

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

Making Functional Materials with Nanotubes

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

MATERIALS RESEARCH SOCIETY
SYMPOSIUM PROCEEDINGS VOLUME 706

Making Functional Materials with Nanotubes

Symposium held November 26–29, 2001, Boston, Massachusetts, U.S.A.

EDITORS:

Patrick Bernier

Université de Montpellier II
Montpellier, France

Pulickel Ajayan

Rensselaer Polytechnic Institute
Troy, New York, U.S.A.

Yoshihiro Iwasa

Tohoku University
Sendai, Japan

Pavel Nikolaev

G.B. Tech./Lockheed Martin
Houston, Texas, U.S.A.



Materials Research Society

Warrendale, Pennsylvania

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

CAMBRIDGE UNIVERSITY PRESS

Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Mexico City

Cambridge University Press

32 Avenue of the Americas, New York NY 10013-2473, USA

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org

Information on this title: www.cambridge.org/9781107411999

Materials Research Society

506 Keystone Drive, Warrendale, PA 15086

<http://www.mrs.org>

© Materials Research Society 2002

This publication is in copyright. Subject to statutory exception
and to the provisions of relevant collective licensing agreements,
no reproduction of any part may take place without the written
permission of Cambridge University Press.

This publication has been registered with Copyright Clearance Center, Inc.
For further information please contact the Copyright Clearance Center,
Salem, Massachusetts.

First published 2002

First paperback edition 2013

Single article reprints from this publication are available through
University Microfilms Inc., 300 North Zeeb Road, Ann Arbor, MI 48106

CODEN: MRSPDH

ISBN 978-1-107-41199-9 Paperback

Cambridge University Press has no responsibility for the persistence or
accuracy of URLs for external or third-party internet websites referred to in
this publication, and does not guarantee that any content on such websites is,
or will remain, accurate or appropriate.

Cambridge University Press
978-1-107-41199-9 - Making Functional Materials with Nanotubes
Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev
Frontmatter
[More information](#)

CONTENTS

Preface.....xiii

Materials Research Society Symposium Proceedings.....xiv

*PROGRESS IN SYNTHESIS
AND PROCESSING I*

*** Fibers of Carbon Nanotubes.....3**
Brigitte Vigolo, Pascale Launois, Marcel Lucas, Stéphane Badaire,
Patrick Bernier, and Philippe Poulin

**Micropatterned Vertically Aligned Carbon Nanotube Growth
on a Si Surface or Inside Trenches for Field-Emission Devices9**
Jung Inn Sohn, Seonghoon Lee, Yoon-Ho Song, Sung-Yool Choi,
Jin Ho Lee, and Young-Il Kang

*PROGRESS IN SYNTHESIS AND
PROCESSING II*

*** Boron Nitride Nanotube, Nanocable and Nanocone.....19**
Dmitri Golberg, Yoshio Bando, Laure Bourgeois, Renzhi Ma,
Kazuhiko Ogawa, Keiji Kurashima, and Tadao Sato

**Processing of Single Wall Carbon Nanotubes and Implications
for Filling Experiments29**
Satishkumar B. Chikkannanavar, Brian W. Smith, Richard M. Russo,
Ferenc Stercel, and David E. Luzzi

Purification of SWNTs Using Microwave Heating35
Avetik R. Harutyunyan, Bhabendra K. Pradhan,
Gamini U. Sumanasekera, Jiping Chang, Gugang Chen,
H. Goto, J. Fujiwara, and Peter C. Eklund

