



Piezoelectric Devices 1

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NEC TOKIN Piezoelectric Technology

Interest is growing around the world concerning the wide variety of applications of piezoelectric devices, which freely convert electrical potential and displacement.

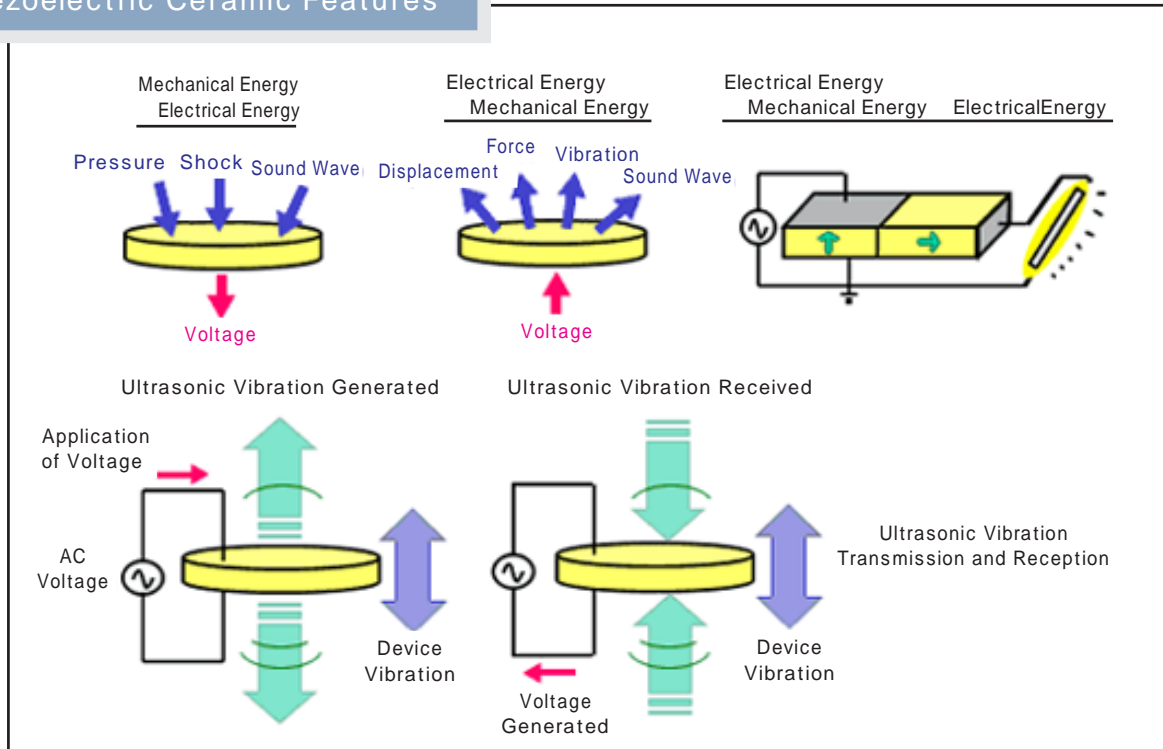
Piezoelectric Technology, leading the New Technological Era

"Piezo" refers to the properties of certain types of crystal that change shape with the application of electrical voltage, and which produce electric voltage as a result of these changes. These properties are one of nature's mysteries. Piezoelectric devices are made with these crystals, which are ceramicized, layered, and converted into elements, to serve as the central units in digital devices. These piezoelectric devices have many advanced qualities.

As well as their great force, rapid response times, and high displacement accuracy, they are exceptionally energy efficient, stable, and produce very little heat or noise. Their design is also exceedingly simple, making them small enough to use in the thinnest, most compact locations.



Piezoelectric Ceramic Features



Flat-screen televisions, digital cameras, and DVD recorders are the latest household status symbols that are in the spotlight for their ability to drive economic growth. Digital home appliances such as these have the often-conflicting demands of advanced features and compactness.

These demands result in an increasingly high density of parts in digital home appliances. At the same time, the higher frequencies used in device operation result in increases in noise and heat production.

Electromagnetic components used in the past have nearly reached the limit of their capabilities to meet such harsh conditions. In order to continue to raise the level of digital home appliances, a new solution is needed.

