Advance Conference Program

The 23rd Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems

ITherm

DENVER, CO

2024

Gaylord Rockies Resort & Convention Center

Denver, CO

May 28 – 31, 2024

CONFERENCE DESCRIPTION

Sponsored by the IEEE's Electronics Packaging Society (EPS), ITherm 2024 is the leading international conference for the scientific and engineering exploration of thermal, thermomechanical and emerging technology issues associated with electronic devices, packages and systems. ITherm 2024 will be held along with the 74th Electronic Components and Technology Conference (ECTC 2024 - http://www.ectc.net), a premier electronics packaging conference at the Gaylord Rockies Resort & Convention Center (Denver, CO).

REGISTRATION

Please register for ITherm 2024 using our online registration page: https://itherm2024.exordo.com/. Registrations include admission to all sessions, conference luncheons, continental breakfasts for all attendees, and an electronic copy of the conference proceedings. Joint registration for ITherm and ECTC is offered at a substantial discount. Registration prices increase after May 3, 2024.

LODGING

The conference venue is the Gaylord Rockies Resort & Convention Center (Denver, CO). Special discounted hotel rates are available using the conference room block until May 4, 2024 or until rooms sell out. To reserve the hotel at the conference rates, please visit https://www.ieee-itherm.net/hotel-information/ for more information. Rooms are filling up fast, so please reserve your rooms early.

CONFERENCE SUMMARY

- **Over 220 Technical Papers and presentations** organized across four Technical Tracks:
    - Component-Level Thermal Management (TI),
    - System-Level Thermal Management (TII),
    - Mechanics & Reliability (M), and
    - Emerging Technologies & Fundamentals (E)

- **3 Keynote Talks**
    - **How Generative AI and Accelerated Compute is Creating the Next generation Liquid Cooled Data Centers with focus on Challenges, Opportunities and the Road Ahead*. Subramanian S. Iyer***, Director of the National Advanced Packaging Manufacturing Program (NAPMP)
    - **Multiscale Thermal Modeling of Electric Vehicle Batteries from Nanoscale Electrodes to Battery Pack Cooling Systems: Illustration of DeepEDH Neural Network-based Optimization of Battery Cold Plates. *Cristina Amon***, Alumni Distinguished Professor and Dean Emerita of the Faculty of Applied Science and Engineering at the University of Toronto
    - **Packaging: Then, Now, and in the Future. *Ali Heydari***, Distinguished Engineer and Data Center Technologist, NVIDIA

- **Richard Chu ITherm Award and Seminar**

- **5 Technology-Talk Sessions** providing deep-dive talks on high-profile topics

- **5 Panels** discussing the latest industry challenges and trends.

- **50 Student Posters** showcasing the latest research in an interactive networking environment

- **Federal Funding Landscape Panel** with representatives from government funding agencies.

- **Student Heat Sink Design Challenge Presentations**

- **ECTC/ITHERM Diversity and Career Growth Panel and Reception**

- **16 Professional Development Courses** offered as a collaboration with ECTC

- **Heterogeneous Integration Roadmap (HIR) All-Day Sessions** consisting of 4 technical sessions on Tuesday May 28, 2024.

CONFERENCE ORGANIZATION COMMITTEE

ORGANIZATION COMMITTEE		
General Chair	Ashish Gupta	Intel Corporation
Program Chair	Amy Marconnet	Purdue University
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Communications Chair	Jack Maddox	University of Kentucky
COMPONENT-LEVEL THERMAL MANAGEMENT TRACK (TI)		
Chair	Luca Amalfi	Seguente
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Co-Chair	Darin Sharar	Army Research Labs
Co-Chair	P. Subrahmanyam	Intel Corporation
SYSTEM-LEVEL THERMAL MANAGEMENT TRACK (TII)		
Chair	Amir H. Shooshtari	University of Maryland
Co-Chair	Patrick Shamberger	Texas A&M University
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EMERGING TECHNOLOGIES & FUNDAMENTALS TRACK (E)		
Chair	Jimil Shah	TMG Core
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Co-Chair	Weihua Tang	Google
Co-Chair	Saket Karajgikar	Meta
MECHANICS & RELIABILITY TRACK (M)		
Chair	David Huitink	University of Arkansas
Co-Chair	Lang Yuan	Intel
Co-Chair	Paul Paret	NREL
SPECIAL TECHNICAL CONTRIBUTIONS		
Panels Chair	Victor Chiriac	Global Cooling Technology Group, LLC
Panels Co-Chair	Kimberly Saviers	Raytheon Technologies
Panels Co-Chair	Vaibhav Bahadur (VB)	UT Austin
Technology-Talk Chair	Naveenan Thiagarajan	GE
Technology-Talk Co-Chair	Georges Pavlidis	University of Connecticut
Technology-Talk Co-Chair	Qian Han	Sorrento Solution
Federal Funding Landscape Chair	Patrick Shamberger	Texas A&M University
Federal Funding Landscape Co-Chair	Satish Kumar	Georgia Tech
Federal Funding Landscape Co-Chair	Sreekant Narumanchi	NREL
Poster Session Chair	Arjang Shahriari	Google
Poster Session Co-Chair	Joseph Hanson	Intel Corporation
Poster Session Co-Chair	Aakrati Jain	IBM
Keynote Chair	John Thome	JJ Cooling SARL
Keynote Co-Chair	Justin Weibel	Purdue University
PDC Short Course Chair	Jeffrey Suhling	Auburn University
PDC Short Course Co-Chair	Kitty Pearsall	IBM (Retired)
Diversity Panel Representative	Cristina Amon	University of Toronto
EPS/K16 Student Design Competition	Joe Alexandersen	Southern Denmark University
EPS/K16 Student Design Competition	Naveenan Thiagarajan	GE Research
EPS/K16 Student Design Competition	Amy Marconnet	Purdue University

EPS/K16 Student Design Competition	Sameer Rao	University of Utah
EPS/K16 Student Design Competition	Ronald Warzoha	US Naval Academy
EPS/K16 Student Design Competition	Jack Maddox	University of Kentucky
ADMINISTRATIVE		
Sponsoring & Exhibitor Chair	Mehdi Asheghi	Stanford University
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COMMUNICATION		
Conference Proceedings Manager	Paul Wesling	ITherm
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Publicity	John (Jack) Maddox	University of Kentucky
Social Media	Chirag Kharangate	Case Western Reserve University
AWARD COMMITTEE		
Richard Chu ITherm Award Chair	Sushil Bhavnani	Auburn University
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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	Thermal Consultant
Best Paper Award Co-Chair	Jeffrey Suhling	Auburn University
INTERNATIONAL ITHERM AMBASSADORS		
Ambassador	Roger Kempers	York University, Canada
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Ambassador	Mehmet Arik	Ozyegin University, Turkey
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Ambassador	Liang Chen	Xi’an Jiaotong University
Ambassador	Fushinobu Kazuyoshi	Tokyo Institute of Technology
Ambassador	Tim Persoons	Trinity College Dublin
Ambassador	Ryan Enright	Seguente

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
Sushil H. Bhavnani	Auburn University
Thomas Brunschwiler	IBM Research – Zurich
Dustin Demetriou	IBM Corporation
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Madhusudan Iyengar	Google
Yogendra K. Joshi	Georgia Institute of Technology
Gary B. Kromann	Thermal Consultant
Satish Kumar	Georgia Tech
Tom Lee	Xilinx
Michael Ohadi	University of Maryland
Alfonso Ortega	Villanova University
Koneru Ramakrishna	Thermal Consultant
Bahgat Sammakia	State University of New York at Binghamton
Jeffrey Suhling	Auburn University
Sandeep Tonapi	Anveshak
Justin Weibel	Purdue University

KEYNOTES

KEYNOTE CHAIRS: Justin Weibel (Purdue University) and John Thome (JJ Cooling Innovation SARL)

K-1: Packaging: Then, Now and in the Future

WEDNESDAY, MAY 29, 9:30 AM – 10:30 AM

Subramanian S. Iyer
Director of the National Advanced Packaging Manufacturing Program (NAPMP)

Abstract: Packaging has evolved from the role of primarily protecting the chip to one of overall system integration of heterogeneous chiplets. An important aspect of this integration is miniaturization. Feature sizes such as substrate wiring pitch, die-to-substrate bonding pitch, and inter-die distances need to shrink in a predictable manner to approach monolithic wiring pitches, last level via pitches and IP block spacings. We refer to this as shrinking down of the package. Simultaneously, we need to increase the number of dies interconnected on the package to improve performance and functionality. We refer to this as scaling out of the package. Current approaches to this include additional levels in the packaging hierarchy with concomitant increases in complexity and cost. We need to think of new ways of flattening the packaging hierarchy by enabling substrates with finer wiring pitches and the ability to assemble dies at fine pitch at high throughput. Besides the technology and processes needed to accomplish this, there are other difficult issues that need to be addressed: these include power delivery and thermal dissipation, high bandwidth, and potentially active wired, wireless, and photonic connectors to the external world or between subsystems. Finally, to make this vision a reality a chiplet ecosystem needs to be developed with mechanical and electrical standards that ensure interoperability and a high level of reuse. Similarly, a comprehensive EDA approach needs to be developed that goes well beyond electrical abstraction of the system and includes among other things thermal, thermomechanical considerations, power delivery, test methodology and reliability. This is a challenging opportunity and promises to continue the trend set by Moore's law, for system integration.

Bio: Subramanian S. Iyer (Subu) is Director of the National Advanced Packaging Manufacturing Program (NAPMP), on assignment from UCLA where he is Distinguished Professor and holds the Charles P. Reames Endowed Chair in the Electrical Engineering Department and a joint appointment in the Materials Science and Engineering Department at the University of California at Los Angeles. He is the founding Director of the Center for Heterogeneous Integration and Performance Scaling (UCLA CHIPS). Prior to that he was an IBM Fellow. His key technical contributions have been the development of the world's first SiGe base HBT, Salicide, electrical fuses, embedded DRAM and 45nm technology node and used to make the first generation of truly low power portable devices as well as the first commercial interposer and 3D integrated products. He has been exploring new packaging paradigms and device innovations that may enable wafer-scale architectures, in-memory analog compute and medical engineering applications. He is a fellow of IEEE, APS, iMAPS and NAI as well as a Distinguished Lecturer of IEEE EDS and EPS. He is a Distinguished Alumnus of IIT Bombay and received the IEEE Daniel Noble Medal for emerging technologies in 2012 the 2020 iMAPS Daniel C. Hughes Jr Memorial award and the iMAPS distinguished educator award in 2021.

