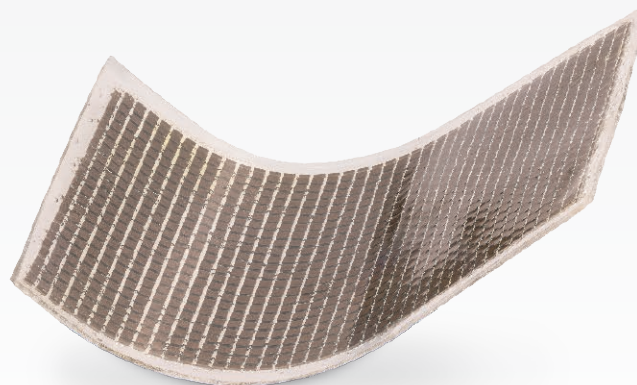


Piezoceramic Composites

**Complex Customized Product Designs
with Flexible Piezo Components**



High Quality Piezoceramic Composites

Piezoceramic composites combine a piezoelectric ceramic part and filling polymer and bring together the advantages of both materials. The composites offer an alternative to the well-known bulk ceramic components. In addition to excellent adaptability to the desired shape, the polymer content offers many other advantages over bulk ceramics. For example, composites can easily adapt to environments with different acoustic impedances. This opens up a wide range of applications in the life sciences and industrial sectors.

Together with customers, PI Ceramic develops piezoceramic composites suitable for the respective application. As our highly qualified team controls all process steps, we can implement customer-specific adaptations in the shortest possible time. In addition to providing consulting during the design and development processes, PI Ceramic also offers the manufacturing of composites with the highest quality.

Support for medical technology applications including

- HIFU incisionless surgery & drug delivery
- Blood flow metering
- Ultrasound imaging
- Cosmetic dermatology

Support for industrial applications including

- Sensor devices
- Hydroacoustics
- Water metering
- Non-destructive testing

Key features of composites

- *Mechanical flexibility*
- *High electromechanical coupling*
- *Low acoustic impedance*
- *Complex designs possible*
- *Low radial displacement*
- *High resolution*

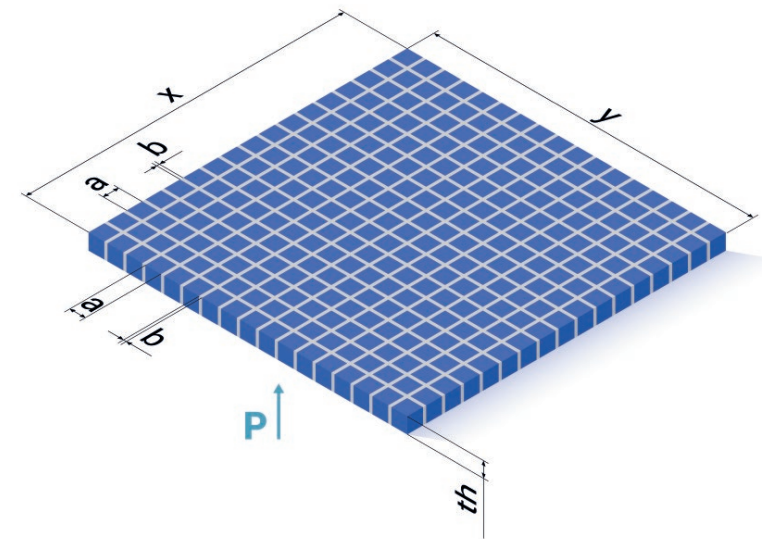
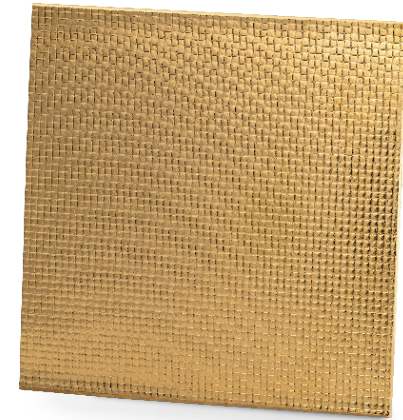
PI's Piezo Composite Capabilities

As sensors, actuators, and in ultrasonic transducers, piezoceramic composites can replace bulk ceramic piezo components in many applications.

PI Ceramic composite prototypes are manufactured using the Dice & Fill method with a 1-3 arrangement, cut to individual pins. In addition to the use of epoxy resin for rigid composites, polyurethane is also available as a filling polymer for flexible composite structures. The dimensions and materials can be selected according to the customer-specific piezo components and produced as a composite:

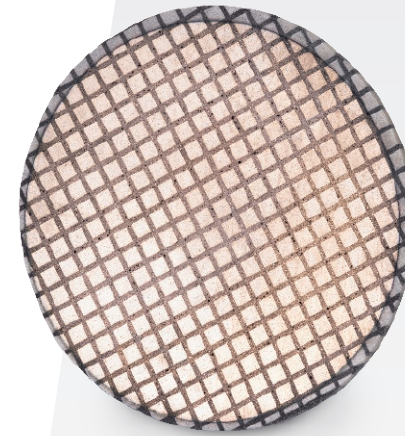
Specifications of piezoceramic composites:

Edge length x,y [mm]	<80
Thickness TH [mm]	>0,1 - 16
Gap dimension b [μm]	>80
Pin dimension a [μm]	>200
Frequency [MHz]	0,08 - 8
Filling volume (volume share of ceramic in total composite) [%]	30 - 80
Electrodes	Thin layer (CuNi)
Filling material	Epoxy resin, polyurethan



1-3 Piezoceramic Composite Disc Samples

Piezo composites utilize the d33 effect and are characterized by limited radial deflection due to the polymer filling. This results in a resonator with low coupling thickness. The pin dimensions of the composite determine the capacitance (C). The working principle is the same as for bulk ceramics of the same design.



