Nanostructures and Nanomaterials

Synthesis, Properties, and Applications

2nd Edition

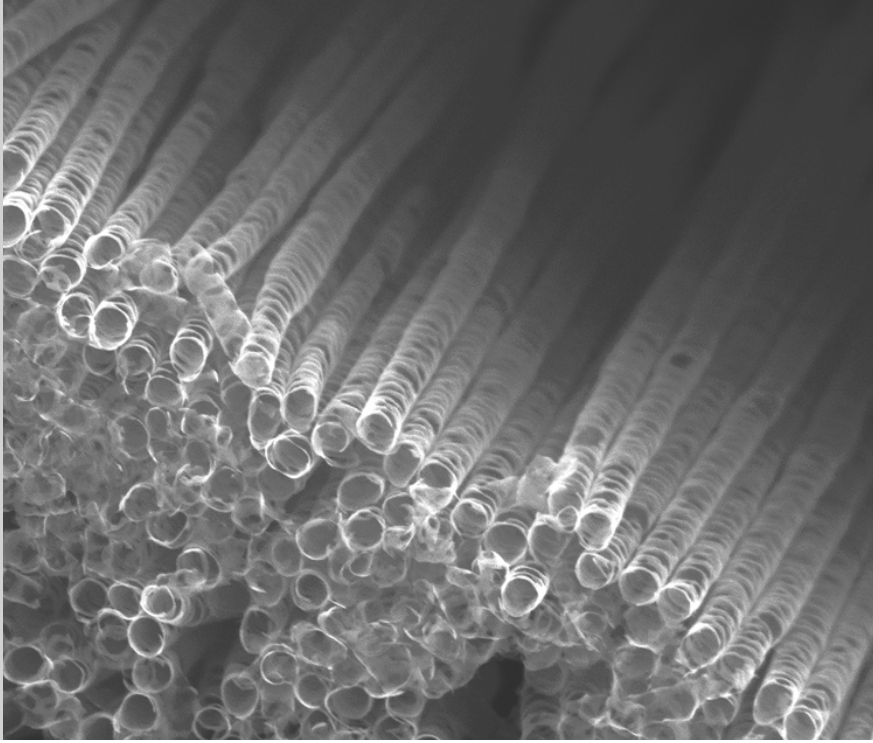
World Scientific Series in Nanoscience and Nanotechnology

Series Editor: Mark Reed (*Yale University*)

Vol. 1 Molecular Electronics: An Introduciton to Theory and Experiment
Juan Carlos Cuevas (*Universidad Autónoma de Madrid, Spain*) *and*
Elke Scheer (*Universität Konstanz, Germany*)

Vol. 2 Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, 2nd Edition
Guozhong Cao (*University of Washington, USA*) *and*
Ying Wang (*Louisiana State University, USA*)

Volume
2
World Scientific Series in
Nanoscience and Nanotechnology



Nanostructures and Nanomaterials

Synthesis, Properties, and Applications

2nd Edition

Guozhong Cao
University of Washington, USA

Ying Wang
Louisiana State University, USA

World Scientific

NEW JERSEY • LONDON • SINGAPORE • BEIJING • SHANGHAI • HONG KONG • TAIPEI • CHENNAI

Published by

World Scientific Publishing Co. Pte. Ltd.

5 Toh Tuck Link, Singapore 596224

USA office: 27 Warren Street, Suite 401-402, Hackensack, NJ 07601

UK office: 57 Shelton Street, Covent Garden, London WC2H 9HE

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

World Scientific Series in Nanoscience and Nanotechnology, Vol. 2
NANOSTRUCTURES AND NANOMATERIALS, 2nd Edition
Synthesis, Properties, and Applications

ISBN-13 978-981-4322-50-8
ISBN-10 981-4322-50-4
ISBN-13 978-981-4324-55-7 (pbk)
ISBN-10 981-4324-55-8 (pbk)

Typeset by Stallion Press
Email: enquiries@stallionpress.com

Printed in Singapore.

Preface to the Second Edition

We are delighted by the publication of this second edition by World Scientific Publishing Co. The first edition arrived at a time of great excitement in nanotechnology, and this excitement continues to grow. The main objective of this new edition was, therefore, to update with the new development in the processing and fabrication of nanostructures and nanomaterials in the past seven years, but retain the scope and the characteristic of the first edition: to summarize the fundamentals and technical approaches in synthesis, fabrication, and processing of nanostructures and nanomaterials so as to provide the readers with a systematic and coherent picture of the field and to serve as a general introduction to people just entering the field and experts seeking for information in other subfields.

The new edition features some rewritings to improve clarity, ranging from rewording to rearranging some paragraphs. Updates are found mostly in Chapters 3, 4, 6, and 9. Updated information on the synthesis of nanoparticles and core–shell nanostructures has been integrated into Chapter 3. A review on synthesis and properties of inorganic nanotubes (other than carbon nanotubes) has been added into Chapter 4. Chapter 6 has been updated by adding more information on synthesis of mesoporous materials and subsections on inverse opals and bio-induced materials. Chapter 9 has the most extensive expansion by adding applications of nanostructures and nanomaterials in lithium-ion batteries, hydrogen storage, thermoelectrics, environmental applications, photonic crystals, and plasmon devices. Other updates and revision include the replacement of figures in Chapters 1, 5, and 8.

We want to take this opportunity to thank the support from the readers throughout the world, and our particular appreciation goes to those who pointed out the errors, omissions, and ambiguity in the first edition.

We tried hard to make all the correction and improve the presentation in the second edition. However, it is apparent that we could not possibly incorporate all the important topics and all the new advancement in nanostructures and nanomaterials into this book.

We wish to acknowledge the help and support received from our colleagues, students, friends, and loved family members. We are indebted to Chuan Cai and Dongsheng Guan for taking care of the figures and the copyright permissions.

Guozhong Cao
Seattle, WA

Ying Wang
Baton Rouge, LA
10 May 2010

Contents