

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:

Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

**Magnetic Materials,
Structures and Processing
for Information Storage**

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:

Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

**MATERIALS RESEARCH SOCIETY
SYMPOSIUM PROCEEDINGS VOLUME 614**

Magnetic Materials, Structures and Processing for Information Storage

Symposium held April 24–27, 2000, San Francisco, California, U.S.A.

EDITORS:

Brian J. Daniels

Honeywell Electronic Materials
Sunnyvale, California, U.S.A.

Tom P. Nolan

Seagate Technology
Fremont, California, U.S.A.

Michael A. Seigler

Seagate Research
Pittsburgh, Pennsylvania, U.S.A.

Shan X. Wang

Stanford University
Stanford, California, U.S.A.

Christopher B. Murray

IBM T.J. Watson Research Center
Yorktown Heights, New York, U.S.A.



Materials Research Society
Warrendale, Pennsylvania

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

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/9781107413139

Materials Research Society

506 Keystone Drive, Warrendale, PA 15086

<http://www.mrs.org>

© Materials Research Society 2001

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 2001

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 978-1-107-41313-9 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
978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage
Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and
Christopher B. Murray
Frontmatter
[More information](#)

CONTENTS

Preface ix

Acknowledgments xi

Materials Research Society Symposium Proceedings xii

***PATTERNED MAGNETIC
RECORDING MEDIA I***

On Extreme Density of Data Storage in Patterned Magnetic Media F1.5
E. Meilikhov, B. Aronzon, B. Gurovich, and E. Kuleshova

***PATTERNED MAGNETIC
RECORDING MEDIA II***

**Superparamagnetic Behavior of Granular Co-C Films Consisting
of Nanocrystalline Cobalt Encapsulated in Carbon** F2.7
Hao Wang, S.P. Wong, W.Y. Cheung, N. Ke, M.F. Chiah,
G.H. Wen, and X.X. Zhang

***JOINT SESSION:
MAGNETIC RECORDING MEDIA***

TEM to Support Magnetic Media Development in YR2000 F3.3/G1.3
Warren J. MoberlyChan, Paul Dorsey, Tom Nolan,
Michael Alex, and Tom Yamashita

**Grain Size Relationships Between the Magnetic Layer and the
Underlayers in CoCrPtTa Recording Media** F3.4/G1.4
Kai Ma, Robert Sinclair, Gerardo Bertero, and Wei Cao

***Chemical Ordering and Microstructure of FePd Thin Films With
Perpendicular Magnetic Anisotropy** F3.7/G1.7
B. Gilles, F.F. Xu, D. Halley, A. Marty, Y. Samson, and G. Patrat

*Invited Paper

Cambridge University Press
978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage
Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and
Christopher B. Murray
Frontmatter
[More information](#)

*JOINT SESSION:
CHARACTERIZATION OF MAGNETIC
THIN FILMS AND STRUCTURES*

***X-ray Probes of Magnetic Multilayer Structure F4.1/G2.1**
B.K. Tanner, T.P.A. Hase, B.D. Fulthorpe, J. Clarke,
G.M. Luo, S.K. Halder, A.S.H. Rozatian, and S.B. Wilkins

**Structural Characterization of Epitaxial GMR Magnetic
Multilayers and Spin Valves Grown by Sputter Deposition F4.7/G2.7**
H. Geng, R. Loloee, J.W. Heckman, J. Bass, W.P. Pratt, Jr.,
and M.A. Crimp

**Residual Stresses and Magnetoelastic Coupling in Ultrathin
Fe Films Deposited on GaAs(001) F4.9/G2.9**
P. Gergaud, C. Lallaizon, M. Putero, B. Lépine, O. Thomas,
and A. Guivarc'h

*JOINT SESSION:
MAGNETIC TUNNEL JUNCTIONS AND
SPIN-DEPENDENT TRANSPORT*

**Spin-Dependent Electron Transport in Ferromagnet/Semiconductor
Schottky Barrier Structures F5.4/G3.4**
Atsufumi Hirohata, Yong-Bing Xu, Christian M. Guertler,
J. Anthony C. Bland, and Stuart N. Holmes