Prototype specifications of 1-3 rigid piezoceramic discs, OD 25mm, PIC255:

Resonance frequency (thickness) f [kHz]	Thickness TH (mm)	Pin dimension PIN (mm)	Piezo-ceramic share of volume (%)	Resonant impedance I (Ω)	Electrical capacitance C* (nF)	Dielectric loss factor $\tan \delta$ ($\times 10^{-3}$)	Coupling factor k_{eff} (%)
400	4.0	1.0 x 1.0	83	<30	1.6	<20	>55
600	2.6	0.5 x 0.5	69	<15	2.1	<20	>60
1500	1.1	0.4 x 0.4	69	<5	5.0	<20	>55
2000	0.7	0.3 x 0.3	64	<3	6.5	<20	>55

Customized Piezoceramic Composite Designs

PI Ceramic has in-depth expertise, from the selection of suitable materials to the development and manufacturing of composites according to the desired specifications and applications. In addition to the selection of composites according to the piezo components, the following parameters can be customized:

- Material
- Design
- Layout of the pins
- Electrodes

Larger dimensions are checked upon request

Composite Design

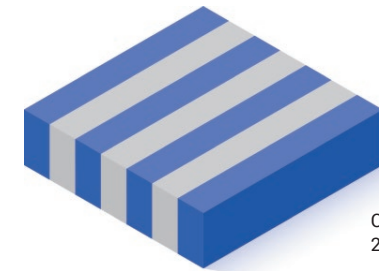
The composite structure allows for components such as plates, discs, half-shells, or tubes, as well as more complex shapes such as smooth-surfaced shafts.

Composites can be manufactured in soft and hard PZT and in various arrangements. In addition to the 1-3 variant (individual pins), the 2-2 arrangement (ceramic rows) is also available.

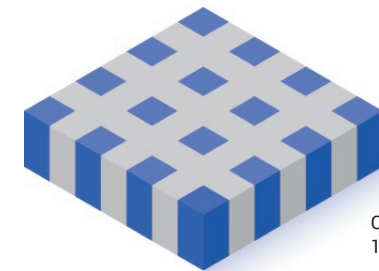
Electrodes & Contacting

Electrodes are applied to the finished composite by sputtering. In addition to copper-nickel (CuNi), other compounds such as gold (Au) are possible. Both full surface electrodes, e.g., for broadband applications, as well as insulated single electrodes are available upon request.

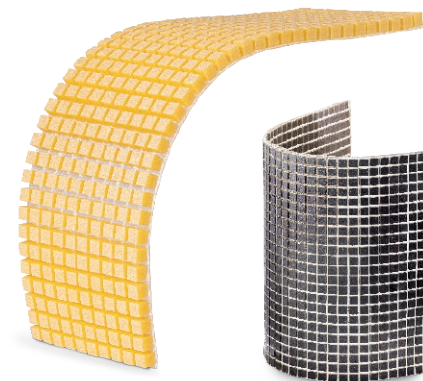
If contacting is required, stranded wires or flexible circuit boards can be bonded to the composites.



Composite in
2-2 arrangement



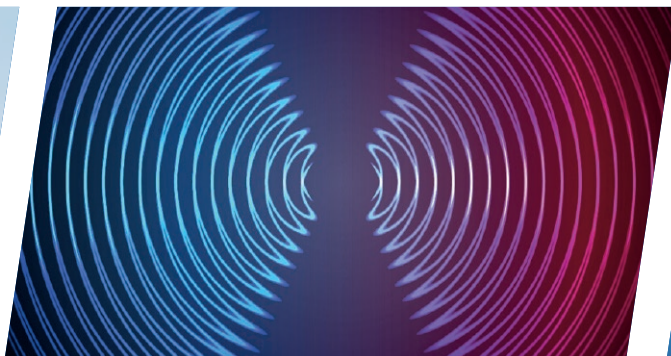
Composite in
1-3 arrangement



PI Ceramic

Founded in 1992, PI Ceramic develops and produces high-tech solutions based on piezoceramics. As part of the PI Group, PI Ceramic is the global PI competence center for piezo technology with a broad product range consisting of piezoceramic components and multilayer actuators through to highly refined component parts to subsystems for ultrasound technology. PI Ceramic can not only develop and produce customer-specific piezo elements in small volumes but also handle the automated mass production of millions of units.

With over thirty years of experience and technical expertise, PI Ceramic operates successfully in innovative and dynamic markets and realizes sophisticated applications in the areas of medical technology, industrial ultrasonic sensors, and precision dosing.



PI



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