Professional Vita (updated January 2022)

ISSAM MUDAWAR
(Formerly Issam Mudawwar)

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PERSONAL: American Citizen
Wife: Jane Ausman-Mudawar, daughter: Alexine

EDUCATION:

1980-1984	Massachusetts Institute of Technology - Cambridge, Massachusetts: Ph.D. in Mechanical Engineering, with minor in Management received February 1984; thesis entitled "Boiling Heat Transfer in Rotating channels with Reference to Gas Turbine Blade Cooling"
1978-1980	Massachusetts Institute of Technology - Cambridge, Massachusetts: M.S. in Mechanical Engineering received May 1980; thesis entitled "Transverse Waves in MHD Slag Flows"
1974-1978	American University of Beirut, Lebanon: B.E. in Mechanical Engineering received June 1978

EXPERIENCE:

2015-present	Betty Ruth and Milton B. Hollander Family Professor of Mechanical Engineering
2014-2016	Chairman, Heat Transfer Area, Purdue University
2000-2001	Chairman, Heat Transfer Area, Purdue University
1993-2015	Professor of Mechanical Engineering, Purdue University, West Lafayette, Indiana
1992-present	President, Mudawar Thermal Systems Inc., West Lafayette, Indiana
1989-1993	Associate Professor of Mechanical Engineering, Purdue University
1984-1989	Assistant Professor Mechanical Engineering, Purdue University
1984-present	Founder and Director of the Purdue University International Electronic Cooling Alliance (PUIECA)
1984-present	Founder and Director of the Purdue University Boiling and Two-Phase Flow Laboratory (BTPFL)

CITATION RECORD:

ISI:	Thomson Reuters Highly Cited Researcher, 2015
ISI:	Included in Thomson Reuters list of "The World's Most Influential Scientific Minds 2015"
Google Scholar:	23,942 citations, h-index: 94

PROFESSIONAL BACKGROUND:

Since joining Purdue University in 1984, Prof. Issam Mudawar founded both the Purdue University Boiling and Two-Phase Flow Laboratory (PU-BTPFL) and the Purdue University International Electronic Cooling Alliance (PU-IECA). He also served as principal investigator for NASA's Flow Boiling and Condensation Experiment (FBCE) for the International Space Station (ISS) and co-principal investigator for both the Rolls Royce Purdue University Center in High Mach Propulsion and the Hydrogen Storage Laboratory. He has supervised over 75 Ph.D. and M.S. students and Visiting Scholars, and written 4 handbooks, 240 archival journal papers, 9 book chapters, and numerous conference papers and technical reports. He is also a Thomson Reuters Highly Cited Researcher. He has made signification contributions to ASME, AIAA, ASGSR and other engineering societies in the capacity of keynote speaker, author, reviewer and conference session chair.

Prof. Mudawar is internationally recognized for his theoretical and experimental research on phase change mechanisms and applications in energy, intelligent materials processing, space and electronics thermal management. Following are brief descriptions of his contributions in each of these areas.

Theoretical Two-Phase Research: His theoretical research encompasses virtually every aspect of phase change. Examples include theory of initiation of nucleate boiling, critical heat flux (CHF), minimum film boiling point, contact angle, turbulence in the vicinity of moving interfaces, pool boiling, wavy falling films, thin film condensation, heating, evaporation and boiling, channel flow boiling, flow boiling on curved surfaces, boiling in rotating systems, droplet impact dynamics, sprays, jets, and enhanced surfaces. He is also credited for authoring the first comprehensive methodology for analysis of boiling in micro-channels. He has developed customized experimental methods for these studies including simultaneous use of laser Doppler velocimetry (LDV) and parallel-wire conductance probes, micro-particle image velocimetry (micro-PIV), photomicrography, high speed video imaging, and specialized microfabrication techniques and carbon nanotube surface coating.

Energy Research: Prof. Mudawar's energy research encompasses numerous energy systems and applications, including magnetohydrodynamic energy conversion, liquid-cooled industrial gas turbine engines, high efficiency gas turbine power cycles, vertical evaporators, rotating evaporators, vertical condensers, desalination, particle accelerators, metal hydride hydrogen fuel cell storage systems, energy efficiency improvement and reduced water utilization in metal processing, and nuclear power generation. Published in 1999, his theoretical models and consolidated databases in the three-volume handbook "Critical Heat Flux (CHF) for Water in Tubes" is used by many nuclear reactor manufacturers to predict upper safely limits for reactor operation.

Electronics Thermal Management: launched in 1984, Prof. Mudawar's PU-IECA quickly became the nation's first laboratory dedicated to the study of very-high-flux and phase change thermal management of electronics using such schemes as thermosyphons, semi-passive falling film cooling, channel-flow boiling, micro-channel boiling, micro-channel condensation, jet impingement, spray cooling, and vapor compression loops. He has played a pioneering national and international role in the development of thermal solutions for supercomputers, servers, laptops, chip testing, hybrid vehicle power electronics, and x-ray medical devices and systems.

Space Research: Prof. Mudawar has played a critical role in NASA's shift from present mostly single-phase liquid-cooled thermal management and control systems for space missions to two-phase thermal management. These efforts are aimed at capitalizing upon the orders-of-magnitude enhancement that is possible with boiling and condensing flows compared to their single-phase counterparts. Prof. Mudawar has performed extensive microgravity flow boiling experiments in parabolic flight and developed the first theoretical model for flow boiling CHF in microgravity. He is presently partnering with the NASA Glenn Research Center on the design of FBCE, which will be ready for testing on the ISS in 2020. Data from this facility are expected to have important long-term impact on phase change processes in space nuclear propulsion, cabin temperature control, waste management, cryogenic fluid transfer, and regenerative fuel cells. In a related study, he developed a theoretical model for successful startup of capillary pumped loops used for thermal management in many types of satellites and space systems.

Intelligent Materials Processing: Since the late 1980s, Prof. Mudawar has pursued several studies aimed at developing an intelligent heat treating technology for complex-shaped metal alloy parts that would eliminate altogether the trial-and-error approach prevalent in the industry today. Using cooling and metallurgical transformation models, he developed a CAD-based pilot facility where the most critical phase of heat treating, the quench, is optimized by configuring water cooling sprays in response to the part's shape. This technology has been shown to greatly increase part strength and hardness, enhance corrosion resistance, reduce residual stresses, warping, and cracking, greatly increased productivity, and virtual eliminate scrap. Another important aspect of this technology is the development of new non-contact temperature measurement techniques and algorithms.

Prof. Mudawar's research contributions and innovations are highly acknowledged worldwide. His research contributions earned him the title of Fellow of ASME in 1997. He is also a Senior Member of AIAA and Member of ASGSR. One of his key research accomplishments is attainment of the world's highest phase-change cooling heat flux, over 27,000 W/cm^2, using innovative micro-heat-exchanger technology. In 1995 and 1996, "Business Week" featured Prof. Mudawar's breakthroughs under "Developments to Watch" in three separate issues during a single 10-month period. He has received numerous awards, including best paper awards at the 1988 National Heat Transfer Conference, 1992 ASME/JSME Joint Conference on Electronic Packaging, and ITherm 2008. He also received the ASME Journal of Electronic Packaging Outstanding Paper Award for 1995, in addition to numerous awards and recognitions from ASME, AIAA, IEEE, JSME, ASM, US Navy, US Missile Defense Agency, and Rolls Royce. In 2013, he received the American Society for Gravitational and Space Research (ASGSR) Founder's Award, the ASME Heat Transfer Memorial Award in Science Category, and 75th Anniversary Medal of the ASME Heat Transfer Division. In 2019, he received the AIAA Space Processing Award. Many of his publications have been recognized for top international citation rankings.

Prof. Mudawar is also highly committed to education, evidenced by the many awards he received at Purdue for teaching and both curriculum and instructional heat transfer laboratory development, as well as dedicated service to minority students and organizations.

