

# 6

## Membrane Background

In this chapter we discuss membrane properties in relation to their use in ion-sensitive electrodes. Membranes are of great importance in almost all types of sensors but specifically in biosensors where a greater variety of membranes exist. Membranes are used both as filters and as sensors. When used as a filter, the membrane is chosen to be selective to (permeable to) a specific species, which is then detected, for example, by electrochemical means. When used as a sensor, the potential is often measured which develops across the membrane/electrolyte interface (or membrane/gas interface; see Chapter 2) by the equilibration of the species to be detected interacting with a mobile or immobile entity (a site) within the membrane. These two roles for membranes often are both present in the same sensing device.

Chapter 6 begins with the description of a series of fundamental characteristics of a membrane cell (Section 6.1). The origin of the potential across a membrane that separates two compartments—one with a known concentration of the ion to be detected (reference side), the other with an unknown amount of the same ion (analyte)—is described first. This potential varies typically with the Nernstian “log concentration” or “log activity” law. A measure of the potential, in principle, yields the concentration of the ion in the analyte. The same Nernst law was derived earlier in Chapter 2, which emphasized solid electrolyte gas sensors. Here the emphasis is on membranes in solution.

The description of the contact between two different electrolyte solutions, called a *liquid junction*, will be described next. Liquid junctions are almost always part of the external reference electrode in a membrane cell.

# Chemical Sensing With Solid State Devices

**John C. Carrano, Artūras Žukauskas**



## **Chemical Sensing With Solid State Devices:**

*Chemical Sensing with Solid State Devices* Marc J. Madou, S. Roy Morrison, 1989-04-28 This book is a lucid presentation for chemists electrical engineers surface scientists and solid state physicists of the fundamentals underlying the construction of simple and small chemical sensors The first part of the book is a review of the theoretical background in solid state physics chemistry and electronics Semiconductor and solid electrolyte bulk models are reviewed as well as solid gas and solid liquid interface models Membranes and catalysis theory are also covered expansively The second part is a discussion of more complete sensor devices their essential components and of the important developments in this area over the last fifteen to twenty years The book provides guidance through the multidisciplinary world of chemical sensors It should be understandable to students with some training in physics and chemistry and a general knowledge of electronics Finally comments on economic considerations in the development of new sensor products and suggestions for future research and development should be of value to company R D planners

*Chemical Sensing with Solid State Devices* Marc J. Madou, S. Roy Morrison, 2012-12-02 This book is a lucid presentation for chemists electrical engineers surface scientists and solid state physicists of the fundamentals underlying the construction of simple and small chemical sensors The first part of the book is a review of the theoretical background in solid state physics chemistry and electronics Semiconductor and solid electrolyte bulk models are reviewed as well as solid gas and solid liquid interface models Membranes and catalysis theory are also covered expansively The second part is a discussion of more complete sensor devices their essential components and of the important developments in this area over the last fifteen to twenty years The book provides guidance through the multidisciplinary world of chemical sensors It should be understandable to students with some training in physics and chemistry and a general knowledge of electronics Finally comments on economic considerations in the development of new sensor products and suggestions for future research and development should be of value to company R D planners

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Solid State Chemical Sensors reviews the basic chemical and physical principles involved in the construction and operation of solid state sensors A major portion of the book is devoted to explanation of the basic mechanism of operation and the many actual and potential applications of field effect transistors for gas and solution sensing This text is comprised of four chapters the first of which describes the basics of device fabrication Emphasis is placed on the physical description of semiconductor devices with catalytic metal gates along with their drawbacks and their promise The behavior of hydrogen in the Pd SiO<sub>2</sub> system is also considered and some applications of hydrogen sensitive transistors such as smoke detection and biochemical reaction monitoring are described The second chapter focuses on chemically sensitive field effect transistors and their thermodynamics while the third chapter explains the general fabrication procedure for solid state chemical sensors The final chapter introduces the reader to piezoelectric and pyroelectric chemical sensors paying particular attention to the sensor nature of piezoelectricity the piezoelectric gravimetric sensor and pyroelectric gas analysis This book is intended to assist electrical engineers in understanding the chemistry involved in the construction and operation of solid state sensors and to educate chemists in solid state science **Design and Operation of Chemical Sensing Films for a Microfabricated Sensor from Platinum Titanium Bilayers** Michael DiBattista, 1999 **Chemical Sensing Using Semiconductor Luminescence** Anne-Marie L. Nickel, 2002 Solid State Chemical Sensors Jiří Janata, Robert J. Huber, 1985 Multifunctional (NO<sub>x</sub>/CO/O<sub>2</sub>) Solid-state Sensors for Coal Combustion Control Eric D. Wachsman, 2005

