
Tonio Buonassisi, Ph.D.
Massachusetts Institute of Technology

Education and Training

B.S., Applied Physics, University of Notre Dame, 2001, Sigma Pi Sigma
Ph.D., Applied Science & Technology, University of California at Berkeley, 2006

Professional Experience

- 2012 – present Associate Professor, Massachusetts Institute of Technology, Cambridge, MA
2007 – 2012 Assistant Professor
- Head of the MIT Photovoltaic Research Laboratory, interdisciplinary laboratory focused on defect and materials engineering
 - Co-founder of Fraunhofer Center for Sustainable Energy Systems (FhCSE)
- 2005 – 2007 Crystal Growth Scientist, Evergreen Solar Inc., Marlborough, MA
- Member of team tasked with developing the “Quad furnace” growth system
 - Spearheaded projects to improve solar cell efficiency and yield
- 2001 – 2006 Graduate Student Researcher, UC Berkeley, Berkeley, CA
- Developed technologies & patent that contributed to form Calisolar (now Silicor)
 - Visiting researcher at Max-Planck Institute for Microstructure Physics, Halle, Germany (2004) and Fraunhofer Institute for Solar Energy Systems, Freiburg, Germany (2002, 2003); Imaging characterization of solar cells

Research Highlights

1. Developed widely accepted approach for impurity management in PV-grade silicon, which contributed to founding of Calisolar, Inc. (now Silicor Materials)
2. Using bottom-up cost model, demonstrated that silicon-based PV can exceed the SunShot cost targets and achieve global manufacturing competitiveness, *via* targeted innovation; NREL collaboration
3. Demonstrated ms-range bulk lifetimes in kerfless silicon *via* impurity control, with industrial partner
4. Advanced synchrotron-based characterization techniques of solar cells, including nanoscale *in-situ* measurements and sub-100 nm X-ray fluorescence, to elucidate the nanostructure and evolution of performance-limiting defects in commercial solar cells during realistic processing conditions
5. Developed iron-mitigation strategies during phosphorus gettering, transferred to industry; Online tool evaluated >2200 processing schemes for industrial and academic users since July 2011
6. Demonstrated record-efficiency electrochemically-deposited cuprous oxide (Cu₂O) and thermally evaporated tin sulfide (SnS) thin-film solar cells *via* interface engineering
7. Demonstrated room-temperature sub-bandgap photoresponse in hyperdoped silicon
8. Developed Si-based solar-cell architecture to enable solar water splitting at neutral pH, in collaboration with chemists; developed equivalent-circuit model to predict performance limits
9. Demonstrated new class of photovoltaic materials with high defect tolerance

Industry Interactions

- Co-founded the Fraunhofer Center for Sustainable Energy Systems (CSE), currently over 50 staff and interns with several industrial contracts in place
- Oversee and contribute to collaborative projects with >24 industrial partners, transferred defect-engineering technologies from the MIT PVLab and assisted industry product & process development (2007 – present)
- Thrust lead for Bay Area PV Consortium and QESST Engineering Research Center

PV Education

- Co-developed, teaches graduate & advanced undergrad course “Fundamentals of Photovoltaics” at Berkeley and MIT (2004 – present)
 - Taught >200 students in 7 classes
 - Alumni joined industry (SunPower, 1366 Tech, Solar Junction...), government (ARPA-E, DOE, DOS, OSTP...), and universities (UC Irvine, Utah...), advancing solar policy, research, and technology, and achieving record cell efficiencies
 - Online solar research lectures viewed over 26,600 times; 2nd most popular MechE course on MIT OpenCourseware
- Workshop Chair, “Modernizing Photovoltaics Education at the University Level” (2008)
- Member of organizing committee & lecturer at S. Kurtz’ Hands-On PV Experience (HOPE): One-week event to strengthen graduate-student PV fundamentals through lectures & labs (2012–2015)

DOE National Laboratory Engagement

- NREL NCPV External Review, Member (2012)
- Assisted NREL-led cost-modeling effort for PV (2011 – 2015)
- Scientific spokesperson for the high-throughput *in-situ* nanoprobe (ISN) beamline under development at the Advanced Photon Source, Argonne National Laboratory (2011 – 2015)
- Member, NSLS Hard X-ray Nanoprobe Beamline Scientific Advisory Board (2009 – 2012)
- DOE Risk Analysis Team, PV Subgroup (2008)
- Six active research collaborations with DOE national laboratories

Conferences & Service

- Organized and chaired the *Solar Energy Technology & Innovation in Mexico* (2015): 118 attendees, Mexico City, Mexico <http://www.solarmx.org>
- Organized and chaired the 5th *International Workshop on Crystalline Silicon Solar Cells* (2011): 133 attendees, 15 countries <http://pv.mit.edu/cssc5/>
- Co-organized and co-chaired workshop *Accelerating Development of Earth-Abundant Thin-Film Photovoltaics* (2013): 50 attendees, 3 countries <http://resnick.caltech.edu/e-earth-abundant.php>
- Member of PV conference committees, incl. *NREL Workshop on Crystalline Silicon Solar Cells* (2007–present), *Gettering and Defect Engineering in Semiconductor Technology* (2009–present), *International Conference on Crystalline Silicon Solar Cells* (2009–present), *Silicon Materials Workshop* (2013), and Intersolar North America (2008)
- Session co-chair for the *IEEE PVSC* (2013) and *March APS* (2011)
- Abstract reviewer for *IEEE PVSC* (2014), *Silicon PV Conference* (2013), among others.
- Proposal review panels: NSF CAREER (2015), SBIR (2013), EPAS (2011), MPM (2007), others.

