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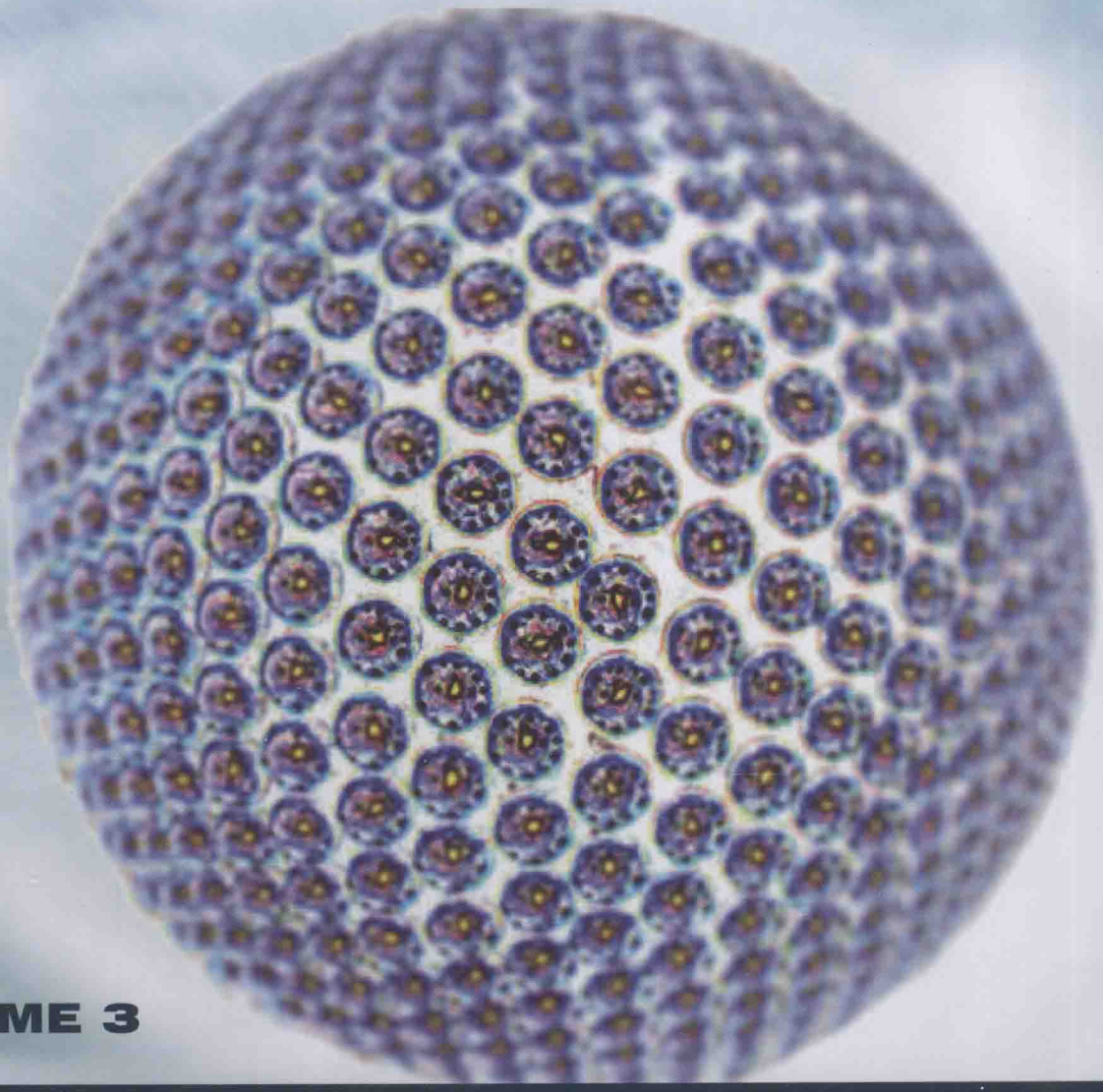

