

# PROCEEDINGS OF SPIE

## ***Nanostructured Thin Films***

**Geoffrey B. Smith**  
**Akhlesh Lakhtakia**  
*Editors*

**13–14 August 2008**  
**San Diego, California, USA**

*Sponsored and Published by*  
SPIE

**Volume 7041**

Proceedings of SPIE, 0277-786X, v. 7041

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Nanostructured Thin Films*, edited by Geoffrey B. Smith, Akhlesh Lakhtakia, Proceedings of SPIE Vol. 7041 (SPIE, Bellingham, WA, 2008) Article CID Number.

ISSN 0277-786X

ISBN 9780819472618

Published by

**SPIE**

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445

[SPIE.org](http://SPIE.org)

Copyright © 2008, Society of Photo-Optical Instrumentation Engineers

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at [copyright.com](http://copyright.com). Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/08/\$18.00.

Printed in the United States of America.

Publication of record for individual papers is online in the SPIE Digital Library.

The logo for SPIE Digital Library features the word "SPIE" in a bold, sans-serif font above the words "Digital Library" in a similar font. To the right of the text is a stylized graphic consisting of three vertical bars of increasing height, resembling a bar chart or a signal waveform.

[SPIDigitalLibrary.org](http://SPIDigitalLibrary.org)

---

**Paper Numbering:** Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

# Contents

- vii *Conference Committee*
- ix *Introduction*
- xi *Revivals of molecular nonlinear optics in physics, chemistry, and life sciences (Plenary Paper) [7040-100]*  
*J. Zyss, Lab. de Photonique Quantique et Moléculaire, CNRS, Institut d'Alembert (France)*

---

## SESSION 1 STRUCTURE AND GROWTH I

- 7041 02 **AFM of self-organised nanoparticle arrays: frequency modulation, amplitude modulation, and force spectroscopy (Invited Paper) [7041-01]**  
A. Sweetman, P. Sharp, A. Stannard, S. Gangopadhyay, P. J. Moriarty, Univ. of Nottingham (United Kingdom)
- 7041 03 **Stochastic continuum modeling self-assembled epitaxial quantum dot formation (Invited Paper) [7041-02]**  
L. H. Friedman, The Pennsylvania State Univ. (United States)

---

## SESSION 2 STRUCTURE AND GROWTH II

- 7041 07 **Shadowing growth of biaxially textured nanostructured films (Invited Paper) [7041-05]**  
T.-M. Lu, F. Tang, G.-C. Wang, Rensselaer Polytechnic Institute (United States)
- 7041 08 **Reinforced membrane based on crosslink reaction between water soluble sulfonated carbon nanotubes and sulfonated polystyrene [7041-06]**  
Y. Dai, H. Hong, South Dakota School of Mines and Technology (United States); J. S. Welsh, Air Force Research Lab. (United States)
- 7041 09 **Multilayer alumina and titania optical coatings prepared by atomic layer deposition [7041-07]**  
N. Biluš Abaffy, Royal Melbourne Institute of Technology (Australia); P. Evans, G. Triani, Australian Nuclear Science and Technology Organisation (Australia); D. McCulloch, Royal Melbourne Institute of Technology (Australia)

---

## SESSION 3 PLASMONICS AND NANOSTRUCTURE I

- 7041 0A **Sensitivity enhancement of guided wave surface plasmon resonance sensors using top nano dielectric layer (Invited Paper) [7041-09]**  
A. Lahav, M. Auslender, I. Abdulhalim, Ben Gurion Univ. of the Negev (Israel)

- 7041 0B **Tailoring coupling of light to local plasmons by using Ag nanorods/dielectric layer/mirror sandwich structures (Invited Paper)** [7041-10]  
M. Suzuki, Y. Imai, H. Tokunaga, K. Nakajima, K. Kimura, Kyoto Univ. (Japan); T. Fukuoka, Japan Science and Technology Agency (Japan); Y. Mori, Doshisha Univ. (Japan)
- 7041 0C **Porosity effect on surface plasmon resonance from metallic sculptured thin films** [7041-11]  
I. Abdulhalim, Ben Gurion Univ. of the Negev (Israel); A. Lakhtakia, The Pennsylvania State Univ. (United States); A. Lahav, Ben Gurion Univ. of the Negev (Israel); F. Zhang, J. Xu, The Pennsylvania State Univ. (United States)
- 7041 0D **Applications of nanostructured porous silicon in the field of optical sensing** [7041-12]  
R. J. Martín-Palma, V. Torres-Costa, M. Manso, J. M. Martínez Duart, Univ. Autónoma de Madrid (Spain)