K-2: Multiscale Thermal Modeling of Electric Vehicle Batteries from Nanoscale Electrodes to Battery Pack Cooling Systems: Illustration of DeepEDH Neural Network-based Optimization of Battery Cold Plates

THURSDAY, MAY 30, 9:30 AM – 10:30 AM

Cristina Amon
Alumni Distinguished Professor and Dean Emerita of the Faculty of Applied Science and Engineering

University of Toronto

Abstract: This presentation will focus on thermal-related issues of Lithium-ion batteries in electric vehicles (EV), beginning with a brief overview of current thermal challenges. We will describe our group's research activities of multiscale multiphysics thermal modeling from electrodes to cells, modules and battery packs, spanning up to six orders of magnitude, including temperature effects on electrode and cell degradation, thermophysical cell characterization, and thermal runaway. This keynote will also present our surrogate modeling methodology based on modular deep convolutional encoder-decoder hierarchical (DeepEDH) neural network architectures for computationally intensive conjugate heat transfer. We will illustrate the DeepEDH methodology for analyzing and optimizing EV battery thermal management pin-fin cold plate systems.

Bio: Cristina Amon is University Professor, Alumni Distinguished Professor and Dean Emerita of the Faculty of Applied Science and Engineering at the University of Toronto (UofT). She is the Scientific Director of the UofT's Electrification Hub and Director of the ATOMS Laboratory. Prior to joining UofT in 2006, she was the Raymond J. Lane Distinguished Professor and Director of the Institute for Complex Engineered at Carnegie Mellon University. She has pioneered the field of Computational Fluid Dynamics and the development of multidisciplinary multiscale hierarchical modelling, concurrent design and optimization methodologies for thermo-fluid transport phenomena, with applications to renewable energy, biomedical devices, and thermal management of electronics and electric vehicles.

Professor Amon was appointed to the Order of Canada and inducted into the Canadian Academy of Engineering, Royal Society of Canada, Hispanic Engineer Hall of Fame, Spanish Royal Academy and National Academy of Engineering. She is a fellow of all the technical societies in her field, including AAAS, ASME, ASEE, and IEEE, was recognized with the 2021 Richard Chu ITherm Award for excellence in Thermal and Thermo-Mechanical Management of Electronics, and received the highest honor for Engineers in Canada (2020 Engineers Canada Gold Medal) and Ontario (2015 PEO Gold Medal) for outstanding engineering public service, technical excellence and professional leadership.

Cristina Amon is the founding chair of the Global Engineering Deans Council and has served in numerous editorial and technical conference leadership roles, advisory and review boards in North America and abroad. She was the ITherm General Chair in 2002 and has been the co-organizer and founding chair of the ECTC-ITherm Diversity Panel since its inception in 2017. She received her Mechanical Engineering degree from Simon Bolivar University in Venezuela, and her M.S. and Sc.D. from the Massachusetts Institute of Technology.

K-3: How Generative AI and Accelerated Compute is Creating the Next generation Liquid Cooled Data Centers with focus on Challenges, Opportunities and the Road Ahead

FRIDAY, MAY 31, 9:30 AM – 10:30 AM

Ali Heydari
Distinguished Engineer and
Data Center Technologist

NVIDIA

Abstract: As NVIDIA continues to push the boundaries of high-performance computing, managing escalating power densities in data centers has become a crucial challenge. This keynote addresses the significant shift towards racks with power densities approaching 100 kW and the critical role of advanced liquid cooling systems in sustaining these high-density environments. We will delve into the implementation of both single-phase liquid and two-phase pumped refrigeration cooling techniques, examining their effectiveness in optimizing Power Usage Effectiveness (PUE) and reducing Total Cost of Ownership (TCO). The presentation will highlight the transformative impact these cooling solutions have on enhancing energy efficiency and operational sustainability in modern data centers. Attendees will gain insight into the challenges and innovations shaping the future of data center infrastructure, poised to support the intensive requirements of high-performance computing.

Additionally, the talk will delve into the role of NVIDIA Omniverse in creating physics-informed digital twins of data centers. This platform facilitates accurate simulations and real-time analytics, enabling data center operators to predictively model and optimize energy consumption and cooling efficiency across their facilities. By leveraging Omniverse, NVIDIA is setting a new standard in data center design and management, marrying high computational performance with environmental sustainability.

Attendees will gain valuable insights into the strategic implementations that are shaping the future infrastructure of data centers, poised to meet the demanding requirements of next-generation technologies.

Bio: Ali Heydari is a Distinguished Engineer and Data Center Technologist at Nvidia in charge of all data center cooling technology development at Nvidia. He has 20+ years of experience in the design and deployment of high-performance servers and DCs, including some of the largest in existence, involving hardware, software, infrastructure, efficiency, reliability, manufacturing, and deployment. He has extensive experience with customized high-performance systems as well as the deployment of energy efficiency measures in low, medium, and high-volume operations.

RICHARD CHU ITHERM AWARD FOR EXCELLENCE

ON SOME REACTION-DIFFUSION PROBLEMS IN ADVANCED PACKAGING

AWARD LUNCHEON TALK, WEDNESDAY, MAY 29, 12:30 PM – 2:00 PM,

2024 Richard Chu ITherm Awardee

Prof. Ganesh Subbarayan
James G. Dwyer Professor of Mechanical Engineering

Purdue University

Abstract: Reaction-diffusion phenomena such as electromigration, intermetallic compound (IMC) formation, phase segregation, and corrosion can significantly impact the reliability of interconnects in 2.5D and 3D packages. As the interconnects approach micron length scales, surface diffusion becomes a critical mechanism contributing to the observed failure phenomena in these structures. Therefore, it is essential to develop length scale appropriate governing theories, experimental techniques, and simulation methodologies that can capture the complex multiphysics interactions including surface diffusion. This presentation will provide an overview of recent work by the senior author and co-workers on these topics. We will describe a general continuum thermodynamics theory governing interfacial phenomena, and its specialization for reaction-diffusion problems. This will then be followed by Blech-inspired test structures to characterize the capping layer influence on electromigration void growth rate in circuit lines, as well as its extension to In-Line test structures for characterizing electromigration caused voiding and phase segregation in solder microbumps. We connect the theory with the electromigration experiments for the inverse calculation of adhesion energies of circuit lines to capping layers as well as for estimating diffusivities of Bi in SnBi solder joints. We will follow the experimental observations with an overview of phase field and Enriched Isogeometric Analysis (EIGA) simulation methodologies to solve the governing equations on complex geometrical domains. The experimental observations are explained using the simulation results. Finally, potential areas for future research in interconnect reliability modeling and characterization are discussed.

Ganesh Subbarayan is the James G. Dwyer Professor of Mechanical Engineering at Purdue University and the Co-Director of the Purdue-Binghamton SRC Center for Heterogeneous Integration Research in Packaging (CHIRP). He also serves as the Director of the recently created Atalla Institute for Advanced System Integration and Packaging (ASIP) at Purdue University. He began his professional career at IBM Corporation (1990-1993). He holds a B.Tech degree in Mechanical Engineering (1985) from the Indian Institute of Technology, Madras and a Direct Ph. D. (1991) in Mechanical Engineering from Cornell University. Dr. Subbarayan's research is broadly concerned with modeling and experimentally characterizing failure in microelectronic devices and assemblies. He was a pioneer in using geometric models directly for analysis, popularly referred to as Isogeometric Analysis. Among others, Dr. Subbarayan received the 2022 SRC Technical Excellence Award, 2005 Excellence in Mechanics Award from the ASME Electronics and Photonics Packaging Division and the NSF CAREER award. He is a Fellow of ASME as well as IEEE, and he served as the Editor-in-Chief of IEEE Transactions on Advanced Packaging during 2002-2010.

PROFESSIONAL DEVELOPMENT COURSES

A set of 16 Professional Development Courses (PDCs) are being offered as a collaboration between ITherm and ECTC conferences. Each of these courses are presented by world-class experts, enabling participants to broaden their technical knowledge base. All PDC courses will be held on Tuesday, May 28, 2024, the first day of the ITherm and ECTC conferences. A separate registration fee is required to attend these courses, and the PDC course registration can be performed at the ECTC registration website: https://www.ectc.net/registration/ or at the ECTC registration desk.

MORNING COURSES 8:00 AM – 12:00 PM

1. High Reliability Soldering in Semiconductor Packaging
COURSE LEADER: NING-CHENG LEE – SHINEPURE HI-TECH

2. Photonic Technologies for Communication, Sensing, and Displays
COURSE LEADER: TORSTEN WIPIEJEWSKI, Huawei Technologies

3. From Wafer to Panel Level Packaging
COURSE LEADERS: TANJA BRAUN AND PIOTR MACKOWIAK – FRAUNHOFER IZM

4. Eliminating Failure Mechanisms in Advanced Packages
COURSE LEADER: DARVIN EDWARDS – EDWARDS ENTERPRISES

5. Navigating Thermal and Reliability Challenges in Chip Components for Automotive High-Performance Compute Systems
COURSE LEADER: FEN CHEN -- AUTOMOTIVE RELIABILITY/VALIDATION CONSULTATION SERVICES

6. Polymers for Advanced Packaging
COURSE LEADER: JEFFREY GOTRO –INNOCENTRIX, LLC

7. Flip Chip Technologies
COURSE LEADER: SHENGMIN WEN – HAISEMI, INC.

8. Reliable Integrated Thermal Packaging for Power Electronics
COURSE LEADER: PATRICK MCCLUSKEY – UNIVERSITY OF MARYLAND

AFTERNOON COURSES 1:30 PM – 5:30 PM

9. Additive Flexible Hybrid Electronics – Manufacturing and Reliability
COURSE LEADER: PRADEEP LALL – AUBURN UNIVERSITY

10. Fundamentals of RF Design and Fabrication Processes of Fan-Out Wafer/Panel Level and Advanced RF Packages
COURSE LEADERS: IVAN NDIP – FRAUNHOFER IZM/BRANDENBURG UNIVERSITY OF TECHNOLOGY AND MARKUS WÖHRMANN – FRAUNHOFER IZM

