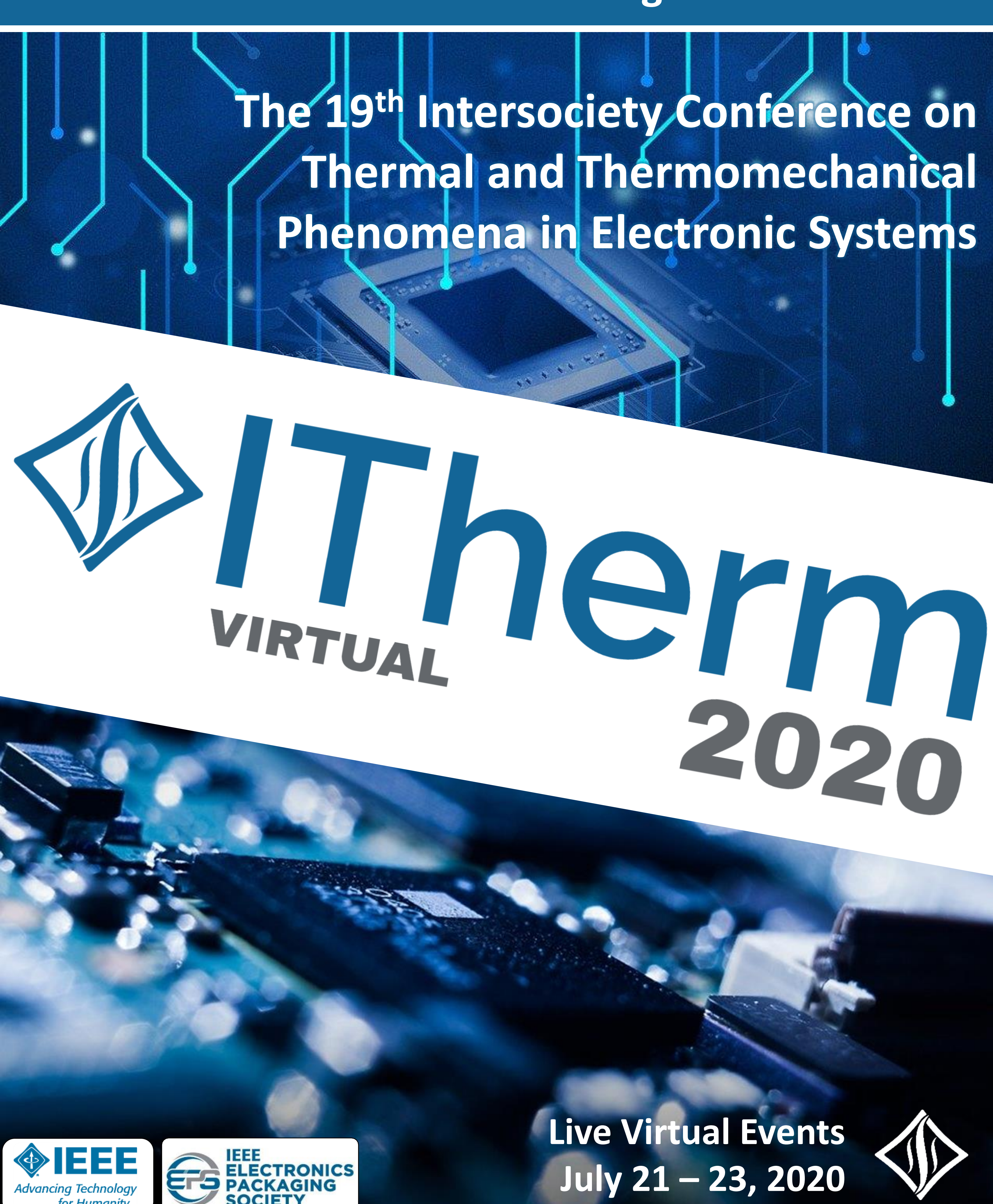
Final Conference Program



WELCOME LETTER

On behalf of the organizing committee, it is our great pleasure to welcome you to ITherm 2020 Virtual, the leading international conference for scientific and engineering exploration of thermal, thermo-mechanical and emerging technology issues associated with electronic devices from the die to the data center level. This is an unusual year for ITherm, as it is for all of us. Converting ITherm 2020 from an in-person to a virtual event has touched all the aspects of the conference from planning and organizing to participating and presenting.

ITherm 2020 Virtual is packed with many live and recorded activities. Join us from 12:00-4:00 PM Eastern on July 21st-23rd for daily live events including: 3 Keynote Talks addressing the future of the 3D system integration technology, ethics in AI, and thermal management challenges of aircraft electrification; an Invited Presentation by the recipient of the Richard Chu ITherm Award for Excellence, 3 Technology-Talk sessions providing deep dive talks on high profile topics; and the returning joint ASME K-16 / IEEE EPS Student Design Challenge on additive manufacturing of heat sinks, sponsored by GE. Recorded events will be available from July 21st till August 19th, and include over 180 technical papers in 50 sessions in 4 Technical Tracks; 60+ Student Posters as a highly engaging forum on the latest research; a joint ECTC/ITherm Diversity Panel and Heterogeneous Integration Roadmap workshop.

Many thanks go to everyone who has contributed to the success of ITherm 2020 Virtual. We recognize that this year there was a lot more work than any of us would wish to handle. Thus, taking time and contributing to ITherm over and above regular everyday responsibilities is highly appreciated. In particular, we would like to thank our track chairs and co-chairs, session chairs/co-chairs, technology-talks organizers, and many others. Last, but not least, the support of our Executive Committee is highly appreciated. A complete list of key contributors is listed later in this program.

We have sought sponsorships to support the expanded student participation with the opportunities to present their work in the virtual poster presentations, as well as other activities at the conference. ITherm sponsorship support comes from both industry and academia. Our thanks go out to each of this year's sponsors for the critical role their sponsorship provides to ITherm. Please visit their websites and published materials, benefit from exchange of information, and thank them for their sponsorship.

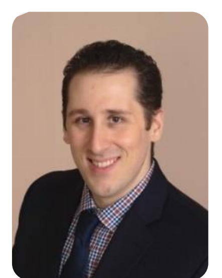
Thank you for participating in the ITherm 2020 Virtual conference and making it possible by your virtual attendance. Whether this is your first time or if you attended ITherm before, this year's virtual format is new for everybody. Interact with your fellow attendees using the live chat feature of the online conference platform or connect with them through the ITherm LinkedIn group. Regardless of whether this is your first time with us or not, we will endeavor to have you enjoy the virtual conference and come back to attend again in the future. We hope that you enjoy the wide variety of technical venues that ITherm 2020 Virtual offers.

ITherm 2021 will be held in San Diego, CA on June 1-4, 2021, and we hope that you mark your calendars to be there as well.

Best wishes,

Vadim Gektin
General Chair

Justin A. Weibel
Program Chair



Dustin W. Demetriou
Vice Program Chair

Satish Kumar
Communications Chair

Sponsored by the IEEE's Electronics Packaging Society (EPS), ITherm is an international conference for scientific and engineering exploration of thermal, thermomechanical and emerging technology issues associated with electronic devices, packages and systems (http://ieee-itherm.net). The ITherm 2020 Virtual Conference will be held July 21 – 23, 2020. Registered attendees will be able to join live each day of the conference for one-time plenary events with options to interact with the presenters from 12:00 PM – 4:00 PM Eastern Daylight Time (EDT). In addition to these live events, registered ITherm attendees will receive a copy of the conference proceedings and be able to view all of the technical paper sessions, as well as elevator pitches of the student posters, at their convenience for a period of 4 weeks after the conference opens.

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LIVE VIRTUAL EVENTS (July 21st -23rd)

- **3 Keynote Talks** covering the areas of ethics in artificial intelligence, 3D system integration, and aircraft electrification and thermal management
- **3 Technology Talk Sessions** providing deep dive talks on high profile topics
- **Student Heat Sink Design Challenge**
- **Richard Chu ITherm Award** for Excellence and Invited Presentation
- Announcement of the **ITherm 2020 Best Paper Awards**

RECORDED CONTENT (until August 19)

- Access to over **180 Technical Papers** and **Recorded Session Presentations** from **4 Technical Tracks** including Component-Level Thermal Management (TI), System-Level Thermal Management (TII), Mechanics & Reliability (M), and Emerging Technologies & Fundamentals (E)
- **60+ Student Posters** with recorded elevator pitches showcasing students' latest research
- **ECTC/ITherm Joint Diversity Panel**
- **Heterogeneous Integration Roadmap (HIR) Workshop**

VIRTUAL PROGRAM OVERVIEW

Live Virtual Events

All Times Eastern	Day 1 (Tues, July 21)	Day 2 (Wed, July 22)	Day 3 (Thurs, July 23)
11:30 - Noon	Connect Live!		
Noon - 1:00	**Keynote 1** Beena Ammanath (Deloitte) *"Future of Work Depends on Ethics in AI"*	**Keynote 2** Eric Beyne (imec) *"The Future of 3D System Integration Technology"*	**Keynote 3** Charles Lents (Raytheon Technologies) *"Aircraft Electrification Feasibility and Thermal Mangement Challenges"*
1:00-1:30	Break		
1:30 - 2:30	**Richard Chu ITherm Award For Excellence** Invited Presentation by the 2020 Awardee: Ravi Mahajan (Intel)	**Tech Talk Session 2: AI in Thermal Management** Mark D. Fuge (University of Maryland) R. Radermacher, V. Aute (University of Maryland)	**Joint ASME K-16 / IEEE EPS Student Design Challenge** (1:30-2:45) *Sponsored by GE*
2:30 - 3:00	Break		
3:00 - 4:00	**Tech Talk Session 1: Heterogeneous Integration** Amr S. Helmy (University of Toronto) Bill Bottoms (IEEE EPS and 3MTS)	**Tech Talk Session 3: Transient Thermal Management** Neera Jain (Purdue) Darin Sharar (US Army Research Labs)	**Best Paper Awards** and Closing (3:15-4:00)

Recorded Content Available July 21st to Aug 19th

Recorded Session Presentations from 180+ Papers across 4 Technical Tracks

60+ Student Posters with recorded elevator pitches

ECTC/ITherm Joint Diversity Panel

Heterogeneous Integration Roadmap (HIR) Workshop

GENERAL INFORMATION

REGISTRATION

Registration is now open for ITherm 2020 Virtual: http://www.cvent.com/d/knq090

The ITherm 2020 Virtual conference registration includes access to all virtual live and recorded events and an electronic copy of the conference proceedings. The registration fees are:

IEEE Member Fee: $100	Life Member Fee: $50
Non Member Fee: $150	Student Fee: $50

Note that the e-mail entered upon registration will be granted access to the live virtual events. *Please register at least 24 hours prior to the event to ensure that your access credentials are valid.* Registration will remain open through the close of the conference on Aug 19th.

ON24 VIRTUAL CONFERENCE PLATFORM

We are working with IEEE Meetings, Conference, and Events (MCE) to bring the event to you using the ON24 virtual conference environment. Links to the ON24 platform content (both live events and recorded content) will be accessible through the ITherm website:
https://www.ieee-itherm.net/itherm/conference/ITherm-2020-Virtual

For more information regarding system and bandwidth requirements, browser compatibility, and to test your system in advance of the event, please visit the ON24's Event Help Guide:
https://event.on24.com/view/help/

CONFERENCE Q&A FORMAT

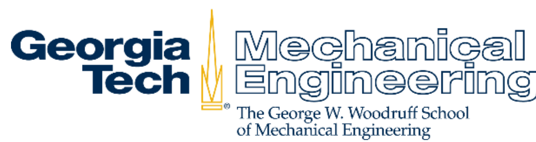
The ITherm 2020 Virtual Conference will have multiple different mechanisms for engaging the speakers and authors with your questions, depending on the event type.

