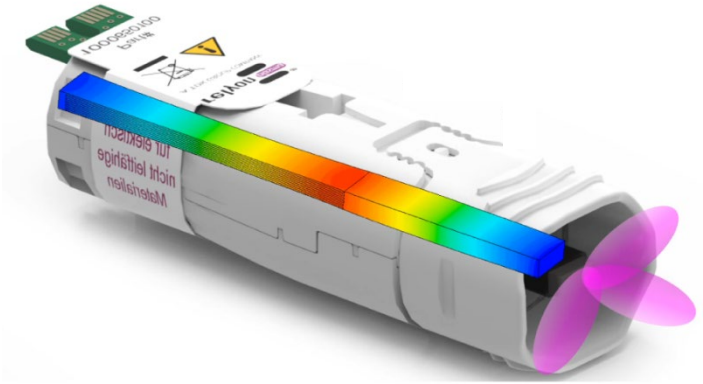
Primary zone: Low voltage is applied to provoke its geometrical deformation (indirect/converse piezoelectric effect), mechanically connected to the secondary zone.

Secondary zone: Deformation of the first block is causing mechanical stress on the second block, which results in the generation of a high voltage on the output side.



CeraPlas F-type element

CeraPlas F-type element operation in the PiezoBrush module



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Plasma Surface Treatment
How Does it Work?

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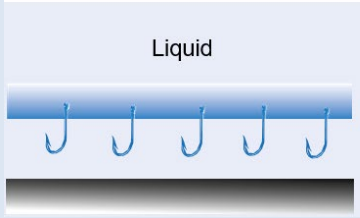
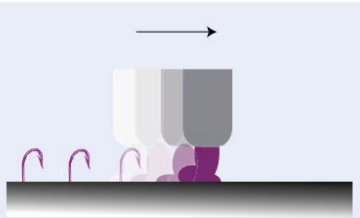
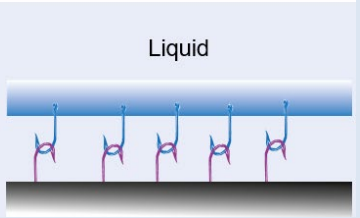
Plasma activation is used for an optimized adhesion of suitable liquids

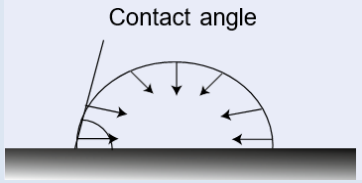
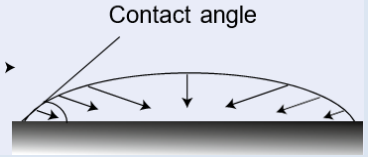
The cleanliness and wettability of a surface are of decisive importance for adhesion in gluing, bonding, printing, painting, or coating processes.

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.

Solid body – untreated	Plasma treatment	Solid body – plasma treated
		
• Low surface energy • Insufficient wetting • Weak bonds	• Generation of anchor groups • Activation of surface • Hardly any thermal input	• High surface energy • Increased wetting • Strong bonds

How to determine the effectiveness of the plasma treatment?

To prove the effectiveness of plasma treatment, a contact angle analysis is often performed.

Untreated surface	Plasma treatment	Plasma treated surface
		
1. A drop of a liquid with known surface tension is applied to the surface, and then the contact angle is measured between the liquid and solid surface.	2. The surface is then treated with plasma.	3. The contact angle is measured again and 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.

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Effect of Surface Wettability on Printing Results

