

Jeffrey D. Cain

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Education

Ph. D. Materials Science and Engineering (in progress)

Evanston, IL

- Northwestern University

B.S. Physics, with Honors (2012)

B.S. Materials Science and Engineering, with Honors (2012)

East Lansing, MI

- Michigan State University
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Research Experience

Northwestern University (August 2012-Present)

I work to explore exotic phenomena stemming from spatial and dimensional confinement in two-dimensional (2D) layered structures, under Prof. Vinayak Dravid. I study the synthesis and characterization of 2D materials including, but not limited to, the metal chalcogenides. These materials are then used to study doping and heterostructuring, and as a platform for investigating electronic and photonic properties in the 2D limit. This is a collaborative project involving multiple departments including physics, chemistry, applied physics and electrical engineering.

Sandia National Laboratory (August 2016)

Visiting scientist working on the growth of two-dimensional (2D) materials in the Electrical, Optical, and Nano Materials Department at Sandia National Laboratory, Albuquerque, NM.

Michigan State University (September 2010- September 2011)

I worked under Prof. Donald Morelli assisting in the development, synthesis and characterization of compounds for thermoelectric power generation and cryogenic Peltier cooling. This work was part of the United States Department of Energy -Energy Frontier Research Center.

Pennsylvania State University (June 2010 – August 2010)

National Science Foundation funded Research Experience for Undergraduates (REU) in the physics department at Pennsylvania State University under Prof. Peter Schiffer.

Michigan State University (October 2009- May 2010)

National Science Foundation funded Research Experience for Undergraduates (REU) in the materials science and engineering department at Michigan State University under Prof. Donald Morelli.

National Superconducting Cyclotron Laboratory, Michigan State University (June 2009- June 2011)

Research assistant, nuclear and accelerator sciences

Fellowships, Awards, and Honors

IIN Outstanding Researcher Award- International Institute for Nanotechnology, Northwestern University (2016)

Terminal Year Doctoral Fellowship- Robert R. McCormick School of Engineering and Applied Science, Northwestern University (2016)

Ryan Fellowship for Nanotechnology -International Institute for Nanotechnology, Northwestern University (2015)

National Defense Science and Engineering Graduate (NDSEG) Research Fellowship (2013)

National Science Foundation (NSF) Graduate Research Fellowship (2013)

Dean's List-Michigan State University (2007-2012)

Teaching and Outreach

As Teaching Assistant

Materials Science and Engineering-Freshmen Seminar; Northwestern University (Fall 2015)

Materials Science and Engineering-Introduction to Electron Microscopy; Northwestern University (Spring 2015)

As Research Mentor

Mentored and supervised multiple undergraduate students as they worked through independent research projects (2012- present)

Served as graduate adviser for two students working on senior theses within the materials science and engineering department (2013-Present)

National Science Foundation Research Experience for Undergraduates (NSF-REU) mentor- guided visiting undergraduate students through summer research project (2014-2016)

Community Outreach and Volunteer Service

Letter to a Pre-Scientist, Pen-pal with under-privileged elementary school students interested in STEM fields (2014-Present)

Judge, City-Wide Chicago High School Science Fair (2014-2016)

Guest Speaker- Skokie Public Schools, Skokie IL (2014)

Peer Assisted Learning, Michigan State University College of Engineering- National Science Foundation funded program that provided tutoring for introductory engineering classes for engineering underclassmen (2011- 2012)

Professional Society Memberships

American Chemical Society (2014-Present)
Materials Research Society (2012-Present)
American Physical Society (2010-Present)

Publications and Presentations

Under Review, Submitted, and In Preparation

1. J.D. Cain, E.D. Hanson, V.P. Dravid, "Towards Time-Temperature-Transformation Diagrams for Deterministic Synthesis of Transition Metal Dichalcogenide Heterostructures and Alloys".

**In Preparation*

2. Y. Li, J.D. Cain, E.D. Hanson, A.A. Murthy, S. Hao, F. Shi, Q. Li, C. Wolverton, X. Chen, V.P. Dravid, "Developing Au@MoS₂ Core-Shell Heterostructures with Strong Light-Matter Interactions".

**In preparation*

3. S. Butun, E. Palacios, J.D. Cain, V.P. Dravid, K. Aydin, "Enhanced Light Absorption in Large-Area Monolayer WS₂ Using Plasmonic Nanodisc Arrays".