11. Advanced Packaging – Fan-Out, Chiplet, and Heterogeneous Integration
COURSE LEADER: JOHN LAU – UNIMICRON

12. Analysis of Fracture and Delamination in Microelectronic Packages
COURSE LEADER: ANDREW TAY - NATIONAL UNIVERSITY OF SINGAPORE

13. Advanced Packaging for MEMS and Sensors
COURSE LEADER: HORST THEUSS – INFINEON TECHNOLOGIES AG

14. Nano Materials and Polymer Composites for Electronic Packaging
COURSE LEADERS: C.P. WONG – GEORGIA TECH AND DANIEL LU – HENKEL CORPORATION

15. Design-On-Simulation for Advanced Packaging Reliability and Life Prediction
COURSE LEADERS: KUO-NING CHIANG – NATIONAL TSING HUA UNIVERSITY AND XUEJUN FAN – LAMAR UNIVERSITY

16. Thermal Spreading and Contact Resistance
COURSE LEADERS: YURI MUZYCHKA – MEMORIAL UNIVERSITY OF NEWFOUNDLAND AND MARC HODES – TUFTS UNIVERSITY

HETEROGENEOUS INTEGRATION ROADMAP (HIR) SPECIAL SESSIONS

TUESDAY, MAY 28, 8:00 AM – 5:30PM

Chairs: Ravi Mahajan (Intel) and **William Chen (ASE)**

- Engineering Chiplets for the AI Era
- Challenges and Innovations in Thermal Engineering from Fan-out to 2.5D and 3D Stacking
- Packaging Challenges and Innovation for Future Communication Systems
- CHIPS Act Roundtable Chat

YOUNG PROFESSIONALS NETWORKING PANEL

TUESDAY, MAY 28, 7:00 – 7:45 PM

Chairs: Aakrati Jain (IBM)

Join us for an invaluable opportunity to connect with industry leaders and fellow emerging talents! Tailored specifically for young professionals, including current graduate students, this event is crafted with your needs in mind. Engage in dynamic interactions with senior EPS members and professionals through a series of active and engaging activities. Seize the chance to delve deeper into packaging-related topics, pose career questions, and connect with industry professionals for a valuable learning experience

ECTC/ITHERM DIVERSITY & CAREER GROWTH PANEL AND RECEPTION

EFFECTIVE PRACTICES TO ATTRACT, PROMOTE AND RETAIN A DIVERSE WORKFORCE

WEDNESDAY, MAY 29, 6:30 – 7:30 PM

Chairs: Cristina Amon (University of Toronto) and **Vidya Jarayam (Intel)**

Semiconductor, electronic packaging and energy-related companies are planning to grow their workforces to meet the current and expected demands due to policy incentives and domestic investments, including the CHIPS Act. To achieve business and economic success, we will need to attract a broader group of students to the relevant fields and expand beyond the traditional pool of candidates to include women and underrepresented minorities from rural candidates to veterans and mid-career retrainees. This panel will focus on how best practices in Diversity, Equity and Inclusion have been implemented and can be used to attract students and hire, develop, promote and retain employees within organizations to meet their goals.

The panelists will introduce some of the challenges faced by women, minorities, and underrepresented groups, as well as share their organization’s strategies for professional development, promotion, retention, and success. This will be followed by an interactive Q&A with the audience. After the panel session, a social and networking reception will be held. All ECTC and ITherm attendees are invited to join in on this engaging discussion and the reception afterwards.

Panelists:

Kylie Patterson
NIST-CHIPS Program Office

Allyson Stewart
Marvell Inc.

Al Ortega
Villanova University

Tina Herrera
NREL

Margaret Kindling
SEMI Foundation

Ravi Mahajan
Intel

EPS PRESIDENT'S PANEL SESSION

CHALLENGES IN EDUCATION AND WORKFORCE DEVELOPMENT IN THE NEW CHIPS ECONOMY

FRIDAY, MAY 31, 8:00-9:15 AM

Chairs: **Patrick Thompson (Texas Instruments), Mark Poliks (Binghamton University), Jeff Suhling (Auburn University),** and **Kitty Pearsall (Boss Precision Inc.)**

The semiconductor and packaging industries are currently experiencing unparalleled growth, driven by demand in areas such as AI, transportation electrification, digital manufacturing, data centers, mobile devices, hybrid flexible electronics, virtual reality, and photonics and MEMS. This expansion has prompted substantial global investments in new fabs and packaging infrastructure, supported by government spending in North America, Europe, and Asia.

However, the parallel surge in demand for skilled labor poses a considerable challenge, with estimates indicating a threefold increase in headcount required over the next five years. The industry is seeking individuals with multidisciplinary education, ranging from technician degrees to Ph.D. degrees. The panel will explore workforce needs, industry perspectives on student preparation, global approaches to electronics packaging education, and innovative strategies to attract students to the semiconductor packaging field.

Panelists:

John Oakley
Semiconductor Research Corporation

Toni Mattila
Business Finland

Jim Wieser
Texas Instruments

Robert Geer
SUNY Polytechnic University

Wenhui Zhu
Central South University

STUDENT HEAT SINK DESIGN CHALLENGE

WEDNESDAY, MAY 29, 5:30 – 6:30 PM

The Student Heat Sink Design Challenge is a team competition in which students design, analyze, and optimize an additively manufactured, stainless steel heat sink to cool a constant heat flux power electronics module subject to natural convection. The design from each student team is then evaluated based on a series of design and manufacturing criteria. The teams having the most effective and creative designs had the opportunity to test their design using the additive manufacturing facilities at GE and using state-of-the-art test equipment at the University of Southern Denmark in the lab of Prof. Joe Alexandersen.

Aero Pro Max

It Depends

MSAM-MDAM

Team UC

Team Radiant

Crimson Peak

LeoSink

Team ETH

SRM Mass

Additive Manufacturing supported by:

FEDERAL FUNDING LANDSCAPE PANEL

THURSDAY, MAY 30, 4:00 – 5:30PM

Session Chair: **Patrick Shamberger (Texas A&M University), Sreekant Narumanchi (NREL),** and **Satish Kumar (Georgia Tech)**

The federal funding landscape panel provides a platform to engage with program managers of different government agencies and learn better about their programs. In this workshop, program managers will describe their programs and the successes that have come out of them, as well as directions moving forwards.

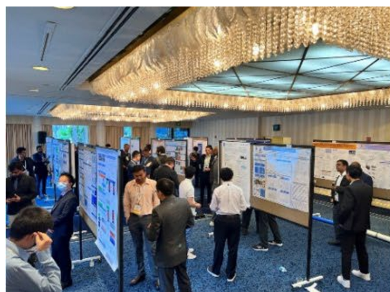
Speakers:

- Dr. Peter de Bock (ARPA-E)
- Dr. Yogendra Joshi (DARPA)
- Dr. Sumanta Acharya (NSF)
- Dr. Tina Kaarsberg (AMMTO)

STUDENT POSTER SESSION

THURSDAY, MAY 30, 5:30 – 7:00 PM

Students get the opportunity to present their research and interact with other conference attendees from industry and academia during the Student Poster and Networking Session. They can also distribute resumes and get connected to industrial representatives. Outstanding posters will be selected for awards and will be judged based on technical merit, clarity and self-sufficiency of the content, novelty and originality of the work, overall impact of the poster display, and oral presentation at the poster session.



TECHNOLOGY-TALK SESSIONS

TT-1 DATA CENTERS IN 2035

WEDNESDAY, MAY 29, 8:15 – 9:15 AM

Session Chair: Naveenan Thiagarajan (GE) and Qian Han (Sorrento Solution)

NREL SUSTAINABLE HPC/DATA CENTER EFFORTS: PAST, PRESENT, AND FUTURE

David Sickinger
NREL

Abstract: The National Renewable Energy Laboratory (NREL) made the move in 2012 to use liquid cooling technologies such as cold plate and immersion in its high-performance computing (HPC) data center. A paradigm-shift mentality has kept NREL's researchers pushing the boundaries of computing – with major objectives involving the responsible stewardship of energy, water, and waste products. Data center heat reuse within the campus, and an innovative thermosyphon cooling system that has saved over 6.5 million gallons of water since 2016 are illustrations of that. Algorithmic energy consumption improvements and measurements, data center efficiency, and the waste cycle of computers and materials are currently being explored. The talk will share a vision on sustainable HPC/data centers of the future.

Bio: David Sickinger is a researcher in the Advanced Computing Operations Group within the Computational Science Center at the National Renewable Energy Laboratory (NREL) located in Golden, Colorado. Since 2012, he has been involved with the operation of the mechanical systems supporting NREL's High Performance Computing data center that currently house the Eagle and Kestrel supercomputers. His research focus is on energy-/water- efficient data center facilities and liquid-cooling technologies. He has a MS degree in mechanical engineering from the University of Arizona. David is a Certified Energy Manager (CEM - from the Association of Energy Engineers) and a Data Center Energy Practitioner – HVAC Specialist (DCEP - from the U.S. Department of Energy).

DATA CENTERS IN 2035 AND BEYOND: DEFUSING JEVON'S PARADOX

Daniel Bizo
Uptime Institute

Abstract: Data center infrastructure presents a multi-layered conundrum. While underpinning disruptive services, they're surprisingly resistant to forces of change themselves; they also remain wasteful with capacity and energy, but performance improvements contribute to even higher resource consumption, also known as Jevon's paradox. Further optimizations of power, cooling and IT systems will unlikely change this trajectory — rather, as the explosive demand for large generative AI models shows, will only accelerate the strain on the environment and supply chains. As growing energy, water and land use will prove to be untenable with the public and policymakers, the data center industry will be forced to radically change its ways. This presentation offers a draft image of what the future of data centers may look like.

Bio: Daniel Bizo, Research Director, Uptime Intelligence, an Uptime Institute Unit. Daniel serves as Research Director at Uptime Institute. Over the past 20 years, he has covered the business and technology of enterprise IT and infrastructure in various roles, the past 13 years as an industry analyst and advisor. His research primarily focuses on data center energy performance, including thermal operation guidelines, liquid cooling and heat rejection, and IT thermal and power management.