*Invited Paper

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)***SYNTHESIS, PROCESSING, AND
POLYMER COMPOSITES***

Effects of Fe Film Thickness and Ammonia on the Growth Behavior of Carbon Nanotubes Grown by Thermal Chemical Vapor Deposition	43
Jung Inn Sohn, Chel-Jong Choi, Tae-Yeon Seong, and Seonghoon Lee	
Structure of Frilled Carbon Nanowires Synthesized by Sulfur-Assisted Chemical Vapor Deposition.....	49
Tadashi Mitsui, Takashi Sekiguchi, Mikka Nishitani-Gamo, Yafei Zhang, and Toshihiro Ando	
Controlling the Aligned Growth of Carbon Nanotubes by Substrate Selection and Patterning	55
Y. Jung, B.Q. Wei, R. Vajtai, J. Ward, R. Zhang, G. Ramanath, and P.M. Ajayan	
CFD Analysis on a Vortex Enhanced CVD Reactor Design	61
Kazunori Kuwana, Rodney Andrews, Eric A. Grulke, and Kozo Saito	
Reproducible Synthesis of C60@SWNT in 90% Yields	67
Brian W. Smith, Richard M. Russo, S.B. Chikkannanavar, Ferenc Stercel, and David E. Luzzi	
Carbon Networks Synthesized Using Microwave Plasma Enhanced Chemical Vapor Deposition	73
D.J. Yang, Qing Zhang, S.F. Yoon, J. Ahn, S.G. Wang, and Q. Wang	
Orientational Growth of Carbon Nanotube by Thermal CVD	79
Shen Zhu, Ching-Hua Su, J.C. Cochrane, S. Gorti, S. Lehoczky, Y. Cui, and A. Burger	
Electric Transport Properties and Percolation in Carbon Nanotubes/PMMA Composites.....	85
Jean-Michel Benoit, Benoit Corraze, Serge Lefrant, Patrick Bernier, and Olivier Chauvet	
Polymer-Single Wall Carbon Nanotube Composites for Potential Spacecraft Applications.....	91
Cheol Park, Zoubeida Ounaies, Kent A. Watson, Kristin Pawlowski, Sharon E. Lowther, John W. Connell, Emilie J. Siochi, Joycelyn S. Harrison, and Terry L. St. Clair	

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

Dispersion and Alignment of Carbon Nanotubes in Polycarbonate.....	97
Michael Sennett, Elizabeth Welsh, J.B. Wright, W.Z. Li, J.G. Wen, and Z.F. Ren	

NANOTUBE-POLYMER COMPOSITES

Carbon-Nanofiber-Filled Thermoplastic Composites	105
Jan Sandler, Milo S.P. Shaffer, Yeng-Ming Lam, Alan H. Windle, Philipp Werner, Volker Altstädt, Jacek Nastalczyk, Georg Broza, Karl Schulte, and Christian-André Keun	

NANOTUBES FOR FIELD EMISSION

Fabrication and Characterization of Carbon Nanotube Field Emitters.....	113
Jun Jiao, Lifeng Dong, David W. Tuggle, Catherine L. Mosher, Sean Foxley, and Jaswant Tawdekar	

The Role of Adsorbates on the Field Emission Properties of Single-Walled Carbon Nanotubes	119
R. Collazo, M. Liang, R. Schlessner, and Z. Sitar	

Field Emission Properties of Vertically Aligned Carbon Nanotubes Driven by Polar and Non-Polar Gas Adsorption.....	125
Youngsik Song, Brian Usner, Jaewu Choi, Seong-Chu Lim, and Young Hee Lee	

Plasma Enhanced Chemical Vapor Deposited Carbon Nanotubes for Field Emission Applications	131
K.B.K. Teo, G. Pirio, S.B. Lee, M. Chhowalla, P. Legagneux, Y. Nedellec, D.G. Hasko, H. Ahmed, D. Pribat, G.A.J. Amaratunga, and W.I. Milne	

***CHARACTERIZATION, FIELD EMISSION AND
ELECTRONIC DEVICES***

Injection of Polarized Spins and Anti-Localization Caused by Slight Doping of Heavy Impurities Into One End of Carbon Nanotubes	139
Junji Haruyama, Izumi Takesue, and Tetsuro Hasegawa	

