ZACHARY CHARLES HOLMAN

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APPOINTMENTS

08/2019–	**Director of Faculty Entrepreneurship** Ira A. Fulton Schools of Engineering, Arizona State University (Tempe, Arizona)
08/2019–	**Associate Professor** School of Electrical, Computer, and Energy Engineering, Arizona State University (Tempe, Arizona)
10/2016–	**Trustees of ASU Professor** School of Electrical, Computer, and Energy Engineering, Arizona State University (Tempe, Arizona)
03/2013–07/2019	**Assistant Professor** School of Electrical, Computer, and Energy Engineering, Arizona State University (Tempe, Arizona)
07/2014–08/2014	**Visiting Professor** Photovoltaics and Thin-Film Electronics Laboratory, Institute of Microengineering, Ecole Polytechnique Fédérale de Lausanne (Neuchâtel, Switzerland)
10/2010–03/2013	**Postdoctoral Researcher** Photovoltaics and Thin-Film Electronics Laboratory, Institute of Microengineering, Ecole Polytechnique Fédérale de Lausanne (Neuchâtel, Switzerland)

EDUCATION

10/2010	**Doctor of Philosophy** Mechanical Engineering; Nanoparticle Science and Engineering (minor), University of Minnesota (Minneapolis, Minnesota) Dissertation: *Germanium nanocrystal solar cells*; Advisor: Prof. Uwe Kortshagen
05/2005	**Bachelor of Arts** Physics, Reed College (Portland, Oregon) Thesis: *Electron transport in amorphous silicon*; Advisor: Prof. John Essick

RESEARCH INTERESTS

Broad research interests span the fields of solar cells, coatings, nanotechnology, semiconductors, plasmas, and aerosols. Specific interests include silicon-based tandem solar cells, contacts to solar cells, light management in silicon solar cells, novel uses of nanoparticles in devices, semiconductor nanoparticles, optical and electronic properties of nanoscale materials, plasma synthesis of powders, and deposition of powders and thin films.

AWARDS & HONORS

2019	IEEE Stuart R. Wenham Young Professional Award
2019	NSF CAREER Award
2018	Gordon and Betty Moore Foundation Inventor Fellowship

2018	Fulton Entrepreneurial Professorship
2017	ASU Fulton Schools of Engineering Top 5% Teaching Award
2016	Trustees of ASU Professorship
2016	Joseph C. Palais Distinguished Faculty Scholar Award
2016	Fulton Outstanding Assistant Professor Award
2015	ASU Fulton Schools of Engineering Top 5% Teaching Award
2014	ASU Senior Sustainability Scientist
2013	3rd International Conference on Crystalline Silicon Photovoltaics top 5% of papers
2010	NSF EAPSI Fellowship at the Tokyo Institute of Technology
2010	University of Minnesota Doctoral Dissertation Fellowship
2008	Particle Society of Minnesota Scholarship
2007	18th International Symposium on Plasma Chemistry Best Paper Award
2005	NSF IGERT Fellowship at the University of Minnesota

AWARDS WON BY STUDENTS AND POSTDOCS

2019	University Graduate Fellowship (Salman Manzoor)
2019	SiliconPV Best Poster Award (William Weigand and Jason Yu)
2018	ASU Dean's Fellowship (Barry Hartweg)
2018	Palais' Outstanding Doctoral Student Award (Jason Yu)
2018	Venture Madness Hardware Tech Winner (Peter Firth)
2017	European PV Solar Energy Conference and Exhibition Student Award (Jason Yu)
2017	IEEE Photovoltaic Specialists Conference Most Outstanding Technical Contribution (Jason Yu)
2017	MRS Graduate Student Silver Award (Jason Yu)
2017	Rice Business Plan Competition Department of Energy Cleantech University Prize (Peter Firth and Jonathan Bryan)
2017	ASU Innovation Open SRP Innovation Award (Peter Firth)
2017	SiliconPV Award (Jason Yu)
2017	SiliconPV Award (Mathieu Boccard)
2017	ASU Graduate and Professional Student Association Research Award (Jason Yu)
2017	ThinkSwiss Research Scholarship (Nathan Rodkey)
2017	ARCS (Achievement Awards for College Scientists) Award (Peter Firth)
2017	Zero Mass Water Materials Award (Peter Firth)
2017	DOE Science Undergraduate Laboratory Internship at NREL (Nathan Rodkey)
2017	Rhodes Scholarship (Ngoni Mugwisi)
2016	Palais Senior Design Prize (Heliovation senior design team)
2016	Arizona Student Energy Conference Distinguished Poster Award (Jason Yu)
2016	IEEE Photovoltaic Specialists Conference Best Paper Award (Mathieu Boccard)
2016	IEEE Photovoltaic Specialists Conference Best Poster Award (Mathieu Boccard)
2016	ASU Dean's Fellowship (Will Weigand)
2016	ASU Dean's Fellowship (Jonathan Bryan)
2016	ASU New Venture Challenge Winner (Peter Firth)
2016	ARCS (Achievement Awards for College Scientists) Award (Peter Firth)

