Reviews on Advanced Materials Science

Volume 5, Number 2, October 2003

Proceedings

of "Nano Workshop for US Scientists at the International Conference NANOMATERIALS AND NANOTECHNOLOGIES (Crete, Creece, August 30 – September 6, 2003)"

Guest Editor: **S. Seal**

University of Central Florida

Editorial Policy. The journal “Reviews on Advanced Materials Science” provides an international medium for the publication of reviews, topical issues and international conference proceedings in the area of theoretical and experimental study of advanced materials. Focuses are placed on, but not limited to nanostructured materials, semiconductors and high-transition-temperature superconductors. We encourage prospective authors to correspond with the principal editor before submitting a review article. Proposals should include an outline with key citations. All papers submitted will be rigorously peer-reviewed prior to publication. The journal “Reviews on Advanced Materials Science” is published in both paper and electronic versions.

CONTENTS

PREFACE

The emerging fields of nanoscience and engineering – the ability to work at the molecular level, atom by atom, to create large structures with fundamentally new molecular organization – are leading to unprecedented understanding and control over the fundamental building blocks of all physical things. Compared to the physical properties and behavior of isolated molecules or bulk materials, materials with structural features in the ranges of 1 to 100 nanometers – 100 to 10,000 times smaller than the diameter of a human hair – exhibit important changes for which traditional models and theories cannot explain. Developments in this emerging arena are likely to revolutionize the scientific world – from medical vaccines to computers to automobile parts to objects not yet envisioned – is designed and made.

The US nanoinitiative (NNI) will support long-term nanoscale research and development leading to potential breakthroughs in areas such as materials and manufacturing, nanoelectronics, medicine and healthcare, environment, energy, chemicals, biotechnology, agriculture, information technology, and national security. The effect of nanotechnology on the health, wealth, and lives of people could be at least as significant as the combined influences of microelectronics, medical imaging, computer-aided engineering, and man-made polymers developed in this century. The initiative, which nearly doubles the nanoscale R&D investment over FY 2000 and continuing to 2003, supports a broad range of scientific disciplines including material sciences, physics, chemistry, and biology, and creates new opportunities for interdisciplinary research.

Agencies participating in the NNI include the National Science Foundation (NSF), the Department of Defense (DOD), the Department of Energy (DOE), National Institutes of Health (NIH), National Aeronautics and Space Administration (NASA), and the Department of Commerce's National Institute of Standards and Technology (DOC/NIST). Roughly 70% of the new funding proposed under the NNI will go to university-based research; funds that will help meet the growing demand for workers with nanoscale science and engineering skills. Nanoscience is still in its infancy and, outside of a handful of examples, only rudimentary nanostructures can be created with some control. It will take many years of sustained investment to achieve many of the NNI's research goals, but that is precisely why there is an important role for the Federal government.

To address the issue of international cooperation and monitoring, it is prudent to arrange frequent visits to foreign countries as well as to develop collaborative research programs with foreign institutions. It is easier for academic researchers to gain first-hand knowledge of the scientific and technological research being pursued in other parts of the world than for the US companies to learn what is happening in the foreign research laboratories and academic institutions. Visits by US delegation to European Nano conferences and Workshops, and academic institutions can greatly help in this regard. This NSF workshop is aimed at organizing a visit by a US delegation to participate in a "Nano Workshop for US Scientists at the International Conference on NANOMATERIALS AND NANOTECHNOLOGIES - NN2003, Crete, Greece, Aug 30–Sep 6 – 2003".

In order to further strengthen the ties between the US and Western researchers for exchange of technical information and for conducting cooperative research of mutual interest, it is important that the NSF encourages participation in this conference, and provides opportunities for US scientists to interact with the rest of the world's researchers. Such opportunities should be provided to a diversified group of scientists (from Academia, National Laboratories, including Professors, Postdoctoral fellows and minority participants) as a part of any US delegation. The goal of this workshop is to provide incentives to these researchers to consider making this trip and obtaining the first-hand knowledge. Partial travel support from

NSF can help them to attract funds from other sources including their institutions and research sponsors, and other activities as noted below.

- Synthesis, Processing, Assembly and Manufacturing of Nanostructures
- Advanced Probes and Characterization Methods of Nanostructures
- Modeling of Nanostructures
- Functional Properties (Mechanical, Magnetic, Optical and Electronic)
- Applications including Structural, Device, Electronic, Biochemical, Biomedical and Biological
- Identification of future directions for R&D in this area
- The gathering of invited international experts to address this area of high technology will bring a broad impact to R&D in the US, European, Asian and other countries, with consequent benefits to regional and global economy.