Data Center Cooling Technology for a Sustainable Future- Elimination of Water Usage with an End-to-End Pumped-2-Phase (P2P) Refrigerant Closed Loop Ecosystem Cooling Architecture

Herman Chu
Celestica

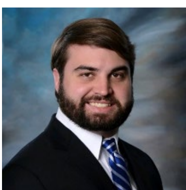
Abstract: As data center deployments growing exponentially and increasing power demand of the servers and networking equipment, it is an enormous strain on municipal water supply. The talk will highlight Celestica's efforts in transforming today's single-phase liquid (mainly some form of water mixture) cooling to refrigerant based cooling that can eliminate the complete usage of water in the data center for cooling purposes. We are developing P2P cooling systems to take the heat directly from the chip all the way out to the environment with refrigerant. The talk will highlight the overall architecture, thermal performance advantage and supply base landscape to go to P2P cooling technology, and new refrigerants from being developed for reduced global warming potential.

Bio: Herman Chu is a senior principal engineer at Celestica and manages the thermal engineering team in North America. His passion, since the early 2000, has been in energy efficiency and sustainability for telco space and data centers. He established rack level power density design targets for networking equipment design based upon different parameters, such as global energy consumption and data center cooling performance and efficiency, before the term "Green" was coined for sustainability. He was an early participant in the Telecom industry in defining the metrics for measuring energy efficiency for telco equipment.
Throughout his career, he has been an industry leader in pioneering efforts developing and deploying high performance thermal solutions, such as high-fin density folded/zipper fin heat sink, heat pipe, vapor chamber and pumped-2-phase liquid cooling for commercial computing/networking equipment.

TT-3 Quantum computing - Packaging and Thermal Considerations

WEDNESDAY, MAY 29, 2:00 – 3:30 PM

Session Chair: Georges Pavlidis (University of Connecticut) and Naveenan Thiagarajan (GE)



Challenges and Opportunities in mK System Thermal Management

Christopher Barrow
Northrup Grumman

Abstract: As interest in and the maturity of superconductive electronics systems grows, more engineering effort is pouring into chip, package, and cryo-system design. Although, the on-chip circuits in these systems are superconducting and dissipate little power, the supporting hardware can be a source of active power dissipation as well as passive heat load from high temperature stages. The extremely low temperature (10s of mK) of operation necessarily implies that relevant thermal conductivities will be reduced by many orders of magnitude, such that mismanagement of even a few uW could cause unacceptable thermal profiles. We review important design considerations for these systems, which include electron-phonon decoupling, superconductivity, phononic thermal transport, interfacial thermal resistance, low-temperature material (bulk & thin-film) properties, and the challenges of verification through low-temperature metrology.

Bio: Christopher is a Principle Thermal Engineer at Northrop Grumman Microelectronics Center, developing thermal models for the next generation of computing. He is completing his Doctorate at the University of Kentucky under Dr. Jack Maddox.

THERMAL AND PACKAGING CONSIDERATIONS FOR TRAPPED ION QUANTUM COMPUTING

Daniel Slichter
National Institute of Standards and Technology (NIST)

Abstract: Atomic ions trapped in ultra-high vacuum are a leading platform for a variety of applications, including quantum computing. The ions are confined by a combination of static and oscillating electric potentials applied to complex electrode structures, which are often microfabricated on chips. Such surface-electrode ion traps can enable scaling to large numbers of trapped ion qubits, as require for quantum computing applications. In addition to the electrodes used to confine and spatially reconfigure the ions, the trap chips can also integrate elements used to control and read out the states of trapped ion qubits, such as current-carrying wires, photonic waveguides, photon detectors, and active electronics such as digital-to-analog converters. Scaling up surface-electrode ion traps, especially those with additional integrated elements, to hold increasing numbers of ion qubits comes with a corresponding increase in dissipated power on chip due to the confining potentials and the control signals, as well as an increase in the number of electrical and optical signals that must be routed to the chip. The trap chip itself is in ultra high vacuum, typically in a cryogenic environment at temperatures near 4 K. In this presentation, I will endeavor to describe the thermal, electrical, and optical packaging challenges that present themselves for larger-scale trapped-ion quantum computing systems.

Bio: Daniel Slichter is a physicist in the Ion Storage Group at NIST in Boulder, Colorado. His research focuses on quantum information experiments with trapped atomic ions, with an emphasis on developing new paradigms for scalable trapped ion quantum computing and creating long-distance quantum networks with trapped ion memory and computation nodes. He received his A.B. in physics (2004) from Harvard University, and his M.A. (2007) and Ph.D. (2011) in physics from the University of California, Berkeley. His Ph.D. research was in the field of superconducting quantum information, where he demonstrated the first continuous high-fidelity measurement of a superconducting qubit, and studied quantum feedback, measurement backaction, and near-quantum-limited parametric amplification. He was the recipient of a Hertz Foundation Fellowship (2006–2011), the Hertz Foundation Thesis Prize (2012), an NRC Postdoctoral Fellowship (2012–2014), a Kavli Fellowship (2016), and the NIST Jacob Rabinow Applied Research Award (2023). He has also served as an Associate Editor for IEEE Transactions on Quantum Engineering (2020-2023). He is a Senior Member of IEEE.

THERMAL BUDGET FOR CRYOGENIC SIGNAL DELIVERY IN SUPERCONDUCTING QUANTUM COMPUTING

Florent Lecocq
National Institute of Standards and Technology (NIST)

Abstract: As superconducting quantum computers steadily increase in complexity, they are outgrowing the cryogenic environment in which they are housed. This realization has sparked brute-force engineering projects aiming at building larger cryostats with higher density wiring. It also motivated the idea of using photonic links to enable the massive delivery of classical signals to ultracryogenic temperatures, or even quantum-coherent links to build a network of processors living in separate cryostats. Here I will review the state-of-the-art, focusing on the delicate balance between wiring heat load and cryostat cooling power.

Bio: Florent Lecocq is a research scientist at the National Institute of Standards and Technology (NIST) in Boulder, in the Advanced Microwave Photonics group. The group focuses on developing technologies for quantum measurements and quantum information science using superconducting circuits. This includes the development of high-speed parametric qubit gates, nonreciprocal parametric amplifiers, microwave opto-mechanical devices and microwave-to-optical interconnects. Florent received his PhD in physics from the University of Grenoble and the Néel Institute before joining NIST in 2011.

IBM Quantum - System Thermal Design

Milnes P. David
IBM

Abstract: Beginning in 2016, IBM has continued to innovate in and develop qubit chip design, quantum system design and scaling, and quantum software, for research and commercial use. This work resulted in Quantum System One, which was unveiled as the first commercial circuit-based quantum system in January 2019. Since that beginning, there are now over 10 utility-scale quantum systems deployed worldwide, two global quantum data centers, and the upcoming unveiling of Quantum System Two, a modular quantum computer architecture enabling quantum-centric supercomputing.

This tech-talk will provide an overview of the cryogenic cooling used in IBM Quantum System One to maintain the qubits at the necessary millikelvin temperatures, and then delve into other important factors in thermal management of the quantum system. This includes the thermal design to cool the extensive room temperature electronics that interface the qubits to the outside world and how this design intersects with acoustic and industrial needs. We will also provide a brief overview of the upcoming Quantum System Two hardware.

Bio: Dr. Milnes P. David is the zSystems Thermal Architect with IBM Corporation in the Infrastructure Power Packaging and Cooling Group. He is responsible for managing the thermal technology roadmap and leading the overall design, analyses and development of cooling hardware and solutions used in the IBM zSeries Mainframes. He also leads the exploration and enablement of new thermal technologies to improve thermal management and energy efficiency of IBM hardware. Milnes also provides system-level thermal design, analysis and deployment support for IBM Quantum. He is also an IBM Master Inventor with over 100 patents and is an author on over 30 publications. Before joining IBM, Milnes received his doctoral degree in Mechanical Engineering from Stanford University where he studied Two-Phase Flows in Microstructures with Prof. Ken Goodson.

TT-5 Innovations in Industrial Systems

WEDNESDAY, MAY 29, 2:00 – 3:30 PM

Session Chair: Naveenan Thiagarajan (GE) and Qian Han (Sorrento Solution)

Thermal and Energy Management Enabling Next Generation Industrial Systems for the Energy Transition

Bill Gerstler
GE Vernova Advanced Research

Abstract: The energy transition requires simultaneously electrifying and decarbonizing the world. The U.S. Energy Information Administration (EIA) projects a 33-75% increase in global electrical demand by 2050 in their 2023 International Energy Outlook (IEO) while COP28 (Conference of the Parties) in 2023 maintained a goal of worldwide net zero carbon dioxide emissions by 2050 to limit global warming to 1.5C by 2100. Carbon Capture, including Direct Air Capture (DAC) is a key technology that supports net zero goals. Concurrently, the availability and management of water is increasingly challenging – from industrial & military needs, building heating ventilation and air conditioning (HVAC), and worldwide availability of clean drinking water. Atmospheric Water Extraction (AWE) plays a role to meet the challenge. Thermal and energy management are intimately integrated in both DAC and AWE. Modeling and analysis show thermal integration is a key aspect to meet operating and capital cost goals that enable DAC. Similarly, thermal and energy integration in AWE enables technology to operate in environmental conditions impossible for existing technologies while using less energy. Lessons learned from thermal and energy management of DAC and AWE can be applied to other key industries that are part of the energy transition including Data Centers and HVAC.

Bio: Bill Gerstler is a Senior Principal Engineer in the Carbon Capture organization at GE Vernova Advanced Research in Niskayuna NY. During his 23-year career at GE, his research has concentrated in thermal management of applications including power turbines, generators, motors, power electronics, aircraft systems, and aircraft engines. Current interests include thermal and energy management, system design & testing, and applications for carbon capture and atmospheric water extraction technologies. Bill has 38 conference and journal publications. He also has 69 U.S. patents granted. He is a Fellow of ASHRAE.

Advanced Power Electronics and Electric Machines Packaging, Thermal Management, and Reliability for Electric-Drive Mobility Applications

Sreekant Narumanchi
NREL

Abstract: Electronics, power electronics, and electric machines are becoming important for an array of mobility/transportation, renewable energy, and energy efficiency applications. In this presentation, I will introduce NREL and my group. Then, I will describe some challenges and opportunities for power electronics, electric machines, and electric traction drive systems for mobility applications. After that, I will give an overview of my group's recent research activities in power electronics, electric machines and integrated (electric) traction drive systems with focus on thermal management and packaging.

