

MRS SYMPOSIUM PROCEEDINGS

Volume 1754 • 2014 MRS Fall Meeting

State-of-the-Art Developments in Materials Characterization

EDITORS

Rozaliya Barabash

Liane G. Benning

Arda Genc

Yunseok Kim

Aude Lereu

Dongsheng Li

Ulrich Lienert

Klaus-Dieter Liss

Masato Ohnuma

Olga Ovchinnikova

Ali Passian

Jeffrey D. Rimer

Laurene Tetard

Thomas Thundat

Renato Zenobi

Vassilia Zorba

CAMBRIDGE

A publication of the

MRS MATERIALS RESEARCH SOCIETY®
Advancing materials. Improving the quality of life.

State-of-the-Art Developments in Materials Characterization

**MATERIALS RESEARCH SOCIETY
SYMPOSIUM PROCEEDINGS VOLUME 1754**

State-of-the-Art Developments in Materials Characterization

Symposium held November 30-December 5, 2014 Boston, Massachusetts. U.S.A.

EDITORS

Rozaliya Barabash

Oak Ridge National Laboratory
Knoxville, Tennessee, U.S.A.

Liane G. Benning

University of Leeds
Leeds, United Kingdom

Arda Genc

FEI Company
Hillsboro, Oregon, U.S.A.

Yunseok Kim

Sungkyunkwan University
Seoul, Republic of Korea

Aude Lereu

Institut Fresnel
Marseille, France

Dongsheng Li

Pacific Northwest National Laboratory
Richland, Washington, U.S.A.

Ulrich Lienert

DESY
Hamburg, Germany

Klaus-Dieter Liss

Australian Nuclear Science and Technology Organisation Lucas Heights,
Australia and University of Wollongong
Wollongong, Australia

Masato Ohnuma

Hokkaido University
Sapporo, Japan

Olga Ovchinnikova

Oak Ridge National Laboratory
Knoxville, Tennessee, U.S.A.

Ali Passian

Oak Ridge National Laboratory
Knoxville, Tennessee, U.S.A.

Jeffrey D. Rimer

University of Houston
Houston, Texas, U.S.A.

Laurene Tetard

University of Central Florida
Orlando, Florida, U.S.A.

Thomas Thundat

University of Alberta
Edmonton, Canada

Renato Zenobi

ETH Honggerberg
Zurich, Switzerland

Vassilia Zorba

Lawrence Berkeley National Laboratory
Berkeley, California, U.S.A.



Materials Research Society
Warrendale, Pennsylvania



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/9781605117317

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

© Materials Research Society 2015

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 2015

CODEN: MRSPDH

ISBN: 978-1-60511-731-7 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	xi
Materials Research Society Symposium Proceedings	xiii

IN SITU CHARACTERIZATION OF DYNAMIC PROCESSES

* SAXS and <i>In Situ</i> SAXS to Follow the Structural Evolution in Hybrid Materials	3
Silvia Pabisch, Harald Renzhofer, Nicola Hüsing, and Herwig Peterlik	
Evolution of Carbon Fiber Microstructure During Carbonization and High-temperature Graphitization Measured <i>In Situ</i> Using Synchrotron Wide-angle X-ray Diffraction	13
Michael Behr, James Rix, Brian Landes, Bryan Barton, Eric Hukkanen, Jasson Patton, Steven Weigand, and Denis Keane	
A Novel <i>In Situ</i> Nanoindentation Characterization of Phase Transforming Materials	19
A. Alipour Skandani, R. Ctvrtlik, and M. Al-Haik	
<i>In Situ</i> Scanning Electron Microscope Observations of Strain-confined Lithium Nucleation at Electrode/Electrolyte Interfaces in All-solid-state-lithium Battery.	25
Munekazu Motoyama, Makoto Ejiri, and Yasutoshi Iriyama	
Observations of Magnetic Domain Structure Change in Nd ₂ Fe ₁₄ B Magnets at Elevated Temperature with External Magnetic Field by Lorentz Microscopy	31
Toshimasa Suzuki, Koichi Kawahara, Haruka Tanaka, and Kimihiro Ozaki	

*Invited Paper

A Differential Scanning Calorimetric Study of Carbide Transition in 10Cr Tempered Martensitic Steels 37
H.C. Wang