- *Live Keynotes and Richard Chu ITherm Award Lecture:* Submit your questions during the presentation to be addressed by the speakers live at the end of each talk
- *Tech Talks and Student Heat Sink Design Competition:* Interactive live chat with the invited speakers
- *Recorded Session Presentations*: Post questions to the session message board, which will be monitored and addressed by the Authors throughout the event period

SPONSORS & VENDOR EXHIBITS

For more details on our ITherm 2020 Sponsors, Exhibitors, and Partners, please visit: http://ieee-itherm.net/itherm/conference/sponsors_and_exhibitors

SPONSORS



EXHIBITORS

PARTNER CONFERENCES

EPTC 2020

ITherm LINKEDIN GROUP

You can follow ITherm activities at LinkedIn: https://www.linkedin.com/groups/8650280

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ORGANIZATION COMMITTEE		
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Vice Program Chair	Dustin W. Demetriou	IBM Corporation
Communications Chair	Satish Kumar	Georgia Institute of Technology
COMPONENT-LEVEL THERMAL MANAGEMENT TRACK		
Chair	Kamal Sikka	IBM Corporation
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Co-Chair	Stephanie Allard	IBM Corporation
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SYSTEM-LEVEL THERMAL MANAGEMENT TRACK		
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EMERGING TECHNOLOGIES & FUNDAMENTALS TRACK		
Chair	Amir H. Shooshtari	University of Maryland
Co-Chair	Amy Marconnet	Purdue University
Co-Chair	Sukwon Choi	Penn State University
MECHANICS & RELIABILITY TRACK		
Chair	Pradeep Lall	Auburn University
Co-Chair	Przemyslaw Gromala	Bosch
Co-Chair	David Huitink	University of Arkansas
SPECIAL TECHNICAL CONTRIBUTIONS		
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Keynote Co-Chair	Amy Fleischer	Cal Poly
Keynote Co-Chair	Satish Kumar	Georgia Institute of Technology
Technology-Talk Chair	Peter de Bock	GE Global Research
Technology-Talk Co-Chair	David H. Altman	Raytheon
Technology-Talk Co-Chair	Madhusudan Iyengar	Google
Panels Chair	Victor Chiriac	Qualcomm
Panels Co-Chair	Amy Marconnet	Purdue University
Panels Co-Chair	Przemyslaw Gromala	Bosch
Poster Session & Art-in-Science Chair	Mahsa Ebrahim	Loyola Marymount University
Poster Session Co-Chair	Khosrow Ebrahimi	Minnesota State University, Mankato
Poster Session Co-Chair	Ron Warzoha	United States Naval Academy
Poster Session Co-Chair	Joseph Hanson	Intel Corporation
PDC Short Course Chair	Jeffrey Suhling	Auburn University
PDC Short Course Co-Chair	Kitty Pearsall	IBM Corporation

SPECIAL TECHNICAL CONTRIBUTIONS		
Women's Panel Representative	Cristina Amon	University of Toronto
Women's Panel Representative	Amy Fleischer	Cal Poly
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Richard Chu ITherm Award Co-Chair	Koneru Ramakrishna	Cirrus Logic
Richard Chu ITherm Award Co-Chair	Yogendra K. Joshi	Georgia Institute of Technology
Best Paper Award Chair	Yogendra K. Joshi	Georgia Institute of Technology
Best Paper Award Co-Chair	Koneru Ramakrishna	Cirrus Logic
Best Paper Award Co-Chair	Jeffrey Suhling	Auburn University
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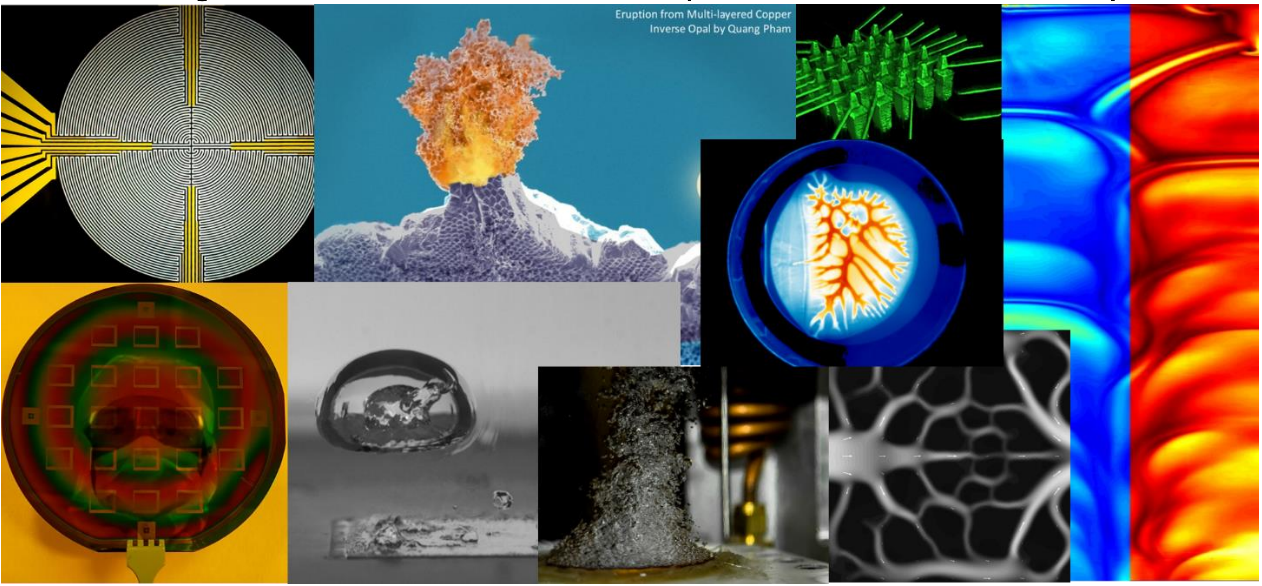
CONFERENCE EXECUTIVE COMMITTEE

The Executive Committee is made up of past ITherm General Chairs who are willing to assist the conference. It provides the leadership and continuity needed to carry forward the thrust of our Inter Society Conference.

Dereje Agonafer	University of Texas at Arlington
Cristina H. Amon	University of Toronto
Mehdi Asheghi	Stanford University
Avram Bar-Cohen	University of Maryland
Sushil H. Bhavnani	Auburn University
Thomas Brunschwiler	IBM Research – Zurich
Madhusudan Iyengar	Google
Yogendra K. Joshi	Georgia Institute of Technology
Gary B. Kromann	Consultant
Tom Lee	Xilinx
Michael Ohadi	University of Maryland
Alfonso Ortega	Villanova University
Koneru Ramakrishna	Cirrus Logic
Bahgat Sammakia	State University of New York at Binghamton
Jeffrey Suhling	Auburn University
Sandeep Tonapi	Anveshak

Collage of Previous Art-in-Science Entries (Event will Resume ITherm 2021)



KEYNOTES

KEYNOTE 1: FUTURE OF WORK DEPENDS ON ETHICS IN AI

Presenter: Beena Ammanath
Founder and CEO of Humans for AI and AI Managing Director, Deloitte
July 21, Tuesday, 12:00 – 1:00 PM (Eastern)

Abstract: As innovations in artificial intelligence, robotics, and other technology bring us virtual assistants, wearable health tech, autonomous vehicles, and more, many industries are transforming rapidly. While these new technologies have brought unimaginable benefits, they also are disrupting many industries and changing the structure of the workforce. The challenges and opportunities posed by AI are so great that calls are being made around the world for an ethical framework that would govern the development and use of AI, so that deployment of AI will be safe and beneficial for society as a whole.

Biography: Beena is an award winning senior executive with extensive global experience in Artificial Intelligence and digital transformation. She is the Founder and CEO of Humans For AI and AI Managing Director at Deloitte. Her knowledge spans across e-commerce, financial, marketing, telecom, retail, software products, services and industrial domains with companies such as HPE, GE, Thomson Reuters, British Telecom, Bank of America, e*trade and a number of Silicon Valley startups. She has co-authored the book "AI Transforming Business."

A well-recognised thought leader and keynote speaker in the industry, she also serves on the Industrial Advisory Board at Cal Poly College of Engineering and has been a Board Member and Advisor to several startups including Flerish, Predii, iguazio, CliniVantage and ProjectileX. Beena has been honored several times for her contribution to tech and her philanthropic efforts, including UC Berkeley 2018 Woman of the Year in Business Analytics, San Francisco Business Times' 2017 Most Influential Women in Bay Area, WITI's Women in Technology Hall of Fame, National Diversity Council's Top 50 Multicultural Leaders in Tech, CIO.com and Drexel University's Analytics 50 innovator, Forbes Top 8 Female Analytics Experts and Women Super Achiever Award from World Women's Leadership Congress. Beena thrives on envisioning and architecting how data, artificial intelligence and technology in general, can make our world a better, easier place to live.

KEYNOTE 2: THE FUTURE OF 3D SYSTEM INTEGRATION TECHNOLOGY: KEEPING COOL WHILE TURNING UP THE HEAT

Presenter: Eric Beyne
Imec fellow, VP R&D, Director 3D System integration program
July 22, Wednesday, 12:00 – 1:00 PM (Eastern)

Abstract: As advanced CMOS technology keeps scaling, monolithic large-scale heterogeneous system-on-chip integration becomes ever more challenging, technically and economically. While individual functions for memory storage or logic still benefit significantly from CMOS scaling, the optimum implementation is diverging. A better solution can be realized by functionally partitioning the system into multiple smaller die ("chiplets") that can be realized using different, heterogenous technologies. High density 3D integration technologies are needed to recombine these chiplets, with minimal impact on the electronic circuit performance. Different 3D integration technologies can be applied at different levels of the 3D interconnect hierarchy, from the package to the die, to the wafer, to the standard cell and even to the transistor level, spanning an exponential scale in interconnect density. The 3D integration solutions allow for the integration of ever larger systems. This also implies that power dissipation density increases, and power delivery and heat removal become significant challenges. Hot spots become increasingly localized and time variable. This requires rethinking of the standard high-performance cooling approaches. To identify the correct choice and specifications for the 3D System integration approach, it is increasingly important to consider this during the earliest phases of system design. EDA tools are needed that enable the co-design of functionally partitioned heterogeneous systems in an "SOC" design style, including the power delivery and power removal systems.

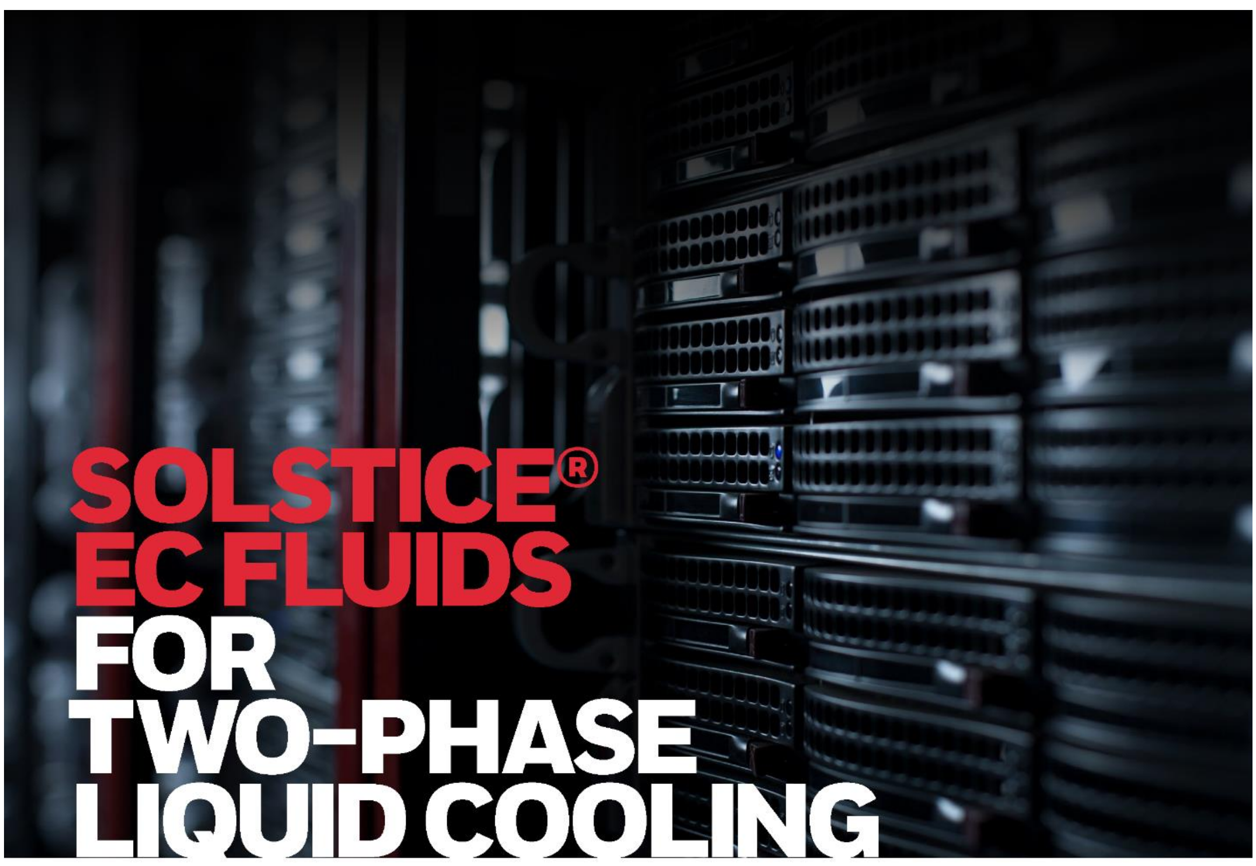
Biography: Dr.ir. Eric Beyne obtained an MSc degree in Electrical Engineering in 1983 and the PhD in Applied Sciences in 1990, both from the University of Leuven (KU Leuven). Since 1986 he has been with imec in Leuven, Belgium. Currently, he is imec fellow, VP R&D and Director of imec's 3D System Integration program in which Imec's own staff works alongside engineers from 30+ industrial partners (IDMs, foundries, fabless semiconductor companies, OSATs as well as equipment, material, and software tool suppliers) This team performs R&D in the field of high-density interconnection and packaging techniques focused on "system-in-a-package" integration, 3D-interconnections including through-silicon vias, micro-bumps, and copper pillars, wafer-level packaging, as well as research on packaging reliability including thermal and thermo-mechanical characterization. He is and has been an active member of the IEEE-EPS and IMAPS societies. He received the 2003 Microwave Prize from the IEEE Microwave Theory and Techniques Society, the 2016 European Semiconductor Award from Semi-Europe for his work on 3D technology and the 2019 W. D. Ashman-J.A.Wagnon Technical Achievement Award from IMAPS.

