

AMIT H MUNSHI

1320 Campus Delivery, ERC B109, Colorado State University, Fort Collins CO 80526

Cell +1 970 215 4116 · Office+1 970 491 8861

Amit.Munshi@colostate.edu · www.linkedin.com/in/amit-munshi

Expert thin-film researcher with 10 years of experience in interface engineering, materials characterization and advanced process development and optimization.

EDUCATION

MAY 2017

DOCTOR OF PHILOSOPHY (Mechanical Engineering), COLORADO STATE UNIVERSITY

Dissertation – Investigation of Processing, Microstructure and Efficiencies of Polycrystalline CdTe Photovoltaic Films and Devices

Advisor – Dr. Walajabad S. Sampath

MAY 2013

MASTER OF SCIENCE (Mechanical Engineering), COLORADO STATE UNIVERSITY

Thesis – Investigation of gold as material for thermal radiation shielding

Advisor – Dr. Walajabad S. Sampath

JUNE 2010

BACHELOR OF ENGINEERING (Automobile Engineering), S.P. UNIVERSITY (INDIA)

Specialization – IC Engines, diagnosis and testing of automotive systems, manufacturing and design of transmission mechanism.

Advisor – Dr. Sudhir K. Gupte

HONORS AND AWARDS

- **2020 Administrative Professional Star Award** at Colorado State University, February 2020. Award announcement transcript from Trish Torres, co-chair awards committee, CSU Administrative Professional Council - *"I am here to recognize you for being nominated and winning the AP Star Award for 2020. Congratulations! You were selected as a recipient because of your enthusiasm, continually taking initiatives for team building opportunities, and for your work acquiring materials with limited funding. On behalf of the Administrative Professional Council the committee thanks you for your service to Colorado State University"*.
- **Award Nomination** (outcome pending) for *Stuart R. Wenham Young Professional Award* at 47th IEEE Photovoltaics Specialists Conference 2020.
- **Best Poster Award (co-author)** at 46th IEEE Photovoltaics Specialists Conference 2019.
- **Invited Talk** – MRS Spring Meeting 2019 - Progress and Challenges in Absorber and Interface Fabrication of Polycrystalline CdTe Photovoltaics – Invited to submit featured journal paper
- **Best Student Paper Award** at 44th IEEE Photovoltaics Specialists Conference 2017 – Paper invited for publication in Journal of Photovoltaics.
- **Best Poster Award** at 43rd IEEE Photovoltaics Specialists Conference 2016.
- **Invited Talk (co-author)** – IEEE PVSC 2016 – Progress and Challenges with CdTe Cell Efficiencies

- **Best student paper award finalist (co-author)** – at 46th IEEE Photovoltaics Specialists Conference 2019- Analysis of an MZO/CdTe photovoltaic device treated with cadmium bromide
- **Best poster award finalist (co-author, with equal contribution)** – at 45th IEEE Photovoltaics Specialists Conference 2018– Doping CdTe Absorber Cells using Group V Elements
- **Best poster award finalist (co-author)** – at 45th IEEE Photovoltaics Specialists Conference 2018 - 3D Distributions of Chlorine and Sulphur Impurities in a Thin-Film Cadmium Telluride Solar Cell

PATENTS

- Sampath, Walajabad S., Amit H. Munshi, Adam H. Danielson, and Kurt L. Barth. *"Doping and passivation for high efficiency solar cells."* U.S. Patent Application 16/404,479, filed November 7, 2019.

RESEARCH EXPERIENCE

MAY 2017 – PRESENT

RESEARCH SCIENTIST I, COLORADO STATE UNIVERSITY

- Responsibilities – experiment planning, experiment execution, writing publications, drafting proposals
- Project reporting to National Science Foundation and U.S. Department of Energy
- Mentoring graduate and undergraduate students

Graduate students mentored

2017 - Present	Adam Danielson, Ph.D. Department of Mechanical Engineering (Advisor – W.S. Sampath)
2017 - Present	Anna Kindvall, M.S. Department of Mechanical Engineering (Advisor – W.S. Sampath)
2018 Jan – Jun	Kulandai Velu, M.E. Amrita University, India (Intern at Colorado State University, Advisor – W.S. Sampath) – Currently Ph.D. Student at Amrita University, India

Under-graduate students mentored (Research Experience for Undergraduates)

2019 - Present	Cody Griffin, B.S. Department of Mechanical Engineering (Advisor – W.S. Sampath)
2019 - Present	Garrett Robison, B.S. Department of Mechanical Engineering (Advisor – W.S. Sampath)
2019 Jan - Dec	David Miller, B.S. Department of Physics (Advisor – J.R. Sites)
2019 Jan - May	Susan Ossareh, B.S. Department of Mechanical Engineering (Advisor – W.S. Sampath) – Intern at Sandia National Laboratory
2019 Jan – May	Kip Ringsrud, B.S. Department of Mechanical Engineering (Advisor – W.S. Sampath)
2018 Jan - Jun	Vivek Manchala, B.E. Amrita University, India (Intern at Colorado State University, Advisor – W.S. Sampath)
2017 May - Dec	Shiva Tarun Reddy, B.E. Amrita University, India (Intern at Colorado State University, Advisor – W.S. Sampath) – Graduated M.S. from Colorado State University
2017 May - Dec	Sreeram Lal – B.E. Amrita University, India (Intern at Colorado State University, Advisor – W.S. Sampath) – Currently Research Fellow – NIMAC at University College Dublin

