

# Nanostructured Magnetic Materials and their Applications

Edited by

Bekir Aktaş, Lenar Tagirov and Faik Mikailov

NATO Science Series

II. Mathematics, Physics and Chemistry – Vol. 143

TM 27-53  
N18  
0002

# Nanostructured Magnetic Materials and their Applications

edited by

**Bekir Aktaş**

Gebze Institute of Technology,  
Gebze, Kocaeli, Turkey

**Lenar Tagirov**

Kazan State University,  
Kazan, Russia

and

**Faik Mikailov**

Institute of Physics of NAS,  
Baku, Azerbaijan



E200501272

**Kluwer Academic Publishers**

Dordrecht / Boston / London

Published in cooperation with NATO Scientific Affairs Division

Proceedings of the NATO Advanced Research Workshop on  
Nanostructured Magnetic Materials and their Applications  
Istanbul, Turkey  
1–4 July 2003

A C.I.P. Catalogue record for this book is available from the Library of Congress.

ISBN 1-4020-2003-1  
ISBN 1-4020-2200-X (e-book)

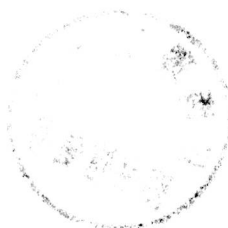
---

Published by Kluwer Academic Publishers,  
P.O. Box 17, 3300 AA Dordrecht, The Netherlands.

Sold and distributed in North, Central and South America  
by Kluwer Academic Publishers,  
101 Philip Drive, Norwell, MA 02061, U.S.A.

In all other countries, sold and distributed  
by Kluwer Academic Publishers,  
P.O. Box 322, 3300 AH Dordrecht, The Netherlands.

*Printed on acid-free paper*



---

All Rights Reserved

© 2004 Kluwer Academic Publishers

No part of this work may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, microfilming, recording or otherwise, without written permission from the Publisher, with the exception of any material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work.

Printed in the Netherlands.

# Nanostructured Magnetic Materials and their Applications

# NATO Science Series

*A Series presenting the results of scientific meetings supported under the NATO Science Programme.*

The Series is published by IOS Press, Amsterdam, and Kluwer Academic Publishers in conjunction with the NATO Scientific Affairs Division

## *Sub-Series*

<b>I. Life and Behavioural Sciences</b>	IOS Press
<b>II. Mathematics, Physics and Chemistry</b>	Kluwer Academic Publishers
<b>III. Computer and Systems Science</b>	IOS Press
<b>IV. Earth and Environmental Sciences</b>	Kluwer Academic Publishers
<b>V. Science and Technology Policy</b>	IOS Press

The NATO Science Series continues the series of books published formerly as the NATO ASI Series.

The NATO Science Programme offers support for collaboration in civil science between scientists of countries of the Euro-Atlantic Partnership Council. The types of scientific meeting generally supported are "Advanced Study Institutes" and "Advanced Research Workshops", although other types of meeting are supported from time to time. The NATO Science Series collects together the results of these meetings. The meetings are co-organized by scientists from NATO countries and scientists from NATO's Partner countries – countries of the CIS and Central and Eastern Europe.

**Advanced Study Institutes** are high-level tutorial courses offering in-depth study of latest advances in a field.

**Advanced Research Workshops** are expert meetings aimed at critical assessment of a field, and identification of directions for future action.

As a consequence of the restructuring of the NATO Science Programme in 1999, the NATO Science Series has been re-organised and there are currently Five Sub-series as noted above. Please consult the following web sites for information on previous volumes published in the Series, as well as details of earlier Sub-series.

<http://www.nato.int/science>

<http://www.wkap.nl>

<http://www.iospress.nl>

<http://www.wtv-books.de/nato-pco.htm>



**Series II: Mathematics, Physics and Chemistry – Vol. 143**

## Contributing Authors

**A. Al-Jibouri**

Nordiko Ltd., Havant, Hampshire, PO9 2NL, UK

**B. Aktaş**

Gebze Institute of Technology, P.O. 141,  
41400, Kocaeli, Turkey

**O.D. Asenchik**

Gomel State Technical University, October av. 48,  
Gomel, 246746, Belarus

**I. Avgin**

Electrical and Electronics Engineering Department,  
Ege University, Bornova, Izmir 35100 Turkey