HONORS AND AWARDS:

- Physical Sciences Panel Member, Congressionally requested National Academies Decadal Survey on Life and Physical Sciences for 2023-2032 NASA-sponsored space research, 2021.
- 2021 ASME Allan Kraus Thermal Management Medal
- Most Accessed Article in 2020, ASME Journal of Thermal Science and Engineering Applications: I. Mudawar, "Recent Advances in High-Flux, Two-Phase Thermal Management," Vol. 5, 021012 (2013).
- Life Fellow of the American Society of Mechanical Engineers (ASME), 2020.
- Author of four "Most Downloaded International Journal of Heat Mass Transfer Articles" in 2020.
- Most Accessed Article in 2019, ASME Journal of Thermal Science and Engineering Applications: I. Mudawar, "Recent Advances in High-Flux, Two-Phase Thermal Management," Vol. 5, 021012 (2013).
- Certificate of recognition and celebration of 35 years of service and contributions to Purdue University, 2019.
- American Institute of Aeronautics and Astronautics (AIAA) Space Processing Award, presented biennially, "recognizing decades of research and advances in fluid-based heat transfer in aerospace applications, including the Flow Boiling and Condensation Experiment for the ISS," 2019.
- Member, EU Academy of Sciences (EUAS), 2019.
- List of 150 Most Cited Scholars in Energy Research, Elsevier Scopus Data, 2016.
- Included in the Thomson Reuters list of "The World's Most Influential Scientific Minds 2015."
- The Betty Ruth and Milton B. Hollander Family Professor of Mechanical Engineering, 2015.
- Thomson Reuters Highly Cited Researcher, 2015.
- "Professor Issam Mudawar on his 60th Birthday," article co-authored by leading heat transfer researchers and former students, International Journal of Heat and Mass Transfer, Vol. 89, pp. A1-A3, 2015.
- Keynote Speaker, "Criteria for Negating Influence of Gravity on Flow Boiling Critical Heat Flux in Space Systems," 9th International Conference on Two-Phase Systems for Space and Ground Applications, Baltimore, MD, September 22-26, 2014.
- 2013 American Society for Gravitational and Space Research (ASGSR) Founder's Award. This award is "the highest honor given by ASGSR to a member of the Society for distinguished scientific contributions to and leadership in the field of gravitational research."
- 2013 Heat Transfer Memorial Award in Science Category for pioneering theoretical and experimental research on phase change mechanisms and applications in energy, materials processing, aerospace propulsion and thermal management, and electronics cooling, American Society of Mechanical Engineers (ASME) Heat Transfer Division (HTD).

- 75th Anniversary Medal of the American Society of Mechanical Engineers (ASME) Heat Transfer Division (HTD), 2013.
- Invited paper, "Recent Advances in High-Flux, Two-Phase Thermal Management," ASME Journal of Thermal Science and Engineering Applications, special issue celebrating 75th anniversary of the establishment of the ASME Heat Transfer Division, Vol. 5, pp. 021012-1-15, 2013.
- Faculty Entrepreneurs Innovators Hall of Fame Award, Purdue Office of Technology Commercialization, 2012-2013.
- Certificate of Recognition in testimony of distinguished achievement of research in thermal engineering and service to engineering profession, The Japanese Society of Mechanical Engineers (JSME) and the American Society of Mechanical Engineers (ASME), 2011.
- Keynote Speaker, "Two-Phase Micro-Channel Heat Sinks: Theory, Applications and Limitations," ASME/JSME 2011 8th Thermal Engineering Joint Conference, Honolulu, Hawaii, March 2011.
- Certificate of Recognition for 25 years of sustained contributions to the advancement of the arts, sciences and technology of aeronautics and astronautics, American Institute of Aeronautics and Astronautics (AIAA).
- Certificate of Recognition for 25 years of Service, American Society of Mechanical Engineers (ASME).
- Certificate of Recognition, Department of the Navy, Office of Naval Research, Small Business Innovation Program, June 7, 2010.
- The most cited article for the years 2005-2008, International Journal of Heat and Mass Transfer, for the paper "Two-Phase Flow in High-Heat-Flux Micro-Channel Heat Sink for Refrigeration Cooling Applications: Part I – Pressure Drop Characteristics," by J. Lee and I. Mudawar, Vol. 48, pp. 928-940, 2005.
- The second most cited article for the years 2005-2008, International Journal of Heat and Mass Transfer, for the paper "Two-Phase Flow in High-Heat-Flux Micro-Channel Heat Sink for Refrigeration Cooling Applications: Part I – Heat Transfer Characteristics," by J. Lee and I. Mudawar, Vol. 48, pp. 941-955, 2005.
- Rolls-Royce Milestone Award for design of air-to-fuel heat exchanger for high Mach aircraft turbine engines, LibertyWorks, North American Technologies operations of Rolls-Royce, February 2009.
- Best Paper Award in Thermal Management, for the paper "Single-Phase and Two-Phase Hybrid Cooling Schemes for High-Heat-Flux Thermal Management of Defense Electronics," by M. Sung and I. Mudawar, Orlando, 11th Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm 2008), FL, May 28-31, 2008.
- One of most cited articles for the years 2002-2005, International Journal of Heat and Mass Transfer, for the paper "Experimental and Numerical Study of Pressure Drop and Heat Transfer in a Single-phase Micro-channel heat Sink," by W. Qu and I. Mudawar, Vol. 45, pp. 2549-2565, 2002.
- Top 1% citation in research field, for the paper "Experimental and Numerical Study of Pressure Drop and Heat Transfer in a Single-Phase Micro-Channel Heat Sink," by W. Qu and I. Mudawar, International Journal of Heat and Mass Transfer, Vol. 46, pp. 2737-2753, 2003. Compiled by Essential Science Indicators, Thomson Publishing, 2005.
- Top 1% citation in research field, for the paper "Flow Boiling Heat Transfer in Two-Phase Micro-Channel Heat Sinks – I. Experimental Investigation and Assessment of Correlation Methods," by W. Qu and I. Mudawar, International Journal of Heat and Mass Transfer, Vol. 46, pp. 2755-2771, 2003. Compiled by Essential Science Indicators, Thomson Publishing, 2005.
- The Solberg Award for Best Teacher in the School of Mechanical Engineering, 2003-2004.
- Recognition plaque, Space and Missile Defense Conference and Expo, Huntsville, Alabama, August 2003
- Recognition plaque, SBIR Pavilion 5th Space and Missile Defense Conference, Huntsville, Alabama, August 2002.
- Citation of Appreciation for Contribution to ITherm 2002: International Conference on Thermal, Mechanics and Thermomechanical Phenomena in Electronic Systems, IEEE CPMT Society, 2002.

- Keynote Speaker, "Assessment of High-Heat-Flux Thermal Management Schemes," I-Therm 2000: International Conference on Thermal, Mechanics and Thermomechanical Phenomena in Electronic Systems, Joint IEEE, ASME, CPMT, IMAPS, NIST conference, Las Vegas, Nevada, May 2000.
- Invited Speaker, “High-Heat-Flux Liquid Cooling Schemes,” Manufacturing Test Research Symposium 2000, Intel Corp., Hillsboro, Oregon, August 24, 2000.
- Who’s Who in the World, 2000-present.
- The Ruth and Joel Spira Award for “outstanding contributions to the School of Mechanical Engineering and its students,” 1999.
- Inaugural member of the Purdue University Book of Great Teachers for lasting tribute to those 200 teachers "who have defined Purdue teaching excellence since the institution's birth," 1999.
- Citation for Excellence in Teaching, School of Mechanical Engineering, 1997-1998
- Founding Fellow of The Purdue University Teaching Academy, 1997.
- Fellow of the American Society of Mechanical Engineers (ASME), 1997.
- The Purdue University Charles Murphy Award for Outstanding Teaching, 1996-1997.
- Citation for Excellence in Teaching, School of Mechanical Engineering, 1996-1997.
- Certificate of Appreciation, Heat Treating Society, ASM International, for the presentation "Investigation of Droplet Heat Transfer and Spray Quenching," 2nd International Conference on Quenching and the Control of Distortion, Cleveland, 1996.
- The Solberg Award for Best Teacher in the School of Mechanical Engineering, 1995-1996.
- Citation for Excellence in Teaching, School of Mechanical Engineering, 1995-1996.
- Keynote Speaker, "High-Flux Thermal Management of Avionics," 31st AIChE-ASME-ANS-AIAA National Heat Transfer Conference, Houston, Texas, August 1996.
- Who's Who in Science and Engineering, 1996-present.
- Outstanding Paper Award for 1995, The ASME Journal of Electronic Packaging, for the paper "Two-Phase Electronic Cooling using Mini-Channel and Micro-Channel Heat Sinks: Parts 1 and 2," Vol. 116, 1994.
- Nominee for State of Indiana Award for SBIR Innovation, 1995.
- Citation for Excellence in Teaching, School of Mechanical Engineering, 1994-1995.
- Certificate of Appreciation, International Society for Hybrid Microelectronics, 1994.
- Citation for Excellence in Teaching, School of Mechanical Engineering, 1992-1993.
- Best Paper in Thermal Management, 1992 ASME/JSME Joint Conference on Electronic Packaging, Milpitas, California, for the paper "Enhancement of Single-Phase Heat Transfer and Critical Heat Flux from an Ultra-High-Flux Simulated Microelectronic Heat Source to a Rectangular Impinging Jet of Dielectric Liquid".
- Keynote Speaker, "Direct-Immersion Cooling for High Power Electronic Chips," I-Therm II: Intersociety Conference on Thermal Phenomena in Electronic Systems, Austin, Texas, February 1992.
- Who's Who in the Mid West, 1992-present.
- Citation for Excellence in Teaching, School of Mechanical Engineering, 1991-1992.
- The Solberg Award for Best Teacher in the School of Mechanical Engineering, 1991-1992.
- Best Paper in Electronic Cooling, 1988 ASME/AIChE/ANS National Heat Transfer Conference, Houston, Texas, for the paper "Microelectronic Cooling by Enhanced Pool Boiling of a Dielectric Fluorocarbon Liquid".
- Certificate of appreciation in recognition of support to minority engineering students and programs at Purdue University awarded by the Purdue Chapter of the National Society of Black Engineers, 1987-1988.
- Professor of the Year Award, Purdue Chapter of the National Society of Black Engineers, 1986-1987.
- The Solberg Award for Best Teacher in the School of Mechanical Engineering, 1986-1987.
- Professor of the Year Award, Purdue Chapter of the National Society of Black Engineers, 1984-1985.