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

Single-Wall Carbon Nanotube Electron Emitters Produced by Electrophoresis.....	145
Elena D. Obraztsova, Anatoly S. Pozharov, Sergey V. Terekhov, Alexander V. Osadchy, Sergey M. Pimenov, Vitaly I. Konov, T.V. Kononenko, Tatiana A. Skaballanovich, Svetlana R. Ivanova, Alexander P. Volkov, and Alexander N. Obraztsov	
Large-Area Deposition of Carbon Nanotubes for Field Emission Displays	151
Young-Jun Park, In-Taek Han, Ha-Jin Kim, Yun-Sung Woo, Nae-Sung Lee, Yong-Wan Jin, Jae-Eun Jung, Chong-Yun Park, and Jong-Min Kim	
Production and Characterization of MoSe₂ Nanotubes by Electron Irradiation	157
D.H. Galván, R. Rangel, and E. Adem	
Effects of Ion Irradiation on Supported Carbon Nanotubes and Nanotube-Substrate Interfaces.....	163
A.V. Krashenninnikov, K. Nordlund, and J. Keinonen	
Interference of Electron Waves on Carbon Nanotubes at Room Temperature	169
A. Hassanien, P. Umek, D. Vrbancic, M. Mozetic, P. Venturini, M. Tokumoto, D. Mihailovic, and S. Pejovnik	
Magnetic Anisotropy of Cerium Endohedral Metallofullerene	175
Masayasu Inakuma, Toshiaki Enoki, Haruhito Kato, and Hisanori Shinohara	
Dependence of the Second-Order G'-Band Profile on the Electronic Structure of Single-Wall Nanotubes.....	181
A.G. Souza Filho, A. Jorio, G. Dresselhaus, M.S. Dresselhaus, A.K. Swan, M.S. Ünlü, B.B. Goldberg, J.H. Hafner, C.M. Lieber, M.A. Pimenta, and R. Saito	
G-Band Raman Spectra of Isolated Single Wall Carbon Nanotubes Diameter and Chirality Dependence	187
A. Jorio, A.G. Souza Filho, G. Dresselhaus, M.S. Dresselhaus, A.K. Swan, M.S. Ünlü, B.B. Goldberg, M.A. Pimenta, J.H. Hafner, C.M. Lieber, and R. Saito	
Structure and Properties of C60@SWNT	193
Brian W. Smith, Richard M. Russo, S.B. Chikkannanavar, Ferenc Stercel, and David E. Luzzi	

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)**Thermodynamic Analysis of Carbon Nucleation on a Metal Surface..... 199**Vladimir L. Kuznetsov, Anna N. Usoltseva, Andrew L. Chuvilin,
Elena D. Obraztsova, Jean-Marc Bonard**Filling Single Wall Carbon Nanotubes with Metal Chloride
and Metal Nanowires and Imaging With Scanning
Transmission Electron Microscopy..... 205**Satishkumar B. Chikkannanavar, Andreas Taubert, and
David E. Luzzi**A Novel Class of Carbon Nanocones..... 211**

Svetlana Dimovski, Joseph A. Libera, and Yury Gogotsi

***CHARACTERIZATION OF NANOTUBE
SYSTEMS (LIMITS AND CHALLENGES)****** Raman Spectra From One Carbon Nanotube..... 219**M.S. Dresselhaus, A. Jorio, A.G. Souza Filho,
G. Dresselhaus, R. Saito, and M.A. Pimenta*** Interactions in Carbon Nanotubes and Polymer/Nanotubes
Composites as Evidenced by Raman Spectroscopy 231**Serge Lefrant, Jean-Pierre Buisson, Olivier Chauvet,
Jean-Michel Benoit, M. Baibarac, I. Baltog, and P. Bernier**Binary Phase of Layered Nanotubes..... 239**R.L.D. Whitby, W.K. Hsu, C.B. Boothroyd, P.K. Fearon,
H.W. Kroto, and D.R.M. Walton**Single Wall Carbon Nanotubes Filled With Metallocenes:
A First Example of Non-Fullerene Peapods..... 245**