Bio: Sreekant Narumanchi is a Distinguished Member of Research Staff, and the Group Manager of the Advanced Power Electronics and Electric Machines (APEEM) Group within the Center of Integrated Mobility Sciences at the National Renewable Energy Laboratory, in Golden, CO, U.S.A., where he is

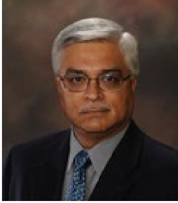
currently in his 20th year. He leads a Group of 15 researchers focused on electro-thermal, thermal-fluids, thermo-mechanical and reliability aspects of power electronics and electric machines for electric-drive vehicles and several energy efficiency and renewable energy applications. Over the years, his group has collaborated with over 80 institutions cutting across industry, universities, national labs, federal agencies, and other research institutions.

Sreekant is an American Society of Mechanical Engineers (ASME) Fellow, and an Institute of Electrical and Electronics Engineers (IEEE) Senior Member. He has published over 115 peer-reviewed journal and conference papers and book chapters. Professionally, he is active in leadership roles on multiple committees, advisory boards, conferences, and journals – including those under IEEE and ASME. Some of the external awards Sreekant has received include the 2023 ASME Avram Bar-Cohen Memorial Medal, and the 2022 THERMI Award. Sreekant received a Ph.D. from Carnegie Mellon University (2003), M.S. from Washington State University (1999), and B. Tech. from Indian Institute of Technology Kanpur (1997), all in Mechanical Engineering.

TT-7 Novel Structures and Surfaces for Enhanced Heat Transfer

WEDNESDAY, MAY 29, 2:00 – 3:30 PM

Session Chair: Naveenan Thiagarajan (GE) and Georges Pavlidis (University of Connecticut)



Phase-Change Cooling of Electronics in Microgravity

Sushil H. Bhavnani
Auburn University / ECS Tech

Abstract: Manned space missions to neighboring planetary destinations have risen to the top of NASA's priorities. Advances in control and communication technologies drive the need for higher heat fluxes in on-board electronics. Phase-change cooling is once-again an ongoing area of interest. Under microgravity conditions, the absence of buoyancy forces disrupts bubble dynamics preventing bubbles from detaching from surfaces. This leads to the formation of a large vapor mass attached to the surface that leads to a large rise in surface temperature. This Tech Talk features the exploration of a meso-scale engineered surface in the form of saw-toothed structures that causes favorable changes in the interfacial radius of curvature of the vapor slug in the immediate vicinity of the surface, producing a net force that can propel the vapor mass away from the heat source in a lateral direction. The surface is built with intentional nucleation sites to allow this motion to occur in a designed direction. Following terrestrial studies on a variety of surface morphologies and process conditions, experiments were conducted on-board zero-gravity aircraft and the International Space Station. The test chambers were in the form of square cross-sectioned glass ampoules, with deposited thin film heaters. The flight test and instrumentation hardware; ASCENT (Asymmetric Sawtooth and Cavity-Enhanced Nucleation-driven Transport) was developed in concert with a NASA implementation partner to conform to stringent flight requirements. The Tech Talk will include both quantitative data and imagery obtained by orthogonal high-speed cameras, for several geometric and process variables. The microstructured surface offers the promise of enhanced thermal management solutions for electronics in suppressed buoyancy conditions without the complexity of flow loops.

Bio: Sushil H. Bhavnani is Burt Professor Emeritus at Auburn University. His current affiliation is with ECS Tech in Fairfax, Virginia, supporting DARPA Programs. His primary research area is in liquid cooling of high-powered microprocessors. He is a past recipient of the ASME Electrical and Electronics Packaging Division's Clock Award for sustained contributions to the area of electronics packaging. He has served as the General Chair of the Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems (ITherm). He has authored 180 refereed journal and conference publications resulting from research sponsored by agencies such as NASA, the National Science Foundation, Southern Company, the U. S. Department of Energy, and the U. S. Department of Defense. While at Auburn, he was recognized with several teaching excellence awards, including the Mortar Board Award, the Walker Award, the Birdsong Award, the Pumphrey Award, and the Leischuck Presidential Award for Excellence in Teaching. He is a Fellow of the American Society of Mechanical Engineers.

ENHANCED HEAT TRANSFER WITH FEMTOSECOND LASER SURFACE PROCESSING (FLSP)

Craig Zuhlke & George Gogos
University of Nebraska – Lincoln

Abstract: Surface functionalization with micro- and nano-scale features has been shown to lead to enhanced heat transfer for thermal management, anti-icing surfaces, anti-microbial surfaces, drag reducing surfaces, and enhanced solar absorption to name a few. There are two major issues that have limited the widespread application of surface functionalization: (1) lack of permanency in terms of maintaining unique properties, and (2) inability to scale the functionalization techniques to large areas for real-world applications.

Profs. Craig Zuhlke and George Gogos from the Center for Electro-optics and Functionalized Surfaces (CEFS) at the University of Nebraska-Lincoln will present on multidisciplinary research efforts to develop a new, transformative approach to functionalize surfaces using finely controlled laser-matter interactions in femtosecond laser surface processing (FLSP). With FLSP, surface properties of a material are modified directly and permanently by producing quasi-periodic hierarchical micro- and nano-scale surface features along with surface and subsurface microstructure and chemical changes. A major advantage of FLSP over other surface modification technologies is the ability to produce micro- and nano-structured surfaces on metals in a single processing step, without adding coatings, and without affecting the properties of the bulk material. Additionally, the dynamics of the ablation process allow for controlled chemical alteration of the surface and alteration of subsurface grain structure during processing, resulting in a fully functionalized surface that can be adapted to specific applications. FLSP has a plethora of applications due to the ability to impart unique properties. Some of the applications of FLSP that CEFS has investigated include, enhanced two-phase heat transfer for thermal management of electronic and optical devices; anti-microbial surfaces; anti-icing surfaces; drag-reducing surfaces; broadband absorbing/emitting surfaces for applications in solar and thermal management through radiative heat transfer; and surfaces for enhanced electrolysis. Prof. Zuhlke will present an overview of the FLSP research program, fundamental research on FLSP, and an overview of applications being investigated by CEFS. Prof. Gogos will present research on the application of FLSP surfaces to enhance two-phase heat transfer.

Bio: Prof. Craig Zuhlke is an Associate Professor in Electrical and Computer Engineering at the University of Nebraska-Lincoln (UNL) and Co-Director of the Center for Electro-optics and Functionalized Surfaces (CEFS). Prof. Zuhlke received B.S. and Ph.D. degrees in Electrical Engineering from UNL. He conducts research utilizing the unique interaction between ultrashort laser pulses and matter to achieve new modalities of manufacturing. Dr. Zuhlke has worked to develop femtosecond laser surface processing (FLSP) techniques for functionalizing surfaces for a wide range of applications. He has led several federally- and industry-funded multidisciplinary research projects related to FLSP and its applications, including research on the fundamental physics of FLSP, and applications of the FLSP. Some of the applications of FLSP that CEFS has investigated include, enhanced two-phase heat transfer for thermal management of electronic and optical devices, anti-microbial surfaces, anti-icing surfaces, drag-reducing surfaces, broadband absorbing/emitting surfaces for applications in solar and thermal management through radiative heat transfer, and surfaces to enhance catalysis.

Bio: Prof. George Gogos holds a B.S. degree in Mechanical Engineering from the Massachusetts Institute of Technology (1980) and an M.S. (1982) and PhD (1986) degrees in Mechanical Engineering and Applied Mechanics from the University of Pennsylvania. After he completed his studies, he joined Rutgers University as an Assistant Professor and in 1993 moved to the University of Nebraska – Lincoln as an Associate professor where he is currently the Wilmer J. and Sally L. Hergenrader Professor of Mechanical & Materials Engineering, Director of the Nebraska Center for Energy Sciences Research (NCESR), and Co-Director of the Center for Electro-optics and Functionalized Surfaces (CEFS). Over the past fifteen years, his research emphasis is on two interdisciplinary research areas: a) thermal/fluids

applications of metallic, ceramic and silicon surfaces that are functionalized with femtosecond lasers, and b) propane flaming for weed control in agronomic crops. The second one has led to a successful startup (Agricultural Flaming Innovations (AFI), website: agflame.com). He has also conducted research in fuel combustion, with emphasis on droplet combustion, droplet vaporization at elevated pressures and microgravity combustion, as well as in a number of interdisciplinary areas that required his expertise in the thermal/fluids sciences, such as rapid DNA multiplication for detection of biological agents (rapid PCR development), blast wave mitigation and rotational molding. His research funding sources include NSF, NASA, DARPA, NIH, ARO, ONR, USDA, Boeing and other industries. He has co-authored more than 150 technical papers in archival Journals and Conference Proceedings and holds 5 patents. He teaches undergraduate and graduate courses in heat and mass transfer processes, fluid mechanics, thermodynamics, computational heat transfer and fluid flow and in combustion.

SINGLE PHASE POWER ELECTRONICS COLD PLATES FOR MODERN DEVICE TECHNOLOGIES

Yogendra Joshi
Georgia Tech

Abstract: Emerging applications of power converters for ground vehicle and aircraft electrification are pushing for dramatically higher power densities in compact, and light-weight form factors. Another quiet revolution is underway in device technologies migration from Si to SiC and GaN, to achieve higher efficiencies at these power densities. Cold plate architectures for these applications have seen significant changes in the past decade, enabled through advances in additive manufacturing. In this talk, two studies will be summarized. The first will focus on the application of jet impingement over structured surfaces to achieve dramatic enhancement in heat transfer, using the current state-of-the-art direct-bonded-copper (DBC) packaging technology. The second will describe an approach for a radical departure from DBC, to a multi-functional architecture to enable both power delivery and heat spreading. Through the use of additive manufacturing, new topologies such as triply-periodic minimal surfaces can be utilized to fabricate heat transfer enhancement structures to achieve superior thermal performance.