PATENTS:

- "Finned Heat Exchanger for Metal Hydride Hydrogen Storage," inventors: Issam Mudawar, Milan Visaria, Hui Zhang, and Timothee Pourpoint, US Patent No. 8,636,836, issued Jan. 28, 2014.
- "Coiled and Microchannel Heat Exchangers for Metal Hydride Storage Systems," inventors: Issam Mudawar, Milan Visaria, US Patent No. 8,778,063 B2, issued Jul. 15, 2014.
- "Accelerated Electric Charging with Subcooled Coolant Boiling," inventors: Issam Mudawar, Seunghyun Lee, Devahdhanush Vijayaraju Swathibanu, Myung Sung, and Mike Denger. Joint Purdue Research Foundation Patent Application: Purdue research Foundation #PRF 2020-MUDA-68800 and Ford Global Technologies, LLC #84301967/FMC 9879 PUS, 30 December 2020.

SCIENTIFIC AND HONOR SOCIETIES:

- Fellow, ASME
- Senior Member, AIAA
- Member, American Society for Gravitational and Space Research (ASGSR)

PUBLICATIONS:

I. Handbooks

1. Hall, D.D. and Mudawar, I., 1999, "Critical Heat Flux (CHF) for Water Flow in Tubes. Volume I. Compilation and Assessment of the World CHF Data," Published by the Boiling and Two-Phase Flow Laboratory, Purdue University, West Lafayette, IN, 151 pages plus CD-ROM of the entire world database for CHF.
2. Hall, D.D. and Mudawar, I., 1999, "Critical Heat Flux (CHF) for Water Flow in Tubes. Volume II. PU-BTPFL CHF Database," Published by the Boiling and Two-Phase Flow Laboratory, Purdue University, West Lafayette, IN, 1375 pages.
3. Hall, D.D. and Mudawar, I., 1999, "Critical Heat Flux (CHF) for Water Flow in Tubes. Volume III. Subcooled CHF Correlations," Published by the Boiling and Two-Phase Flow Laboratory, Purdue University, West Lafayette, IN, 300 pages.
4. Mudawar, I. and Qu, W., 2004, "Mini/Micro-Channel Thermal/Fluid Transport Phenomena," Published by Purdue University International Electronic Cooling Alliance, West Lafayette, IN, 434 pages.

II. Book Chapters

1. Mudawwar, I. and El-Masri, M.A., 1987, "Experimental Investigation of Boiling Water Films in Radial Rotating Channels," in ***Heat Transfer and Fluid Flow in Rotating Machinery***, W.J. Yang, ed., Hemisphere Publishing Corporation, New York, pp. 255-269.
2. Lee, C., and Mudawwar, I., 1987, "A New Critical Heat Flux Model for Subcooled Two-Phase Flow Through a Vertical Tube," in ***Particulate Phenomena and Multiphase Transport***, Vol. 1, T.N. Veziroglu, ed., Hemisphere Publishing Corporation, New York, pp. 425-442.
3. Koskie, J., Mudawwar, I., and Tiederman, W., 1987, "Characteristics of Interfacial Waves on Freely-Falling Liquid Films," in ***Particulate Phenomena and Multiphase Transport***, Vol. 2, T.N. Veziroglu, ed., Hemisphere Publishing Corporation, New York, pp. 319-330.
4. Mudawwar, I., Incropera, T.A., and Incropera, F.P., 1987, "Critical Heat Flux (CHF) in Falling Liquid Films," in ***Particulate Phenomena and Multiphase Transport***, Vol. 2, T.N. Veziroglu, ed., Hemisphere Publishing Corporation, New York, pp. 345-360.
5. Shmerler, J. and Mudawwar, I., 1987, "Effects of Interfacial Waves on Heat Transfer to Free-Falling Turbulent Liquid Films," in ***Particulate Phenomena and Multiphase Transport***, Vol. 2, T.N. Veziroglu, ed., Hemisphere Publishing Corporation, New York, pp. 361-376.

6. Mudawar, I., Incropera, T.A., and Incropera, F.P., 1988, "Microelectronic Cooling by Fluorocarbon Liquid Films," in ***Cooling Technology for Electronic Equipment***, W. Aung, ed., Hemisphere Publishing Corporation, New York, pp. 417-434.
7. Mudawar, I. and Bowers, M.B., 1996, "Parametric Study of Ultra-High CHF in Highly Subcooled Water Flow Inside Small Diameter Tubes," in ***Convective Flow Boiling***, J.C. Chen, Y. Fujita, F. Mayinger, and R.A. Nelson, eds., Taylor and Francis, Washington, DC, pp. 117-122.
8. Mudawar, I., Galloway, J.E., Gersey, C.O., and Reed, S.J., 1996, "Theoretical Modeling of CHF for Near-Saturated Pool Boiling and Flow Boiling from Short Heaters using the Interfacial Lift-off Criterion," in ***Convective Flow Boiling***, J.C. Chen, Y. Fujita, F. Mayinger, and R.A. Nelson, eds., Taylor and Francis, Washington, DC, pp. 219-224.
9. Mudawar, I. and Estes, K.A., 1996, "Modeling of Hydrodynamic Parameters and Critical Heat Flux in Spray Cooling," in ***Convective Flow Boiling***, J.C. Chen, Y. Fujita, F. Mayinger, and R.A. Nelson, eds., Taylor and Francis, Washington, DC, pp. 345-350.

III. Journal Publications

1. Mudawwar, I., El-Masri, M.A., Wu, C.S., and Ausman-Mudawwar, J.R., 1985, "Boiling Heat Transfer and Critical Heat Flux in High-Speed Rotating Liquid Films", ***International Journal of Heat and Mass Transfer*****,** Vol. 28, pp. 795-806.
2. Mudawwar, I. and El-Masri, M.A., 1986, "Momentum and Heat Transfer Across Freely-Falling Turbulent Liquid Films," ***International Journal of Multiphase Flow***, Vol. 12, pp. 771-790.
3. Mudawwar, I., 1986, "Interfacial Instabilities of Air-Driven Liquid Films", ***International Communications in Heat and Mass Transfer***, Vol. 13, pp. 535-543.
4. Mudawwar, I., Incropera, T.A., and Incropera, F.P., 1987, "Boiling Heat Transfer and Critical Heat Flux in Liquid Films Falling on Vertically-Mounted Heat Sources," ***International Journal of Heat and Mass Transfer***, Vol. 30, pp. 2083-2095.
5. Grimley, T.G., Mudawwar, I., and Incropera, F.P., 1988, "CHF Enhancement in Flowing Fluorocarbon Liquid Films Using Structured Surfaces and Flow Deflectors," ***International Journal of Heat and Mass Transfer***, Vol. 31, pp. 55-65.
6. Shmerler, J.A. and Mudawwar, I., 1988, "Local Heat Transfer Coefficient in Wavy Free-Falling Turbulent Liquid Films Undergoing Uniform Sensible Heating," ***International Journal of Heat and Mass Transfer***, Vol. 31, pp. 67-77.
7. Shmerler, J.A. and Mudawwar, I., 1988, "Local Evaporative Heat Transfer Coefficient in Turbulent Free-Falling Liquid Films," ***International Journal of Heat and Mass Transfer***, Vol. 31, pp. 731-742.
8. Mudawwar, I. and El-Masri, M.A., 1988, "Boiling Incipience in Plane Rotating Water Films," ***Journal of Heat Transfer***, Vol. 110, pp. 532-535.
9. Grimley, T.G., Mudawwar, I., and Incropera, F.P., 1988, "Limits to Critical Heat Flux Enhancement in a Liquid Film Falling over a Structured Surface which Simulates a Microelectronic Chip," ***Journal of Heat Transfer***, Vol. 110, pp. 535-538.
10. Lee, C.H. and Mudawwar, I., 1989, "A Mechanistic Critical Heat Flux Model for Subcooled Flow Boiling Based on Local Bulk Flow Conditions," ***International Journal of Multiphase Flow***, Vol. 14, pp. 711-728.
11. Marsh, W.J. and Mudawar, I., 1989, "Predicting the Onset of Nucleate Boiling in Wavy Free-Falling Turbulent Liquid Films," ***International Journal of Heat and Mass Transfer***, Vol. 32, pp. 361-378.
12. Maddox, D.E. and Mudawar, I., 1989, "Critical Heat Flux in Subcooled Flow Boiling of Fluorocarbon Liquid on a Simulated Electronic Chip in a Rectangular Channel," ***International Journal of Heat and Mass Transfer***, Vol. 32, pp. 379-394.
13. Marsh, W.J. and Mudawar, I., 1989, "Effects of Surface Tension and Contact Angle on Sensible Heating and Boiling Incipience in Dielectric Falling Films," ***Journal of Electronic Packaging***, Vol. 111, pp. 46-53.