---

#### SESSION 4 PLASMONICS AND NANOSTRUCTURE II

- 7041 0E **Review of surface-wave propagation at the planar interface of a columnar or chiral sculptured thin film and an isotropic substrate (Invited Paper)** [7041-13]  
J. A. Polo, Jr., Edinboro Univ. of Pennsylvania (United States); A. Lakhtakia, The Pennsylvania State Univ. (United States)
- 7041 0F **Excitation of surface plasmon polaritons at the interface of a metal and a sculptured nematic thin film** [7041-14]  
M. A. Motyka, A. Lakhtakia, The Pennsylvania State Univ. (United States)
- 7041 0G **Comparative study of enhanced fluorescence from nano sculptured thin films** [7041-15]  
I. Abdulhalim, A. Karabchevsky, Ben Gurion Univ. of the Negev (Israel); C. Patzig, B. Rauschenbach, Leibniz-Institut für Oberflächenmodifizierung e.V. (Germany); B. Fuhrmann, Martin-Luther-Univ. Halle (Germany)
- 7041 0H **Metal nanowhiskers synthesized by high-temperature glancing angle deposition** [7041-16]  
M. Suzuki, K. Hamachi, R. Kita, K. Nagai, K. Nakajima, K. Kimura, Kyoto Univ. (Japan)

---

#### SESSION 5 SWITCHABLE AND ACTIVE FILMS

- 7041 0J **Frequency and percolation dependence of the observed phase transition in nanostructured and doped VO<sub>2</sub> thin films** [7041-18]  
A. R. Gentle, G. B. Smith, A. I. Maarroof, Univ. of Technology, Sydney (Australia)
- 7041 0K **All-optical switching based on optical control of energy transfer between thin-film layers** [7041-19]  
D. S. Bradshaw, D. L. Andrews, Univ. of East Anglia, Norwich (United Kingdom)

---

#### SESSION 6 OXIDE AND SEMICONDUCTOR FILMS

- 7041 0M **Ultraviolet optical functions of ZnO and Ga<sub>2</sub>O<sub>3</sub> thin films (Invited Paper)** [7041-21]  
S. Fujita, Kyoto Univ. (Japan)

- 7041 OP **Reconfigurable photonic crystal filters for multi-band optical filtering on a monolithic substrate** [7041-24]  
G. Shambat, Univ. of Virginia (United States); R. Athale, G. Euliss, MITRE Corp. (United States); M. Mirotznik, Catholic Univ. of America (United States); E. Johnson, V. Smolski, Univ. of North Carolina at Charlotte (United States)

---

**SESSION 7 COMPLEX MEDIUMS**

---

- 7041 OR **Effective properties of membrane photonic crystals (Invited Paper)** [7041-25]  
D. Felbacq, B. Guizal, Univ. of Montpellier II (France); G. Bouchitté, Univ. of Toulon (France)
- 7041 OS **Circular polarization emission from an external cavity diode laser** [7041-26]  
J. Xu, F. Zhang, A. Lakhtakia, S. M. Pursel, M. W. Horn, The Pennsylvania State Univ. (United States)
- 7041 OT **Review of the role of dielectric anisotropy in Dyakonov surface-wave propagation** [7041-27]  
S. R. Nelatury, The Pennsylvania State Univ. (United States); J. A. Polo, Jr., Edinboro Univ. of Pennsylvania (United States); A. Lakhtakia, The Pennsylvania State Univ. (United States)
- 7041 OU **Photoconductivity on nanocrystalline ZnO/TiO<sub>2</sub> thin films obtained by sol-gel** [7041-28]  
G. Valverde-Aguilar, J. A. García-Macedo, R. Juárez-Arenas, Univ. Nacional Autónoma de México (Mexico)

---

**POSTER SESSION**

---

- 7041 OX **Blue photoluminescence of PECVD SiC-based films** [7041-31]  
V. I. Ivashchenko, Institute for Problems in Materials Science (Ukraine); A. V. Vasin, Institute of Semiconductor Physics (Ukraine); L. A. Ivashchenko, M. V. Ushakov, Institute for Problems in Materials Science (Ukraine)
- 7041 OY **Nano-structured surface plasmon resonance sensor for sensitivity enhancement** [7041-32]  
J.-H. Kim, H.-S. Kim, J.-H. Kim, Ajou Univ. (Korea, Republic of); S.-W. Choi, Y.-J. Cho, Korea Food Research Institute (Korea, Republic of)
- 7041 OZ **Different sensing layers for SPR sensing of organic vapours** [7041-33]  
S. Zuccon, M. G. Pelizzo, P. Nicolosi, D. Buso, A. Martucci, Univ. degli Studi di Padova (Italy)
- 7041 10 **Optical properties of silver nanorod arrays prepared by oblique angle deposition** [7041-34]  
Y.-J. Jen, W.-L. Hsu, C.-W. Yu, National Taipei Univ. of Technology (Taiwan)
- 7041 11 **Large area assembled periodic nanoarrays by block copolymer templating and glancing angle deposition** [7041-35]  
J. Chai, National Research Council Canada (Canada) and Univ. of Alberta (Canada); M. T. Taschuk, Univ. of Alberta (Canada); M. J. Brett, J. M. Buriak, National Research Council Canada (Canada) and Univ. of Alberta (Canada)
- 7041 12 **Analysis of silver columnar thin films by atomic force microscopy** [7041-37]  
F. Benkabou, Univ. de Moncton (Canada); A. Lakhtakia, The Pennsylvania State Univ. (United States)