*JOINT SESSION:
GMR AND SPIN VALVES*

**First Principles Based Solution to the Boltzmann Transport
Equation for Co/Cu/Co Spin Valves F7.3/G5.3**
J.M. MacLaren, L. Malkinski, and J.Q. Wang

Manufacturability of GMR Heads: 10Gb/in² and Beyond F7.4/G5.4
S. Sahu, Jian Chen, V. Talghader, S. Cool, and S. Mao

**Changes in Stress and Microstructure in PtMn/CoFe Bilayers
During Annealing F7.6/G5.6**
S.P. Bozeman, B.J. Daniels, and D.J. Larson

*Invited Paper

Cambridge University Press
978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage
Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and
Christopher B. Murray
Frontmatter
[More information](#)

Large Anisotropy Via Oblique Sputtering of Ta Underlayers F7.7/G5.7
J.E. Bonevich, R.D. McMichael, C.G. Lee, P.J. Chen, W. Miller,
and W.F. Egelhoff

***POSTER SESSION:
MEDIA/GMR/CMR***

Structure and Magnetic Properties of Nd-Co-Fe-Si-C Intermetallics F8.4
Monica Sorescu, A. Grabias, and M. Vaeleau

**Magnetic Behavior and Structure of Electrodeposited,
Mechanically Hard Fe-C and Fe-Ni-C Alloys F8.6**
A.S.M.A. Haseeb, Y. Hayashi, and M. Masuda

**Magnetoresistive Properties of 1st AFM Co/Cu Multilayers
Sputtered in an Ar+O₂ Atmosphere F8.8**
D. Kubinski, M. Parsons, and J. Hangas

ESR Investigations on Ca Perovskite F8.11
M. Chipara, Sy-Hwang Liou, C.N. Borca, R. Shoemaker,
S. Adenwalla, and P.A. Dowben

**Magnetotransport and Magnetic Properties of La_{0.7}MnO_{3-δ} and
Pr_{0.65}Ba_{0.05}Ca_{0.3}MnO_{3-δ} Superlattices F8.12**
Srinivas V. Pietambaram, D. Kumar, Rajiv K. Singh, and C.B. Lee

***WRITER MATERIALS AND
CHARACTERISTICS***

***Microstructures and Soft Magnetic Properties of High Saturation
Magnetization Fe-Co-N Alloy Thin Films F9.2**
N.X. Sun, S.X. Wang, Chin-Ya Hung, Chester X. Chien,
and Hua-Ching Tong

***MAGNETIC STRUCTURE
PROCESSING TECHNIQUES***

***Dry Etching of MRAM Structures F10.2**
S.J. Pearton, H. Cho, K.B. Jung, J.R. Childress, F. Sharifi, and
J. Marburger

*Invited Paper

Cambridge University Press
978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage
Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and
Christopher B. Murray
Frontmatter
[More information](#)

Smoothing Thin Films With Gas-Cluster Ion Beams F10.3
D.B. Fenner, J. Hautala, L.P. Allen, J.A. Greer, W.J. Skinner,
and J.I. Budnick

Selective Area Chemical Vapor Deposition of Chromium Oxides F10.4
Ruihua Cheng, C.N. Borca, and P.A. Dowben

Author Index

Subject Index

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:

Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

PREFACE

This volume contains papers from Symposium F, "Magnetic Materials, Structures and Processing for Information Storage," held April 24–27 at the 2000 MRS Spring Meeting in San Francisco, California. Contributions in this volume focus on magnetic materials, modeling, structures, and processing as pertaining to information storage.

The exponential growth in information technologies has resulted in an explosion in the need for data storage with increased speed and reliability. These requirements have caused rapid development of complex magnetic materials and structures. The rate of technology development has led to a situation where the performance envelope of new materials is not fully known until the materials are fabricated into devices. In response to this, the focus of this volume is not only on magnetic materials, but also on techniques and technology associated with device fabrication, including sections on magnetic media, thin film/structure characterization, magnetic tunnel junctions, giant magnetoresistance, colossal magnetoresistance, processing techniques, and spin valves. The work presented in this volume effectively spans the range of the myriad of information storage research from concept to product.

