



Education

- 2015–Present **Ph.D.**, *California Institute of Technology*.
Materials Science and Applied Physics
- 2011–2015 **B.A.**, *Bowdoin College*.
Majors: Mathematics, Physics and Astronomy
Minor: Computer Science

Research Experience

- 2015–Present **High Contrast Gratings Evolutionary Optimization**, *California Institute of Technology*, Advisor: Professor Harry Atwater.
We develop optimized metasurface and high-contrast grating, spectrally-selective filter designs via a Genetic Algorithm (GA) optimization. Exploiting selective reflectivity and omnidirectionality, we demonstrate potential applications such as use in a tandem LSC device.
- 2015–Present **Tandem Luminescent Solar Concentrator Fabrication**, *California Institute of Technology*, Advisor: Professor Harry Atwater.
This project develops and fabricates non-traditional Luminescent Solar Concentrator (LSC) technology by harnessing ultra-high efficient Quantum Dot (QD) luminophores, planar InGaP micro-cells, traditional flat plate Si photovoltaic cells, spectrally-selective dielectric stack filters, and traditional LSC waveguide technology in order to induce record high efficiency devices at lower manufacturing costs.
- 2015–2017 **Tandem Luminescent Solar Concentrator Design**, *California Institute of Technology*, Advisor: Professor Harry Atwater.
We build both a theoretical and computational model to simulate luminescent solar concentrator (LSC) module performance under low direct normal incidence (DNI) conditions. By rigorously exploring the device parameter space, we develop a fundamental understanding of the power conversion efficiency limits and gains made possible by such a light trapping mechanism.
- 2014–2015 **Evolutionary Artificial Neural Networks: An Application to Facial Recognition**, *Bowdoin College*, Advisor: Professor Stephen Majercik.
Exploring the limited connection topology for an Artificial Neural Network, this project hybridizes the Artificial Neural Network Algorithm (ANNA) and the Genetic Algorithm (GA) in order to develop a novel facial recognition software founded on nature inspired techniques.

- 2014–2015 **Photosystem I/Zinc Oxide/Silicon Solar Cells**, *Vanderbilt University*, Advisors: Professor David Cliffler, Professor Gabriel LeBlanc.
Building off of previous work using films of Photosystem I (PSI) on p-doped silicon, this project exploits the confined-plume chemical deposition (CPCD) process to interface Zinc Oxide (ZnO) and PSI in order to demonstrate, as a proof of concept, the electrical performance of a solid-state photovoltaic device consisting of Silicon, PSI, ZnO, and Indium Tin Oxide (ITO).
- 2014–2015 **Biohybrid Solid State Solar Cells**, *Vanderbilt University*, Advisor: Professor David Cliffler.
Inspired by inexpensive, flexible solar cells, this research combines solid state device physics, polymer chemistry, and PSI biophysics to develop a novel solar cell composed of Reduced Graphene Oxide (rGO), Poly(3,4-ethylenedioxythiophene) Polystyrene sulfonate (PEDOT:PSS), PSI, and p-Doped Silicon to create a flexible, biohybrid photovoltaic device.
- 2013–2014 **Dye Sensitized Solar Cells and Polycrystalline Photovoltaic Cells**, *Bowdoin College*, Advisor: Professor Madeline Msall.
This research focuses on quantifying the relative efficiency between a Dye Sensitized Solar Cell (DSSC) and a traditional, Polycrystalline Photovoltaic Cell (PPC) with respect to incident light wavelength and intensity.

