Piezoelectric Foil Sensors and Actuators

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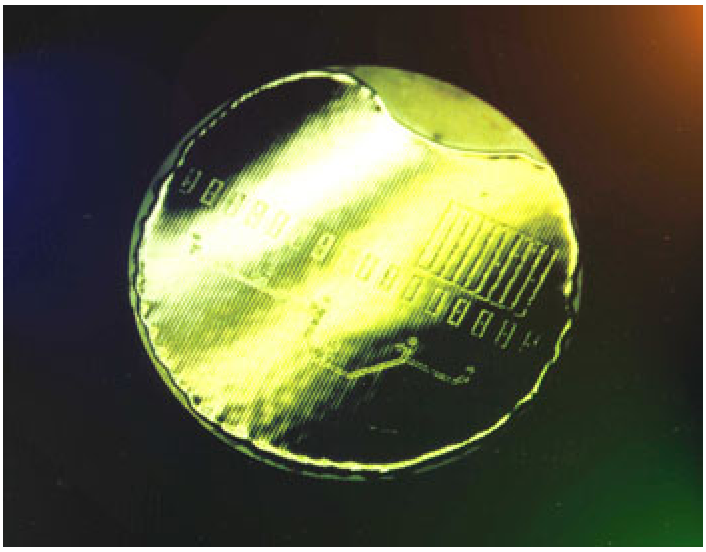

Technology abstract

Piezoelectric films made of PVDF (Polyvinylidene fluoride) are very thin and flexible active electromechanical transducers, which may convert about 12% of mechanical energy into electrical energy, and vice versa. Thus they are useful as a sensor as well as an actuator.

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Technology Description

The piezo foil technique allows the design of extremely flexible and thin sensors as well as actuators, which may be placed on 3D-contured surfaces or inserted in small gaps as well as embedded in GRP/CRP structures.

Piezofilm properties

The piezofilm is a transparent film of highly polar poly-vinylidene-fluoride (PVDF). In proportion to the influence of mechanical stress or strain the film develops an electrical charge, that could be shunted over the metal coated surfaces. Otherwise the application of electric current leads to a proportional mechanic deformation.

In sensor applications the direct piezoelectric effect and in actuator applications the inverse piezoelectric effect is used.

Under electronic aspects the piezofilm is a capacitor that reacts on a change of applied force with a proportional change in electric charge. Piezoelectric materials are anisotropic. This means, that their electrical and mechanical properties vary upon the direction of applied force, strain or electrical field.

The film´s axes are identified by the numerals indicated in fig. 1. The symbols listed in Technical Data for strain- and stress constant dii and gii are declared as followed. The first index identifies the direction of applied electrical field (always thickness direction when using piezoelectric films). The second index refers to the axis of induced mechanical strain or applied stress.

Duties

Piezofilm sensors are well qualified for detecting dynamic events, like pressure fluctuations, vibrations or force changes. Especially under space limited conditions, the extreme thin sensor material is advanced use. Because of the high dynamic range, the great bandwidth and the high flexibility a lot of measurement problems could be solved, which is impossible to do with other techniques.

Sensor and actuator design

The piezofilm could be designed as single- or multi sensor array in nearly any form and dimension. Single point sensors with a minimum diameter of 0.25 mm could be realized. Multi layer sensors with different orientations could be used as filters for separating definite force directions or for screening the sensor signals. Acting as an actuator, really complex bending-torsion motions could be realized, i.e. for adjustable mirrors.

The piezofilm metal coat consists usually of aluminum or nickel. Other metallizations such as copper, gold or silver could be delivered on special request. Concerning different measuring tasks the piezofilm sensor signals are enhanced by special adapted amplifiers and can be stored and computed with common data-recording and processing units.