**B. Bakar**

Universiteit Antwerpen Departement Natuurkunde  
Groenenborgerlaan, 171 B2020 Antwerpen België

**M. Bal**

University of Massachusetts, Department of Physics,  
Amherst, MA 01003, USA

**N. Berdunov**

SFI Laboratories, Trinity College,  
Dublin 2, Ireland

**F. S. Bergeret**

Ruhr-University Bochum,  
D-44780 Bochum, Germany

**H. Braak**

Institut für Festkörperforschung, Forschungszentrum Jülich GmbH,  
D-52425 Jülich, Germany d.buergler@fz-juelich.de

**G. Brown**

School for Computational Science and Information Technology,  
Florida State University, Tallahassee, FL, USA

**H. Brückl**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**M. Brzeska**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**D. E. Bürgler**

Institut für Festkörperforschung, Forschungszentrum Jülich GmbH,  
D-52425 Jülich, Germany

**M. Buchmeier**

Institut für Festkörperforschung, Forschungszentrum Jülich GmbH,  
D-52425 Jülich, Germany d.buergler@fz-juelich.de

**S. Budak**

Fatih University, Faculty of Art and Science,  
Physics Department, 34900, Istanbul, Turkey

**S.F. Ceballos**

SFI Laboratories, Trinity College,  
Dublin 2, Ireland

**H. Cheng**

Laboratorio de Física de Sistemas Pequeños y Nanotecnología  
Consejo Superior de Investigaciones Científicas  
Serrano 144, Madrid 28006, Spain

**J.P. Clerc**

Ecole Polytechnique, Universitaire de Marseille,  
Technopole de Chateau Gombert, 13453, Marseille, France

**D. Dolgy,**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**A. Domantovsky,**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**K.B. Efetov**

Ruhr-University Bochum,  
D-44780 Bochum, Germany

**M. Z. Fattakhov**

Zavoisky Physical-Technical Institute,  
Russian Academy of Sciences, 420029 Kazan

**N. García**

Laboratorio de Física de Sistemas Pequeños y Nanotecnología  
Consejo Superior de Investigaciones Científicas  
Serrano 144, Madrid 28006, Spain

**R.R. Gareev**

Institut für Festkörperforschung, Forschungszentrum Jülich GmbH,  
D-52425 Jülich, Germany

**I. A. Garifullin**

Zavoisky Physical-Technical Institute,  
Russian Academy of Sciences, 420029 Kazan

**N.N. Garifyanov**

Zavoisky Physical-Technical Institute,  
Russian Academy of Sciences, 420029 Kazan

**A. Gedanken**

Department of Chemistry, Bar-Ilan University,  
52900, Ramat-Gan, Israel



**G. Gorodetsky**

Department of Physics, Ben-Gurion University of the Negev,  
P.O. Box 653, 84105, Beer-Sheva, Israel

**A. Granovsky**

P Faculty of Physics, Lomonosov Moscow State University,  
119992 Moscow, Russia

**P. Grünberg**

Institut für Festkörperforschung, Forschungszentrum Jülich GmbH,  
D-52425 Jülich, Germany [d.buergler@fz-juelich.de](mailto:d.buergler@fz-juelich.de)

**C. Guerrero**

Laboratorio de Física de Sistemas Pequeños y Nanotecnología  
Consejo Superior de Investigaciones Científicas  
Serrano 144, Madrid 28006, Spain

**A. Gupta**

IBM T.J. Watson R.C., Yorktown Heights,  
New York 10598, USA

**B. Gurovich**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**T. He**

Department of Chemical and Materials Engineering,  
University of Cincinnati, Cincinnati, OH 45221-0012, USA

**B. Heinrich**

Simon Fraser University, Burnaby,  
BC, V5A 1S6, Canada

**A. Hütten**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**M. Inoue**

Toyohashi University of Technology,  
Toyohashi 441-8580, Japan

**J.S. Jiang**

Materials Science Division, Argonne National Laboratory,  
Argonne, Illinois USA

**S. Kämmerer**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**I.B. Khaibullin**

Kazan Physical-Technical Institute, Sibirsky Trakt 10/7,  
420029 Kazan, Russia

**R.I. Khaibullin**

Kazan Physical-Technical Institute, Sibirsky Trakt 10/7,  
420029 Kazan, Russia

**S. Ya. Khlebnikov**

Zavoisky Physical-Technical Institute,  
Russian Academy of Sciences, 420029 Kazan

