PROCEEDINGS OF SPIE

SPIDigitalLibrary.org/conference-proceedings-of-spie

Front Matter: Volume 8461

, "Front Matter: Volume 8461," Proc. SPIE 8461, Spintronics V, 846101 (15 October 2012); doi: 10.1117/12.2009159

Event: SPIE NanoScience + Engineering, 2012, San Diego, California, United States

PROCEEDINGS OF SPIE

Spintronics V

Henri-Jean Drouhin
Jean-Eric Wegrowe
Manijeh Razeghi
Editors

12–16 August 2012
San Diego, California, United States

Sponsored and Published by
SPIE

Volume 8461

Proceedings of SPIE 0277-786X, V.8461

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

Spintronics V, edited by Henri-Jean Drouhin, Jean-Eric Wegrowe, Manijeh Razeghi,
Proc. of SPIE Vol. 8461, 846101 · © 2012 SPIE · CCC code: 0277-786/12/\$18 · doi: 10.1117/12.2009159

Proc. of SPIE Vol. 8461 846101-1

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 *Spintronics V*, edited by Henri-Jean Drouhin, Jean-Eric Wegrowe, Manijeh Razeghi, Proceedings of SPIE Vol. 8461 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN: 0277-786X

ISBN: 9780819491787

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

Copyright © 2012, 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. 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/12/\$18.00.

Printed in the United States of America.

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

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 as 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

ix	Conference Committee
xiii	Introduction

SPIN COHERENCE, DYNAMICS, AND FLUCTUATION

8461 05	Spin noise spectroscopy: hole spin dynamics in semiconductor quantum dots (Invited Paper) [8461-4] M. Oestreich, R. Dahbashi, F. Berski, J. Hübner, Leibniz Univ. Hannover (Germany)
---------	--

SPIN-INJECTION I

8461 06	Thickness dependence of spin pumping at YIG/Pt interface (Invited Paper) [8461-5] T. Tashiro, R. Takahashi, Y. Kajiwara, K. Ando, H. Nakayama, T. Yoshino, D. Kikuchi, Tohoku Univ. (Japan); E. Saitoh, Tohoku Univ.(Japan) and CREST, Japan Science and Technology Agency (Japan) and Japan Atomic Energy Agency (Japan)
8461 07	Experimental demonstration of a magnetic bipolar junction transistor (Invited Paper) [8461-6] E. Johnston-Halperin, The Ohio State Univ. (United States); M. E. Flatte, The Univ. of Iowa (United States); D. D. Awschalom, Univ. of California, Santa Barbara (United States)

SPIN-INJECTION III

8461 0D	Thermal spin-accumulation (Invited Paper) [8461-11] J.-E. Wegrowe, H.-J. Drouhin, Ecole Polytechnique, LSI, CNRS (France) and CEA/DSM/IRAMIS (France); D. Lacour, Institut Jean Lamour, CNRS, Univ. H. Poincaré (France)
8461 0F	First-principles calculations of transport and magnetic properties of rare-earth materials (Invited Paper) [8461-13] J. K. Glasbrenner, J. M. An, Univ. of Nebraska-Lincoln (United States); J. Kudrnovský, V. Drchal, Institute of Physics of the ASCR, v.v.i. (Czech Republic); S. Khmelevskiy, Vienna Univ. of Technology (Austria); I. Turek, Institute of Physics of Materials of the ASCR, v.v.i. (Czech Republic); K. D. Belashchenko, Univ. of Nebraska-Lincoln (United States)

MAGNETIC TUNNEL JUNCTION

8461 0G	Barrier breakdown mechanisms in MgO-based magnetic tunnel junctions under pulsed conditions and correlation with low-frequency noise (Invited Paper) [8461-14] S. Amara-Dababi, H. Bea, R. C. Sousa, C. Baraduc, SPINTEC, UMR CEA/CRNS/UJF-Grenoble 1 (France); K. MacKay, Crocus Technology (France); B. Dieny, SPINTEC, UMR CEA/CRNS/UJF-Grenoble 1 (France)
---------	--

