

**Diamond Electronics and Biotechnology—
Fundamentals to Applications V**

MATERIALS RESEARCH SOCIETY
SYMPOSIUM PROCEEDINGS VOLUME 1395

Diamond Electronics and Biotechnology—Fundamentals to Applications V

Symposium held November 28–December 2, 2011, Boston, Massachusetts, U.S.A.

EDITORS

Philippe Bergonzo

CEA-LIST, Centre d'Etudes de Saclay
Gif-sur-Yvette, France

Richard B. Jackman

University College London
London, United Kingdom

Kian Ping Loh

National University of Singapore
Singapore

Greg M. Swain

Michigan State University
East Lansing, Michigan, U.S.A.

Oliver A. Williams

Cardiff University
Cardiff, United Kingdom



Materials Research Society
Warrendale, Pennsylvania



CAMBRIDGE
UNIVERSITY PRESS

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

www.cambridge.org
Information on this title: www.cambridge.org/9781605113722

Materials Research Society
506 Keystone Drive, Warrendale, PA 15086
<http://www.mrs.org>

© Materials Research Society 2012

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

First published 2012

CODEN: MRSPDH

ISBN: 978-1-60511-372-2 Hardback

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

CONTENTS

Preface	ix
Materials Research Society Symposium Proceedings	xi
* Recent Progress in Diamond Raman Lasers	1
Richard P. Mildren	
Dopant Uniformity and Concentration in Boron Doped Single Crystal Diamond Films	13
Shannon N. Demlow, I. Berkun, M. Becker, T. Hogan, and T.A. Grotjohn	
Electrochemical Oxidation of Phenol in Water Solutions Using Nanocrystalline Boron-Doped Diamond Film Anode	21
Jorge Arturo Lara Viera, Manoj K. Ram, Pedro Villalba, Mikhail Ladanov, and Ashok Kumar	
Fabrication of Diamond Nanopit Arrays by Room-temperature Curing Nanoimprint Lithography Using Glass-like Carbon Molds	27
Shuji Kiyohara, Chigaya Ito, Ippei Ishikawa, Hirofumi Takikawa, Yoshio Taguchi, Yoshinari Sugiyama, Yukiko Omata, and Yuichi Kurashima	
Micro-organic Light-emitting Devices Fabricated by Room-temperature Curing Nanoimprint Lithography Using Diamond Molds	33
Ippei Ishikawa, Taisuke Okuno, Shuji Kiyohara, Yoshio Taguchi, Yoshinari Sugiyama, Yukiko Omata, and Yuichi Kurashima	
Influence of the Doping Level at Boron Doped Nanocrystalline Diamond Films in the Electrochemical Determination of Nitrite	39
Jorge T. Matsushima, Diego H.L. Souza, Fernando A. Souza, Adriana F. Azevedo, Mauricio R. Baldan, and Neidenei G. Ferreira	

*Invited Paper

Copper Photoelectrodeposition onto Boron Doped Diamond Electrodes at Different Doping Level to Enhance Nitrate Electroreduction.45
A.B. Couto, M.R. Baldan, and N.G. Ferreira	
Field Emission Mechanism of H-Terminated N-Type Diamond NEA Surface51
Takatoshi Yamada, Masataka Hasegawa, Hisato Yamaguchi, Yuki Kudo, Ken Okano, and Christoph E. Nebel	
The Influence of Boron Doping in the Growth of Ultra/Nanocrystalline Diamond Films57
Fernando A. Souza, Adriana F. Azevedo, Maurício R. Baldan, and Neidenêi G. Ferreira	
Anodic and Cathodic Pre-treatment Effects on BDD Surface to Deposit Copper Nanoparticles Applied to Nitrate Reduction.63
L.C.D. Santos, A.B. Couto, J.T. Matsushima, M.C. Forti, M.R. Baldan, and N.G. Ferreira	
Roles of Boron in Growth of Diamond Grains in Ultrananocrystalline Diamond/Hydrogenated Amorphous Carbon Composite Films Prepared by Pulsed Laser Deposition69
Shinya Ohmagari, Yūki Katamune, Hikaru Ichinose, and Tsuyoshi Yoshitake	
Enhanced Wettability of Nanocrystalline Diamond Films for Biocoating Applications75
Jason H.C. Yang and Kungen Tei	
Comparative Electrode Kinetics of Micro and Nano-crystalline Boron Doped Diamond.81
E. Saito, A.F. Azevedo, F.A. Souza, N.G. Ferreira, and M.R. Baldan	
Field Emission from Nanocrystalline Diamond/Carbon Nanowall Composite Films Deposited on Scratched Substrates.87
C.Y. Cheng, M. Nakashima, and K. Tei	
Shaping of Diamonds in 1D Nanostructures and Strategies for Fabrication of All-Diamond Microcomponents93
S. Orlanducci, V. Guglielmotti, V. Sessa, E. Tamburri, M.L. Terranova, F. Toschi, and M. Rossi	