2016	Micron Technology Team Prize (Hall Effect senior design team)
2015	IEEE Photovoltaic Specialists Conference Best Poster Award (Jason Yu)
2015	Harold and Lucille Dunn Memorial Engineering Scholarship (Jason Yu)
2015	Barrett Electronic Materials Fellowship (Peter Firth)
2015	ASU Dean's Fellowship (Peter Firth)
2015	Arizona Student Energy Conference Distinguished Poster Award (Priyaranga Koswatta)
2015	NSF Graduate Research Fellowship (Joe Carpenter)
2014	NSF Integrative Graduate Education and Research Traineeship (Michael Bernstein)
2014	NSF Integrative Graduate Education and Research Traineeship (Joe Carpenter)
2014	University Graduate Fellowship (Salman Manzoor)

PROFESSIONAL ACTIVITIES & OUTREACH

- Co-leader of Thrust 2 of the Quantum Energy and Sustainable Solar Technology ERC (2015–)
- Program Committee Member for the IEEE Photovoltaic Specialists Conference (2020)
- Organizing Committee Member for the International Workshop on Silicon Heterojunction Solar Cells (2019)
- Symposium Organizer for the E-MRS Spring Meeting (2017)
- Symposium Organizer for the IEEE Photovoltaic Specialists Conference (2016, 2017, 2018)
- Lead Symposium Organizer for the MRS Spring Meeting (2016, 2018)
- Symposium Organizer for the MRS Spring Meeting (2015)
- Session Chair for IEEE Photovoltaic Specialists Conference, MRS Spring Meeting, SiliconPV (2013–)
- Member of the Fulton Schools of Engineering Dean's Research Committee (2017–)
- Member of the ASU Goldwater Materials Science Facility Steering Committee (2014–2016)
- Member of the ASU Leadership Academy Materials Team (2015–2016)
- Member of the ASU University Undergraduates Standards Committee (2015–2017)
- Member of the ASU Instrument Design and Fabrication Board (2016–2019)
- Member of the ASU Eyring Materials Center Board (2017–)
- Member of the ASU ECEE Faculty Search Committee in photovoltaics (2015, 2018)
- Member of the ASU ECEE Website Design Committee (2015)
- Member of the ASU Faculty Working Group for the MS degree in Innovation and Venture Development
- Designer and instructor of a new course entitled *EEE 598: Manuscript Writing for Engineers*
- Reviewer for funding bodies, including NSF, and journals, including *Journal of Applied Physics, ACS Nano, Solar Energy Materials and Solar Cells*, *Thin Solid Films, Nanotechnology, IEEE Journal of Photovoltaics*
- Volunteer Scientist for ASU's Night of The Open Door, ASU's Summer Transportation Institute, Cesar Chavez High School, Minnesota FIRST LEGO League, and the Science Museum of Minnesota

FUNDING

10/2019–09/2020	US Government, "Flexible and advanced solar panel technologies," (PI)
08/2019–07/2021	NSF, "Center to center (C2C) international collaboration on advanced photovoltaics: Electrode manufacturing and indoor power applications," (Co-PI)
08/2019–07/2022	DOE SETO, "Scalable manufacturing of efficient perovskite/silicon tandem modules," (Co-PI)