Sensing properties of a La<sub>2</sub>CuO<sub>4</sub> and WO<sub>3</sub> based potentiometric NO<sub>x</sub> sensor were investigated both in N<sub>2</sub> and in a simulated

exhaust gas We performed temperature programmed reaction TPR and desorption TPD experiments to determine the reaction and adsorption characteristics of O<sub>2</sub> NO<sub>x</sub> CO CO<sub>2</sub> and their mixtures on the electrodes and related the results to sensor performance

**Solid-State Sensors** Ambarish Paul, Mitradip Bhattacharjee, Ravinder Dahiya, 2023-10-24 Solid State Sensors A thorough and up to date introduction to solid state sensors materials fabrication processes and applications Solid State Sensors provides a comprehensive introduction to the field covering fundamental principles underlying theories sensor materials fabrication technologies current and possible future applications and more Presented in a clear and accessible format this reader friendly textbook describes the fundamentals and classification of all major types of solid state sensors including piezoresistive capacitive thermometric optical bio chemical magnetic and acoustic based sensors Throughout the text the authors offer insight into how different solid state methods complement each other as well as their respective advantages and disadvantages in relation to specific devices and a variety of state of the art applications Detailed yet concise chapters include numerous visual illustrations and comparative tables of different subtypes of sensors for a given application With in depth discussion of recent developments current research and key challenges in the field of solid state sensors this volume Describes solid state sensing parameters and their importance in sensor characterization Explores possible future applications and breakthroughs in associated fields of research Covers the fundamental principles and relevant equations of sensing phenomena Discusses promising smart materials that have the potential for sensing applications Includes an overview of the history classification and terminology of sensors With well balanced coverage of the fundamentals of sensor design current and emerging applications and the most recent research developments in the field Solid State Sensors is an excellent textbook for advanced students and professionals in disciplines such as Electrical and Electronics Engineering Physics Chemistry and Biomedical Engineering

*Principles of Chemical and Biological Sensors* Dermot Diamond, 1998-07-16 Ion selective electrodes and optodes Biomaterials for biosensors Optical chemical sensors Miniaturized chemical sensors Sensor signal processing

*Sensors, Chemical and Biochemical Sensors* Wolfgang Göpel, T. A. Jones, Michel Kleitz, Ingemar Lundström, Tetsuro Seiyama, 1997-07-14 Sensors is the first self contained series to deal with the whole area of sensors It describes general aspects technical and physical fundamentals construction function applications and developments of the various types of sensors This is the first of two volumes focusing on chemical and biochemical sensors providing definitions typical examples of chemical and biochemical sensors and historical remarks It describes chemical sensor technologies and interdisciplinary tasks in the design of chemical sensors The major part consists of a description of basic sensors They include electrolyte sensors solid electrolyte sensors electronic conductivity and capacitance sensors field effect sensors calorimetric sensors optochemical sensors and mass sensitive sensors This volume is an indispensable reference work for both specialists and newcomers researchers and developers

**Chemical and Biological Sensors** Marc J. Madou, Jose P. Joseph, 1991

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**Sensors** Ronald E. Shaffer, Radislav A. Potyrailo, 1999 This work brings together a selection of papers dealing with various aspects of internal standardization and calibration architectures for chemical sensors Chemical and Biological Point Sensors for Homeland Defense, 2003

**Chemical and Biological Microsensors** Jacques Fouletier, Pierre Fabry, 2010-01-26 This book reviews the state of art in the field of chemical sensors for analyses of ionic or molecular species dissolved in liquid media mainly in aqueous solutions The transduction of such devices is based on chemical biological and physical phenomena The fundamental phenomena involved in these sensors are described in the different chapters by specialists having a good expertise in the field Numerous recent bibliographic references are given Most of the devices could be miniaturised using modern technologies allowing a fabrication on a large scale for a mass production at low cost Moreover such devices could open the field of applications in a near future environmental biomedical food industries domestic and automotive applications etc

*Quantitative Chemical Analysis* Daniel C. Harris, 2010-04-30 The most widely used analytical chemistry textbook in the world Dan Harris's *Quantitative Chemical Analysis* provides a sound physical understanding of the principles of analytical chemistry showing how these principles are applied in chemistry and related disciplines especially in life sciences and environmental science As always the new edition incorporates real data spreadsheets and a wealth of applications in a witty personable presentation that engages students without compromising the depth necessary for a thorough and practical understanding of analytical chemistry *1987 Abstracts*, 1987

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*Biosensors and Chemical Sensors* Peter G. Edelman, American Chemical Society. Division of Polymeric Materials: Science and Engineering, 1992 Provides in depth coverage of advances in polymeric materials used for designing biosensors and chemical sensors including permselective membranes and immobilization for enzyme systems electropolymerized thin films polymer membranes on planar substrates and hydration dependent polymer applications Covers fundamental aspects relevant to the design and fabrication of biosensors and offers unique insights into materials used for their fabrication Offers an interdisciplinary approach toward correlating material properties with biosensor and chemical sensor response to optimize sensor performance Also includes an overview chapter by Elizabeth Hall

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