KEYNOTE 3: AIRCRAFT ELECTRIFICATION FEASIBILITY AND THERMAL MANAGEMENT CHALLENGES

Presenter: Charles Lents
Associate Director, Research, Raytheon Technologies Research Center
July 23, Thursday, 12:00 – 1:00 PM (Eastern)

Abstract: Aircraft electrification has been steadily progressing over the last 30 years as the demand for electric power on aircraft continues to increase. The typical airliner class aircraft (> 120 passengers) now has approximately 180 kW of installed electric power capability, supplying standard electric loads, such as lighting, avionics and passenger services, and supplying limited subsystems' power demands such as hydraulic pumps, fuel pumps, and fans. Most of these loads are passively cooled with process fluid or ambient air. The electric generators are oil cooled at nearly 100°C. The Boeing 787 ushered in a new era, with installed electric power of 1.5 MW. The increased capability meets the demands of a so called "More Electric Aircraft" (MEA) where subsystems traditionally powered either hydraulically or pneumatically are now powered electrically, most notably the aircraft environmental control system (ECS) and the wing anti-ice system. The ECS is supplied by greater than 100 kW electric compressors and wing anti-ice is provided by electric resistive thermal blankets. The varying voltage and frequency requirements of these different loads leads to the incorporation of ac-dc and dc-ac inverters for load power conditioning. These inverters generate a significant amount of heat at relatively low temperature. Now with the interest in propulsion electrification of airliner class aircraft, electric power demand could range between a few mega-watts up to greater than 20 MW. Propulsion electrification holds the promise of reducing aviation's carbon footprint, both by enabling access to green electric power and by reducing the power required for flight though distributed propulsion and propulsion airframe integration. Like the electric system of an MEA aircraft, the electric drive train (EDT) of an electrified propulsion system will require power electronics for propulsive load power conditioning. Even at efficiencies approaching 98%, these EDT components will reject a significant amount of low temperature heat (~ 25 to 50°C). This talk will discuss MEA background, describe the design space of possible electrified propulsion systems and aircraft, discuss the rationale and feasibility of various concepts, and highlight the thermal management challenges of electrified propulsion systems.

Biography: Mr. Lents has over thirty years of experience in the conceptual design of integrated aircraft primary and secondary power and thermal management systems. Mr. Lents is responsible for integrated aircraft systems, thermal management, and innovative propulsion systems technology development. He led the development of an integrated modeling environment for the study of integrated total aircraft power systems and their impact on air vehicle performance and led several studies investigating power and thermal management solutions for vehicles such as the JUCAS and future JSF derivatives. Currently, he is leading a NASA funded effort that developed the conceptual design of a single-aisle parallel hybrid propulsion system and is presently developing enabling technology for hybrid electric propulsion. He has experience in a diverse set of technical areas, including thermodynamics, fluid dynamics, turbo-machinery, heat transfer, power electronics cooling, systems integration and aircraft secondary power systems, reliability, risk/uncertainty analysis and life-cycle cost modeling. Mr. Lents received his B.S. in Mechanical Engineering from the University of Illinois and his M.S. in Mechanical Engineering from Purdue University.



Several industries are adopting liquid cooling and 2-phase solutions have been commercialized successfully

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Honeywell

RICHARD CHU ITherm AWARD FOR EXCELLENCE

QUIET REVOLUTIONS: HOW ADVANCED MICROELECTRONICS PACKAGING CONTINUES TO DRIVE HETEROGENEOUS INTEGRATION

Presented by the 2020 Awardee Dr. Ravi Mahajan,
Intel Fellow , High Density Interconnect Pathfinding, Vice-President of Publications, IEEE Electronics Packaging Society, & Managing Editor-in-Chief of the IEEE Transactions of the CPMT
July 21, Tuesday, 1:30 - 2:30 PM (Eastern)

Abstract: The past few years have seen increasing interest in advanced package architectures as compact, high performance platforms for heterogeneous integration across a wide variety of applications. Interest in advanced packaging is driven by the need for increased on-package bandwidth, the need to integrate diverse IP from multiple foundries and the need for improved yield resiliency. A number of innovative package architectures that enable power-efficient on-package bandwidth interconnects have made major advances in microelectronics performance possible. Focus on heterogeneous integration makes visible to broader audiences, the packaging community that in a quiet, systematic and largely unheralded manner continues to drive momentous changes in packaging, assembly and associated test technologies. In this presentation, I will attempt to describe some of these changes and more importantly offer a perspective for how packaging should evolve and what this means to the thermal management community.

Ravi Mahajan is an Intel Fellow and the Director of Pathfinding for Assembly and Packaging technologies for future silicon nodes. Ravi also represents Intel in academia through research advisory boards, conference leadership and participation in various student initiatives.

Ravi has led Pathfinding efforts to define Package Architectures, Technologies and Assembly Processes for multiple Intel silicon nodes since 2000, spanning 90nm, 65nm, 45nm, 32nm, 22nm and 7nm silicon. Earlier in his Intel career, he spent eight years as a Technologist and manager for the Thermal-Mechanical Tools and Analysis Group. In these roles, Ravi oversaw a Thermal-Mechanical Lab chartered with delivering detailed thermal and mechanical characterization of Intel's packaging solutions for current and future processors. His group was also responsible for the collaborative development of a number of technologies for the thermal management of micro-electronics, high precision thermal and thermo-mechanical characterization and modeling techniques.

A prolific inventor and recognized expert in microelectronics packaging technologies, Ravi holds more than 50 patents, including the original patents for silicon bridges that became the foundation for Intel's EMIB technology. His early insights also led to high-performance, cost-effective cooling solutions for high-end microprocessors and the proliferation of photo-mechanics techniques used for thermo-mechanical stress model validation.

Ravi joined Intel in 1992 after earning a bachelor's degree from Bombay University, a master's degree from the University of Houston, and a Ph.D. from Lehigh University, all in Mechanical Engineering. His contributions during his Intel career have earned him numerous industry honors, including the SRC's 2015 Mahboob Khan Outstanding Industry Liaison Award, the 2016 THERMI Award from SEMITHERM, the 2016 Allan Kraus Thermal Management Medal & the 2018 InterPACK Achievement award from ASME and the 2019 "Outstanding Service and Leadership to the IEEE" Awards from IEEE Phoenix Section & Region 6.

He is an IEEE EPS Distinguished Lecturer. He is one of the founding editors for the Intel Assembly and Test Technology Journal (IATTJ) and currently VP of Publications & Managing Editor-in-Chief of the IEEE Transactions of the CPMT. Additionally, he has been long associated with ASME's InterPACK conference and was Conference Co-Chair of the 2017 Conference. Ravi is a Fellow of two leading societies, ASME and IEEE. He was named an Intel Fellow in 2017.

STUDENT HEAT SINK DESIGN CHALLENGE

JULY 23, THURSDAY, 1:30 – 2:45 PM (EASTERN)

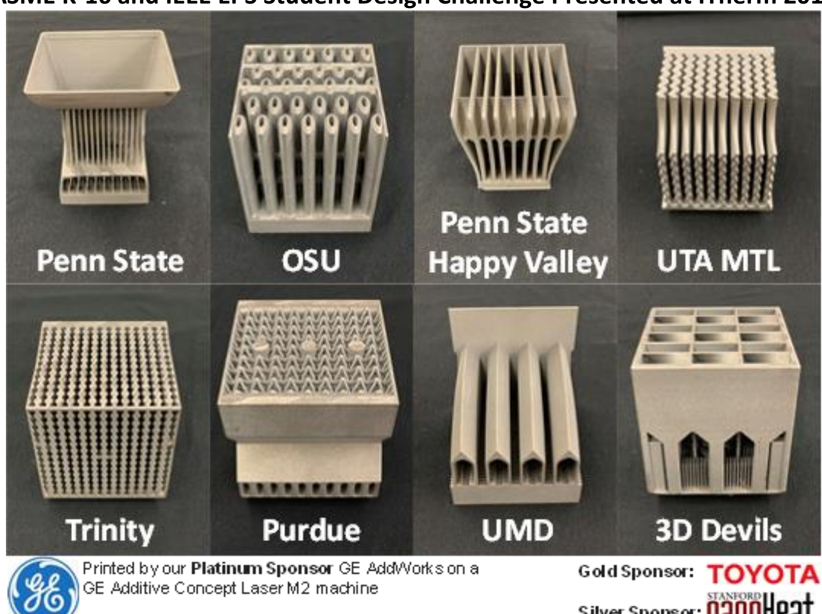
The ITherm organizing committee is delighted to again host the joint ASME K-16 / IEEE EPS Student Design Challenge: "Expand the Possibilities of Heat Sink Design using Additive Manufacturing" during ITherm 2020 Virtual Conference.

The Student Heat Sink Design Challenge is a team competition in which students design, analyze, and optimize an aluminum additively manufactured heat sink to cool a constant heat flux source subject to forced convection. Each year's competition offers a new flow configuration and performance metric. The design submitted from each student team, supported by their performance prediction, is evaluated based on a series of design and manufacturing criteria. The semi-finalist teams having the most effective and creative designs are granted the opportunity to have their designs fabricated using the additive manufacturing facilities at GE and performance tested at Oregon State University. The finalists are invited to present their designs to the ITherm community.

For the 2020 competition, designs were submitted by teams from around the world and evaluated by a team of experts. The top designs were 3D printed and experimentally tested. Six teams selected as finalists will present their work at the 2020 ITherm Virtual Conference:

1. University of Texas Arlington
2. Purdue University
3. Penn State University
4. Georgia Tech
5. Oregon State University
6. University of Texas Arlington

ASME K-16 and IEEE EPS Student Design Challenge Presented at ITherm 2019



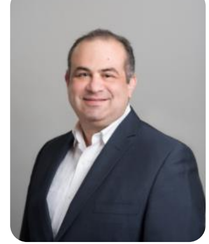
2019 Finalists:
ASU 3D Devils, Purdue Heat Sink Makers,
Trinity College Dublin, and University of Maryland

2019 Winner:
Penn State Happy Valley

TECHNOLOGY-TALK SESSIONS

TECH TALK SESSION 1: HETEROGENEOUS INTEGRATION
JULY 21, TUESDAY, 3:00 – 4:00 PM (EASTERN)

Session Chairs: Madhusudan Iyengar (Google); **Weihua Tang (Intel)**



EFFICIENT, ATHERMAL, PHOTONICS USING METAL OPTICS

Speaker: Amr S. Helmy (University of Toronto); Y. Su, P. Chang and C. Lin

Abstract: The talk will start with an overview of the current state of Si photonics. Then an overview of some of the thermal limitations of this formidable platform will be provided. After, a novel class of nanoscale devices that address unmet performance demands for applications in data communications will be discussed. Within the Si photonic platform, dielectric waveguides confine light via total internal reflection. This imposes bounds on minimizing device dimensions and density of integration. Those bounds arise due to the diffraction limit and the cross-coupling between neighboring waveguides. Nanoscale Plasmonic waveguides provide the unique ability to confine light within a few nanometers and allow for near perfect transmission through sharp bends. With these structures as a building block, new levels of optoelectronic integration and performance metrics for athermal transceivers with achievable bandwidths in excess of 500 Gbps as will be overviewed in this talk.