The key technology for this new technological era is none other than the piezoelectric device.

Piezoelectric and Electromagnetic Device Comparison		
	Electromagnetic	Piezoelectric
Generated force	×	○
Displacement accuracy	×	○
Response speed	×	○
Energy efficiency	×	○
Heat Generation	×	○
Noise	×	○
Size	△	○
Cost	○	△
Displacement	○	×
Overall Evaluation	△	⊙

× = below average △ = average ○ = good ⊙ = superior

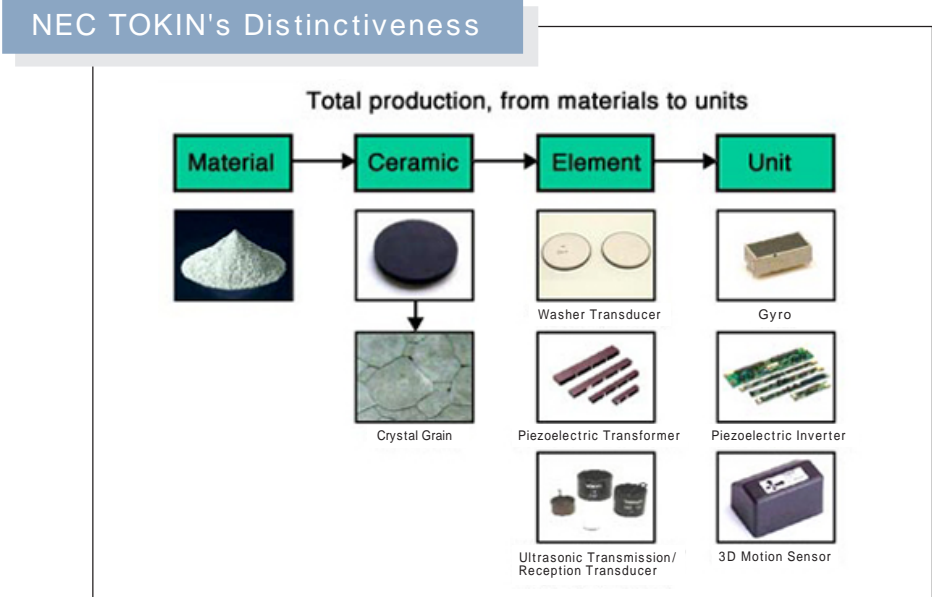
At NEC TOKIN, we have almost 40 years of experience working with piezoelectric devices.

We saw the potential in piezoelectric technology from the very beginning, and have since brought forth numerous developments and accumulated a great deal of technology. Over this time, we have gained experience and developed significant intellectual properties.

For example, when it comes to ceramicizing materials, we have the ability to control not only basic physical aspects such as composition, impurity management, sintering density, and vacancy diameter, but also advanced physical aspects such as crystal grain diameter, grain diameter distribution, grain boundary structure, and vacancy distribution essential for high-quality ceramics production. In the layering process of device construction as well, our foresight has enabled us to use the simple yet leading patented technology of full surface electrode construction, thereby avoiding the weaknesses of piezoelectric devices and continuing to open up a wide range of applications.

