

# DAVID BERNEY NEEDLEMAN

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## EDUCATION

**Massachusetts Institute of Technology**, Cambridge, MA.

- Doctor of Philosophy in Mechanical Engineering, expected 2016.  
Thesis: "Performance Limits of Silicon Solar Cells Due to Structural Defects"
- Master of Science in Mechanical Engineering, 2014.  
Thesis: "Optical Design Guidelines for Spectral Splitting Photovoltaic Systems"
- Awards: National Defense Science and Engineering Graduate (NDSEG) Fellow.

**Robert D. Clark Honors College, University of Oregon**, Eugene, OR

- Bachelor of Science in Physics, Minor in Mathematics, 2007.  
Thesis: "Characterization of Bifacial CIGS Solar Cells" (highest honors)
- Honors: Phi Beta Kappa Society, Dept. Honors, Friars Society, Dean's Scholarship, Dean's List.
- Awards: Centurion Award for Dedication and Outstanding Service as a Student Leader (2004).

## SELECTED PROFESSIONAL AND RESEARCH EXPERIENCE

**Massachusetts Institute of Technology**, Cambridge, MA.

September 2012 – Present

*Photovoltaic Research Laboratory, Graduate Research Assistant*

- Simulated the device performance impacts of grain boundaries and dislocations in Si solar cells.
  - Developed numerically tractable model for recombination and band bending at structural defects.
  - Implemented model in 3-D TCAD simulations of standard, PERC, and heterojunction Si solar cells.
  - Determined maximum structural defect density and distribution for high efficiency in each cell type.
  - Performed experiments to show model predicts cell performance from grain boundary activity.
- Developed technique to rapidly map dislocation density on large-area Si wafers with a flatbed scanner.
- Performed techno-economic analysis of Si solar cell manufacturing using bottom-up cost modeling.
- Analyzed sensitivity of spectral-splitting PV to optical parameters with coupled optical/device modeling.

**Pontifícia Universidade Católica do Rio Grande do Sul**, Porto Alegre, Brazil.

June – August 2014

*Núcleo de Tecnologia em Energia Solar, Visiting Graduate Researcher*

- Compared processes for depositing dielectrics for passivation of Si surfaces for solar cells.

**Massachusetts Institute of Technology**, Cambridge, MA.

January 2011 – July 2012

*Photovoltaic Research Laboratory, Research Specialist*

- Characterized silicon solar cells for defect engineering R&D projects with industrial partners.
- Installed and maintained laboratory equipment in class 10,000 cleanroom.
- Environmental Health & Safety officer for lab containing chemical, fire, explosive, and laser hazards.

**Atlantic Solar**, Cape Town, South Africa.

September 2009 – June 2010

*Research and Development, Engineer*

- Developed, tested, and prototyped a way to make direct solar hot water collectors frost-tolerant.
- Established relationships with universities and companies to share facilities, resources, and results.
- Trained and managed a team of student interns.
  - Assigned tasks and supervised progress.

**University of Oregon**, Eugene, OR.

July 2006 – June 2007

*Materials Science Institute, Undergraduate Research Assistant*

- Performed experiments & simulations to characterize metastable defects in thin-film CIGS solar cells.

## RELEVANT SKILLS

Material & device characterization: I-V(-T) analysis, photo/electro-luminescence imaging, lock-in thermography, Suns- $V_{oc}$ , quasi-steady-state and transient photoconductance (Sinton eddy current and Semilab microwave reflectivity), 4-point probe resistivity, optical microscopy, spectroscopic ellipsometry.

Material & device processing:  $POCl_3$  diffusion/gettering, Si etching/cleaning, atomic layer deposition, LP-CVD thermal oxidation, thermal annealing, cleanroom experience, statistical process control (course).

Software: TCAD Synopsys Sentaurus, PC1D, SCAPS-1D, Griddler, Matlab, Microcal Origin, MS Office.

Communication: Writing, public presentations, conversational French, basic Portuguese.

