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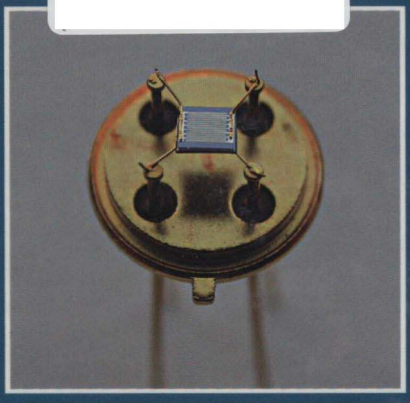

Nanosensors for Chemical and Biological Applications

Sensing with Nanotubes, Nanowires and Nanoparticles

Edited by Kevin C. Honeychurch

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Introduction

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Nano-sized materials have been shown to have a number of novel and interesting physical and chemical properties. These can have marked differences from those of the bulk material, offering the possibility of new applications and improved performance. This book comprises a set of in-depth monographs which seek to provide an overview of some of the important and recent developments brought about by the application of nanotechnology for both chemical and biological sensor development. Up-to-date information on the fabrication, properties and operating mechanisms of these sensors is given. Progress in the field, fundamental issues and challenges facing researchers, and prospects for future development are discussed. The book will be of interest to those with a general interest in the area, researchers actively engaged in one or more of the areas covered, and research students who are just entering into the field. It is hoped that the book will also provide insights into the direction of future developments.

The book is organised into two sections: firstly the electrochemical and secondly the spectrographic application of nanosensors technology. Chapter 1 describes the synthesis of both single-wall and multi-wall carbon nanotubes and their application in electrochemical biosensor systems. The second chapter continues this theme, concentrating on the application of nanotechnology for the electrochemical glucose biosensor. The chapter discusses how nano-sized materials have been incorporated into conventional enzymatic and non-enzymatic electrochemical glucose sensors, and the construction of complete sensors on the micro/nanometre scale. Chapter 3 examines some of the analytical advantages that metal nanoparticles provide for stripping voltammetric electroanalysis, discussing several analytical applications of the technology. A great deal of interest has focused on exploring the biochemistry of living cells, and Chapter 4 reports on the development and application of nano-sized electrochemical sensors capable of interfacing directly with living cells. This chapter shows that such an approach can allow for previously unattainable insights into intracellular and extracellular purposes to be monitored. Chapter 5 reviews the determination of

gases with low dimensional and semi-conductive nanoparticle-based metal oxide chemiresistor-based sensors. The fundamentals of these sensors are explored with descriptions of techniques typically adopted for their preparation. New research trends, and low cost and alternative substrates are also discussed. In Chapters 6 and 7 the possibility of integrating nanotechnology and polymer science is investigated. In the first of these chapters, electropolymerised molecularly imprinted polymers are investigated as biomimetic sensors. The integration of nanomaterials into the sensing layer of these devices is reported to have a number of advantages, such as increased surface area, mass transport and conductivity allowing for the electrochemical preparation of catalytically active molecularly imprinted polymers. Chapter 7 discusses the available methods for fabricating conducting polymer nanomaterials, and looks at their application to electrochemical sensing and biosensing of a range of different analytes.

In the second section, developments of nanotechnology for spectrographic-based sensors are discussed. In the first chapter in this section, Chapter 8, nanoparticle-based sensors utilising the enhancement of spontaneous Raman scattering are described. The following chapter describes the application of coated gold nanoparticles for creating high performance chemiresistive sensors. The chapter reviews their use, synthesis, and the choice of coating material, and gives a review of present applications. Chapter 10 explores both the theory and practical possibilities of enzyme encapsulation into the pores of nanoporous silicon material as an effective method for obtaining enzymatic biosensors. The chapter then illustrates the application of this approach for the determination of formaldehyde. The penultimate chapter explores the application of quantum dots for the development of sensors and biosensors based on Förster fluorescence resonance energy transfer detection of proteins and enzymatic activities and nucleic acids. In the final chapter, the environmental fate, behaviour, disposition and toxicity of nanoparticles are discussed. An overview of the present analytical methods and sample preparation used for their determination is given.

I would like to thank all the authors who have contributed to the successful completion of this book and the very high standard of the contributions made, as well as for their dedication, professionalism and the friendly manner in which all this has been achieved. I would also like to thank all the staff at Woodhead for their helpful assistance throughout the development of this project.

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