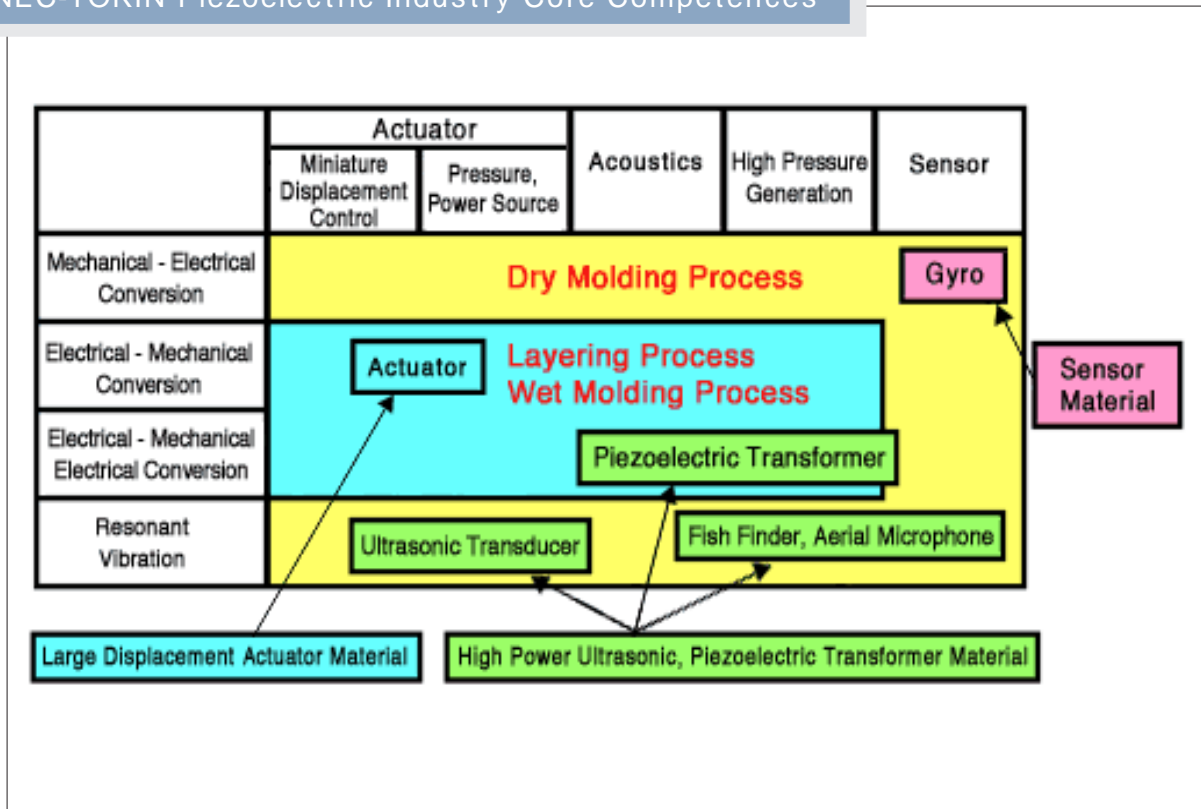
We also have a long record of processing ceramics into elements, unit production technologies, and measurement technologies for the objective evaluation of completed device and unit performance.

Our distinctiveness is in our solid, systematized technological strength in all processes related to the construction of piezoelectric devices, from basic materials technologies to unit and measurement technologies. NEC TOKIN's approach to surveying the entirety of piezoelectric technologies while rapidly responding to customer needs is a culture unto itself.



In the 21st century, piezoelectric devices will not only make the expansion of current markets possible, but increasingly replace markets where electromagnetic components have been dominant, leading to entirely new applications and a dramatic increase in usage. Our advanced technological strength is sure to contribute greatly to society in this coming era.

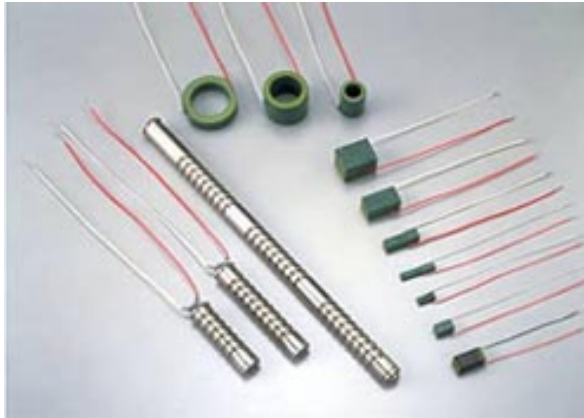
NEC-TOKIN Piezoelectric Industry Core Competences



NEC TOKIN 's Piezoelectric Devices

The term "piezoelectric device" actually refers to a range of applications so wide that it would be impossible to cover completely. Here, we'd like to introduce two of our piezoelectric products.

Multilayer Piezoelectric Actuators



Ultracompact Piezoelectric Actuator

Piezoelectric actuators feature outstanding characteristics that cannot be provided by hydraulic pressure, air pressure, or electromagnetic approaches: a response time of 0.01 milliseconds; precision movement of 0.01 microns; low energy consumption; and a generated force of 3 kilograms per square millimeter. These characteristics are significantly superior to other technologies.

