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Dielectric electroactive elastomers: from eye lid control to wave power generation with one single material

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Today the term 'artificial muscle' is used for several types of smart materials or systems to generate motion for a variety of uses, such as materials and/or devices with muscle-like structural or functional properties. One of the systems belonging to this class is the Electroactive Polymers (EAP). EAPs consist of materials capable of changing shape in response to an applied electrical stimulus due to the deformable elastomer being sandwiched in between the compliant electrodes. EAP based actuators show useful properties, such as high mechanical flexibility, fast response, light-weight, structural simplicity and versatility, no acoustic noise, little or no generation of heat, and generally low costs.

EAPs are used in many applications in many different fields, including amongst many others mechatronics, robotics, biomimetics, haptics, optics and acoustics. Specific examples of uses include compliant and light-weight drive mechanisms for robotics and also very recently as implants in the human body with the eye lid control developed by scientist at the Medical Center of the University of California Davis as the first example of a true implant. Another application area of the EAPs is the conversion of mechanical energy into electrical energy for sensing and energy harvesting.

Danfoss Polypower A/S, one of the only producers of EAPs worldwide, utilizes a silicone elastomer which from nature has several advantages with respect to the use of the elastomer in EAP applications such as very fast actuation speed, fairly high dielectric permittivity, low elastic modulus, and relatively high dielectric breakdown strength. However, the tear strength of the material is poor so it is mandatory to optimize the elastomer formulation by e.g. addition of fillers. Also process considerations may put restrictions on the elastomer formulation.