*** Translocation of N-acetyl Cysteine Capped Fluorescent Quantum Dots in Plant Tissue: Confocal Imaging Studies. 43**
Smruti Das, Jeremy Tharkur, Laurene Tetard, and Swadeshmukul Santra

Polyelectrolyte brushes: Water Content, Zeta Potential and Mechanical Properties 53
Joseba Irigoyen, Jagoba Iturri, José Luis Camacho, Edwin Donath, and Sergio Moya

ADVANCES IN SCANNING PROBE MICROSCOPY FOR MULTIMODAL IMAGING AT THE NANOSCALE

Investigation of Polymer Dendritic Growth in Composite Material Using Contact Resonance Method 61
Ravi Gaikwad, Xunchen Liu, Priyesh Dhandharia, and Thomas Thundat

Determination of the Physical Properties of Oil Sands Components using Scanning Probe Microscopy 69
Ravi Gaikwad, Tinu Abraham, Aharnish Hande, Fatemeh Bakhtiari, Siddhartha Das, and Thomas Thundat

Comprehensive Characterization of Neat Polymers and Compositional Imaging Heterogeneous Polymer Systems with AFM Based Mechanical, Electric and Spectroscopic Methods 75
Marko Surtchev, Sergey Belikov, Ivan Malovichko, and Sergei Magonov

Nanometer Thermal Conductivity Mapping Using Laser-based Scanning Thermal Microscopy 81
Jeremy Goeckeritz, Gary Aden, and Ami Chand

*Invited Paper

Tip Enhanced Laser Ablation Sample Transfer for Mass Spectrometry 87
 Kermit K. Murray, Suman Ghorai, and
 Chinthaka A. Seneviratne

Practical Realization of Apertureless Scanning Near-field Optical Microscopy Using Hybrid Mode Atomic Force Microscopy 97
 Sergey Zayats, John Alexander,
 Sergei Magonov, and Dmitry Kazantsev

Dynamic Photo-induced Force Microscopy 103
 Junghoon Jahng and Eric O. Potma

*ADVANCES IN MATERIALS EXPLORATION WITH NEUTRONS
 AND X-RAYS—THE STATE-OF-THE-ART IN THE INTERNATIONAL
 YEAR OF CRYSTALLOGRAPHY*

*** The European Spallation Source and Future Opportunities for Materials Science 111**
 Oliver Kirstein

Texture Evolution in Metals Under Mechanical Stress: Application of a Tensile Stage on a Laboratory X-ray System 123
 J. te Nijenhuis, N. Dadivanyan, and D.J. Götz

Comparative High-resolution X-Ray Diffraction Analysis of GaN/AlGaN Heterostructure on Al₂O₃ and Si (111) Substrate Grown by Plasma Assisted Molecular Beam Epitaxy 129
 Sanjay Kr. Jana, Saptarsi Ghosh,
 Syed Mukulika Dinara, Apurba Chakraorty, and
 D. Biswas

*** Hard X-ray Beam Damage Study of Monolayer Ni Islands Using SX-STM. 135**
 Nozomi Shirato, Marvin Cummings,
 Heath Kersell, Yang Li, Dean Miller,
 Daniel Rosenmann, Saw-Wai Hla, and
 Volker Rose

*Invited Paper

* Non-equilibrium Processes in Martensitic Phase Transformations by X-ray Photon Correlation Spectroscopy	141
Michael Widera and Uwe Klemradt	
Application of the Electron Density Correlation Function for Structural Analysis of X-ray Scattering/Diffraction Information from Polymer-based Nano-composites	147
Kenan Song, Yiying Zhang, Navid Tajaddod, and Marilyn L. Minus	
Author Index	153
Subject Index	155

*Invited Paper

PREFACE

Symposium OO, “In Situ Characterization of Dynamic Processes during Materials Synthesis and Transformation;” Symposium PP, “Advances in Scanning Probe Microscopy for Multimodal Imaging at the Nanoscale;” Symposium QQ, “Advances in Nanoscale Subsurface, Chemical and Time-Resolved Studies of Soft Matter;” and Symposium TT, “Advanced Materials Exploration with Neutrons and X-Rays—The State-of-the-Art in the International Year of Crystallography,” were held November 30–December 5 at the 2014 MRS Fall Meeting in Boston, Massachusetts.

