

Peter Bermel

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- Education**
- MASSACHUSETTS INSTITUTE OF TECHNOLOGY** (2001-2007) Cambridge, MA
Ph.D., Dept. of Physics, June 2007. Thesis: "Active materials in photonic crystals"
- CAMBRIDGE UNIVERSITY** (2000-2001) Cambridge, England
Masters of Philosophy, Dept. of Physics, June 2002. Thesis: "Photonic bandstructure of cholesteric elastomers."
- UNIVERSITY OF NORTH CAROLINA** (1996-2000) Chapel Hill, NC
Bachelor of Science with Highest Honors, Physics and Biology, May 2000. Graduated *summa cum laude*. Senior
Thesis: "Monte-Carlo simulation of adsorption of a polyampholyte chain on a charged surface"
- Awards**
- Phi Kappa Beta Inductee (1999)
Most Outstanding Physics Undergraduate, University of North Carolina (2000)
Winston Churchill Foundation Scholar (2000—2001)
Compton Fellow, MIT Dept. of Physics (2001—2003)
NSF Graduate Research Fellow (2001—2004)
Finalist, Ignite Clean Energy Business Plan Competition (2007)
Winner, \$150K New England Energy Innovation Collaborative Business Plan Competition (2007)
Winner, \$300K solar cell research grant from private foundation (2008)
- Research Experience**
- MASSACHUSETTS INSTITUTE OF TECHNOLOGY** (2007-present) Cambridge, MA
Postdoctoral Associate, Dept. of Physics (advisor: John D. Joannopoulos)
- Developed custom code to calculate and optimize efficiency of photovoltaic and thermophotovoltaic systems
 - Trained and certified to use MIT's Microsystems Technology Labs (MTL) and Center for Materials Science and Engineering's Shared Experimental Facility
 - Designed and fabricated optimized 3D photonic crystal structures for improved light trapping in thin-film silicon solar cells
- MASSACHUSETTS INSTITUTE OF TECHNOLOGY** (2001-2007) Cambridge, MA
Graduate Research Assistant, Dept. of Physics (advisor: John D. Joannopoulos)
- Applied numerical and theoretical techniques to study diverse phenomena in photonic crystals
 - Analyzed quantum-mechanical system capable of single-photon switching; calculated behavior in MATLAB
 - Wrote extension to time-domain code to calculate behavior of fluorescent materials; demonstrated photonic crystals can be used for ultra-low threshold lasers
 - Used time-domain code to calculate efficiency of the capture of light emitted by single molecules, as well as bending losses, in photonic crystal omniguide structures
 - Used frequency-domain code to calculate tunable bandstructures of MEMS-actuated devices
- CAMBRIDGE UNIVERSITY** (2000-2001) Cambridge, England
Research Fellow, Cavendish Laboratory of Physics
- Analyzed structure of novel materials (cholesteric elastomers)
 - Wrote original C++ code to numerically calculate their photonic bandstructures
- UNIVERSITY OF NORTH CAROLINA** (1999-2000) Chapel Hill, NC
Undergraduate Research Assistant, Department of Chemistry
- Analyzed multiple regimes of polyampholyte folding near charged surfaces
 - Wrote original Monte-Carlo C code to numerically calculate ensemble averages
- Teaching Experience**
- MASSACHUSETTS INSTITUTE OF TECHNOLOGY** (2007-2008, 2010) Cambridge, MA
Supervised 2 undergraduate physics researchers through the UROP program. Helped formulate research proposals, guided numerical calculations, wrote up results in final report for the UROP program
- MASSACHUSETTS INSTITUTE OF TECHNOLOGY** (Fall 2004) Cambridge, MA
Teaching Assistant, Department of Physics
Graded graduate first-semester statistical mechanics (8.333)
- Publications**
- Peter Bermel, Michael Ghebrebrhan, Walker Chan, Yi Xiang Yeng, Mohammad Araghchini, Rafif Hamam, Christopher H. Marton, Klavs F. Jensen, Marin Soljacic, John D. Joannopoulos, Steven G. Johnson, Ivan Celanovic, "Design and global optimization of high-efficiency thermophotovoltaic systems", *Opt. Express* **18**, A314 (2010).

Peter Bermel, Walker Chan, Yi Xiang Yeng, John D. Joannopoulos, Marin Soljacic, Ivan Celanovic, "Design and global optimization of high-efficiency thermophotovoltaic systems", 25th European Photovoltaic Solar Energy Conference (September 9, 2010).

Walker Chan, Peter Bermel, Yi Xiang Yeng, Christopher H. Marton, Klavs F. Jensen, Marin Soljacic, John D. Joannopoulos, Ivan Celanovic, "A high-efficiency millimeter-scale thermophotovoltaic generator", 25th European Photovoltaic Solar Energy Conference (September 9, 2010).