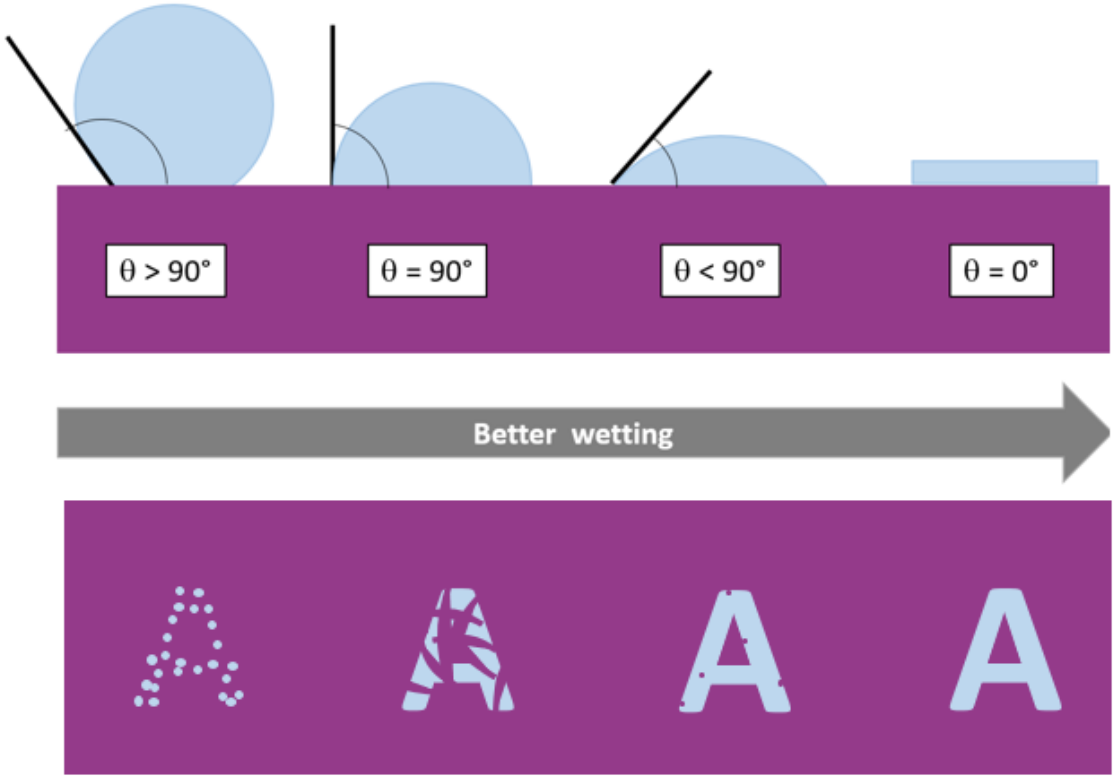
Plasma treatment improves the adhesion of printing inks and varnishes on the surface, thus significantly enhancing the print quality

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 distributed evenly.

The best result is achieved when the contact angle is 0°: The ink wets the surface optimally and creates an even print image.

Example effect of surface wettability on printing results



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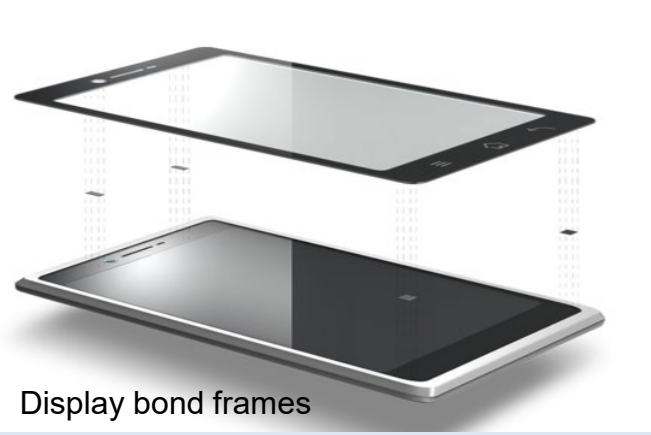
Adhesive Improvements with Cold Plasma

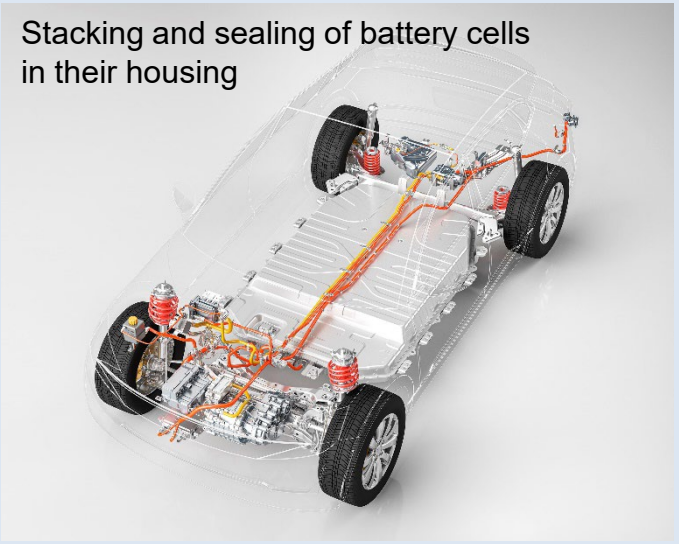
Increased bonding strength on contact surfaces

Different applications in the modern world require excellent sealing properties as well as provide reliable adhesion. A high degree of plasma activation pre-treatment and accuracy is crucial to ensure this longevity.

