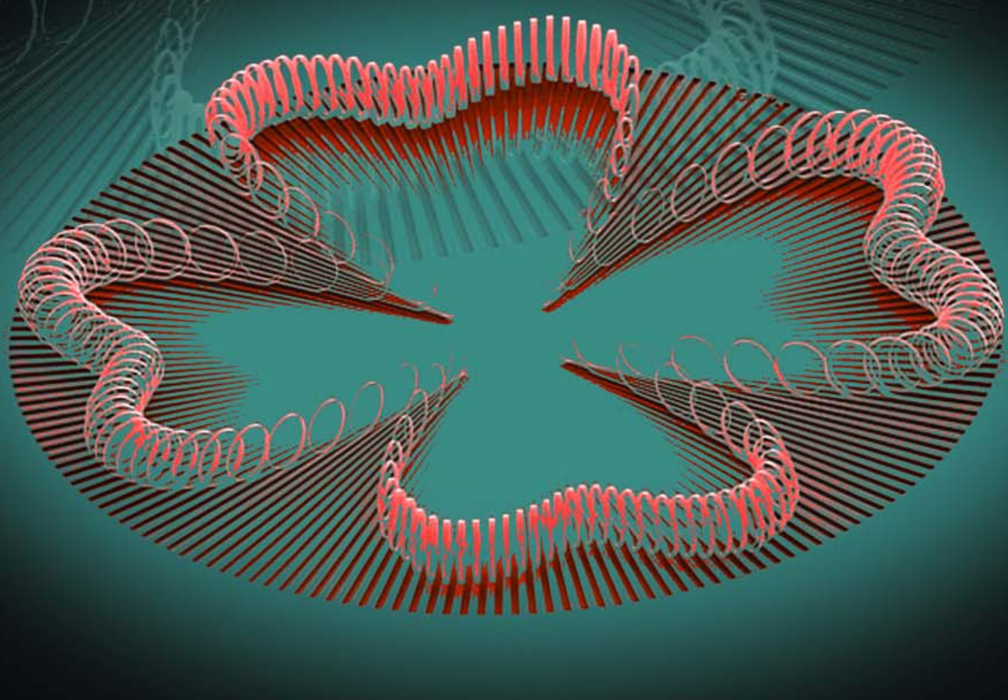
edited by Faiz Rahman

VISTAS IN NANOFABRICATION



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Vistas in Nanofabrication

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Preface

New materials and devices derived from the application of manufacturing technologies where objects are manipulated at ultra-small scales are becoming gradually commonplace. Modifying materials at micrometre and nanometre scales is often crucial to endowing them with properties that are not found in the base material. Sometimes this is done to gain economic and performance benefits, such as in the manufacture of integrated circuits with ever-smaller features. At other times, nanofabrication is utilised to obtain completely new functionalities, such as in making antireflection structures on plastics and glasses. The relatively new discipline of nanotechnology is now finding increasing use in the manufacture of a wide variety of products, ranging from pharmaceuticals and performance chemicals to apparels and electronic devices. This range continues to expand as new process tools and technologies are developed in research laboratories around the world, on a daily basis. It is now a firmly established fact that the importance of nanotechnology will only increase in the years to come as it makes further inroads into almost every area of human activity. We are already seeing the migration of nanofabrication technologies from the traditional area of electronics manufacturing to other fields such as environmental protection, high-performance sporting goods, manufacture of decorative objects, and other products for everyday use. Despite the increasing use of nanotechnology for producing such goods, its primary application remains in electronics and optoelectronics. This is understandable because further increases in performance of electronic and optoelectronic components will come, to a large extent, from the application of clever nanofabrication techniques in device manufacture. Thus, for example, the continued miniaturization of silicon integrated circuits will become impossible as minimum feature dimensions gradually decrease below 10 nm and then new materials and device architectures — driven by continuing advances in nanotechnology — will be needed to maintain the evolution of circuits and devices towards even higher performance levels. For reasons such as this, a great deal of effort is being invested in developing and identifying new materials and processes that can sustain the industries of the future. The contents of this book provide a glimpse of the work being carried out by nanotechnologists in developing novel technologies for material manipulation and structural nanofabrication. Each chapter presents the recent work of a leading researcher or a research group working at the frontiers of nanotechnology research. A special section at the end of the book presents a collection of micrographs that highlight a variety of structures being created at micron and sub-micron scales. Following is a brief description of the chapters.

The use of nanosphere lithography for patterning dense surface features is described by Hirotaka Oshima from Fujitsu Laboratories in Chapter 1. This is followed by a detailed overview of dry etching technologies for semiconductor manufacture in Chapter 2, by S. J. Pearton from the University of Florida. Basudev Lahiri from the National Institute of Standards and Technology describes his work on split ring-based metamaterials in Chapter 3. I and my colleagues present our work on the fabrication of nanotextured photonic crystal light-emitting diodes in Chapter 4. Chapter 5, contributed by Jin-Seo Noh and colleagues from Yonsei University, deals with the fabrication of nano-wires. A nanotrench-based process for advanced photolithography is described in Chapter 6, by Jean-Francois Dayen and colleagues from the University of Strasbourg. Joong-Mok Park and colleagues from a US research consortium in Iowa describe their work on high-aspect-ratio structures for transparent electrodes in Chapter 7. The fabrication of nano-gap electrodes by novel nanofabrication techniques is described in Chapter 8 by Luis De Los Santos Valladares from an international research collaboration. Chapter 9 contains a description of nanometre-scale processing by tribological techniques by Shojiro Miyake from Nippon Institute of Technology and Mai Wang from the OSG Corporation. Sumita Santra and colleagues from the University of Cambridge and the Indian Institute of Technology describe the integration of nanomaterials in CMOS processing technology in Chapter 10. The next chapter, by Michal Urbanek and Tomáš Šikola from Brno University of Technology describes the use of focussed ion beam techniques for making metallic nanostructures. The section titled “Technology Showcase” presents a compilation of micrographs from the world of nanotechnology.

In putting together this collection of contemporary work on nanofabrication technologies, the editor and the contributors hope to highlight some of the most rapidly developing techniques for micro- and nano-manipulation for modern nanoscale device fabrication. This collection of chapters from leading technologists provides a good survey of the state of the art in some of the most active research areas in nanotechnology at present. We hope that this book will be of use to both new researchers involved with nanofabrication technologies and practicing engineers and scientists who wish to update their knowledge in this fast-changing field.

Faiz Rahman
Glasgow, United Kingdom
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