

Dr. Nicholas J. Borys

Project Scientist in Nano-optics and Nanoscale Optoelectronics

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EDUCATION

- ◇ **Ph.D., Physics – The University of Utah**, May 2011, Salt Lake City, UT USA.
Dissertation Title: *Optical structure-property relations in metal and semiconductor nanoparticles*.
Adviser: John M. Lupton.
- ◇ **M.Sc., Physics – The University of Utah**, May 2007, Salt Lake City, UT USA.
- ◇ **B.Sc., Math and Computer Science – The Colorado School of Mines**, May 2004, Golden, CO USA.

CURRENT RESEARCH INTERESTS

- ◇ Many-body excitonic phenomena and optoelectronics in two-dimensional monolayer transition metal dichalcogenide semiconductors.
- ◇ Advanced nano-optical, time-resolved and super-resolution imaging and spectroscopy techniques.
- ◇ Disorder-enhanced sub-wavelength light localization and light-matter coupling in plasmonic metal nanostructures.
- ◇ Energy and charge transfer coupling mechanisms in hybrid nanoscale material systems.
- ◇ Nanoscale magnetic phenomena in two-dimensional semiconductors and other materials.

SUMMARY OF PROFESSIONAL EXPERIENCE & KEY ACHIEVEMENTS

- ◇ Materials Project Engineer/Scientist, Molecular Foundry, Lawrence Berkeley National Lab, Berkeley, CA; September 2013 – Present. Adviser: Jim Schuck.
 - Initiated research on two-dimensional transition metal dichalcogenides with near-field optical imaging and spectroscopy of monolayer MoS₂, discovering the formation of disordered peripheral edges and quantifying exciton quenching at grain boundaries.
 - Pursuing near-field imaging of indirect excitons in two-dimensional semiconductor heterostructures of monolayer MoS₂ and WS₂.
 - Developing hyperspectral optical imaging and lifetime mapping to study the spatial and temporal dependence of exciton relaxation dynamics in monolayer MoS₂.
 - Developing data analysis and experimental automation tools in Python and C++.
 - Supporting more than a dozen projects of visiting scholars, industrial users and graduate students.
 - Co-advising three Ph.D. students.
- ◇ Postdoctoral Research Associate, Department of Physics & Astronomy, University of Utah, Salt Lake City, UT; March 2011 – September 2013. Adviser: John Lupton.
 - Served as interim leader and scientific adviser for the Nanoscale Optoelectronics Group
 - Co-advised one completed Ph.D. thesis and two postdoctoral research associates.
 - Combined super-resolution and nonlinear optical microscopies to study sub-wavelength light localization in random metal nanostructures.

SUMMARY OF PROFESSIONAL EXPERIENCE & KEY ACHIEVEMENTS (CONTINUED)

- ◇ Research Assistant & Ph.D. Student, Department of Physics & Astronomy, University of Utah, Salt Lake City, UT; August 2006 – March 2011.
 - Used single particle optical spectroscopy correlated with electron microscopy to unravel optoelectronic structure-property relations in semiconductor nanocrystal heterostructures.
 - Studied the nonlinear optical response of random metal films and nanoparticles, discovering blinking of optical second-harmonic generation and leading to the development of a patented, sub-diffraction optical transmission microscopy technique.
 - Researched the photophysics and optoelectronic properties of conjugated polymers.
 - Built custom analysis and visualization packages for Windows in C, C++, C#, VB and Java.
 - Designed and constructed a single molecule spectroscopy lab automated with LabView.
 - Fabricated OLEDs and solar cells for magnetic resonance measurements.
- ◇ Teaching Assistant & M.Sc. Student, Department of Physics & Astronomy, University of Utah, Salt Lake City, UT; August 2005 – August 2006.
 - Served as a teaching assistant for a general physics with calculus class.
- ◇ Software Engineer, The Boeing Company, Colorado Springs, CO; September 2004 – August 2005.
 - Developed USDOD IT and visualization software in C, C++ and Java resulting in a patent.
 - Demonstrated software to high-ranking U.S. military personnel on several occasions.
- ◇ Software Engineer, Open Scan Technologies, Inc., Denver, CO; January 2001 - September 2004.
 - Lead developer, designer, and manager of several high-value projects.
 - Software and database development for high-volume mail processing (C++, VB, MS SQL).