- Laboratory (equipment) maintenance
- Purchasing for laboratory supplies
- Hiring of undergraduate student and new prospective students
- Current projects – High efficiency photovoltaic device fabrication using interface passivation and arsenic doping in CdTe-based thin-film devices

FEB 2020 – PRESENT

EXPERT RESEARCH SUPPORT, COLORADO STATE UNIVERSITY

- Controlled copper doping of textured titanium surfaces and titania nanotubes for application in biomedical implant to utilize antimicrobial property of copper alloys
- Precision polishing of titanium surface to form ultra-smooth slippery surface to reduce blood clots in biomedical implants

MAY 2013 – APRIL 2017 (As a Ph.D. Student)

GRADUATE RESEARCH ASSISTANT, COLORADO STATE UNIVERSITY

- Responsibilities – Thin-film device fabrication, materials characterization and photovoltaic device analysis
- Proficient operation of RF sputter systems, sublimation systems, physical vapor deposition systems, electron microscopes
- Experiment planning and execution
- Fabricated over 30,000 small area solar cells
- Demonstrated high efficiency solar cells using CdTe-only ($\eta = 18.7\%$) and $\text{CdSe}_x\text{Te}_{1-x}/\text{CdTe}$ ($\eta = 19.2\%$) devices using a high-speed repeatable process. These are the highest efficiency devices demonstrated by any academic institution.

TEACHING EXPERIENCE

JAN 2020 (SPRING 2020)

INSTRUCTOR, COLORADO STATE UNIVERSITY

- Instructor for **Introduction to Engineering Materials (MECH 331)** –
 - 4 credit including course lectures and laboratory for a class of 57 students
 - Teaching properties, characteristics and behavior of engineering materials
 - Preparing exams, homework and quiz, supervise grading
 - Maintain parallel progress between class lectures and laboratory experiments
 - Development and implementation of new hands-on teaching laboratories

GRADUATE TEACHING ASSISTANT, COLORADO STATE UNIVERSITY

- Teaching Assistant for **Manufacturing Processes (MECH 200)** –
 - Teaching and supervising machine shop with lathe, milling machines, electric saws, welding equipment, molding and casting of metals.
 - Grading homework assignments, projects and exams.
 - Student and equipment safety during laboratory sessions in machine shop
- Teaching Assistant for **Engineering Design I (MECH 201)** –
 - Conducting 4 laboratory session where students used Creo Parametric to learn perspectives, constraints in mechanical design and GD&T.
 - Worked with the supervising professor (Prof. Sakurai) in preparing grading rubrics

- Grading homework assignments, exams and final projects.
- Teaching Assistant for **Engineering Design II (MECH 202)** –
 - Teaching project management and project scheduling.
 - Teach a class of over 100 students while serving as a graduate teaching assistant
 - Grading projects, homework assignments and exams
 - Organizing final project and competition for the class.

2014 – PRESENT (As a GRA and Research Scientist I)

VISITING LECTURER FOR SPECIALITY TOPICS, COLORADO STATE UNIVERSITY

- Teach ME431 (Metals and Alloys) and ME575 (Solar and Alternate Energies) as a substitute for Prof. W.S. Sampath in his absence.
 - *Topics covered* – Basics of solar energy, thin-film fabrication, characterization of engineering materials, materials failure mechanisms and identification, and advanced materials characterization methods

INDUSTRIAL EXPERIENCE

MAY 2012 – JULY 2013 (Internship during M.S. and Ph.D.)

ENGINEERING MATERIALS FAILURE ANALYST, WOODWARD INC.

- Identify the causes for failure of engineering parts under test condition and occasionally in the field.
- I handled multiple projects and identified failure causes for several engineering parts which included fatigue fractures, chlorine induced corrosions and cavitation.
- Served on a team of over 15 engineers and project managers for development of a new product and material selection.

MAY 2011 – AUGUST 2011 (Internship during M.S.)

SUMMER DESIGN ENGINEERING INTERN, COLORADO STATE UNIVERSITY

- As an engineering intern at the Energy Institute (then Engines and Energy Conversion Laboratory - EECL) I was hired to work on a project named SEED (Small Engines for Economic Development).
- Design and development of a small engine combined with a lightweight water pump to be used for irrigation by farmers in developing countries such as Bangladesh, China and India.
- Major challenges were to make the product light weight to allow one person to carry the unit on their shoulder to the farm while maintaining a low cost.

CONSULTATION EXPERIENCE

FEB 2015 – PRESENT

EXPERT WITNESS, MEDICAL IMPLANTS FAILURE

- Analysis of failure mode for medical implants during its service life in patients' body
- Microscopic characterization of failed surfaces to verify failure mechanism
- Preparing expert witness reports for legal arguments and proceedings

