

Andrey Gunawan

George W. Woodruff School of Mechanical Engineering
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EDUCATION

Ph.D. Mechanical Engineering, Arizona State University (ASU), Tempe, AZ 2015

Dissertation: Electrolyte- and Transport-Enhanced Thermogalvanic Energy Conversion

(Advisor: Dr. Patrick E. Phelan)

Committee: Dr. Daniel A. Buttry, Dr. Vladimiro Mujica, Dr. Candace K. Chan, and Dr. Robert Y. Wang

M.S. Aerospace Engineering, University of Southern California, Los Angeles, CA 2010

B.S. Aeronautics and Astronautics, Institut Teknologi Bandung (ITB), Bandung, Indonesia 2008

Thesis: Development of Stereoscopic Particle Image Velocimetry (PIV) System (Advisor: Dr. Lavi R. Zuhai)

RESEARCH INTERESTS

Thermogalvanic/thermoelectrochemical cells/thermocells, ionic heat and mass transfer, concentrated solar power (CSP) thermal-to-electrical energy conversion, high-temperature thermally regenerative electrochemical cycles (TREC), vehicle efficiency and waste heat recovery, flexible thermoelectrics, body heat-powered portable/wearable electronics.

AWARDS AND HONORS

- Best Paper Award (Second Prize), ASME Power & Energy Conference, Lake Buena Vista, FL 2018
- Best Paper Award (First Prize), ASME Power & Energy Conference, San Diego, CA 2015
- University Graduate Fellowship, Arizona State University (ASU) 2015
- Outstanding Mentor Award (Nominee), ASU Graduate & Professional Student Association 2015
- Joseph W. Richards Summer Fellowship, The Electrochemical Society 2014
- Link Foundation Energy Fellowship (Honorable Mention), Link Foundation 2014
- Graduate Research Support Program Award, ASU Graduate & Professional Student Association 2014
- Outstanding Graduate Student Service Award, ASU School for Eng. of Matter, Transp. & Energy 2014
- Eta Kappa Nu International electrical and computer engineering honor society of the IEEE 2014
- Cover Article, *Journal of Applied Physics* (co-author article) 2013
- Cover Article, *Nanoscale and Microscale Thermophysical Engineering* (first-author article) 2013

RESEARCH EXPERIENCE

Research Engineer II, Georgia Institute of Technology Jan 2016 – present

PI: Dr. Shannon K. Yee

Senior personnel at Scalable Thermal Energy Engineering Laboratory:

- Co-leading \$2.2 million Department of Energy (DOE) Solar Energy Technologies Office Gen3CSP project on researching high temperature (>700 °C) thermophysical property measurements of heat transfer media and containment materials to advance high-temperature concentrating solar power (CSP) systems
- Leading multimillion-dollar research project funded by industrial partners under non-disclosure agreements
- Led \$2.5 million DOE SunShot project on novel dual-stage alkali metal thermoelectric converter (AMTEC)

Graduate Research Assistant, Arizona State University Jan 2011 – Nov 2015

PI: Dr. Patrick E. Phelan

Studied thermogalvanic energy transport and energy conversion

- Investigated the feasibility of incorporating thermogalvanic waste heat recovery systems into automobiles; observed tens of mW m⁻² of electricity with temperature difference between the electrodes of < 10 °C

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- Investigated Seebeck coefficient enhancement of mixed-ligand complex formation of Cu/Cu²⁺ electrolytes; observed up to 160% improvement
- Theoretically and experimentally investigated the effect of natural convection on power generation of Cu/Cu²⁺ thermogalvanic cell; observed up to 100% improvement on the maximum power output of the cell
- Designed and built thermogalvanic cell apparatuses to investigate the effect of different operational conditions on Seebeck coefficient and power generation of Cu/Cu²⁺ thermogalvanic cell

Studied nanoscale thermal transport in liquid suspensions of nanoparticles for direct-absorption solar collectors