Preparation of Diamond Nanocrystallites in Powder by Using a Coaxial Arc Plasma Gun.99
 Aki Tominaga, Kenji Hanada, Tomohiro Yoshida,
 and Tsuyoshi Yoshitake

Effects of Crystallographic Planes on Focused Ion Beam Milled Patterns of Single Crystal Diamonds105
 Rustin Golnabi, Won I. Lee, Deok-Yang Kim,
 and Glen R. Kowach

Deposition of Bronze Microwires on Ultrananocrystalline Diamond (UNCD) Electrodes111
 Corina Grodek, Lori A. Lepak, Anirudha V. Sumant,
 Ralu Divan, Orlando Auciello, Daniel Rosenmann,
 Suzanne Miller, Ephriam Daniels, and Michael P. Zach

Fabrication of Nano-needle Arrays on Diamond Surface by Reactive Ion Etching117
 T. Misu, K. Koh, and T. Arai

Author Index123

Subject Index125

PREFACE

Symposium N, “Diamond Electronics and Biotechnology – Fundamentals to Applications V” was held at the 2011 MRS Fall Meeting in Boston, Massachusetts, November 28 – December 2, 2011. This volume contains submitted, peer-reviewed articles of the rapid advances in these fields. The scope of this meeting stretched from fundamentals to applications of all kinds of diamond, be they single crystal to nanocrystalline, bulk film to nanoparticle. New forms and applications of carbon such as graphene and single photon emission were given particular attention.

The attendance of this series has been consistently high, due to the excellent quality and international nature of the contributions, as well as the choice of invited speakers. New areas such as microplasma arrays from CVD were placed alongside such standards as diamond growth and electrochemistry.

In this symposium, 10 invited oral presentations, 49 contributed oral presentations and 46 posters were presented representing more than 15 countries. We would like to thank all those who contributed to making this diverse and exciting program, especially the student members.

The organizers express their gratitude to the broad spectrum of international members of the scientific committee who actively contributed to the refereeing of abstracts and the construction of such a dynamic program.

The symposium was supported by the following sponsors, to whom we are very grateful:

- Advanced Diamond Technologies Inc.
- Applied Diamond Inc.
- CEA, LIST, France
- Hasselt University, Belgium
- Seki Technotron Inc.
- Sp3 Inc.

We would also like to thank the MRS staff members for their highly professional support and encouragement throughout the process of bringing this symposium to fruition, its smooth running, and the publication of this proceedings volume.

Philippe Bergonzo
Richard B. Jackman
Kian Ping Loh
Greg N. Swain
Oliver A. Williams