PROFESSIONAL SERVICE

- ◇ Participation in multiple K-12 outreach activities such as the Bay Area Science Fair.
- ◇ Reviewer for Nature Physics, Scientific Reports, ACS Nano, ChemPhysChem and Optics Express, ACS Applied Materials and Interfaces.
- ◇ Reviewer for Narodowe Centrum Nauki of Poland.
- ◇ Served as discussion leader for the Gordon Research Seminar on colloidal nanocrystals.

AWARDS AND HONORS

- ◇ J. Irvin and Norma K. Swigart Graduate Student Scholarship, Fall 2010.
- ◇ Outstanding Teaching Assistant Award, University of Utah, May 2006.
- ◇ Outstanding Graduating Senior in Math & Comp. Sci., The Colorado School of Mines, May 2004.

PUBLICATIONS (*corresponding author, †equal contributions)

30. L. Richey-Simonsen, **N. J. Borys** *et al.*,
“Investigating surface effects of GaN nanowires using confocal microscopy at below-band gap excitation,”
J. Mater. Res. (in press).
29. D. J. Garfield, **N. J. Borys** *et al.*,
“Enrichment of molecular antenna triplets amplifies upconverting nanoparticle emission,”
(submitted).
28. S. Dhuey, A. Testini, A. Kosholev, **N. J. Borys** *et al.*,
“Three-dimensional woodpile photonic crystals for visible light applications,”
J. Phys. Commun. (in press).

PUBLICATIONS (CONTINUED)

27. K. Yao, A. Yan, S. Kahn, A. Suslu, Y. Liang, E. S. Barnard, S. Tongay, A. Zettl, **N. J. Borys*** and P. J. Schuck*
“Optically discriminating carrier-induced quasiparticle band gap and exciton energy renormalization in monolayer MoS₂,”
Phys. Rev. Lett. (in press).
26. K. Zhang[†], **N. J. Borys[†]**, B. Bersch[†] *et al.*,
“Deconvoluting the photonic and electronic response of 2D materials,”
(submitted).
25. M. A. Koc, S. N. Raja, L. A. Hanson, S. C. Nguyen, **N. J. Borys et al.**,
“Characterizing photon reabsorption in quantum dot-polymer composites for use as displacement sensors,”
ACS Nano 11, 2075 (2017).
24. G. Calafiore, A. Kosholev, T. P. Darlington, **N. J. Borys et al.**,
“Campanile near-field optical probes fabricated by nanoimprint lithography on the facet of an optical fiber,”
Sci. Rep. 7 1651 (2017).
23. Z. Lin, A. McCreary, N. Briggs, S. Subramanian, K. Zhang, Y. Sun, X. Li, **N. J. Borys et al.**,
“2D materials advances in 2015-2016: from large scale synthesis and controlled hetero-structures to improved characterization techniques, defects and applications,”
2D Mater. 3, 042001 (2016).
22. C. Kastl, C. Chen, T. R. Kuykendall, T. P. Darlington, **N. J. Borys et al.**,
“The important role of water in growth of monolayer transition metal dichalcogenides,”
2D Mater. 4, 021024 (2017).
21. **N. J. Borys***, P. J. Schuck *et al.*,
“Anomalous above-gap photoexcitations and optical signatures of localized charge puddles in monolayer molybdenum disulfide,”
ACS Nano 11, 2115 (2017).
20. E. S. Barnard*, B. Ursprung, E. Colegrove, H. R. Moutino, **N. J. Borys et al.**,
“3D Lifetime Tomography Reveals How CdCl₂ Improves Recombination Throughout CdTe Solar Cells,”
Adv. Mater. 29, 1603801 (2016).
Highlighted by LBNL news.
19. J. Kilbane, E. Chan, C. Monachon, **N. J. Borys et al.**,
“Far-field optical nanothermometry using individual sub-50 nm upconverting nanoparticles,”
Nanoscale 8, 11611 (2016).
18. F. Toma, J. K. Cooper, V. Kunzelmann, M. T. McDowell, J. Yu, D. Larson, **N. J. Borys et al.**,
“Mechanistic Insights into Chemical and Photochemical Transformations of Bismuth Vanadate Photoanodes,”
Nature Commun. 7, 12012 (2016).
17. P. J. Schuck, W. Bao and **N. J. Borys**,
“A polarizing situation: taking an in-plane perspective for next-generation near-field studies,”
Front. Phys. 11, 117804 (2016).
16. D. F. Ogletree*, P. J. Schuck*, A. F. Weber-Bargioni*, **N. J. Borys et al.**,
“Revealing optical properties of reduced dimensionality materials at relevant length scales,”
Adv. Mater. 27, 5693 (2015).
15. W. Bao[†], **N. J. Borys[†]**, P. J. Schuck* *et al.*,
“Visualizing nanoscale excitonic relaxation properties of disordered edges and grain boundaries in monolayer molybdenum disulfide,”
Nat. Commun. 6, 7993 (2015).
Covered by cleantechnica.com.

