

Pre-Conference Workshop 3

## ***Microelectrode Array Technologies***

**Organizer:**           **Dr. Martin Schuettler**  
Laboratory for Biomedical Microtechnology  
Department of Microsystems Engineering - IMTEK  
University of Freiburg, Germany  
*schuettler@imtek.de*

**Presenters:**       **S. Kisban**  
Laboratory for Microsystems Materials, IMTEK

**B. Rubehn**  
Laboratory for Biomedical Microtechnology, IMTEK

**C. Henle**  
Laboratory for Biomedical Microtechnology, IMTEK

### **Scope**

Micromachining is the key technology for fabricating small-sized electrode arrays with very high integration densities. This workshop introduces the attendees to three different approaches of micromachining: 1.) Classical micromachining of silicon for the fabrication of shaft-type electrodes, 2.) polyimide-based micromachining, allowing the fabrication of flexible electrode arrays like retina electrodes and peripheral nerve cuff electrodes, and 3.) micromachining of silicone rubber, suitable for building flexible arrays, e.g. for epilepsy research and brain-computer interfaces. The advantages and limitations of each technology will be discussed, providing an aid for choosing the suitable technologies for a specific application. The presentations are given by PhD students who worked for at least 2 years in the development of microelectrode technologies at IMTEK.

### **Session 1: Silicon Microelectrodes**

The first micro machined silicon-based nerve electrode was proposed by Wise in the late 1960s. Since then a number of groups started fabricating silicon microelectrodes in various shapes and with different processes. This session will give you an overview on the most prominent fabrication processes, explaining the crucial processing steps, e.g. photolithography, thin-film deposition methods, isotropic and anisotropic etching. Interconnection methods that allow the wiring of the micro devices to macro world amplifiers and stimulators are presented. The use of silicon microelectrodes in animal work will be described. Samples of shaft electrodes and shaft electrode arrays fabricated at IMTEK can be examined by the attendees.

### **Session 2: Polyimide Microelectrodes**

In contrast to silicon, which is a rigid material, numerous polymers were utilized as substrates for micro fabricating very flexible electrode arrays. The fabrication process of polymer-based microelectrodes will be explained on the basis of polyimide technology, as it is established at IMTEK clean room facilities. Polyimide microelectrodes are assembled as flat structures on a silicone wafer which acts as a mechanical carrier that is discarded after the last process step. These flat structures can be permanently transferred to the third dimension and e.g. be used as cuff-type peripheral nerve interfaces. Results from recording and stimulation of neural tissue in animals are presented and discussed, samples of polyimide-based nerve electrodes will be on display.

### **Session 3: Silicone Rubber Microelectrodes**

The fabrication of flexible microelectrodes made from medical grade silicone rubber and high purity platinum foil is based on laser-ablation using a Nd:YAG laser. Although laser-ablation cannot compete with photolithography in respect to minimal feature size and definition, it offers an attractive alternative to “traditional” micromachining since the process line involves only two machines: a spin coater and a laser. The fabrication process is described in detail and samples of fabricated electrodes are passed around the auditorium

### **Session 4: Comparison of Technologies**

Each medical application has a technology that is suited best for the fabrication of microelectrodes that meet the individual requirements. Intended as an open discussion with all three presenters, strengths and weaknesses of the three technologies as well as future developments are explained and help is provided for selecting the right electrode technology for your experiments.