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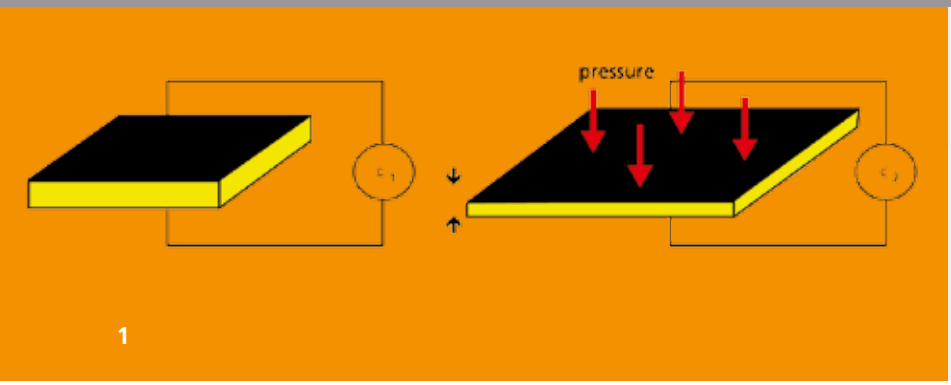

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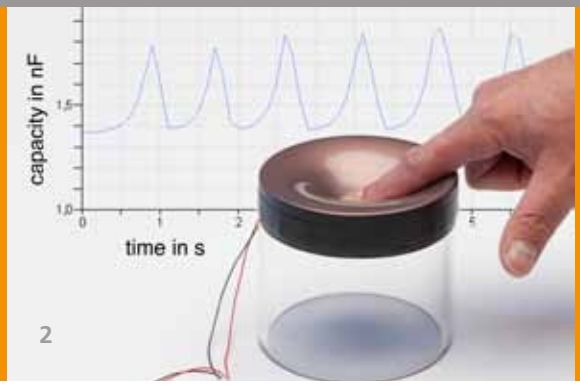

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1 *Measurement principle of a dielectric elastomer sensor showing the change in capacitance – left: not under load; right: under load*

2 *Dielectric elastomer sensor displaying the measured capacitance*

HIGHLY FLEXIBLE MECHANICAL SENSORS MADE OF DIELECTRIC ELASTOMERS

Dielectric elastomer sensors (DES) are a new class of mechanical sensors which can be used to measure deformations, forces and pressures. They offer extremely high elasticity and can therefore be integrated in structures which are themselves subjected to strong deformations.

Potential for the application of DES exists in medical technology, e.g. for monitoring body functions or preventing bedsores, in logistics for inventory monitoring and in automation technology e.g. for activating functions via floor loading.

Measurement principle

Dielectric elastomer sensors consist of a very elastic elastomer film, coated on both sides with highly flexible electrodes. The sensor effect stems from the measurement of electrical capacitance. Under compression or tensile loading the thickness of the sensor film decreases while at the same time the surface expands, causing an increase in capacitance.

Materials

Silicone rubber is the preferred basic material for the elastomer film, but other elastomer materials such as acrylate or polyurethane elastomer can also be used. Apart from the design and the geometric dimensions, the hardness of the elastomer determines the sensitivity of the sensor.

Silicone rubber offers a broad variability of hardness through chemical cross-linking. As a result, the material can be adapted to the specific requirements of the sensor.

The electrodes on the elastomer film consist of electrically conductive particles which are integrated in a matrix. To reduce wear, the sensor can be encapsulated.

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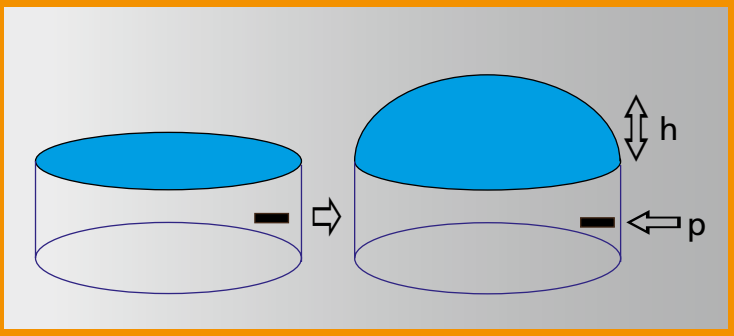