Endless applications in the industry, from battery cell manufacturing or sealing the glass cover of a headlamp to keep the moisture out to gluing the different layers of the display of your cell phone screen, rely on cold plasma pretreatment to obtain outstanding results.



Display bond frames



Stacking and sealing of battery cells in their housing

Self-adhesive labels

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Bonding Improvement with Cold Plasma
A Best Practice Example

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Bonding of Polyamide 12 (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.

Through a plasma pre-treatment, up to three times the strength of the adhesive joints is achieved without the use of environmentally harmful chemical primers.

Four individual parts from unfilled PA12 printed by selective laser sintering (SLS)

1. Parts were activated with cold plasma via PiezoBrush PZ3
2. Spotted with cyanoacrylate (superglue)
3. Structurally bonded with a two-component adhesive

Three times stronger bond than without surface activation!

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Wire Bonding Improvement with Cold Plasma
A Best Practice Example

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Wire bonding:
Increased bonding strength on contact surfaces

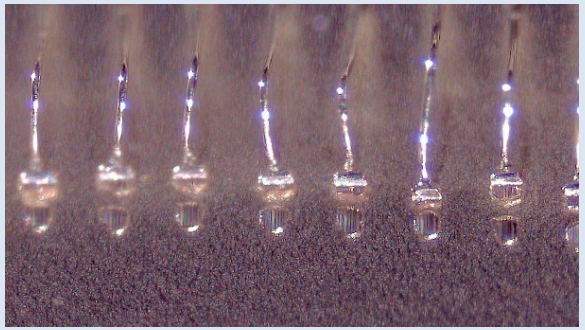
Contaminations on metal surfaces (bond pads) of semiconductor components or carrier materials can result in non-stick-on-pads (NSOP) or so-called “lifts” (elevations of the bonds).