TEHCNICAL EXPERTISE

- **Thin-film fabrication and interface engineering**
 - Sublimation and closed-space sublimation of semiconductors for photovoltaic application
 - Defect passivation and activation of photovoltaic thin-films
 - RF and DC sputter deposition of thin films
 - Physical vapor deposition for deposition for electrical contacts
 - Application of organic solutions for development of organic back contacts for II-VI photovoltaics
 - Metal Organic Chemical Vapor Deposition and Chemical Bath Deposition
 - Plasma and chemical etching for surface and interface preparation
 - Vacuum system design, operation and maintenance
 - SCAPS 1-D interface modeling
- **First-principle Density Functional Theory (DFT)**
 - Multi-body model generation
 - Submitting simulation job to supercomputer for computing
 - Result analysis using Synopsys QuantumATK
- **Electron microscopy and X-ray methods (SEM, TEM/HRTEM, EDS, XPS)**
 - Specimen preparation for electron microscope imaging using Dual Beam FIB
 - Secondary electron and back-scatter electron imaging with SEM
 - Bright field, dark field and high angle annular dark field electron imaging using TEM
 - Image analysis to understand film morphology
 - Energy dispersive X-ray spectroscopy (EDS) for elemental mapping and composition
 - SIMS, ICP, CL, SCM and SKPM data analysis and interpretation
 - Cross-section transmission electron microscope imaging for grain structure and defects
 - High-resolution transmission electron microscopy for interface and defect analysis
 - XPS compositional analysis
 - Argon ion etching and depth profiling using XPS
- **Focused Ion Beam (Gallium Ion-Electron Dual-beam)**
 - Ultra-thin electron transparent TEM sample fabrication (<60 nm cross section) for TEM and HRTEM imaging
 - Specimen preparation for thin-film cross-section composition analysis using EDS
 - Specimen preparation for cross-section EBSD analysis
- **Electrical measurement and analysis**
 - Current density v/s voltage (JV),
 - Quantum efficiency (EQE),
 - Capacitance v/s voltage (CV) and Capacitance v/s frequency (CF) measurement and data analysis
 - Time Resolved and low-temperature photoluminescence
- **Computer aided designing, manufacturing and analysis (CAD, CAM, CFD, FEA)**
 - Company certified PTC (ProEngineer Wildfire) Creo engineer
 - Computation fluid dynamics analysis using Ansys and Workbench
 - Finite Element Analysis using Abaqus
- **Machining**
 - Lathe and milling - steel, brass, aluminum, wood and acrylic
 - Welding – SMAW, GTAW, MIG

RESEARCH ACTIVITIES

Google Scholar Profile

Key Words – Amit Munshi CdTe

Citations – 336

h-index – 10

i10 index – 11

Research gate profile –

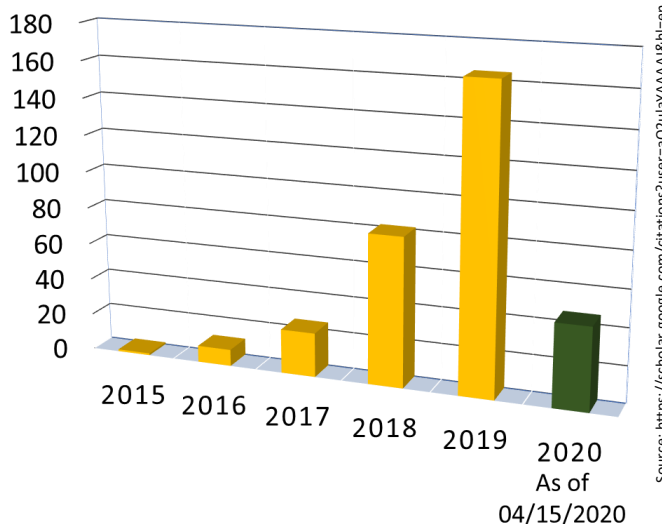
Rating – 21.27

Total research interest – 227.1

recommendations – 23

Reads – 4,292

PROGRESS IN CITATION BY YEAR



Demonstration of High Research Impact –

- At 2019 IEEE Photovoltaics Specialists Conference, **over 85%** of the 40 published manuscripts in this field cited my research.
- At European Materials Research Society Spring 2020 meeting, I am author/co-author for **8 out of 10** oral presentations in this field of research, remaining 2 also site my research.

PEER REVIEWED JOURNAL PUBLICATIONS

1. Misra, Sudhajit, Jeffery A. Aguiar, Sophia Gardner, Xiahan Sang, Raymond R. Unocic, **Amit Munshi**, Walajabad Sampath, Chris S. Ferekides, and Michael A. Scarpulla. "Cadmium Selective Etching in CdTe Solar Cells Produces Detrimental Narrow-gap Te in Grain Boundaries." *ACS Applied Energy Materials* (2020). **[Impact Factor – 15.00]**
2. *Fiducia, Thomas AM, Budhika G. Mendis, Kexue Li, Chris RM Grovenor, ***Amit H. Munshi**, Kurt Barth, Walajabad S. Sampath et al. "Understanding the role of selenium in defect passivation for highly efficient selenium-alloyed cadmium telluride solar cells." *Nature Energy* 4, no. 6 (2019): 504. **[Impact Factor – 54.00]** *Equal contribution – Device fabricated by me enabled this research
3. *Fiducia, Thomas AM, Kexue Li, ***Amit H. Munshi**, Kurt Barth, Walajabad S. Sampath, Chris RM Grovenor, and John M. Walls "3D Imaging of Selenium and Chlorine Distributions in Highly Efficient Selenium-Graded Cadmium Telluride Solar Cells" *IEEE Journal of Photovoltaics*, (2019); doi: 10.1109/JPHOTOV.2019.2955313. **[Impact Factor – 3.74]** *Equal contribution – Device fabricated by me enabled this research
4. *Jinglong Guo, Arun Mannodi-Kanakkithodi, Fatih G. Sen, Eric Schwenker, E.S. Bernard, ***Amit Munshi**, W. Sampath, Maria K. Y. Chan and Robert F. Klie. "Effect of selenium and chlorine co-passivation in polycrystalline CdSeTe devices." *Applied Physics Letters* 115, 153901 (2019). **[Impact Factor – 3.52]** *Equal contribution – Device fabricated by me enabled this research
5. Bittau, Francesco, Shridhar Jagdale, Christos Potamialis, Jake W. Bowers, John M. Walls, **Amit H. Munshi**, Kurt L. Barth, and Walajabad S. Sampath. "Degradation of Mg-doped zinc oxide buffer layers in thin film CdTe solar cells." *Thin Solid Films* (2019): 137556. **[Impact Factor – 1.94]**
6. *Guo, Jinglong, Fatih G. Sen, Arun Mannodi-Kannakithodi, Edward S. Barnard, W. Sampath, ***Amit Munshi**, Maria KY Chan, and Robert F. Klie. "Study of Effects of Cl and Se in CdSeTe Solar Cells Using