Bio: Dr. Yogendra Joshi joined DARPA in July 2022 as a Program Manager in the Microsystems Technology Office (MTO). He is a professor and the John M. McKenney and Warren D. Shiver Distinguished Chair at Georgia Institute of Technology's G.W. Woodruff School of Mechanical Engineering. In addition, he has a courtesy appointment at Georgia Tech/s School of Electrical and Computer Engineering. His research interests are in multi-scale thermal management. Joshi is the author or co-author of more than 450 publications in this area, including more than 225 journal articles. He received his Bachelor of Technology in mechanical engineering from the Indian Institute of Technology (Kanpur) in 1979, Master of Science in mechanical engineering from the State University of New York at Buffalo in 1981, and doctorate in mechanical engineering and applied mechanics from the University of Pennsylvania in 1984. Joshi is an elected fellow of the American Society of Mechanical Engineers (ASME), the American Association for the Advancement of Science, IEEE, and American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE). He's been recognized for his contributions through several awards, including the Inventor Recognition Award from the Semiconductor Research Corporation (2001), the IBM Faculty Award (2008), the IIT Kanpur Distinguished Alumnus Award (2011), the AIChE Donald Q. Kern Award (2018), and multiple honors from IEEE and ASME (including the Heat Transfer Memorial Award in 2013).

TT-9 Coolants for High Performance Computing and Industrial Systems – Challenges and Advances

WEDNESDAY, MAY 29, 2:00 – 3:30 PM

Session Chair: Georges Pavlidis (University of Connecticut) and Qian Han (Sorrento Solution)

Unlocking Potential: Navigating Challenges and Seizing Opportunities in Two-Phase Liquid Immersion Cooling

Jimil Shah
Stealth Startup

Abstract: Two-Phase Liquid Immersion Technology is gaining traction in today's market as a means of combatting compounding data center concerns related to energy and resource consumption. Nowhere are such issues perhaps better revealed than in the current contentious debate about water usage requirements for data center facilities in draught-stricken western states. The two-phase liquid immersion approach to cooling computing equipment is being recognized for the many opportunities that are made available such as higher processing density, more densely packed DIMMs, the possibility for overclocking, and faster server refresh rates, as well as increased energy efficiency. The presentation will include a high-level comparison of Single- and Two-phase immersion cooling as well as a further discussion of special technical topics related to two-phase immersion cooling of data centers. As is always true with any burgeoning technology, challenges to the implementation of two-phase liquid immersion cooling are legitimate; concerns about fluid loss, fluid selection, limited power density, material compatibility, safety, and environmental impact are real and must be addressed for this technology to succeed. This presentation will address these issues and debate mitigation strategies for these challenges as well as opportunities with respect to the widespread adoption of this technology. The path forward for Two-Phase Liquid Immersion Technology requires an honest evaluation of the challenges, a comprehensive review, and debate regarding mitigation strategies for those challenges, and an accurate assessment of this technology that is unencumbered by entrenched interests.

Bio: Jimil M. Shah, Ph.D. is an Immersion Cooling Staff Engineer in a Stealth Startup. He is contributing to developing a cutting-edge two-phase immersion cooling system for a hyperscale data center for Artificial intelligence applications, contributing to enhanced energy efficiency and reduced operational costs. He is working on the Thermal and reliability aspects of the immersion cooling technology leading towards the operating procedures for the data centers. Previously, Dr. Shah held the position of Senior Director of Thermal Sciences at TMGcore. Before joining TMGcore, he was an Application Development Engineer for Server Liquid Cooling of Data Centers at 3M Company. His research in advanced cooling solutions for data center thermal management focuses on single- and two-phase direct-to-chip as well as immersion cooling using dielectric fluids. Before joining 3M, Dr. Shah was a Post-Doctoral Research Associate at the University of Texas at Arlington. Dr. Shah received his doctorate in Mechanical Engineering from the University of Texas at Arlington in 2018. He holds senior membership status in IEEE and is a professional member of ASHRAE TC9.9, ASME, and OpenCompute. Notably, at InterPACK 2018, Dr. Shah was honored with the "ASME Electronic and Photonic Packaging Division (EPPD) Student Engineer of The Year Award." With a prolific record, he has submitted over 40 patent applications and holds 5 issued/allowed patents. Furthermore, Dr. Shah has contributed to 36 journal and conference papers, with an additional article currently under review.

TITLE TBD

Gustavo Pottker
Chemours

Abstract: The exponential rise in computing power and big data, the ongoing electrification of traditional mechanical systems and the growing focus on sustainability are driving the need for more effective and energy efficient cooling technologies in applications from data centers, to electric vehicles and power electronics. Liquid cooling technologies, which for years were considered niche, are now becoming mainstream. Heat transfer fluids are a central piece in liquid cooling and while water- and oil-based fluids can meet cooling requirements in many applications, they have limitations that can only be overcome by two-phase heat transfer using fluorinated fluids, or "F-Gases", with lower boiling points. The presentation will discuss the key attributes and requirements of different two-phase fluids used in thermal management, with particular focus on a low Global Warming Potential (GWP) class called Hydrofluoroolefins (HFOs). Recent developments in the application of HFOs in two-phase direct-to-chip and immersion cooling in data centers and other applications will be shared, together with a critical assessment of advantages, challenges, and opportunities. Finally, we will examine typical HFOs atmospheric chemistry and the impact of environmental regulations.

Bio: Gustavo Pottker is a Senior Principal Engineer at the Thermal and Specialized Solutions Division of the Chemours Company. His research life started at 18 year's old as an undergrad research assistant at the Federal University of Santa Catarina in Brazil, where he also obtained his Master's degree in Mechanical Engineering in 2006. He has combined more than 20 years of industry and academic experience in the Air conditioning, Refrigeration and Thermal Management areas, including a variety of R&D roles. Gustavo also holds a PhD in Mechanical Engineering from the University of Illinois at Urbana-Champaign. He is the author of dozens of patents, conference, and journal publications while also an active member of industry organizations. At Chemours, Gustavo currently leads the application development of heat transfer fluids for thermal management applications, with primary focus on two-phase immersion cooling.

PANEL SESSIONS

P-2: Opportunities at the Intersection of Artificial Intelligence (AI) and Thermal Management

WEDNESDAY, MAY 29, 11:00 AM – 12:30 PM

Moderators: Vaibhav Bahadur (The University of Texas at Austin) and Luca Amalfi (Seguente)

Panelists: Hemanth Dhavaleswarapu (AMD), John Kim (Seguente), Yoonjin Won (UC Irvine), Dursetti Chidambarrao (IBM), and Sumanta Acharya (IIT)

Thermal management is becoming essential to ensure performance and reliability of AI-related hardware (e.g., GPUs) that is critical to realizing the benefits of AI in many areas. Synergistically, AI can also enable the advancement of thermal management solutions in multiple ways (materials discovery, optimization, digital twinning, etc.). A panel of distinguished professionals from industry and academia will discuss these aspects and share their vision on the future of AI as it relates to thermal management.

P-4: Mechanics and Co-Design Opportunities

WEDNESDAY, MAY 29, 4:00 – 5:30 PM

Moderators: Hemanth Dhavaleswarapu (AMD) and Abhijit Dasgupta (University of Maryland)

Panelists: Ganesh Subbarayan (Purdue), Keith Newman (AMD), Hesham Taha (Teramount), Alex Janta (IBM), Luke Garner (Intel)

Heterogeneous Integration (HI) for next-generation chiplet-based systems requires a systematic and sophisticated co-design approach that can simultaneously account for electrical performance (digital, analog, RF and power), thermal performance, mechanical performance and long-term degradation/reliability. The experts in this panel will share their insights about the mechanics challenges and solution roadmaps, in the context of this codesign ecosystem. The panel will consist of 3 HI experts from industry at various levels of the microelectronics/photonics supply-chain, and 3 mechanics experts from academic R&D Centers.

P-6 Thermal Challenges and Opportunities for Consumer Electronics/Mobile/IoT/Auto/High Power Compute

THURSDAY, MAY 30, 11:00 AM – 12:30 PM

Moderator: Victor Chirac (GCTG)

Panelists: Eric Bert (Exentis AG USA), Raj Pendse (META), Shlomo Novotny (Seguente), Amy Marconnet (Purdue), Ravi Mahajan (Intel), and Mike Ohadi (UMD)

The digital world requires higher performance, more data and faster processors. Heterogeneous Computing involves the central processing units (CPUs), the graphics processing units (GPUs), high speed interconnects and other elements that push forward the computing industry. The emergence of 5G/6G leads to significant rise in mobile communication, IoT, automotive, AI and high-power computing devices, providing the infrastructure needed to carry large amounts of data, allowing for a smarter and more connected world – enabling Smart Cities, connected roads, Self-driving cars, AR/VR, AI robotics, Digital healthcare. A panel of experts will share their vision on the future of small to large electronics thermal management and other advanced system level thermal challenges and solutions.

P-10 Two-Phase Electronics Cooling

FRIDAY, MAY 31, 11:00 AM – 12:30 PM

Moderator: John R. Thome (JJ Cooling Innovation SARL)

Panelists: Victor Chiriac (GCTG), Ali Heydari (Nvidia), Todd Salamon (Nokia), Jackson Marcinichen (JJ Cooling Technologies), and Winston Zhang (Novark Technologies)

Two-phase cooling is coming forward as the new solution for datacenters to handle the AI HPC heat loads, mobile electronics, Edge AI, 5G, battery cooling, new semiconductor power electronics, EV-aircraft systems, etc. These primarily fall into the categories of pumped two-phase cooling and passive two-phase cooling (thermosyphons and pulsating heat pipes). The panelists will present their experiences on laying out new two-phase cooling technologies for their industrial sectors.

P-11: Electronics Cooling for Large Scale Applications

FRIDAY, MAY 31, 2:00 – 3:30 PM

Moderator: Kimberly Saviers (RTX)

Panelists: Vaidehi Oruganti (Microsoft), Ryan Enright (Seguente), Bahgat Sammakia (SUNY Binghamton), Kaz Yazawa (Purdue), and Damena Agonafer (UMD)

As electronic devices continue to evolve and scale up in complexity, efficient cooling solutions are crucial to ensure optimal performance and reliability. This panel will bring together experts to discuss cutting-edge approaches, challenges, and innovations in electronics cooling for large-scale applications. Topics will include advancements in thermal management techniques, novel cooling technologies, integration strategies, and the impact of emerging applications such as data centers, electric vehicles, and aerospace systems. With advancements in technology leading to smaller form factors and higher power densities, conventional air-cooling methods struggle to dissipate heat effectively. Alternative cooling techniques such as liquid cooling, phase change materials and advanced thermal management solutions are gaining popularity to address the growing thermal challenges in electronic devices. These innovative approaches offer improved heat dissipation capabilities, enabling electronic devices to operate more efficiently and reliably even in demanding applications.

