HL 48 Symposium: Bio- and Neurotransistors

Zeit: Dienstag 10:45–13:15 Raum: TU P270

HL 48.1 Di 10:45 TU P270

Transistors with Ion Channels, Nerve Cells and Brain Tissue — •Peter Fromherz — Department of Membrane and Neurophysics, Max Planck Institute for Biochemistry, Martinsried, München

An overview is given on various aspects of transistor recording in neuronal systems using simple silicon chips and CMOS technology. On the biological side, the three levels of ion channels, nerve cells and brain tissue are considered. The geometry and electrical features of cell-chip contacts are analyzed with luminescent dyes taking advantage of fluorescence interference and of the Stark effect. The nature of signal transmission from ionic systems to the transistor is studied with recombinant sodium and potassium channels. On that basis, transistors are applied for various cellular systems: (i) Recombinant ligand-gated channels provide a basis for selective cell-based biosensors. (ii) Electrical excitation is recorded for individual nerve cells from snails and rats. (iii) The release of individual synaptic vesicles is detected. For brain tissue, dynamic electrical maps of neuronal activity are obtained at a resolution below 10 micrometer and 0.5 ms using large transistor arrays of a CMOS chip.

HL 48.2 Di 11:15 TU P270

Interfacing cells with microelectronics — •Günter Wrobel, Frank Sommerhage, Sven Ingebrandt, and Andreas Offenhäusser — Institute Thin Films and Interfaces (ISG-2), Forschungszentrum Jülich, 52425 Jülich, Germany

The interface between functional biological systems and inorganic materials is of central importance for the development of functional bioassays, biosensors and future information systems. Our efforts aim at developing neuroelectronic systems as well as complex sensors for biological and chemical diagnostics. In order to investigate the principles of the cell-transistor coupling genetically modified cells overexpressing voltage-gated ion-channels are used. In our experiments we have focussed on the time-dependence of the cell-transistor recordings. We examined the electrical coupling of HEK293 cells, which were stably transfected with voltage-gated potassium or chloride channels. Cells were cultured on n- and p-channel field-effect transistors to compare the influence of the device type on the signal shape. The signals of the active ion channels of the whole cell and those in the contact region on the transistor gate are examined using electrophysiological techniques.

HL 48.3 Di 11:45 TU P270

Detecting DNA Hybridization by a Microfabricated Field-effect Sensor — •Jürgen Fritz — MIT Media Laboratory, 20 Ames Street, Cambridge, MA 02139, USA. — present adress: International University Bremen, Campus Ring 1, 28759 Bremen, Germany

Detecting the presence and activity of biomolecules by electronic means is of growing interest due to its potential to simplify and miniaturize biosensors or medical devices. Label-free electronic detection of biomolecules with a microfabricated device offers the advantage of online-monitoring of biological samples and processes, and miniaturization and parallelization of sensors into arrays by using standard microfabrication techniques. One route to achieve electronic detection of biomolecules is to detect the intrinsic molecular charge of biomolecules by a field-effect device. Here we report on a microfabricated field-effect sensor which detects the binding of short DNA molecules to its sensor surface 1. We show functionalization strategies for such a sensor, and concentration dependence and specificity of the sensor signal. We summarize field-effect detection of biomolecules, show its promises, limits, and future applications.

HL 48.4 Di 12:15 TU P270

A BioFET on the basis of intact insect antennae — •M. J. Schöning[1,2], S. Schütz[3], H. E. Hummel[4], H. Lüth[2], and C.-D. Kohl[5] — [1]Fachhochschule Aachen (Abteilung Jülich), Labor für Chemo- und Biosensorik — [2]Forschungszentrum Jülich, ISG — [3]Universität Göttingen, Fakultät für Forstwissenschaften und Waldökologie — [4]Universität Giessen, Institut für Phytopathologie und Angewandte Zoologie — [5]Universität Giessen, Institut für Angewandte Physik

More than one million species of insects with sometimes extraordinary sensory abilities present a tremendous potential of highly optimised chemoreceptors. To make these abilities usable for analytical tools, some interface between chemoreceptive organs of insects and microelectronic components of analytical instruments has to be established. One promising possibility is the design of biosensors on the basis of intact chemoreceptors utilising electrophysiological techniques, like electroantennography (EAG). For natural analyte concentrations the EAG responses have a rise time of 50 ms and a time constant for decay of about 200 ms. In order to circumvent, major drawbacks of conventional EAG methods such as electrical and mechanical instability, the need for pre-amplification and the limited ability for miniaturisation, we designed a direct field effect transistor (FET)-insect antenna junction, representing the first BioFET on the basis of intact insect antennae. Two different set-ups will be presented the whole-beetle BioFET and the isolated-antenna BioFET. Considering that detection limits of analytes are typically in the ppb range or even lower, a biosensor on the basis of intact chemoreceptors could serve as an analytical device with unrivalled data acquisition time.

HL 48.5 Di 12:45 TU P270

Biosensor Applications of AlGaN/GaN Solution Gate Field Effect Transistors — •Georg Steinhoff, Barbara Baur, Martin Stutzmann, and Martin Eickhoff — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, D-85748 Garching

AlGaN surfaces are chemically inert in aqueous solutions and non-toxic to living cells. Covalent functionalization with self assembled monolayers (SAMs) of APTES for the immobilization of single stranded oligonucleotides and of ODTMS for the subsequent deposition of lipid monolayers is possible, allowing label-free detection of DNA hybridization or the detection of ligand binding to specific receptors in lipid monolayers on functionalized gates of solution gate AlGaN/GaN heterostructure field effect transistors. A different approach for the realization of biosensors is the cultivation of living cells directly on the gate area and the measurement of their ionic response to chemical or physical stimuli. We systematically studied the electronic characteristics of AlGaN/GaN FET arrays for the detection of electrical cell signals, such as low-frequency noise, transconductance and the sensitivity towards specific ions. Extracellular action potential recordings from a confluent layer of rat heart muscle cells cultivated directly on the non-metallized gate surface are discussed.