**D.K. Kim**

Royal Institute of Technology, Materials Chemistry Division,  
Stockholm, Sweden

**H. Koop**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**A. Kozlov**

P Faculty of Physics, Lomonosov Moscow State University,  
119992 Moscow, Russia

**Y. Köseoğlu**

Fatih University, Physics Department,  
Istanbul, Turkey

**U. Kreibig**

Physikalisches Institut IA der RWTH, Sommerfeldstrasse 14,  
52056 Aachen, Germany

**V. Krivoruchko**

Donetsk Physics & Technology Institute,  
Donetsk-114, 83114 Ukraine

**E. Kuleshova,**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**A. Layadi**

Département de Physique, Université Ferhat Abbas,  
Sétif 19000, Algeria

**V. Leiner**

Institut Laue Langevin,  
Grenoble, France

**L.F. Lemmens**

Universiteit Antwerpen Departement Natuurkunde  
Groenenborgerlaan 171 B2020 Antwerpen België

**J. Lian**

Department of Nuclear Engineering and Radiological Science,  
University of Michigan, Ann Arbor, MI 48109, USA

**Z. Lu**

CRIST, School of Computing, Communication and Electronics,  
Univerisyt of Plymouth, Plymouth, Devon, PL4 8AA, UK

**G. Mariotto**

SFI Laboratories, Trinity College,  
Dublin 2, Ireland

**K. Maslakov,**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**E. Meilikhov,**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**D. Meyners**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**M. Muhammed**

Royal Institute of Technology, Materials Chemistry Division,  
Stockholm, Sweden

**W. Nawrocki**

Poznan University of Technology, ul. Piotrowo 3A,  
60-965 Poznan, Poland

**N.D. Nikolic**

Laboratorio de Física de Sistemas Pequeños y Nanotecnología  
Consejo Superior de Investigaciones Científicas  
Serrano 144, Madrid 28006, Spain

**M.A. Novotny**

Mississippi State University,  
Mississippi State, MS, USA

**C. Okay**

Faculty of Art and Science, Physics Department,  
Marmara University, P.K. 81040, Göztepe/Istanbul, Turkey

**M. Özdemir**

Faculty of Art and Science, Physics Department,  
Marmara University, Istanbul Turkey

**K. Özdoğan**

Gebze Institute of Technology, P.K.141,  
41400, Kocaeli, Turkey

**Y. Öztürk**

Electrical and Electronics Engineering Department,  
Ege University, Bornova, Izmir 35100 Turkey

**G. Pan**

CRIST, School of Computing, Communication and Electronics,  
Univerisyt of Plymouth, Plymouth, Devon, PL4 8AA, UK

**G. Pang**

Department of Chemistry, Bar-Ilan University,  
52900, Ramat-Gan, Israel

**A.C. Papageorgopoulos**

Laboratorio de Física de Sistemas Pequeños y Nanotecnología  
Consejo Superior de Investigaciones Científicas  
Serrano 144, Madrid 28006, Spain

**R. Pecenka**

Physikalisches Institut IA der RWTH, Sommerfeldstrasse 14,  
52056 Aachen, Germany

**L.L. Pohlmann**

Institut für Festkörperforschung, Forschungszentrum Jülich GmbH,  
D-52425 Jülich, Germany [d.buergler@fz-juelich.de](mailto:d.buergler@fz-juelich.de)

**K. Prikhodko,**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**B.Z. Rameev**

Kazan Physical-Technical Institute, Sibirsky Trakt 10/7,  
420029 Kazan, Russia

**A. Reinholdt**

Physikalisches Institut IA der RWTH, Sommerfeldstrasse 14,  
52056 Aachen, Germany

**G. Reiss**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**P.A. Rikvold**

Center for Materials Research and Technology and Department of  
Physics, Florida State University, Tallahassee, FL, US

**E. Rozenberg**

Department of Physics, Ben-Gurion University of the Negev,  
P.O. Box 653, 84105, Beer-Sheva, Israel

**V. Rylkov,**

Russian Research Center "Kurchatov Institute", Kurchatov sq. 1,  
Moscow 123182, Russia

