

# Preface

This volume addresses several fundamental gas sensing concepts which have gained increased interest during the last years. Various basic sensor principles, including micro-gravimetric sensors, semiconducting and nanotube sensors, calorimetric sensors and optical sensors, are covered. Also recent developments on the related sensitive layers are discussed. These include new properties due to nanostructuring in well-known metal oxide layers, an in-depth insight into the interesting chemistry and signal generation of copper oxide in percolating sensors as well as a variety of applications of functional polymers possible due to proper imprinting.

Many of the recent developments are driven by current application requirements. Extension to higher operating temperatures necessitates new material developments and it may be no surprise that also a new sensor mechanism (for  $\text{In}_2\text{O}_3$ ) became evident as a side-product. A workgroup of the DGM (German Material Science Association) focuses on high temperature sensor physics and chemistry.

But also in the low temperature regime stability is an important issue. There are new approaches to improve signal reproducibility. On the material side carbon nanotubes allow for cheap and reliable sensors for integrated devices which will benefit from the highly stable nature of the carbon nanotubes. Potential applications cover the field of environmental monitoring, healthcare, or integrated devices. However, for rough industrial surroundings oxide-based sensors are more promising. Mimicking insect olfactory systems utilizing semiconducting sensors combines the “evolutionary experience” with the reliability and long-term ruggedness of the technical system. Another approach introduces optical readout technique of space charge for inorganic and organic semiconductor sensor to avoid electrical contacts to the sensing material. Such devices are currently (2014) under development within a project funded by the European Union. They also open prospects to sensors for chemically aggressive environments without contact corrosion problems.

On the system side the concept of virtual multisensors has proven to be advantageous. This general concept, which in principle is not limited to semiconductor sensors, is based on the adjustment of several optimized operating conditions which

are applied sequentially to only one physical sensing element. The so generated virtual sensing elements combined with refined data algorithms meet the necessary specificity and selectivity for reliable hazard detection.

There is also the necessity to pick the proper transducer technique. Calorimetric sensors offer a versatile transducer concept not only for sensing of explosives, but also in biology and medical applications. Even the concept of imprinted layers can be transferred to them. However, a lot of boundary conditions apply to implement them into a process, e.g. in biology, medicine, or food industry. A contribution deals with a common problem of such applications, to provide an aseptic surrounding.

The concept of percolation is most of us known from current transport in very thin metal films. There exists a characteristic dose (deposition rate multiplied by the time span) and then a sudden irreversible steep conductance increase occurs. This concept has been successfully transferred to chemically reactive gas sensor layers able to act as dosimeters. By cyclic operation those layers can also be used for quasi-continuous monitoring.

For many larger molecules with low vapor pressure and correspondingly stronger tendency to enrich on surfaces with geometrically and chemically optimized surface sites the concept of imprinted layers realized on bulk and surface acoustic wave substrates is a flexible technique. Marked progress has been made in specificity and sensitivity of single sensor systems as well as in sensor arrays.

So we hope that you will be inspired by this book to new thoughts in your own work and the editors like to thank all authors of this volume for their engagement and the quality of their contributions.

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