F. Stercel, N.M. Nemes, J.E. Fischer, and D.E. Luzzi

***MODELING AND SIMULATIONS
OF NANOTUBE SYSTEMS****** Quantum Transport in Nanotube-Based Structures..... 253**

M. Buongiorno Nardelli, J.-L. Fattebert, and J. Bernholc

*Invited Paper

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

Li Uptake in Carbon Nanotube Systems: A First Principles Investigation	263
Vincent Meunier, Jeremy Kephart, Christopher Roland, and Jerry Bernholc	
<i>MODELING, ENERGY STORAGE, ELECTRODE APPLICATIONS, AND CHEMICAL MODIFICATIONS</i>	
Model Narrow Nanotubes Related to C₃₆, C₃₂ and C₂₀: Computational Insight	271
Zdenek Slanina and Filip Uhlík	
D-Band Raman Spectra of Graphite and Single Wall Carbon Nanotubes	277
R. Saito, A. Grueneis, L.G. Cançado, M.A. Pimenta, A. Jorio, A.G. Souza Filho, G. Dresselhaus, and M.S. Dresselhaus	
Atomistic Study of Mechanical Properties of Carbon Nanotubes	283
T. Narita and K. Shintani	
Carbon Nanotubes Under Bending Strain	289
M. Huhtala, A. Kuronen, and K. Kaski	
Pressure Isotherms of Hydrogen Adsorption in Carbon Nanostructures	295
Xiaohong Chen, Urszula Dettlaff-Weglikowska, Miroslav Haluska, Martin Hulman, Siegmur Roth, Michael Hirscher, and Marion Becher	
Pneumatic Actuator Response from Carbon Nanotube Sheets.....	301
Geoffrey M. Spinks, Gordon G. Wallace, Leonard S. Fifield, Larry R. Dalton, Alberto Mazzoldi, Danilo De Rossi, Ilyas I. Khayrullin, and Ray H. Baughman	
Focused Electron Beam Induced Deposition of High Resolution Magnetic Scanning Probe Tips	307
I. Utke, F. Cicoira, G. Jaenchen, P. Hoffmann, L. Scandella, B. Dwir, E. Kapon, D. Laub, Ph. Buffat, N. Xanthopoulos, and H.J. Mathieu	

Cambridge University Press
978-1-107-41199-9 - Making Functional Materials with Nanotubes
Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev
Frontmatter
[More information](#)

Utilizing Old Egyptian Wisdom for Stabilization of Individual Carbon Nanotubes in Aqueous Dispersions.....313
Rajdip Bandyopadhyaya, Einat Nativ-Roth, Oren Regev, and Rachel Yerushalmi Rozen

Study in the Dispersion of Carbon Nanotubes.....323
Matthew Bratcher, Bonnie Gersten, Helen Ji, and Jimmy Mays

ENERGY STORAGE, ELECTRODE APPLICATIONS AND CHEMICAL MODIFICATION OF NANOTUBES

Large Cryogenic Storage of Hydrogen in Carbon Nanotubes at Low Pressures331
B.K. Pradhan, A. Harutyunyan, D. Stojkovic, P. Zhang, M.W. Cole, V. Crespi, H. Goto, J. Fujiwara and P.C. Eklund

Thermoelectric Study of Hydrogen Storage in Carbon Nanotubes337
G.U. Sumanasekera, C.K.W. Adu, B.K. Pradhan, G. Chen, H.E. Romero, and P.C. Eklund

Carbon Nanotube Anodes for Lithium Ion Batteries343
Ryne P. Raffaele, Thomas Gennett, Jeff Maranchi, Prashant Kumta, Aloysius F. Hepp, Michael J. Heben, Anne C. Dillon, and Kim C. Jones

NANOTUBE-BASED DEVICES

*** Nanoengineering of Carbon Nanotubes and The Status of Its Applications.....353**
Yoshikazu Nakayama and Seiji Akita

Design and Quantification of a Nanoscale Field Effect Transistor: Distributed Response Analysis for Investigating Conductive Behavior365
Marc in het Panhuis, Jonathan N. Coleman, Paul A. Popelier, Brian Foley, Robert W. Munn, and Werner J. Blau

Imaging Schottky Barriers at Carbon Nanotube Contacts.....371
Marcus Freitag and A.T. Johnson

*Invited Paper

Cambridge University Press
978-1-107-41199-9 - Making Functional Materials with Nanotubes
Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev
Frontmatter
[More information](#)