This conference provided an opportunity to discuss important research activities in nanoscience through state-of-the-art review lectures, contributed papers, panel discussions, and workshops. This event comprised a diverse community, including internationally renowned experts, young researchers, graduate students and minorities. The conference attracted about 130 participants around the world, including about forty US participants.

This Conference "Nanomaterials and Nanotechnologies (NN 2003) and the workshop aims to discuss in-depth the current trends and future challenges of this new emerging field. We are now at the threshold of a revolution in the ways in which materials and products are created. How this revolution will develop, how great will be the opportunities that nanostructuring can yield, and how rapidly we progress, will depend upon the ways in which a number of challenges are met.

Among the challenges facing us are those concerned with making the necessary advances in enabling technologies in order for rapid progress to continue in this field. We must increase characterization capabilities in visualization and chemical analysis at ever-finer size scales. We must be able to manipulate matter at ever finer size scales, and we must eventually use computational approaches in directing this, if we are really going to take full advantage of the available opportunities.

Furthermore, we need to understand the critical roles that surfaces and interfaces play in nanostructured materials. Nanoparticles have very high specific surface areas, and thus in their assembled forms there are large areas of interfaces. We need to know in detail not only the structures of these interfaces, but also their local chemistries and the effects of segregation and interaction between the nanoscale building blocks and their surroundings. We need to learn more about the control of nanostructure size and size distribution, composition, and assembly. For some applications, there are very stringent conditions on these parameters; in other applications less so. We must therefore understand the relationships between this stringency and the desired material or device properties. We also need to be concerned with the thermal, chemical, and structural stability of nanostructured materials and the devices made there from, in the face of both the temperature and changing chemistries of the environments in which these nanostructures are asked to function. A nanostructure that is only a nanostructure at the beginning of a process is not of much use to anybody, unless the process is over in a very short time or the process itself is the actual nanostructure advantage.

So for many applications, stability is an important consideration, and we must investigate whether natural stability is sufficient or whether we must additionally stabilize against changes that we cannot afford. To effectively commercialize and utilize the nanostructuring of matter we also need enhancements in statistically driven process control. Achieving reproducibility and scalability of nanoparticle synthesis and consolidation processes in nanostructuring/manufacturing are paramount if successful scale-up is to be effected and if what we do in the laboratory is to contribute to the society that pays for this research.

Given a commercial need, the viability of nanostructure production and utilization is wrapped up in the costs of precursors or raw materials, processing costs, and also the costs of dealing with effluent. It is the total integrated cost, in terms of raw materials, synthesis of the building blocks, manufacture of parts from those building blocks, and effluent clean-up costs, that is important and that will ultimately determine commercial viability. Establishing basic material structure-function relationships is now of great importance to a wide range of future applications in sensing, magneto-electronics, data storage, biomedical devices, catalysis, etc. and other functional devices.

Finally, in order for the field of nanostructure science and technology to truly reach fruition, it is an absolute necessity to create a new breed of researchers who can work across traditional disciplines and think "outside the box." Educating this new breed of researchers, who will either work across disciplines or know how to work with others in the interfaces between disciplines, is vital to the future of nanostructure science and technology. People must start thinking in unconventional ways if we are to take full advantage of the opportunities in this new and revolutionary field.