Amr is a Professor in the department of electrical and computer engineering at the University of Toronto. Prior to his academic career, he held a position at Agilent Technologies, R&D division, in the UK between 2000 and 2004. At Agilent his responsibilities included developing InP-based photonic semiconductor integrated circuits and high-power submarine-class 980 nm pump lasers. He received his Ph.D. and M.Sc. from the University of Glasgow with a focus on photonic devices and fabrication technologies, in 1999 and 1995 respectively. He received his B.Sc. from Cairo University in 1993. His research interests include photonic device physics and engineering, with emphasis on nonlinear and quantum optics in III-V semiconductors as well as nanophotonic circuits utilizing plasmonics. He has served as Vice President Membership for the IEEE Photonics Society (2008-2010). He is currently the CLEO Program Chair (2018-2020). He also served as the Technical Program Chair for IPC 2016-2018.

IEEE HETEROGENEOUS INTEGRATION ROADMAP INITIATIVE

Speaker: Bill Bottoms

Abstract: The pace of progress from 1965 was enabled by the CMOS scaling of Moore's Law. The benefits of scaling decreased as the geometries approached the limit of the physics and many things changed. The electronics world entered a state of technology chaos which drove an explosive increase in innovation. The ITRS, with a focus on the benefits of CMOS scaling, published its last edition in July of 2016. The Heterogeneous Integration Roadmap (HIR) was established in the first quarter of 2015 with a goal of providing a roadmap to maintain the pace of progress for decades into the future. This presentation will address the HIR structure and governance and present the 2019 edition and work toward the 2020 edition. The HIR is organized into five sections: (1) Market Applications; (2) Heterogeneous Integration Components; (3) Cross Cutting Topics; (4) Integration Processes; (5) Co-Design and Simulation. The highlights from the 23 chapters in the 2019 Edition and the status of the 2020 Edition will be presented.

Dr. Bottoms received a B.S. degree in Physics from Huntington College in Montgomery, Alabama in 1965, and a Ph.D. in Solid State from Tulane University in New Orleans in 1969 and is currently Chairman of Third Millennium Test Solutions. He has worked as a faculty member in the department of electrical engineering at Princeton University, manager of Research and Development at Varian Associates, founding President of the Semiconductor Equipment Group of Varian Associates and general Partner of Patricof & Co. Ventures. Dr. Bottoms has participated in the startup and growth of many companies through his venture capital activity and through his own work as an entrepreneur. Some of his current responsibilities include: Emeritus Member of the Board of Tulane University; Co-Chair of the Heterogeneous Integration Roadmap; Chairman of the SEMI's Awards Committee; Member of the Board of MIT's Microphotonic Center; Chairman of Fluence Analytics; Chairman of the Technology Board of Tulane's POLYRMC center.

TECH TALK SESSION 2: AI IN THERMAL MANAGEMENT
JULY 22, WEDNESDAY, 1:30 – 2:30 PM (EASTERN)

Session Chairs: Peter deBock (GE); Ram Ranjan (Raytheon Technologies)

LOST IN SPACE: DESIGN MANIFOLDS CAN ACCELERATE DESIGN AND OPTIMIZATION ITERATIONS SEVERAL FOLD

Speaker: Mark D. Fuge (University of Maryland)

Abstract: When designing complex geometry like the surface of a turbine blade or heat exchanger, engineers face a choice. They can use many surface control points to achieve subtle design changes that can lead to potentially important performance improvements — at the risk of getting lost in the larger design space that results. Or they can play it safe, using a lower-dimensional, standard design representation that they can tractably explore and optimize — at the risk of settling with lower performance designs. This talk advocates for a different path that seemingly gets the best of both worlds. I propose learning a Design Manifold — a non-linear, low-dimensional subspace via Machine Learned Generative Models — that captures the key ways in which a design space varies by leveraging past examples of successful designs. I will describe this idea and then demonstrate how it aids gradient-free optimization via an example of airfoil design, where using Design Manifolds reduces the design iteration time by 10x compared to traditional representations and 2-3x compared to state of the art research. Importantly, these approaches do not require access to performance gradients and thus apply to any simulation code, and can adapt to multi-part assemblies.

Mark Fuge is an Assistant Professor of Mechanical Engineering at the University of Maryland, College Park, where he is also an affiliate faculty in the Institute for Systems Research and a member of the Maryland Robotics Center and Human-Computer Interaction Lab. His staff and students study fundamental scientific and mathematical questions behind how humans and computers can work together to design better complex engineered systems, from the molecular scale all the way to systems as large as aircraft and ships using tools from Applied Mathematics and Computer Science. He received his Ph.D. from UC Berkeley and has received a NSF CAREER Award, a DARPA Young Faculty Award, and a National Defense Science and Engineering Graduate (NDSEG) Fellowship. He has prior/current support from NSF, DARPA, ARPA-E, NIH, ONR, and Lockheed Martin.

INNOVATION IN HEAT EXCHANGERS WITH SURROGATE MODELING AND SHAPE OPTIMIZATION

Speaker: Vikrant Aute, Reinhard Radermacher (University of Maryland)

Abstract: Space conditioning and electronic equipment cooling accounts for a significant fraction of the primary energy consumption. Air-to-refrigerant heat exchangers are a key component in such equipment and have a major influence on the cost, performance, efficiency and global warming impact of these systems. The air-side thermal resistance is the dominant resistance in such heat exchangers and as such, has received significant research attention. This talk presents a novel framework for design discovery and optimization of air-to-refrigerant heat exchangers. The framework couples surrogate modeling, multi-objective genetic algorithms, CFD, finite element analysis, and multiscale modeling to arrive at optimal and robust heat exchanger designs. The resulting designs are prototyped using additive and conventional manufacturing methods and tested in a standardized wind tunnel. Comprehensive testing for a radiator, condenser, and evaporator applications are conducted. The predicted performance agreed within 12% of measured values for all performance metrics. The novel designs have the potential to be 20% lighter, 20% smaller and exhibit more than 20% reduction in charge.

Vikrant Aute is a Research Scientist and Co-Director of the industry and government-funded Center for Environmental Energy Engineering at the University of Maryland. He has more than 20 years of experience in developing algorithms and numerical methods for modeling and design optimization of heat exchangers and heat pumps. His research focus includes: modeling and optimization of HVAC&R systems and components, innovation in next-generation heat exchangers, approximation assisted and multi-objective robust optimization, genetic algorithms, data visualization and applications of machine learning for HVAC&R. He is an active member of ASHRAE and serves on multiple technical and standards committees. He holds a BE in Mechanical Engineering from the University of Pune (India), MS and PhD in Mechanical Engineering from the University of Maryland and an MS in Data Analytics from the University of Maryland University College.

TECH TALK SESSION 3: TRANSIENT THERMAL MANAGEMENT
JULY 22, WEDNESDAY, 3:00 – 4:00 PM (EASTERN)

Session Chairs: David Altman (Raytheon); Patrick Shamberger (Texas A&M)

CONTROL CO-DESIGN FOR TRANSIENT THERMAL MANAGEMENT

Speaker: Neera Jain (Purdue)

Abstract: Over the last few decades, many factors, including increased electrification, have led to a critical need for fast and efficient transient cooling. Thermal management systems (TMSs) are typically designed using steady-state assumptions and to accommodate the most extreme operating conditions that could be encountered, such as maximum expected heat loads. Unfortunately, by designing systems in this manner, closed-loop transient performance is neglected and often constrained. If not constrained, conventional design approaches result in oversized systems that are less efficient under nominal operation. In this talk I will discuss why transient component modeling and subsystem interactions should be considered at the design stage for TMSs to avoid costly future redesigns, and how techniques such as control co-design can be used to accomplish this.

Neera Jain joined the School of Mechanical Engineering and Ray W. Herrick Laboratories at Purdue University as an assistant professor in January 2015. At Purdue, she leads the Jain Research Laboratory where her research spans dynamic modeling, control, and optimization of thermal energy systems, transportation systems, manufacturing processes, and human-automation interaction systems. From May 2013-May 2014, Dr. Jain was a visiting member of the research staff in the Mechatronics Group at Mitsubishi Electric Research Laboratories in Cambridge, MA where she designed advanced control algorithms for HVAC systems. Before earning her doctorate in Mechanical Engineering at the University of Illinois at Urbana-Champaign in 2013, Dr. Jain earned her S.B. from the Massachusetts Institute of Technology in 2006 and her M.S. from the University of Illinois at Urbana-Champaign in 2009, both in Mechanical Engineering. She is a recipient of the Department of Energy Office of Science Graduate Fellowship (2010-2013) and the ASME Graduate Teaching Fellowship (2011-2012).

EMERGING THERMAL ENERGY STORAGE NEEDS: HIGH-POWER ELECTRONIC AND PHOTONIC COOLING

Speaker: Darin Sharar (US Army Research Laboratory)

Abstract: Thermal energy storage using phase change materials promises tremendous benefits in a diverse array of technology spaces, ranging from large scale power generation to residential heating and cooling, and even more-localized electronic/photonic thermal management. This discussion covers ongoing efforts at the Army Research Lab to develop high-capacity, high-power thermal energy storage systems for military and (by extension) commercial and residential applications. The discussion begins with a description of transient thermal load scenarios and progresses to tradeoffs between different active and passive cooling approaches. Focus is placed on emerging technologies and energy landscapes, and the need for improved thermal energy storage materials, modeling tools, and systems as a means for future passive transient mitigation.

Dr. Sharar began his career with the U.S. Army ten years ago after completing his undergraduate degree, receiving his Mechanical Engineering doctorate degree two years ago, and transitioning to a career civil servant one year ago. Upon joining ARL, Dr. Sharar initiated the first phase change thermal management thrust at ARL through the DARPA Thermal Ground Plane (TGP) program, where Dr. Sharar led the design, fabrication, and operation of a custom high-g thermal test station to test vapor chambers for DOD applications. Dr. Sharar initiated a two-phase flow boiling research effort and first-of-a-kind test bed in which he developed and experimentally validated a new flow regime map and heat transfer model that recognizes the role played by two-phase flow structures in enhancing thermal transport within refrigeration tubes. These new models marked a significant contribution to the scientific community, leading to the completion of Dr. Sharar's doctorate degree, and enabling more reliable thermofluid prediction, design, and optimization of two-phase (refrigeration) cooling systems for DOD systems such as Microclimate Cooling Systems (MCS) on Navy, Army, and Marine Corps ground and aerial vehicle systems, Environmental Control Units (ECU), vehicle cabin cooling systems, and heat exchanger components for laser diodes and Si electronics. More recently, Dr. Sharar has initiated a solid-state transient cooling thrust at ARL, including vulnerability-protection mechanisms, elastocaloric cooling, and passive phase change transient cooling.

HIR VIRTUAL WORKSHOP

RECORDING AVAILABLE JULY 21st – AUG 19th

The Heterogeneous Integration Roadmap (HIR), released October 2019, is a roadmap to the future of electronics, identifying technology requirements and potential solutions. The primary objective is to stimulate pre-competitive collaboration between industry, academia and government to accelerate progress. The roadmap offers professionals, industry, academia and research institutes a comprehensive, strategic forecast of technology over the next 15 years. The HIR also delivers a 25-year projection for heterogeneous integration of Emerging Research Devices and Emerging Research Materials with longer research-and-development timelines. With the release of the 2019 HIR edition, the preparation of the 2020 edition is well underway.

All ITherm 2020 Virtual registrants will have access to the recording of the HIR Workshop held as part of the 70th ECTC Virtual Event. This HIR workshop will feature speakers from all 22 chapters in 4 separate sessions together with an HIR overview presentation. They will describe their work in HIR 2019 and their focus for HIR 2020. The purpose of the HIR workshop is to broaden the proliferation of the roadmap content to the virtual ITherm 2020 Virtual participants for dialogue and feedback for inclusion into the 2020 edition.