CONFERENCE TECHNICAL PROGRAM

TRACKS & SESSIONS

COMPONENT-LEVEL THERMAL MANAGEMENT

- TI-01 Jet Impingement and Hot Spot Management
- TI-02 Heatsinks and Coldplates I
- TI-03A Embedded Cooling
- TI-03B TIMs and Spreaders
- TI-04 Heat Pipes and Vapor Chambers I
- TI-05 Single and Two-Phase Liquid Cooling
- TI-06 Two-Phase Cooling I
- TI-07A Two-Phase Cooling II
- TI-07B Thermal Modeling and Analysis
- TI-08 Heat Pipes and Vapor Chambers II
- TI-09 Heatsinks and Codplates II
- TI-10 Packaging and Thermal Management

SYSTEM-LEVEL THERMAL MANAGEMENT

- TII-01 Automotive, Batteries and Thermal Storage
- TII-02 Advances in Design and Modeling
- TII-03 Data Center Thermal Management I
- TII-04 Immersion Cooling and Refrigeration I
- TII-05 Thermal Management in Space and Aerospace
- TII-06 Data Center Thermal Management II
- TII-07 Immersion Cooling and Refrigeration II
- TII-08 Phase Change Materials and Novel Cooling Techniques
- TII-09A Mobile and Internet of Things
- TII-09B Thermal Management
- TII-10 Liquid Cooling Solutions

EMERGING TECHNOLOGIES & FUNDAMENTALS

- E-01 Immersion Cooling
- E-02 Reliability of Additively Printed Electronics
- E-03 Heatpipes, Vapor Chambers and Wicks
- E-04 Novel Materials and Fabrication Techniques
- E-05 Phase Change on Enhanced Surfaces
- E-06 Sustainability and Additive Manufacturing
- E-07 Machine Learning and Predictive Analytics
- E-08 Two-Phase Cooling
- E-10 Packaging and MEMS
- E-11 Additively Printed Electronics and Two-Phase Fundamentals

MECHANICS & RELIABILITY

- M-01 EMC Reliability
- M-02 Solder Joint Reliability and Methodologies
- M-04 Board Level Reliability
- M-05 Thermal Interface Reliability
- M-06 Board Level Reliability - BGAs
- M-08 Solder Metallurgy
- M-10 Accelerated Testing and Novel Reliability Methods

Day 1: Wednesday, May 29th 08:15 AM–09:15 AM

TI-01 — TI-01 Jet Impingement and Hot Spot Management — Breakout 1
Chairs: *Tiwei Wei (Purdue University)*

08:15 AM **EXPERIMENTAL AND NUMERICAL INVESTIGATION OF THERMAL PERFORMANCE OF PIEZOELECTRIC FAN**; ***Mr. Ahmet KOYUNCU***[1], Dr. Abdullah Berkan ERDOGMUS[2]; *[1]thermal design specialist, [2]thermal design team leader*

08:30 AM **Heat Transfer Enhancement for Direct-on-Chip Impingement Jet Cooling using Variable Micro Pin Fins and Tapered Impingement Cavity**; ***Mr. Akshat Hetal Patel***[1], Dr. Gopinath Sahu[1], Prof. Tiwei Wei[1]; *[1]Purdue University*

08:45 AM **Enhancement of Direct Liquid Jet Impingement Cooling through Laser-Fabricated Micro Pin-Fins on the Chip-Backside**; ***Mr. Georg Elsinger***[1], Dr. Herman Oprins[2], Dr. Vladimir Cherman[2], Dr. Geert Van der Plas[2], Dr. Eric Beyne[2], Prof. Ingrid De Wolf[1]; *[1]KU Leuven, imec, [2]imec*

09:00 AM **Automated Gimbaling of Conical Nozzles for Jet Vectoring Impingement Cooling to Mitigate Workload Dependent Hotspots in High Power Density Silicon**; ***Dr. Prabhakar Subrahmanyam***[1], Dr. Sankarananda Basak[1], Mr. Vishnu Prasadh Sugumar[1], Dr. Ying-Feng Pang[1], Mr. Arunkumar Krishnamoorthy[1], Mr. Mark Bianco[1]; *[1]Intel Corporation*

TII-01 — TII-01 Automotive, Batteries and Thermal Storage I — Breakout 2
Chairs: *M Cynthia Hipwell, Tiwei Wei (Purdue University)*

08:15 AM **An innovative examination of composite PCM capacitor**; Mrs. michal fadida[1], ***Dr. Motti Raizner***[1]; *[1]Rafael – advanced defense systems*

08:30 AM **Closed-loop Analysis of Thermal Energy Storage Device Arrangement in a Thermal Management System**; ***Mr. Parikesit Pandu Dewanatha***[1], Mr. Demetrius Gulewicz[1], Prof. Neera Jain[1]; *[1]Purdue University*

08:45 AM **Predicting cell-to-cell thermal runaway propagation in modular battery energy storage systems**; ***Dr. Christopher Doerrer***[1], Mr. Youhan Fu[2], Dr. Carlos M. DaSilva[1], Prof. Cristina Amon[3]; *[1]Department of Mechanical and Industrial Engineering, ATOMS Laboratory, University of Toronto, Toronto, ON, Canada, [2]eCAMION Inc., [3]Department of Mechanical and Industrial Engineering, ATOMS Laboratory, University of Toronto, Toronto, ON, Canada & Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, ON, Canada*

09:00 AM **A novel framework to design phase change material composite for cooling of electronic devices**; ***Mr. Ayushman Singh***[1], Dr. Srikanth Rangarajan[2], Prof. Bahgat Sammakia[3]; *[1]Graduate Student Researcher, [2]Co-Principal investigator, [3]Principal Investigator*

M-01 — M-01 EMC Reliability — Breakout 3
Chairs: *John Harris (University of Arkansas)*

08:15 AM **Novel Nano-indentation Dynamic Mechanical Thermal Analysis (NiDMTA) Technique for Characterizing Viscoelastic Properties of Polymeric Materials in Semiconductor Packages**; ***Dr. Hung-Yun Lin***[1], Dr. Siva Gurrum[1], Mr. Alexander Gamez[1], Mr. Wassie Yusuf[1]; *[1]Texas Instruments*

08:30 AM **Cohesive Zone Modeling of Chip-UF and EMC-Substrate Interfaces In FCBGAS Subject To Thermo-Mechanical Loading**; Prof. Pradeep Lall[1], ***Mr. Aathi Raja Ram Pandurangan***[1], Mr. Padmanava Choudhury[1], Mr. Madhu Kasturi[1]; *[1]Auburn University*

08:45 AM **Effect of Temperature and Humidity Conditioning on EMC-to-Substrate Interfacial Delamination Subjected to Monotonic and Fatigue Loading**; ***Prof. Pradeep Lall***[1], Mr. Madhu Kasturi[1], Mr. Jaimal Williamson[2], Dr. Varughese Mathew[3]; *[1]Auburn University, [2]Texas Instruments, [3]NXP Semiconductor*

09:00 AM **Investigation of Fatigue Performance for Bulk Epoxy Molding Compound (EMC) in Sustained High-Temperature Environment up to 1 Year Aging.**; ***Prof. Pradeep Lall***[1], Mr. Yunli Zhang[1], Dr. Jeff Suhling[1]; *[1]Auburn University*

E-01 E-01 IMMERSION COOLING — BREAKOUT 4

Chairs: *Arad Azizi (Honeywell International Inc.), Srikanth Rangarajan (Co-Principal investigator)*

08:15 AM **Unveiling the Dual Limits of Critical Heat Flux and Implications for Immersion Cooling**; ***Mr. SUHAS TAMVADA***[1], Dr. Daniel Attinger[2], Dr. Saeed Moghaddam[1]; *[1]University of Florida, [2]Struo LLC*

08:30 AM **A Research on High Speed Signal Integrity Design Optimal for Immersion Cooled Server**; ***Ms. Ying-Shan Lo***[1], Dr. Jiahong Wu[1], Mr. Liwen Guo[2], Ms. Yaling Huang[3], Mr. Tong Xu[3], Ms. Carrie Chen[1], Mr. JUN ZHANG[1], Mr. Jeff Ho[4], Mr. ALLEN LIANG[1], Mr. Xiang Mao[5]; *[1]Intel Corporation, [2]Shenzhen institute for Advanced Study, UESTC, [3]Foxconn Corporation, [4]Intel, [5]Shenzhen Institute for AdvancedStudy*

08:45 AM **Thermal Performance, Stability and Material Compatibility of a New Two-Phase Immersion Fluid**; Dr. Gustavo Pottker[1], ***Dr. Abigail Van Wassen***[1], Mr. Drew Brandt[1], Dr. Xue Sha[1]; *[1]The Chemours Company*

09:00 AM **Development of a Novel Analytical Model for Liquid Synthetic Jets and Introduction of Their Application in Immersion Cooling Systems**; ***Mr. Mohammad Azarifar***[1], Mr. Faisal Ahmed[1], Dr. Muhammad Ikhlaq[2], Prof. Mehmet Arik[1]; *[1]Auburn University, [2]Newcastle University*

Day 1: Wednesday, May 29th 11:00 AM–12:30 PM

TI-02 — TI-02 Heatsinks and Coldplates I — Breakout 1

Chairs: *Ryan Enright (Seguente, Inc.), Anil Yuksel, Omidreza Ghaffari (University of Sherbrooke)*

11:00 AM **Additively Manufactured Cold Plate with Internal Phase Separator for Hybrid Two-Phase Cooling**; ***Dr. Mohammad Reza Shaeri***[1], Mr. Maksym Demydovych[1]; *[1]Advanced Cooling Technologies, Inc.*

11:15 AM **Thermal Performance of Transient Liquid Diffusion Bonded Multi-Layer Cold Plate**; ***Mr. Masahiro Matsuda***[1], Mr. Yoji Kawahara[1], Mr. Yasuhiro Hriuchi[1], Mr. Yuichiro Tahara[1], Dr. Yuji Saito[1], Mr. Toshimizu Tomitsuka[1]; *[1]Fujikura Ltd.*

11:30 AM **High Heat Flux Thermal Management using CuW Microchannel Heat Sinks and FC3283**; ***Ms. Isabella Amyx***[1], Mr. Caleb Anderson[1], Ms. Nicole Cassada[1], Mr. Devin Funaro[2], Dr. Clint Frye[2], Dr. Salmaan Baxamusa[2], Dr. Jack Kotovsky[2], Ms. Kathy Jackson[2], Dr. Todd Bandhauer[1]; *[1]Colorado State University, [2]Lawrence Livermore National Laboratory*