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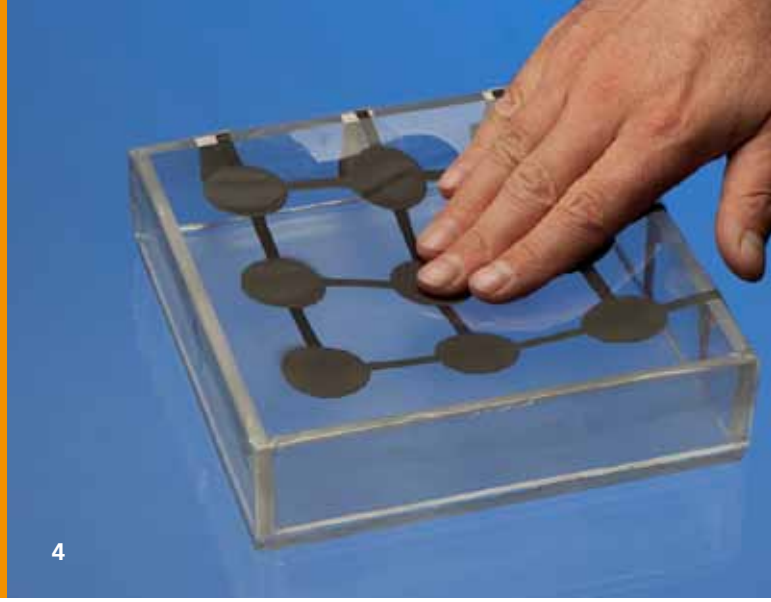

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Strain sensor

A simple film sensor can be used to measure strain. As the film elongates, the capacitance changes, increasing almost linearly with the strain (see top graphic in the right column).

Pressure sensor

In the pressure sensor a dielectric membrane is inflated by the pressure applied and changes its capacitance. The measurement principle is illustrated in Figure 3. The bottom graphic in the right-hand column shows the change in capacitance as the pressure increases.

Sensor array

By structuring the electrodes on the elastomer film, an array of many elements can be built up. To this end, the electrodes are divided one- or two-dimensionally into segments and activated electrically and separately. As a result, the force acting on the film can be localized or a pressure distribution can be detected (see touchpad, Figure 4).

Applications

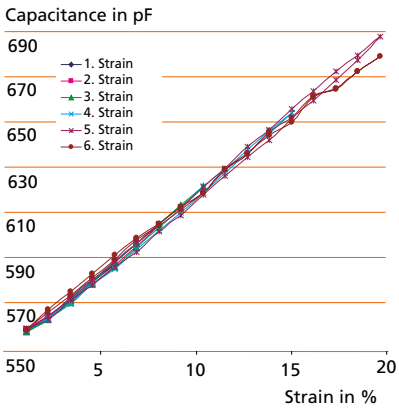
Measurement of the change in capacitance of dielectric elastomers can be put to use for example in the following applications:

- Footstep sensors in floors
- Measuring stock levels by weight
- Continuous pressure measurement of gases and liquids
- Monitoring body functions such as respiration, pulse or blood pressure
- detecting pressure distributions e.g. to prevent bedsores

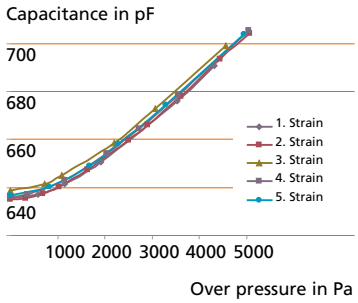
Different applications require different properties in the dielectric elastomer. These can be obtained by changing the composition of the materials, the film geometry and the sensor design.

Expertise at the Fraunhofer ISC

- Development and adaptation of materials for dielectric elastomer sensors for customer-specific applications
- Development and implementation of new sensor designs adapted to customer-specific requirements
- Integration of dielectric elastomer sensors in mechanical, and flexible, structures



Change in capacitance of the strain sensor



Change in capacitance of the pressure sensor

3 *Measurement principle of a pressure sensor*

4 *Sensor array as a touchpad*