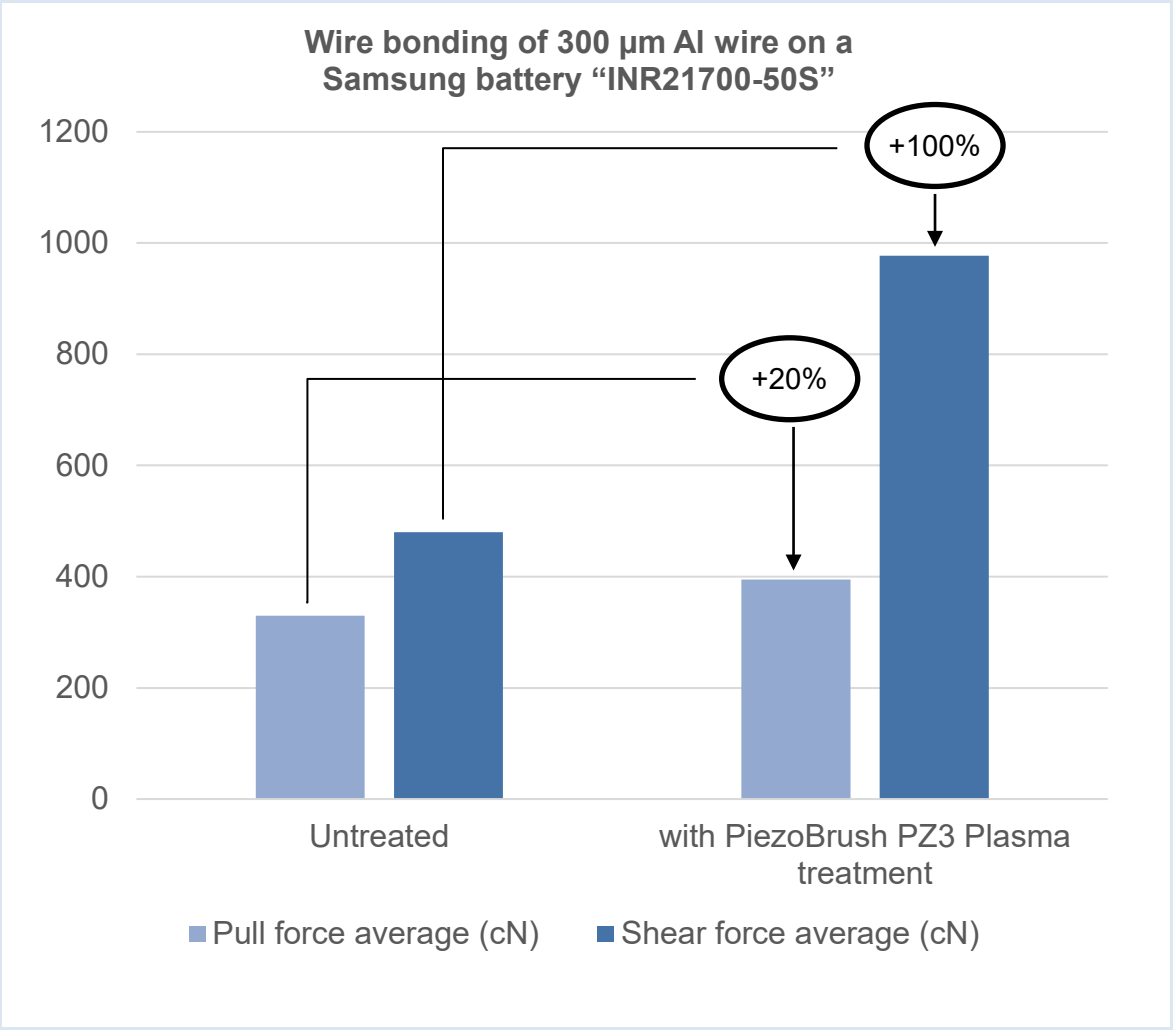
Before the wire bonding process, a fine-cleaning with cold plasma via PiezoBrush PZ3 is performed.

Increased bonding by double times improved shear force and quarter times improved pull force.

Without cold plasma treatment

With cold plasma treatment





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Cold Plasma for Dental Applications

Cold plasma for implants:
Three good reasons to smile thanks to plasma ☺

1 Improves the manufacturing process of implants through functionalization of
- bonding of individual components of different materials
- coloring adaption of the implant to the natural teeth color.

2 Increases the biocompatibility through optimized wettability:
- Improved acceptance of surrounding tissue
- Control of homogeneous cell colonization and sterilization

3 Sterilizes the surfaces

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PiezoBrush PZ3
Handheld Overview and Details