14. Anderson, T.M. and Mudawar, I., 1989, "Microelectronic Cooling by Enhanced Pool Boiling of a Dielectric Fluorocarbon Liquid," ***Journal of Heat Transfer***, Vol. 111, pp. 752-759.
15. Maddox, D.E. and Mudawar, I., 1989, "Single- and Two-Phase Convective Heat Transfer from Smooth and Enhanced Microelectronic Heat Sources in a Rectangular Channel," ***Journal of Heat Transfer***, Vol. 111, pp. 1045-1052.
16. Koskie, J.E., Mudawar, I., and Tiederman, W.G., 1989, "Parallel-Wire Probes for Measurement of Thick Liquid films," ***International Journal of Multiphase Flow***, Vol. 15, pp. 521-530.
17. Lin, W.S., Pei, B.S., Lee, C.H., and Mudawwar, I., 1989, "A Theoretical Critical Heat Flux Model for Rod Bundles under PWR Conditions," ***Nuclear Technology***, Vol. 85, pp. 213-226.
18. Deiters, T.A. and Mudawar, I., 1989, "Optimization of Spray Quenching for Aluminum Extrusion, Forging or Continuous Casting," ***Journal of Heat Treating***, Vol. 7, pp. 9-18.
19. Mudawar, I. and Valentine, W.S., 1989, "Determination of the Local Quench Curve for Spray Cooled Metallic Surfaces," ***Journal of Heat Treating***, Vol. 7, pp. 107-121.
20. Mudawar, I. and Maddox, D.E., 1990, "Enhancement of Critical Heat Flux from High Power Microelectronic Heat Sources in a Flow Channel," ***Journal of Electronic Packaging***, Vol. 112, pp. 241-248.
21. Mudawar, I. and Anderson, T.M., 1990, "Parametric Investigation into the Effects of Pressure, Subcooling, Surface Augmentation and Choice of Coolant on Pool Boiling in the Design of Cooling Systems for High-Power Density Chips," ***Journal of Electronic Packaging***, Vol. 112, pp. 375-382.
22. Wadsworth, D. and Mudawar, I., 1990, "Cooling of a Multichip Electronic Module by Means of Confined Two-Dimensional Jets of Dielectric Liquid," ***Journal of Heat Transfer***, Vol. 112, pp. 891-898.
23. Deiters, T.A. and Mudawar, I., 1990, "Prediction of the Temperature-Time Cooling Curves for Three-Dimensional Aluminum Products During Spray-Quenching," ***Journal of Heat Treating***, Vol. 8, pp. 81-91.
24. Lyu, T.H. and Mudawar, I., 1991, "Statistical Investigation of the Relationship Between Interfacial Waviness and Sensible Heat Transfer to a Falling Liquid Film," ***International Journal of Heat and Mass Transfer***, Vol. 34, pp. 1451-1464.
25. Mudawar, I. and Wadsworth, D.C., 1991, "Critical Heat Flux from a Simulated Electronic Chip to a Confined Rectangular Impinging Jet of Dielectric Liquid," ***International Journal of Heat and Mass Transfer***, Vol. 34, pp. 1465-1480.
26. Lyu, T.H. and Mudawar, I., 1991, "Determination of Wave-Induced Fluctuations of Wall Temperature and Convective Heat Transfer Coefficient in the Heating of a Turbulent Falling Liquid Film," ***International Journal of Heat and Mass Transfer***, Vol. 34, pp. 2521-2534.
27. Lyu, T.H. and Mudawar, I., 1991, "Simultaneous Measurements of Thickness and Temperature Profile in a Wavy Liquid Film Falling Freely on a Heating Wall," ***Experimental Heat Transfer***, Vol. 4, pp. 217-233.
28. Klinzing, W.P., Rozzi, J.C., and Mudawar, I., 1992, "Film and Transition Boiling Correlations for Quenching of Hot Surfaces with Water Sprays," ***Journal of Heat Treating***, Vol. 9, pp. 91-103.
29. Rozzi, J.C., Klinzing, W.P., and Mudawar, I., 1992, "Effects of Spray Configuration on the Uniformity of Cooling Rate and Hardness in the Quenching of Aluminum Parts with Non-Uniform Shapes," ***Journal of Materials Engineering and Performance***, Vol. 1, pp. 49-60.
30. Galloway, J.E. and Mudawar, I., 1992, "Critical Heat Flux Enhancement by Means of Liquid Subcooling and Centrifugal Force Induced by Flow Curvature," ***International Journal of Heat and Mass Transfer***, Vol. 35, pp. 1247-1260.
31. Willingham, T.C. and Mudawar, I., 1992, "Channel Height Effects on Forced-Convection Boiling and Critical Heat Flux from a Linear Array of Discrete Heat Sources," ***International Journal of Heat and Mass Transfer***, Vol. 35, pp. 1865-1880.
32. Wadsworth, D.C. and Mudawar, I., 1992, "Enhancement of Single-Phase Heat Transfer and Critical Heat Flux from an Ultra-High-Flux Simulated Microelectronic Heat Source to a Rectangular Impinging Jet of Dielectric Liquid," ***Journal of Heat Transfer***, Vol. 114, pp. 764-768.

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20. Nahra, H.K., Hasan, M.M., Balasubramaniam, R., Patania, M., Hall, N., Wagner, J., Mackey, J., Frankenfield, B., Hauser, D., Harpster, G., Nawrocki, D., Clapper, R., Kolacsz, J., Butcher, R., May, R., Chao, D., Mudawar, I., Kharangate, C.R., O'Neill, L., "Development and Capabilities of ISS Flow Boiling and Performance Evaluation of the International Space Station Flow Boiling and Condensation Experiment," American Society for Gravitational and Space Research (ASGSR) 31th Annual Meeting, Alexandria, VA, November 11-14, 2015.
21. Mackey, J.R., Hall, N.R., Hasan, M.M., Wagner, J.D., Nahra, H.K., and Mudawar, I., "High Frame Rate PCIe/104 Imaging Systems for Scientific Research aboard the International Space Station," American Society for Gravitational and Space Research (ASGSR) 31st Annual Meeting, Alexandria, VA, November 11-14, 2015.