VOLUME 3

COMPREHENSIVE NANOSCIENCE AND TECHNOLOGY

NANOSTRUCTURED SURFACES

AP

COMPREHENSIVE NANOSCIENCE AND TECHNOLOGY

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COMPREHENSIVE NANOSCIENCE AND TECHNOLOGY

Editors-in-Chief Biographies

David Andrews is Professor of Chemical Physics at the University of East Anglia, where he leads a theory group conducting wide-ranging research on fundamental photonics, fluorescence and energy transport, nonlinear optics and optomechanical forces. He has 250 research papers and ten other books to his name, and he is a regularly invited speaker at international meetings. In North America and Europe he has organized and chaired numerous international conferences on nanoscience and technology. Professor Andrews is a Fellow of the Royal Society of Chemistry, the Institute of Physics, and the SPIE – the international society for optics and photonics. In his spare time he enjoys relaxing with family and friends; he also is a keen painter of the British landscape. His other interests generally centre on music, art and graphics, and writing.

Greg Scholes is a Professor at the University of Toronto in the Department of Chemistry. His present research focuses on elucidating the principles deciding electronic structure, optical properties, and photophysics of nanoscale systems by combining synthesis, theory, and ultrafast laser spectroscopy. Recent awards honoring his research achievements include election to the Academy of Sciences, Royal Society of Canada in 2009, the 2007 Royal Society of Canada Rutherford Medal in Chemistry, a 2007 NSERC Steacie Fellowship, the 2006

Canadian Society of Chemistry Keith Laidler Award, and an Alfred P. Sloan Fellowship (2005–2006). Dr. Scholes serves as a Senior Editor for the Journal of Physical Chemistry and Associate Editor for the Journal of Nanophotonics. He enjoys basketball, hiking, photography, family and friends.

Gary Wiederrecht is the Group Leader of the Nanophotonics Group in the Center for Nanoscale Materials at Argonne National Laboratory. His research interests center on the photochemistry and photophysics of nanoparticles and periodic assemblies, hybrid nanostructures, photochemical energy conversion, and nonlinear optical responses resulting from photoinduced charge separation. His experimental expertise is in the areas of ultrafast optical spectroscopy and scanning probe microscopy, including near-field scanning optical microscopy. He has received an R&D100 award, the Department of Energy Young Scientist Award, and the Presidential Early Career Award for Scientists and Engineers. He has authored or co-authored approximately 80 peer-reviewed research articles, and works collaboratively with scientists around the world. He enjoys traveling, nature, and spending time with his family.

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Preface

Volume 3: Nanostructured Surfaces

The ability to structure surfaces at the nanometer scale has driven countless discoveries across many disciplines. This volume aims to highlight representative advances ranging from light–matter interactions on nanostructured metal surfaces to the self-assembly of molecules on substrates and in solution to controlling friction via nanoscale patterns.

For example, plasmonics, where the properties of light are manipulated at the nanoscale by metal nanostructures, has benefited from advances in nanofabrication. As surface plasmons are extremely sensitive to interfaces, the capability to engineer the metal surfaces has been crucial for tuning plasmonic responses. Several chapters are devoted to outlining theoretical and experimental methods to control plasmons as well as applications that result from such control. The chapter by Schatz and co-workers (Chapter 3.06) describes popular computational approaches used to model the optical responses of nanostructured surfaces. Electromagnetic properties of a simple system, such as a single isolated nano-aperture, are first introduced, and then more complex behavior from arrays of apertures is discussed. The chapter by Wurtz *et al.* (Chapter 3.05) demonstrates how a fine periodic structuring can alter surface plasmon properties and how plasmons can be dynamically and actively controlled through nonlinear effects or an external electrical command. The chapters by van Duyne and co-workers (Chapter 3.09) and Diaz and Khoo (Chapter 3.08) discuss how surfaces patterned with metal nanoparticles can behave as ideal surface-enhanced Raman scattering (SERS) substrates and as platforms for manipulating the optical properties of liquid crystals.

