Universität Basel

Research Project

Enhancing the capabilities of artificial muscle implants using low-voltage dielectric elastomer sensors

Third-party funded project

Project title Enhancing the capabilities of artificial muscle implants using low-voltage dielectric elastomer sensors

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Organisation / Research unit

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Department

Project start 01.09.2017

Probable end 31.03.2019

Status Completed

Dielectric elastomer transducers (DET) exhibit a strain-stress behavior comparable to human tissues. During my PhD thesis I have demonstrated DE actuators based on elastomer layers several hundred nanometers thin generating 6 % strain applying voltages as low as 12 V. To build a sphincter (actuator) thousands of nanostructures have to be stacked realizing the force comparable to natural muscles. Therefore, this Bridge-application will focus on the sensing capability of dielectric elastomer transducers (DETs). Molecular beam deposition (MBD) will serve for the preparation of about a dozen nanometer-thin elastomer and metal layers. Pre-stretched nanometer-thin electrodes are intended to keep the whole DE-sensor as soft as the elastomer itself and avoid the stiffening by the gold. Tailored elastomers for MBD are proposed in collaboration with D. Opris (Laboratory of Functional Polymers, Empa) to obtain highly elastic films with significantly increased permittivity. Whereas, MBD is a flexible and extremely precise deposition technique, electro-spray deposition (ESD) of polymers is the cheaper alternative. Currently this setup has been assembled into vacuum atmosphere for enhanced homogeneity and reduced defect density within the elastomer membrane. I am convinced that this state-of-the-art technique allows realizing nanometer-thin DETs for the first time. For both MBD and ESD, spectroscopic ellipsometry will enable the growth control with nanometer precision. Finally, these fabrication techniques will serve for direct integration of the sensor without implying further geometrical restrictions to the medical implant. The resulting high-performance multi-layer sensors will remain operational even if one or the other layer fails due to breakdowns. The expected long-term reliability and low power compsuption permits the implanted dielectric elastomer sensor to be autonomous. With millisecond time response the functionality of artificial sphincters for incontinence treatments will be significantly enhanced. Here, several collaborations have been established: besides Myopowers S.A. (St. Louis, France), our partner in the nanotera.ch initiative, I am in contact with the team of N. Dhar (Wayne University, USA) seeking for artificial sphincters with smart pressure adaption. Colleagues from our department, including G. Rauter, like to implement the DET into sophisticated devices. Within the MIRACLE project the sensor arrays could become part of the endoscope that enables laser-based tissue cutting. Consequently, several patent applications can be filed, which should form a sound basis to establish a MedTech start-up company.

Keywords Dielectric elastomer transducer; Organic molecular beam deposition; Smart medical implants; Compliant metal/elastomer nanostructures; Nanometer-thin polymer films; Low-voltage force feedback sensor

Financed by

Swiss National Science Foundation (SNSF)

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