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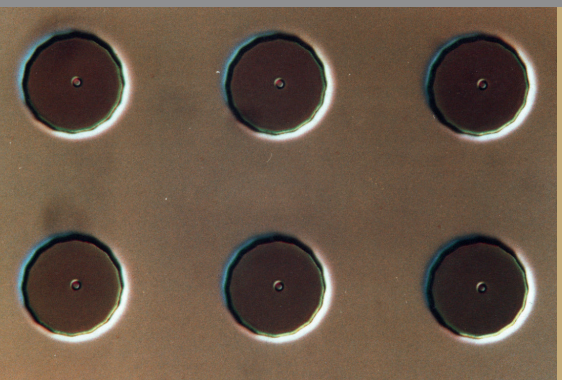
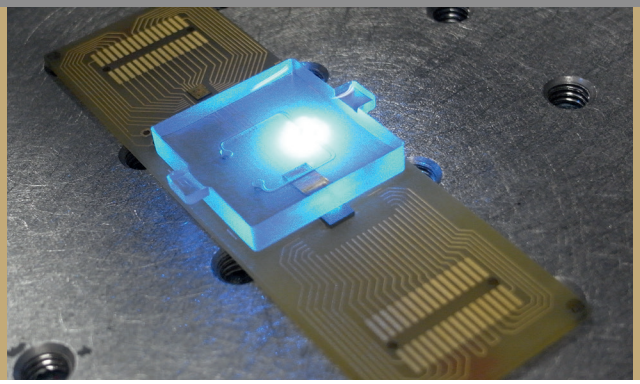
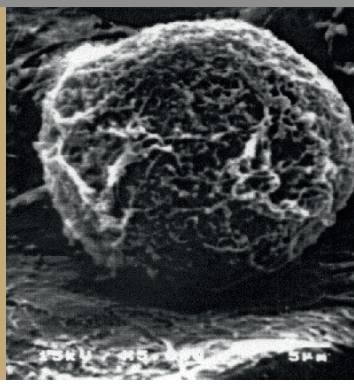
FRAUNHOFER INSTITUTE FOR MICROELECTRONIC CIRCUITS AND SYSTEMS IMS







1 *Ultra micro electrodes*
2 *Integrated microfluidic diagnostic system*
3 *Biohybrid interface*

INTEGRATED SOLUTIONS FOR BIOELECTRONIC SENSING

- LABEL-FREE DETECTION
- BIOELECTRONIC TRANSDUCERS
- MINIATURIZED SYSTEMS

Fraunhofer Institute for Microelectronic Circuits and Systems IMS

Finkenstr. 61
D - 47057 Duisburg
phone +49 203 37 83-0
fax +49 203 37 83-266
www.ims.fraunhofer.de

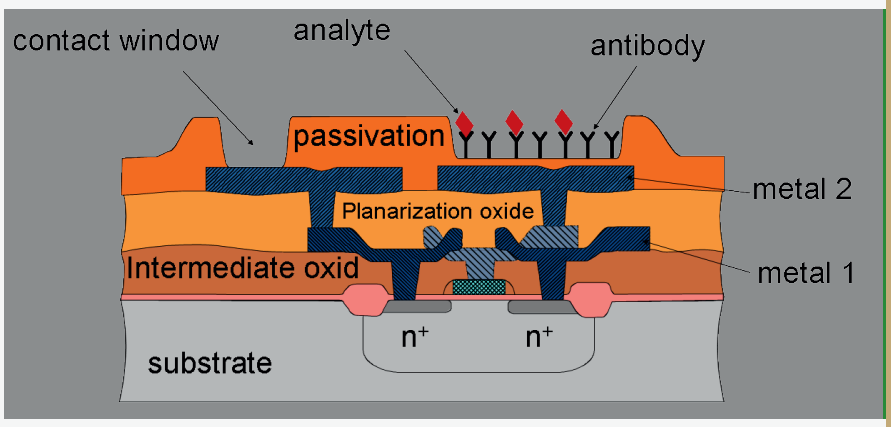
Contact
Michael Bollerott
phone +49 203 37 83-227
vertrieb@ims.fraunhofer.de