22. Mudawar, I., O'Neill, L.E., Konishi, C., Hasan, M.M., Nahra, H.K., Hall, N.R., May, R.L., Balasubramaniam, R., Mackey, J.R., "Flow Boiling and Condensation Experiment (FBCE) for the International Space Station," American Society for Gravitational and Space Research (ASGSR) 32nd Annual Meeting, Cleveland, OH, October 26-29, 2016.
23. Hasan, M.M., Balasubramaniam, R., Nahra, H.K., Mackey, J., Wagner, J., Hall, N., Frankenfield, B., Harpster, G., May, R., Mudawar, I., Kharangate, C.R., O'Neill, L., Mudawar, Talmor, M., "Performance Evaluation of the International Space Station Flow Boiling and Condensation Experimental (FBCE) Test Facility," American Society for Gravitational and Space Research (ASGSR) 32nd Annual Meeting, Cleveland, OH, October 26-29, 2016.
24. Mudawar, I., O'Neill, L.E., Lee S., V.S. Devahdhanush, Ganesan V., Lee J., Hasan, M.M., Nahra, H.K., Balasubramaniam, R., Mackey, J.R., "Flow Boiling and Condensation Experiment (FBCE) for the International Space Station," American Society for Gravitational and Space Research (ASGSR) 33nd Annual Meeting, Seattle, WA, October 25-28, 2017.
25. Mudawar, I., "Direct Liquid Impingement Cooling of Power Electronics Substrates," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, September 5-6, 2018.
26. Mudawar, I., "Experimental and Theoretical Investigation into Prediction and Prevention of Two-phase Flow Instabilities in High-flux Micro-channel Heat Sinks," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, September 5-6, 2018.
27. O'Neill, L.E., Mudawar, I., Hasan, M.M., Nahra, H.K., Balasubramaniam, R., Mackey, J.R., "Experimental Investigation and Modeling of Density Wave Oscillations in Vertical Upflow Boiling," American Society for Gravitational and Space Research (ASGSR) 34th Annual Meeting, Washington, DC, October 29-November 3, 2018.
28. Nahra, H.K., Balasubramaniam, R., Hasan, M.M., Mackey, J.R., Mudawar, I., O'Neill, L.E., May, R.L., "Flow Boiling Experiments Using the Flow Boiling and Condensation Experiment (FBCE) Breadboard Test B," American Society for Gravitational and Space Research (ASGSR) 33th Annual Meeting, Washington, DC, October 29-November 3, 2018.
29. Mackey, J.R., Lant, C., O'Neill, L.E., Mudawar, I., Lokey, A., Hasan, M.M., Nahra, H.K., "Test Section Image Quality Characterization of Flow Boiling Module for Microgravity Experiment," American Society for Gravitational and Space Research (ASGSR) 34th Annual Meeting, Washington, DC, October 29-November 3, 2018.
30. O'Neill, L.E. and Mudawar, I., "Analysis of Temperature Rise and Peak Temperature Position during the CHF Transient for Subcooled Flow Boiling in 1-g and Microgravity," Gordon Research Conference on Micro and Nanoscale Phase Change Heat Transfer, Lucca (Barga), Italy, February 3-8, 2019.
31. V.S. Devahdhanush, Mudawar, I., "Direct Liquid Impingement Cooling of Power Electronics Substrates," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, August 21-22, 2018.
32. Lee, J., O'Neill, L., Darges, S., Mudawar, I., "Experimental Investigation into Parallel-channel Instabilities of Two-phase Flow in Micro-channel Heat sinks," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, August 21-22, 2018.
33. O'Neill, L.E. and Mudawar, I., "Analysis of Temperature Rise and Peak Temperature Position during the CHF Transient for Subcooled Flow Boiling in 1-g and Microgravity," Gordon Research Conference on Micro and Nanoscale Phase Change Heat Transfer, Lucca (Barga), Italy, February 3-8, 2019.
34. Mudawar, I., Lee, J., "Experimental and Theoretical Investigation into Parallel-channel Instabilities of Two-phase Flow in Micro-channel Heat sinks," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), UCLA, Los Angeles, CA, February 27-28, 2019.
35. V.S. Devahdhanush, Mudawar, I., "Direct Liquid Impingement Cooling of Power Electronics Substrates," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), UCLA, Los Angeles, CA, February 27-28, 2019.

36. Lee, J., O'Neill, L., Darges, S., Mudawar, I., "Experimental Investigation into Parallel-channel Instabilities of Two-phase Flow in Micro-channel Heat sinks," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, August 21-22, 2019.
37. V.S. Devahdhanush, Mudawar, I., "Direct Liquid Impingement Cooling of Power Electronics Substrates," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, August 21-22, 2019.
38. Mudawar, I., Lee J., O'Neill, L.E., Hasan, M.M., Nahra, H.K., Balasubramaniam, R., "Flow Boiling and Condensation Experiment (FBCE) for the International Space Station," American Society for Gravitational and Space Research (ASGSR) 35th Annual Meeting, Denver, CO, November 20-23, 2019.
39. Nahra, H.K., Balasubramaniam, R., Hasan, M.M., Mudawar, I., "Flow Boiling in Horizontal Channel with Upward and Downward Facing Heat surfaces Encompassing Gravity to Inertia Dominated Regimes," American Society for Gravitational and Space Research (ASGSR) 35th Annual Meeting, Denver, CO, November 20-23, 2019.
40. Mudawar, I., Ganesan, V., Hartwig, J., "Generalized Single-phase and Two-phase Correlations for Cryogenic Fluids," American Society for Gravitational and Space Research (ASGSR) 35th Annual Meeting, Denver, CO, November 20-23, 2019.
41. Lee, J., Darges, S., Mudawar, I., "Experimental Investigation into Parallel-channel Instabilities of Two-phase Flow in Micro-channel Heat sinks," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), UCLA, Los Angeles, CA, February 26-27, 2020.
42. V.S. Devahdhanush, Mudawar, I., "Direct Liquid Impingement Cooling of Power Electronics Substrates," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), UCLA, Los Angeles, CA, February 26-27, 2020.
43. Lee, J., Darges, S., Mudawar, I., "Experimental Investigation into Parallel-channel Instabilities of Two-phase Flow in Micro-channel Heat sinks," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, August 26-27, 2020.
44. V.S. Devahdhanush, Mudawar, I., "Direct Liquid Impingement Cooling of Power Electronics Substrates," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, August 26-27, 2020.
45. Lee, J., Darges, S., Kim, S., Mudawar, I., "Experimental Investigation into Parallel-channel Instabilities of Two-phase Flow in Micro-channel Heat sinks," Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Purdue University, West Lafayette, IN, February 25, 2021.
46. Mudawar, I., "Two-phase Flow – My Perspective," Keynote Presentation, International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems (InterPACK), October 26-28, 2021.
47. Mudawar, I., Hasan, M.M., Nahra, H.K., Balasubramaniam, R., Hall N.R., Guzik, M., "Flow Boiling and Condensation Experiment (FBCE): from Initial Concept to Full Implementation on the International Space Station," American Society for Gravitational and Space Research (ASGSR) Annual Meeting, Baltimore, MD, November 3-6, 2021.
48. Lee, J., Devahdhanush, V.S., Darges S., Mudawar, I., Hasan, M.M., Nahra, H.K., Balasubramaniam, Gonia, P.T., May, R.L., Mackey, J.R., "Experimental, Computational, Theoretical and Analytical Investigation of Flow Boiling in Reduced Gravity," American Society for Gravitational and Space Research (ASGSR) Annual Meeting, Baltimore, MD, November 3-6, 2021.
49. Kim, S., Damle, N., Ganesam, V., Patel, R., Mudawar, I., Hartwig, J., "Universal Heat Transfer Correlations and Reduced Gravity Experiments for Cryogenic Flow Boiling in Uniformly Heated Tubes," American Society for Gravitational and Space Research (ASGSR) Annual Meeting, Baltimore, MD, November 3-6, 2021.
50. Mudawar, I. "Flow Boiling and Condensation Experiment," Joint CSA/ESA/JAXA/NASA ISS Increment 66 Science Symposium, Virtual, December 14-16, 2021.

GRADUATE STUDENTS:

