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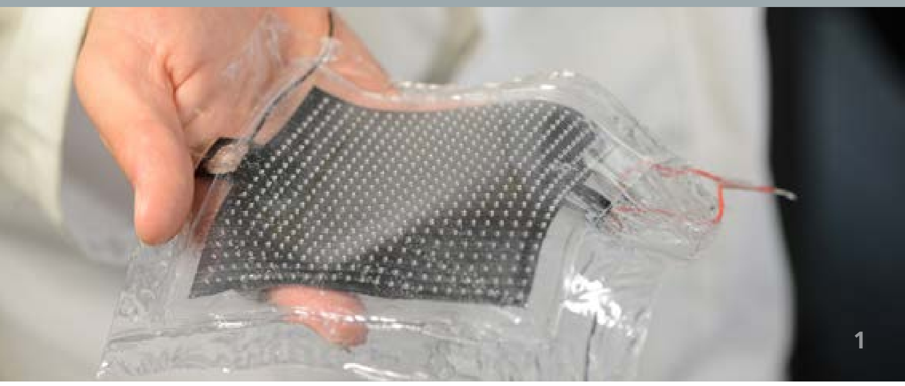

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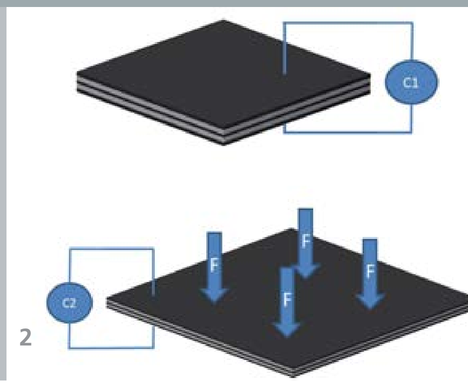

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1 *DES for pressure sensing*

2 *2 Rise up of capacitance of a DES caused by pressure load*

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HIGHLY FLEXIBLE MECHANICAL SENSORS FOR STRAIN, STRESS AND COMPRESSION LOADS

Dielectric elastomer sensors (DES) shown in figure 1, 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 automotive industry for seat occupation surveillance, in logistics for inventory monitoring and in automation technology e.g. for activating functions via floor loading and robot safety.

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 tensile loading or deformation the surface expands while at the same time the thickness of the sensor film decreases, causing an increase in capacitance, as shown in figure 2.

Materials

Silicone rubber is the preferred basic material for the elastomer film, but other elastomer materials such as natural rubber, acrylate or polyurethane elastomers 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 may be encapsulated.

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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. Very high strains up to 100 % and more can also be achieved.

Pressure sensor

For measuring compression loads even on flexible substrates, new sensor mats have been developed. In a novel approach, the compression load is transformed to a strain load of the elastomer film by profiled surfaces giving very high sensitivity. The characteristics of the sensor mat can be tuned by the material properties and the design of the profiles.

Sensor array

By patterning 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.

Applications

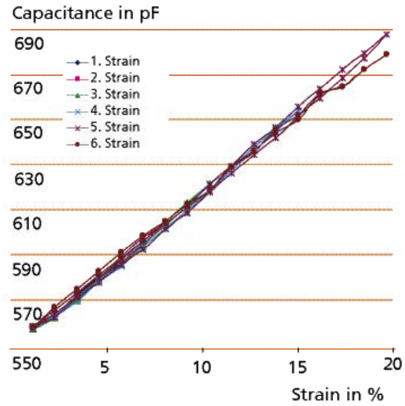
Measurement of the change in capacitance of dielectric elastomers can be put to use for example in the following applications:

- Seat occupation monitoring
- 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
- Pressure sensitive switches in steering wheels, figure 3
- Evaluation of gripping forces, figure 4

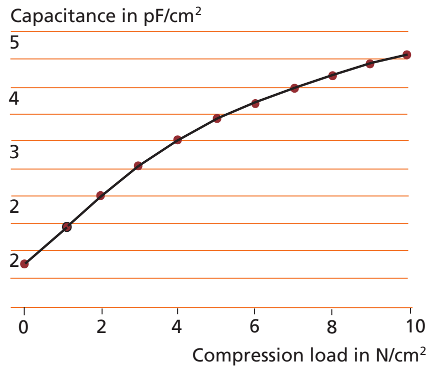
Different applications require different properties in the dielectric elastomer. These can be obtained by changing the composition of the materials, the film geometry and the sensor design. An additional advantage is that DES can be manufactured at low costs.

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 of capacitance upon compression load

3 Steering wheel with embedded DES (white circles)

4 DES in a sensor glove to analyse gripping forces