- 8461 OJ **Spin filter superconducting tunnel junctions (Invited Paper)** [8461-17]
M. G. Blamire, A. Pal, Z. H. Barber, Univ. of Cambridge (United Kingdom); K. Senapati, National Institute of Science Education and Research (India)
- 8461 OK **Electrical spin injection in p-type Si using Fe/MgO contacts (Invited Paper)** [8461-18]
A. Spiesser, AIST, Spintronics Research Ctr. (Japan); S. Sharma, AIST, Spintronics Research Ctr. (Japan) and Univ. of Groningen (Netherlands); H. Saito, R. Jansen, S. Yuasa, K. Ando, AIST, Spintronics Research Ctr. (Japan)

SPIN-ORBIT INTERACTION

- 8461 OL **Spin-orbit coupling in graphene structures (Invited Paper)** [8461-19]
D. Kochan, M. Gmitra, J. Fabian, Univ. Regensburg (Germany)
- 8461 OO **Spin dynamics in two-dimensional electron and hole systems revealed by resonant spin amplification (Invited Paper)** [8461-22]
T. Korn, M. Griesbeck, M. Kugler, S. Furthmeier, C. Gradl, M. Hirmer, D. Schuh, Univ. Regensburg (Germany); W. Wegscheider, ETH Zurich (Switzerland); K. Korzekwa, P. Machnikowski, Wroclaw Univ. of Technology (Poland); T. Kuhn, Westfälische Wilhelms-Univ. (Germany); M. M. Glazov, Ioffe Physico-Technical Institute (Russian Federation); E. Y. Sherman, The Univ. of the Basque Country (Spain) and IKERBASQUE Basque Foundation for Science (Spain); C. Schüller, Univ. Regensburg (Germany)
- 8461 OP **Optical spin injection and spin lifetime in Ge heterostructures (Invited Paper)** [8461-59]
F. Pezzoli, Univ. degli Studi di Milano-Bicocca (Italy); F. Bottegoni, Politecnico di Milano (Italy); D. Trivedi, Univ. of Rochester (United States); F. Ciccacci, Politecnico di Milano (Italy); A. Giorgioni, Univ. degli Studi di Milano-Bicocca (Italy); P. Li, Univ. of Rochester (United States); S. Cecchi, Politecnico di Milano (Italy); E. Grilli, Univ. degli Studi di Milano-Bicocca (Italy); Y. Song, Univ. of Rochester (United States); M. Guzzi, Univ. degli Studi di Milano-Bicocca (Italy); H. Dery, Univ. of Rochester (United States); G. Isella, Politecnico di Milano (Italy)

SPIN TRANSFER

- 8461 OS **Manipulating the voltage dependence of tunneling spin torques (Invited Paper)** [8461-26]
A. Manchon, King Abdullah Univ. of Science and Technology (Saudi Arabia)
- 8461 OT **STVOs in multilayered metallic NWs electrodeposited inside nanoporous alumina templates: experimental measurements and micromagnetic study (Invited Paper)** [8461-27]
F. Abreu Araujo, Univ. Catholique de Louvain (Belgium); V. Cros, Unité Mixte de Physique CNRS/Thales (France); K. A. Zvezdin, A. M. Prokhorov General Physics Institute (Russian Federation) and Istituto P.M. s.r.l. (Italy); L. Piroux, Univ. Catholique de Louvain (Belgium)

NANOMAGNETISM

- 8461 OU **Spin wave mediated magnetic vortex core reversal (Invited Paper)** [8461-28]
H. Stoll, Max Planck Institute for Intelligent Systems (Germany)

- 8461 OW **Signal propagation in dipole coupled nanomagnets for logic applications (Invited Paper)** [8461-30]
D. Carlton, Lawrence Berkeley National Lab. (United States); B. Lambson, Z. Gu, Univ. of California, Berkeley (United States); S. Dhuey, Lawrence Berkeley National Lab. (United States); L. Gao, B. Hughes, IBM Almaden Research Ctr. (United States); D. Olynick, Lawrence Berkeley National Lab. (United States); C. Rettner, IBM Almaden Research Ctr. (United States); A. Scholl, Lawrence Berkeley National Lab. (United States); B. Youngblood, Univ. of California, Irvine (United States); A. Young, Lawrence Berkeley National Lab. (United States); I. Krivorotov, Univ. of California, Irvine (United States); S. Parkin, IBM Almaden Research Ctr. (United States); J. Bokor, Univ. of California, Berkeley (United States)