Scanning Transmission Electron Microscopy." *Microscopy and Microanalysis* 25, no. S2 (2019): 2150-2151. **[Impact Factor – 2.67]** *Equal contribution – Device fabricated by me enabled this research

7. **Munshi, Amit H.**, Jason M. Kephart, Ali Abbas, Adam Danielson, Guillaume Gélinas, Jean-Nicolas Beaudry, Kurt L. Barth, John M. Walls, and Walajabad S. Sampath. "Effect of CdCl₂ passivation treatment on microstructure and performance of CdSeTe/CdTe thin-film photovoltaic devices." *Solar Energy Materials and Solar Cells* 186 (2018): 259-265. **[Impact Factor – 6.01]**
8. **Munshi, Amit H.**, Nikhil Sasidharan, Subin Pinkayan, Kurt L. Barth, W. S. Sampath, and Weerakorn Ongsakul. "Thin-film CdTe photovoltaics–The technology for utility scale sustainable energy generation." *Solar Energy* 173 (2018): 511-516. **[Impact Factor – 4.67]**
9. Berg, Morgann, Jason M. Kephart, **Amit Munshi**, Walajabad S. Sampath, Taisuke Ohta, and Calvin Chan. "Local electronic structure changes in polycrystalline CdTe with CdCl₂ treatment and air exposure." *ACS applied materials & interfaces* 10, no. 11 (2018): 9817-9822. **[Impact Factor – 8.45]**
10. Kephart, Jason M., Anna Kindvall, Desiree Williams, Darius Kuciauskas, Pat Dippo, **Amit Munshi**, and W. S. Sampath. "Sputter-deposited oxides for interface passivation of CdTe photovoltaics." *IEEE Journal of Photovoltaics* 8, no. 2 (2018): 587-593. **[Impact Factor – 3.74]**
11. **Munshi, Amit H.**, Jason M. Kephart, Ali Abbas, Tushar M. Shimpi, Kurt L. Barth, John M. Walls, and Walajabad S. Sampath. "Polycrystalline CdTe photovoltaics with efficiency over 18% through improved absorber passivation and current collection." *Solar Energy Materials and Solar Cells* 176 (2018): 9-18. **[Impact Factor – 6.01]**
12. **Munshi, Amit H.**, Jason Kephart, Ali Abbas, John Raguse, Jean-Nicolas Beaudry, Kurt Barth, James Sites, John Walls, and Walajabad Sampath. "Polycrystalline CdSeTe/CdTe absorber cells with 28 mA/cm₂ short-circuit current." *IEEE Journal of Photovoltaics* 8, no. 1 (2017): 310-314. **[Impact Factor – 3.74]**
13. Shimpi, Tushar M., Jason M. Kephart, Drew E. Swanson, **Amit H. Munshi**, Walajabad S. Sampath, Ali Abbas, and John M. Walls. "Effect of the cadmium chloride treatment on RF sputtered Cd_{0.6}Zn_{0.4}Te films for application in multijunction solar cells." *Journal of Vacuum Science & Technology A: Vacuum, Surfaces, and Films* 34, no. 5 (2016): 051202. **[Impact Factor – 1.72]**
14. **Munshi Amit** and Walajabad Sampath. "CdTe photovoltaics for sustainable electricity generation." *Journal of Electronic Materials* 45, no. 9 (2016): 4612-4619. **[Impact Factor – 1.68]**

MANUSCRIPTS UNDER REVIEW

15. *Thomas Fiducia, Ashley Howkins, Ali Abbas, Budhika Mendis, **Amit Munshi**, Kurt Barth, Walajabad Sampath, Michael Walls. " Passivation of Grain Boundaries by Selenium in Alloyed CdTe Solar Cells Revealed by TEM-based Cathodoluminescence." *Nature Energy*. **[Impact Factor – 54.00]** *Equal contribution – Device fabricated by me enable this research
16. Yegor Samoilenko, Gavin Yeung, **Amit Munshi**, Ali Abbas, Carey Reich, Michael Walker, Matthew Reese, Andriy Zakutaeyv, John Walls, Walajabad Sampath and Colin Wolden. "Stable Magnesium Zinc Oxide by Reactive Co-sputtering for CdTe-based Solar Cells" *Solar Energy Materials and Solar Cells*. **[Impact Factor – 6.01]**

17. Ian Mathews, Sai Nithin Reddy Kantareddy, Zhe Liu, **Amit Munshi**, Kurt Barth, Walajabad Sampath, Tonio Buonassisi and Ian Marius Peters. "CdTe Photovoltaic Cells Performance Under Ambient Lighting for Internet of Things Applications" *Applied Physics Letters*. **[Impact Factor – 3.52]**

