Master Thesis

Implantable blood glucose sensors: Probing of glucose-responsive hydrogel layers with ultrasound

Approximately one in ten adults in Germany is affected by the metabolic disease diabetes mellitus. Patients have to regularly measure and regulate their blood glucose level. Sensors that can be implanted under the skin allow for continious monitoring, making everyday life easier for these patients. However, the sensors must be replaced every six months and as a result the tissue becomes increasingly scarred with each replacement. Therefore, at the Department of Microsystems Engineering (IMTEK) a new type of glucose sensor is being investigated. The sensor principle is based on a glucose-responsive hydrogel, which is injected under the skin and which changes its mechanical properties depending on the interstitial glucose concentration. This change can be read transcutaneously using ultrasound. Since the hydrogel degrades in the body over time, explantation is not necessary and scarring is prevented. Up to now, an ultrasound imaging device has been used to read out the glucose-responsive hydrogel. This rather bulky device is now to be replaced by a compact measuring setup with miniaturized ultrasound transducers. This transition is an important step towards a wearable implementation of this sensing principle.

The objective of this work is to test glucose-responsive hydrogels in a measurement setup with a compact ultrasonic transducer. Instead of evaluating ultrasound images, this setup will use the raw signal from the ultrasound transducer to determine the prevailing glucose concentration at the hydrogel. The so-called “pulse-echo mode” will be used for this purpose. A suitable in vitro measurement setup is already available and can be used to evaluate the hydrogel layers. The tasks involved in the master‘s thesis include the preparation of the glucose-responsive hydrogel, the adaptation of the measurement setup, and the subsequent characterization of the hydrogel in the setup. The thesis thus provides proof of principle that glucose-responsive hydrogels can be evaluated in vitro using compact ultrasonic transducers.

This work is particularly suitable for students of Microsystems Engineering, Embedded Systems Engineering, Materials Science, Chemistry, or related fields.

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