- Investigated volumetric boiling characteristic of the synthesized nanoparticles-liquid suspensions; observed up to 50% more vapors are generated in the suspensions than in conventional 'base' fluid
- Synthesized Ag, Cu, Ni, Al, multiwalled carbon nanotubes, and graphite nanoparticles-liquid suspensions
- Designed and built an integrated infrared (IR) and visible light image/video acquisition system to complement the existent laser-induced volumetric boiling experiment setup

Graduate Student Researcher, University of Southern California

Aug 2008 – May 2010

PI: Dr. Tait S. Pottebaum (currently affiliated with Opto-Knowledge Systems, Inc., Los Angeles, CA)

- Designed and built a nonintrusive microthermometry setup to investigate flow and driving force on bubbles and droplets in a microchannel with an imposed temperature gradient using thermochromic liquid crystals

Research Assistant, Institut Teknologi Bandung

Aug 2006 – Feb 2008

PI: Dr. Lavi R. Zuhail

- Designed and built a stereoscopic particle image velocimetry system to measure pseudo-3-dimensional instantaneous velocity field

Vehicle Evaluation Department Intern, PT. Toyota Motor Manufacturing Indonesia

Summer 2005

Supervisors: Mr. Edi Wiranto and Mr. Rahmat Wahyudi

- Conducted 2-dimensional CFD analysis using FLUENT and GAMBIT to evaluate the effect of Toyota original equipment manufacturer accessory products towards the drag coefficient of a minivan

GRANT WRITING

Source: Department of Energy Solar Energy Technologies Office (SETO): Gen3CSP

Title: Thermophysical Property Measurement of Heat Transfer Media and Containment Materials

Award Size: \$2,184,934

Performance Period: August 15 2018 – August 15 2023

Program Manager: Matthew Bauer

PI: Shannon K. Yee

Co-PI: Andrey Gunawan

Source: Department of Energy Solar Energy Technologies Office (SETO): FY2018

Title: Braze Ion Conducting Ceramics Enable Sodium Thermal Electrochemical (Na-TECC) Power Blocks and Sodium Sulfur (Na-S) Thermal and Electrochemical Storage

Award Size: \$375,000 (Unfunded)

PI: Shannon K. Yee

Co-PIs: Andrey Gunawan, Seung Woo Lee (Georgia Institute of Technology)

Source: Arizona State University: GPSA's Graduate Research Support Program Grant

Title: Thermogalvanic Waste Heat Recovery in Automobiles

Award Size: \$1,600

Performance Period: November 15 2014 – November 15 2015

Program Manager: Nedim Yel

PI: Andrey Gunawan

Co-PI: Nicholas W. Fette

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Source: The Electrochemical Society (ECS): Summer Fellowship

Title: Thermogalvanic Waste Heat Recovery in Transportation Energy Systems

Award Size: \$5,000

Performance Period: April 15 2014 – August 15 2014

PI: Andrey Gunawan

Source: National Science Foundation CBET Thermal Transport Processes, Energy for Sustainability

Title: Transport-Enhanced Thermogalvanic Energy Conversion

Award Size: \$300,000

Performance Period: September 12 2012 – August 31 2017

Program Manager: José Lage

PI: Vladimiro Mujica (Arizona State University)

Co-PI: Patrick E. Phelan (Arizona State University), Daniel A. Buttry (Arizona State University)

Contributed extensively to the full proposal: concept, preliminary works, research plan and budget

Source: Department of Energy Golden Field Office

Title: A Public/Private Consortium to Accelerate the Deployment of Renewable Energy Technologies in Indonesia

Award Size: \$1,000,000 (Unfunded)

PI: Elisabeth Graffy (Arizona State University)

Co-PI: Patrick E. Phelan, Ronald Calhoun, Gary Dirks, Dan O'Neill, Martin Pasqualetti, Ellen Stechel, Mick Dalrymple (all affiliated with Arizona State University); Sub-Recipient: Eng Go, Jurianto Joe, Yohanes Surya (all affiliated with Surya Institute)

