



Nanotechnology

Nanofabrication,
Patterning and
Self Assembly

Nanotechnology Science and Technology Series

Charles J. Dixon
Ollin W. Curtines
Editors

NOVA

NANOTECHNOLOGY SCIENCE AND TECHNOLOGY SERIES

**NANOTECHNOLOGY:
NANOFABRICATION, PATTERNING
AND SELF ASSEMBLY**

**CHARLES J. DIXON
AND
OLLIN W. CURTINES
EDITORS**

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CONTENTS

Preface		xi
Research and Review Studies		1
Chapter 1	Electrochemical Nanofabrication <i>Di Wei</i>	3
Chapter 2	Fabrication and Application of Novel Two-Dimensional Nanowebs via Electrospinning <i>Bin Ding, Chunrong Li, Dong Wang and Seimei Shiratori</i>	51
Chapter 3	Nano-scale Characterization and Spectroscopy of Strained Silicon <i>Norihiko Hayazawa and Alvarado Tarun</i>	71
Chapter 4	Nanotechnologies for Cancer Diagnostics and Treatment <i>Phong Tran and Thomas J. Webster</i>	107
Chapter 5	Mechanical Characterization at Nanometric Scale of Ceramic Superconductor Composites <i>J.J. Roa, X.G. Capdevila and M. Segarra</i>	151
Chapter 6	ZnO Nanowire Arrays: Template-free Assembly Growth and Their Physical Properties <i>Bingqiang Cao and Weiping Cai</i>	237
Chapter 7	Spatially Resolved Control of Electrical Resistivity in Organic Materials —Development of a New Fabrication Method of Junction Structures <i>Toshio Naito</i>	275
Chapter 8	Fabrication of Electrical Contacts on Individual Metal Oxide Nanowires and Novel Device Architectures <i>Francisco Hernandez-Ramirez, Juan Daniel Prades, Roman Jimenez-Diaz, Olga Casals, Albert Cirera, Albert Romano-Rodriguez, Joan Ramon Morante, Sven Barth and Sanjay Mathur</i>	293

Chapter 9	Functionalization of Nanoparticles, Nanotubes and Nanowires by Surface-Initiated Atom Transfer Radical Polymerization <i>Jinying Yuan, Mi Zhou and Yingwu Yin</i>	309
Chapter 10	Synthesis and Applications of Nano-sized Ferroelectrics via Mechanochemical Activation <i>L.B. Kong, Z. Xu and T.S. Zhang</i>	331
Chapter 11	Preparation and Characterization of Monoatomic Carbon Chains: Unraveling, Field Ion Microscopy, and Field Emission <i>Igor M. Mikhailovskij</i>	371
Chapter 12	Sequential Nucleation and Growth of Complex Nanostructures by a Two-Step Strategy <i>Li Yang, Paul W. May and Lei Yin</i>	409
Chapter 13	Progress of Self-standing Diamond Film Fabricated by DC Arc Jet Plasma CVD <i>G.C. Chen, F.X. Lu, B. Li, C.M. Li, W.Z. Tang, J.H. Song, L.F. Hei and Y.M. Tong</i>	435
Chapter 14	Nanoshell Arrays: Fabrication and Enhanced Photoluminescence <i>Zhipeng Huang and Jing Zhu</i>	459
Chapter 15	A Strategy for the Incorporation of Trivalent Lanthanide Ions into Anatase TiO ₂ Nanocrystals <i>Wenqin Luo, Chengyu Fu, Renfu Li and Xueyuan Chen</i>	479
Chapter 16	Nanocrystallite Superhard Titanium Nitride Film in Multi-arc Ion Plating <i>Xiang Yu, Chengbiao Wang, Meng Hua, Yang Liu and Shengli Ma</i>	509
Chapter 17	Embedded Optical-electrical Nanomaterials Fabricated by Ion Implantation <i>X.T. Zu, X. Xiang, S. Zhu and L.M. Wang</i>	525
Chapter 18	Structural, Dynamical and Optical Properties of Self-assembled Porphyrins at the Mesoscopic Scale <i>Valentina Villari, Norberto Micali and Luigi Monsú Scolaro</i>	559
Short Communications		603
Short Communication A	The Influence of Thiophene Addition on Catalytic Pyrolysis of Poly (Dimethyl Siloxane) <i>K.F. Cai, C.W. Zhou, A.X. Zhang and J.L. Yin</i>	605

Short Communication B

Nanofinishing of Cotton Textiles

615*N. Vigneshwaran and Virendra Prasad***Index****621**

Chapter 1

ELECTROCHEMICAL NANOFABRICATION

Di Wei

Nokia Research Centre, c/o Nanoscience Centre
at University of Cambridge,
11 JJ Thomson Avenue, CB3 0FF, Cambridge, UK

Abstract

Nano- and micro-fabrications have been largely used in the applications such as integrated circuits, micro/nano electro-mechanical systems (M/NEMS), micro-optics and countless others. The methodology of nanofabrication can be divided into two types, top-down and bottom-up processes, which themselves can be further divided. Top-down process refers to approaching the nanoscale from the top (or larger dimensions), such as lithography, nanoimprinting, scanning probe and E-beam technique etc.. In bottom-up fabrication processes, the nanotechnology process builds nanoscale artifacts from the molecular level up, through single molecules or collections of molecules that agglomerate or self-assemble. Using a bottom-up approach, such as self-assembly enables scientists to create larger and more complex systems from elementary subcomponents (e.g. atoms and molecules). In general, top-down processes that transfer minute patterns onto material are more matured than bottom-up processes. An exception is epitaxial processes that create layers through layer-by-layer growth with registry at the atomic level.

Electrodeposition has actually been used for decades to form high quality, mostly metallic, thin films. It has recently been shown that high quality copper interconnects for ultra large scale integration chips can be formed electrochemically on Si wafer [1;2]. Electrodeposition has thus been shown compatible with state of the art semiconductor manufacturing technology. The largest semiconductor companies, for example, IBM, Intel, AMD, Motorola etc. are installing wafer-electroplating machines on their fabrication lines [1]. The electrodeposition of Cu with the line width 250 nm was used in the mass-production of micro-processor Pentium III in 1998. In 2003, the line width of the CPU was reduced to 130 nm in Pentium IV. Electrochemistry was largely used in chip fabrication [3] and the packaging of micro-electronics [4]. However, comparing with other nanofabrication techniques, electrochemical nanofabrication is still a maiden area which needs further development and fulfilment.