03/2019–02/2024	NSF CAREER, “CAREER: Transparent, passivating, and carrier-selective heterojunction contacts for silicon and cadmium telluride solar cells,” (PI)
01/2019–12/2021	DOE SETO, “Diagnosing and overcoming recombination and resistive losses in non-silicon solar cells using a silicon-inspired characterization platform,” (PI)
01/2019–12/2021	DOE SETO, “Bringing high-efficiency silicon solar cells with heterojunction contacts to market with a new, versatile deposition technique,” (PI)
01/2019–06/2020	DOE SETO, “Wide-bandgap polycrystalline III-Vs as transparent, carrier-selective heterojunction contacts for silicon photovoltaics,” (Co-PI)
01/2019–12/2020	NREL, “ASU-NREL joint silicon solar cell research: passivated contacts, metallization, and bulk defects,” (PI)
01/2019–12/2021	ARPA-E DAYS, “Solid state thermal battery,” (Co-PI)
01/2019–12/2019	FSE/CLAS/AMI Seed, “MRSEC planning and preliminary data collection,” (Co-PI)
10/2018–09/2020	Fulton Entrepreneurial Professors Program, “Aerosol impaction-driven assembly of functional nanomaterial coatings,” (PI)
10/2018–09/2021	Moore Foundation Inventor Fellowship, “Aerosol impaction-driven assembly of functional nanomaterial coatings,” (PI)
10/2018–09/2019	FSE/CLAS/AMI Seed, “Diamond and III-nitride integration for ultra-gap devices,” (PI)
06/2018–05/2019	NSF SBIR, “Non-thermal plasma source for functional metal-oxide nanoparticle coatings,” (Co-PI)
02/2018–09/2018	NREL, “PERC and SHJ silicon solar modules with high infrared reflectance,” (Co-PI)
01/2018–01/2021	ARENA, “Hydrogenated and hybrid heterojunction p-type silicon PV cells R&D project,” (Co-PI)
10/2017–09/2020	DOE PVRD-II, “Perovskite-on-silicon tandem solar cells,” (Co-PI)
10/2017–09/2019	DOE DuraMAT, “Silicon IBC modules with copper foil electrodes: Failure mechanisms of electrically conductive adhesive bonds between cells and foil,” (PI)
10/2017–09/2018	BAPVC, “Low capex solar manufacturing enabled by perovskite semiconductors,” (Co-PI)
08/2017–01/2019	ACAP, “P-type hybrid heterojunction solar cells,” (Co-PI)
05/2017–04/2019	NSF EAGER, “Collaborative research: 30%-efficient, stable perovskite/silicon monolithic tandem solar cells,” (PI)
02/2017–04/2017	NSF SBIR, “The aerosol-spray deposition of photoluminescent quantum-dot coatings on substrates,” (Co-PI)
01/2017–12/2019	ARPA-E SHIELD, “Single-pane windows with insulating sprayed particulate coatings,” (PI)
12/2016–11/2017	NSF SBIR, “Low damage sputter magnetron for silicon heterojunction PV production,” (Co-PI)
11/2016–10/2018	DOE NextGen-III, “Developing efficient silicon cells for perovskite/silicon tandem devices,” (Co-PI)
09/2016–08/2017	American Jobs Project, “Arizona’s advanced energy landscape,” (PI)
08/2016–07/2019	DOE PVRD, “Monolithic silicon module manufacturing at < 0.40 $/W,” (PI)

08/2016–07/2018	DOE PVRD, "15%-efficiency (Mg,Zn)CdTe solar cells with 1.7 eV bandgap for tandem applications," (PI)
08/2016–07/2017	SolarReserve, "Hybrid heliostat development," (PI)
07/2016–01/2017	FSE Technology Innovation Laboratory, "Advanced manufacturing of nanoparticle-based coatings," (PI)
06/2016–05/2017	DOE PVRD SIPS, "A new class of tandems: Optically coupled III-V/silicon module with outdoor efficiency exceeding 30%," (PI)
05/2016–11/2016	FSE Technology Innovation Laboratory, "Hybrid heliostat for combined photovoltaic and solar thermal power plants," (PI)
04/2016–03/2019	NSF REU Site, "Solar energy research for the Terawatt Challenge," (PI)
01/2016–12/2018	DOE SuNLaMP, "Overcoming bottlenecks to low-cost, high-efficiency Si PV and industrially relevant, ion implanted interdigitated back passivated contact cell development," (Co-PI)
09/2015–08/2018	NSF Energy for Sustainability, "Collaborative research: 30%-efficient III-V/silicon tandem solar cells," (PI)
08/2015–07/2020	NSF ERC, "Nano-Enabled Water Treatment: NEWT," (Co-PI)
06/2015–05/2020	USAID, "U.S.-Pakistan Centers for Advanced Studies in Energy," (Co-PI)
05/2015–04/2016	ARPA-E I-Corps Supplement, "PVMirror: Cost competitive solar with storage," (PI)
02/2015–01/2017	RCSA Scialog, "Scalable tandem architecture for solar water splitting," (PI)
06/2014–05/2017	ARPA-E FOCUS, "PVMirror: A solar concentrator mirror incorporating PV cells," (PI)
09/2013–08/2016	DOE FPACE-II, "Thin silicon solar cells: A path to 35% Shockley-Queisser limits," (Co-PI)
08/2011–07/2021	NSF/DOE ERC, "Quantum Energy and Sustainable Solar Technologies: QESST," (Co-PI)
06/2010–08/2010	NSF EAPSI, "Novel solar cells using silicon nanocrystals synthesized in an atmospheric-pressure plasma," (PI)