VOLTAGE CONTROL

- 8461 OY **Voltage control of magnetism in ferromagnetic structures (Invited Paper)** [8461-67]
L. Herrera Diez, Institut NéEL, CNRS-UJF (France); W. Lin, Institut d'Électronique Fondamentale, CNRS (France); A. Bernand-Mantel, L. Ranno, D. Givord, Institut NéEL, CNRS-UJF (France); L. Vila, P. Warin, A. Marty, Commissariat à l'Énergie Atomique (France); N. Lei, T. Devolder, J. V. Kim, N. Vernier, P. Lecoeur, D. Ravelosona, Institut d'Électronique Fondamentale, CNRS (France)
- 8461 OZ **Switching spin and charge between edge states in topological insulator constrictions: a transfer matrix approach (Invited Paper)** [8461-33]
V. Krueckl, K. Richter, Univ. Regensburg (Germany)

MAGNETIC SC, MULTIFERROICS, AND GRAPHENE

- 8461 11 **Negative capacitance in a ferroelectric-dielectric heterostructure for ultra low-power computing (Invited Paper)** [8461-35]
S. Salahuddin, Univ. of California, Berkeley (United States)

SPIN-OPTICS I

- 8461 16 **Spinoptics in nanostructures (Keynote Paper)** [8461-40]
E. Hasman, V. Kleiner, Technion-Israel Institute of Technology (Israel)
- 8461 17 **Transverse voltage induced by circularly polarized obliquely incident light in plasmonic crystals (Invited Paper)** [8461-41]
T. Ishihara, T. Hatano, H. Kurosawa, Tohoku Univ. (Japan); Y. Kurami, N. Nishimura, Kyoto Univ. (Japan)
- 8461 18 **Spin and orbital angular momentum of light and particle beams and their inter-conversion (Invited Paper)** [8461-42]
L. Marrucci, Univ. di Napoli Federico II and CNR-SPIN Complesso Univ. di Monte S. Angelo (Italy)

SPIN CALORITRONICS

- 8461 1A **Magnon-drag thermopile (Invited Paper)** [8461-44]
M. V. Costache, G. Bridoux, Institut Català de Nanotecnologia (Spain); I. Neumann, Institut Català de Nanotecnologia (Spain) and Univ. Autònoma de Barcelona (Spain);
S. O. Valenzuela, Institut Català de Nanotecnologia (Spain) and Univ. Autònoma de Barcelona (Spain) and Institució Catalana de Recerca i Estudis Avançats (Spain)
- 8461 1B **Anatomy of phonon-induced spin relaxation processes in silicon (Invited Paper)** [8461-45]
Y. Song, H. Dery, Univ. of Rochester (United States)

SPIN-OPTICS II

- 8461 1C **Plasmonic antennas as building blocks for spin optics and quantum optics applications (Invited Paper)** [8461-46]
G. Rui, W. Chen, Univ. of Dayton (United States); D. C. Abeysinghe, C. E. Tabor, R. L. Nelson, Air Force Research Lab. (United States); Q. Zhan, Univ. of Dayton (United States)
- 8461 1D **Spin hall effect of light in graphene (Invited Paper)** [8461-47]
X. Zhou, H. Luo, S. Wen, Hunan Univ. (China)

SPIN-OPTICS AND OPTOELECTRONICS

- 8461 1F **Spin-photodiodes for SiGe spin-optoelectronics (Invited Paper)** [8461-49]
C. Rinaldi, M. Espahbodi, M. Cantoni, R. Bertacco, Politecnico di Milano (Italy)