PUBLICATIONS (CONTINUED)

14. S. Liu, **N. J. Borys**^{*}, S. Sapra, A. Eychmuller and J. M. Lupton,
“Localization and dynamics of long-lived excitations in colloidal semiconductor nanocrystals with dual quantum confinement,”
ChemPhysChem 16, 1663 (2015).
13. **N. J. Borys**^{*}, E. Shafran and J. M. Lupton,
“Surface plasmon delocalization in silver nanoparticle aggregates revealed by subdiffraction supercontinuum hot spots,”
Sci. Rep. 3, 2090 (2013).
12. E. Shafran, **N. J. Borys**^{*}, J. Huang, D. V. Talapin and J. M. Lupton,
“Indirect exciton formation due to inhibited carrier thermalization in single CdSe/CdS nanocrystals,”
J. Phys. Chem. Lett. 4, 691 (2013).
11. S. Liu, **N. J. Borys**, J. Huang, D. V. Talapin and J. M. Lupton^{*},
“Exciton storage in CdSe/CdS tetrapod semiconductor nanocrystals: electric field effects on exciton and multiexciton states,”
Phys. Rev. B 86, 045303 (2012).
10. S. Liu, D. Schmitz, S-S. Jester, **N. J. Borys**, S. Höger and J. M. Lupton^{*},
“Coherent and incoherent interactions between cofacial π -conjugated oligomer dimers in macrocycle templates,”
J. Phys. Chem. B 117, 4197 (2013) (published online in 2012).
9. D. Li, **N. J. Borys**^{*} and J. M. Lupton,
“Probing the electrode-polymer interface in conjugated polymer devices with surface-enhanced Raman scattering,”
Appl. Phys. Lett. 100, 141907 (2012).
8. **N. J. Borys** and J. M. Lupton^{*},
“Surface-enhanced light emission from single hot spots in fractal silver nanoparticle films: linear versus non-linear optical excitation,”
J. Phys. Chem. C 115, 13645 (2011).
7. E. Da Como, **N. J. Borys**, P. Stroehriegl, M. J. Walter and J. M. Lupton^{*},
“Formation of a Defect-Free π -Electron System in Single β -Phase Polyfluorene Chains,”
J. Am. Chem. Soc. 133, 3690 (2011).
Highlighted in the Editor’s Choice section of Science.
6. **N. J. Borys**, M. J. Walter, J. Huang, D. V. Talapin and J. M. Lupton^{*},
“The role of particle morphology in interfacial energy transfer in CdSe/CdS heterostructure nanocrystals,”
Science 330, 1371 (2010).
Highlighted in MRS Today.
5. **N. J. Borys**, M. J. Walter and J. M. Lupton^{*},
“Intermittency in second-harmonic radiation from hot spots on rough silver films,”
Phys. Rev. B 80, 161407(R) (2009).
Highlighted in the Research Highlights section of Nature Physics.
4. D. Chaudhuri, J. W. Galusha, M. J. Walter, **N. J. Borys**, M. H. Bartl^{*} and J. M. Lupton^{*},
“Towards sub-diffraction transmission microscopy of diffuse materials by using silver nanoparticle white-light beacons,”
Nano Lett. 9, 952 (2009).
Highlighted on sciencemag.org.
3. M. J. Walter, **N. J. Borys**, G. Gaefke, S. Höger and J. M. Lupton^{*},
“Spatial Anticorrelation between Nonlinear White-Light Generation and Single Molecule Surface-Enhanced Raman Scattering,”
J. Am. Chem. Soc. 130, 16830 (2008).