- **HIR Overview:**
  William (Bill) Chen and WR (Bill) Bottoms
- **HI for Communication**
  Moderator: Amr Helmy, Univ of Toronto
- **HI for Consumer & Industrial Applications**
  Moderator: Ravi Mahajan, ASME EPPD & Intel
- **HI for High Performance Computing**
  Moderator: Bill Bottoms, IEEE EPS and 3MTS
- **HI for Special Applications**
  Moderator: Tom Salmon, SEMI

HETEROGENEOUS
INTEGRATION ROADMAP

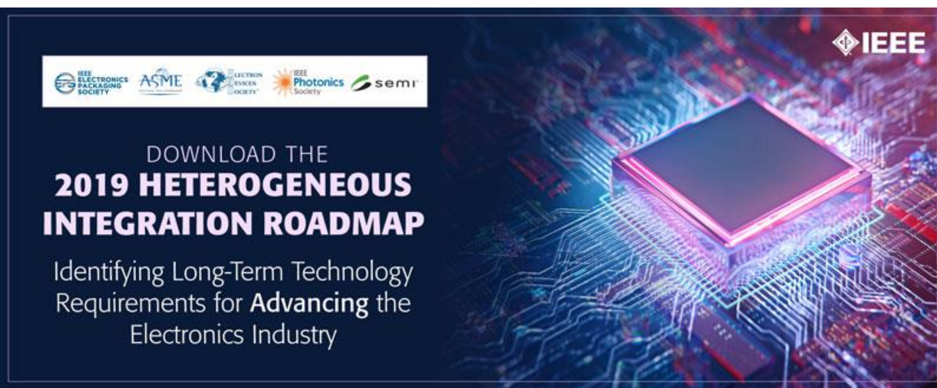
Bill Chen

Bill Bottoms

Amr Helmy

Ravi Mahajan

Tom Salmon



RECORDINGS AVAILABLE JULY 21st – AUG 19th

ECTC/ITherm JOINT DIVERSITY PANEL

DIVERSITY AND INCLUSION DRIVES INNOVATION AND PRODUCTIVITY

ITherm Chair: Cristina Amon (University of Toronto); ECTC Chair: Kitty Pearsall (Boss Precision)

Diversity in today's workplace and academia must be more inclusive than just race, gender, and ethnicity. There are religious, political, educational, and cultural differences. Adding to this mix are varied socioeconomic backgrounds, sexual orientation, and people with disabilities. The Global Diversity Practice Consultancy Group puts forth: "Openness to diversity widens our access to the best talent. Inclusion allows us to engage talent effectively. Together, this leads to enhanced innovation, creativity, productivity, reputation, engagement and results." The panel will discuss their experiences, challenges and best practices that have delivered positive outcomes.

Panelists:

Adeel Bajwa
Kulicke and Soffa

Allyson Hardzell
Veryst Engineering

Amy S. Fleisher
California Polytechnic State University

Ivan Ndip
Fraunhofer IZM

STUDENT POSTER SESSION

This student poster presentation and networking event will feature 4 virtual session rooms, one for each technical track, open for viewing by all registered conference attendees. These sessions will include a pre-recorded, 2-minute long elevator pitch alongside an E-poster for each student presenter. Furthermore, the poster session committee will share the resumes of those student presenters who are seeking jobs and internships upon their requests with the professional attendees in order to connect the students to potential employers.

All student first authors with accepted papers were eligible to apply for poster session. Each E-poster was submitted in advance of the conference judged offline by industry and academic professionals. Additionally, the elevator pitch presentations will be judged during the virtual conference period. The judgment process will be based on technical merit, clarity and self-sufficiency of the content, novelty of the work, overall impact of the poster display, and the elevator pitch oral presentations.

Outstanding posters will be selected for awards based on the evaluation scores. Poster awards will be announced after the conference via email and award certificates will be mailed to the awardees. The poster awards are independent of the paper awards, and the same work is eligible for winning both awards based on the specific judging criteria for each award.

ITherm 2019 Student Poster Presenters

LIST OF STUDENT POSTERS

SESSION 1: EMERGING TECHNOLOGIES

	Student name	School	Paper #	Poster title
1	Hong-Wen Chiou	National Chiao Tung University	P196	Temperature-to-Power Mapping for Smartphones
2	Melissa McCann	Washington University in St. Louis	P224	Analyzing the Distribution of Microencapsulated Organic Phase Change Materials Embedded in a Metallic Matrix
3	Sankar Muthukrishnan	University of Minnesota, Twin Cities	P238	A Systematic Study of Microstructure Length Scale on Heat Transfer Enhancement in Spray Cooling
4	Khan Md. Rabbi	University of Central Florida	P246	A Low-Cost Thermal Mapping Technique for Electronics Cooling using Quantum Dots
5	Soumya Bandyopadhyay	Purdue University	P278	A Cascaded Multi-Core Vapor Chamber for Intra-Lid Heat Spreading in Heterogeneous Packages
6	Ruochun Zhang	University of Wisconsin-Madison	P337	Parameter-free Shape Optimization of Heat Sinks
7	Diego Vaca	Georgia Institute of Technology	P363	Thermal Conductivity of B-Ga2O3 Thin Films Grown by Molecular Beam Epitaxy
8	Farid Soroush	Stanford University	P393	Mechanical Design and Reliability of Gold-Tin Eutectic Bonding for Silicon-based Thermal Management Devices
9	Ved Soni	Auburn University	P426	Effect of Dynamic Folding with Varying Fold Orientations and C-rates on Flexible Power Source Capacity Degradation
10	Kartik Goyal	Auburn University	P428	Additively Printed Multi-Material Temperature Sensor Realized using Screen Printing
11	Jinesh Narangaparambil	Auburn University	P435	Sintering Process Conditions for Additive Printing of Multi-Layer Circuitry Aerosol-Jet Process in Conjunction with Nanoparticle Ink
12	Hyesoo Jang	Auburn University	P442	Study on Folding-Reliability of Wearable Biometric Band
13	Mrinmoy Saha	Auburn University	P446	Evolution of High Strain Rate Mechanical Properties of SAC-R with High Temperature Storage at 50C with High and Low operating temperatures
14	Chongyang Cai	Binghamton University	P458	Comparative Analysis of Package Warpage Using Confocal Method and Digital Image Correlation

SESSION 2: COMPONENT LEVEL THERMAL MANAGEMENT

	Student name	School	Paper #	Poster title
1	Tanvir Ahmed Chowdhury	University of Central Florida	P135	Measurement of Hotspot Cooling Performance of Submerged Water Jet via Infrared Thermography
2	Gokberk Tarcin	Ozyegin University	P157	Rapid Heating and Cooling Chamber for Photonics Junctions Measurement System
3	Justin Costa-Greger	University of Nebraska-Lincoln	P219	Pool Boiling Inversion and Hysteresis with Femtosecond Laser Processed 304 Stainless Steel Surfaces for Heat Transfer Enhancement
4	Assaad El Helou	Southern Methodist University	P235	High Resolution Thermoreflectance Imaging and Numerical Modeling of Self-Heating in GaN HEMTs
5	Georgios Damoulakis	University of Illinois at Chicago	P282	Vapor Chamber with Wickless Condenser - Thermal Diode
6	Amitav Tikadar	Georgia Institute of Technology	P313	Coupled Electro-Thermal Analysis of Permanent Magnet Synchronous Motor for Electric Vehicles
7	Sougata Hazra	Stanford University	P349	Microfabrication Challenges for Silicon-based Large Area (>500 mm^2) 3D-manifolded Embedded Micro-cooler Devices for High Heat Flux Removal
8	Karthekeyan Sridhar	Auburn University	P362	Phase Change Cooling of Spacecraft Electronics: Terrestrial Reference Experiments prior to ISS Microgravity Experiments
9	Ceren Cengiz	Ozyegin University	P376	Enhanced Thermal Performance of High Flux LED Systems with Two-Phase Immersion Cooling
10	Gerard Laguna	Universitat de Lleida	P411	Experimental Validation of a Microfluidic Cell Cooling Solution
11	Remco van Erp	École polytechnique fédérale de Lausanne	P420	Embedded Microchannel Cooling for High Power-Density GaN Power Integrated Circuits
12	Ji Yong Kim	Ulsan National Institute of Science and Technology	P466	Effect of CVD Deposited Graphene Monolayer Thermal Effusivity on Phase Change Heat Transfer in 2-D Plate Condition with Highly Wettable FC-72

SESSION 3: SYSTEM LEVEL THERMAL MANAGEMENT / MECHANICS AND RELIABILITY

	Student name	School	Paper #	Poster title
1	Adeel Arshad	University of Nottingham	P117	Thermal Performance of PCM-based Heat Sink with Partially Filled Copper Oxide Coated Metal-Foam for Thermal Management of Microelectronics
2	Tyler Shelly	Purdue University	P141	A Dynamic Simulation Framework for the Analysis of Battery Electric Vehicle Thermal Management Systems
3	Andrew Michalak	University of Toronto	P145	A Novel Thermal Management Design Methodology for Hybrid Power Electronics Utilizing Genetic Optimization and Additive Manufacturing Techniques
4	Joshua Tompkins	University of Arkansas	P149	Air Flow Inversion for Enhanced Electronics Cooling in Additively Manufactured Air Channels
5	Justin Wang	US Army Research Laboratory	P167	Towards Time-Scale Matched Composites: System-Level Modeling of Organic and Metallic Phase-Change Material Composites Using a Two-Temperature Model
6	Gargi Kailkhura	University of Maryland College Park	P228	Numerical Investigation of a Novel Cross-Media Heat Exchanger for Liquid Cooling Applications
7	Alison Hoe	Texas A&M University	P240	Forward Selection Methodology for Phase Change Material Composite Optimization
8	Joshua Kasitz	University of Arkansas	P256	Nanoparticle Enhanced Crystallization of Sorbitol PCMs For Latent Heat and Temperature Control
9	Girish Anant Kini	Georgia Institute of Technology	P310	Corrosion in liquid cooling systems with water based coolant - Part 1: Flow loop design for reliability tests
10	Cristina Dragan	University Politehnica Timisoara, Romania	P329	Thermal Chamber Conditions vs. Car Environment Conditions
11	Albraa Alsaati	Purdue University	P394	Confined Immersion Cooling in Microscale Gaps
12	Francy Akkara	Auburn University	P300	Effect of Combining Solder Pastes with SAC305 Spheres on Component Reliability in Harsh Thermal Cycling
13	Thomas Germain	University of Central Florida	P335	The Effect of the Stiffness of Soft Materials on Hemiwicking Performance
14	Abhishek Deshpande	University of Maryland College Park	P346	Effect of Microscale Heterogeneities and Stress State on the Mechanical Behavior of Solder Joints
15	Abdullah Fahim	Auburn University	P354	Nanomechanical Characterization of Various Materials within PBGA Packages Subjected to Thermal Cycling Loading
16	Jacek Nazdrowicz	Lodz University of Technology	P390	Thermal Expansion Phenomena and Influence on Damping Coefficient and Stiffness Variation for MEMS Kinematic Quantity Microsensors and Microactuators
17	Debabrata Mondal	Auburn University	P404	Modeling Deformation Behavior of SAC305 Solder Joints with Multiple Grains