Contributed extensively: concept (white paper), finding Indonesian partners, project plan (full proposal)

PUBLICATIONS AND PRESENTATIONS

Journal Covers



Total Number of Citations: 693

Google Scholar Profile: <https://scholar.google.com/citations?user=FOT749AAAAAJ&hl=en>

Refereed Journal Articles

1. A. Gunawan, R.A. Simmons, M.W. Haynes, D. Moreno, A.K. Menon, M.C. Hatzell, S.K. Yee, *Technoeconomics of Cogeneration Approaches for Combined Power and Desalination from Concentrated Solar Power*, **ASME J. Sol. Energy Eng.**, 141(2), 021004, 2018
2. A. Limia, J.M. Ha, P. Kottke, A. Gunawan, A.G. Fedorov, S.W. Lee, S.K. Yee, *A dual-stage sodium thermal electrochemical converter (Na-TEC)*, **J. Power Sources**, 371, 217-224, 2017

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3. [A. Gunawan](#), H. Li, C.-H. Lin, D.A. Buttry, V. Mujica, R.A. Taylor, R.S. Prasher, P.E. Phelan, *The Amplifying Effect of Natural Convection on Power Generation of Thermogalvanic Cells*, **Int. J. Heat Mass Transf.**, 78, 423-434, 2014
4. R.A. Taylor, J.K. Wong, S. Baek, Y. Hewakuruppu, X. Jiang, C. Chen, [A. Gunawan](#), *Nanoparticle-Assisted Heating Utilizing a Low-Cost White Light Source*, **ASME J. Nanotechnol. Eng. Med.**, 4, 040903, 2014
5. S. Lee, P.E. Phelan, L. Dai, R. Prasher, [A. Gunawan](#), R.A. Taylor, *Experimental Investigation of the Latent Heat of Vaporization in Aqueous Nanofluids*, **Appl. Phys. Lett.**, 104, 151908, 2014
6. [A. Gunawan](#), C.-H. Lin, D.A. Buttry, V. Mujica, R.A. Taylor, R.S. Prasher, P.E. Phelan, *Liquid Thermoelectrics: Review of Recent and Limited New Data of Thermogalvanic Cell Experiments*, **Nanoscale Microscale Thermophys. Eng.**, 17, 304-323, 2013 ([Cover Article](#); [Top 5 'Most cited articles'](#))
7. R.A. Taylor, S. Coulombe, T.P. Otanicar, P.E. Phelan, [A. Gunawan](#), W. Lv, G. Rosengarten, R.S. Prasher, H. Tyagi, *Small Particle, Big Impacts: A Review of the Diverse Applications of Nanofluids*, **Appl. Phys. Rev.** (was still a part of J. Appl. Phys.), 113, 011301, 2013 ([Cover Article](#))
8. R.A. Taylor, P.E. Phelan, R.J. Adrian, [A. Gunawan](#), T.P. Otanicar, *Characterization of Light-Induced, Volumetric Steam Generator in Nanofluids*, **Int. J. Therm. Sci.**, 56, 1-11, 2012

Technical Report

1. [A. Gunawan](#), Thermogalvanic Waste Heat Recovery in Transportation Energy System, *Electrochemical Society Interface*, 23, pp. 81-82, 2014

