Seminar

CENTER FOR ADAPTIVE NEURAL SYSTEMS

IRA A. FULTON SCHOOL OF ENGINEERING

JOINTLY HOSTED BY: HARRINGTON DEPARTMENT OF BIOENGINEERING

Stretchable Microelectrodes for Biomedical Applications

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Abstract: In this seminar, I present the recent development of stretchable microelectrodes and discuss their biomedical applications. Numerous applications for the electrical stimulation of neurons and muscles have been developed over the recent decades. For example, surgeries to implant pacemakers, deep brain stimulators (DBS) and cochlear prosthesis are routine procedures in clinical settings. Other applications such as retinal prosthesis and brain-computer interfaces (BCI) are in development and currently limited to small scale clinical trials. All of these applications suffer (some more than others) from issues at the interface of the stimulating electrode and the stimulated tissue. The mismatch in mechanical properties, such as the elastic modulus, between electrode and tissue is responsible for most of these issues. The elastic modulus of materials that are typically used as the stimulating electrodes in these applications, such as tungsten, platinum or silicon, is on the order of 10^{11}Pa. In contrast, the elastic modulus of the tissue that these electrodes interface with ranges from less than 10^{3}Pa (brain tissue) to 10^{5}Pa (peripheral nerve, muscles).

The elastic modulus of my newly developed microelectrodes is only 10^{6}Pa, i.e., the mismatch in mechanical properties with biological tissue is thus reduced by about 5 orders of magnitude compared to conventional microelectrodes. These stretchable microelectrodes consist of thin metal films patterned on a compliant elastomeric silicone substrate (poly dimethyl siloxane, PDMS). The encapsulation of the electrodes and the opening of contact holes are accomplished using a photopatternable silicone. The metal films remain electrically conducting under large strain (>50%) and repeated stretching.

As one of the early applications, we use these stretchable microelectrode arrays (SMEAs) as an *in vitro* model off traumatic brain injury (TBI). Organotypic hippocampal tissue slices are cultured on a stretchable microelectrode array. The tissue adheres to the underlying silicone membrane when stretched biaxially, thereby simulating the biomechanics of a TBI. The electrodes and the tissue stretch together enabling electrophysiological recordings pre- and post-injury from the same location on the tissue. A goal of this research is to develop a high content screening platform to identify novel neuroprotective treatment strategies that can minimize post-traumatic injury cell death and dysfunction. The potential use of stretchable microelectrodes for devices with biomedical applications is enormous. In this seminar, I seek to solicit ideas about interesting applications of this technology to help set the course for future research in this area.

Dr. Oliver Graudejus received his Ph.D. degree in Chemistry from the University of Giessen in 1996. His early research focused on synthesis and characterization of inorganic fluorides with metals in high oxidation states. In 1996, he received an Alexander von Humboldt fellowship and joined the research group of Prof. Neil Bartlett at the University of California, Berkeley. In 1999, he joined Novellus Systems, a supplier of equipment to the semiconductor industry. He worked on chemical vapor deposition, physical vapor deposition and atomic layer deposition. Since 2006, he has been a member of Prof. Sigurd Wagner's group at Princeton University. He has developed a program of research that improves the reliability of the stretchable interconnect technology and extends it to different biomedical applications, including traumatic brain injury, spinal cord injury and osteopathic manipulative medicine.

Location and Time:

Location: SCOB 150, ASU
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