With the emergence of nanoscale dimensions in material science, the needs to advance metrology such as for time-resolved, spatially-resolved and material specific signatures have become more and more demanding. This symposium proceedings volume represents the recent advances relevant to these aspects of material and process discoveries. The papers have been organized to convey advances in: (1) *in situ* characterization of dynamic processes, (2) scanning probe microscopy for multimodal imaging at the nanoscale and (3) neutrons and X-rays for material science. Manuscripts in this volume explore various aspects of the most recent developments in metrology and characterization of materials at the most fundamental level, with spatial resolution down to the nanometer range. Our team has organized these reports in a way that, we hope, highlights the rich scientific advances taking place in the field of characterization and illustrates the importance of this field for materials research.

Dongsheng Li
Vassilia Zorba
Laurene Tetard
Klaus-Dieter Liss

October 2015

MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS

- Volume 1717E— Organic Bioelectronics, 2015, M.R. Abidian, C. Bettinger, R. Owens, D.T. Simon, ISBN 978-1-60511-694-5
- Volume 1718— Multifunctional Polymeric and Hybrid Materials, 2015, A. Lendlein, N. Tirelli, R.A. Weiss, T. Xie, ISBN 978-1-60511-695-2
- Volume 1719E— Medical Applications of Noble Metal Nanoparticles (NMNPs), 2015, X. Chen, H. Duan, Z. Nie, H-R. Tseng, ISBN 978-1-60511-696-9
- Volume 1720E— Materials and Concepts for Biomedical Sensing, 2015, X. Fan, L. Liu, E. Park, H. Schmidt, ISBN 978-1-60511-697-6
- Volume 1721E— Hard-Soft Interfaces in Biological and Bioinspired Materials—Bridging the Gap between Theory and Experiment, 2015, J. Harding, D. Joester, R. Kröger, P. Raiteri, ISBN 978-1-60511-698-3
- Volume 1722E— Reverse Engineering of Bioinspired Nanomaterials, 2015, L. Estroff, S-W. Lee, J-M. Nam, E. Perkins, ISBN 978-1-60511-699-0
- Volume 1723E— Plasma Processing and Diagnostics for Life Sciences, 2015, E.R. Fisher, M. Kong, M. Shiratani, K.D. Weltmann, ISBN 978-1-60511-700-3
- Volume 1724E— Micro/Nano Engineering and Devices for Molecular and Cellular Manipulation, Simulation and Analysis, 2015, D.L. Fan, J. Fu, X. Jiang, M. Lutolf, ISBN 978-1-60511-701-0
- Volume 1725E— Emerging 1D and 2D Nanomaterials in Health Care, 2015, P.M. Ajayan, S.J. Koester, M.R. McDevitt, V. Renugopalakrishnan, ISBN 978-1-60511-702-7
- Volume 1726E— Emerging Non-Graphene 2D Atomic Layers and van der Waals Solids, 2015, M. Bar-Sadan, J. Cheon, S. Kar, M. Terrones, ISBN 978-1-60511-703-4