STUDENTS, POSTDOCS, AND STAFF ADVISED

- Ph.D.:
  - Ashling Leilaeioun (2013–2018)
  - Jason Yu (2014–2018)
  - Joe Carpenter (2014–)
  - Jonathan Bryan (2016–)
  - Barry Hartweg (2018–)
  - Abdulwahab Alafour (2019–)
  - Mark Li (2019–)
  - Jianwei Shi (2013–2018)
  - Salman Manzoor (2014–)
  - Peter Firth (2015–)
  - William Weigand (2016–)
  - Warda Mushtaq (2018–)
  - David Quispe (2019–)
  - Alan Wu (2019–)
- M.S.:
  - Salman Manzoor (2013–2014)
  - Priyaranga Koswatta (2013–2016)
  - Michael Bernstein (2014–2016)
  - Trent Hoffman (2016–2017)
  - Prateek Garg (2013–2015)
  - Peter Firth (2014–2015)
  - Alec Jackson (2014–2016)
  - Sujyot Mony (2018–2019; MORE)
- Undergraduate:
  - Claire Block (2017–2018)
  - Christopher Chen (2017–2019)
  - Angelica Guzman (2018–2019; FURI)
  - Sanketh Kamath (2013–2015; FURI)
  - Joe Carpenter (2013–2014; FURI)
  - Angelo Delluomo (2015–2016; FURI)
  - Justin Huxel (2017–2019; FURI)
  - Mark Kapron (2017–2018; FURI)

	Ngoni Mugwisi (2016–2017; Barrett)	Corbin Ott (2017–2018; FURI)
	Marcial Rodarte (2016–2017)	Nathan Rodkey (2015–2018; FURI, Barr.)
	Kari Sanford (2015–2017; FURI, Barrett)	Nicholas Scheenstra (2015–2016; FURI)
	Daniel Sinclair (2017–2018; FURI)	Marshall Styers (2015–2016)
	Brian Wu (2018– ; FURI)	
• Postdoc:	Mathieu Boccard (2014–2016)	Drew Swanson (2016–2017)
	Martyn Fisher (2016–2018)	Arthur Ono (2017–)
	Shalinee Kavadiya (2018–)	Shannon Poges (2018–)
• Staff:	Kathryn Fisher (2014–)	Nathan Rodkey (2018–2019)
• Research faculty:	Jason Yu (2018–)	
• REU visitor:	Emily Dafflon (2013)	Ethan Bendau (2015)
	Juan Asencio (2018)	William Firth (2015)
	Culver McWhirter (2016)	Amine El Mahati (2016)
	Jones Ou (2016)	Matthew Warner (2016)
	Jakob Häusele (2017)	Noemi Mundhaas (2017)
	Stefan Mercado (2017)	Syeda Mohsin (2017)
	Tien Ngo (2017)	Yuji Okamoto (2017)
	David Quispe (2017)	Mateo Estrada (2018)
	Jewel Haik (2018)	Richelle Javier (2018)
	Xingyi Wang (2019)	Alexa Cetta (2019)
	Jorge Almeida (2019)	Maria Garcia (2019)
• PCASE visitor:	Saleem Ahmed (2016)	Asad Ali (2016)
	Asghar Ali (2016)	Waqar Ali (2016)
	Farah Qazi (2016)	Ijaz Husnain (2016)
	Mahmood Jamil (2016)	Mehwish Javed (2016)
	Syeda Qudsia (2016)	Warda Mushtaq (2016)
	Maham Akhlaq (2017)	Kamran Alam (2017)
	Maoz (2017)	Asma Shamim (2017)
	Hira Rehman (2017)	Shah Naveed (2017)
	Maria Kanwal (2018)	Sundas Khan (2018)
	Fazal Subhan (2018)	Mudasar Rashid (2019)
	Qandeel Rehman (2019)	Kashan Ahmad (2019)
	Muneeza Ahmad (2019)	Saddam Hussain (2019)

