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# Use of SPICE for Modeling Silicon-Based Chemical Sensors

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For almost every present-day device, silicon technology is one of the most promising for sensor development. Moreover, powerful simulation tools are available which, originally introduced for designing electronic circuits, can be adapted to the design of silicon-based sensors. These considerations are embodied in the description of the modifications made by us in the program SPICE for simulating chemically sensitive field effect transistors. Initially, a detailed analysis of the basic $H^+$-sensitive insulator-semiconductor structure is given. Subsequently, this scheme is applied to model $H^+$-sensitive FETs and the functional coupling of biological membranes to such devices.

## 1. Introduction

Any natural or artificial system communicates with its surrounding environment through sensors. Design and production of sensors cover a broad range of applications, including car controls, human health, environmental monitoring, food industry, and many others.

For almost every present-day device, silicon technology is one of the most promising for sensor development. Silicon technology offers the key advantage of integration, i.e., the opportunity to integrate several different sensors and the related circuitry for signal amplification and processing on the same chip. Moreover, powerful simulation tools are available which, originally introduced for designing electronic circuits, can be adapted to the design of silicon-based sensors.

This point will be considered extensively in the following, with reference to the modifications made in the program SPICE[1] for the simulation of chemically sensitive field effect transistors (CHEMFETs) and biosensors (BIOFETs).