

Preface

Anyone with the most cursory knowledge of sensors must have had a chance to use such devices at some point in their life or career. Whether to collect data in a lab course, to automate an otherwise tedious process, to improve the efficiency of a delicately tuned process, or to do something as mundane as taking a family picture, sensors have become an integral part of our environment and our daily lives. Charge-coupled devices also known as CCD photodetector arrays, for example, have revolutionized photography, astronomy, spectroscopy, X-ray diffraction, and medical imaging to name but a few. A number of scientific discoveries have been enabled by CCDs including the possibility to determine molecular and lattice structures at intermediate stages of a chemical synthesis or a structural transformation. At the core of the widespread adoption of sensors are their rapidly decreasing footprint and cost and increased functionality. The miniaturization of solid-state devices in general and sensors in particular was made possible thanks to significant transformations and a large number of incremental and disruptive inventions in the area of thin-film and nanostructure science and fabrication technologies.

Thin films and nanostructures can play multiple roles in a sensor including structural support, reliability enhancement, filtering, and transduction. Thin films and nanostructures are called functional when they fulfill a function other than structural support. These micro- and nanostructured materials have applications that extend far beyond sensing to data storage, lighting, displays, hydrophobic coatings, decoration, and a large number of other fields that are outside the scope of this book. In this book, these materials are discussed in the context of transduction and how they contributed to the current sensor revolution.

Sensor design and fabrication are multidisciplinary and require broad and deep knowledge in diverse areas of science and engineering such as materials science, physics, chemistry, biology, and mechanical and electrical engineering. Covering a subject with so many roots in diverse scientific and engineering disciplines is undoubtedly a daunting task and any author who attempts it will do so with significant trepidation. Aware of the challenge at hand, the editors of this book attempted, ambitiously, to cover in one volume an account of general sensor theory, design considerations related to the use of functional thin films and nanostructures, and specific case studies of functional thin films and nanostructure applications in sensing. Part of our motivation in taking on this task is that no such work, to our

knowledge, has been published. Having said this, we are strongly familiar with the large body of publications in this area that we refer to in this book and we are keenly indebted to the works of many authors in putting this book together.

This book is devoted to teaching the new sensor designer the key steps involved in developing sound transducer technology from materials selection, to design for performance, to process development, and finally to integration. Throughout the chapters, the authors emphasize and highlight the important role played by functional thin films in solving problems and discuss how to take advantage of such materials to build superior devices. The book is also intended to provide the more experienced designers with a condensed summary of sensor design methodology and excellent references that will prove useful in future sensor design endeavors. To put all of the shared design and fabrication knowledge into perspective and add a touch of reality to the concepts discussed in Chapters 1 through 4, Chapters 5 through 8 are completely dedicated to putting the theory into practice and demonstrating the whole design process using a number of concrete applications.

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Synthesis, Physics and Applications

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