

# ***Principles of Chemical Sensors***

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# ***Principles of Chemical Sensors***

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**To the memory of my teachers**

*Do not learn the tricks of  
the trade, learn the trade*

Inscription on a tea bag

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## ***Preface***

It is sometimes difficult to appreciate the impact of events taking place in the period of time within which we live and work. Perhaps one day people will look back in awe at the second half of this century and marvel at the extent of the computer revolution which took place at that time. Whether we like it or not, we are all very much a part of it, regardless of our specialization. The sheer amount of data-processing capacity which exists now and is growing out of all proportion creates a need for new information from every possible, and sometimes impossible, source. The purpose of a sensor is to provide information about our physical, chemical, and biological environment. In that respect it is a logical element in the information acquisition-processing chain.

The field of chemical sensors is one of the most diverse I have ever encountered, owing to the nature of the environment sensed and the different types of processes involved. This creates obvious problems in writing a textbook on the subject. If one invites coauthors the final result should be profound in every aspect covered, but it is rarely presented evenly. In preparing a single-author textbook, the writer inevitably covers subjects which lie outside his area of expertise and can only provide his own interpretations. I hope that the resulting number of serious errors will be minimal. The second approach has been selected mainly for two reasons. In the last few years I have been teaching courses on chemical sensors at various levels. To convert lecture notes to a textbook is seemingly natural, particularly in the absence of other suitable texts in the area. The second reason is more fundamental. It is possible to engineer a new sensor in such a way that its output is related to the concentration for a given set of conditions without paying too much attention to the mechanism of the processes involved. The result is a device which may perform well within the conditions for which it has been developed, but *only* for those conditions.

The danger is that the result so obtained may be an experimental artifact. Another approach is to examine in as much detail as possible the principles underlying the operation of a new device. This may not lead to a new sensor immediately, but those developed along these lines tend to be more reliable. The accent in this book is therefore on the principles behind the operation (“the trade”) rather than on a description of applications (“the tricks of the trade”) of individual sensors. In this respect it is written for students at both graduate and upper undergraduate levels. Approximately one semester’s worth of material is presented. The book may also be useful for scientists and engineers involved in the development of new types of chemical sensors or for those who discover that “somebody else’s sensor just does not work as it should” and wish to know why.

The book is divided into five sections dealing with the four principal modes of transduction: thermal, mass, electrochemical, and optical, as well as a general introduction common to the four types. I have included five appendixes, which are intended as a quick reference for readers who may not possess sufficient background in some areas covered in the main text. I have run out of symbols in both the Latin and Greek alphabets. In order to avoid confusion and ambiguity I have confined the use of a set of symbols to each chapter and provided glossaries at the end of each chapter.

Finally, I wish to thank all my students and collaborators at the University of Utah from whom I have learned this trade, and also, in particular, my secretary of many years, Mrs. LaRue Dignan. I furthermore thank my colleagues and friends at the Universität der Bundeswehr München who provided the environment in which most of this book was written.

Jiří Janata

*Salt Lake City and Munich*

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