**AFM-Based Surface Potential Measurements on Carbon
Nanotubes377**
Sandra B. Schujman, Robert Vajtai, Yuriy Shusterman,
Sujit Biswas, Brian Dewhurst, Leo J. Schowalter, Bin Q. Wei,
and Pulickel M. Ajayan

Author Index383

Subject Index.....387

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)

PREFACE

The possible use of carbon nanotubes in macroscale structures and microdevices has been demonstrated based on their exceptional mechanical, electronic, and chemical properties. The field is rapidly growing with a strong interdisciplinary focus spanning domains of solid-state physics and chemistry, materials engineering, composites, and biosystems. There are many likely applications for nanotubes ranging from nano-electronics to high-strength composites, field emission displays, and hydrogen storage materials.

The focus of the current volume, containing papers presented at Symposium Z, "Making Functional Materials with Nanotubes," held November 26–29 at the 2001 MRS Fall Meeting in Boston, Massachusetts, is on the designing, making, and understanding of nanotube-based materials, structures, and devices for any possible applications. Readers will find contributions concerning:

- Controlled synthesis routes producing either bulk quantities of nanotubes or organized nanotube arrays designed for specific applications; and
- Post-synthesis processing of nanotubes, during which the as-produced nanotubes are manipulated into elaborate nano- to macroscale systems.

This concerns chemical functionalization, self assembly, crystallization, coagulation to produce fibers and thin films, and orientation processes by magnetic or electric fields, etc.

Patrick Bernier
Pulickel Ajayan
Yoshihiro Iwasa
Pavel Nikolaev

April 2002

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)**MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS**