April 2012

MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS

- Volume 1371 — Nanostructured Materials and Nanotechnology, C. Gutiérrez-Wing, J.L. Rodríguez-López, O.A. Graeve, J.J. Boeckl, P. Soukiassian, 2012, ISBN 978-1-60511-348-7
- Volume 1372 — Structural and Chemical Characterization of Metals, Alloys, and Compounds – 2011, R. Pérez Campos, A. Contreras Cuevas, R.A. Esparza Munoz, 2012, ISBN 978-1-60511-349-4
- Volume 1373 — Advanced Structural Materials – 2011, H.A. Calderon, A. Salinas Rodriguez, H. Balmori Ramirez, 2012, ISBN 978-1-60511-350-0
- Volume 1374 — Cultural Heritage and Archaeological Issues in Materials Science, J.L. Ruvalcaba Sil, J. Reyes Trujeque, A. Velazquez Castro, M. Espinosa Pesqueira, 2012, ISBN 978-1-60511-351-7
- Volume 1376E — Biomaterials for Medical Applications, S. Rodil, A. Almaguer, K. Anselme, 2012, ISBN 978-1-60511-353-1
- Volume 1380E — Materials Research for Mining and Mineral Processing, F.R.C. Pedroza, 2012, ISBN 978-1-60511-357-9
- Volume 1381E — Materials Welding and Joining Technologies, F.A.R. Valdes, 2012, ISBN 978-1-60511-358-6
- Volume 1383 — Material Challenges in Current and Future Nuclear Technologies, K.R. Whittle, M. Bertolus, B. Ueberuaga, R.W. Grimes, 2011, ISBN 978-1-60511-360-9
- Volume 1384E — Advanced Materials for Fuel Cells, J. Hertz, M.L. DiVona, P. Knauth, H.L. Tuller, 2011, ISBN 978-1-60511-361-6
- Volume 1385E — *In-Situ* Studies of Solid-Oxide Fuel-Cell Materials, R. Maher, 2011, ISBN 978-1-60511-362-3
- Volume 1386E — Sustainable Synthesis of Nanomaterials, H. Fan, M. Knez, S.S. Wong, W. Lee, 2011, ISBN 978-1-60511-363-0
- Volume 1387E — Advanced Materials for Solar-Fuel Generation, C. Hill, 2011, ISBN 978-1-60511-364-7
- Volume 1388E — Mobile Energy, S. Mhaisalkar, K. Shenai, G. Amaratunga, A. Nathan, 2011, ISBN 978-1-60511-365-4
- Volume 1389E — Applications of Hierarchical 3D Structures, J.H. Moon, S. Jeon, S. Yang, R.A. Vaia, 2011, ISBN 978-1-60511-366-1
- Volume 1390 — Organic Photovoltaics-Materials to Devices, V. BommiSETTY, G. Li, C. Deibel, T-Q. Nguyen, D.C. Olson, M. Riede, M. Leclerc, V. Dyakonov, G. Rumbles, N.S. Sariciftci, 2011, ISBN 978-1-60511-367-8
- Volume 1391E — Photonic and Plasmonic Materials for Enhanced Photovoltaic Performance, R. Biswas, 2011, ISBN 978-1-60511-368-5
- Volume 1392E — Materials for High-Performance Photonics, T.M. Cooper, S.R. Flom, M. Bockstaller, C. Lopes, 2011, ISBN 978-1-60511-369-2
- Volume 1393E — Topological Insulator Materials, C. Felser, Y. Cui, H. Peng, S. Murakami, 2011, ISBN 978-1-60511-370-8
- Volume 1394E — Oxide Semiconductors—Defects, Growth and Device Fabrication, T. Veal, S. Durbin, J. Phillips, M. Grundmann, 2011, ISBN 978-1-60511-371-5
- Volume 1395 — Diamond Electronics and Biotechnology—Fundamentals to Applications V, O.A. Williams, R.B. Jackman, P. Bergonzo, G.M. Swain, K.P. Loh, 2011, ISBN 978-1-60511-372-2
- Volume 1396 — Compound Semiconductors for Generating, Emitting and Manipulating Energy, T. Li, M. Mastro, A. Dadgar, H. Jiang, J. Kim, 2011, ISBN 978-1-60511-373-9
- Volume 1397E — Ferroelectric and Multiferroic Materials, M. Bibes, C.J. Fennie, L.W. Martin, B. Noheda, T. Kimura, 2011, ISBN 978-1-60511-374-6
- Volume 1398E — Magnetoelectric Composites, P. Finkel, 2011, ISBN 978-1-60511-375-3
- Volume 1399E — Compliant Electronics and Photonics, D. Tyler, 2011, ISBN 978-1-60511-376-0
- Volume 1400E — Solution Processing of Inorganic and Hybrid Materials for Electronics and Photonics, P.J. Smith, M.F.A.M. van Hest, D.B. Mitzi, A. Morrin, 2011, ISBN 978-1-60511-377-7
- Volume 1401E — Large-Area Processing and Patterning for Active Optical and Electronic Devices III, I. Kymissis, T. Anthopoulos, C. Madigan, M. Shtein, 2011, ISBN 978-1-60511-378-4
- Volume 1402E — Charge Generation/Transport in Organic Semiconductor Materials, J. Anthony, 2011, ISBN 978-1-60511-379-1
- Volume 1403 — Multifunctional Polymer-Based Materials, A. Lendlein, Y. Feng, T. Xie, Z. Guan, 2011, ISBN 978-1-60511-380-7
- Volume 1404E — Phonons in Nanomaterials—Theory, Experiments and Applications, S.L. Shinde, D.H. Hurley, G.P. Srivastava, M. Yamaguchi, 2011, ISBN 978-1-60511-381-4

MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS

- Volume 1405E — Advances in Energetic Materials Research, M.R. Manaa, C-S. Yoo, E.J. Reed, M.S. Strano, 2011, ISBN 978-1-60511-382-1
- Volume 1406 — Functional Metal-Oxide Nanostructures, A. Vomiero, S. Mathur, Z.L. Wang, E. W-G. Diau, 2011, ISBN 978-1-60511-383-8
- Volume 1407 — Carbon Nanotubes, Graphene and Related Nanostructures, Y.K. Yap, 2011, ISBN 978-1-60511-384-5
- Volume 1408 — Functional Nanowires and Nanotubes, K. Nielsch, A.F. i Morral, H. Linke, H. Shin, L. Shi, 2011, ISBN 978-1-60511-385-2
- Volume 1409E — Functional Semiconductor Nanocrystals and Metal-Hybrid Structures, K.S Leschkie, P. Nagpal, M.A. Pelton, H. Mattoussi, P. Kambhampati, 2011, ISBN 978-1-60511-386-9
- Volume 1410E — Transport Properties in Polymer Nanocomposites II, S. Nazarenko, J. Grunlan, J. Bahr, E. Espuche, 2011, ISBN 978-1-60511-387-6
- Volume 1411E — Self Organization and Nanoscale Pattern Formation, S. Persheyev, 2011, ISBN 978-1-60511-388-3
- Volume 1412E — Mechanical Nanofabrication, Nanopatterning and Nanoassembly, G. Cross, A. Schirmeisen, A. Knoll, M. Rolandi, 2011, ISBN 978-1-60511-389-0
- Volume 1413E — Safety and Toxicity Control of Nanomaterials, W.W. Yu, V.L. Colvin, Q. Dai, P.C. Howard, 2011, ISBN 978-1-60511-390-6
- Volume 1415 — MEMS, BioMEMS and Bioelectronics—Materials and Devices, T. Albrecht, M.P. de Boer, F.W. DelRio, M.R. Dokmeci, C. Eberl, J. Fukuda, H. Kaji, C. Keimel, A. Khademhosseini, 2011, ISBN 978-1-60511-392-0
- Volume 1416E — Nanofunctional Materials, Nanostructures and Nanodevices for Cancer Applications, S. Svenson, P. Grodzinski, S. Manalis, X J. Liang, W. Lin, 2011, ISBN 978-1-60511-393-7
- Volume 1417E — Biomaterials for Tissue Regeneration, C.C. Sorrell, 2011, ISBN 978-1-60511-394-4
- Volume 1418 — Gels and Biomedical Materials, F. Horkay, R. Narayan, V. Dave, S. Jin, N. Langrana, J.D. Londono, W. Oppermann, S. Ramakrishna, D. Shi, R.G. Weiss, 2011, ISBN 978-1-60511-395-1
- Volume 1419E — Nucleation and Growth of Biological and Biomimetic Materials, P.M. Rodger, J. Harding, L.B. Gower, P. Vekilov, 2011, ISBN 978-1-60511-396-8
- Volume 1420E — Multiscale Mechanics of Hierarchical Materials, F. Barthelat, 2011, ISBN 978-1-60511-397-5
- Volume 1421E — Three-Dimensional Tomography of Materials, S. Pennycook, 2011, ISBN 978-1-60511-398-2
- Volume 1422E — Functional Imaging of Materials—Advances in Multifrequency and Multispectral Scanning Probe Microscopy and Analysis, A. Baddorf, 2011, ISBN 978-1-60511-399-9
- Volume 1423E — Dynamics in Confined Systems and Functional Interfaces, M.H. Müser, D.L. Irving, S.B. Sinnott, I. Szlufarska, 2011, ISBN 978-1-60511-400-2
- Volume 1424 — Properties and Processes at the Nanoscale—Nanomechanics of Material Behavior, D. Bahr, P. Anderson, N. Moody, R. Spolenak, 2011, ISBN 978-1-60511-401-9
- Volume 1425E — Combinatorial and High-Throughput Methods in Materials Science, J.B. Miller, J. Genzer, Y. Matsumoto, R.A. Potyrailo, 2011, ISBN 978-1-60511-402-6

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