- 7041 13 **Effect of alloy addition and growth conditions on the formation of Mg-based bioabsorbable thin films** [7041-38]  
S. M. Pursel, J. D. Petrilli, M. W. Horn, B. A. Shaw, The Pennsylvania State Univ. (United States)

*Author Index*

# Conference Committee

## *Symposium Chairs*

**David L. Andrews**, University of East Anglia Norwich (United Kingdom)  
**James G. Grote**, Air Force Research Laboratory (United States)  
**Kevin J. Liddane**, Oerlikon Optics USA Inc. (United States)

## *Conference Chairs*

**Geoffrey B. Smith**, University of Technology, Sydney (Australia)  
**Akhlesh Lakhtakia**, The Pennsylvania State University (United States)

## *Program Committee*

**Ibrahim S. Abdulhalim II**, Ben-Gurion University of the Negev (Israel)  
**Richard J. Blaikie**, University of Canterbury (New Zealand)  
**Michael J. Brett**, University of Alberta (Canada)  
**Dentcho A. Genov**, University of California, Berkeley (United States)  
**Cheng-Chung Lee**, National Central University (Taiwan)  
**Tom G. Mackay**, University of Edinburgh (United Kingdom)  
**Katyayani Seal**, Oak Ridge National Laboratory (United States)  
**Motofumi Suzuki**, Kyoto University (Japan)  
**Cuong Ton-That**, University of Technology, Sydney (Australia)  
**Jian Xu**, The Pennsylvania State University (United States)

## *Session Chairs*

- 1 Structure and Growth I  
**Didier Felbacq**, Université Montpellier II (France)
- 2 Structure and Growth II  
**Katyayani Seal**, Oak Ridge National Laboratory (United States)
- 3 Plasmonics and Nanostructure I  
**John A. Polo, Jr.**, Edinboro University of Pennsylvania (United States)
- 4 Plasmonics and Nanostructure II  
**Ibrahim S. Abdulhalim II**, Ben-Gurion University of the Negev (Israel)
- 5 Switchable and Active Films  
**Jian Xu**, The Pennsylvania State University (United States)

- 6 Oxide and Semiconductor Films  
**Motofumi Suzuki**, Kyoto University (Japan)
- 7 Complex Mediums  
**Cuong Ton-That**, University of Technology, Sydney (Australia)



## Introduction

After the inaugural SPIE conference on Nanocoatings held in 2007, it was decided to rename the conference Nanostructured Thin Films in 2008. Nanostructured thin films have been produced and studied for several decades, but interest in the topic has skyrocketed in recent times, along with the general growth in all things labeled 'nano'. Nanostructured thin films underpin many emerging technologies and involve exciting and sometimes puzzling new science. Thin films whose properties depend on their nanostructure are of increasing interest for applications in solar energy, energy efficiency and storage, biosensors, medicine, photonics and telecommunications, and chemical processing. They can extend product lifetimes, self-clean, sterilize, or display novel decorative properties. Several applications are featured in the papers included in this volume.

Several papers in this volume provide useful details on how to deposit thin films and how to control their nanostructure and optical response. Controlled deposition processes directly lead to the desired nanostructures, thereby eliminating the need for expensive post processing, apart from, say, thermal annealing. The deposition processes are essential for large-area coatings, for example in solar cells, some photo catalysis and advanced windows, but of course they are also useful for any cost-sensitive device. Thin films whose plasmonic responses are unusual but useful and interesting are covered in several of these papers. Some of these thin films conduct, while some are insulating but contain conducting nanoparticles.

This volume testifies to the interdisciplinary and multidisciplinary nature of the field with contributions from physicists, chemists, engineers, materials scientists, and biotechnologists. This diversity is a hallmark of nanotechnology as well as of SPIE.

**Geoffrey B. Smith**  
**Akhlesh Lakhtakia**

