

传感材料与传感技术丛书

Sensing Material and Sensing Technology Series

# 化学传感器：传感材料基础

第 5 册

## 聚合物与其他材料的特性及应用

CHEMICAL SENSORS:

FUNDAMENTALS OF SENSING MATERIALS

The Characteristics and Applications of Polymers and Other Materials

Ghenadii Korotcenkov 主编

影印版

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哈尔滨工业大学出版社  
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Ghenadii Korotcenkov

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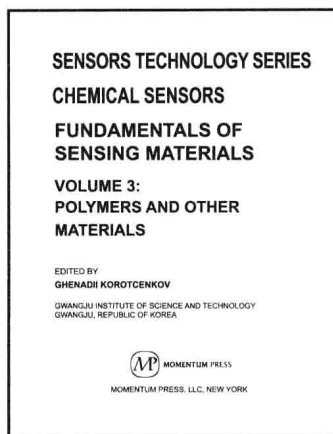
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# **PREFACE TO CHEMICAL SENSORS: FUNDAMENTALS OF SENSING MATERIALS**

Sensing materials play a key role in the successful implementation of chemical and biological sensors. The multidimensional nature of the interactions between function and composition, preparation method, and end-use conditions of sensing materials often makes their rational design for real-world applications very challenging.

The world of sensing materials is very broad. Practically all well-known materials could be used for the elaboration of chemical sensors. Therefore, in this series we have tried to include the widest possible number of materials for these purposes and to evaluate their real advantages and shortcomings. Our main idea was to create a really useful “encyclopedia” or handbook of chemical sensing materials, which could combine in compact editions the basic principles of chemical sensing, the main properties of sensing materials, the particulars of their synthesis and deposition, and their present or potential applications in chemical sensors. Thus, most of the materials used in chemical sensors are considered in the various chapters of these volumes.

It is necessary to note that, notwithstanding the wide interest and use of chemical sensors, at the time the idea to develop these volumes was conceived, there was no recent comprehensive review or any general summing up of the fundamentals of sensing materials. The majority of books published in the field of chemical sensors were dedicated mainly to analysis of particular types of devices. This three-volume review series is therefore timely.

This series, *Chemical Sensors: Fundamentals of Sensing Materials*, offers the most recent advances in all key aspects of development and applications of various materials for design of chemical sensors. Regarding the division of this series into three parts, our choice was to devote the first volume to the fundamentals of chemical sensing materials and processes and to devote the second and third volumes to properties and applications of individual types of sensing materials. This explains why, in *Volume 1: General Approaches*, we provide a brief description of chemical sensors, and then detailed discussion of desired properties for sensing materials, followed by chapters devoted to methods of synthesis, deposition, and modification of sensing materials. The first volume also provides general background information about processes that participate in chemical sensing. Thus the aim of this volume, although not exhaustive, is to provide basic knowledge about sensing materials, technologies used for their preparation, and then a general overview of their application in the development of chemical sensors.

Considering the importance of nanostructured materials for further development of chemical sensors, we have selected and collected information about those materials in *Volume 2: Nanostructured Materials*. In this volume, materials such as one-dimension metal oxide nanostructures, carbon nanotubes, fullerenes, metal nanoparticles, and nanoclusters are considered. Nanocomposites, porous semiconductors, ordered mesoporous materials, and zeolites also are among materials of this type.

*Volume 3: Polymers and Other Materials*, is a compilation of review chapters detailing applications of chemical sensor materials such as polymers, calixarenes, biological and biomimetic systems, novel semiconductor materials, and ionic conductors. Chemical sensors based on these materials comprise a large part of the chemical sensors market.

Of course, not all materials are covered equally. In many cases, the level of detailed elaboration was determined by their significance and interest shown in that class of materials for chemical sensor design.

While the title of this series suggests that the work is aimed mainly at materials scientists, this is not so. Many of those who should find this book useful will be “chemists,” “physicists,” or “engineers” who are dealing with chemical sensors, analytical chemistry, metal oxides, polymers, and other materials and devices. In fact, some readers may have only a superficial background in chemistry and physics. These volumes are addressed to the rapidly growing number of active practitioners and those who are interested in starting research in the field of materials for chemical sensors and biosensors, directors of industrial and government research centers, laboratory supervisors and managers, students and lecturers.