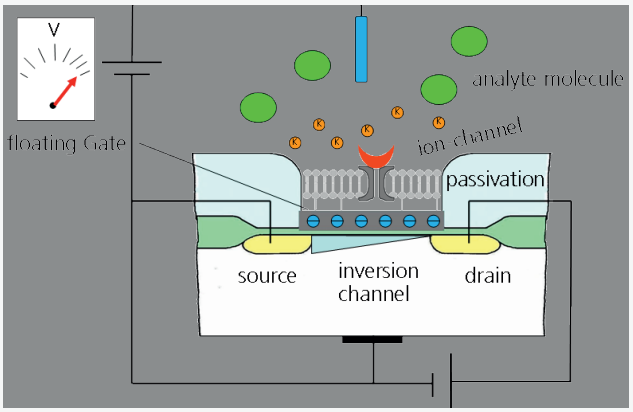
Introduction

For applications in medicine, life science, food- and environmental technology the detection of biological and biochemical parameters is of high interest. Immuno-assays are typically in use. Although a standard, this technique is associated with costly and labour-intensive washing steps and labelling with fluorescence markers, followed by optical readout, and still needs cumbersome detectors. New quick and cost-effective techniques for mobile operation at the point of interest are required. Fraunhofer IMS is elaborating new bioelectronic transducers for miniaturized label-free detection.

Biohybrid systems

In biohybrid systems electronic components are interfacing with biological compounds enabling the detection of biochemical parameters or the influence thereof. Bioelectronic sensors allow a direct label-free detection of analytes. Due to the small signals integrated on-chip electronics are crucial for a good signal-to-noise ratio. Based on CMOS technology two approaches using FET (field effect transistor) as bioelectronic transducers are developed at Fraunhofer IMS.





• seFET

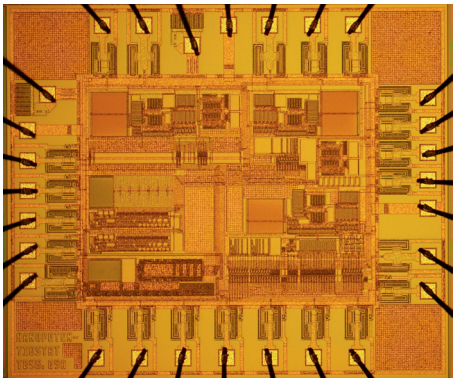
In one approach called seFETs an extended gate is modified, e.g. by the immobilization of antibodies, enhancing the specificity of the detection of charged analytes. The advantage of the extended gate is the independent choice of the modification area in size and material with respect to the operating point of the transistor.

• BioPROM

In a second approach called BioPROM the electronic structure is covered by a tethered bilayer lipid membrane (figure 5) making use of the gating effect of ion channels for the detection of changes in the charge concentration.

Single-chip potentiostat

Electrochemical sensors constitute another group of well-known bioelectronic sensing devices. For potential control typically bench-top sized potentiostats are used. For the purpose of mobile applications IMS has developed a single-chip potentiostat (figure 6). The device can be used in amperometric measurements, e.g. with enzyme electrodes, or in cyclo voltammetry.

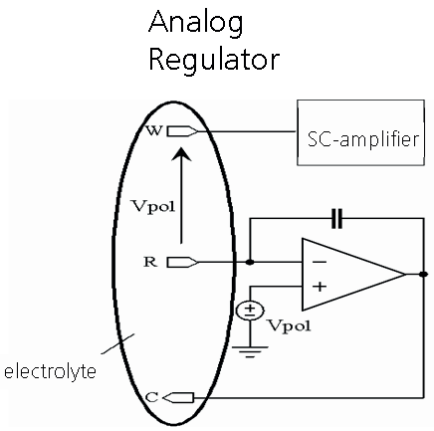


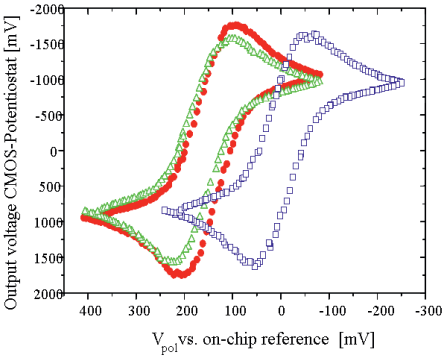
Further bioelectronic transducers

Apart from FET-based and amperometric transducers, IMS also provides solutions for potentiometric and conductometric measurements. Furthermore, mass sensitive detection can be offered using IMS surface micromachined resonating diaphragm technology.

IMS services

Combining the know-how for mixed signal circuit design, sensor technology and system design, IMS offers customized system solutions. Our services cover the full range from concept, feasibility study to first sample development and prototyping, up to pre-series and series production of the sensor ASICs. A modern 1300 m² 8'' fab, working at four shifts, ensures the production of the ASICs. A 600 m² class 10 clean room dedicated to MEMS technology provides high variability in the development of integrated bioelectronic sensing systems.





4 *Specificity enhanced FET (seFET)*

5 *Sensor with tethered bilayer lipid membrane (BioPROM)*

6 *Single-chip potentiostat*

7 *Electrodes connected to potentiostat*

8 *Voltage response of single-chip potentiostat*