**J. Schmalhorst**

University of Bielefeld, Department of Physics, Nanodevice group,  
P.O. Box 100 131, 33501 Bielefeld, Germany

**T. Schmitte**

Institut für Experimentalphysik/Festkörperphysik,  
Ruhr-Universität, D 44780 Bochum, Germany

**R. Schreiber**

Institut für Festkörperforschung, Forschungszentrum Jülich GmbH,  
D-52425 Jülich, Germany [d.buergler@fz-juelich.de](mailto:d.buergler@fz-juelich.de)

**A.I. Shames**

Department of Physics, Ben-Gurion University of the Negev,  
P.O. Box 653, 84105, Beer-Sheva, Israel

**D. Shi**

Department of Chemical and Materials Engineering, University of  
Cincinnati, Cincinnati, OH 45221-0012, USA

**I.V. Shvets**

SFI Laboratories, Trinity College,  
Dublin 2, Ireland

**A. Smirnov**

P. L. Kapitza Institute for Physical Problems RAS,  
117334 Moscow, Russia

**E.G. Starodubtsev**

Gomel State Technical University, October av. 48,  
Gomel, 246746, Belarus

**A.L. Stepanov**

Kazan Physical-Technical Institute, Sibirsky Trakt 10/7,  
420029 Kazan, Russia

**S. M. Stinnett**

Mississippi State University., Mississippi State, MS, USA

**L.R. Tagirov**

Kazan State University, 420008 Kazan, Russian Federation

**S. Tarapov**

Institute of Radiophysics and Electronics NAS of Ukraine,  
12 Ac Proskura St., 61085, Kharkov, Ukraine

**K. Theis-Bröhl**

Institut für Experimentalphysik/Festkörperphysik,  
Ruhr-Universität Bochum, 44780 Bochum, Germany

**A. Thomas**

MIT, Francis Bitter Magnet Lab., NW 14-2128,  
170 Albany St., 02139 Cambridge, MA, USA

**D.A. Tikhonov**

Zavoisky Physical-Technical Institute,  
Russian Academy of Sciences, 420029 Kazan

**M.T. Tuominen**

University of Massachusetts,  
Department of Physics,  
Amherst, MA 01003, USA

**R. Urban**

Simon Fraser University, Burnaby,  
BC, V5A 1S6, Canada

**B.P. Vodopyanov**

Kazan Physico-technical Institute of RAS,  
420029 Kazan, Russian Federation

**F. Volkov**

Ruhr-University Bochum,  
D-44780 Bochum, Germany

**H. Wang**

Laboratorio de Física de Sistemas Pequeños y Nanotecnología  
Consejo Superior de Investigaciones Científicas  
Serrano 144, Madrid 28006, Spain

**L.M. Wang**

Department of Nuclear Engineering and Radiological Science,  
University of Michigan, Ann Arbor, MI 48109, USA

**M. Wawrzyniak**

Poznan University of Technology,  
ul. Piotrowo 3A, 60-965 Poznan, Poland

**K. Westerholt**

Institut für Experimentalphysik/Festkörperphysik,  
Ruhr-Universität Bochum, 44780 Bochum, Germany

**A. Westphalen**

Institut für Experimentalphysik/Festkörperphysik,  
Ruhr-Universität, D 44780 Bochum, Germany

**G. Woltersdorf**

Simon Fraser University, Burnaby,  
BC, V5A 1S6, Canada

**A. Yakubovsky**

Russian Research Center "Kurchatov Institute",  
Kurchatov sq. 1, Moscow 123182, Russia

**O. Yalçın**

Department of Physics, Gaziosmanpaşa University,  
60110, Tokat Turkey

**R. Yilgin**

Gebze Institute of Technology, P.K.141,  
41400, Kocaeli, Turkey

**F. Yıldız**

Gebze Institute of Technology, P.K.141,  
41400, Kocaeli, Turkey



**A. Yurasov**

P Faculty of Physics, Lomonosov Moscow State University,  
119992 Moscow, Russia

**H. Zabel**

Institut für Experimentalphysik/Festkörperphysik,  
Ruhr-Universität Bochum, 44780 Bochum, Germany

**V.A. Zhikharev**

Kazan Physical-Technical Institute of RAS,  
420029 Kazan, Russia

**M. Ziese**

Department of Superconductivity and Magnetism,  
University of Leipzig, 04103 Leipzig, Germany