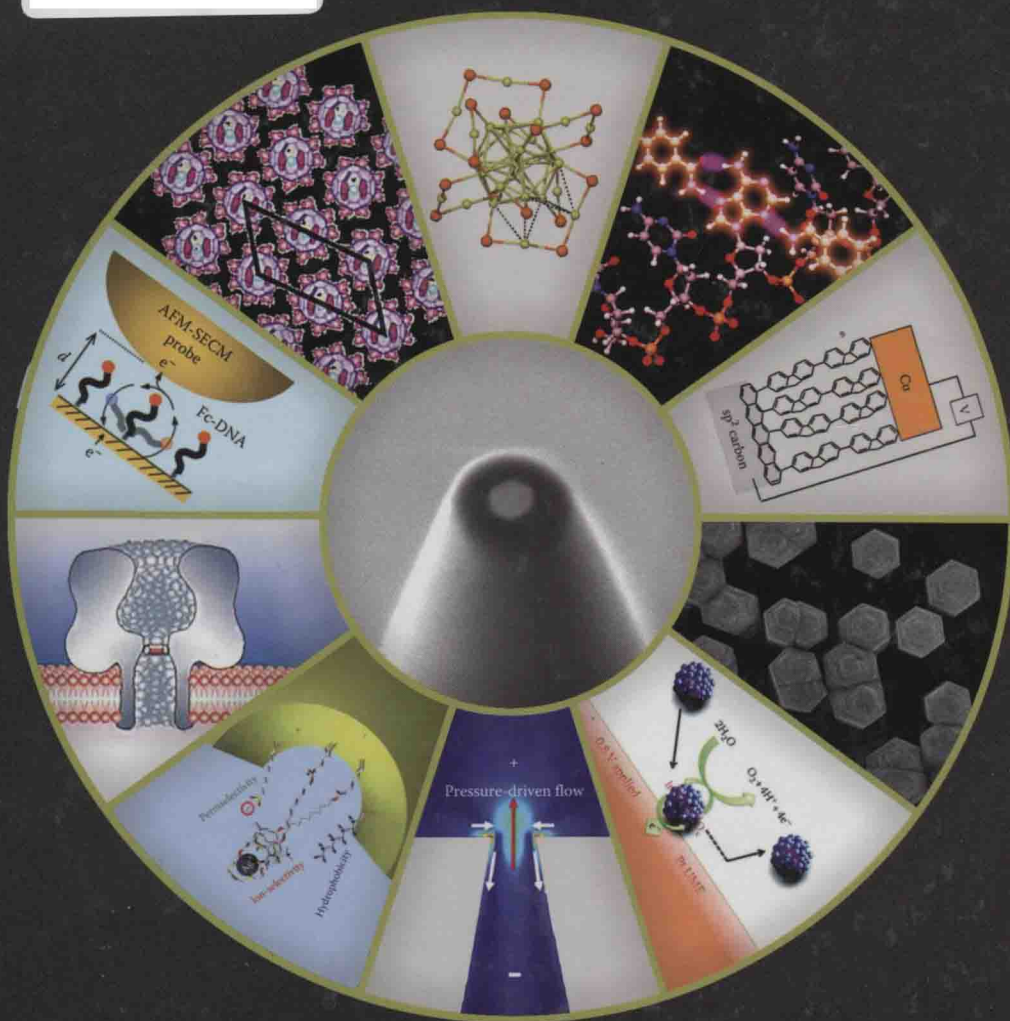


NANOELECTROCHEMISTRY



edited by
Michael V. Mirkin • Shigeru Amemiya



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NANOELECTROCHEMISTRY

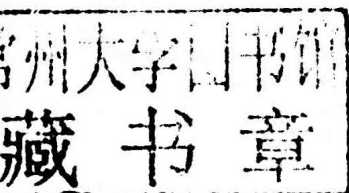
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Preface

The number of scientific disciplines whose names begin with the prefix *nano* has grown dramatically since the launch of the National Nanotechnology Initiative in 2000. Some of those specialties were born to be *nano* either because their research subjects are nanometer-sized objects or because of the use of nanometer-scale experimental tools, for example, the scanning tunneling microscope. It took electrochemistry two centuries (counting from Alessandro Volta's creation of the voltaic pile in 1800) to acquire the prefix *nano*. To work on the nanoscale, electrochemists had to produce nanometer-sized probes, learn to accurately measure ultralow currents, and develop a new theory required for data analysis. The evolution of electrochemistry to nanoscience was also accelerated by the development and synthesis of many new nanomaterials and systems. Was the transition to *nano* worth this effort? Our book aims to answer this question with a resounding *Yes!* By the early 1980s, electrochemistry could be seen as a mature and application-driven science. The move to the nanoscale rejuvenated this field and allowed it to generate new electrode systems and begin to gain molecular-level knowledge about heterogeneous processes complementary to that obtained with various spectroscopic and surface science techniques. The nanoscale capabilities also gave electrochemistry a niche in two of the most active areas of current chemical research—biomedical and alternative energy.

This book covers three integral aspects of nanoelectrochemistry. The first two chapters contain theoretical background, which is essential for everyone working in the field, that is, theories of electron transfer (Chapter 1), transport, and double-layer processes (Chapter 2) at nanoscale electrochemical interfaces. The other chapters are dedicated to the electrochemical studies of nanomaterials and nanosystems (Chapters 3 through 14) or the development and applications of nanoelectrochemical techniques (Chapters 15 through 22) and are self-contained. Nanoelectrochemistry has proved useful for a broad range of interdisciplinary research. The applications discussed in this book range from studies of biological systems to nanoparticles and from electrocatalysis to molecular electronics, nanopores, and membranes. Although we did not intend to present even a brief survey of those diverse areas of research, each chapter provides sufficient detail to allow a specialist to evaluate the applicability of nanoelectrochemical approaches to solving a specific problem, and the key ideas are discussed at a level suitable for beginning graduate students.

Our hope is that this book will be useful to all interested in learning about nanoelectrochemical systems. We thank our students, coworkers, and colleagues who have done so much to advance this field.

Editors

Michael V. Mirkin is professor of chemistry at Queens College, City University of New York, New York City, New York. His professional interests are in the application of electrochemical methods to solving problems in physical and analytical chemistry and include charge-transfer reactions at solid–liquid and liquid–liquid interfaces, electrochemical kinetics, and nanoelectrochemistry. He has published more than 110 peer-reviewed papers and book chapters and coedited the first monograph on scanning electrochemical microscopy (second edition, 2012). He earned a PhD in electrochemistry (1987) from Kazakh State University (former USSR) and did postdoctoral research at The University of Texas at Austin from 1990 to 1993.

Shigeru Amemiya is associate professor, Department of Chemistry, University of Pittsburgh, Pittsburgh, Pennsylvania. He is the author or coauthor of more than 60 scholarly papers and book chapters in electroanalytical chemistry. His research interests are electrochemical sensing and imaging for biological and material studies, including the development of nanoscale scanning electrochemical microscopy and ultrasensitive ion-selective electrodes. He earned his BS (1993) and PhD (1998) in chemistry from The University of Tokyo, Japan, and received a postdoctoral fellowship from the Japan Society for the Promotion of Science to work at The University of Tokyo and The University of Texas at Austin.

1. Introduction

The purpose of this study is to investigate the effects of the proposed system on the performance of the system. The study is divided into two main parts: a theoretical analysis and an experimental evaluation. The theoretical analysis is based on the principles of the system and the experimental evaluation is based on the results of the experiments.

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Section I

Theory of Nanoelectrochemistry