FUNDAMENTAL PROPERTIES OF MATERIALS

- 8461 1J **Evidence for spin injection and transport in solution-processed TIPS-pentacene at room temperature (Invited Paper)** [8461-52]
S. Mooser, J. F. K. Cooper, K. K. Banger, Cavendish Lab., Univ. of Cambridge (United Kingdom); J. Wunderlich, Hitachi Cambridge Lab. (United Kingdom) and Institute of Physics ASCR, v.v.i. (Czech Republic); H. Sirringhaus, Cavendish Lab., Univ. of Cambridge (United Kingdom)
- 8461 1L **Theory of organic magnetoresistance in disordered organic semiconductors (Invited Paper)** [8461-54]
N. J. Harmon, M. E. Flatté, Univ. of Iowa (United States)

OPTICAL METHODS AND DEVICES

- 8461 1O **Time-resolved spectroscopy of MOVPE-grown III-Mn-V ferromagnetic semiconductors (Invited Paper)** [8461-57]
G. A. Khodaparast, M. Bhowmick, Virginia Polytechnic Institute and State Univ. (United States); C. Feeser, B. W. Wessels, Northwestern Univ. (United States); D. Saha, G. D. Sanders, C. J. Stanton, Univ. of Florida (United States)

- 8461 1P **Optically detecting spin-split bands in semiconductors in magnetic fields (Invited Paper)** [8461-58]
X. Pan, Y. Sun, D. Saha, G. D. Sanders, Univ. of Florida (United States); M. B. Santos, R. E. Doezema, Univ. of Oklahoma (United States); S. E. Hayes, Washington Univ. (United States); G. Khodaparast, Virginia Polytechnic Institute and State Univ. (United States); H. MuneKata, Tokyo Institute of Technology (Japan); Y. H. Matsuda, Univ. of Tokyo (Japan); J. Kono, Rice Univ. (United States); C. J. Stanton, Univ. of Florida (United States)

POSTER SESSION

- 8461 1R **Room temperature ferromagnetism in swift heavy ion irradiated V doped ZnO thin films** [8461-61]
G. Jayalakshmi, National Institute of Technology (India); K. Saravanan, Helmholtz Zentrum Dresden Rossendorf (Germany); T. Balasubramanian, National Institute of Technology (India)
- 8461 1S **Surface functionalization of ZnO films by THIOL** [8461-62]
G. Jayalakshmi, National Institute of Technology (India); K. Saravanan, Helmholtz Zentrum Dresden Rossendorf (Germany); T. Balasubramanian, National Institute of Technology (India)
- 8461 1T **Strong correlation between induced ferromagnetism and oxygen deficiency in hydrothermally synthesized Cu-doped TiO₂ nanorods** [8461-63]
S. K. S. Patel, N. S. Gajbhiye, Indian Institute of Technology (India)

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)

Symposium Cochairs

Satoshi Kawata, Osaka University (Japan)
Manijeh Razeghi, Northwestern University (United States)

Conference Chairs

Henri-Jean Drouhin, Ecole Polytechnique (France)
Jean-Eric Wegrowe, Ecole Polytechnique (France)
Manijeh Razeghi, Northwestern University (United States)

Conference Program Committee

Jack Bass, Michigan State University (United States)
Franco Ciccacci, Politecnico di Milano (Italy)
Russell P. Cowburn, University of Cambridge (United Kingdom)
Vincent Cros, Unité Mixte de Physique CNRS/Thales (France)
Hanan Dery, University of Rochester (United States)
Michel I. Dyakonov, Université Montpellier 2 (France)
Michael E. Flatté, The University of Iowa (United States)
Jean-Marie George, Unité Mixte de Physique CNRS/Thales (France)
Henri Jaffrès, Unité Mixte de Physique CNRS/Thales (France)
Andrew D. Kent, New York University (United States)
Mathias Klaui, Universität Konstanz (Germany)
Yuri A. Mamaev, St. Petersburg State Polytechnical University (Russian Federation)
Ryan P. McClintock, Northwestern University (United States)
Laurens W. Molenkamp, Julius-Maximilians- Universität Würzburg (Germany)
Hiro Munekata, Tokyo Institute of Technology (Japan)
Yoshichika Otani, The University of Tokyo (Japan)
Dafiné Ravelosona, Institut d'Électronique Fondamentale (France)
Nitin Samarth, The Pennsylvania State University (United States)
Alain Schuhl, Commissariat à l'Énergie Atomique (France)
Jing Shi, University of California, Riverside (United States)
Donald J. Silversmith, Defense Threat Reduction Agency (United States)