Degrees Awarded

1. Incropera, Terri A., "Boiling Heat Transfer in Falling Films," MSME, May 1985.
2. Grimley, Terrence A., "Enhancement of Boiling in Falling Liquid Films," MSME, August 1985.
3. Shmerler, Jeffrey A., "A Study of Sensible Heating and Evaporation in Free-Falling Liquid Films," MSME, December 1986.
4. Lee, Chien-Hsiung, "A New Critical Heat Flux Model for Subcooled Two-Phase Flow Through a Vertical Tube," Ph.D., May 1987.
5. Koskie, John E., "Interfacial Characteristics of Falling Liquid Films," MSME, December 1987.
6. Maddox, Douglas E., "Enhancement of Forced Convection Boiling from a Simulated Microelectronic Heat Source in a Rectangular Channel," MSME, May 1988.
7. Marsh, William J., "Predicting the Onset of Nucleate Boiling in Wavy Free-Falling Turbulent Liquids Films," MSME, August 1988.
8. Anderson, Timothy M., "Enhancement of Pool Boiling from a simulated Microelectronic Heat Source," MSME, December 1988.
9. Valentine, William S., "Heat Transfer to Water Sprays," MSME, December 1988.
10. Deiters, Thomas A., "Optimization of Spray Cooling for Aluminum Extrusions, Forgings, or Castings," MSME, December 1989.
11. Wadsworth, Derek C., "Single and Two-Phase Cooling of a Multichip Electronic Module by Means of Confined Two-Dimensional Jets of Dielectric Liquid," MSME, May 1990.
12. Lyu, Tae-Hwan, "Interfacial Wave Effects on Heat Transfer to a Falling Liquid Film," Ph.D., May 1990.
13. Houpt, Ronald A., "One and Two Component Velocity and Simultaneous Film Thickness Measurements in Smooth and Wavy Falling Liquid Films," MSME, May 1991.
14. Willingham, Thomas C., "Forced Convection Boiling and Critical Heat Flux From a Linear Array of Discrete Heat Sources," MSME, August 1991.
15. Klinzing, William P., "Development of Spray Quenching Test Bed and Correlations for Film Boiling in Water Sprays," MSME, December 1991.
16. Rozzi, Jay C., "Quenching of Aluminum Parts having Irregular Geometries using Multiple Water Sprays," MSME, December 1991.
17. Galloway, Jesse E., "Critical Heat Flux Enhancement in the Presence of Stream-Wise Curvature," Ph.D., December 1991.
18. Bernardin, John D., "Intelligent Heat Treatment of Aluminum Alloys: Material, Surface Roughness, and Droplet-Surface Interaction Characteristics," MSME, May 1993.
19. Jimenez, Peter E., "Immersion Cooled Standard Electronic Clamshell Modules for Future Aircraft Avionics," MSME, December 1993.
20. Gersey, Christopher O., "Effects of Orientation and Heater Length on Critical Heat Flux from Discrete and Continuous Heaters," Ph.D., December 1993.
21. Hall, David D., "A Method of Predicting and Optimizing the Thermal History and resulting Mechanical Properties of Aluminum Alloy Parts subjected to Spray Quenching," MSME, December 1993.
22. Estes, Kurt A., "Critical Heat Flux in Spray Cooling and Jet Impingement Cooling of Small Targets," MSME, May 1994.
23. Johns, Murray E., "Application of Jet Impingement Boiling in an Ultra-High Power Avionic Clamshell Module," MSME, May 1994.
24. Bowers, Morris B., "High Heat-Flux Dissipation using Small Diameter Channels," Ph.D., December 1994.
25. Bernardin, John D., "Leidenfrost Point and Film Boiling Heat Transfer of Single Droplets and Sprays," Ph.D., August 1996.

26. Reed, Stanley J., "Elimination of Boiling Incipience Temperature Drop and Enhancement of Boiling Heat Transfer in Highly Wetting Fluids through Low Contact Force Attachments," MSME, December 1996.
27. Lethander, Andrew T., "Measurement and Analysis of the Thermal Performance of an Avionics Cooling System," MSME, December 1997.
28. Sturgis, J. Christopher, "Single- and Two-Phase Heat Transfer Enhancement in a Curved, Rectangular Channel Subjected to Concave Heating," Ph.D., May 1998.
29. Caillat, Frederic F., "Structural and Thermal Design of an Avionics Cooling System using Two-Phase Jet Impingement," MSME, May 1998.
30. Howard, Alicia A., "Effects of Orientation and Downward-Facing Convex Curvature on Pool Boiling Critical Heat Flux," Ph.D., May 1999.
31. Hall, David D., "Critical Heat Flux in Subcooled Flow Boiling," Ph.D., August 1999.
32. LaClair, Timothy J., "Pre- and Post-Boiling Nucleation Thermal and Fluid Flow Transients During the Startup of Capillary Pumped Loops," Ph.D., May 2000.
33. Tope, Terry E., "Experimental Assessment of Flow Boiling CHF Mechanism," MSME, May 2001.
34. Mukherjee, Swaraj, "Smart, Low-Cost, Pumpless Loop for Micro-Channel Electronic Cooling using Flat and Enhanced Surfaces," MSME, May 2002.
35. Zhang, Hui, "Experimental and Theoretical Assessment of Flow Boiling CHF in Reduced Gravity using Different Flow Channel Orientations in 1-g Ground-Based Experiments," MSME, May 2002.
36. Meyer, Michael T., "High-Flux Rectangular Jet-Impingement Cooling," MSME, May 2004.
37. Qu, Weilin, "Transport Phenomena in Single-Phase and Two-Phase Micro-Channel Heat Sinks," Ph.D., August 2004.
38. Kibbey, Tim P., "Impinging Jets for Application in High-Mach Aircraft Thermal Management," MSAAE, December 2004.
39. Lee, Jaeseon, "Implementation of Micro-Channel Evaporator for High-Heat-Flux Refrigeration Cooling Applications," MSME, December 2004.
40. Rybicki, Jon, "Single-Phase and Two-Phase Cooling Characteristics of Upward-Facing and Downward-Facing Sprays, MSME, May 2005.
41. Wen, Chang-Da, "Emissivity Characteristics of Aluminum Alloy Surfaces and Assessment of Multispectral Radiation Thermometry (MRT) Emissivity Models," Ph.D., August 2005.
42. Ujereh, Sebastine Jr., "Effect of Carbon Nanotube Arrays on Nucleate Boiling Heat Transfer," MSME, August 2006.
43. Zhang, Hui, "Flow Boiling Critical heat Flux in Microgravity," Ph.D., December 2006.
44. Visaria, Milan K., "Theoretical and Experimental Study of the Effects of Spray Inclination on Two-Phase Spray Cooling and Critical Heat Flux," MSME, December 2006.
45. Bares, Geoffrey C., "Modeling of Condensing Two-Phase Annular Flow in Variable Gravity," MSME, December 2007.
46. Velagapudi, Varsha, "Thermal Management of Metal Hydride Systems for Hydrogen Storage Applications,' MSME, December 2007.
47. Lee, Jaeseon, "Investigation of Subcooled Boiling in Micro-channel Heat sink for Indirect Refrigeration Cooling Applications," Ph.D., May 2008.
48. Sung, Myung Ki, "Low Temperature Hybrid Micro-Channel/Micro-Jet Impingement Cooling," Ph.D., May 2008.
49. Khanikar, Vikash, "Effects of Carbon Nanotube Coating on Flow Boiling in a Micro-channel," MSME, December 2008.
50. Park, Il-Chung, "Experimental and Analytical Investigations of Fluid Condensation on a Vertical Tube," MSME, December 2008.

51. Nacke, Robert A., “Air-To-Fuel Heat Exchanger for High Mach Flow Turbine Engines,” MSME, August 2009.
52. Mascarenhas, Nikhin H., “Analytical and Computational Methodology for Modeling Spray Quenching of Alloy Cylinders and Tubes,” MSME, August 2010.
53. Northcutt, Brittany, A., “Optimization of Cross-Flow Micro-Channel Heat Exchanger Module for Application in High Mach Aircraft Gas Turbine Engines,” MSME, August 2010.
54. Kim, Joseph, “Experimental Analysis of High-Flux Microchannel Condensation,” MSME, May 2011.
55. Visaria, Milan, “Design and Analysis of Heat Exchangers for High Pressure Metal Hydride Hydrogen Storage,” Ph.D., May 2011.
56. Lee, Hyoung-Soon, “Comprehensive Design Methodology for Finned Air-Cooled Condensers and Spray Cooling,” MSME, May 2011.
57. Kharangate, Chirag R., “Photographic Study and Modeling of Critical Heat Flux in Horizontal Flow and Vertical Upflow Boiling with Inlet Vapor Void,” MSME, August 2011.
58. Kim, Sung-Min, "Universal Predictive Tools for Two-Phase Pressure Drop and Heat Transfer in Boiling and Condensing Mini/Micro-Channel Flows," Ph.D., August 2012.
59. Lee, Hyoungsoon, “Experimental, Theoretical and Computational Investigation of Flow Boiling and Condensation in Earth’s gravity and Microgravity,” Ph.D., August 2014.
60. Konishi, Christopher A., “Investigation of the Influence of Gravitational Body Force Effects on Critical Heat Flux for Flow Boiling with Subcooled and Two-phase Inlet,” Ph.D., August 2014.
61. Mascarenhas, Nikhin, “Study of Interfacial Characterization and Heat Transfer in Turbulent Two-Phase Flows,” Ph.D., August 2014.
62. Park, Ilchung, “Effects of Flow Orientation on Condensation in Tubes,: Ph.D., December 2014.
63. O’Neill, Lucas E., “Analysis of Body Force Effects on Flow Boiling and Condensation with Finite Inlet Quality,” MSME, May 2016.
64. Kharangate, Chirag R., “Experimental, Theoretical and Computational Modeling of Flow Boiling, Flow Condensation and Evaporating Falling Films,” Ph.D., August 2016.
65. Lee Seunghyun, “Analytical and Experimental Investigation of Future Hybrid Thermal Control System,” Ph.D., August 2017.
66. Ganesan, Vishwanath, “Development of a Finite Volume General Two-Phase Navier-Stokes Solver for Direct Numerical Simulations on Cut-Cells with Sharp Fixed Interface,” MSME, May 2018.
67. O’Neill, Lucas E., “Experimental Investigation and Modeling of Key Design Parameters in Flow Boiling and Condensation,” Ph.D., August 2019.
68. Patel, Raj, M., “Review of Cryogenic Pool Boiling Critical Heat Flux Databases, Assessment of Models and Correlations, and Development of New Universal Correlation,” MSME, December 2021.

