

# **Nano Science and Technology: Novel Structures and Phenomena**

*Edited by*

**Zikang Tang and Ping Sheng**

*Hong Kong University of Science and Technology  
Clear Water Bay, Hong Kong*



**Taylor & Francis**  
Taylor & Francis Group

LONDON AND NEW YORK

First published 2003  
by Taylor & Francis  
11 New Fetter Lane, London EC4P 4EE

Simultaneously published in the USA and Canada  
by Taylor & Francis Inc,  
29 West 35th Street, New York, NY 10001

*Taylor & Francis is an imprint of the Taylor & Francis Group*

© 2003 Zikang Tang and Ping Sheng

*Printer's Note:*

This book was prepared from camera-ready-copy  
supplied by the authors

Printed and bound in Great Britain by  
TJ International, Padstow, Cornwall

All rights reserved. No part of this book may be reprinted or reproduced or utilised in any form or by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying and recording, or in any information storage or retrieval system, without permission in writing from the publishers.

Every effort has been made to ensure that the advice and information in this book is true and accurate at the time of going to press. However, neither the publisher nor the authors can accept any legal responsibility or liability for any errors or omissions that may be made. In the case of drug administration, any medical procedure or the use of technical equipment mentioned within this book, you are strongly advised to consult the manufacturer's guidelines.

*British Library Cataloguing in Publication Data*

A catalogue record for this book is available from the British Library

*Library of Congress Cataloging in Publication Data*

Croucher ASI on Nano Science and Technology (2nd : Hong Kong University of Science and Technology)

Nano science and technology : novel structures and phenomena / edited by Zikang Tang and Ping Sheng.  
p. cm.

Proceedings of the second Croucher ASI on Nano Science and Technology, held at the Hong Kong University of Science and Technology  
Includes bibliographical references and index.

ISBN 0-415-30832-1 (hb)

1. Nanostructure materials—Congresses. 2. Nanotechnology—Congresses.  
I. Tang, Zikang, 1959– II. Sheng, Ping, 1946– III. Title.

TA418.9.N35 C76 2003

620'.5—dc21

2002075066

ISBN 0-415-30832-1

# Contents

## Preface

### Part 1 NOVEL NANOSTRUCTURES AND DEVICES

- 1 Nanopatterning with Diblock Copolymers  
*P. M. Chaikin, C. Harrison, M. Park, R. A. Register,  
D. H. Adamson, D. A. Huse, M. A. Trawick, R. Li and P. Dapkus*
- 2 Nanostructured Materials: Basic Concepts, Microstructure  
and Properties  
*H. Gleiter*
- 3 Tuning the Electronic Structure of Solids by Means of  
Nanometer-sized Microstructures  
*H. Gleiter*
- 4 Epitaxial Growth and Electronic Structure of Self-assembled  
Quantum Dots  
*P. M. Petroff*
- 5 Self Assembled Quantum Dot Devices  
*P. M. Petroff*
- 6 Solvothermal Synthesis of Non-oxides Nanomaterials  
*Y. T. Qian*
- 7 Nanostructures at Solid/Liquid Interface  
*L. J. Wan and C. L. Bai*
- 8 Fabrication, Characterization and Physical Properties of  
Nanostructured Metal Replicated Membranes  
*Y. Lei, W. Cai and L. Zhang*
- 9 Vesicular and Tubular Nanoassemblies of an Helical  
Amphiphilic Polyacetylene  
*B. S. Li, K. K. L. Cheuk, J. Chen, X. Xiao, C. Bai  
and B. Z. Tang*
- 10 Evolution of Two-Dimensional Nanoclusters on Surfaces  
*W. W. Pai and D. 4. Liu*

### Part 2 FULLERENES AND NANOTUBES

- 11 Exploring the Concave Nanospace of Fullerenic Material  
*H. Kuzmany, R. Pfeiffer, T. Pichler, Ch. Kramberger, M. Krause  
and X. Liu*

- 12 Controlled Synthesis of Carbon Nanotubes and their Field Emission Properties  
*S. Fan, L. Liu, Z Yuan and L. Sheng*
- 13 Superconductivity in 4-Angstrom Carbon Nanotubes  
*P. Sheng, Z K. Tang, L. Zhang, N. Wang, X. Zhang, G. H. Wen, G. D. Li, J. Wang and C. T. Chan*
- 14 Ultra-small Single-walled Carbon Nanotubes and their Novel Properties  
*Z K. Tang, L L Li, Z M. Li, N. Wang and P. Sheng*
- 15 Free Radical Attack on C. Embedded in Nanochannels of Mesoporous Silica  
*C. H. Lee, H. P. Lin, T. S. Lin and C. Y Mou*
- 16 Template-directed Synthesis of Carbon Nanotube Array by Microwave Plasma Chemical Reaction at Low Temperature  
*Q. Wu, Z. Hu, X. Z Wang, X. Chen and Y Chen*
- 17 Field Emission Enhancement of Multiwalled Carbon Nanotubes Film by Thermal Treatment under UHV and in Hydrogen and Ethylene Atmospheres  
*L. Stobinski, C. S. Chang, H. M. Lin and T T. Tsong*