Select Honors & Awards

- 2015 Everett Moore Baker Memorial Award for Excellence in Undergraduate Teaching, MIT
- 2015 Google Faculty Award
- 2012 NSF CAREER Award
- 2012 BOSCH Energy Research Network Award
- 2010 MIT-Deshpande Innovation Grant
 - +27 awards and fellowships for members of research group
- 2008 SMA Career Development Assistant Professor in Manufacturing
- 2005 European Materials Research Society (E-MRS) Young Scientist Presentation Award
- 2005 National Renewable Energy Laboratory Graduate Student Award
- 2004 German Academic Exchange Service (DAAD) Graduate Research Fellowship

Key Publications (13 of 122 in refereed journals)

Crystalline Silicon

1. D.M. Powell, R. Fu, K. Horowitz, P.A. Basore, M. Woodhouse, and T. Buonassisi, “The capital intensity of photovoltaics manufacturing: barrier to scale and opportunity for innovation,” *Energy & Environmental Science* DOI: 10.1039/C5EE01509J (2015)
2. A.E. Morishige, H.S. Laine, J. Schön, A. Haarahiltunen, J. Hofstetter, C. del Cañizo, M.C. Schubert, and T. Buonassisi, “Building intuition of iron evolution during solar cell processing through analysis of different process models,” *Applied Physics A* **120**, 1357 (2015)
3. A.J. Akey, D. Recht, J.S. Williams, M.J. Aziz, and T. Buonassisi, “Single-phase filamentary cellular breakdown via laser-induced solute segregation,” *Advanced Functional Materials* DOI: 10.1002/adfm.201501450 (2015)
4. M.M. Kivambe, D.M. Powell, S. Castellanos, M. Ann Jensen, A.E. Morishige, K. Nakajima, K. Morishita, R. Murai, and T. Buonassisi, “Minority-carrier lifetime and defect content of n-type silicon grown by the noncontact crucible method,” *Journal of Crystal Growth* **407**, 31 (2014)
5. D.M. Powell, J. Hofstetter, D.P. Fenning, R. Hao, T.S. Ravi, and T. Buonassisi, “Effective lifetimes exceeding 300 μ s in gettered p-type epitaxial kerfless silicon for photovoltaics,” *Applied Physics Letters* **103**, 263902 (2013)
6. D.M. Powell, M.T. Winkler, H.J. Choi, C.B. Simmons, D. Berney Needleman, T. Buonassisi, “Crystalline silicon photovoltaics: a cost analysis framework for determining technology pathways to reach baseload electricity costs,” *Energy & Environmental Science* **5**, 5874 (2012)

Thin Films

7. V. Steinmann, R.E. Brandt, T. Buonassisi, “Non-cubic solar cell materials,” *Nature Photonics, News & Views* **9**, 355 (2015)
8. R.E. Brandt, V. Stevanovic, D.S. Ginley, and T. Buonassisi, “Identifying defect-tolerant semiconductors with high minority-carrier lifetimes: beyond hybrid lead halide perovskites,” *MRS Communications* **5**, 265–275 (2015)
9. Y.S. Lee, D. Chua, R.E. Brandt, S.C. Siah, J.V. Li, J.P. Mailoa, S.W. Lee, R.G. Gordon, T. Buonassisi, “Atomic layer deposited gallium oxide buffer layer enables 1.2 V open-circuit voltage in cuprous oxide solar cells,” *Advanced Materials* **26**, 4704–4710 (2014)

Advanced Concepts

10. J.P. Mailoa, C.D. Bailie, E.C. Johlin, E.T. Hoke, A.J. Akey, W.H. Nguyen, M.D. McGehee, and T. Buonassisi, “A 2-terminal perovskite/silicon multijunction solar cell enabled by a silicon tunnel junction,” *Applied Physics Letters* **106**, 121105 (2015)
11. J.P. Mailoa, A.J. Akey, C.B. Simmons, D. Hutchinson, J. Mathews, J.T. Sullivan, D. Recht, M.T. Winkler, J.S. Williams, J.M. Warrender, P.D. Persans, M.J. Aziz, T. Buonassisi, “Room-temperature sub-band gap optoelectronic response of hyperdoped silicon,” *Nature Communications* **5**, 3011 (2014)
12. C.R. Cox, J.Z. Lee, D.G. Nocera, T. Buonassisi, “Ten-percent solar-to-fuel conversion with nonprecious materials,” *Proceedings of the National Academy of Sciences* in press (2014); DOI: 10.1073/pnas.1414290111
13. J.J.H. Pijpers, M.T. Winkler, Y. Surendranath, T. Buonassisi, D.G. Nocera, “Light-induced water oxidation at silicon electrodes functionalized with a cobalt oxygen-evolving catalyst,” *Proceedings of the National Academy of Sciences* **108**, 10056 (2011)