Brian J. Daniels
Tom P. Nolan
Michael A. Seigler
Shan X. Wang
Christopher B. Murray

December 2000

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

ACKNOWLEDGMENTS

We would like to thank the following organizations for their generous support of this symposium:

IBM T.J. Watson Research Center
Kurt J. Lesker Company
Seagate Technology, Inc.
Unaxis Semiconductor (formerly Plasma-Therm, Inc.)
Veeco Instruments, Inc.

We would also like to thank all of the participants—speakers, poster presenters, session chairs, joint symposium organizers, and attendees—for making this a successful symposium.

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:
Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS

- Volume 578— Multiscale Phenomena in Materials—Experiments and Modeling, I.M. Robertson, D.H. Lassila, R. Phillips, B. Devincere, 2000, ISBN: 1-55899-486-6
- Volume 579— The Optical Properties of Materials, J.R. Chelikowsky, S.G. Louie, G. Martinez, E.L. Shirley, 2000, ISBN: 1-55899-487-4
- Volume 580— Nucleation and Growth Processes in Materials, A. Gonis, P.E.A. Turchi, A.J. Ardell, 2000, ISBN: 1-55899-488-2
- Volume 581— Nanophase and Nanocomposite Materials III, S. Komarneni, J.C. Parker, H. Hahn, 2000, ISBN: 1-55899-489-0
- Volume 582— Molecular Electronics, S.T. Pantelides, M.A. Reed, J. Murday, A. Aviram, 2000, ISBN: 1-55899-490-4
- Volume 583— Self-Organized Processes in Semiconductor Alloys, A. Mascarenhas, D. Follstaedt, T. Suzuki, B. Joyce, 2000, ISBN: 1-55899-491-2
- Volume 584— Materials Issues and Modeling for Device Nanofabrication, L. Merhari, L.T. Wille, K.E. Gonsalves, M.F. Gyure, S. Matsui, L.J. Whitman, 2000, ISBN: 1-55899-492-0
- Volume 585— Fundamental Mechanisms of Low-Energy-Beam-Modified Surface Growth and Processing, S. Moss, E.H. Chason, B.H. Cooper, T. Diaz de la Rubia, J.M.E. Harper, R. Murti, 2000, ISBN: 1-55899-493-9
- Volume 586— Interfacial Engineering for Optimized Properties II, C.B. Carter, E.L. Hall, S.R. Nutt, C.L. Briant, 2000, ISBN: 1-55899-494-7
- Volume 587— Substrate Engineering—Paving the Way to Epitaxy, D. Norton, D. Schlom, N. Newman, D. Matthiesen, 2000, ISBN: 1-55899-495-5
- Volume 588— Optical Microstructural Characterization of Semiconductors, M.S. Unlu, J. Piqueras, N.M. Kalkhoran, T. Sekiguchi, 2000, ISBN: 1-55899-496-3