- Volume 664—Amorphous and Heterogeneous Silicon-Based Films—2001, M. Stutzmann, J.B. Boyce, J.D. Cohen, R.W. Collins, J. Hanna, 2001, ISBN: 1-55899-600-1
- Volume 665—Electronic, Optical and Optoelectronic Polymers and Oligomers, G.E. Jabbour, B. Meijer, N.S. Sariciftci, T.M. Swager, 2002, ISBN: 1-55899-601-X
- Volume 666—Transport and Microstructural Phenomena in Oxide Electronics, D.S. Ginley, M.E. Hawley, D.C. Paine, D.H. Blank, S.K. Streiffer, 2001, ISBN: 1-55899-602-8
- Volume 667—Luminescence and Luminescent Materials, K.C. Mishra, J. McKittrick, B. DiBartolo, A. Srivastava, P.C. Schmidt, 2001, ISBN: 1-55899-603-6
- Volume 668—II-VI Compound Semiconductor Photovoltaic Materials, R. Noufi, R.W. Birkmire, D. Lincot, H.W. Schock, 2001, ISBN: 1-55899-604-4
- Volume 669—Si Front-End Processing—Physics and Technology of Dopant-Defect Interactions III, M.A. Foad, J. Matsuo, P. Stolk, M.D. Giles, K.S. Jones, 2001, ISBN: 1-55899-605-2
- Volume 670—Gate Stack and Silicide Issues in Silicon Processing II, S.A. Campbell, C.C. Hobbs, L. Clevenger, P. Griffin, 2002, ISBN: 1-55899-606-0
- Volume 671—Chemical-Mechanical Polishing 2001—Advances and Future Challenges, S.V. Babu, K.C. Cadien, J.G. Ryan, H. Yano, 2001, ISBN: 1-55899-607-9
- Volume 672—Mechanisms of Surface and Microstructure Evolution in Deposited Films and Film Structures, J. Sanchez, Jr., J.G. Amar, R. Murty, G. Gilmer, 2001, ISBN: 1-55899-608-7
- Volume 673—Dislocations and Deformation Mechanisms in Thin Films and Small Structures, O. Kraft, K. Schwarz, S.P. Baker, B. Freund, R. Hull, 2001, ISBN: 1-55899-609-5
- Volume 674—Applications of Ferromagnetic and Optical Materials, Storage and Magnetoelectronics, W.C. Black, H.J. Borg, K. Bussmann, L. Hesselink, S.A. Majetich, E.S. Murdock, B.J.H. Stadler, M. Vazquez, M. Wuttig, J.Q. Xiao, 2001, ISBN: 1-55899-610-9
- Volume 675—Nanotubes, Fullerenes, Nanostructured and Disordered Carbon, J. Robertson, T.A. Friedmann, D.B. Geohagan, D.E. Luzzi, R.S. Ruoff, 2001, ISBN: 1-55899-611-7
- Volume 676—Synthesis, Functional Properties and Applications of Nanostructures, H.W. Hahn, D.L. Feldheim, C.P. Kubiak, R. Tannenbaum, R.W. Siegel, 2002, ISBN: 1-55899-612-5
- Volume 677—Advances in Materials Theory and Modeling—Bridging Over Multiple-Length and Time Scales, L. Colombo, V. Bulatov, F. Cleri, L. Lewis, N. Mousseau, 2001, ISBN: 1-55899-613-3
- Volume 678—Applications of Synchrotron Radiation Techniques to Materials Science VI, P.G. Allen, S.M. Mini, D.L. Perry, S.R. Stock, 2001, ISBN: 1-55899-614-1
- Volume 679E—Molecular and Biomolecular Electronics, A. Christou, E.A. Chandross, W.M. Tolles, S. Tolbert, 2001, ISBN: 1-55899-615-X
- Volume 680E—Wide-Bandgap Electronics, T.E. Kazior, P. Parikh, C. Nguyen, E.T. Yu, 2001, ISBN: 1-55899-616-8
- Volume 681E—Wafer Bonding and Thinning Techniques for Materials Integration, T.E. Haynes, U.M. Gösele, M. Nastasi, T. Yonehara, 2001, ISBN: 1-55899-617-6
- Volume 682E—Microelectronics and Microsystems Packaging, J.C. Boudreaux, R.H. Dauskardt, H.R. Last, F.P. McCluskey, 2001, ISBN: 1-55899-618-4
- Volume 683E—Material Instabilities and Patterning in Metals, H.M. Zbib, G.H. Campbell, M. Victoria, D.A. Hughes, L.E. Levine, 2001, ISBN: 1-55899-619-2
- Volume 684E—Impacting Society Through Materials Science and Engineering Education, L. Broadbelt, K. Constant, S. Gleixner, 2001, ISBN: 1-55899-620-6
- Volume 685E—Advanced Materials and Devices for Large-Area Electronics, J.S. Im, J.H. Werner, S. Uchikoga, T.E. Felter, T.T. Voutsas, H.J. Kim, 2001, ISBN: 1-55899-621-4
- Volume 686—Materials Issues in Novel Si-Based Technology, W. En, E.C. Jones, J.C. Sturm, S. Tiwari, M. Hirose, M. Chan, 2002, ISBN: 1-55899-622-2
- Volume 687—Materials Science of Microelectromechanical Systems (MEMS) Devices IV, A.A. Ayon, S.M. Sparing, T. Buchheit, H. Kahn, 2002, ISBN: 1-55899-623-0
- Volume 688—Ferroelectric Thin Films X, S.R. Gilbert, Y. Miyasaka, D. Wouters, S. Trolrier-McKinstry, S.K. Streiffer, 2002, ISBN: 1-55899-624-9