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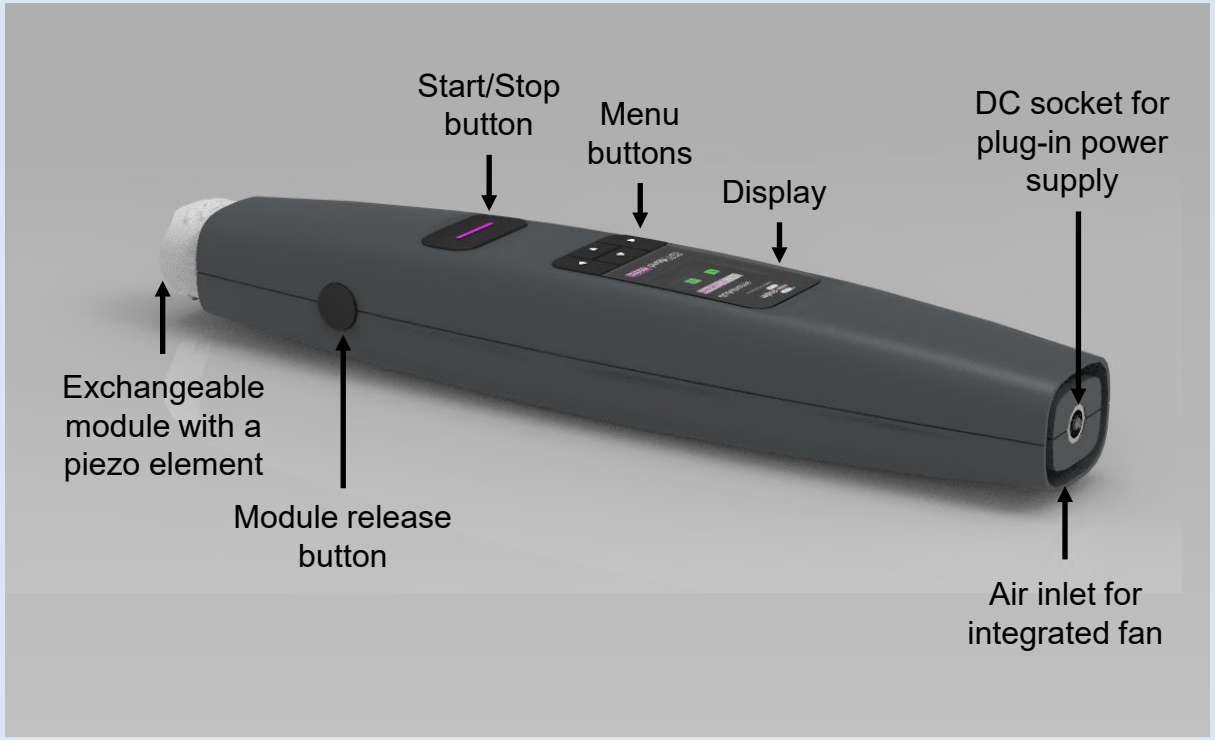
	PiezoBrush PZ3 professional set
Electrical connection [V / Hz]	110 … 240 / 50 … 60, 24 V DC
Power consumption, max. [W]	18
Weight [g]	110
Sound level [dB]	45
Plasma temperature [°C]	< 50
Treatment speed [cm^2/s]	5
Treatment distance, typ. [mm]	2 … 10
Treatment width, max. [mm]	29
Process control	Power adjustment; error detection; 3 different types of process control with visual and acoustic feedback
Interchangeable plasma source	Yes, via modules
Ordering Code	B54324D5120A140



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PiezoBrush PZ3
Modules Overview and Details

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	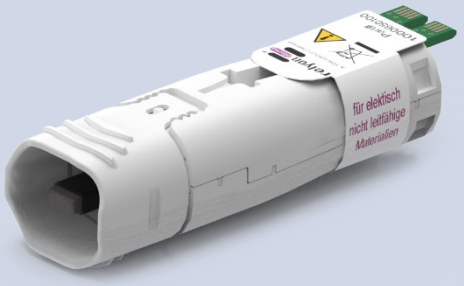	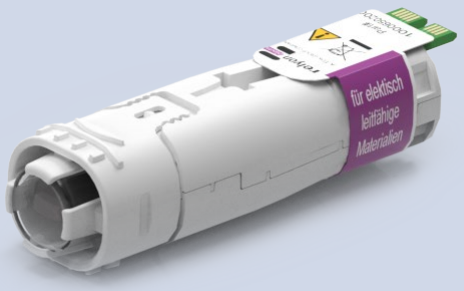
	Module “Standard”	**Module “Nearfield”**
Treatment of	Non-conductive substrates / material	Conductive substrates / material
Material examples	Plastics (PTFE, PE, PA, PP, etc.), glass, ceramics, paper, natural fibres, etc.	Metals (steel, aluminum, alloys, etc.), carbon fiber composites, doped semiconductors, wood, rubber, organic tissue etc.
Specialty	-	Integrated dielectric barrier at the tip
Plasma temperature [°C]	< 50	< 70
Treatment speed [cm^2/s]	5	3
Treatment distance, typ. [mm]	5 … 10	0.5 … 5
Treatment width, max. [mm]	5 … 29	10 … 15
Ordering code	B54321P5100A020	B54321P5100A120

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PiezoBrush for Every Application

PROFESSIONAL

For professional use

PiezoBrush PZ3 handheld

+

PiezoBrush PZ3 modules

INDUSTRIAL

For industrial use

PiezoBrush PZ3-i

+

PiezoBrush PZ3 modules

CUSTOMIZED

For customized solutions

PiezoBrush PZ3-c
Driver & Module adaptor

+

PiezoBrush PZ3 modules

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