Luc Thomas, IBM Almaden Research Center (United States)
Evgeny Tsybal, University of Nebraska-Lincoln (United States)
Olaf M. J. van 't Erve, U.S. Naval Research Laboratory (United States)
Joerg Wunderlich, Hitachi Cambridge Laboratory (United Kingdom)
Igor Zutic, University at Buffalo (United States)

Session Chairs

- 1 Spin Coherence, Dynamics, and Fluctuation
Jean-Eric Wegrowe, Ecole Polytechnique (France)
- 2 Spin-Injection I
Aurelie M. Spiesser, National Institute of Advanced Industrial Science and Technology (Japan)
- 3 Spin-Injection II
Junsaku Nitta, Tohoku University (Japan)
- 4 Spin-Injection III
Yuichiro Ando, Osaka University (Japan)
- 5 Magnetic Tunnel Junction
Jean-Marie George, Unité Mixte de Physique CNRS/Thales (France)
- 6 Spin-Orbit Interaction
Shoji Ikeda, Tohoku University (Japan)
- 7 Spin Transfer
Christian Binek, University of Nebraska-Lincoln (United States)
- 8 Nanomagnetism
Yves Acremann, ETH Zürich (Switzerland)
- 9 Voltage Control
Marius Vasile Costache, Institut Català de Nanotecnologia (Spain)
- 10 Magnetic SC, Multiferroics, and Graphene
Luc Thomas, IBM Almaden Research Center (United States)
- 11 Spin-Optics I
Henri-Jean Drouhin, Ecole Polytechnique (France)
- 12 Spin Caloritronics
Jean-Eric Wegrowe, Ecole Polytechnique (France)
- 13 Spin-Optics II
Erez Hasman, Technion-Israel Institute of Technology (Israel)

- 14 Spin-Optics and Optoelectronics
Qiwen Zhan, University of Dayton (United States)
- 15 Fundamental Properties of Materials
Igor Zutic, University at Buffalo (United States)
- 16 Optical Methods and Devices
Michael Oestreich, Leibniz Universität Hannover (Germany)

Introduction

The fifth edition of the Spintronics symposium of the SPIE conference gathered more than sixty five speakers in San Diego from Sunday 12 to Thursday 16 August 2012.

As for the four previous editions, the symposium covered the main topics of Spintronics, witnessing for the dynamism of a very active field of research. These proceedings report some important results presented at the meeting.

The fourteen sessions covered: Spin Coherence, Spin Injection (three sessions), Magnetic Tunnel Junctions, Spin-Orbit Interaction, Spin-Transfer, Nanomagnetism, Voltage Controlled Magnetism, Magnetic Semiconductors, Multiferroics and Graphene, Spin-Optics (two sessions), Spin Caloritronics, Spin-Optics and Optoelectronics, Fundamental Properties of Materials, and Optical Methods and Devices.

This symposium was an opportunity to focus on the hot topics of Spin Caloritronics, Voltage Controlled Magnetism, and Spin-Optics.

This year, for the first time, three sessions were devoted to the emerging field of spin optics, where effects related to the photon spin are observed on the propagation of light beams, e.g. optical Spin Hall Effect, in analogy to spintronics experiments based on the electron spin. These spin optics sessions, introduced by a keynote presentation by Erez Hasman (see proceedings), allowed a stimulating matching with other conferences focused on photonics and were an opportunity for exciting discussions and cross-fertilization.

Overall, the conference was an invaluable opportunity for open exchange and stimulating discussions in a friendly atmosphere.

We are grateful to SPIE, to the Program Committee, and to all speakers and authors that have made this conference a success.

Henri-Jean Drouhin
Jean-Eric Wegrowe
Manijeh Razeghi