### **Part 3 NANOCOMPOSITES AND SEMICONDUCTOR NANOSTRUCTURES**

- 18 Micro-domain Engineering for Optics and Acoustics  
*S. N. Zhu, Y.Y. Zhu and N.B. Ming*
- 19 Distinguishing Spinodal and Nucleation Phase Separation in Dewetting Polymer Films  
*O. K. C. Tsui, B. Du, F. Xie, Y. J. Wang, H. Yan and Z. Yang*
- 20 Fabrication of Mesoscopic Devices using Atomic Force Microscopic Electric Field Induced Oxidation  
*F. K. Lee, G. H. Wen, X. X. Zhang and O. K. C. Tsui*
- 21 Copper Nanowires Prepared by the Treatment of the Cu<sub>2</sub>S Nanowires in a Radio-frequency Hydrogen Plasma  
*S. Wang, X. Wen and S. Yang*
- 22 The Viscoelastic Effect on the Formation of Mesoglobular Phase of Dilute Heteropolymer Solutions  
*Chi Wu*
- 23 Chemical Coating of the Metal Oxides onto Mesoporous Silicas  
*H.P. Lin, Y.H. Liu and C.Y. Mou*

- 24 Emission in Wide Band Gap II-VI Semiconductor Compounds with Low Dimensional Structure  
*X. W. Fan, G. Y. Yu, Y. Yang, D. Z Shen, J. Y Zhang, Y C. Liu and Y. M. Lu*
- 25 Temperature and Magnetic Field Dependent Transports in Granular Structures  
*H. Y. Cheung, T. K. Ng and P. M. Hui*
- 26 Mechanism and Method of Single Atom Pyramidal Tip Formation from a Pd Covered W Tip  
*T. Y. Fu and T. T. Tsong*
- 27 Hydrogen and Proton Transport Properties of Nanoporous Zeolite Micromembranes  
*J. L. H. Chau, A. Y. L. Leung, M. B. Shing, K. L. Yeung and C. M. Chan*

#### **Part 4 THEORY AND SIMULATIONS**

- 28 Alkali Intercalation of Ultra-Small Radius Carbon Nanotubes  
*H. J. Liu, J. L. Yang and C. T. Chan*
- 29 Engineering Acoustic Band Gaps in Phononic Crystals  
*Z. Q. Zhang, Y. Lai and X. Zhang*
- 30 Quantum Dynamics of Coupled Quantum-Dot Qubits and Dephasing Effects Induced by Detections  
*Z. T. Jiang, J. Peng, J. Q. You, S. S. Li and H. Z Zheng*
- 31 Coherent Dynamics and Quantum Information Processing in Josephson Charge Devices  
*J. Q. You, F. Nori and J. S. Tsai*

# Preface

This volume represents the proceedings of the second Croucher ASI on Nano Science and Technology held at HKUST. The first one was exactly three years ago.

This ASI invited six plenary speakers. They not only delineated the cutting edge of research in nano science and technology, but in the process also “wowed” the audience and created a stir. Prof. Donald Eigler and Prof. Kunio Takayanagi were especially impressive in showing pictures and videos of atomic manipulations, creating novel functionalities at the nanometer scale. Their talks opened listeners' eyes to the future potential of nanotechnology, and brought quantum mechanics, formerly a somewhat abstract topic, to a direct visual level. Prof. Steve Louie showed that the greatly increased predictive power of theory and simulation has brought us a step closer to the holy grail of “material-by-design,” whereby the material properties can be predicted and their associated structures specified as recipes for fabrication. Prof. Paul Chaiken and Prof. Pierre Petroff showed two orthogonal approaches to the fabrication of semiconductor quantum dots (artificial atoms), and their potentials to optical and electronic technologies. Prof. Herbert Gleiter, a pioneer in nanoscience and nanotechnology, delineated the direction of nanotechnology in traditional disciplines such as metallurgy.

Complementing the plenary talks were the excellent invited talks by both local, Chinese mainland, and Taiwan speakers. The talks gave a snapshot of the best works done in this region over the past two years, and showed the great progress that has been achieved recently in nanoscience and nanotechnology in this region.

From the responses of the participants, it is clear that the topic of nanoscience and nanotechnology has captured a resonance of our times. During the discussion sessions of the ASI, there were lively debates on the nature of this “nano phenomenon” and where it is leading us. From our personal observations at the level of working scientists, it is clear that the primary driving force for the nano phenomenon comes from the scientific possibilities that arise due to the confluence of advances in characterization, measurements, and computation. Research fundings are the consequence, rather than the cause, of this manifest “destiny.” Hence the nano phenomenon represents a historical trend, starting from thousands of years ago with the human mastery of kilometre-scale technology (e.g., Egyptian

Pyramids, the Chinese Great Wall), to the millimetre-scale technology (e.g., watches) a few hundred years ago, to the micrometre-scale technology (e.g., microelectronics) of the twentieth century, to the present development of the nanometre-scale technology platform. Once the nanotechnology platform is established, perhaps ten to twenty years from now, there is no doubt that another revolution in human lives would occur.

It is our hope that the present volume can capture the spirit of this Croucher ASI and give readers one cross sectional view of the rapidly evolving nano science and technology.

**Zikang Tang and Ping Sheng**

*Hong Kong University of Science & Technology*

*Clear Water Bay, Hong Kong*

*May, 2002*