CONFERENCE PROCEEDINGS – POSTERS/ORALS/ABSTRACTS

1. Yegor Samoilenko, Gavin Yeung, **Amit Munshi**, Ali Abbas, Carey Reich, Michael Walker, Matthew Reese, Andriy Zakutaeyv, John Walls, Walajabad Sampath and Colin Wolden. "Stable Magnesium Zinc Oxide by Reactive Co-sputtering for CdTe-based Solar Cells" *Solar Energy Materials and Solar Cells*
2. Misra, Sudhajit, Jeffery A. Aguiar, Sophia Gardner, Xiahan Sang, Raymond R. Unocic, **Amit Munshi**, Walajabad Sampath, Chris S. Ferekides, and Michael A. Scarpulla. "Cadmium Selective Etching in CdTe Solar Cells Produces Detrimental Narrow-gap Te in Grain Boundaries." *ACS Applied Energy Materials* (2020).
3. **Amit H Munshi**, Adam H Danielson, Santosh Swain, Carey L Reich, Tushar M Shimpi, Seth W McPherson, Kelvin G Lynn, Darius Kuciauskas, Andrew Ferguson, Jinglong Guo, Robert Klie, Walajabad S Sampath. " Doping CdSe_xTe_{1-x}/CdTe Graded Absorber Films with Arsenic for Thin-Film Photovoltaics." In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019. (Oral Presentation)
4. Anna E. Kindvall, **Amit H. Munshi**, Tushar M. Shimpi, Adam H. Danielson, Walajabad S. Sampath.. "Effect of Process Temperature and Copper Doping on the Performance of ZnTe:Cu Back Contacts in CdTe Photovoltaics." In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019. **[Best Poster Presentation Award]**
5. **Amit Munshi**, Jason Kephart, Ali Abbas, Thomas Fiducia, Adam Danielson, Carey Reich, Tushar Shimpi, John Walls, Walajabad Sampath." Progress and Challenges in Absorber and Interface Fabrication of Polycrystalline CdTe Photovoltaics." *Materials Research Society Spring Meeting 2019*. **[Invited Talk, Invited to submit manuscript to Journal of Materials Research as a featured article]**
6. William Weigand, Carey Reich, **Amit Munshi**, Arthur Onno, Adam Danielson, Walajabad Sampath, Zachary Holman."P-Type Hydrogenated Amorphous Silicon—A Hole-Selective Contact to Cadmium Telluride Based Solar Cells." *Materials Research Society Spring Meeting 2019*. (Oral Presentation)
7. Arthur Onno, **Amit Munshi**, Adam Danielson, Carey Reich, William Weigand, Salman Manzoor, Jason Yu, Walajabad Sampath, Darius Kuciauskas, Zachary Holman." Diagnosing Recombination and Resistive Losses in Thin-Film Chalcogenide Solar Cells Using a Silicon-Inspired Characterization Platform." *Materials Research Society Spring Meeting 2019*. (Oral Presentation)
8. Jinglong Guo, Fatih G. Sen, Arun Mannodi-Kannakithodi, Edward S. Barnard, Walajabad S. Sampath, **Amit Munshi**, Moon Kim, Maria K. Y. Chan, Robert F. Klie. "Study of Se and Cl segregation in polycrystalline CdSeTe" In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019. (Oral Presentation)
9. Thomas A. M. Fiducia, Kexue Li, **Amit H. Munshi**, Kurt Barth, Walajabad S. Sampath, Chris R. M. Grovenor, John M. Walls. "3D Imaging of Selenium Distributions in High Efficiency Selenium-Graded Cadmium Telluride Solar Cells." In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019. (Oral Presentation) (Oral Presentation)

10. Kholoud Alajmi, Dhruv Patel, **Amit Munshi**, Walajabad Sampath, Roseanne Warren, M.A. Scarpulla "Capacitance Spectroscopies on FTO/MZO/CdSeTe Thin Film Solar Cells" In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019.
11. Dhruv Patel, Kholoud Alajmi, Abdul Shaik, **Amit Munshi**, Walajabad Sampath, Dragica Vasileska, Roseanne Warren, M.A. Sarpulla "Observation of Current Voltage Hysteresis in Air Exposed FTO/MZO/CdSeTe/Te Thin Film Solar Cells" In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019.
12. Rachael C. Greenhalgh, Vincent Tsai, Ali Abbas, Vladislav Kornienko, Tom A. M. Fiducia, Mustafa Togay, Kexue Li, Chris Grovener, Adam Danielson, **Amit H. Munshi**, Kurt L. Barth, Walajabad S. Sampath, Jake W. Bowers, John M. Walls. "Analysis of an MZO/CdTe photovoltaic device treated with cadmium bromide" In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019. **[Best Paper Award Finalist]**
13. Adam H. Danielson, **Amit H. Munshi**, Arthur Onno, William Weigand, Anna Kindvall, Carey Reich, Zhengshan J. Yu, Jianwei Shi, Zachary Holman, Walajabad Sampath, Darius Kuciauskas, Ali Abbas, John M. Walls "Sputtered Aluminum Oxide and p+ Amorphous Silicon Back-contact for Improved Hole Extraction in Polycrystalline CdSe_xTe_{1-x} and CdTe Photovoltaics." In *2019 IEEE 46th IEEE Photovoltaics Specialists Conference, Chicago*. IEEE, 2019. (Oral Presentation)
14. **Munshi, Amit H.**, Adam H. Danielson, Kurt L. Barth, Guillaume Gélinas, Jean-Nicolas Beaudry, and W. S. Sampath. "Advanced Co-sublimation of Low Bandgap CdSe_xTe_{1-x} Alloy to Achieve Higher Short-Circuit Current." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 0148-0152. IEEE, 2018.
15. Abbas, A., **A. Munshi**, K. L. Barth, W. S. Sampath, G. D. West, and J. M. Walls. "Investigation of localized Phase Changes using High Resolution Electron Back-Scatter Diffraction in Thin Film Cadmium Telluride Photovoltaic Material with High Lattice Defect Densities." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 1692-1696. IEEE, 2018.
16. **Munshi, Amit H.**, Adam H. Danielson, Anna Kindvall, Kurt Barth, and Walajabad Sampath. "Investigation of Sputtered Oxides and p+ Back-contact for Polycrystalline CdTe and CdSeTe Photovoltaics." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 3009-3012. IEEE, 2018.
17. **Munshi, Amit H.**, Jason M. Kephart, Carey L. Reich, Davis R. Hemenway, Tushar M. Shimpi, Ali Abbas, Kevan C. Cameron et al. "Advanced co-sublimation hardware for deposition of graded ternary alloys in thin-film applications." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 0842-0845. IEEE, 2018.
18. Fiducia, Thomas AM, **Amit H. Munshi**, Kurt Barth, Daniela Proprentner, Geoffrey West, Walajabad S. Sampath, and John M. Walls. "Defect Tolerance in as-deposited Selenium-alloyed Cadmium Telluride Solar Cells." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 0127-0130. IEEE, 2018.
19. Danielson, Adam, **Amit Munshi**, Anna Kindvall, Santosh Kumar Swain, Kurt Barth, Kelvin Lynn, and Walajabad Sampath. "Doping CdTe Absorber Cells using Group V Elements." In *2018 IEEE 7th World*

Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC), pp. 0119-0123. IEEE, 2018. **[Best Poster Presentation Finalist]**

20. Greenhalgh, R. C., Ali Abbas, **A. H. Munshi**, Tushar M. Shimpi, Kurt L. Barth, Walajabad S. Sampath, Jake W. Bowers, and J. M. Walls. "Activation of thin film CdTe solar cells using a cadmium bromide treatment." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 2990-2993. IEEE, 2018.
21. Nicholson, Anthony P., **Amit H. Munshi**, Umberto Pozzoni, and Walajabad S. Sampath. "First Principles Approach to CdTe/Te Interface Band Alignment Using Density Functional Theory and Nonequilibrium Green's Function." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC)(A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 1932-1936. IEEE, 2018.
22. Kindvall, Anna, **Amit Munshi**, Tushar Shimpi, Adam Danielson, and Walajabad S. Sampath. "Copper-Doped Zinc Telluride Thin-Films as a Back Contact for Cadmium Telluride Photovoltaics." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 2994-2997. IEEE, 2018.
23. Fiducia, Thomas AM, Kexue Li, **Amit H. Munshi**, Kurt Barth, Walajabad S. Sampath, Chris Grovenor, and John M. Walls. "Large Area 3D Elemental Mapping of a MgZnO/CdTe Solar Cell with Correlative EBSD Measurements." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 1702-1706. IEEE, 2018.
24. Danielson, Adam, **Amit Munshi**, Drew Swanson, Jennifer Drayton, Giray Kartopu, Kurt Barth, Stuart Irvine, and Walajabad Sampath. "MOCVD Deposition of Group V Doped CdTe in Sublimated CdTe and CdSeTe Devices." In *2018 IEEE 7th World Conference on Photovoltaic Energy Conversion (WCPEC) (A Joint Conference of 45th IEEE PVSC, 28th PVSEC & 34th EU PVSEC)*, pp. 0153-0156. IEEE, 2018.
25. Fiducia, Thomas AM, Kexue Li, **Amit H. Munshi**, Kurt Barth, Walajabad S. Sampath, Chris RM Grovenor, and John M. Walls. "3D Distributions of Chlorine and Sulphur Impurities in a Thin-Film Cadmium Telluride Solar Cell." *MRS Advances* 3, no. 56 (2018): 3287-3292. **[Best Poster Presentation Finalist]**
26. **Munshi, Amit**, Piotr M. Kaminski, Ali Abbas, Shiva T. Reddy, Sreeram Chandralal, Michael Walls, and Walajabad S. Sampath. "Characterization of CdTe photovoltaic devices passivated using hydrogen plasma." In *2017 IEEE 44th IEEE Photovoltaics Specialists Conference, Portland*. IEEE, 2017. (2017).
27. **Munshi, Amit H.**, Jason Kephart, Ali Abbas, John Raguse, Jean-Nicolas Beaudry, Kurt Barth, James Sites, John Walls, and Walajabad Sampath. "Polycrystalline CdSeTe/CdTe absorber cells with 28 mA/cm² short-circuit current." In *2017 IEEE 44th IEEE Photovoltaics Specialists Conference, Portland*. IEEE, 2017. (2017). **[Best Paper Award – Invited for publication in IEEE Journal of Photovoltaics]**
28. Sites, James, **Amit Munshi**, Jason Kephart, Drew Swanson, and W. S. Sampath. "Progress and challenges with CdTe cell efficiency." In *2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC)*, pp. 3632-3635. IEEE, 2016. **[Invited Talk]**
29. **Munshi, Amit H.**, Jason M. Kephart, Ali Abbas, Tushar M. Shimpi, Kurt Barth, John M. Walls, and Walajabad S. Sampath. "Effect of varying deposition and substrate temperature on sublimated CdTe thin-film photovoltaics." In *2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC)*, pp. 0465-0469. IEEE, 2016. **[Best Poster Presentation Award]**