Refereed Conference Proceedings

1. [A. Gunawan](#), J.M. Ha, D.M. England, A. Limia, P.A. Kottke, A.G. Fedorov, S.W. Lee, S.K. Yee, Brazings for Metal-Ceramic Joining in Sodium Thermal Electrochemical Converter (Na-TEC) Devices, in *Proceedings of the ASME 2018 12th International Conference on Energy Sustainability*, ES2018-7517 (2018)
2. [A. Gunawan](#), A. Limia, J.M. Ha, P.A. Kottke, S.W. Lee, A.G. Fedorov, S.K. Yee, Techno-Economic Analysis of Dual-Stage Sodium Thermal Electrochemical Converter (Na-TEC) Power Block for Distributed CSP, in *Proceedings of the ASME 2018 12th International Conference on Energy Sustainability*, ES2018-7505 (2018)
3. M.W. Haynes, [A. Gunawan](#), S.K. Yee, Techno-Economic Comparison Between Conventional and Innovative Combined Solar Thermal Power and Desalination Methods for Cogeneration, in *Proceedings of the ASME 2018 Power Conference*, POWER2018-7515 (2018) [[Best Paper Award \(Second Prize\) in the ASME Power Division Student Paper Competition](#)]
4. [A. Gunawan](#), A. Rajan, D.M. Rodin, P. Creamer, S.K. Yee, New Directions in Thermoelectric and Thermal-Electric Cooling, in *Proceedings of the SPIE Photonics West 2017*, (2017) [[Invited Paper](#)]
5. [A. Gunawan](#), N.W. Fette, P.E. Phelan, Thermogalvanic Waste Heat Recovery System in Automobiles, in *Proceedings of the ASME 2015 Power Conference*, POWER2015-49094 (2015) [[Best Paper Award \(First Prize\) in the ASME Power Division Student Paper Competition](#)]
6. C.-H. Lin, [A. Gunawan](#), D. Buttry, V. Mujica, R.A. Taylor, R.S. Prasher, P.E. Phelan, Optimization of Cell Configuration for Maximizing Performance of a Cu/Cu²⁺ Aqueous Thermogalvanic Cell, in *Proceedings of the ASME 2012 International Mechanical Engineering Congress & Exposition*, IMECE2012-88796 (2012)
7. R.A. Taylor, S. Coulombe, T.P. Otanicar, P.E. Phelan, [A. Gunawan](#), W. Lv, G. Rosengarten, R.S. Prasher, H. Tyagi, Critical Review of the Novel Applications and Uses of Nanofluids, in *Proceedings of the ASME 3rd Micro/Nanoscale Heat & Mass Transfer International Conference*, MNHMT2012-75189 (2012)
8. R.A. Taylor, P.E. Phelan, R.J. Adrian, [A. Gunawan](#), T.P. Otanicar, Characterization of a Nanofluid Volumetric Solar Absorber/Steam Generator, in *Proceedings of the ASME 5th International Conference on Energy Sustainability*, ES2011-54062 (2011)

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Refereed Conference Presentations (Speaker underlined)