SESSION 4: MECHANICS AND RELIABILITY

	Student name	School	Paper #	Poster title
1	Tumininu Olatunji	University of Arkansas	P161	Fabrication of compliant interconnects using additive manufacturing
2	Rachel McAfee	Oregon State University	P174	Compatibility Analysis of Liquid Gallium and Common Packaging Metals for Applications in Electronic Component Thermal Management
3	Xin Wei	Auburn University	P301	Fatigue Performance of Doped SAC Solder Joints in BGA Assembly
4	Minghong Jian	Auburn University	P302	Effect of Varying Amplitude Cycling on SAC-Bi Solder Joint Fatigue
5	Mohammed Abueed	Auburn University	P305	Effect of Creep and Fatigue on Individual SAC305 Solder Joints Reliability at Elevated Temperature
6	Mohammad Al Ahsan	Auburn University	P332	Effect of Thermal Cycling on the Mechanical Behavior of Lead Free Solder Materials
7	Jun Chen	Auburn University	P336	Measurement of the Temperature Dependence of the Piezoresistive Coefficients of 4H Silicon Carbide
8	S M Hasan	Auburn University	P359	Mechanical Behavior Evolution of SAC+Bi Lead Free Solder Exposed to Thermal Cycling
9	KM Rafidh Hassan	Auburn University	P399	Microstructural Evolution of SAC305 BGA Joints during Extreme High Temperature Aging
10	Mohd Aminul Hoque	Auburn University	P402	Cyclic Stress-Strain and Constitutive Behaviors of SAC-Bi-Ni-Sb Solder Alloys
11	Jing Wu	Auburn University	P405	Investigation and Comparison of Microstructural Changes in SAC and SAC+X Solders Exposed to Short-Term Aging
12	Madhu Kasturi	Auburn University	P430	Effect of Long Term Isothermal Exposure on Underfill Material Properties
13	Aathi Raja Ram Pandurangan	Auburn University	P431	Effect of Shock Angle on Solder-Joint Reliability of Potted Assemblies Under High-G Shock
14	Padmanava Choudhury	Auburn University	P432	Effect of Thermal Aging on the Interface Fracture Toughness of the PCB-UF Interface
15	Vishal Mehta	Auburn University	P438	High Strain Rate Properties for SAC305 at Cold Operating Temperatures down to -65°C
16	Vikas Yadav	Auburn University	P440	Low Temperature High Strain-Rate Material Properties for SAC-Q Leadfree Alloy
17	Yunli Zhang	Auburn University	P441	The Degradation Mechanisms of Underfills Subjected to High Temperature Long Term Aging
18	Tony Thomas	Auburn University	P445	RUL Estimations of SAC305 Solder PCB's under Different Conditions of Temperature and Vibration Loads
19	Pengcheng Yin	SUNY Binghamton	P462	Shock Performance Enhancement of a Container for Rack Server
20	Jong Hwan Ha	SUNY Binghamton	P467	Effect of Misaligned Passive Component on Fatigue Life of Solder Joints and Solder Shape

CONFERENCE TECHNICAL PROGRAM

TRACKS & SESSIONS

COMPONENT-LEVEL THERMAL MANAGEMENT

- TI-1: Heat Sinks and Heat Exchangers I
- TI-2: Heat Sinks and Heat Exchangers II
- TI-3: Cold Plates I
- TI-4: Cold Plates II
- TI-5: Heat Pipes and Vapor Chambers I
- TI-6: Heat Pipes and Vapor Chambers II
- TI-7: TIMs and Heat Spreaders
- TI-8: Two-Phase Cooling Applications
- TI-9: LEDs and Power Electronics
- TI-10: Heterogeneous Integration
- TI-11: Thermal Analysis and Modeling
- TI-12: Cooling Fluids
- TI-13: Equipment Cooling

SYSTEM-LEVEL THERMAL MANAGEMENT

- TII-1: Data Center – Transient and Efficiency
- TII-2: Data Center – Air Flow
- TII-3: Data Center – Thermosyphon
- TII-4: Liquid Cooling – Boiling, Corrosion, and Fluids
- TII-5: Liquid Cooling – Immersion and Impingement
- TII-6: Liquid Cooling – Advanced Modeling
- TII-7: Thermal Systems - Semiconductor
- TII-8: Thermal Systems - Automotive
- TII-9: Thermal Systems - Edge
- TII-10: Thermal Systems - Battery Thermal Management
- TII-11: Thermal Systems – Mobile Devices
- TII-12: Thermal Systems - Motors and High Power Electronics
- TII-13: Solid-Liquid Phase Change - Materials and Modeling
- TII-14: Solid-Liquid Phase Change - Integration
- TII-15: Air Cooling - Extreme, Heat Sinks, and Fans

EMERGING TECHNOLOGIES & FUNDAMENTALS

- E-1: Numerical Methods, Nano-To-Macro Scale I
- E-2: Numerical Methods, Nano-To-Macro Scale II
- E-3: Additive Manufacturing I
- E-4: Additive Manufacturing II
- E-5: Flexible Electronics
- E-6: Single-/Two-Phase Convection in Microchannels and Jets
- E-7: Novel Measurements, Instrumentation and Experimental Techniques I
- E-8: Novel Measurements, Instrumentation and Experimental Techniques II
- E-9: Silicon Fabrication for Thermal Management Devices
- E-10: Emerging Materials and Fabrication Techniques
- E-11: Thermal Transport in Nanotechnology

MECHANICS & RELIABILITY

- M-1: Solder Joint Reliability I
- M-2: Solder Joint Reliability II
- M-3: Solder Joint Reliability III
- M-4: Solder Joint Reliability IV
- M-5: Package and Interconnect Reliability I
- M-6: Package and Interconnect Reliability II
- M-7: Aging of Solder Joint I
- M-8: Aging of Solder Joint II
- M-9: Reliability of Advanced Packaging
- M-10: Materials Characteristics and Accelerating Testing
- M-11: Chip Package Interaction
- M-12: Reliability Under Harsh Environments
- M-13: Sensors and Power Packages
- M-14: Reliability of Restraint Mechanisms

TRACKS, SESSIONS, AND PRESENTATIONS

Below is a listing of tracks, sessions, and papers for all ITherm 2020 Virtual papers that have been accepted after the peer review process. Pre-recorded presentations will be available for all registered attendees to view in the period of July 21st to Aug 19th. Links to all sessions are available on the ITherm website:
https://www.ieee-itherm.net/itherm/conference/ITherm-2020-Virtual

TRACK: COMPONENT LEVEL THERMAL MANAGEMENT

SESSION TI-1: HEAT SINKS AND HEAT EXCHANGERS I

Session Chairs: Yingying Wang (Google), Jorge Padilla (Google), Zhihang Song (Northeastern University China)

Novel experimental methodology for characterizing fan performance in a Highly Resistive Environments (p348)
Yaman Manaserh[1], Mohammad Tradat[1], Ghazal Mohsenian[1], Bahgat Sammakia[1], Alfonso Ortega[2], Mark Seymour[3], Kourosh Nemati[3]. [1]Binghamton University, [2]Villanova University, [3]Future Facilities

Force convection performance of the heat sink with embedded heat pipes comparing two embedding technologies for heat pipes (p425)
Neda Mansouri[1], Ahmed Zaghlol[2], Cliff Weasner[1]. [1]Mersen, [2]McMaster University

A novel heat exchanger effectiveness approach for exploring performance limits of two-phase mini-channel boilers (p378)
Felipe Valenzuela, Alfonso Ortega, Villanova University

SESSION TI-2: HEAT SINKS AND HEAT EXCHANGERS II

Session Chairs: Jorge Padilla (Google), Liang Yin (GE Global Research)

Thermal Hydraulic Performance of High Porosity High Pore Density Thin Copper Foams Subject to Array Jet Impingement (p206)
Varun Prasanna Rajamuthu, Sanskar Panse, Srinath Ekkad. North Carolina State University

Conjugate heat transfer analysis of the supercritical CO_2 based counter flow compact 3D heat exchangers (p251)
Janhavi Chitale[1], Abas Abdoli[2], George Dulikravich[1], Adrian Sabau[3], James Black[4]. [1]Florida International University, [2]TKelvin Corporation, [3]Oak Ridge National Laboratory, [4]National Energy Technology Laboratory

Numerical investigation of thermal transport in foam filled heat exchangers employing circular and non-circular jet impingement cross sections (p377)
Sina Kashkuli and Shadi Mahjoob. California State University Northridge

SESSION TI-3: COLD PLATES I

Session Chairs: Mark Schultz (IBM)

Evaluation of additively manufactured single-pass and two-pass enhanced microchannel heat sinks (p204)
Sanskar Panse and Srinath Ekkad. North Carolina State University

Experimental validation of a microfluidic cell cooling solution (p411)
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Session Chairs: Dishit Parekh (IBM), Corey Wilson (Thermavant), Benjamin Alexander (Thermavant)

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Session Chairs: Anil Yuksel (IBM Corporation), Stephanie Allard (IBM)

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Tanvir Ahmed Chowdhury, Chance Brewer, Shawn Putnam. University of Central Florida

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David Deisenroth, Michael Ohadi, Avram Bar-Cohen. University of Maryland

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Ji Yong Kim, Kyung Mo Kim, In Cheol Bang. Ulsan National Institute of Science and Technology

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TRACK: SYSTEM LEVEL THERMAL MANAGEMENT

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Session Chairs: Michael Fish (US Army Research Laboratory), Liang Gong (China University of Petroleum), Vibhash Jha (Dell Technologies)

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James VanGilder, Wei Tian, John Bean. Schneider Electric

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General thermosyphon simulation code for electronics cooling applications (p269)
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Implementation of passive two-phase cooling to an entire server rack (p270)
Filippo Cataldo[1], Raffaele Luca Amalfi[2], Jackson Braz Marcinichen[3], John Richard Thome[3]. [1]Provides Metalmeccanica Srl, [2]Nokia Bell Labs, [3]JJ Cooling Innovation Sarl - EPFL

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Session Chairs: Darin Sharar (US Army Research Laboratory), Damena Agonafer (Washington University)

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Session Chairs: Joshua Gess (Oregon State University), Bahman Abasi (Oregon State)

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Monique Embury, Stephen Solovitz. Washington State University Vancouver

Physically-motivated Figure of Merit (FOM) assessing the cooling performance of fluids suitable for the direct cooling of electrical components (p142)
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Effects of jet to wall spacings on heat transfer characteristics and flow fields of turbulently impinging nozzled jets on hot silicon (p355)
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Session Chairs: Akhilesh Rallabandi (Intel Corporation), Gavin Stanley (Microsoft)

Numerical study of multi hot spot GaN cooling in a cold plate considering different flow networks (p104)
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Thermal modeling of electrical machines with advanced fluid cooling (p171)
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Weihao Li[1,2], Longguang Zhu[2], Feng Ji[3], Jinling Yu[1], Yufeng Jin[2], Wei Wang[2]. [1]Fuzhou University, [2]Peking University, [3]Beijing Institute of Remote Sensing Equipment

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Session Chairs: Brian Donovan (United States Naval Academy), Sachin Deshmukh (Intel Corporation)

Numerical investigation of a novel cross-media heat exchanger (iCMHX) for gas-to-liquid cooling applications (p228)
Gargi Kailkhura, Raphael Kahat Mandel, Amir Shooshtari, Michael Ohadi. University of Maryland

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Sevket Umut Yuruker, Raphael Kahat Mandel, Patrick McCluskey, Michael Ohadi. University of Maryland

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Priyanka Tunuguntla, Guixiang (Ellen) Tan, Evan Chenelly. Intel Corp

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Session Chairs: David Huitink (University of Arkansas)

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Tyler Shelly, Justin Weibel, Davide Ziviani, Eckhart Groll. Purdue University

A thermal management design methodology for advanced power electronics utilizing genetic optimization and additive manufacturing techniques (p145)
Andrew Michalak, Shawkat Zaman, Omri Tayyara, Miad Nasr, Carlos Da Silva, James Mills, Olivier Trescases, Cristina Amon. University of Toronto

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Session Chairs: Xiaopeng Qu (Micron Technology)

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Systematic approach in Intel SoC (System on Chip) thermal solution design using CFD (Computational Fluid Dynamics) simulation (p455)
Chun Howe (CH) Sim, Chew Ching Lim, Vijay Hoskoti. Intel Microelectronics

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Session Chairs: Peter DeBock (GE Global Research)

An electrochemical-thermal coupled gas generation and overcharge-to-thermal-runaway model for large-format lithium ion battery (p158)
Jiajun Xu[1], Christopher Hendricks[2]. [1]University of the District of Columbia, [2]Naval Surface Warfare Center

Air-cooled battery-pack thermals and capacities under various operating temperatures and processes (p314)
Yuanchen Hu[1], Xiangfei Yu[1], Milnes David[1], Pinghan Chen[2], Steven Ahladas[1], Noah Singer[1]. [1]IBM Systems, [2]AcBel Polytech Inc.