We believe that this series will be of interest to readers because of its several innovative aspects. First, it provides a detailed description and analysis of strategies for setting up successful processes for screening sensing materials for chemical sensors. Second, it summarizes the advances and the remaining challenges, and then goes on to suggest opportunities for research on chemical sensors based on polymeric, inorganic, and biological sensing materials. Third, it provides insight into how to improve the efficiency of chemical sensing through optimization of sensing material parameters, including composition, structure, electrophysical, chemical, electronic, and catalytic properties.

We express our gratitude to the contributing authors for their efforts in preparing their chapters. We also express our gratitude to Momentum Press for giving us the opportunity to publish this series. We especially thank Joel Stein at Momentum Press for his patience during the development of this project and for encouraging us during the various stages of preparation.

Ghenadii Korotcenkov

# **PREFACE TO VOLUME 3: *POLYMERS AND OTHER MATERIALS***

This volume covers a variety of topics in the rapidly developing field of chemical sensors. The purpose of this volume is to explain and illustrate the use of multifunctional materials such as polymers, calixarenes, ion conductors, biological systems, and novel semiconductors in chemical sensors. These materials differ fundamentally from standard metal oxides and metals, so their application provides opportunities to design sensors based on entirely different mechanisms of sensing. As a result, new trends in the elaboration of sensors with different functional attributes and for building instruments with previously unavailable capabilities demanded by new applications have opened up. Therefore, this book is intended to be a primary source for both fundamental and practical information related to these multifunctional materials, which will be necessary for future development.

This volume comprises seven chapters written by active researchers who are well-known experts in their fields and who have made significant contributions to the field over the past several years. Thus, this book presents the most recent advances in all the key aspects of development and application of polymers and other multifunctional materials for chemical and biological analysis. The chapters in this book have been written to give the reader the “big picture,” from the design phase to implementation of chemical sensors of various types. Every chapter addresses the particulars of multifunctional materials synthesis and characterization. In every chapter you will also find descriptions of a very wide range of devices that may be designed using such multifunctional materials. These chapters thus highlight the materials, the physics, the devices, and even key fabrication issues. We hope that the information presented in this volume will help the reader understand the details of sensing material design for specific applications and establish quantitative structure–function relationships.

The intended audience is scientists, researchers, and engineers in industries and research laboratories. With its many references to the vast resources of recently published literature on the subject, this book serves as a significant and insightful source of valuable information pertaining to the ongoing scientific debates, the current state of understanding, and future directions. Students will also find the book to be very useful in their research and understanding of chemical sensors and multifunctional materials. The structure of this book offers a basis for a high-throughput instrumentation course at the advanced undergraduate or graduate level. As such, it should be very useful to university post-docs and professors as well.

Ghenadii Korotcenkov

## ABOUT THE EDITOR

***Ghenadii Korotcenkov*** received his Ph.D. in Physics and Technology of Semiconductor Materials and Devices in 1976, and his Habilitate Degree (Dr.Sci.) in Physics and Mathematics of Semiconductors and Dielectrics in 1990. For a long time he was a leader of the scientific Gas Sensor Group and manager of various national and international scientific and engineering projects carried out in the Laboratory of Micro- and Optoelectronics, Technical University of Moldova. Currently, he is a research professor at Gwangju Institute of Science and Technology, Gwangju, Republic of Korea.

Specialists from the former Soviet Union know G. Korotcenkov's research results in the study of Schottky barriers, MOS structures, native oxides, and photoreceivers based on Group III–V compounds very well. His current research interests include materials science and surface science, focused on metal oxides and solid-state gas sensor design. He is the author of five books and special publications, nine invited review papers, several book chapters, and more than 180 peer-reviewed articles. He holds 16 patents. He has presented more than 200 reports at national and international conferences. His articles are cited more than 150 times per year. His research activities have been honored by the Award of the Supreme Council of Science and Advanced Technology of the Republic of Moldova (2004), The Prize of the Presidents of Academies of Sciences of Ukraine, Belarus and Moldova (2003), the Senior Research Excellence Award of Technical University of Moldova (2001, 2003, 2005), a Fellowship from the International Research Exchange Board (1998), and the National Youth Prize of the Republic of Moldova (1980), among others.



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