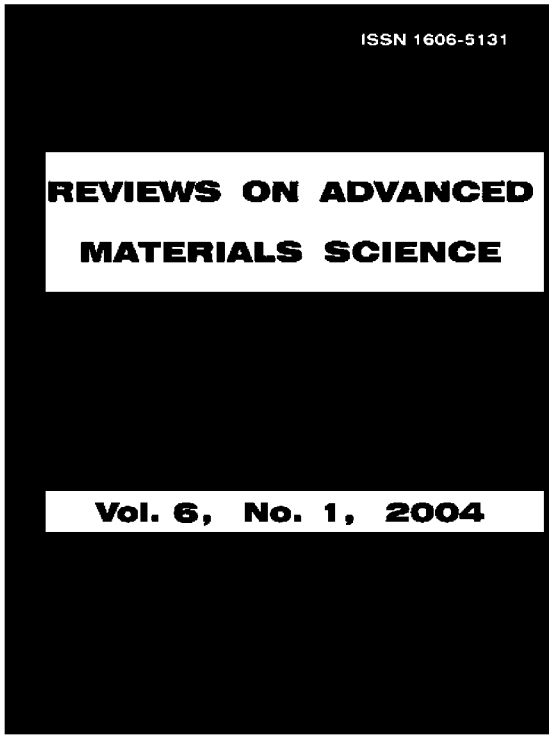
The participants in this NSF sponsored workshop are Sudipta Seal: Associate Professor, Nanoinitiative coordinator and the Organizer of the Workshop, Advanced Materials Processing and Analysis Center and Mechanical, Materials and Aerospace and Engineering, University of Central Florida (Tile: Phase Stabilization in Nanocrystalline Zirconia – NANO PARTICLES in LARGE SCALE), M. J. Soileau: (Vice President Research), University of Central Florida (Title: Merging Science and Technology: A Coherent Sum), Fereshteh Ebrahami: Professor, Materials Science and Engineering, University of Florida, Florida (Tile: Structure and Properties of Electrodeposited Nanocrystalline FCC Ni-Fe Alloys – NANO STRUCTURAL MATERIALS), Carl. C. Koch: Professor, North Carolina State University, (Title: Top-down synthesis of nanostructured materials: mechanical and thermal processing methods – NANO SYNTHESIS & MECHANICAL, THERMAL PROPERTIES), Pelagia-Irene (Perena) Gouma Assistant Professor, SUNY at Stony Brook, Stony Brook (Title: Nanostructured Polymorphic Oxides for Advanced Chemosensors – NANO BIO SENSORS), Ramma Reddy: Professor, ACIPCO Professor and Associate Director, The University of Alabama, (Title: Processing of Nanoscale Materials – NANO MANUFACTURING), Merrilea Joyce Mayo: Professor & Scientist, GUIRR, The National Academies, (Title: Thermodynamics for nanosystems: grain and particle-size dependent phase diagrams – NANO – THERMODYNAMICS), Billie Abrams: Scientist and Post Doctoral Fellow, Sandia National Laboratory (Title: Degradation of nanoparticulate-coated and uncoated sulfide-based cathodoluminescent phosphors. – NANO ELECTRONICS), and Ilya Ovid'ko: Professor, Russian Academy of Sciences, Organizer of NN 2003 Conference on Nanomaterials and Nanotechnologies.

Sudipta Seal
NSF Nanotechnology Workshop Chair – NN 2003 Conference, Crete, Greece

Journal
REVIEWS ON ADVANCED MATERIALS SCIENCE

ADVANCED MATERIALS AND NANOSTRUCTURES FROM A NEW ANGLE!

The journal **«Reviews on Advanced Materials Science»** (Principal Editor: I.A.Ovid'ko) provides an international medium for the publication of review articles, conference proceedings and topical issues in the area of theoretical and experimental studies of advanced materials. Particular attention is paid to fundamental and applied research of advanced nanostructured materials.



2004, four or more Issues
ISSN Print 1606-5131

Institutional Rate
for Print Version: US$ 390.00
(plus Free Online Version)

Personal Rate
for Print Version: US$ 169.00
(plus Free Online Version)

For subscription order and details, see back page

Titles of some review papers published in *Reviews on Advanced Materials Science*:
Top-Down Synthesis of Nanostructured Materials: Mechanical and Thermal Processing Methods (by C.C. Koch); Thermodynamics for Nanosystems: Grain and Particle Size Dependent Phase Diagrams (by M.J. Mayo et al) "Ferroelectric Nanotubes" (by F.D. Morrison et al); "Diffusion and Related Phenomena in Bulk Nanostructured Materials" (by M.D. Baro et al); "Theoretical Models of Plastic Deformation Processes in Nanocrystalline Materials" (by M.Yu.Gutkin et al); "Disclinations in Large-Strain Plastic Deformation and Work-Hardening" (by M.Seefeldt)

The journal **«Reviews on Advanced Materials Science»** in the electronic form may be found on the websites: **http://www.ipme.nw.ru/e-journals/RAMS/** and **http://www.ipme.ru/e-journals/RAMS/**

NEW JOURNAL

MATERIALS PHYSICS AND MECHANICS

Commencing publication with the March 2000 issue, the new journal "Materials Physics and Mechanics" specializes in the rapid publication of international conference proceedings in every area of materials physics and mechanics. This permits such proceedings to be conveniently referenced, abstracted and read. All contributions are peer-reviewed, edited by the corresponding guest editor(s) and they may not be published elsewhere. The journal covers research activities in physics and mechanics of the traditional as well as the newly emerging materials.