What is an Actuator?

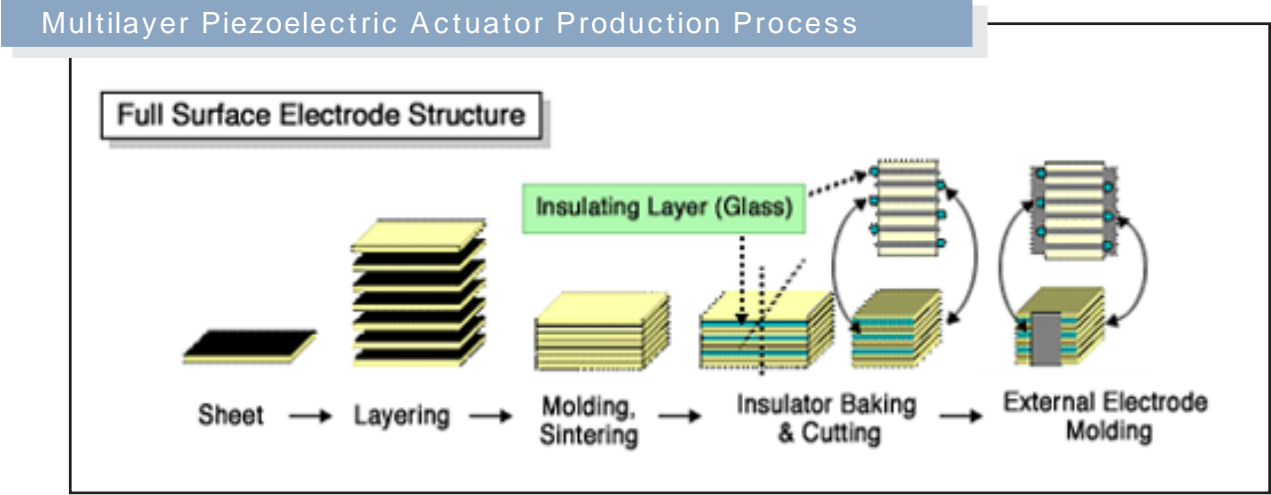
An actuator is

a device that converts input energy, such as electricity, hydraulic pressure, and air pressure, into mechanical output (movement)



Drive Source	Range	Accuracy	Generated Force	Response
Stepping Motor	1 0 0 0 mm	1 0 μm	3 0 k g	1 0 0 msec
Voice Coil Motor	1 mm	0. 1 μm	2 0 k g	1 msec
Piezoelectric Actuator	0. 0 5 mm	0. 0 1 μm	3 k g/mm ²	0. 0 1 msec

We use full surface electrode technology to produce multilayer piezoelectric actuators consisting of 200 to 300 layers of alternating thin piezoelectric ceramic and electrode layers. Full surface electrodes, as the name indicates, are electrodes that completely cover the ceramic layer. This structure allows piezoelectric ceramics and full surface electrodes to be layered and built into large blocks, which can then be cut to the size and shape needed, and made into an actuator with the application of an electrode. This enables the creation of small, 0.6 mm elements and cylindrical, tubular, and ring shapes unique to NEC TOKIN. With such flexibility, piezoelectric components are usable in small spaces and applications requiring unusual component shapes.



Piezoelectric actuators have typically enjoyed wide use in semiconductor production and industrial devices requiring precision control. However, in recent years, the use of piezoelectric actuators in digital cameras and camera-equipped cell phones has grown rapidly. Driven by a focus on advanced functionality, the digital camera market has augmented the number of pixels in order to achieve improved resolution, resulting in an increase in compact products with zoom capabilities of 10x and greater. This invariably has led to a need for a stabilizing feature that prevents the blurring caused by hand movement. Piezoelectric actuators provide stabilizing compensation, as well as auto-focus lens drives and zoom features for various uses.

With their low power consumption, compact size, and high-speed precision motion, piezoelectric actuators are being used in an ever-growing number of fields outside of conventional usage arenas.