Ardavan Farjadpour, David Roundy, Mihai Ibanescu, Peter Bermel, John D. Joannopoulos, and Steven G. Johnson, "Meep: a flexible free-software package for electromagnetic simulations by the FDTD method", *Computer Physics Communications* **181**, 687 (2010).

Michael Ghebrehghan, Peter Bermel, Yehuda Avniel, John D. Joannopoulos, Steven G. Johnson, "Global optimization of silicon photovoltaic cell front coatings", *Optics Express* **17**, 7505 (2009).

Lirong Zeng, Peter Bermel, Yasha Yi, Bernard Alamariu, Kurt A. Broderick, J. Liu, C. Hong, Xiaoman Duan, John D. Joannopoulos, and Lionel C. Kimerling, "Demonstration of Enhanced Absorption in Thin Film Si Solar Cells with Textured Photonic Crystal Back Reflector", *Applied Physics Letters* **93**, 221105 (2008).

Rafif E. Hamam, Mihai Ibanescu, Evan J. Reed, Peter Bermel, Steven G. Johnson, Erich Ippen, John D. Joannopoulos, and Marin Soljacic, "Purcell effect in nonlinear photonic structures: a coupled mode theory analysis", *Optics Express* **16**, 12523 (2008).

Peter Bermel, Chiyuan Luo, Lirong Zeng, Lionel C. Kimerling, and John D. Joannopoulos, "Improving thin-film crystalline silicon solar cell efficiencies with photonic crystals", *Optics Express* **15**, 16986 (2007).

Jorge Bravo-Abad, Alejandro Rodriguez, Peter Bermel, Steven G. Johnson, John D. Joannopoulos, and Marin Soljacic, "Enhanced nonlinear optics in photonic-crystal nanocavities", *Optics Express* **15**, 16161 (2007).

Peter Bermel, Alejandro Rodriguez, John D. Joannopoulos, and Marin Soljacic, "Tailoring optical nonlinearities via the Purcell effect", *Physical Review Letters* **99**, 053001 (2007).

Yasha Yi, S. Akiyama, Peter Bermel, Xiaoman Duan, Lionel C. Kimerling, "Sharp bending of on-chip silicon Bragg cladding waveguide with light guiding in low-index core materials", *IEEE Journal of Selected Topics in Quantum Electronics* **12** (6), 1345 (2006).

Lirong Zeng, Peter Bermel, Yasha Yi, Ning-ning Feng, Bernard Alamariu, Ching-yin Hong, Xiaoman Duan, John Joannopoulos, and Lionel C. Kimerling, "Optimization of Textured Photonic Crystal Backside Reflector for Si Thin Film Solar Cells", *Materials Research Society Symposium Proceedings*, vol. **974E**, CC2.6 (2006).

Peter Bermel, Alejandro Rodriguez, Steven G. Johnson, John D. Joannopoulos and Marin Soljacic "Single-photon all-optical switching using waveguide-cavity quantum electrodynamics", *Physical Review A* **74**, 043818 (2006).

Ardavan Farjadpour, David Roundy, Alejandro Rodriguez, Mihai Ibanescu, Peter Bermel, John D. Joannopoulos, Steven G. Johnson, and G.W. Burr, "Improving accuracy by subpixel smoothing in the finite-difference time domain", *Optics Letters* **31** (20), 2972 (2006).

Peter Bermel, Eleftherios Lidorikis, Yoel Fink, and John D. Joannopoulos, "Simulations of active materials in an electromagnetic field", *Physical Review B* **73**, 165125; also republished in *Virtual Journal of Nanoscale Science & Technology* **13** (18), 2006.

Yasha Yi, Shoji Akiyama, Peter Bermel, Xiaoman Duan, and Lionel C. Kimerling, "On-chip Si-based waveguide with 1D photonic crystal cladding," *Optics Express* **12**, 4775 (2004).

Peter Bermel, John D. Joannopoulos, Yoel Fink, Paul A. Lane, Charles Tapalian, "Properties of radiating pointlike sources in cylindrical omnidirectionally reflecting waveguides," *Physical Review B* **69**, 035316 (2004).

Yasha Yi, Peter Bermel, Kazumi Wada, Xiaoman Duan, John D. Joannopoulos, and Lionel C. Kimerling, "Tunable multichannel optical filter based on silicon photonic band gap materials actuation", *Applied Physics Letters* **81**, 4112 (2002).

Peter Bermel, Mark Warner. "Photonic band structure of cholesteric elastomers", *Physical Review E* **65**, 056614 (2002).