The journal "Materials Physics and Mechanics" is published in both paper and electronic versions.

Audience: Materials Scientists, Physicists, Metallurgists, Mechanical Engineers, Ceramists

Postal Address:

Materials Physics and Mechanics
Editorial Office

Institute of Problems of Mechanical Engineering
Russian Academy of Sciences
Bolshoj 61, Vas.Ostrov, St.Petersburg, 199178, Russia

Fax: +7 (812)321 4771
E-mail: mpm@def.ipme.ru

Web-sites: http://www.ipme.nw.ru/e-journals/MPM/
http://www.ipme.ru/e-journals/MPM/

ADVANCED STUDY CENTER.
TRANSFER OF COPYRIGHT AGREEMENT

Article entitled:
Corresponding author:

To be published in the journal: "Reviews on Advanced Materials Science"

Effective upon acceptance for publication, copyright (including all rights thereunder and including the right to authorise photo-copying and reproduction in all media, whether separately or as a part of a journal issue or otherwise) in the above article and any modifications of it by the author(s) is hereby transferred throughout the world and for the full term and all extensions and renewals, to:

"Advanced Study Center" Co. Ltd., (St. Petersburg, Russia)

This transfer includes the right to adapt the presentation of the article for use in conjunction with computer systems and programs, including reproduction or publication in machine-readable form and incorporation in retrieval systems.

Rights of authors

The following rights are retained by the author(s):

1. Patent and trademark rights and rights to any process or procedure described in the article.
2. The right to photocopy or make single electronic copies of the article for their own personal use, including for their own classform use, or for the personal use of colleagues, provided the copies are not offered for sale and are not distributed in a systematic way outside of their employing institution (e.g. via an e-mail list or public file server). Posting of a preprint version of this work on an electronic public server is permitted. Posting of the published article on a secure network (not accessible to the public) within the author's institution is permitted. However, posting of the published article on an electronic public server can only be done with written permission of Advanced Study Center. Co. Ltd.
3. The right, subsequent to publication, to use the article or any part thereof free of charge in a printed compilation of works of their own, such as collected writings or lecture notes, in a thesis, or to expand the article into book-length form for publication.

Note

All copies, paper or electronic, or other use of the information must include an indication of the copyright ownership and a full citation of the journal source. ***Please refer requests for all uses not included above, including the authorization of third parties to reproduce or otherwise use all or part of the article (including figures and tables) to:***

Reviews on Advanced Materials Science
Editorial Office
Institute of Problems of Mechanical Engineering Russian Academy of Sciences
Bolshoj 61, Vas.Ostrov, St.Petersburg 199178, Russia
E-mail: rams@def.ipme.ru Fax: +(7 812)321 4771

Authorship

If the article was prepared jointly with other author(s), the signing author has informed the co-author(s) of the terms of this copyright transfer and is signing on their behalf as their agent and represents that he or she is authorized to do so. Please confirm by marking the appropriate box following the signature line. The signing author shall bear the responsibility for designating the co-author(s) and must inform Advanced Study Center of any changes in authorship.

If copyright is held by the employer, the employer or an authorized representative of the employer must sign. If the author signs, it is understood that this is with the authorization of the employer and the employer's acceptance of the terms of the transfer. Please confirm by marking the appropriate box following the signature line.

Warranties

The author(s) warrant(s) that the article is the author's original work and has not been published before. The author(s) warrant(s) that the article contains no libelous or other unlawful statements, and does not infringe on

the rights of others. If experts from copyrighted works are included, the author(s) has (have) obtained or will obtain written permission from the copyright owners and will credit the sources in the article.

Signature of copyright owner(s) *:
Name (printed):
Title (if employer representative):
Company or institution:
Date:

If any of the following apply, please mark the box(es):

author on behalf of all co-authors
employer representative

PLEASE SIGN IN INK AND RETURN THE COMPLETE **ORIGINAL** (do not send by fax), retaining a copy of this form for your files, TO:

Reviews on Advanced Materials Science
Editorial Office
Institute of Problems of Mechanical Engineering Russian Academy of Sciences
Bolshoj 61, Vas.Ostrov, St.Petersburg 199178, Russia
E-mail: rams@def.ipme.ru, Fax: +(7 812)321 4771

*To be signed by the author, also on behalf of any co-authors, or to be signed by employer, where appropriate.