- Volume 589— Advances in Materials Problem Solving with the Electron Microscope, J. Bentley, U. Dahmen, C. Allen, I. Petrov, 2000, ISBN: 1-55899-497-1
- Volume 590— Applications of Synchrotron Radiation Techniques to Materials Science V, S.R. Stock, S.M. Mini, D.L. Perry, 2000, ISBN: 1-55899-498-X
- Volume 591— Nondestructive Methods for Materials Characterization, G.Y. Baaklini, N. Meyendorf, T.E. Matikas, R.S. Gilmore, 2000, ISBN: 1-55899-499-8
- Volume 592— Structure and Electronic Properties of Ultrathin Dielectric Films on Silicon and Related Structures, D.A. Buchanan, A.H. Edwards, H.J. von Bardeleben, T. Hattori, 2000, ISBN: 1-55899-500-5
- Volume 593— Amorphous and Nanostructured Carbon, J.P. Sullivan, J. Robertson, O. Zhou, T.B. Allen, B.F. Coll, 2000, ISBN: 1-55899-501-3
- Volume 594— Thin Films—Stresses and Mechanical Properties VIII, R. Vinci, O. Kraft, N. Moody, P. Besser, E. Shaffer II, 2000, ISBN: 1-55899-502-1
- Volume 595— GaN and Related Alloys—1999, T.H. Myers, R.M. Feenstra, M.S. Shur, H. Amano, 2000, ISBN: 1-55899-503-X
- Volume 596— Ferroelectric Thin Films VIII, R.W. Schwartz, P.C. McIntyre, Y. Miyasaka, S.R. Summerfelt, D. Wouters, 2000, ISBN: 1-55899-504-8
- Volume 597— Thin Films for Optical Waveguide Devices and Materials for Optical Limiting, K. Nashimoto, R. Pachter, B.W. Wessels, J. Shmulovich, A.K.-Y. Jen, K. Lewis, R. Sutherland, J.W. Perry, 2000, ISBN: 1-55899-505-6
- Volume 598— Electrical, Optical, and Magnetic Properties of Organic Solid-State Materials V, S. Ermer, J.R. Reynolds, J.W. Perry, A.K.-Y. Jen, Z. Bao, 2000, ISBN: 1-55899-506-4
- Volume 599— Mineralization in Natural and Synthetic Biomaterials, P. Li, P. Calvert, T. Kokubo, R.J. Levy, C. Scheid, 2000, ISBN: 1-55899-507-2
- Volume 600— Electroactive Polymers (EAP), Q.M. Zhang, T. Furukawa, Y. Bar-Cohen, J. Scheinbeim, 2000, ISBN: 1-55899-508-0
- Volume 601— Superplasticity—Current Status and Future Potential, P.B. Berbon, M.Z. Berbon, T. Sakuma, T.G. Langdon, 2000, ISBN: 1-55899-509-9
- Volume 602— Magnetoresistive Oxides and Related Materials, M. Rzechowski, M. Kawasaki, A.J. Millis, M. Rajeswari, S. von Molnár, 2000, ISBN: 1-55899-510-2
- Volume 603— Materials Issues for Tunable RF and Microwave Devices, Q. Jia, F.A. Miranda, D.E. Oates, X. Xi, 2000, ISBN: 1-55899-511-0
- Volume 604— Materials for Smart Systems III, M. Wun-Fogle, K. Uchino, Y. Ito, R. Gotthardt, 2000, ISBN: 1-55899-512-9