COURSES TAUGHT

- EEE 352: Properties of Electronic Materials (F15, F16, F17, F18)
- EEE 436/591: Fundamentals of Solid State Devices (F13, F14, S16)
- EEE 465/591: Photovoltaic Energy Conversion (S15)
- EEE 498/591: Solar Energy (S14)
- EEE 536: Semiconductor Characterization (S17)
- EEE 598: Manuscript Writing for Engineers (F14, F15, F17, F18, F19)
- ASU 101: The ASU Experience (F14)

PEER-REVIEWED PUBLICATIONS

(ASU students in red; ASU postdocs and staff in orange)

79. B. Chen*, Z. Yu*, S. Manzoor, S. Wang, W. Weigand, Z. Yu, G. Yang, Z. Ni, Z. Holman, and J. Huang, "Blade-coated perovskites on textured silicon for 26%-efficient monolithic perovskite/silicon tandem solar cells," (under review). *Denotes co-first author.

78. C. Sun, W. Weigand, J. Shi, Z. Yu, R. Basnet, S. Pheng Phang, Z. Holman, and D. Macdonald, "Origins of hydrogen that passivates bulk defects in silicon heterojunction solar cells," *Appl. Phys. Lett.* **115**, 252103 (2019).

77. S. Manzoor, M. Filipič, A. Onno, M. Topič, and Z. Holman, "Visualizing light trapping within textured silicon solar cells," (under review).

76. J. Xu, C. Boyd, Z. Yu, A. Palmstrom, D. Witter, B. Larson, R. France, J. Werner, S. Harvey, E. Wolf, W. Weigand, S. Manzoor, M. van Hest, J. Berry, J. Luther, Z. Holman, and M. McGehee, "Triple-halide wide-bandgap perovskites with suppressed photoinduced phase-segregation for efficient tandems," (under review).

75. P. Muralidharan, A. Leilaeioun, W. Weigand, Z. Holman, S. Goodnick, and D. Vasileska, "Understanding transport in hole contacts of silicon heterojunction solar cells by simulating TLM structures," *IEEE J. Photovoltaics* (in press).

74. N. Vulic, J. Carpenter, P. Firth, N. Rodkey, Z. Holman, and S. Goodnick, "Pore formation in silicon nanoparticle thin films and its impact on optical properties," *ACS Appl. Energy Mater.* **2**, 8587–8595 (2019).

73. A. Onno, N. Rodkey, A. Asgharzadeh, S. Manzoor, Z. Yu, F. Toor, and Z. Holman, "Predicted power output of silicon-based bifacial tandem photovoltaic systems," *Joule* (in press).

72. A. Onno, C. Chen, P. Koswatta, M. Boccard, and Z. Holman, "Passivation, conductivity, and selectivity in solar cell contacts: concepts and simulations based on a unified partial-resistances framework," *J. Appl. Phys.* **126**, 183103 (2019).

71. E. Vadiee, E. Clinton, J. Carpenter, H. McFavilen, C. Arena, Z. Holman, C. Honsberg, and A. Doolittle, "The role of Mg bulk hyper-doping and delta-doping in low-resistance GaN homojunction tunnel diodes with negative differential resistance," *J. Appl. Phys.* **126**, 083110 (2019).

70. E. Clinton, Z. Engel, E. Vadiee, J. Carpenter, Z. Holman, B. Gunning, and A. Doolittle, "Ultra-wide-bandgap AlGaN homojunction tunnel diodes with negative differential resistance," *Appl. Phys. Lett.* **115**, 082104 (2019).

69. N. Liew, Z. Yu, Z. Holman, and H.-J. Lee, "Feasibility analysis of a PV/CSP hybrid power plant using wavelength selective films," (under review).

68. A. Leilaeioun*, W. Weigand*, M. Boccard, Z. Yu, K. Fisher, and Z. Holman, "Contact resistivity of the p-type amorphous silicon hole contact in silicon heterojunction solar cells," *IEEE J. Photovoltaics* **10**, 54–62 (2020). *Denotes co-first author.