30. Reich, Carey, Drew Swanson, Tushar Shimpi, Jennifer Drayton, **Amit Munshi**, Ali Abbas, and Walajabad Sampath. "Passivation of a $Cd_{1-x}Mg_xTe$ absorber for application in a tandem cell." In *2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC)*, pp. 0487-0491. IEEE, 2016.
31. Dangate, Milind, **Amit Munshi**, W. S. Sampath, Olga V. Boltalina, Steven H. Strauss, C. Saravanan, and Shantikumar Nair. "Investigation of organic small molecules and polymer compounds for CdTe back contact." In *2016 IEEE 43rd Photovoltaic Specialists Conference (PVSC)*, pp. 1438-1442. IEEE, 2016.
32. Abbas, Ali, D. Swanson, **Amit Munshi**, Kurt L. Barth, Walajabad S. Sampath, G. D. West, Jake W. Bowers, Piotr M. Kaminski, and J. M. Walls. "The effect of a post-activation annealing treatment on thin film CdTe device performance." In *2015 IEEE 42nd Photovoltaic Specialist Conference (PVSC)*, pp. 1-6. IEEE, 2015.
33. Swanson, Drew E., Ali Abbas, **Amit H. Munshi**, Jennifer A. Drayton, John M. Raguse, Russell M. Geisthardt, James R. Sites, and Walajabad S. Sampath. "Incorporation of $Cd_{1-x}Mg_xTe$ as an electron reflector for cadmium telluride photovoltaic cells." *MRS Online Proceedings Library Archive 1771* (2015): 133-138.
34. **Munshi Amit**, Ali Abbas, John Raguse, Kurt Barth, Walajabad S. Sampath, and J. M. Walls. "Effect of varying process parameters on CdTe thin film device performance and its relationship to film microstructure." In *2014 IEEE 40th Photovoltaic Specialist Conference (PVSC)*, pp. 1643-1648. IEEE, 2014.

SYNERGISTIC ACTIVITIES

- **IEEE Photovoltaics Specialists Conference 2017** - Session Chair for Area 2: Interfaces and Contact Layers in Thin Film PV
- **Materials Research Society Spring Meeting 2019** – Session Chair for Area ES20.11: Module Fabrication and Stability
- **IEEE Photovoltaics Specialists Conference 2019** - Session Chair for Area 2: Interfaces and Contact Layers in Thin Film PV
- **IEEE Photovoltaics Specialists Conference 2019** - Session Chair for Area 2: Fabrication and Degradation of CIGSe
- **IEEE Photovoltaics Specialists Conference 2019** – Organizer and sub-area Chair for Area 2
- Co-organizer **E-MRS (European Materials Research Society) 2020 spring meeting** in Strasbourg, France for Chalcogenide Thin-Film Solar Cells Symposium.

PEER REVIEW AND EVALUATION

- Journal of Solar Energy Materials and Solar Cells (2017, 2018, 2019)
- Journal of Solar Energy (2018, 2019)
- IEEE Journal of Photovoltaics (2018, 2019)
- Journal of Thin-Solid Films (2019)
- Journal of Vacuum Science and Technology (2018, 2019)
- Ph.D. Dissertation Evaluator – Visvesvaraya Technological University, Karnataka, India (2018)
- American Institute of Physics Advances (2019)

- Photonics Technology Letters (2019)
- IEEE Photovoltaics Specialists Conference abstract evaluation (2019,2020)
- European Materials Research Society (EMRS) abstract evaluation (2020)
- Solid State Communications (2020)
- Journal of Applied Energy (2020)

RESEARCH PROPOSALS AND FUNDING

- Concluded projects –
 - NSF AIR-RA – **Major Contributor** - *Advanced Thin-Film Photovoltaics for Sustainable Energy*. Contributions include experiment execution, data analysis and reporting.
Total Budget – US \$1.2M over 3 years. **Project successfully concluded July 2019.**
 - U.S. Department of Energy, Solar Energy Technology Office (SETO) - **Co-Principal investigator** – *High Lifetime and Mobility CdTe Alloys by Co-Sublimation*.
Total Budget - US \$189,000. **Project successfully concluded June 2019.**
 - Three National Science Foundation Research Experience for Undergraduate (REU) supplements including two for diversity students. Contributions include mentoring undergraduate students, managing hours in laboratory and reporting.
Total Budget – US \$24k for 1 year.
- Ongoing projects -
 - U.S. Department of Energy Solar Energy Technology Office – **Senior Personal**: *Doping of CdTe and CdSeTe for higher efficiency*. Contributions include experiment planning, experiment execution, data analysis, reporting to DOE and results publications.
Total Budget – US \$937K over 3 years.
 - U.S. Department of Energy Solar Energy Technology Office – **Senior Personal** (subcontract, Arizona State University lead): *Diagnosing and overcoming recombination and resistive losses in non-silicon solar cells using a silicon-inspired characterization platform*. Contributions include experiment planning, experiment execution, data analysis, reporting to DOE and results publications.
Total Budget – US \$1.47M, **CSU Budget** – US \$375K for 3 years.
 - National Science Foundation Industry/University Cooperative Research Center for Next Generation Photovoltaics. Research lead on 2-3 annual projects since 2013 focused on materials characterization and process development. Contributions include experiment planning and execution, data analysis, quarterly reporting, biannual presentation to NSF and Industrial Advisory Board, annual project reporting and research publications.
Annual Budget – US \$350K per year.
- Projects under review (or being proposed) –
 - National Science Foundation Major Research Instrumentation – **Co-principal Investigator**: *Development of an Advanced Semiconductor Process System Integrated with Quantum Simulation for Fundamental Understanding*.
Proposed budget – US \$2.1M over 3 years.
 - U.S. Department of Energy Solar Energy Technology Office – **Co-principal Investigator** (Subcontract, University of Nevada at Las Vegas lead): *Maximizing Long Term Power Output for Thin-film Photovoltaics: Metastability and long-term degradation in CdTe and CdSeTe solar cells: Quantification of interface and bulk degradation*.
Anticipated subcontract budget – US \$650k over 3 years.