Cambridge University Press

978-1-107-41313-9 - Materials Research Society Symposium Proceedings: Volume 614:

Magnetic Materials, Structures and Processing for Information Storage

Editors: Brian J. Daniels, Tom P. Nolan, Michael A. Seigler, Shan X. Wang and

Christopher B. Murray

Frontmatter

[More information](#)

MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS

- Volume 605— Materials Science of Microelectromechanical Systems (MEMS) Devices II, M.P. deBoer, A.H. Heuer, S.J. Jacobs, E. Peeters, 2000, ISBN: 1-55899-513-7
- Volume 606— Chemical Processing of Dielectrics, Insulators and Electronic Ceramics, A.C. Jones, J. Veteran, D. Mullin, R. Cooper, S. Kaushal, 2000, ISBN: 1-55899-514-5
- Volume 607— Infrared Applications of Semiconductors III, M.O. Manasreh, B.J.H. Stadler, I. Ferguson, Y.-H. Zhang, 2000, ISBN: 1-55899-515-3
- Volume 608— Scientific Basis for Nuclear Waste Management XXIII, R.W. Smith, D.W. Shoesmith, 2000, ISBN: 1-55899-516-1
- Volume 609— Amorphous and Heterogeneous Silicon Thin Films—2000, R.W. Collins, H.M. Branz, S. Guha, H. Okamoto, M. Stutzmann, 2000, ISBN: 1-55899-517-X
- Volume 610— Si Front-End Processing—Physics and Technology of Dopant-Defect Interactions II, A. Agarwal, L. Pelaz, H.-H. Vuong, P. Packan, M. Kase, 2000, ISBN: 1-55899-518-8
- Volume 611— Gate Stack and Silicide Issues in Silicon Processing, L. Clevenger, S.A. Campbell, B. Herner, J. Kittl, P.R. Besser, 2000, ISBN: 1-55899-519-6
- Volume 612— Materials, Technology and Reliability for Advanced Interconnects and Low-k Dielectrics, K. Maex, Y.-C. Joo, G.S. Oehrlein, S. Ogawa, J.T. Wetzel, 2000, ISBN: 1-55899-520-X
- Volume 613— Chemical-Mechanical Polishing 2000—Fundamentals and Materials Issues, R.K. Singh, R. Bajaj, M. Meuris, M. Moinpour, 2000, ISBN: 1-55899-521-8
- Volume 614— Magnetic Materials, Structures and Processing for Information Storage, B.J. Daniels, M.A. Seigler, T.P. Nolan, S.X. Wang, C.B. Murray, 2000, ISBN: 1-55899-522-6
- Volume 615— Polycrystalline Metal and Magnetic Thin Films—2000, L. Gignac, O. Thomas, J. MacLaren, B. Clemens, 2000, ISBN: 1-55899-523-4
- Volume 616— New Methods, Mechanisms and Models of Vapor Deposition, H.N.G. Wadley, G.H. Gilmer, W.G. Barker, 2000, ISBN: 1-55899-524-2
- Volume 617— Laser-Solid Interactions for Materials Processing, D. Kumar, D.P. Norton, C.B. Lee, K. Ebihara, X. Xi, 2000, ISBN: 1-55899-525-0
- Volume 618— Morphological and Compositional Evolution of Heteroepitaxial Semiconductor Thin Films, J.M. Millunchick, A.-L. Barabasi, E.D. Jones, N. Modine, 2000, ISBN: 1-55899-526-9
- Volume 619— Recent Developments in Oxide and Metal Epitaxy—Theory and Experiment, M. Yeadon, S. Chiang, R.F.C. Farrow, J.W. Evans, O. Auciello, 2000, ISBN: 1-55899-527-7
- Volume 620— Morphology and Dynamics of Crystal Surfaces in Complex Molecular Systems, J. DeYoreo, W. Casey, A. Malkin, E. Vlieg, M. Ward, 2000, ISBN: 1-55899-528-5
- Volume 621— Electron-Emissive Materials, Vacuum Microelectronics and Flat-Panel Displays, K.L. Jensen, W. Mackie, D. Temple, J. Itoh, R. Nemanich, T. Trottier, P. Holloway, 2000, ISBN: 1-55899-529-3
- Volume 622— Wide-Bandgap Electronic Devices, R.J. Shul, F. Ren, M. Murakami, W. Platschen, 2000, ISBN: 1-55899-530-7
- Volume 623— Materials Science of Novel Oxide-Based Electronics, D.S. Ginley, D.M. Newns, H. Kawazoe, A.B. Kozyrev, J.D. Perkins, 2000, ISBN: 1-55899-531-5
- Volume 624— Materials Development for Direct Write Technologies, D.B. Chrisey, D.R. Gamota, H. Helvajian, D.P. Taylor, 2000, ISBN: 1-55899-532-3
- Volume 625— Solid Freeform and Additive Fabrication—2000, S.C. Danforth, D. Dimos, F.B. Prinz, 2000, ISBN: 1-55899-533-1
- Volume 626— Thermoelectric Materials 2000—The Next Generation Materials for Small-Scale Refrigeration and Power Generation Applications, T.M. Tritt, G.S. Nolas, G. Mahan, M.G. Kanatzidis, D. Mandrus, 2000, ISBN: 1-55899-534-X
- Volume 627— The Granular State, S. Sen, M. Hunt, 2000, ISBN: 1-55899-535-8
- Volume 628— Organic/Inorganic Hybrid Materials—2000, R.M. Laine, C. Sanchez, E. Giannelis, C.J. Brinker, 2000, ISBN: 1-55899-536-6
- Volume 629— Interfaces, Adhesion and Processing in Polymer Systems, S.H. Anastasiadis, A. Karim, G.S. Ferguson, 2000, ISBN: 1-55899-537-4
- Volume 630— When Materials Matter—Analyzing, Predicting and Preventing Disasters, M. Ausloos, A.J. Hurd, M.P. Marder, 2000, ISBN: 1-55899-538-2

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