Professional Vita (updated June 2021)

ISSAM MUDAWAR
(Formerly Issam Mudawwar)

Purdue University
School of Mechanical Engineering
585 Purdue Mall
West Lafayette, IN 47907-2088
Tel: (765) 494-5705
Fax: (765) 494-0539
E-mail: *mudawar@ecn.purdue.edu*
Web Pages: *https://engineering.purdue.edu/mudawar*

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:

DOCKET ALARM
Find authenticated court documents without watermarks at docketalarm.com.

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.

DOCKET ALARM
Find authenticated court documents without watermarks at docketalarm.com.

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:

- 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.

DOCKET ALARM
Find authenticated court documents without watermarks at docketalarm.com.

- 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.

DOCKET ALARM
Find authenticated court documents without watermarks at docketalarm.com.

- 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:

DOCKET ALARM
Find authenticated court documents without watermarks at docketalarm.com.

DOCKET ALARM

Explore Litigation Insights

Docket Alarm provides insights to develop a more informed litigation strategy and the peace of mind of knowing you're on top of things.

Real-Time Litigation Alerts

Keep your litigation team up-to-date with **real-time alerts** and advanced team management tools built for the enterprise, all while greatly reducing PACER spend.

Our comprehensive service means we can handle Federal, State, and Administrative courts across the country.

Advanced Docket Research

With over 230 million records, Docket Alarm's cloud-native docket research platform finds what other services can't. Coverage includes Federal, State, plus PTAB, TTAB, ITC and NLRB decisions, all in one place.

Identify arguments that have been successful in the past with full text, pinpoint searching. Link to case law cited within any court document via Fastcase.

Analytics At Your Fingertips

Learn what happened the last time a particular judge, opposing counsel or company faced cases similar to yours.

Advanced out-of-the-box PTAB and TTAB analytics are always at your fingertips.

API

Docket Alarm offers a powerful API (application programming interface) to developers that want to integrate case filings into their apps.

LAW FIRMS
Build custom dashboards for your attorneys and clients with live data direct from the court.

Automate many repetitive legal tasks like conflict checks, document management, and marketing.

FINANCIAL INSTITUTIONS
Litigation and bankruptcy checks for companies and debtors.

E-DISCOVERY AND LEGAL VENDORS
Sync your system to PACER to automate legal marketing.