- U.S. Department of Energy Solar Energy Technology Office – **Principal Investigator** (Subcontract, Arizona State University lead): Transparent back-contact and interface development in CdTe solar cells for bifacial and tandem cell applications.
Anticipated subcontract budget – US \$750k over 3 years.
- National Science Foundation Research Experience for Undergraduate (REU) supplement for one student.
Budget – US \$8k.
- U.S. Department of Energy Solar Energy Technology Office – **Senior personal** (Subcontract, University of Illinois at Chicago lead): Advanced characterization of interfaces and defects in polycrystalline thin-film photovoltaics.
Anticipated subcontract budget – US \$450k over 3 years.
- U.S. Department of Energy Solar Energy Technology Office – **Senior personal** (Subcontract, Colorado School of Mines lead): Thin-film transistor fabrication and its integration into modules to allow active control of reverse bias damage due to shadowing.
Anticipated subcontract budget – US \$300k over 3 years.
- Past proposals -
 - **Principal investigator** - U.S. Department of Energy, Solar Energy Technology Office (SETO) – Low Band-gap Sb_2Se_3 for Tandem Application with Thin-Film CdTe – Proposal Encouraged
 - **Principal investigator** (sub-contract) - U.S. Department of Energy, Solar Energy Technology Office (SETO) - Advanced Buffer Layers for CdTe-based Solar Cells - Proposal Encouraged
 - **Principal investigator** (sub-contract) - U.S. Department of Energy, Solar Energy Technology Office (SETO) – Maximizing Long Term Power Output for Thin-film Photovoltaics: Quantification of Interface and Bulk Degradation Mechanisms vis In-Situ Stress Analyses - Proposal Encouraged.

ACTIVE RESEARCH COLLABORATIONS

- **University of Utah, US**
 - Prof. Michael Scarpulla
- **Arizona State University, US**
 - Prof. Zachary Holman
 - Prof. Richard King
- **University of Chicago at Illinois, US**
 - Prof. Robert Klie
- **Texas A&M University, US**
 - Prof. Russ Porter
 - Prof. Taylor Harvey
- **University of Texas at Austin, US**
 - Prof. Brian Korgel
- **University of Toledo, US**
 - Prof. Adam Philips
- **Colorado School of Mines, US**
 - Prof. Colin Wolden
- **University of Nevada at Las Vegas, US**
 - Prof. Shubhra Bansal
- **Sanida National Laboratories, US**
 - Dr. Morgann Berg



- **First Solar Inc., US**
 - Dr. Markus Gloeckler
 - Dr. Gang Xiong
 - Dr. Chungho Lee
- **Reel Solar Inc., US**
 - Dr. Hsiao Kuo-Jui
- **National Renewable Energy Laboratory, US**
 - Dr. Darius Kuciauskas
 - Dr. Dave Albin
 - Dr. Wyatt Metzger
- **Washington State University at Pullman, US**
 - Lt. Prof. Kelvin Lynn
 - Dr. Santosh Swain
- **Massachusetts Institute of Technology, US**
 - Prof. Ian Marius Peters
- **Synopsys QuantumATK, Denmark**
 - Dr. Umberto Pozzoni
- **5N Plus Inc., Canada**
 - Dr. Jean-Nicholas Beaudry
 - Dr. Gulliaume Gélinas
- **Loughborough University, UK**
 - Prof. John Walls
 - Prof. Jake Bowers
- **University of Liverpool, UK**
 - Prof. Ken Durose
- **University of Oxford, UK**
 - Prof. Chris Grovenor
- **Chinese Academy of Sciences, China**
 - Prof. Xiangxin Liu
- **CTF Solar GmbH, Germany**
 - Dr. Bastian Siepchen
- **Asian Institute of Technology, Thailand**
 - Prof. Weerakorn Ongsakul
 - Prof. Subin Pinkayan
- **Advanced Solar Power, China**
 - Dr. Xuanzhi Wu
 - Dr. Jie Zhou
- **Amrita University, India**
 - Prof. Balashankar Nair

PROFESSIONAL REFERENCES –

- **Prof. Walajabad S. Sampath**
Graduate Advisor
Professor, Colorado State University
Department of Mechanical Engineering
Email – Sampath@engr.colostate.edu
Phone – (970) 430-8878
- **Prof. Michael Scarpulla**
Research Collaborator
Professor, University of Utah
Department of Materials Science & Engineering
Department of Electrical & Computer Engineering
Email – Mike.Scarpulla@utah.edu
Phone – (801) 585-1231
- **Dr. Darius Kuciauskas**
Research Collaborator
Senior Scientist, National Renewable Energy Laboratory
Chemistry Research
Email – Darius.Kuciauskas@nrel.gov
Phone – (303) 384-6572
- **Prof. Robert F. Klie**
Research Collaborator
Professor, University of Illinois at Chicago
Department of Physics
Email – rflkie@uic.edu
Phone – (312) 996-6064
- **Prof. Susan P. James**
Graduate Exam Committee Member
Professor, Colorado State University
Department of Mechanical Engineering/Department of Biomedical Engineering
Email – sjames@engr.colostate.edu
Phone – (970) 491-0924