Yasha Yi, Peter Bermel, Kazumi Wada, Xiaoman Duan, John D. Joannopoulos, and Lionel C. Kimerling, "Low Voltage Tunable One Dimensional Photonic Crystal with Large Air Defects", *Proceedings of the Materials Research Society*, vol. **722**, L3.3 (2002).

Peter Bermel, Mark Warner. "Photonic band structure of highly deformable self-assembling systems", *Phys. Rev. E* **65**, 010702 (2002).

Invited Talks

Peter Bermel, Michael Ghebrebrhan, Walker Chan, Yi Xiang Yeng, Mohammad Araghchini, Rafif Hamam, Christopher H. Marton, Klavs F. Jensen, Marin Soljacic, John D. Joannopoulos, Steven G. Johnson, Ivan Celanovic, "Design and global optimization of high-efficiency thermophotovoltaic systems", 25th European Photovoltaic Solar Energy Conference (September 9, 2010).

Peter Bermel, Michael Ghebrebrhan, John D. Joannopoulos, Lirong Zeng, Lionel Kimerling, Minghao Qi, Leo Varghese, Yi Xiang Yeng, Walker Chan, Ivan Celanovic, Steven G. Johnson, Marin Soljacic, "Enhancing the efficiency of solar power with photonic crystals", Stanford University (May 24, 2010).

Peter Bermel, (Michael Ghebrebrhan, John D. Joannopoulos, Lirong Zeng, Lionel Kimerling, Minghao Qi, Leo Varghese, Steven G. Johnson), "Enhancing thin-film photovoltaic cell efficiencies through light trapping", 2009 MIT Solar Energy Symposium (January 29, 2009).

Peter Bermel, (Michael Ghebrebrhan, John D. Joannopoulos, Lirong Zeng, Lionel Kimerling, Minghao Qi, Leo Varghese, Steven G. Johnson), "Enhancing thin-film photovoltaic cell efficiencies through light trapping", University of North Carolina Solar Energy Research Center Inaugural Conference (January 16, 2009).

Lirong Zeng, (Peter Bermel, Yasha Yi, Bernard Alamariu, Kurt A. Broderick, Jifeng Liu, Ching-yin Hong, Xiaoman Duan, John D. Joannopoulos, and Lionel C. Kimerling), "Realization of Significant Efficiency Enhancement in Thin Film Silicon Solar Cells with a Textured Photonic Crystal Backside Reflector ", Materials Research Society Fall Meeting, Session P2, talk 1 (December 2, 2008).

Lirong Zeng, (Peter Bermel, Yasha Yi, Ning-ning Feng, Bernard Alamariu, Ching-yin Hong, Xiaoman Duan, John D. Joannopoulos, and Lionel C. Kimerling), "Optimization of Textured Photonic Crystal Backside Reflector for Si Thin Film Solar Cells", Materials Research Society Fall Meeting, Session CC2, talk 6 (November 2006).

Peter Bermel, (Chiyan Luo, John D. Joannopoulos), "Improving Solar Cell Efficiencies through Periodicity", MIT CIPS 3rd Annual Conference (May 5, 2006).

Yasha Yi, (Peter Bermel, Kazumi Wada, Xiaoman Duan, John D. Joannopoulos, and Lionel C. Kimerling), "Low Voltage Tunable One Dimensional Photonic Crystal with Large Air Defects", Materials Research Society Fall Meeting, Session L3, talk 3, (December 2002).

Patents

5 patents filed with USPTO:

- "Design and global optimization of high-efficiency thermophotovoltaic systems"
- "Global Optimization of Thin Film Photovoltaic Cell Front Coatings"
- "Improving Solar Cell Efficiencies through Periodicity"
- "A Pi Phase Shift Device for Light"
- "Enhancing or Suppressing Optical Nonlinearities via the Purcell Effect"

Publicity & Media

"Boosting the Power of Solar Cells", **MTL Micronotes**, November 11, 2009

"Taming Photons", **MIT Spectrum**, Spring 2009

"Efficient Thin-Film Solar Cells", **Technology Review**, December 4, 2008

"Solar Cell Efficiency Research Heats Up", **Earth2Tech**, November 27, 2008

"Boosting the power of solar cells", **MIT News Office**, November 26, 2008

"MIT Boasts Big Solar Cell Efficiency Gains", **Greentech Media**, November 24, 2008

"Boosting the Power of Solar Cells", **Science Daily**, November 24, 2008

"Nonlinearities could be strengthened by photonic crystals", **PhysOrg**, July 10, 2007

"Cheaper, More Efficient Solar Cells", **Technology Review**, March 21, 2007

New England Energy Innovation Collaborative \$150,000 Business Creation Competition Winner, March 12, 2007

References

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Marin Soljatic, Assistant Professor of Physics
Massachusetts Institute of Technology
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