67. R. Basnet, W. Weigand, Z. Yu, C. Sun, S. Phang, H. Sio, F. Rougieux, Z. Holman, and D. Macdonald, "Impact of pre-fabrication treatments on n-type solar-grade wafers for 21% efficient silicon heterojunction solar cells," *Sol. Energy Mater. Sol. Cells* **205**, 110287 (2020).

66. B. Stefani, W. Weigand, M. Wright, A. Soeriyadi, Z. Yu, M. Kim, D. Chen, Z. Holman, and B. Hallam, "P-type upgraded metallurgical-grade multicrystalline silicon heterojunction solar cells with open-circuit voltages over 690 mV," *Phys. Status Solidi A* **216**, 1900319 (2019).

65. X. Meng, K. Fisher, L. Reinhart, W. Taylor, M. Stuckelberger, Z. Holman, and M. Bertoni, "Optical characterization of curved silicon PV modules with dichroic polymeric films," *Sol. Energy Mater. Sol. Cells* **201**, 110072 (2019).

64. A. Basiri, X. Chen, J. Bai, P. Amrollahi, J. Carpenter, Z. Holman, C. Wang, and Y. Yao, "Nature-inspired chiral metasurfaces for circular polarization detection and full-Stokes polarimetric measurement," *Light: Science & Applications* **8**, 78 (2019).

63. S. Fan, Z. Yu, Y. Sun, W. Weigand, P. Dhingra, M. Kim, R. Hool, E. Ratta, Z. Holman, and M. Lee, "20%-efficient epitaxial GaAsP/Si tandem solar cells," *Sol. Energy Mater. Sol. Cells* **202**, 110144 (2019).

62. N. Mundhaas, Z. Yu, K. Bush, H.-P. Wang, J. Häusele, S. Kavadiya, M. McGehee, and Z. Holman, "Series resistance measurements of perovskite solar cells using J_{sc}-V_{oc} measurements," *Sol. RRL* 1800378 (2019).

61. D. Chen, M. Kim, J. Shi, B. Vicari Stefani, Z. Yu, S. Liu, R. Einhaus, S. Wenham, Z. Holman, and B. Hallam, "Defect engineering of p-type silicon heterojunction solar cells fabricated using commercial-grade low-lifetime silicon wafers," *Prog. Photovoltaics*, DOI: 10.1002/pip.3230 (2019).

60. A. Atkinson, Y. Bi, P. Firth, O. Alrehaili, P. Westerhoff, and Z. Holman, "Aerosol impaction-driven assembly produces evenly dispersed nanoparticle coating on polymeric water treatment membranes," (under review).

59. A. Leilaieoun, A. Onno, S. Manzoor, J. Shi, K. Fisher, Z. Yu, and Z. Holman, "Power losses in the front transparent conductive oxide layer of silicon heterojunction solar cells: Design guide for single-junction and four-terminal tandem applications," *IEEE J. Photovoltaics* (in press).

58. Z. Yu, K. Fisher, J. Hyatt, R. Angel, and Z. Holman, "GaAs/silicon PVMirror tandem photovoltaic mini-module with 29.6% efficiency with respect to the outdoor global irradiance," *Prog. Photovoltaics* **27**, 469–475 (2019).

57. C. Zhang, L. Ding, M. Boccard, T. Nærland, N. Faleev, S. Bowden, M. Bertoni, C. Honsberg, and Z. Holman, "Silicon nitride barrier layers mitigate minority-carrier lifetime degradation in silicon wafers during simulated MBE growth of III–V layers," *IEEE J. Photovoltaics* **9**, 431–436 (2019).

56. B. Chen*, Z. Yu*, K. Liu*, X. Zheng, Y. Liu, J. Shi, D. Spronk, Z. Holman, and J. Huang, "Grain engineering for perovskite/silicon monolithic tandem solar cells with efficiency of 25.4%," *Joule* **3**, 1–14 (2019). *Denotes co-first author.

55. K. Bush, S. Manzoor, K. Frohna, Z. Yu, J. Raiford, A. Palmstrom, H.-P. Wang, R. Prasanna, S. Bent, Z. Holman, and M. McGehee, "Minimizing current and voltage losses to reach 25%-efficient monolithic two-terminal perovskite-silicon tandem solar cells," *ACS Energy Lett.* **3**, 2173–2180 (2018).

54. S. Manzoor, J. Häusele, K. Bush, A. Palmstrom, J. Carpenter, Z. Yu, S. Bent, M. McGehee, and Z. Holman, "Optical modeling of wide-bandgap perovskite and perovskite/silicon tandem solar cells using complex refractive indices for arbitrary-bandgap perovskite absorbers," *Opt. Express* **26**, 27441–27460 (2018).

