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Cover illustration: The fabrication procedure for nanoscale molecular-switch devices by imprint lithography. A monolayer of switchable molecules is deposited over a Pt nanowire bottom electrode made by imprint lithography. A blanket of Ti contact layer is deposited on top of the molecular layer, which also protects the molecules from damage during the fabrication process. Finally, reactive ion etching is used to remove the blanket Ti protective layer, leaving a crossbar device with the molecular monolayer sandwiched between two metal nanowires.
Permission for front cover art granted by Hewlett-Packard Co. (authors: Yong Chen and R. Stanley Williams)

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Preface

The high level of attention and interest of the global community to NANO science and technology to a large extent is linked to the GIGAntic challenges for the continuing growth of information technology, which sparked an unprecedented level of interdisciplinary and international cooperation among industrial and academic researchers, companies, IT market rivals, and countries, including former political and military rivals. Microelectronics technologies have reached a new stage in their development: The latest miniaturization of electronic devices is approaching atomic dimensions, interconnect bottlenecks are limiting circuit speeds, new materials are being introduced into microelectronics manufacture at an unprecedented rate, and alternative technologies to mainstream complementary metal–oxide semiconductors (CMOSs) are being considered.

The very dynamic stage of science and technology related to the advanced and future electronics and photonics creates a growing gap between the large number of rapid publications and nanotechnology highlights in media on one side and fundamental understanding of underlying phenomena and an adequate evaluation of scientific discoveries and technological innovations on the other side. Writing a tutorial book on fundamentals of science and technology for electronics at this time is almost the same level of challenge as writing a history book during a revolution.

This book, published in the series Nanostructure Science and Technology, is primarily based on the lecture notes presented at the Summer School of the second Nano & Giga Forum in Krakow, Poland. We made an effort to enhance the tutorial component and to provide material complementary to the book which published the school lectures from the first meeting in Moscow (*Nano and Giga Challenges in Microelectronics*, Elsevier, 2003). The book is designed as an introduction for graduate students, engineers, and researchers wishing to obtain a fundamental knowledge and a snapshot in time of the cutting edge in electronics technology research. As a natural consequence, it is also designated to be an essential reference for the "gurus" wishing to keep abreast of the latest directions and challenges in microelectronic technology development and future trends. The combination of viewpoints presented in the book can help to foster further research and

cross-disciplinary interaction needed to surmount the barriers facing future generations of technology design.

The first chapter (by Cerofolini and Mascolo) provides a detailed and critical analysis of the possible routes from advanced microelectronics toward future nanoelectronics and molecular electronics. The second chapter (by Cristoloveanu) offers a comprehensive tutorial on state-of-the-art silicon-on-insulator (SOI) technologies. Basics on the operation and strategies for design of semiconductor lasers, which are in many ways second only to transistors on their impact on today's high-tech industries, are described in Chapter 3 (by Mao). Written by the authors from the Freescale Semiconductor research group, the fourth chapter (by Rao, Sadd, Steimle, Swift, Gasquet, and Stoker) describes new technologies for nanocrystal memories. The introduction of new high-permittivity (*high-k*) dielectrics, which is crucial for future generations of CMOS devices, is described in Chapter 5 (by Lee, Korkin and Huff). Tutorials on one of the most important analytical tools in advanced electronics and other nanotechnology areas, scanning force microscopy, are presented in Chapter 6 (by Such, Krok, and Szymonski). Chapter 7 (by Asenov, Brown, Cheng, Watling, Roy, and Alexander) provides an overview of the problems and simulation technique for nano-CMOS devices bridging the atomic-scale device structure with the device performance and system architecture. The final chapter (by Alexandrov) presents a comprehensive description of the idea and modeling results for polaron-based switches made of nanowires and quantum dots.

It is a great pleasure and honor for the editors to present these collected chapters and we thank our distinguished authors for sharing their insights and expertise as well as the sponsors of NGCM2004 for their gracious support. We invite our readers to join our next Nano & Giga forum in Arizona, March 12–16, 2007 (http://asdn.net/ngc2007/), and future meetings in this series and contribute in the living and developing legacy of science and technology for advanced and future electronics and photonics.

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