Nonlinear optical phenomena are emphasized in the chapter by Brevet (Chapter 3.11), where a comprehensive review of second harmonic generation by nanostructures is provided. In particular, metal nanoparticles are shown to have resonant enhancement and retardation in the yield of surface second harmonic. In addition to these fundamentals chapters, the one by De La Rue and co-workers (Chapter 3.07) highlights a device-oriented application of nanostructured surfaces. Here, the focus is on light-emitting diodes and the societal and economical challenge of maximizing light extraction. The authors describe how photonic crystals can enhance light emission and thus produce brighter sources compatible with low-cost mass production.

Besides chapters on light–matter interactions on nanostructured surfaces, others focus on substrates patterned at length scales less than 100 nm through self-assembly or intrinsic material properties. The chapter by Baddeley and Held (Chapter 3.04) focuses on the assembly of chiral nanomaterials, while Luo and co-workers (Chapter 3.03) focus on bio-inspired assembly. Equally important is the characterization of nanostructured surfaces, such as their tribological properties (Hu and Ma (Chapter 3.12) and Ohmae (Chapter 3.13)). The chapter by Rao *et al.* (Chapter 3.14) provide an extremely detailed overview on how to assemble molecules on organic and inorganic nanostructures. Such molecule–nanostructure assembly is crucial for solubilizing these nanomaterials for widespread applications. These works form the foundation of many applications and new phenomena that result from nanostructuring.

Alexandre Bouhelier and Teri W. Odom

Foreword

Nanotechnology and its underpinning sciences are progressing with unprecedented rapidity. With technical advances in a variety of nanoscale fabrication and manipulation technologies, the whole topical area is maturing into a vibrant field that is generating new scientific research and a burgeoning range of commercial applications, with an annual market already at the trillion dollar threshold. The means of fabricating and controlling matter on the nanoscale afford striking and unprecedented opportunities to exploit a variety of exotic phenomena such as quantum, nanophotonic, and nanoelectromechanical effects. Moreover, researchers are elucidating new perspectives on the electronic and optical properties of matter because of the way that nanoscale materials bridge the disparate theories describing molecules and bulk matter. Surface phenomena also gain a greatly increased significance; even the well-known link between chemical reactivity and surface-to-volume ratio becomes a major determinant of physical properties, when it operates over nanoscale dimensions.

Against this background, this comprehensive work is designed to address the need for a dynamic, authoritative, and readily accessible source of information, capturing the full breadth of the subject. Its five volumes, covering a broad spectrum of disciplines including material sciences, chemistry, physics, and life sciences, have been written and edited by an outstanding team of international experts. Addressing an extensive, cross-disciplinary audience, each chapter aims to cover key developments in a scholarly, readable, and critical style, providing an indispensible first point of entry to the literature for scientists and technologists from interdisciplinary fields. The work focuses on the major classes of nanomaterials in terms of their synthesis, structure, and applications, reviewing nanomaterials and their respective technologies in well-structured and comprehensive articles with extensive cross-references.

It has been a constant surprise and delight to have found, among the rapidly escalating number who work in nanoscience and technology, so many highly esteemed authors willing to contribute. Sharing our anticipation of a major addition to the literature, they have also captured the excitement of the field itself in each carefully crafted chapter. Along with our painstaking and meticulous volume editors, full credit for the success of this enterprise must go to these individuals, together with our thanks for (largely) adhering to the given deadlines. Lastly, we record our sincere thanks and appreciation for the skills and professionalism of the numerous Elsevier staff who have been involved in this project, notably Fiona Geraghty, Megan Palmer, Laura Jackson, and Greg Harris, and especially Donna De Weerd-Wilson who has steered it through from its inception. We have greatly enjoyed working with them all, as we have with each other.

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