- Volume 1727E— Graphene and Graphene Nanocomposites, 2015, J. Jasinski, H. Ji, Y. Zhu, V. Nicolosi, ISBN 978-1-60511-704-1
- Volume 1728E— Optical Metamaterials and Novel Optical Phenomena Based on Nanofabricated Structures, 2015, Y. Liu, F. Capasso, A. Alú, M. Agio, ISBN 978-1-60511-705-8
- Volume 1729— Materials and Technology for Nonvolatile Memories, 2015, P. Dimitrakis, Y. Fujisaki, G. Hu, E. Tokumitsu, ISBN 978-1-60511-706-5
- Volume 1730E— Frontiers in Complex Oxides, 2015, J.D. Baniecki, N.A. Benedek, G. Catalan, J.E. Spanier, ISBN 978-1-60511-707-2
- Volume 1731E— Oxide semiconductors, 2015, T.D. Veal, O. Bierwagen, M. Higashiwaki, A. Janotti, ISBN 978-1-60511-708-9
- Volume 1732E— Hybrid Oxide/Organic Interfaces in Organic Electronics, 2015, A. Amassian, J.J. Berry, M.A. McLachlan, E.L. Ratcliff, ISBN 978-1-60511-709-6
- Volume 1733E— Fundamentals of Organic Semiconductors—Synthesis, Morphology, Devices and Theory, 2015, D. Seferos, L. Kozycz, ISBN 978-1-60511-710-2
- Volume 1734E— Diamond Electronics and Biotechnology—Fundamentals to Applications, 2015, C-L. Cheng, D.A.J. Moran, R.J. Nemanich, G.M. Swain, ISBN 978-1-60511-711-9
- Volume 1735— Advanced Materials for Photovoltaic, Fuel Cell and Electrolyzer, and Thermoelectric Energy Conversion, 2015, S.R. Bishop, D. Cahen, R. Chen, E. Fabbri, F.C. Fonseca, D. Ginley, A. Hagfeldt, S. Lee, J. Liu, D. Mitzi, T. Mori, K. Nielsch, Z. Ren, P. Rodriguez, ISBN 978-1-60511-712-6
- Volume 1736E— Wide-Bandgap Materials for Solid-State Lighting and Power Electronics, 2015, R. Kaplar, G. Meneghesso, B. Ozpineci, T. Takeuchi, ISBN 978-1-60511-713-3
- Volume 1737E— Organic Photovoltaics—Fundamentals, Materials and Devices, 2015, A. Facchetti, ISBN 978-1-60511-714-0
- Volume 1738E— Sustainable Solar-Energy Conversion Using Earth-Abundant Materials, 2015, Y. Li, S. Mathur, G. Zheng, ISBN 978-1-60511-715-7
- Volume 1739E— Technologies for Grid-Scale Energy Storage, 2015, B. Chalamala, J. Lemmon, V. Subramanian, Z. Wen, ISBN 978-1-60511-716-4
- Volume 1740E— Materials Challenges for Energy Storage across Multiple Scales, 2015, A. Cresce, ISBN 978-1-60511-717-1
- Volume 1741E— Synthesis, Processing and Mechanical Properties of Functional Hexagonal Materials, 2015, M. Albrecht, S. Aubry, R. Collazo, R.K. Mishra, C-C. Wu, ISBN 978-1-60511-718-8
- Volume 1742E— Molecular, Polymer and Hybrid Materials for Thermoelectrics, 2015, A. Carella, M. Chabinye, M. Kovalenko, J. Malen, R. Segalman, ISBN 978-1-60511-719-5
- Volume 1743E— Materials and Radiation Effects for Advanced Nuclear Technologies, 2015, G. Baldinozzi, C. Deo, K. Arakawa, F. Djurabekova, S.K. Gill, E. Marquis, F. Soisson, K. Yasuda, Y. Zhang, ISBN 978-1-60511-720-1

