Technology Offer

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Empa
Materials Science and Technology

# High permittivity silicone for dielectric elastomer actuators

## Invention

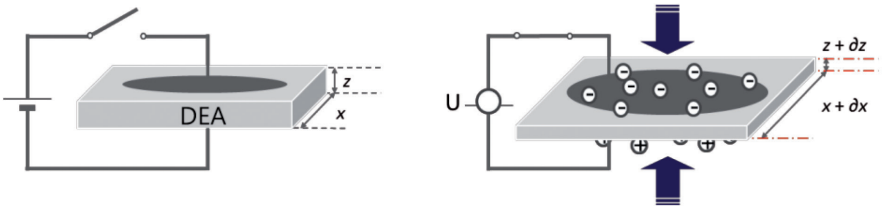
**A simple, low cost, eco-friendly, fast, and easily up-scalable synthesis process for high permittivity silicone-based polymers and elastomers.**

## Background

Dielectric elastomer actuators (DEA) are stretchable capacitors that consist of a thin elastomeric film sandwiched between two compliant electrodes.[1] When a voltage is applied, an electrostatic force is acting on the film, which is compressed. Since elastomers con-serve their volume upon deformation, the film is elongated perpendicular to the applied electric field. This process is reversible; the polymer relaxes back to its original form after removal of the field. Common elastomers meet the mechanical requirements for actuators, however, they suffer from a low permittivity ($\varepsilon'$).[2] Therefore high driving voltages are needed to induce mechanical work which hinders applications in, for example, medical prosthetics or make the electronics complex and expensive.[3] A possible way to improve the performance is to increase $\varepsilon'$ of the elastomers. Herein, a low cost synthesis process for silicone elastomers with $\varepsilon'$ higher than 10 and excellent mechanical properties is presented which allowed the reduction of the driving voltage.

## Advantages

The preparation of these elastomers:
- is straightforward and allows tuning the dielectrical as well as the mechanical properties of the resulting materials,
- leads to homogenous materials – in contrast to the commonly applied blending of higher permittivity phases into a silicone matrix,
- uses starting materials which are readily available and cheap, and
- is simple and up-scalable.




Our material shows 10% lateral strain at 8.5 V/µm

## Applications

The new materials can be used as dielectricum in dielectric elastomer actuators (DEA) technologies. Due to DEA simple working principle and their excellent properties that include lightweight, quiet muscle like actuation, high actuation strain and electromechanical efficiency, their application potential is imense, e.g. actuators, robotics, implantable prosthetic and rehabilitation devices, automotive and aeronautic industry, energy harvesting, sensors, and optical devices, to name a few.[3] Therefore, for all the above mentioned application, silicones with high permittivity are desirable.
Additionaly, materials with high permittivity are also interesting for capacitors and transistors.

## Ownership

Empa, Swiss Federal Laboratories for Materials Testing and Research, Überlandstrasse 129, CH-8600 Dübendorf; *Patent pending*

## References

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[2] P. Brochu, Q. Pei, *Macromol. Rapid Comm.* **2010**, *31*, 10–36.
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## Keywords

High permittivity elastomers, high dielectric constant elastomers, dielectric elastomer actuators, silicone elastomers, silicone synthesis.

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