Publications and Presentations

- [12] D. R. Needell, "Cloudy with a Chance of Solar." *California Institute of Technology GSC Research Spotlight*, Oral Presentation, **2017**.
- [11] D. R. Needell, O. Ilic, C. Bukowsky, H. Bauser, H. Atwater, "Micro-optical Tandem Luminescent Solar Concentrators." *Joule (Under review)*, **2017**
- [10] D. R. Needell, Z. Nett, O. Ilic, C. Bukowsky, J. He, L. Xu, R. Nuzzo, B. Lee, J. Geisz, P. Alivisatos, H. Atwater, "Micro-optical Tandem Luminescent Solar Concentrator." *IEEE PVSC*, **2017**
- [9] D.R. Needell, H. Bauser, Z. Nett, P. Alivisatos, R. Nuzzo, H. Atwater, "Tandem Luminescent Solar Concentrators." *ARPA-E Technology Summit*, Technology Showcase Presentation, **2017**.
- [8] D.R. Needell, O. Ilic, C. Bukowsky, H. Atwater, "Tandem Luminescent Solar Concentrators." *Gordon Research Conference and Seminar*, Poster Presentation, **2017**.
- [7] D.R. Needell, S. Darbe, C. Bukowsky, H. Atwater, "Tandem Luminescent Solar Concentrators." *Resnick Institute Fellowship Symposium*, Poster Presentation, **2016**.
- [6] J.C. Beam, G. LeBlanc, B. L. Ivanov, D.R. Needell, M. J. Shearer, G. K. Jennings, D. E. Cliffler, and C. M. Lukehart, "Construction of a Semiconductor-Biological Interface for Solar Energy Conversion: p-doped Silicon/Photosystem I/ZnO." *Langmuir*, **2015**, *10*, 0743-7463.
- [5] D.R. Needell, "Evolutionary Artificial Neural Networks: An Application to Facial Recognition." *Bowdoin College*, Oral Presentation, **2015**.
- [4] D.R. Needell, "The Three Dimensional Diffusion Model and its Application to DSSC TiO_2 Nanotubes." *Bowdoin College*, Oral Presentation, **2014**.

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- [3] [D.R. Needell](#), "Biohybrid Solid State Solar Cells." *Bowdoin College Presidential Science Symposium*, Poster Presentation, **2014**.
- [2] [D.R. Needell](#), "Biohybrid Solid State Solar Cells." *Vanderbilt University Summer Science Symposium*, Poster Presentation, **2014**.
- [1] [D.R. Needell](#), "DSSC and PPC Spectral Analyses." *Bowdoin College*, Oral Presentation, **2014**.

Teaching Experience

- 2012–2015 **Physics 1130: Introductory Physics I Teaching Assistant**, *Bowdoin College*, Advisor: Professor Mark Battle, Co-advisor: Professor Madeline Msall. Conducted study sessions for Introductory Physics I undergraduate students, graded assignments, held recitations, and occasionally tutored students individually.
- 2014–2015 **Physics 1083: Energy, Physics, and Technology Tutor**, *Bowdoin College*, Advisor: Professor Madeline Msall. Individually tutored undergraduate students in this introductory physics class covering material from basic thermodynamics and heat engines to photovoltaic devices to black body radiation.
- 2014–2015 **Mathematics 2603: Introduction to Real Analysis Teaching Assistant**, *Bowdoin College*, Advisor: Professor Thomas Pietraho. Assisted Introduction to Real Analysis through grading problem sets and exams and holding office hours.

Awards

- 2017 California Institute of Technology Research Spotlight Recipient
- 2015–2016 Charles and Cynthia Zeller Resnick Institute Fellowship
- 2012–2015 Sarah and James Bowdoin Scholar
- 2012–2015 Member of the Mathematics Association of America (MAA)
- 2012–2015 Member of the Society for Industrial and Applied Mathematics (SIAM)
- 2014 National Science Foundation Research Experience for Undergraduates Fellowship

Laboratory and Computer Skills

- Computing C, C++, Java, Matlab, Mathematica, Labview, SketchUp, GraphPad Prism, Fluency L^AT_EX
- Laboratory Sputterer Deposition, Spin Coating, Photochronoamperometry, UV Vis-NIR, Fluency Raman Spectroscopy, Goniometry, Stylus Profilometry, 4-Point Probe

Interests

- Music: Percussion, Guitar, Piano
- Visual Arts: Wheel Thrown Pottery
- Sports: Muay Thai, Boxing, Basketball, Soccer
- Outdoors: Skiing, Hiking, Rock Climbing

Contact Information

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References

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Designation Assistant Professor of Chemistry
Organization The University of Tulsa
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