Transient CFD heat transfer simulation model of air-cooled battery packs (p316)
Yuanchen Hu, Xiangfei Yu, Milnes David, Steven Ahladas, Noah Singer. IBM Systems

Transient thermal analysis on cell stack design for lithium ion battery backup unit in data center (p370)
Shuai Shao, Tianyi Gao, Huawei Yang, Jie Zhao, Jiajun Zhang. Baidu

SESSION TII-11: THERMAL SYSTEMS – MOBILE DEVICES

Session Chairs: Columbia Mishra (Intel Corporation), Yuling Niu (Huawei)

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Joe Alexandersen. University of Southern Denmark

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Thermal aware 3-D floorplanning on multi-stacked board of smart phone (p318)
Youngsang Cho, Heejung Choi, Yunhyeok Im, Heeseok Lee, Hoi-Jin Lee. Samsung Electronics

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Session Chairs: Peter DeBock (GE Global Research)

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Sierra Jarrett, Kyle McWethy, Jeb Flemming. Three-D Glass Solutions

Comparison between the theoretical, experimental and numerical thermal conductivity of composite thermal interface materials using copper metal foam (p217)
Shinya Kawakita[1], Minami Teranishi[2], Yuki Ishizaka[3], Kazuyoshi Fushinobu[3]. [1]Hitachi Automotive Systems Ltd, [2]Hitachi Ltd, [3]Tokyo Institute of Technology

Cooling of integrated electric motors (p345)
Zhaoxi Yao, Yonatan Saadon, Raphael Mandel, Patrick McCluskey. University of Maryland

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Session Chairs: Patrick Shamberger (Texas A&M)

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Justin Wang, Michael Fish, Morris Berman, Melissa McCann. Army Research Laboratory

Forward selection methodology for phase change material composite optimization (p240)
Alison Hoe, Alexandra Easley, Michael Deckard, Jonathan Felts, Patrick Shamberger. Texas A&M University

A reduced-order model for analyzing heat transfer in a thermal energy storage module (p245)
Karan Gohil[1], Michael Deckard[2], Patrick Shamberger[2], Neera Jain[1]. [1]Purdue University, [2]Texas A&M University

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David Huitink, Joshua Kasitz, Andres Vargas. University of Arkansas

SESSION TII-14: SOLID-LIQUID PHASE CHANGE - INTEGRATION

Session Chairs: Jingru Benner (Western New England University)

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Adeel Arshad, Mark Jabbal, Yuying Yan. University of Nottingham

Topology optimized phase change material integrated heat sinks and validation (p208)
Andres Vargas, David Huitink, Ange Christian Iradukunda, Conner Eddy. University of Arkansas

Feasibility study of active thermal energy storage for on-chip transient mitigation (p358)
Michael Fish, US Army Research Laboratory

SESSION TII-15: AIR COOLING - EXTREME, HEAT SINKS, AND FANS

Session Chairs: Ali Heydari (NVIDIA), Palkesh Jain (Qualcomm)

Electrodynamic fan blade for cooling small devices (p107)
Simon Strohmeyr, Sabri Baazouzi, Bernd Gundelsweiler. University of Stuttgart

Cooling heat sinks by forced and natural Convection in microelectronic packages: Numerical modeling and experimental hermal studies (p120)
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Air flow inversion for enhanced electronics cooling in additively manufactured air channels (p149)
Joshua Tompkins and David Huitink. University of Arkansas

TRACK: EMERGING TECHNOLOGIES AND FUNDAMENTALS

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Session Chairs: Amir Shooshtari (University of Maryland), Ajay Vadakkepatt (Qualcomm), Arjang Shahriari (Qualcomm)

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Yuqing Zhou, Tsuyoshi Nomura, Ercan Dede. Toyota

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Ruochun Zhang and Xiaoping Qian. University of Wisconsin-Madison

Numerical analysis of structured ribbed channels for electronic cooling applications (p397)
Daniel Huynh and Shadi Mahjoob. California State University Northridge

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Session Chairs: Huseyin Bostanci (University of North Texas), Eric Dede (Toyota), Amy Marconnet (Purdue University)

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Javed Shaikh, Mark Gallina, Bijendra Singh. Intel

Thermal sensor placement based on meta-model enhancing observability and controllability (p191)
Yunhyeok Im[1], Wook Kim[1], Taekeun An[1], Heeseok Lee[1], Young-Sang Cho[1], Jongkyu Yoo[1], Hoi-Jin Lee[1], Youngmin Shin[1], Myunghoon Lee[2], Vamsi Krishna Yaddanapudi[2]. [1]Samsung Electronics, [2]ANSYS

Temperature-to-power mapping for smartphones (p196)
Hong-Wen Chiou[1], Yu-Min Lee[1], Sheng-Chung Hsu[1], Guan-Jia Chen[1], Chi-Wen Pan[2], Tai-Yu Chen[2]. [1]National Chiao Tung University, [2]MediaTek Inc

SESSION E-3: ADDITIVE MANUFACTURING I

Session Chairs: Farah Singer (University of Maryland), Martinus Adrian Arie (University of Maryland)

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Shailesh Joshi[1], Ziqi Yu[1], Hacin Sennoun[2], Joseph Hampshire[2], Ercan Dede[1]. [1]Toyota, [2]GE Additive

Process development for additive fabrication of z-axis interconnects in multilayer circuits (p434)
Pradeep Lall[1], Nakul Kothari[1], Kartik Goyal[1], Jinesh Narangaparambil[1], Scott Miller[2]. [1]Auburn University, [2]NextFlex

Sintering process conditions for additive printing of multi-layer circuitry aerosol-jet process in conjunction with nanoparticle ink (p435)
Pradeep Lall[1], Jinesh Narangaparambil[1], Ved Soni1, Scott Miller[2]. [1]Auburn University, [2]NextFlex

Process-consistency in printed layers in multi-layer substrate using aerosol jet technology (p449)
Pradeep Lall[1], Kartik Goyal[1], Kyle Schulze[1], Scott Miller[2]. [1]Auburn University, [2]NextFlex

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Session Chairs: Herman Oprins (Imec), David Deisenroth (NIST), Xuhui Feng (NREL)

Additively manufacturing nitinol as a solid-state phase change material (p344)
Darin Sharar[1], Adam Wilson[1], Asher Leff[1], Andrew Smith[2], Kadri Atli[3], Alaa Elwany[3], Raymundo Arroyave[3], Ibrahim Karaman[3]. [1]US Army Research Laboratory, [2]US Naval Academy, [3]Texas A&M University

Additively printed multi-material temperature sensor realized using screen-printing (p428)
Pradeep Lall, Kartik Goyal. Auburn University

Process development and performance analysis of additively printed humidity sensor using aerosol jet printing (p436)
Pradeep Lall and Jinesh Narangaparambil. Auburn University

Process development for printing z-axis interconnects in multilayered flexible substrates (p450)
Pradeep Lall[1], Ved Soni[1], Jinesh Narangaparambil[1], Kyle Schulze[1], Scott Miller[2]. [1]Auburn University, [2]NextFlex

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Session Chairs: Xiaopeng Qu (Micron Technology), Brian Donovan (United States Naval Academy), Jeffrey Didion (NASA)

Effect of dynamic folding with varying fold orientations and C-rates on flexible power source capacity degradation (p426)
Pradeep Lall[1], Ved Soni[1], Scott Miller[2]. [1]Auburn University, [2]NextFlex

Flex-to-install application performance of power sources subjected to varying C-rates and depths of charge (p427)
Pradeep Lall[1], Ved Soni[1], Scott Miller[2]. [1]Auburn University, [2]NextFlex

Study on folding-reliability of wearable biometric band (p442)
Pradeep Lall[1], Hyesoo Jang[1], Curtis Hill[2], Libby Creel[2]. [1]Auburn University, [2]NASA MSFC

Correlation of accelerated tests with human body measurements for flexible electronics in wearable applications (p444)
Pradeep Lall[1], Tony Thomas[1], Jinesh Narangaparambil[1], Kartik Goyal[1], Hyesoo Jang[1], Vikas Yadav[1], Wei Liu[2]. [1]Auburn University, [2]AU-VCOM College Medicine

SESSION E-6: SINGLE-/TWO-PHASE CONVECTION IN MICROCHANNELS AND JETS

Session Chairs: Shadi Mahjoob (California State University Northridge), Harish Ganapathy (Intel)

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Uday Manda, Anatoly Parahovnik, Yoav Peles. University of Central Florida

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Ahmed Elkholy, Roger Kempers. York University

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Wenbin Tian, Michael Berktold, Casey Carte, Ellen Tan. Intel

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A novel thermal mapping technique using nano-confinement assisted quantum dots for transient cooling applications (p246)
Khan Mohammad Rabbi, Christopher Borden, Shawn Putnam. University of Central Florida

Health monitoring and feature vector identification of failure for SAC305 Solder PCBs under shock loads up to 10,000g (p443)
Pradeep Lall[1], Tony Thomas[1], Ken Blecker[2]. [1]Auburn University, [2]US Army CCDC-AC

Comparative analysis of package warpage using confocal method and digital image correlation (p458)
Chongyang Cai, Ke Pan, Junbo Yang, Seungbae Park. Binghamton University

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Qingbao Ren, Huiyu Yu, Yuanyang Liu, Zhenyu Wang. Peking University

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Farid Soroush[1], Ki Wook Jung[1], Madhusudan Iyengar[2], Chris Malone[2], Mehdi Asheghi[1], Kenneth E Goodson[1]. [1]Stanford University, [2]Google

A cascaded multi-core vapor chamber for intra-lid heat spreading in heterogeneous packages (p278)
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Marie-Audrey Raux, Per Anker Hassel, Linn Sorvik, Phillip Mayhew, Henrik Hemmen. CondAlign AS

Analyzing the distribution of microencapsulated organic phase change materials embedded in a metallic matrix (p224)
Melissa McCann[1], Michael Fish[2], Lauren Boteler[2], Damena Agonafer[1]. [1]Washington University in St Louis, [2]Army Research Laboratory

Effects of boundary conditions on the dynamic response of a phase change material (p248)
Patrick Shamberger[1], Alison Hoe[1], Michael Deckard[1], Michael Barako[2]. [1]Texas A&M University, [2]Northrup Grumman

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Pradeep Lall[1], Mrinmoy Saha[1], Jeff Suhling[1], Ken Blecker[2]. [1]Auburn University, [2]US Army CCDC-AC

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Session Chairs: Amy Marconnet (Purdue University), Jorge Padilla (Google)

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Interface density effects on cross-plane thermal conductance of nanolaminate thin films (p283)
Adam Wilson[1], Ronald Warzoha[2], Darin Sharar[1], Andrew Smith[2]. [1]US Army Research Laboratory, [2]US Naval Academy

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Diego Vaca[1], Luke Yates[1], Neeraj Nepal[2], Scott Katzer[2], Brian Downey[2], Virginia Wheeler[2], David Meyer[2], Samuel Graham[1], Satish Kumar[1]. [1]Georgia Institute of Technology, [2]US Naval Research Laboratory

TRACK: MECHANICS AND RELIABILITY

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Session Chairs: Przemyslaw Gromala (Robert Bosch GmbH)

Effect of varying amplitude cycling on SAC-Bi solder joint fatigue (p302)
Minghong Jian, Xin Wei, Sa'd Hamasha, Jeff Suhling, Pradeep Lall. Auburn University

Effect of microscale heterogeneities and stress state on the mechanical behavior of solder joints (p346)
Abhishek Deshpande, Qian Jiang, Abhijit Dasgupta. University of Maryland

The effect of misaligned passive component on fatigue life of solder joints and solder shape (p467)
Jonghwan Ha, Ke Pan, Huayan Wang, Daehan Won, SB Park. Binghamton University

SESSION M-2: SOLDER JOINT RELIABILITY II

Session Chairs: Patrick McCluskey (University of Maryland College Park)

Fatigue performance of doped SAC solder joints in BGA assembly (p301)
Xin Wei, Sinan Su, Sa D Hamasha, Haneen Ali, Jeff Suhling, Pradeep Lall. Auburn University

Effect of fatigue on individual SAC305 solder joints reliability at elevated temperature (p305)
Mohammed Abueed, Raed Alathamneh, Sad Hamasha, Jeff Suhling, Pradeep Lall. Auburn University

Effect of 100°C aging for periods of up to 120-days on high strain rate properties of SAC305 alloys (p437)
Pradeep Lall[1], Vishal Mehta[1], Jeff Suhling[1], Ken Blecker[2]. [1]Auburn University, [2]US Army CCDC-AC

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Session Chairs: A R Nazmus Sakib (NXP Semiconductors)

Parametric design study of a power electronics package for improving solder joint reliability (p303)
Paul Paret, Douglas DeVoto, Joshua Major, Sreekant Narumanchi. National Renewable Energy Laboratory