MATERIALS RESEARCH SOCIETY SYMPOSIUM PROCEEDINGS

- Volume 1744— Scientific Basis for Nuclear Waste Management XXXVIII, 2015, S. Gin, R. Jubin, J. Matyáš, E. Vance, ISBN 978-1-60511-721-8
- Volume 1745E— Materials as Tools for Sustainability, 2015, J. Abelson, C-G. Granqvist, E. Traversa, ISBN 978-1-60511-722-5
- Volume 1746E— Nanomaterials for Harsh Environment Sensors and Related Electronic and Structural Components—Design, Synthesis, Characterization and Utilization, 2015, P-X. Gao, P. Ohodnicki, L. Shao, ISBN 978-1-60511-723-2
- Volume 1747E— Flame and High-Temperature Synthesis of Functional Nanomaterials—Fundamentals and Applications, 2015, E. Kruis, R. Maric, S. Tse, K. Wegner, X. Zheng, ISBN 978-1-60511-724-9
- Volume 1748E— Semiconductor Nanocrystals, Plasmonic Metal Nanoparticles, and Metal-Hybrid Structures, 2015, M. Kuno, S. Ithurria, P. Naggal, M. Pelton, ISBN 978-1-60511-725-6
- Volume 1749E— 3D Mesoscale Architectures—Synthesis, Assembly, Properties and Applications, 2015, H.J. Fan, S. Jin, M. Knez, B. Tian, ISBN 978-1-60511-726-3
- Volume 1750E— Directed Self-Assembly for Nanopatterning, 2015, D.J.C. Herr, ISBN 978-1-60511-727-0
- Volume 1751E— Semiconductor Nanowires—Growth, Physics, Devices and Applications, 2015, G. Koblmüller, ISBN 978-1-60511-728-7
- Volume 1752— Carbon Nanotubes—Synthesis, Properties, Functionalization, and Applications, 2015, P.T. Araujo, A.D. Franklin, Y.A. Kim, M. Krueger, ISBN 978-1-60511-729-4
- Volume 1753E— Mathematical and Computational Aspects of Materials Science, 2015, C. Calderer, R. Lipton, D. Margetis, F. Otto, ISBN 978-1-60511-730-0
- Volume 1754— State-of-the-Art Developments in Materials Characterization, 2015, R. Barabash, L.G. Benning, A. Genc, Y. Kim, A. Lereu, D. Li, U. Lienert, K.D. Liss, M. Ohnuma, O. Ovchinnikova, A. Passian, J.D. Rimer, L. Tetard, T. Thundat, R. Zenobi, V. Zorba, ISBN 978-1-60511-731-7
- Volume 1755E— Scaling Effects on Plasticity—Synergy between Simulations and Experiments, 2015, S. Van Petegem, P. Anderson, L. Thilly, S.R. Niezgodá, ISBN 978-1-60511-732-4
- Volume 1756E— Informatics and Genomics for Materials Development, 2015, A. Dongare, C. Draxl, K. Persson, ISBN 978-1-60511-733-1
- Volume 1757E— Structure-Property Relations in Amorphous Solids, 2015, E. Ma, J. Mauro, M. Micoulaut, Y. Shi, ISBN 978-1-60511-734-8
- Volume 1758E— Recent Advances in Reactive Materials, 2015, D. Adams, E. Dreizin, H.H. Hng, K. Sullivan, ISBN 978-1-60511-735-5
- Volume 1759E— Bridging Scales in Heterogeneous Materials, 2015, H.B. Chew, Y. Gao, S. Xia, P. Zavattieri, ISBN 978-1-60511-736-2
- Volume 1760E— Advanced Structural and Functional Intermetallic-Based Alloys, 2015, I. Baker, M. Heilmaier, K. Kishida, M. Mills, S. Miura, ISBN 978-1-60511-737-9
- Volume 1761E— Hierarchical, High-Rate, Hybrid and Roll-to-Roll Manufacturing, 2015, M.D. Poliks, T. Blaudeck, ISBN 978-1-60511-738-6
- Volume 1762E— Undergraduate Research in Materials Science—Impacts and Benefits, 2015, D.F. Bahr, ISBN 978-1-60511-739-3
- Volume 1763E— Materials for Biosensor Applications, 2015, R. Narayan, S.M. Reddy, T.R.L.C. Paixão, ISBN 978-1-60511-740-9
- Volume 1764— Advances in Artificial Photosynthesis: Materials and Devices, 2015, H.A. Calderon, O. Solarza-Feria, P. Yang, C. Kisielowski, ISBN 978-1-60511-741-6
- Volume 1765— Advanced Structural Materials—2014, 2015, J. López-Cuevas, F.C. Robles-Hernandez, A. García-Murillo, ISBN 978-1-60511-742-3
- Volume 1766— Structural and Chemical Characterization of Metals, Alloys, and Compounds—2014, 2015, A. Contreras Cuevas, R. Campos, R. Esparza Muñoz, ISBN 978-1-60511-743-0
- Volume 1767— New Trends in Polymer Chemistry and Characterization—2014, 2015, L. Fomina, G. Cedillo Valverde, M.P. Carreón Castro, J.A. Olivares, ISBN 978-1-60511-744-7
- Volume 1768E— Concrete with smart additives and supplementary cementitious materials to improve durability and sustainability of concrete structures, 2015, L.E. Rendon-Diaz-Miron, L.M. Torres-Guerra, D.A. Koleva, ISBN 978-1-60511-745-4
- Volume 1769E— Materials for Nuclear Applications, 2015, A. Díaz Sánchez, E. López Honorato, ISBN 978-1-60511-746-1

Prior Materials Research Symposium Proceedings available by contacting Materials Research Society