1. **Thermogalvanic Waste Heat Recovery System in Automobiles.** (poster) A. Gunawan, N.W. Fette, N. Wilson, V. Mujica, D.A. Buttry, P.E. Phelan, 228th ECS Meeting, Phoenix, AZ, October 11-15, 2015
2. **Improving Seebeck Coefficient of Thermogalvanic Cells Using Polyelectrolytes.** (poster) A. Gunawan, P. Tarakeshwar, D. Buttry, V. Mujica, P. Phelan, 227th ECS Meeting, Chicago, IL, May 26, 2015
3. **Electrode Separation and Operating Orientation: Mechanism for Maximizing Performance of Cu/Cu²⁺ Aqueous Thermogalvanic Cells.** (talk) H. Li, A. Gunawan, D.A. Buttry, V. Mujica, R.A. Taylor, R.S. Prasher, P.E. Phelan, ASME 2013 International Mechanical Engineering Congress & Exposition, San Diego, CA, November 15-21, 2013
4. **Experimental Investigation of Latent Heat in Aqueous Nanofluids.** (talk) S. Lee, P.E. Phelan, R.A. Taylor, L. Dai, R.S. Prasher, A. Gunawan, ASME 2013 International Mechanical Engineering Congress & Exposition, San Diego, CA, November 15-21, 2013
5. **Basic Analysis and Modeling of Thermogalvanic Cells.** (talk) A. Gunawan, V. Mujica, D. Buttry, R. Taylor, R. Prasher, P. Phelan, ASME 2013 Heat Transfer Conference, Minneapolis, MN, July 14-19, 2013
6. **Thermoelectric Characterization of Polymer Electrolytes in a Thermogalvanic Cell with a Cu/Cu²⁺ Redox Couple.** (poster) A. Gunawan, J. Johnson, D. Buttry, V. Mujica, R. Prasher, P. Phelan, GRC: Nanomaterials for Applications in Energy Technology, Ventura, CA, February 3-8, 2013
7. **Thermoelectric Characterization of Polymer Electrolytes in a Thermogalvanic Cell with a Cu/Cu²⁺ Redox Couple.** (talk) A. Gunawan, D. Buttry, V. Mujica, R.S. Prasher, P.E. Phelan, MRS-Singapore International Conference of Young Researchers on Advanced Materials, Singapore, July 1-6, 2012
8. **Thermoelectric Power Generation in Copper-Copper Sulfate Electrochemical Systems.** (poster) A. Gunawan, C.-H. Lin, D. Buttry, V. Mujica, R.A. Taylor, R.S. Prasher, P.E. Phelan, ASME 3rd Micro/Nanoscale Heat & Mass Transfer International Conference, Atlanta, GA, March 3-6, 2012
9. **Prospect for Liquid Thermoelectrics.** (poster) A. Gunawan, L. Zhang, C.-H. Lin, C. Ruckel, R. Stinson, M. Zhu, R.A. Taylor, R.S. Prasher, P.E. Phelan, 7th US-Japan Joint Seminar on Nanoscale Transport Phenomena, Shima, Japan, December 11-14, 2011
10. **Axially Asymmetric Rotating Tank Experiments for Thermally Forced Stationary Waves in Geophysical Fluids.** (poster) H.-P. Huang, J.C.R. Hunt, A. Sharma, L. Tse, H.J.S. Fernando, A. Gunawan, P.E. Phelan, A. Madrid, M. Thompson, 64th Annual Meeting of the APS Division of Fluid Dynamics, 58, Baltimore, MD, November 20-22, 2011

Invited Talk

1. **Sodium Ion Expansion Power Block for CSP.** Department of Energy (DOE) Solar Energy Technologies Office Portfolio Review, Washington, DC, February 12, 2018
2. **New Directions in Thermoelectric and Thermal-Electric Cooling.** SPIE Photonics West 2017, San Francisco, CA, February 2, 2017
3. **Electrolyte- and Transport-Enhanced Thermogalvanic Energy Conversion.** Georgia Institute of Technology, October 22, 2015

TEACHING EXPERIENCE

Instructor of Record

at Georgia Institute of Technology:

- ME 3322-H – Thermodynamics Fall 2017

at Arizona State University:

- ASU 101-MEE – The ASU Experience for Mechanical Engineering students Fall 2015

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Teaching Assistants

at Arizona State University:

- MAE 100 – Introduction to Mechanical and Aerospace Engineering & Spring 2011
EEE 101 – Introduction to Engineering Design (combined), Arizona State University

at Institut Teknologi Bandung:

- PN 4201 – Management of Aerospace Industry, Institut Teknologi Bandung Fall 2006 & Fall 2007
- PN 4031 – Experimental Methods, Institut Teknologi Bandung Spring 2007
- PN 2211 – Aircraft Aerodynamics 2, Institut Teknologi Bandung Spring 2007

MENTORING EXPERIENCE

Advisor for Georgia Tech PURA Project (1): Megan W Haynes (B.S., 2018); Student Mentor for ASU Master Theses (3) and Undergraduate Projects (2): Chao-Han Lin (M.S., 2012), Christopher Ruckel (M.S.E., 2011), Rhet Stinson (M.S., 2011), Elizabeth Besenyei (B.S., 2015), Jessica Johnson (B.S., 2015)