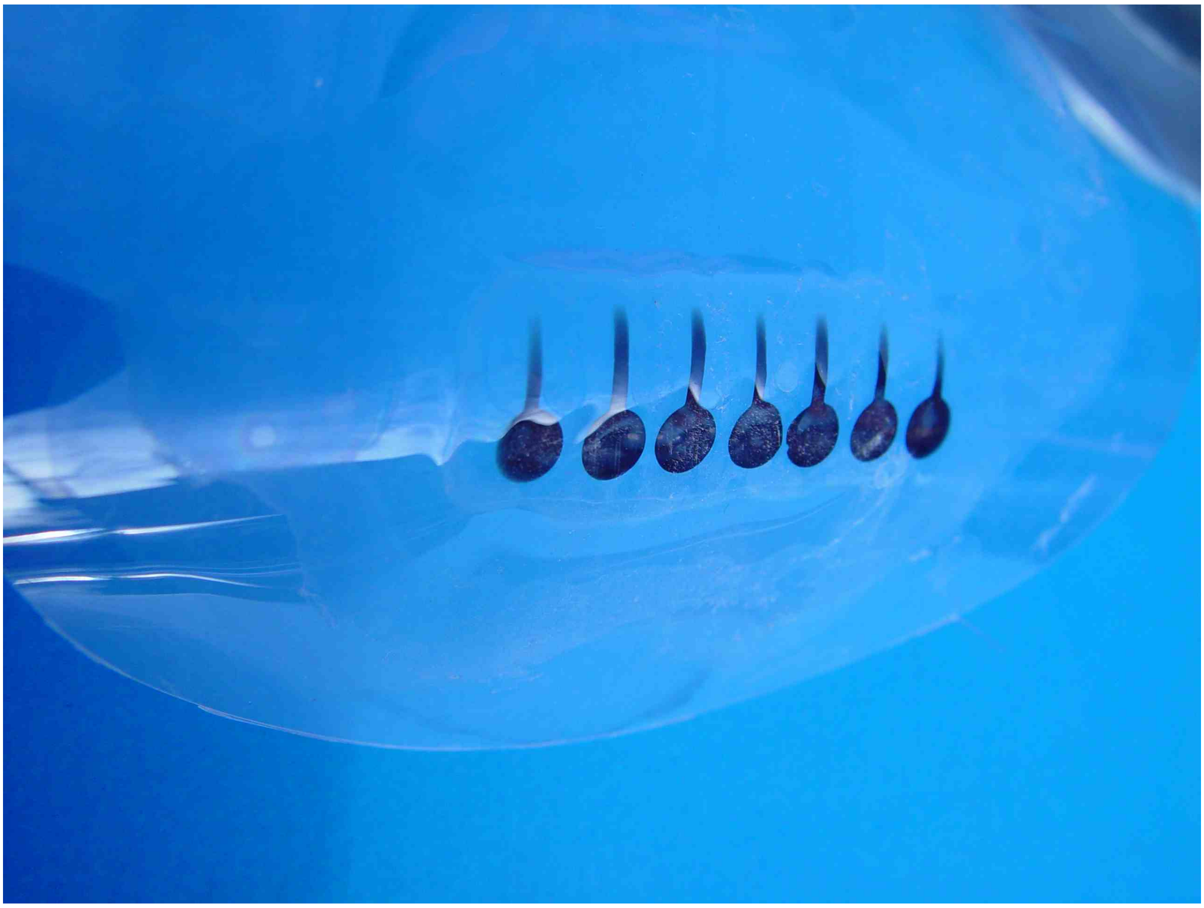
Innovations & Advantages

Due to the piezo-active measurement principle only very small contact wires are required, allowing the integration of a high number of sensors with a spatial resolution down to sub-mm scales. Due to anisotropic properties of mono-axial oriented foils the charge produced by different strain components is amplified or dampened, resulting in a multitude of specific sensor applications. Several multi-layer and multi-element actuators can be realized, producing longitudinal or torsional motion or traveling waves in beam elements.

Current and Potential Domains of Application

The sensor foils are suitable for applications in the areas of dynamic force, pressure, motion and temperature measurements up to high frequencies. Some realized examples are: fluid, IR, vibration and pulse pressure sensors, keyboards, robotics, tactile and ultrasonic sensors. Piezoelectric actuators are suitable for employing large displacements with small forces as for example the damping or amplification of oscillations of light-weight structures, optical components and miniature positioning devices or fans.
Envisaged use e.g. in:

- Infrared sensors
- Vibration sensors
- Strain sensors
- Switches
- Level sensors
- Active vibration damping, stimulating
- Pulse pressure monitoring
- Ultrasound sensors
- Pressure detection in joints
- Microphones
- Acoustic speakers
- Headsets

- 
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