

Science and Engineering Research Program 2022

Faculty of Electrical Engineering and Computer Science

Institute:

Institute of Electrical Engineering and Measurement Technology (Chair for Micro- and Nanointegrated Systems)

Project:

Development and characterization of smart hydrogels for biomedical sensor applications

Background:

Smart hydrogels are three-dimensionally crosslinked hydrophilic polymers which can undergo a volume-phase transition in response to external physical or chemical stimuli (e.g. temperature, pH, ions, light, specific molecules). They can be made from a wide variety of biocompatible materials, feature mechanical properties similar to tissue and allow for chemical tailoring to achieve analyte-specific sensitivity. These properties make smart hydrogels very promising candidates for biomedical sensing elements.

However, current use cases mainly focus on “passive” applications in drug delivery and tissue engineering since the main challenge for sensor applications lies in the development of suitable transduction mechanisms for the smart hydrogel’s volume change.

Project scope:

In my research group, we aim at developing smart hydrogel-based biomedical sensors for non-invasive personalized health monitoring. This requires basic research on many different aspects:

- Modification of material properties of smart hydrogels (e.g. mechanical strength, electrical conductivity by adding metallic nanoparticles or combining different polymers)
- Development of fabrication methods for complex hydrogel structures (e.g. surface structuring, lattice structure) such as molding and 3D printing-based approaches
- Characterization of material properties (electrical, mechanical, optical, gravimetric)
- Development of read-out mechanisms for smart hydrogel volume change (e.g. impedance-based, employing change of optical properties)
- Prototype development of biomedical sensors in which we incorporate the developed hydrogels (e.g. characterization and evaluation of performance in artificial *in vivo* setup)

For all these topics, we offer the opportunity for student research projects and participation. We can easily adjust the specific tasks according to research interests, skills and preferences.

Necessary skills / background:

- Ability and willingness to thoroughly conduct scientific experiments
- Critical thinking and the ability to research scientific literature to understand concepts and evaluate hypotheses
- Curiosity and interest in learning about new scientific topics
- Software skills in data evaluation (e.g. Origin, GnuPlot), programming (e.g. Python, LabView) and CAD design (e.g. Inventor, AutoCad) are helpful

Based on the specific area of interest it may be beneficial to have background knowledge in measurement technology (e.g. basic principles like differential measurements), chemical or biomedical engineering. However, this is not a requirement since we will introduce you to the relevant topics and teach the necessary skills.

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