Silicon-Based Materials and Devices

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Volume 1

Materials and Processing

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To my brothers,

Jagmer Singh
and
Ranvir Singh Chaudhary

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PREFACE

Silicon-Based Materials and Devices is a follow-up to our recently published 10-volume set, *Handbook of Advanced Electronic and Photonic Materials and Devices*. It presents highly coherent coverage of silicon-based materials, namely, those that have been extensively used for applications in electronic and photonic technologies. This extensive reference provides broad coverage of silicon-based materials including different kinds of silicon-related materials, their processing, spectroscopic characterization, physical properties, and device applications. Fourteen chapters review state-of-the-art research on silicon-based materials and their applications to devices.

The details of amorphous silica are summarized by M. Tomozawa, whereas the structures and properties of amorphous silicon dioxide, which are related to the issues of reliability and novel applications, are discussed by H. Nishikawa. F. Giorgis and C. F. Pirri describe the growth, characterization, and physical properties of noncrystalline and nanostructured silicon-based alloys. Silicon carbide is very useful for tribological and structural applications because of its hardness, wide-temperature-range operation, and corrosion resistance. The structural, optical, and electrical properties of amorphous silicon carbide films are discussed by W. K. Choi, and in "Silicon Carbon Nitrides: A New Wideband Gap Material," L. C. Chen and coworkers focus on silicon carbide–related materials. M. Masi, C. Cavallotti, and S. Carra discuss the gas phase and surface kinetics of silicon chemical vapor deposition from silane and chlorosilane.

Three chapters focus on processing and physical properties of silicon; they include "Photonic and Magnetic Properties of Spark-Processed Silicon" by R. E. Hummel; "Wet-Chemical Conditioning of Silicon: Electronic Properties Correlated with the Surface Morphology" by H. Angermann, W. Henrion, and A. Röseler; and "Optical Absorption, Luminescence, and ESR Spectral Properties of Point Defects in Silica" by M. Leone, S. Agnello, R. Boscaino, M. Cannas, and F. M. Gelardi. The effect of pressure, temperature, and wavelength of the incident light on the refractive index of silica glasses is extensively discussed by C. Z. Tan and J. Arndt.

Besides many other applications, silicon is a key component of today's integrated circuit technology. For example, silicon dioxide has been used extensively as an interlayer dielectric material for microelectronic packaging devices, light-emitting diodes, transistors, optical fiber, endoscopy, and so forth. Four chapters focus on the applications of silicon and its related materials in electronic and photonic devices: "Porous Silicon Microcavities" by C. Vinegoni, M. Cazzanelli, and L. Pavesi; "Polycrystalline Silicon-based Thin Film Transistors for Integrated Active-Matrix Liquid-Crystal Displays" by C. A. Dimitriadis; "Light Emission in Silicon" by D. J. Lockwood; and "Erbium in Silicon and Silicon-Germanium" by A. R. Peaker and J. H. Evans-Freeman.

This book covers a broad spectrum of the silicon-based materials and their device applications. Many industries around the world are engaged in silicon-based technology for the new millennium. The applications of silicon and silicon-based materials in present microelectronics and communication technology have been extensively discussed. This reference should be a valuable resource to scientists, graduate and upper level graduate students working in solid state physics, materials science, chemistry, electrical and electronic engineering, optical engineering, microelectronics, data storage, information technology, and semiconductor industries.

Both the editor and the publisher are very grateful to the authors of this project for their outstanding contributions.

Hari Singh Nalwa
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ABOUT THE EDITOR

Dr. H. S. Nalwa is the Managing Director of the Stanford Scientific Corporation, Los Angeles, California. He was Head of Department and R&D Manager at the Ciba Specialty Chemicals Corporation in Los Angeles (1999–2000) and a staff scientist at the Hitachi Research Laboratory, Hitachi Ltd., Japan (1990–1999). He has authored more than 150 scientific articles and 18 patents on electronic and photonic materials and devices. He has edited the following books: *Ferroelectric Polymers* (Marcel Dekker, 1995), *Nonlinear Optics of Organic Molecules and Polymers* (CRC Press, 1997), *Organic Electroluminescent Materials and Devices* (Gordon & Breach, 1997), *Handbook of Organic Conductive Molecules and Polymers*, Vol. 1–4 (John Wiley & Sons, 1997), *Low and High Dielectric Constant Materials* Vol. 1–2 (Academic Press, 1999), *Handbook of Nanostructured Materials and Nanotechnology*, Vol. 1–5 (Academic Press, 1999), *Handbook of Advanced Electronic and Photonic Materials and Devices*, Vol. 1–10 (Academic Press, 2000), *Advanced Functional Molecules and Polymers*, Vol. 1–4 (Gordon & Breach, 2001), *Photodetectors and Fiber Optics* (Academic Press, 2001), *Supramolecular Photosensitive and Electroactive Materials* (Academic Press, 2001), *Nanostructured Materials and Nanotechnology* (Academic Press, 2001), *Handbook of Thin Film Materials*, Vol. 1–5 (Academic Press, 2001), and *Handbook of Surfaces and Interfaces of Materials*, Vol. 1–5 (Academic Press, 2001). The *Handbook of Nanostructured Materials and Nanotechnology* (Vol. 1–5) edited by him received the 1999 Award of Excellence from the Association of American Publishers.

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