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Prof. Dr. Andreas Offenhäusser studied physics and completed his dissertation in 1989 at the University of Ulm. For 2 years he worked in the field of power transistors at Robert Bosch GmbH in Reutlingen, Germany. From 1992 until 1994 he performed a post doctoral study at the Frontier Research Program at RIKEN, Japan. Afterwards, he worked as a group leader at the Max-Planck-Institute for Polymer Research in Mainz, Germany. Since 2001, Offenhäusser is director at the Institute of Complex Systems at Forschungszentrum Jülich and Professor of Experimental Physics at the Rheinisch-Westfälische Technische Hochschule (RWTH) Aachen. His research focuses on bioelectronic hybrid systems and in particular bioelectronic hybrid systems. Moreover, he contributes to neuronal signal processing in in vitro model systems and biosensors based on electronic DNA- and protein-chips. For development of new biological interfaces he investigates nano- and microstructures as well as supported lipid bilayers for surface modifications.

Title of the lecture

Nanoscale Tools to optimize the Neuro-electronic Interface

Understanding how a network of interconnected neurons is processing information in the human brain is one of the greatest challenges today [1]. Precise and long-lasting neuro-electronic hybrid systems are at the center of research and development in this field. Nowadays, the best approach to study the electrophysiological activity of neurons in vitro and in vivo is based on microstructured electrodes which can be integrated with microfluidic devices. However, the weak coupling between cell membrane and electrode surface is one of the major limiting factors and 3D nanostructures [2, 3, 4] are used to improve cell-chip coupling.

A systematic characterization of cell–electrode interaction and an understanding of the interaction of cells with the electronic sensors is of utmost importance as the recorded signals are generally only in the 100 µV range. In order to monitor in real-time the cell–metal interface and to measure in situ the gap distance of the cleft we employed surface plasmon resonance microscopy (SPRM) with the spatial resolution reaching to the optical diffraction limit [5, 6]. To allow a very detailed investigation of the neuro-electronic interface we developed an ultra-thin resin embedding method of individual neurons. To this end, we have performed focused ion beam cross-section cuts through the cell chip interface and subsequent imaging with scanning electron microscopy to determine the exact outline of the membrane deformation caused by the underlying nanoelectrode. Such membrane deformation measurements help to model better electric equivalent models of the seal resistances between the interface of cells and 3D nanoelectrodes.