Preface

Almost since their inception, integrated circuits have been synonymous with NMOS and CMOS technologies; the bipolar ICs reigned for some period. The primeval and perennial CMOS has borne the brunt and onslaught of brutal miniaturization, and has been stubbornly holding on to maintain its supremacy. It has also received ample support from its nanotechnological cousins like nanophotonics, nanomechanics, nanobiotechnology and spintronics. Receiving this support, it has blossomed into beautiful flowers and fruits of "CMOS applications", which have cast a tremendous influence on human life at large. The CMOS IC tree has also burgeoned into relatively new areas, spreading into and embracing all spheres of our lives. Indeed, so profound and overwhelming has been the CMOS proliferation!

Over the past few decades, the researchers have also been constantly bothered by the question: What next after CMOS? So scientists have diverted their attention towards exploratory research in quest of potential CMOS alternatives. A noteworthy consequence of this progress has been that nanoelectronics no longer remains a solo silicon semiconductor technology. One must broaden thinking to include other materials such as carbon one-dimensional materials like carbon nanotubes. There are two-dimensional materials, e.g., graphene and dichalcogenides. Several polymers and biological materials like DNA are important too. Nanoelectronics is no longer the forte of physicists and electrical engineers. Biophysicists, chemists, and biologists equally partake in this field. It appears that physics, engineering, chemistry, biology, and related rivulets have all merged together into nanoelectronics to provide the solutions to unabated shrinkage of devices and circuits.

Transistor switches are not the only possible means of implementing logic operations. One must envisage other models like quantum dot cellular automata or magnetic cellular automata. Wired circuits may not be always required. Wireless field-coupled modus operandi must be foreseen. Room temperature operation should not be compulsorily followed. Superconductive nanoelectronics has its own benefits. Innovative circuit designs and system architectures must be visualized for increased energy efficiency in information processing.

In view of these developments, nanoelectronics of today is an interdisciplinary science and technology poised at the intersection and crossroads of several tributaries of knowledge. This book seeks to present an interdisciplinary perspective of nanoelectronics in contrast to hitherto followed view of looking at it merely from physics and electrical engineering angle. In this respect, it differs from existing books, which concentrate more on the electrical engineering aspects, and less on cross-disciplinary view. In line with the above thinking, the readers will find five parts of this book: (i) A part laying down the groundwork for understanding the subject matter. (ii) A part treating about MOSFET and CMOS technologies, the scaling issues, problems faced in short-channel devices and their remedies, the structural innovations in the form of partially- and fully-depleted SOI MOSFETs, FINFETs and multigate architectures. (iii) A part on sister nanotechnogies of CMOS, viz., those from optical, magnetic, mechanical and biological families. (iv) A part on post-CMOS futuristic technologies like resonant tunneling diodes, tunnel FETs, single-electron transistors, one-dimensional material platforms, e.g., silicon nanowires and carbon nanotubes, two-dimensional materials, like graphene and transition metal dichalcogenides, quantum dot cellular automata, magnetic cellular quantum automata, rapid single flux quantum devices, and finally molecular electronics. (v) A concluding part on nanofabrication techniques and diagnostic instrumentation.

The book is targeted to an assorted audience, which includes but is not limited to graduate students of electrical and electronics engineering, physics, chemistry, nanotechnology, semiconductor fabrication technology, and related courses. Professional engineers and scientists engaged in this frontier field will also be immensely benefitted.

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