PUBLICATIONS (CONTINUED)

2. M. J. Walter, **N. J. Borys**, K. J. van Schooten and J. M. Lupton*, "Light-Harvesting Action Spectroscopy of Single Conjugated Polymer Nanowires," *Nano Lett.* 8, 3330 (2008).
1. D. R. McCamey, H. A. Seipel, S. Y. Paik, M. J. Walter, **N. J. Borys**, J. M. Lupton* and C. Boehme*, "Spin Rabi flipping in the photocurrent of a polymer light-emitting diode," *Nature Mat.* 7, 723 (2008).

PATENTS

2. J. M. Lupton, M. Bartl, D. Chaudhuri, J. Galusha, **N. J. Borys** and M. J. Walter, "Transmission microscopy using light emitted from nanoparticles," US Patent 7929132 (2011).
1. **N. J. Borys**, J. L. Liebbe and N. L. Thrasher, "System and method of communications within a virtual environment," US Patent 20080005237 (2008).

INVITED PRESENTATIONS

7. N. J. Borys, "Broadband excitation and nanoscale relaxation processes of excitons in monolayer MoS₂" 8/2017, SPIE Optics + Photonics, San Diego, California, USA.
6. N. J. Borys & P. J. Schuck, "Sensing and imaging local optoelectronic properties in 2D materials with nano-light" 8/2016, SPIE Optics + Photonics, San Diego, California, USA.
5. N. J. Borys, "The anatomies of excitons and structurally-dependent photophysics in monolayer MoS₂" 6/2016, Graphene and Beyond, Penn State University, USA.
4. N. J. Borys, "The nanoscale excitonic anatomy of monolayer MoS₂," 8/2015, Molecular Foundry User Meeting, Berkeley, California, USA.
3. N. J. Borys, "Nano-optical spectroscopic imaging of monolayer MoS₂," 3/2015, University of Science and Technology of China, Hefei National Lab, Hefei, China.
2. N. J. Borys & J. M. Lupton, "Unveiling plasmon delocalization and ultranarrow resonances in rough silver films with single nonlinear hot spots," 4/2013, ACS 2013 National Spring Meeting, New Orleans, Louisiana, USA.
1. N. J. Borys and J. M. Lupton, "Unraveling optical structure-property relations in nanoscale systems using single particle spectroscopy," 6/2012, Int. Conf. on Functional Organic Materials..., National Tsing Hua University, Taiwan.

CONTRIBUTED PRESENTATIONS

17. N. J. Borys, *et al.*, "Optical spectroscopy and imaging of the higher energy excitons and bandgap of monolayer MoS₂" 3/2015, APS March Meeting, Baltimore, Maryland.
16. N. J. Borys, W. Bao, P. J. Schuck *et al.*, "Nano-optical spectroscopic imaging of monolayer MoS₂," 3/2015, Nanolight 2016, Benasque, Spain.
15. N. J. Borys, W. Bao, E. S. Barnard, P. J. Schuck *et al.*, "Optical spectroscopy and imaging of the higher-energy excitons and bandgap of monolayer MoS₂," 12/2015, 2015 MRS Fall Meeting, Boston, Massachusetts, USA.
14. N. J. Borys, W. Bao, P. J. Schuck *et al.*, "Nano-optical spectroscopic imaging of monolayer MoS₂," 12/2015, 2015 MRS Fall Meeting, Boston, Massachusetts, USA.
13. N. J. Borys, W. Bao, P. J. Schuck *et al.*, "Optically probing 2D materials at length scales that matters: correlating nanoscale charge recombination heterogeneity and surface potential," 1/2015, PSCI-42, Snowbird, Utah, USA.
12. N. J. Borys, P. J. Schuck, *et al.*, "Unraveling the origins of disorder and spatial inhomogeneity of the optoelectronic properties of single-layer MoS₂," 12/2014, 2014 MRS Fall Meeting, Boston, Massachusetts, USA.