Visiting Scholars

1. Prof. C. Gu, Tsing Hua University, China, 1988.
2. Prof. Andrew Hung, National Tsing Hua University, Taiwan, Republic of China, 1990-1991.
3. Dr. Seok-Mann Yoon, Korea Science and Engineering Foundation (KOSEF), Taejon, Korea, 2000-2003.
4. Prof. Yeung Chan Kim, Andong National University, Andong, Korea, 2005-2006.
5. Prof. Gangtao Liang, Dalian University of Technology, China, 2016-2018.

Current Research Team

1. Damle, Nishad (Ph.D. candidate)
2. Darges, Steven (Ph.D. candidate)

3. Devahdhanush, V.S. (Ph.D. candidate)
4. Ganesan, Vishwanath (Ph.D. candidate)
5. Kim, Sunjae (Ph.D. candidate)
6. Lee, Jeongmin (Ph.D. candidate)
7. Schmeidler, Martin (M.S. candidate, AAE)

RESEARCH GRANTS AND CONTRACTS:

1. "Heat Transfer to Turbulent Liquid Films," Faculty Assistance Grant, AMOCO Oil Company, Chicago, Illinois, Aug. 1984 - Dec. 1987, $60,000.
2. "Feasibility of Using Free-Falling Fluorocarbon Liquid Films to Cool Simulated Electronic Heat Dissipating Surfaces," IBM Data Systems Division, Poughkeepsie, New York, Jan. 1985-Dec. 1985, $91,000 (with Prof. F. P. Incropera).
3. "Heating and Evaporation of Turbulent Liquid Films," U.S. Dept. of Energy, Office of Basic Energy Sciences, July 1985-June 1989, $455,000.
4. "Feasibility of Using Free-Falling Fluorocarbon Liquid Films and Boiling Augmentation to Cool Simulated Electronic Heat Dissipating Surfaces," IBM Data Systems Division, Poughkeepsie, New York, Jan. 1986-Dec. 1986, $87,000.
5. "Feasibility of Using a Rotating Phase Separator for Cooling Large-Scale Digital Computers," David Ross Grant, Purdue Research Foundation, Oct. 1986-Sep. 1987, $14,775.
6. "Intelligent Control of Coupled Aluminum Extrusion and Heat Transfer," Purdue University Research Center on Intelligent Manufacturing Systems, Sep. 1986-Aug. 1989, $180,000.
7. "Feasibility of Using Surface Enhancement in Pool and Flow Boiling to Cool Simulated Electronic Heat Dissipating Surfaces," IBM Data Systems Division, Poughkeepsie, New York, Jan. 1987-Dec. 1987, $123,400.
8. "High Power Density Multichip Cooling Modules for Large Digital Computers," National Science Foundation, Aug. 1987-Jul. 1989, $110,094.
9. "Computer System for Aluminum Spray Cooling Project," ALCOA, Lafayette, Indiana, June 1988, $5,000.
10. "Parametric Study of Flow Boiling CHF on Multiple, In-Line Heat Sources," 3M Company, St. Paul, Minnesota, Jan. 1989-Dec. 1991, $325,000.
11. "High-Speed Video Imaging System for a Two-Phase Flow Velocity/Interfacial Boundary Analyzer," U.S. Department of Energy, Sep. 1989-Sep. 1991, $100,690.
12. "Intelligent Control of Heat Transfer from Aluminum Extrusions and Forgings: A Feasibility Study," Purdue University Research Center on Intelligent Manufacturing Systems, Sep. 1989-Aug. 1990, $67,500.
13. "Materials Processing Test Bed," Purdue University Research Center on Intelligent Manufacturing Systems, Sep. 1990-Aug. 1992, $170,000.
14. "High Flux Heat Exchanger," McDonnell Douglas Missile Systems Company, St. Louis, Missouri, Apr. 1991-May 1991, $6,438.
15. "Immersion Cooled Standard Electronic Clamshell Module," Naval Air Warfare Center, Indianapolis, Indiana, Sep. 1991-Sep. 1992, $99,453.
16. "General Electric Foundation Fellowship", General Electric Company, Aug. 1991-Aug. 1992, $14,740.
17. "High Performance Evaporative Cooling for Thermal Management in Electronic Packaging," IBM Data Systems Division, Poughkeepsie, New York, Feb. 1992-Jan. 1993, $60,000.
18. "Materials Processing Test Bed," Purdue University Research Center on Intelligent Manufacturing Systems, Sep. 1992-Aug. 1993, $60,000.
19. "Narrow Channel and Evaporative Cooling for Thermal Management in Electronic Packages," IBM Data Systems Division, Poughkeepsie, New York, Feb. 1993-Dec. 1993, $74,029.

20. Shipments of Fluorinert liquids and specialized filter, 3M Company, St. Paul, Minnesota, 1987-1993, $150,000.
21. "Near-Wall Measurement of Sublayer Dryout and Theoretical Modelling of CHF in Vertical Channels," U.S. Department of Energy, Office of Basic Energy Sciences, Sep. 1993-Aug. 1996, $359,556.
22. "Intelligent Materials Processing Test Bed: Development and Adaptation of Process Models," Purdue University Research Center of Intelligent Manufacturing Systems, Sep. 1993-Sep. 1995, $50,000.
23. "Evaluation of the Feasibility of Liquid Encapsulated Module (LEM) in the Thermal Management of CMOS-based Computer Systems," IBM Shared University Research Program, Dec. 1993-Nov. 1994, $50,000.
24. "Integrated Manufacturing Predoctoral Fellowship," U.S. Department of Energy, Sep. 1993-Aug. 1995, $39,948.48.
25. "Modeling of Liquid Jet Atomization Process," Air Force Office of Scientific Research, Jul. 1994-Jun. 1996, $18,000.
26. "Investigation of the Thermal Resistance of a Low-Cost Detachable Boiling Heat Sink for High Flux Applications," IBM Shared University Research Program, Dec. 1994-Nov. 1995, $50,000.
27. "Subcooled Liquid Change of Phase Thermal Management for Electronic Packaging: New Cooling Concept for a Compact, Light-Weight, Multi-kilowatt Avionic Enclosure for Future Advanced Aircraft," Mudawar Thermal Systems, Inc., West Lafayette, Indiana, Mar. 1996-Mar. 1998, $203,059.
28. Link Foundation Fellowship, Jul. 1996-Jun. 1997, $18,000.
29. "Critical Heat Flux in Micro-Channel Flow," U.S. Department of Energy, Office of Basic Energy Sciences, Sep. 1997-Aug. 2000, $498,905.
30. "Micro-Channel Heat Sink Design," Purdue Research Foundation, Jan. 1998- Mar. 2000, $24,292.
31. Microfabrication facility, equipment donation, including Perkin Elmer 2400-8J Sputtering System, Tamarack 162 Projection Mask Aligner, Headway CB15 spinner, Tencor Alphastep 200 profilometer, and laboratory chemical fume hood, Raytheon Systems Company, Indianapolis, IN, 1998, $1,000,000.
32. "Study of Pressurized Water Reactor DNB," Bettis Atomic Power Laboratory, Apr. 1999-Feb. 2001, $260,922.
33. “High-Heat-Flux Micro-Channel Heat Sinks,” U.S. Department of Energy, Office of Basic Energy Sciences, Sep. 2000-Aug. 2003, $374,642.
34. “Investigation of Critical Heat Flux in Reduced Gravity using Photomicrographic Methods,” NASA, Mar. 1, 2000-Nov. 30, 2003, $280,000.
35. “21st Century Infrared Sensing for Safety and Quality in Biomedical, Food, Environmental and Manufacturing Applications,” Indiana 21st Century Research and Technology Fund, 2000-Aug. 2002, $1,106,765, submitted by Purdue University, Indiana University, University of Notre Dame, En’Urga Inc., Hemocleanse Inc., Bioanalytical Inc., Purdue PIs: I. Mudawar, J. Gore; R. Singh, J. Sojka, L. Xu.
36. Russian propylene loop heat pipe (LHP) for spacecraft thermal management, equipment donation, Air Force Research Laboratory (AFRL), Kirtland Air Force Base, New Mexico, 2000, $10,000.
37. Boiling test chamber, equipment donation, Motorola, Arlington Heights, IL, 2000, $10,000.
38. “Boiling Heat Transfer,” Zmola Memorial Fund, Jan. 2000, $5,300.
39. “Large Surface Area High-Heat-Flux Two-Phase Cooling,” Raytheon Company, Sep. 1, 2001-Aug. 31, 2002, $42,000.
40. “Large Surface Area High-Heat-Flux Two-Phase Cooling,” Raytheon Company, July 17-Dec. 31, 2002, $42,000.
41. “Active Cooling of Solid State Amplifiers,” Raytheon Company, Aug. 1, 2002-Jul. 31, 2003, $60,000.
42. “University Technology Center in High Mach Propulsion,” Rolls Royce and Allison Advanced Development Company, Jan. 2003 – Dec. 2003, $200,000, with Profs. Stephen Heister, William Anderson and Paul Sojka.
43. “Flow Boiling CHF in Reduced Gravity,” NASA, Jan. 1, 2004-Sep. 30, 2008, $507,501.
44. “High-Heat-Flux Micro-Channel Heat Sinks,” U.S. Department of Energy, Office of Basic Energy Sciences, Sep. 2003-Aug. 2004, $80,000.