INSTRUCTIONS FOR AUTHORS

Submission of papers:

Manuscript should be submitted in English in both electronic (by e-mail) and hard copy (original +copy) versions.

Hard copy submission:

Manuscripts should be submitted typed on good quality bond paper of A4 format with 1" margins (right, left, top, bottom), double-spaced, using Times Roman 12 pt font, to:

Reviews on Advanced Materials Science
Editorial Office
Institute of Problems of Mechanical Engineering
Russian Academy of Sciences
Bolshoj 61, Vas.Ostrov, St.Petersburg, 199178, Russia
Fax: +(7 812)321 4771

Electronic submission:

Manuscripts should be submitted by e-mail to:
E-mail: rams@def.ipme.ru
Filetypes: TeX (LaTeX) and MS Word files preferred. LaTeX style files are available on the Web-site: http://www.ipme.nw.ru/e-journals/RAMS/. Pictures and photos should be submitted in TIFF format (400 dpi).

Length:

Papers should be limited to 200 typewritten pages (including Tables and Figures each on separate page).

Structure of the manuscript:

Cover sheet; Text; Tables; References; Figure Captions; Pictures and Photos

A cover sheet should be included that contains the complete title, the names, affiliations, mailing addresses of the authors, fax and e-mail address of the corresponding author and the abstract.
TITLE – bold, centered. (14 pt)
Author(s) – bold, centered, e.g. **S. R. Brown and T. Klein**
Affiliation(s) – centered, complete postal address for all authors, e-mail address of corresponding author.

ABSTRACT. About 150-200 words.

Tables: type each table on the separate page, number consecutively in arabic numerals and supply a heading.

References:

References should be indicated in the text by consecutive numbers in square parentheses, e.g. [1,2,5-7], as a part of the text, the full reference being cited at the end of the text. References should contain the names of the authors together with their initials, the title of the journal, volume number, year and the first page number as illustrated below. References to books should contain the names of the authors, the title (the names of editors), the publisher name, location and year, as illustrated below.

REFERENCES

[1] R. Birringer, H. Gleiter, H.P. Klein and P. Marquardt // *Phys. Lett*. **102** (1984) 365.
[2] F.R. Nabarro, *Theory of Crystal Dislocations* (Clarendon Press, Oxford, 1967).
[3] V. Provenzano, In: *Nanostructured Materials: Science and Technology*, ed. by G.-M. Chow and N.I Noskova (Kluwer, Dordrecht, 1998), p. 335.

Figures:

For best results submit illustrations in the actual size at which they should be published. The line drawings of the original should be laser printed, the photographs should be original, with somewhat more contrast than is required in the printed version. Each figure should be typed on separate page, the listing of the figure captions must be included.

Equations must be clearly printed and numbered sequentially with arabic numbers enclosed with round parentheses at the right-hand margin.

Units – the authors are encouraged to use the SI-units, other units are also acceptable.

Макет подготовлен Издательством "Янус".

Лизензия ЛП № 000349 от 23.12.1999
Отпечатано в типографии ООО "Вертикаль".
Гарнитура Таймс, подписано к печати 23.09.2003, усл. печ. л. 2.1, тираж 990 экз., заказ № 23/2-4

REVIEWS ON ADVANCED MATERIALS SCIENCE

Editorial Office:
Reviews on Advanced Materials Science
Editorial Office
Institute of Problems of Mechanical Engineering (Russian Academy of Sciences),
Bolshoj 61, Vas. Ostrov, St. Petersburg 199178, Russia
FAX +7(812)3214771
E-mail: rams@def.ipme.ru
Web-sites: http://www.ipme.nw.ru/e-journals/RAMS/
http://www.ipme.ru/e-journals/RAMS/

Reviews on Advanced Materials Science (ISSN 1606-5131) – Published by Advanced Study Center Co. Ltd. (St.Petersburg, Russia)

Editorial Policy. The journal "Reviews on Advanced Materials Science" provides an international medium for the publication of reviews, topical issues and international conference proceedings in the area of theoretical and experimental study of advanced materials. Focuses are placed on, but not limited to nanostructured materials, semiconductors and high-transition-temperature superconductors. We encourage prospective authors to correspond with the principal editor before submitting a review article. Proposals should include an outline with key citations. All papers submitted will be rigorously peer-reviewed prior to publication. The journal "Reviews on Advanced Materials Science" is published in both paper and electronic versions.

Owner organization: Advanced Study Center Co. Ltd. (St.Petersburg, Russia)