Cambridge University Press

978-1-107-41199-9 - Making Functional Materials with Nanotubes

Edited by Patrick Bernier, Pulickel Ajayan, Yoshihiro Iwasa and Pavel Nikolaev

Frontmatter

[More information](#)**MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS**

- Volume 689— Materials for High-Temperature Superconductor Technologies, M.P. Paranthaman, M.W. Rupich, K. Salama, J. Mannhart, T. Hasegawa, 2002, ISBN: 1-55899-625-7
- Volume 690— Spintronics, T.J. Klemmer, J.Z. Sun, A. Fert, J. Bass, 2002, ISBN: 1-55899-626-5
- Volume 691— Thermoelectric Materials 2001—Research and Applications, G.S. Nolas, D.C. Johnson, D.G. Mandrus, 2002, ISBN: 1-55899-627-3
- Volume 692— Progress in Semiconductor Materials for Optoelectronic Applications, E.D. Jones, M.O. Manasreh, K.D. Choquette, D. Friedman, 2002, ISBN: 1-55899-628-1
- Volume 693— GaN and Related Alloys—2001, J.E. Northrup, J. Neugebauer, S.F. Chichibu, D.C. Look, H. Riechert, 2002, ISBN: 1-55899-629-X
- Volume 695— Thin Films: Stresses and Mechanical Properties IX, C.S. Ozkan, R.C. Cammarata, L.B. Freund, H. Gao, 2002, ISBN: 1-55899-631-1
- Volume 696— Current Issues in Heteroepitaxial Growth—Stress Relaxation and Self Assembly, E. Stach, E. Chason, R. Hull, S. Bader, 2002, ISBN: 1-55899-632-X
- Volume 697— Surface Engineering 2001—Fundamentals and Applications, W.J. Meng, A. Kumar, Y-W. Chung, G.L. Doll, Y-T. Cheng, S. Veprek, 2002, ISBN: 1-55899-633-8
- Volume 698— Electroactive Polymers and Rapid Prototyping, Y. Bar-Cohen, D.B. Chrisey, Q.M. Zhang, S. Bauer, E. Fukada, S.C. Danforth, 2002, ISBN: 1-55899-634-6
- Volume 699— Electrically Based Microstructural Characterization III, R.A. Gerhardt, A. Washabaugh, M.A. Alim, G.M. Choi, 2002, ISBN: 1-55899-635-4
- Volume 700— Combinatorial and Artificial Intelligence Methods in Materials Science, I. Takeuchi, C. Buelens, H. Koinuma, E.J. Amis, J.M. Newsam, L.T. Wille, 2002, ISBN: 1-55899-636-2
- Volume 702— Advanced Fibers, Plastics, Laminates and Composites, F.T. Wallenberger, N. Weston, K. Chawla, R. Ford, R.P. Wool, 2002, ISBN: 1-55899-638-9
- Volume 703— Nanophase and Nanocomposite Materials IV, S. Komarneni, R.A. Vaia, G.Q. Lu, J-I. Matsushita, J.C. Parker, 2002, ISBN: 1-55899-639-7
- Volume 704— Nanoparticle Materials, R.K. Singh, R. Partch, M. Muhammed, M. Senna, H. Hofmann, 2002, ISBN: 1-55899-640-0
- Volume 705— Nanopatterning—From Ultralarge-Scale Integration to Biotechnology, L. Merhari, K.E. Gonsalves, E.A. Dobisz, M. Angelopoulos, D. Herr, 2002, ISBN: 1-55899-641-9
- Volume 706— Making Functional Materials with Nanotubes, P. Nikolaev, P. Bernier, P. Ajayan, Y. Iwasa, 2002, ISBN: 1-55899-642-7
- Volume 707— Self-Assembly Processes in Materials, S. Moss, 2002, ISBN: 1-55899-643-5
- Volume 708— Organic and Optoelectronic Materials, Processing and Devices, S. Moss, 2002, ISBN: 1-55899-644-3
- Volume 709— Advances in Liquid Crystalline Materials and Technologies, P.T. Mather, D.J. Broer, T.J. Bunning, D.M. Walba, R. Zentel, 2002, ISBN: 1-55899-645-1
- Volume 710— Polymer Interfaces and Thin Films, C.W. Frank, 2002, ISBN: 1-55899-646-X
- Volume 711— Advanced Biomaterials—Characterization, Tissue Engineering and Complexity, 2002, ISBN: 1-55899-647-8
- Volume 712— Materials Issues in Art and Archaeology VI, P.B. Vandiver, M. Goodway, J.R. Druzik, J.L. Mass, 2002, ISBN: 1-55899-648-6
- Volume 713— Scientific Basis for Nuclear Waste Management XXV, B.P. McGrail, G.A. Cragolino, 2002, ISBN: 1-55899-649-4
- Volume 714E—Materials, Technology and Reliability for Advanced Interconnects and Low-k Dielectrics II, S. Lahiri, 2002, ISBN: 1-55899-650-8

Prior Materials Research Society Symposium Proceedings available by contacting Materials Research Society