High strain rate properties of SAC305 at cold operating temperatures down to -65°C (p438)
Pradeep Lall[1], Vishal Mehta[1], Jeff Suhling[1], Ken Blecker[2]. [1]Auburn University, [2]US Army CCDC-AC

Low temperature high strain-rate material properties for SAC-Q leadfree alloys (p440)
Pradeep Lall[1], Vikas Yadav[1], Jeff Suhling[1], David Locker[2]. [1]Auburn University, [2]US ARMY CCDC AvMC

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Session Chairs: Abhijit Dasgupta (UMD)

The effect of Bi on the mechanical properties of aged SAC solder joint (p304)
Mohamed El Amine Belhadi, Francy John Akkara, Raed Alathamneh, Mohammed Abueed, Sa 'd Hamasha, Haneen Ali, Jeff Suhling, Pradeep Lall. Auburn University

Effect of thermal aging on the evolution of Anand parameters for SAC105 leadfree alloys operating at cold temperatures down to -55 C (p439)
Pradeep Lall[1], Vikas Yadav[1], Jeff Suhling[1], David Locker[2]. [1]Auburn University, [2]US Army CCDC-AC

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Session Chairs: Pradeep Lall (Auburn University)

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Iori Yaguchi, Sho Teradaira, Leo Umino, Qiang Yu. Yokohama National University

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Mei-Ling Wu, Wei-Jhih Wong. National Sun Yat-Sen University

Modelling indium interconnects for ultra fine-pitch focal plane arrays (p468)
Stoyan Stoyanov[1], Chris Bailey[1], Rhys Waite[2], Christopher Hicks[2], Terry Golding[3]. [1]University Of Greenwich, [2]Microchip Technology Inc [3]Amethyst Research Inc

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Session Chairs: David Huitink (University of Arkansas)

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Tumininu Olatunji, Mahsa Montazeri, David Huitink. University of Arkansas

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Reza Ghaffarian. California Institute of Technology

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Jia-Shen Lan, Mei-Ling Wu. National Sun Yat-Sen University

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Chung-Kuei Wang, Mei-Ling Wu. National Sun Yat-Sen University

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Session Chairs: David Huitink (University of Arkansas)

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Mohammad Al Ahsan, S M Kamrul Hasan, Abdullah Fahim, Jeffrey Suhling, Pradeep Lall. Auburn University

Mechanical behavior evolution of SAC+Bi lead free solder exposed to thermal cycling (p359)
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Isothermal aging dependent Anand parameters of SAC305 lead free solder at extreme high temperatures (p398)
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Mohd Aminul Hoque, Mohammad Ashraful Haq, Md Mahmudur Chowdhury, Jeffrey Suhling, Pradeep Lall. Auburn University

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Debabrata Mondal, Abdullah Fahim, Jeffrey Suhling, Pradeep Lall. Auburn University

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Jing Wu, Mohammad Alam, KM Rafidh Hassan, Jeffrey Suhling, Pradeep Lall. Auburn University

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Session Chairs: Pradeep Lall (Auburn University)

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Thomas Germain and Shawn Putnam. University of Central Florida

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Jacek Nazdrowicz, Andrzej Napieralski. Lodz University of Technology

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Pradeep Lall, Nakul Kothari. Auburn University

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Pengcheng Yin, Huayan Wang, Jiefeng Xu, Van Lai Pham, Seungbae Park. Binghamton University

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Session Chairs: Kenneth Blecker (CCDC AC)

Fabrication of a low cost flexible micro-device for measuring fiber thermal conductivity (p151)
Andrew Latulippe[1], Yassine Ait-El-Aoud[1], Richard Osgood[2], Hongwei Sun[1]. [1]University of Massachusetts Lowell, [2]US Army Combat Capabilities Development Command

Compatibility analysis of liquid gallium and common packaging metals for applications in electronic component thermal management (p174)
Rachel McAfee[1], Michael Fish[2], David Baker[2], Joshua Gess[1], Lauren Boteler[2]. [1]Oregon State University, [2]US Army Research Laboratory

Disk failure early warning based on the characteristics of customized SMART (p210)
Jian Zhao[1], Yongzhan He[1], Hongmei Liu[1], Jiajun Zhang[1], Bin Liu[1], Jun Zhang[2], Wenqing Lv[2], Alex Zhou[2], Feng Jiang[2], Jing Liu[2], Ahujia Nishi[2]. [1]Baidu, [2]Intel Corp

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Shohei Ohashi, Taiki Ogawa, Qiang Yu. Yokohama National University

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Session Chairs: Przemyslaw Gromala (Robert Bosch GmbH)

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Jun Chen, Jeffrey Suhling, Richard Jaeger. Auburn University

Nanomechanical characterization of various materials within PBGA packages subjected to thermal cycling loading (p354)
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Session Chairs: Steven Dunford (Schlumberger)

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Reza Ghaffarian. California Institute of Technology

Effect of combining solder pastes with SAC305 spheres on component reliability in harsh thermal cycling (p300)
Francy John Akkara, Cong Zhao, Arvind Sreenivasan, Sinan Su, Mohammed Abueed, Sa'd Hamasha, Haneen Ali, Jeff Suhling, Pradeep Lall. Auburn University

Effect of shock angle on solder-joint reliability of potted assemblies under high-G shock (p431)
Pradeep Lall[1], Aathi Pandurangan[1], Kalyan Dornala[1], Jeff Suhling[1], John Deep[2]. [1]Auburn University, [2]US AFRL

RUL estimations of SAC305 solder PCB's under different conditions of temperature and vibration loads (p445)
Pradeep Lall[1], Tony Thomas[1], Ken Blecker[2]. [1]Auburn University, [2]US ARMY CCDC Armament Center

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Session Chairs: Promod Chowdhury (Henkel), Jeff Suhling (Auburn University)

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Pradeep Lall[1], Padmanava Choudhary[1], Jeff Suhling[1], Jaimal Williamson[2]. [1]Auburn University, [2]Texas Instruments

The degradation mechanisms of underfills subjected to high temperature long term aging (p441)
Pradeep Lall[1], Yunli Zhang[1], Jaimal Williamson[2]. [1]Auburn University, [2]Texas Instruments

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Prabhakar Subrahmanyam, and Arun Krishnamoorthy

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Shurong Tian, Todd Takken, Mark Shultz, Chris Marroquin, Vic Mahaney, Yuan Yao, Michael J Ellsworth Jr, Anil Yuksel, and Paul Coteus

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Anirudh Krishna, Jin Myung Kim, Juyoung Leem, Michael Cai Wang, SungWoo Nam, and Jaeho Lee

EMERGING TECHNOLOGIES AND FUNDAMENTALS TRACK

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Investigation of Thermal Metamaterials Based on Nanoporous Silicon Using Ray Tracing and Finite Element Simulations

Ziqi Yu, Zongqing Ren, and Jaeho Lee

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Performance Characterization of a Novel Cross-Media Composite Heat Exchanger for Air-to-Liquid Applications Martinus Arie, David Hymas, Farah Singer, Amir Shooshtari, and Michael Ohadi

A Measurement Technique for Thermal Conductivity Characterization of Ultra- High Molecular Weight Polyethylene Yarns Using High-Resolution Infrared Microscopy Aaditya Candadai, Justin Weibel, and Amy Marconnet

MECHANICS AND RELIABILITY TRACK

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Comparisons of Solder Joints Fatigue Life Predictions and Several Long-Term Testing Results

Rainer Dudek, Kerstin Kreyssig, Sven Rzepka, Michael Novak, Wolfgang Gruebl, Peter Fruehauf, and Andreas Weigert

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Effects of Solder Mask Application Method on the Reliability of an Automotive Flip Chip PBGA Microcontroller

A R Nazmus Sakib, Richard S Lai, and Sandeep Shantaram

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A Metamodeling Approach for Optimization of Manifold Microchannel Systems for High Flux Cooling Applications

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Effect of Filler Configuration on the Effective Thermal Conductivity of Polymer Composites

Debraliz Isaac Aragones, Purdue University

SYSTEM-LEVEL THERMAL MANAGEMENT TRACK

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Heat Transfer and Pressure Drop Performance of Additively Manufactured Plastic Heat Sinks For Low-Weight Directed Cooling Integration For Power Electronics

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Two-Phase Cooling with Micropillar Evaporators: A New Approach to Remove Heat from Future High-Performance Chips

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EMERGING TECHNOLOGIES AND FUNDAMENTALS TRACK

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A Measurement Technique for Thermal Conductivity Characterization of Ultra-High Molecular Weight Polyethylene Yarns Using High-Resolution Infrared Microscopy

Aaditya Anand Candadai, Purdue University

OUTSTANDING POSTER

Identifying Hot Spots in Electronics Packages with a Sensitivity-Coefficient Based Inverse Heat Conduction Method

Patrick Krane, Purdue University

MECHANICS AND RELIABILITY TRACK

BEST POSTER

Investigation of Aging Induced Microstructural Changes in Doped SAC+X Solders

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OUTSTANDING POSTER

Effect of Shallow Charging on Flexible Power Source Capacity Subjected to Varying C-Rates and Extreme Temperature

Ved Soni, Auburn University

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June 1 – 4, 2021 San Diego, CA, USA

20th Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems

Call for Abstracts

The IEEE ITherm Conference is the leading international conference for scientific and engineering exploration of thermal, thermomechanical and emerging technology issues associated with electronic devices, packages, and systems. ITherm 2021 will be held along with the 71st ECTC at the Sheraton Hotel & Marina (San Diego, CA). Joint ITherm/ECTC registrations will be available at a significant discount. All abstracts are followed by full papers to be peer reviewed and published in the IEEE Xplore ITherm proceedings, with no technical presentation-only submissions. Student first authors will have the opportunity to apply for ITherm travel grants in order to participate in a Student Poster and Networking Session. ITherm 2021 will also feature keynotes by prominent speakers, vendor exhibits, panel discussions, invited technology talks, ECTC/ITherm joint networking events and short courses, an art-in-science exhibition, and a student design competition. Original papers are solicited in the following areas of interest:

Component-Level Thermal Management

- 3D Packaging & Heterogeneous Integration
- Package-Integrated Thermal Management
- Embedded Cooling
- Hotspot and Impingement Cooling
- Thermal Interface Materials and Heat Spreaders
- Thermoelectric and Peltier Devices
- Heat Pipes, Vapor Chambers and Thermosyphons
- Single / Two-Phase Cold Plates and Heat Sinks
- RF and Power Electronics
- LEDs, Photovoltaics, and Optoelectronics
- Thermal Management of Electric Machines
- Pulsed Power Dissipation

System-Level Thermal Management

- Air Cooling Techniques and Heat Exchangers
- Liquid Cooling Solutions
- Immersion Cooling and Refrigeration
- Pumps, Compressors, Fans and Blowers
- Phase Change Materials
- Automotive, Batteries and Thermal Storage
- Mobile and Internet of Things
- Telecommunication Systems
- Space and Aerospace
- Data Center Thermal Management
- Thermal Management in Electric Aircraft
- Modeling of Complex Thermal Systems
- Next-Gen Electronics Systems Co-Design

Mechanics & Reliability

- Thermo-Mechanical Modeling and Simulation
- Mechanics and Reliability of Solder Joints and Interconnects
- Materials Characterization, Processing, and Models
- Failure Mechanics, Fatigue, and Damage Modeling
- Measurement of Deformations, Strains and Stresses
- Shock, Drop and Vibrational Analysis
- TSV / 3D Reliability and Packaging
- Mechanics in Assembly and Manufacturing
- Applied Reliability and Failure Analysis
- Process-Structure-Property Relations / Multi-Scale Analyses
- Accelerated Stress Testing and Modeling
- Lifetime Prognostics and Condition Monitoring

Emerging Technologies & Fundamentals

- Boiling, Evaporation, and Condensation
- Convection in Microchannels, Microgaps, and Jets
- Pulsating / Oscillating and Non-Conventional Heat Pipes
- Nanoscale and Transistor-Level Thermal Transport
- Novel Materials and Fabrication Techniques
- Measurement and Diagnostic Techniques
- Numerical Methods, Nano-to-Macro Scale
- Experimental Methods, Nano-to-Macro Scale
- Prognostic Health Management and Reliability Analysis
- Wearable, Flexible, and Printed Electronics
- Additive Manufacturing
- Silicon Fabrication for Thermal Management Devices
- Predictive Analytics and Machine Learning

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