45. “Micro-Channel Flow Boiling Module,” Raytheon Company, Sep. 1-Dec. 31, 2003, $20,000.
46. “University Technology Center in High Mach Propulsion,” Rolls Royce and Allison Advanced Development Company, Jan. 2004 – Dec. 2004, $250,000, with Profs. Stephen Heister, William Anderson and Paul Sojka.
47. “Expansion of Propulsion and Power Center of Excellence,” Indiana 21st Century Research and Technology Fund, Apr. 2004 – Mar. 2006, $1,608,881, with Profs. Stephen Heister, William Anderson Charles Merkle and Paul Sojka, submitted by Allison Advanced Development Company, Purdue University, Indiana University – Purdue University Indianapolis, Indiana Space and LLC corp.
48. “Micro-Channel Refrigeration Cooling System,” Office of Naval Research, Apr. 1, 2004 – Sep. 30, 2008, $537,692.
49. “Diagnostics Facility for High-Flux Micro-Channel Refrigeration Cooling for Defense Electronics,” Defense University Research Instrumentation Program (DURIP), Office of Naval Research, May 1, 2005 – Apr. 30, 2006, $150,485.
50. “Flow Boiling in Reduced Gravity,” NASA, Jan. 8, 2004 – Nov. 30, 2007, $30,001.
51. “Enhanced Heat Transfer for Hydrogen Storage in Metal Hydrides,” General Motors Corporation, Oct. 1, 2005 – Mar. 31, 2007, $169,851, with Profs. Timothy Fisher and Jay Gore.
52. “University Technology Center in High Mach Propulsion,” Allison Advanced Development Company, Jan. 2007 – Dec. 2007, $300,000, with Profs. Stephen Heister, William Anderson and Paul Sojka.
53. “Optimization of Manufacturable High Pressure Metal Hydride Storage Systems,” General Motors Corporation, Apr. 1, 2007 – January 31, 2009, $764,043, with Drs. Timothee Pourpoint, Yuan Zhang and Profs. Timothy Fisher and William Anderson.
54. “Pool Boiling Tests with Enhanced 3M Surfaces,” 3M Company, St. Paul, Minnesota, Jun. 1, 2007 – Jan. 31, 2008, $28,800.
55. “Modeling Tools for Two-Phase Electronics Cooling Systems,” Navy STTR subcontract, Jul. 1, 2007 – Apr. 30, 2008, $29,996.
56. Support for Senior Design Course, General Motors Corporation, Jan. 1, 2007 – Apr. 30, 2008, $8,000.
57. “Rolls-Royce-Purdue University Technology Center in High Mach Propulsion,” Rolls Royce and LibertyWorks, Jan. 2008 – Dec. 2008, $300,000, with Profs. Stephen Heister and Paul Sojka.
58. “Optimization of Manufacturable High Pressure Metal Hydride Storage Systems- Phase 1 Extension Proposal,” General Motors Corporation, June 1, 2008 – June 30, 2009, $347.422, with Drs. Timothee Pourpoint, Yuan Zhang and Profs. Timothy Fisher and William Anderson.
59. “Physics-Based Modeling and Measurement of High-Flux Condensation Heat Transfer,” Office of Naval Research, Oct. 1, 2008 – Sep. 30, 2011, $346,368.
60. “Two-Phase Flow Models,” Mudawar Thermal Systems, STTR subcontract, Nov. 20, 2008 – Aug. 20, 2012, $451,203.
61. “Rolls-Royce-Purdue University Technology Center in High Mach Propulsion,” Rolls Royce and LibertyWorks, Jan. 2009 – Dec. 2009, $300,000, with Profs. Stephen Heister and Paul Sojka.
62. “Effects of Reduced Gravity on Flow Boiling, Including Dryout, and Condensation,” NASA, Mar. 2009 – Feb. 2012, $338,134.
63. “Spray Cooling of Inner Walls of Gun Tubes,” BAE Systems, Mar. 1 – Dec. 31, 2009, $50,000.
64. “Rolls-Royce-Purdue University Technology Center in High Mach Propulsion,” Rolls Royce and LibertyWorks, Jan. 2010 – Dec. 2010, $300,000, with Profs. Stephen Heister and Paul Sojka.
65. “Effects of Reduced Gravity on Flow Boiling, Including Dryout, and Condensation – Funding Addendum,” NASA, Jun. 2011 – May 2012, $61,250.
66. “Rolls-Royce-Purdue University Technology Center in High Mach Propulsion,” Rolls Royce and LibertyWorks, Jan. 2011 – Dec. 2011, $310,000, with Profs. Stephen Heister and Paul Sojka.
67. “Flow Boiling and Condensation Experiment,” NASA, Jun. 2012 – May 2017, $950,000.

68. “Effects of Reduced Gravity on Flow Boiling and Condensation,” NASA, Jun. 2012 – May 2014, grant to support three microgravity parabolic flight experiments.
69. “Adaptable Single Active Loop Thermal Control System (TCS) for Future Space Missions,” NASA, Jan. 1, 2013 – Dec. 31, 2015, $500,000.
70. “Performance of Flow Boiling Hardware and Instrumentation in Reduced Gravity,” NASA, Jun. 2013 – May 2015, grant to support microgravity parabolic flight experiments.
71. “Flow Boiling and Condensation in Microgravity,” NASA Graduate Student Fellowship, Aug. 1, 2015 – Jul. 31, 2019, $297,000.
72. “Flow Boiling and Condensation Experiment,” NASA, Jun. 2017 – Dec. 2021, $795,000.
73. “Novel Ultra-Fast Charging System Thermal Management for Electric Vehicles,” Ford Motor Company, Mar. 1, 2018 – Feb. 29, 2020, $209,998.
74. “Direct Liquid Impingement Cooling of Power Electronics Substrates,” Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Aug. 1, 2018 – Jul. 31, 2020, $170,000.
75. “Universal Two-Phase Flow Pressure Drop and Heat Transfer Correlations for Cryogenic Fluids,” NASA, Oct. 8, 2018 – Sep. 30, 2022, $388,176.90.
76. “Experimental and Theoretical Investigation into Prediction and Prevention of Two-phase Flow Instabilities in High-flux Micro-channel Heat Sinks,” Center of Excellence for Integrated Thermal Management of Aerospace Vehicles (CITMAV), Jan. 1, 2019 – Dec. 31, 2020, $140,000.
77. “Reduced Gravity Experiments to Measure Cryogenic Two-Phase Heat Transfer Coefficients for Future in-Space Transfer Systems,” NASA, Jan. 20, 2021 – Jan. 19, 2023, $624,938.
78. “Heat Transfer Correlations for Complete Cryogenic Pool Boiling Curve Systems,” NASA STTR subcontract, Jul. 1, 2021 – Apr. 30, 2021, $38,000.
79. “Analysis of ISS Data from the Flow Boiling and Condensation Experiment (FBCE),” NASDA, Jan. 1, 2022 – Dec. 31, 2024, $593,534.78