53. C. Sun, D. Chen, W. Weigand, R. Basnet, S. Pheng Phang, B. Hallam, Z. Holman, and D. Macdonald, "Complete regeneration of BO-related defects in n-type upgraded metallurgical-grade Czochralski-grown silicon heterojunction solar cells," *Appl. Phys. Lett.* **113**, 152105 (2018).

52. Z. Yu, J. Carpenter, and Z. Holman, "Techno-economic viability of silicon-based tandem photovoltaic modules in the United States," *Nature Energy* **3**, 747–753 (2018).

51. P. Firth and Z. Holman, "Aerosol impaction-driven assembly system for production of uniform nanoparticle thin films with independently tunable thickness and porosity," *ACS Appl. Nano Mater.* **1**, 4351–4357 (2018).

50. S. Husein, M. Stuckelberger, B. West, L. Ding, F. Dauzou, M. Morales-Masis, M. Duchamp, Z. Holman, and M. Bertoni, "Carrier scattering mechanisms limiting mobility in hydrogen-doped indium oxide," *J. Appl. Phys.* **123**, 245102 (2018). [Editor's Pick]

49. D. Swanson, C. Reich, A. Abbas, T. Shimpi, H. Liu, F. Ponce, J. Walls, Y.-H. Zhang, W. Metzger, W. Sampath, and Z. Holman, "$CdCl_2$ passivation of polycrystalline CdMgTe and CdZnTe absorbers for tandem photovoltaic cells," *J. Appl. Phys.* **123**, 203101 (2018). [Editor's Pick]

48. B. Hallam, D. Chen, J. Shi, R. Einhaus, Z. Holman, and S. Wenham, "Pre-fabrication gettering and hydrogenation treatments for silicon heterojunction solar cells: A possible path to >700 mV open-circuit voltages using low-lifetime commercial-grade p-type Czochralski silicon," *Sol. RRL* 1700221 (2018).

47. K. Bush, N. Rolston, A. Gold-Parker, S. Manzoor, J. Hausele, Z. Yu, J. Raiford, R. Cheacharoen, Z. Holman, M. Toney, R. Dauskardt, and M. McGehee, "Controlling thin film stress and wrinkling during perovskite film formation," *ACS Energy Lett.* **3**, 1225–1232 (2018).

46. J. Becker, C. Campbell, Y. Zhao, M. Lassise, X.-H. Zhao, M. Boccard, Z. Holman, and Y.-H. Zhang, "Monocrystalline 1.7-eV-bandgap MgCdTe solar cell with 11.2% efficiency," *IEEE J. Photovoltaics* **8**, 581–586 (2018).

45. S. Manzoor, Z. Yu, A. Ali, W. Ali, K. Bush, A. Palmstrom, S. Bent, M. McGehee, and Z. Holman, "Improved light management in planar silicon and perovskite solar cells using PDMS scattering layer," *Sol. Energy Mater. Sol. Cells* **173**, 59–65 (2017).

44. M. Boccard, P. Firth, Z. Yu, K. Fisher, M. Leilaeioun, S. Manzoor, and Z. Holman, "Low-refractive-index nanoparticle interlayers to reduce parasitic absorption in metallic rear reflectors of solar cells," *Phys. Status Solidi A* **214**, 1700179 (2017).

43. J. Carpenter, M. Bailly, A. Boley, J. Shi, M. Minjares, D. Smith, S. Bowden, and Z. Holman, "Substrate-independent analysis of microcrystalline silicon thin films using UV Raman spectroscopy," *Phys. Status Solidi B* **254**, 1700204 (2017).

42. R. Saive, M. Boccard, T. Saenz, S. Yalamanchili, C. Bukowsky, P. Jahelka, Z. Yu, J. Shi, Z. Holman, and H. Atwater, "Silicon heterojunction solar cells with effectively transparent front contacts," *Sust. Energy Fuels* **1**, 593–598 (2017).

41. M. Vaisman, K. Nay Yaung, E. Perl, D. Martín-Martín, Z. Yu, M. Leilaeioun, Z. Holman, and M. Lee, "15.3%-efficient GaAsP top cells for high-efficiency, low-cost III-V/Si tandem photovoltaics," *ACS Energy Lett.* **2**, 1911–1918 (2017).

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