

Preface

One-dimensional (1D) nanostructures represent a group of nanomaterials with highly anisotropic morphologies, the smallest dimension falling in the range of 1–100 nm. Typical examples of 1D nanostructures include nanowires and nanotubes. Semiconductor nanowires are characterized by the efficient transport of electrons and excitons, and have been regarded as the most promising building block for nanoscale electronic and optoelectronic devices. Nanosystems can be built from these elements using metallic nanowires as interconnects. Carbon nanotubes, either semiconducting or metallic, are mechanically robust and chemically stable, suggesting numerous potential applications in nanoelectronics. The growth, characterization, and applications of 1D nanostructures invoke all disciplines of science and engineering. As a result, scientists working in one area need to go beyond their own expertise to obtain a broad view of the whole field. The objective of this book is to elucidate the fundamental, underlying science common to 1D nanostructures and their applications. The result is a representative snapshot of the latest developments from diverse perspectives in a series of chapters from highly engaged scientists.

In Chaps. 1–4, particular emphasis is placed on synthesis of nanowires. Chap. 1 summarizes the controversy regarding nanowire growth mechanisms and proposes a Si-assisted growth model. Chap. 2 reviews the synthesis and properties of SiC 1D nanostructures, in both experiments and theories. Chap. 3 deals with self-organization of Si-based nanowires. Chap. 4 demonstrates the formation of large-scale arrays of addressable Si nanowires, with controllable dimension, placement, and orientation, showing the promise for integration of nanowires into device architectures.

Chaps. 5–7 focus on the property characterization of nanowires. Chap. 5 reveals the extreme optical anisotropy of individual nanowires and of nanowire ensembles. Chap. 6 offers a numerical method for a better description of the plasmonic properties of silver nanowires. Chap. 7 investigates electromagnetic nanowire resonances for field-enhanced spectroscopy.

The progress made toward applications is discussed in Chaps. 8–10. Chap. 8 is devoted to detailed analysis of engineering contact barriers and their impact on the electrical transport properties of carbon nanotube field-effect transistors. Chap. 9

presents a comprehensive overview on the current status of low dimensional nanomaterials for spintronics. Chap. 10 reports on 1D phase-change nanomaterials for information storage applications.

Chap. 11 is a theoretical contribution in nature and studies the melting behavior, thermal conductivity, and mechanical properties of crystalline GaN nanotubes through molecular dynamics methods.

While the above chapters deal with freestanding properties of 1D nanostructures, buried semiconductor nanowires – commonly referred to as quantum wires – are the subjects of the last chapter. Chap. 12 reviews the self-assembly of InAs/InAl(Ga)As quantum wires on InP substrates and demonstrates how the lateral composition modulation in InAlAs buffer layers plays an important role in determining their structural and optical properties.

Finally, the editor wishes to thank his wife, Yanze Xie, for her support and understanding. The editor himself is highly involved in many research projects, and therefore, is forced to perform nearly all editorial work at home, often at night and on weekends. This means many sacrifices for Yanze as a mother of two young kids. The editor is honored that she has accompanied him in the past from China to Germany to the United States, and looks forward to spending the rest of his life with her.

Fayetteville
February 2008

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<http://www.springer.com/978-0-387-74131-4>

One-Dimensional Nanostructures

Wang, Z.M. (Ed.)

2008, XII, 330 p., Hardcover

ISBN: 978-0-387-74131-4