**In preparation*

4. Y. J. Chen, J. D. Cain, T. K. Stanev, V. P. Dravid, N. P. Stern, "Valley-Polarized Exciton-Polaritons in a Monolayer Semiconductor Embedded in a Microcavity".

**In preparation*

Published (Continued on next page)

5. J.D. Cain, E.D. Hanson, F. Shi, V.P. Dravid, "Emerging Opportunities in the Two-Dimensional Chalcogenide Systems and Architecture", *Curr. Opin. Solid State Mater. Sci.* (2016)

(DOI: 10.1016/j.cossms.2016.06.001)

6. J.D. Cain, F. Shi, J. Wu, V.P. Dravid, "Growth Mechanism of Transition Metal Dichalcogenide Monolayers: The Role of Self-Seeding Fullerene Nuclei", *ACS Nano* 10, 5440 (2016).

(DOI: 10.1021/acsnano.6b01705)

7. Y. Huang*, J. D. Cain*, L. Peng, S. Hao, T. Chasapis, M. G. Kanatzidis, C. Wolverton, M. Grayson, V.P. Dravid, "Evaporative Thinning: A Facile Synthesis Method for High Quality Ultrathin Layers of 2D Crystals", *ACS Nano* 10, 10851 (2014).

***These authors contributed equally**

8. Y. Zhang, E. Skoug, J.D. Cain, V. Ozoliņ, D. Morelli, C. Wolverton, "First-principles description of anomalously low lattice thermal conductivity in thermoelectric Cu-Sb-Se ternary semiconductors", *Phys. Rev. B.* 85, 054306 (2012).

9. E.J. Skoug, J.D. Cain, D.T. Morelli, "Improved Thermoelectric Performance in Cu-Based Ternary Chalcogenides using S for Se substitution", *Journal of Electronic Materials* 41, 1232, (2012).

10. E. J. Skoug, J. D. Cain, D. T. Morelli "Thermoelectric Properties of Ge-doped Cu_3SbSe_4 " MRS Proceedings, 1314, (2011) mrsf10-1314-ll07-10 (doi:10.1557/opl.2011.266.)
11. E.J. Skoug, J.D. Cain, D.T. Morelli, "High thermoelectric figure of merit in the Cu_3SbSe_4 - Cu_3SbS_4 solid solution", Applied Physics Letters 98, 261911 (2011).
12. E.J. Skoug, J.D. Cain, D.T. Morelli, M. Kirkham, P. Majsztrik, E. Lara-Curzio, "Lattice thermal conductivity of the Cu_3SbSe_4 - Cu_3SbS_4 solid solution" Journal of Applied Physics 110, 023501 (2011).
13. E.J. Skoug, J.D. Cain, P. Majsztrik, M. Kirkham, E. Lara-Curzio, D.T. Morelli, "Doping effects on the thermoelectric properties of Cu_3SbSe_4 ", Science of Advanced Materials 3, pp. 1-5 (2011).
14. E.J. Skoug, J.D. Cain, D.T. Morelli, "Structural effects on the lattice thermal conductivity of antimony and bismuth containing chalcogenide semiconductors" Applied Physics Letters 96, 181905 (2010).
15. E.J. Skoug, J.D. Cain, D.T. Morelli, "Thermoelectric properties of the Cu_2SnSe_3 - Cu_2GeSe_3 solid solution" Journal of Alloys and Compounds 506, pp. 18-21 (2010).

Conference Presentations and Posters

1. J. D. Cain, J. Wu, F. Shi, V. P. Dravid, "Growth and Nucleation in CVD Grown Monolayer MoS_2 " 2015 Materials Research Society Fall Meeting, Boston, MA.
2. Y. Chen , J.D. Cain , T. Stanev , G. Wei , V.P. Dravid, N. Stern "Valley-Polarized Exciton-Polaritons in a Monolayer Semiconductor Embedded in a Microcavity" 2016 American Physical Society March Meeting, Baltimore, MD.
3. Y. Chen , J.D. Cain , T. Stanev , G. Wei , V.P. Dravid, N. Stern "Light-Matter Interactions of Monolayer Semiconductors Integrated with Photonic Microcavities" 2015 American Physical Society March Meeting, San Antonio, TX.
4. J.D. Cain, Y. Huang, L. Peng, S. Hao, T. Chasapis, M. G. Kanatzidis, C. Wolverton, M. Grayson, V.P. Dravid, "Evaporative Thinning: A Facile Synthesis Method for High Quality Ultrathin Layers of 2D Crystals" 2014 Materials Research Society Fall Meeting, Boston, MA.