CONTRIBUTED PRESENTATIONS (CONTINUED)

11. N. J. Borys, Eyal Shafran and John M. Lupton, "Structural and optical visualization of hot spots formed by weak localization phenomena in random silver nanoparticle films,"
12/2014, 2014 MRS Fall Meeting, Boston, Massachusetts, USA.
10. N. J. Borys and J. M. Lupton, "Using Nonlinear Optical Hot Spots to Study Localized and Delocalized Plasmonic Excitations in Silver Nanoparticle Films,"
11/2012, 2012 MRS Fall Meeting, Boston, Massachusetts, USA.
9. N. J. Borys and J. M. Lupton, "Light Harvesting in Single Polymer Chains and Nanostructures,"
8/2011, 2011 International Conference of Photochemistry, Beijing, China.
8. N. J. Borys and J. M. Lupton, "Comparison of the linear and nonlinear optical hot spots of rough silver films used for surface-enhanced Raman scattering,"
8/2011, 2011 International Conference of Photochemistry Beijing, China.
7. N. J. Borys and J. M. Lupton, "Particle Morphology and Interfacial Energy Transfer in Light-Harvesting CdSe/CdS Nanocrystals,"
4/2011, 2011 Light Harvesting Processes, Lichtenfels, Germany.
6. N. J. Borys and J. M. Lupton, "Particle Morphology and Interfacial Energy Transfer in Light-Harvesting CdSe/CdS Nanocrystals,"
3/2011, 2011 APS March Meeting, Dallas, Texas, USA.
5. N. J. Borys and J. M. Lupton, "Comparison of the linear and nonlinear optical hot spots of rough silver films used for surface-enhanced Raman scattering,"
12/2010, 2010 MRS Fall Meeting, Boston, Massachusetts, USA.
4. N. J. Borys, M. J. Walter, J. Huang, D. V. Talapin and J. M. Lupton, "Light harvesting action spectroscopy of single CdSe/CdS nano-heterostructures,"
4/2010, NaNaX4 Conference, Munich, Germany.
3. N. J. Borys, M. J. Walter and J. M. Lupton, "Blinking in the surface-enhanced second-harmonic generation of rough silver films: implications for single molecule SERS,"
12/2009, 2009 MRS Fall Meeting, Boston, Massachusetts, USA.
2. D. Chaudhuri, J. W. Galusha, N. J. Borys, M. H. Bartl and J. M. Lupton, "Single domain spectroscopy of biological photonic crystals using plasmonic beacons,"
12/2009, 2009 MRS Fall Meeting Boston, Massachusetts, USA.
1. N. J. Borys, M. J. Walter and J. M. Lupton, "Nonlinear optical characterization of silver nanoparticle substrates for single molecule SERS,"
3/2009, 2009 ACS National Spring Meeting, Salt Lake City, Utah, USA.

POSTERS

6. N. J. Borys, W. Bao, P. J. Schuck et al., "Unveiling the origins of spatial heterogeneity and the extent of inhomogeneous broadening of excited states and relaxation processes in single-layer MoS₂,"
4/2015, 2015 MRS Spring Meeting, San Francisco, California, USA.
5. N. J. Borys, E. Shafran and J. M. Lupton, "Structural and optical visualization of hot spots formed by weak localization phenomena in random silver nanoparticle films,"
10/2014, NFO13 Conference Salt Lake City, Utah, USA.
4. N. J. Borys, M. J. Walter, J. Huang, D. V. Talapin and J. M. Lupton, "Light-harvesting action spectroscopy of single CdSe/CdS nanocrystals,"
12/2010, 2010 MRS Fall Meeting, Boston, Massachusetts, USA.
3. N. J. Borys, M. J. Walter and J. M. Lupton, "Blinking in the surface-enhanced second-harmonic generation of rough silver films: implications for single molecule SERS,"
4/2010, NaNaX4 Conference, Munich, Germany.

POSTERS (CONTINUED)

2. N. J. Borys, M. J. Walter, J. Huang, D. V. Talapin and J. M. Lupton, "Light harvesting action spectroscopy of single CdSe/CdS nanocrystals,"
12/2009, 2009 MRS Fall Meeting, Boston, Massachusetts, USA.
1. N. J. Borys, M. J. Walter and J. M. Lupton, "Second-Harmonic Generation from Tollens SERS Substrates for Plasmon Enhanced Spectroscopy of π -Conjugated Systems,"
10/2007, 2007 Excited State Processes Conference, Santa Fe, New Mexico, USA.