MicroNano Systems
BTU Cottbus

Faculty 1
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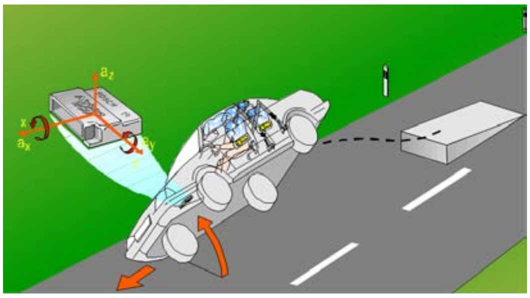
Micro Systems

Modul 13019 (Lecture and Excerise)

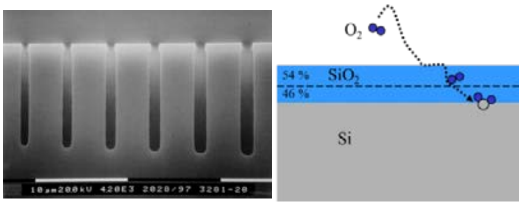
How many **microsensors** are actually in a smartphone, how do they work and how are they manufactured? The lecture provides detailed answers to these questions.

Microsystems technology developed from microelectronics more than 30 years ago. Starting in 1970, the first integrated silicon-based pressure sensors were introduced, which were based on the piezoresistive effect, as is still widely used today. The possibility of extending the purely electronic functionality of a circuit in such a way that the component acquires sensory capabilities and, in addition, can actively influence its environment, had triggered enormous activity in research and development in the following years, which is still growing steadily today. The spread of MEMS (micro-electro-mechanical system) devices is enormous. They are not only in every smartphone, but just as much in every automobile, in every fitness tracker and they represent the sensory organs of digitalization e.g. in Industry 4.0 applications.



MEMS gyroscope for measuring rotation rates using the example of a motor vehicle

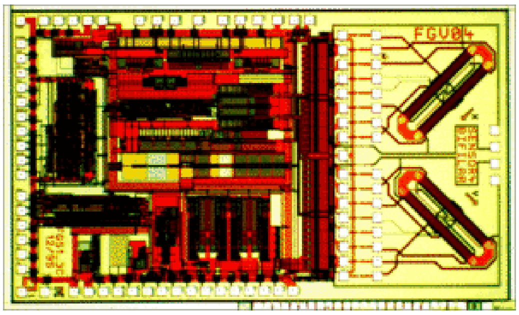
In the first part, the lecture deals with the silicon technology-based processes and their properties for the production of microsystem components. Based on a complete substrate processing flow, all important processes are presented and discussed. These include **layer generation** (e.g., oxidation, chemical vapor deposition, atomic layer deposition), optical lithography processes for pattern transfer, and the most common **patterning processes** (isotropic and anisotropic wet chemical and dry processes, especially deep reactive ion etching). Discussion of selected complex technology processes completes the understanding.



Left: Deep reactive ion etching. Production of vertical openings in the Si substrate. Right: Model for diffusion-limited growth during thermal oxidation.

The **second part** covers the **physical principles** of action on which microsensors and actuators are based. Specific micrometer-scale properties of e.g. piezoelectric, piezoresistive, electrostatic and electromagnetic effects are compared.

The **third part** gives a brief overview of **common tools** for the simulation of complex structures. The **fourth part** deals with the **principles and physical characteristics of complex sensors and actuators**. Here, the understanding of e.g. acceleration sensors, gyroscopes and magnetic field sensors is deepened under consideration of signal readout and noise.



Integrated 2D magnetic field sensor based on the Flux-gate principle

In the Exercises, what has been learned is applied to solve concrete tasks.