PROFESSIONAL DEVELOPMENT

- Preparing Future Faculty Program, ASU, Tempe, AZ Spring 2015, Fall 2012 – Spring 2013
- National Institute for Energy Ethics and Society, ASU, Tempe, AZ Apr 8-12 2013

PROFESSIONAL SERVICE

National

- Session Organizer for Track 2-7-5: Manufacturing Methods for Electrochemical Energy Conversion and Storage at the ASME 2018 Power and Energy Conference & Exhibition, Lake Buena Vista, FL
- Session Organizer for Track 1-12-4: Student Competition at the ASME 2018 Power and Energy Conference & Exhibition, Lake Buena Vista, FL
- Session Co-Organizer for Track 1-14-3: Student Competition at the ASME 2017 Power and Energy Conference & Exhibition, Charlotte, NC
- Session Organizer for Track 1-10-2: Student Competition at the ASME 2016 Power and Energy Conference & Exhibition, Charlotte, NC
- Session Organizer for Track 6-15: Wind, Water, Solar and Other Alternative Energy Systems at the ASME 2012 International Mechanical Engineering Congress & Exposition, Houston, TX
- Session Chair for Track 6-15-3: Applications of Solar Energy at the ASME 2012 International Mechanical Engineering Congress & Exposition, Houston, TX
- Reviewer for *Joule*, *Journal of Power Sources*, *International Journal of Hydrogen Energy*, *International Journal of Thermal Sciences*, *International Journal of Heat and Mass Transfer*, *ASME Journal of Electrochemical Energy Conversion and Storage*, *ASME Journal of Energy Resources Technology*, and *Entropy*
- Reviewer for ASME 2013 International Mechanical Engineering Congress & Exposition, San Diego, CA
- Reviewer for ASME 2012 International Mechanical Engineering Congress & Exposition, Houston, TX

University

- Referee for The Electrochemical Society (ECS) Georgia Local Conference Poster Competition (Apr 27th, 2018)
- Reviewer for Georgia Tech's President's Undergraduate Research Awards (PURA) applications (Fall 2017)
- Judge for Georgia Tech's Spring 2016 Capstone Design Expo (Apr 26th, 2016)
- Judge for Georgia Tech's Career Research and Innovation Development Conference (CRIDC) Poster Competition (Mar 10th, 2016)
- Graduate Student Assessor for Mechanical Engineering undergraduate program at the ASU ABET Mechanical and Aerospace Engineering Assessment Fair (May 1st, 2012, 2013, 2014 and 2015)
- Curriculum Development Team for ASU Ira A. Fulton School of Engineering E2 Camp (Spring 2011)

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- Reviewer for ASU Graduate & Professional Student Association grants: JumpStart Research Grants (Spring 2013 – present), Travel Grants (Fall 2012 – present), Teaching Excellent Awards (Spring 2012)
- Volunteered for the 1st ASU Ira A. Fulton School of Engineering Open House event (K-8 field trip and family day) sponsored by Raytheon (Spring 2012)

SYNERGISTIC EXPERIENCE

Associate Editor, IEEE Transportation Electrification Newsletter Apr 2013 – present
Institute of Electrical and Electronics Engineers (IEEE) Piscataway, NJ (online)

Voluntarily joined the Newsletter during its inception and helped start the newsletter publications

- Initiated and leading a new effort of synthesizing IEEE Distinguished Lecture Series into a series of article for publication in the Newsletter
- Managing an international group of editors, developed and managing the peer-review process

PROFESSIONAL MEMBERSHIPS

- Eta Kappa Nu (IEEE-HKN) Electrical Engineering Honor Society Nov 2014 – present
- The Electrochemical Society Jun 2013 – present
- National Institute for Energy Ethics and Society Apr 2013 – present
- American Society of Mechanical Engineers Dec 2011 – present