## PUBLICATIONS

- **D. Berney Needleman**, H. Wagner, P.P. Altermatt, Z. Xiong, P.J. Verlinden, and T. Buonassisi, "Dislocation-limited performance of advanced solar cells through TCAD modeling." *Solar Energy Materials and Solar Cells* (under review).
- **D. Berney Needleman**, J.R. Poindexter, R.C. Kurchin, I.M. Peters, G. Wilson, and T. Buonassisi, "Economically sustainable scaling of photovoltaics to meet climate targets." *Energy & Environmental Science* (under review).
- K. Nakayashiki, J. Hofstetter, A.E. Morishige, T.-T.A. Li, **D. Berney Needleman**, M.A. Jensen, and T. Buonassisi, "Engineering solutions for and root-cause analysis of light-Induced degradation in p-type multicrystalline silicon PERC modules." *IEEE J. Photovoltaics* (under review).
- **D. Berney Needleman**, H. Wagner, P.P. Altermatt, and T. Buonassisi, "3-D TCAD modeling of grain boundaries in high-efficiency silicon solar cells." *IEEE J. Photovoltaics* (accepted).
- **D. Berney Needleman**, H. Wagner, P.P. Altermatt, and T. Buonassisi, "Assessing the device-performance impacts of structural defects with TCAD modeling." *Energy Procedia* **77**, 8-14 (2015).
- **D. Berney Needleman**, J.P. Mailoa, R.E. Brandt, N.M. Mangan, and T. Buonassisi, "Sensitivity analysis of optical metrics for spectral splitting photovoltaic systems: a case study." *IEEE J. Photovoltaics* **5** 5, 1380-1388 (2015).
- **D. Berney Needleman**, H.J. Choi, D.M. Powell, and T. Buonassisi, "Rapid dislocation-density mapping of as-cut crystalline silicon wafers." *Physica Status Solidi RRL* **7**, 1041-1044 (2013).
- **D. Berney Needleman** and T. Buonassisi, "Toward Defining Tolerances for Structural Defects in Silicon Through 2D and 3D Device Simulations." *Proc. 39<sup>th</sup> PVSC*, Tampa, FL, USA (2013).
- D.M. Powell, M.T. Winkler, H.J. Choi, C.B. Simmons, **D. Berney Needleman**, and T. Buonassisi, "Crystalline silicon photovoltaics: A cost analysis framework for determining technology pathways to reach baseload electricity costs." *Energy & Environmental Science* **5**, 5874-5883 (2012).
- J.W. Lee, **David Berney Needleman**, W.N. Shafarman, and J.D. Cohen: "Understanding Metastable Defect Creation in CIGS by Detailed Device Modeling and Measurements on Bifacial Solar Cells," in *Thin-Film Compound Semiconductor Photovoltaics—2007*, edited by T. Gessert, K. Durose, C. Heske, S. Marsillac, T. Wada (Mater. Res. Soc. Symp. Proc. **Volume 1012**, Warrendale, PA, 2007), Y04-02.

## PRESENTATIONS WITHOUT PROCEEDINGS

- **D. Berney Needleman**, J.P. Mailoa, R.E. Brandt, and T. Buonassisi, "Design guidelines for spectral splitting optics for photovoltaic applications." *MRS Fall Meeting*, Boston, MA, USA (2013).
- **D. Berney Needleman**, H.J. Choi, D.M. Powell, and T. Buonassisi, "Flatbed scanner-based mapping of dislocations in c-Si wafers for PV applications." *MRS Fall Meeting*, Boston, MA, USA (2012).
- **D. Berney Needleman**, H.J. Choi, D.M. Powell, T. Buonassisi, "Rapid dislocation-density mapping of as-cut c-Si wafers." *6<sup>th</sup> Intl. Workshop on Crystalline Silicon Solar Cells*, Aix-les-Bains, France (2012).

**HOBBIES**: Ultimate Frisbee, backpacking, hiking, skiing, reading, travel, food.

**REFERENCES**: Prof. Tonio Buonassisi, MIT, [buonassisi@mit.edu](mailto:buonassisi@mit.edu)

Dr. Pietro Altermatt, Trina Solar, [pietro.altermatt@gpvsim.org](mailto:pietro.altermatt@gpvsim.org)

Dr. Gregory Wilson, Director: NREL National Center for PV, [gregory.wilson@nrel.gov](mailto:gregory.wilson@nrel.gov)