11:45 AM **Compliant Direct Attach Liquid Cooling**; ***Dr. Mark Schultz***[1], Dr. Pritish Parida[2]; *[1]IBM T.J. Watson Research Center, [2]IBM T. J. Watson Research Center, 1101 Kitchawan Rd, Yorktown Heights, NY 10598 USA*

12:00 PM **Reduced Physics Modeling of Two-Phase Flow through High-Density Cooling Structures**; ***Dr. Pritish Parida***[1], Ms. Shurong Tian[1], Dr. Mark Schultz[2], Dr. Timothy Chainer[2]; *[1]IBM T. J. Watson Research Center, 1101 Kitchawan Rd, Yorktown Heights, NY 10598 USA, [2]IBM T.J. Watson Research Center*

12:15 PM **Development of a Hybrid Single/Two-phase Capillary-based Micro-cooler using Copper Inverse Opals Wick with Silicon 3D Manifold for High-Heat-Flux Cooling Application**; ***Dr. Heungdong Kwon***[1], Ms. Qianying Wu[1], Dr. Daeyoung Kong[2], Dr. Sougata Hazra[1], Ms. Kaiying Jiang[3], Mr. Chulmin Ahn[4], Dr. Sreekant V.J. Narumanchi[5], Prof. Hyoungsoon Lee[2], Prof. James Palko[6], Dr. Ercan Dede[7], Prof. Mehdi Asheghi[1], Prof. Kenneth Goodson[3]; *[1]Stanford university, [2]Chung-Ang University, [3]Department of Mechanical Engineering, Stanford University, Stanford, CA 94305, [4]Hyundai Motor Company, [5]National Renewable Energy Laboratory, [6]University of California, Merced, [7]Toyota Research Institute of North America*

TII-02 — TII-02 Advances in Design and Modeling — Breakout 2

Chairs: *Harish Ganapathy, Pratik Bansode (The University of Texas at Arlington)*

11:00 AM **Thermal Design & Performance of 300 mm Wafer Scale System**; ***Dr. Evan Colgan***[1], Mr. Phillip Mann[2], Dr. Kai Schleupen[1]; *[1]IBM T.J. Watson Research Center, [2]IBM Systems Infrastructure*

11:15 AM **Co-Design of 300 mm Wafer Scale Package**; ***Dr. Kai Schleupen***[1], Dr. Evan Colgan[1], Mr. Phillip Mann[2], Dr. Diego Anzola[1], Mr. Brian PEAR[1], Mr. Robert Kuder[1], Mr. James Speidell[1]; *[1]IBM T.J. Watson Research Center, [2]IBM Systems Infrastructure*

11:30 AM **Thermal Analysis of High Current Vertical Power Delivery Network with Embedded Microchannel Cooling**; ***Mr. Mingeun Choi***[1], Mrs. Sriharini Krishnakumar[2], Mr. Ramin Khorasani[3], Prof. Inna Partin-Vaisband[2], Prof. Rohit Sharma[4], Prof. Madhavan Swaminathan[3], Prof. Satish Kumar[1]; *[1]Georgia Institute of Technology, [2]University of Illinois Chicago, [3]The Pennsylvania State University, [4]Indian Institute of Technology Ropar and The Pennsylvania State University*

11:45 AM **Micro-PIV measurements near supercritical CO2 conditions inside the channel**; Mr. Ritesh Ghorpade[1], Dr. Gihun Kim[2], ***Mr. Soroush Niazi***[1], Prof. Yoav Peles[3], Prof. Subith Vasu[4]; *[1]Student, [2]Postdoctoral Researcher, [3]Professor, Chair, [4]Associate Professor*

12:00 PM **Multi-objective design optimization of pin-fin cold plates for electric vehicle battery packs using convolutional neural networks and genetic algorithms**; ***Mr. Takiah Ebbs-Picken***[1], Dr. Carlos M. DaSilva[1], Prof. Cristina Amon[2]; *[1]Department of Mechanical and Industrial Engineering, ATOMS Laboratory, University of Toronto, Toronto, ON, Canada, [2]Department of Mechanical and Industrial Engineering, ATOMS Laboratory, University of Toronto, Toronto, ON, Canada & Chemical Engineering and Applied Chemistry, University of Toronto, Toronto, ON, Canada*

12:15 PM **Novel Programmable Package-level 3D Thermal Evaluation System**; ***Mr. Suresh Parameswaran***[1], Mr. Gamal Refai-Ahmed[1], Mr. Suresh Ramalingam[1], Mr. Jonathan Chang[1], Mr. Saravanan Balakrishnan[1]; *[1]AMD*

M-02 M-02 Solder Joint Reliability and Methodologies **Breakout 3**

Chairs: *Gargi Kailkhura*

11:00 AM **Interpretable Machine Learning Models Can Outperform Statistical Models in Solder Joint Reliability**; ***Mr. Qais Qasaimeh***[1], Dr. Haoran Li[1], Dr. Sa'd Hamasha[1], Dr. John Evans[1], Dr. Jia Liu[1]; *[1]Auburn University*

11:15 AM **Thermal cyclic fatigue life evaluation of BGA solder joints using approximate formula for strain range behavior**; ***Mr. Rintaro Okuzono***[1], Prof. Qiang Yu[1], Mr. Masahiro Kon[1], Mr. Hisataka Fukasu[2], Mr. Akihiro Takikawa[2]; *[1]Department of Mechanical Engineering, Yokohama National University, [2]Komatsu Manufacturing Co.*

11:30 AM **Evaluating the Efficiency of Machine Learning Approaches for Predicting Solder Joint Characteristic Life under Isothermal Aging and Thermal Cycling Test Conditions**; ***Mr. Soroosh Alavi***[1], Dr. Daniel Silva[1], Mr. Palash Pranav Vyas[1], Dr. Sa'd Hamasha[1]; *[1]Auburn University*

11:45 AM **Reliability of FPBGA Assemblies under Martian Cold Thermal Cycles**; Dr. Reza Ghaffarian[1], ***Dr. Seth Gordon***[1], Dr. Thomas Sanders[1]; *[1]JPL*

12:00 PM **Prediction of the Mechanical Responses of Single Grain Lead-Free Solder Joints Using Machine Learning**; ***Mr. Debabrata Mondal***[1], Prof. Jeffrey Suhling[1], Prof. Elham Mirkoohi[1], Prof. Pradeep Lall[1]; *[1]Auburn University*

12:15 PM **Modeling of the Temperature Cycling Performance of BGA Packages with Hybrid SAC/LTS Joints and Various Bi Concentration Gradients**; ***Mr. Souvik Chakraborty***[1], Mr. Debabrata Mondal[1], Prof. Jeffrey Suhling[1], Prof. Pradeep Lall[1]; *[1]Auburn University*

E-02 E-02 Reliability of Additively Printed Electronics **Breakout 4**

Chairs: *Unique Rahangdale (Rivian Automotive)*

11:00 AM **Reliability Assessment of Encapsulated Flexible Hybrid Electronic Assemblies Under Board-Level Drop Test**; ***Prof. Pradeep Lall***[1], Mr. Aathi Raja Ram Pandurangan[1], Mr. Md Golam Sarwar[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

11:15 AM **Repairability Of Additively Printed Circuits Using Sustainable Aqueous-Based Silver Nanoparticle Ink on Polymide Substrates**; ***Prof. Pradeep Lall***[1], Mr. Daniel Karakitie[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

11:30 AM **Fabrication and Reliability Evaluation of Additively Printed Temperature and Humidity Sensor on Additively Manufactured ABS Substrate.**; ***Prof. Pradeep Lall***[1], Mr. Hyesoo Jang[1], Mr. Curtis Hill[2]; *[1]Auburn University, [2]QuaniTech Inc, Jacobs Space Exploration Group, ESSCA Contract, NASA MSFC*

11:45 AM **Screen-Printed Thermoformed Circuits Performance and Reliability under Sustained High Temperatures for In-Mold Electronics**; ***Prof. Pradeep Lall***[1], Mr. Shriram Kulkarni[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

12:00 PM **Reliability of Additively Printed In-Mold Electronics Using ECA in Sustained High-Temperature Operation**; ***Prof. Pradeep Lall***[1], Mr. Md Golam Sarwar[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

12:15 PM **Performance Stability and Reliability of Gravure Offset Printed Thermoformed IME Circuits Subjected to Sustained High Temperature Storage**; ***Prof. Pradeep Lall***[1], Mr. Ved Soni[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

Day 1: Wednesday, May 29th 02:00 PM–03:30 PM

TI-03A — TI-03A Embedded Cooling — Breakout 1

Chairs: *Herman Oprins (imec), Gopinath Sahu (Purdue University)*

02:00 PM **Thermal Analysis of Dual-sided Cooling for Backside Power Delivery Networks (BSPDN) on 2.5D Glass/Silicon Interposer Package**; Mr. Feifan Xie[1], ***Mr. SHUHANG Lyu***[1], Prof. Tiwei Wei[1]; [1] *Purdue University*

02:15 PM **Transient Thermal Buffer for Microchannel Flow Boiling Using Gallium Phase Change Material**; ***Mr. Caleb Anderson***[1], Dr. Charles Lewinsohn[1], Dr. Todd Bandhauer[1]; [1] *Colorado State University*

02:30 PM **Embedded cooling to meet the 2kW thermal design power of HPC chips in the future**; ***Mr. Jianyu Feng***[1], Dr. chuan chen[1], Dr. Rong Fu[1], Prof. liqiang cao[1], Prof. qidong wang[1], Dr. fengze hou[1]; [1] *Institute of Microelectronics of the Chinese Academy of Sciences*

02:45 PM **Thermal and Mechanical Analysis of Embedded Liquid Cooling with Microchannel and Pin-fin Structures**; ***Ms. Risa Miyazawa***[1], Mr. Hiroyuki Mori[1], Dr. Akihiro Horibe[1]; [1] *IBM Research*

03:00 PM **Porous Liquid Metal-Based Phase Change Materials for Sustainable Thermal Buffer**; ***Dr. Seokkan Ki***[1], Mr. Seongjong Shin[2], Mr. Sumin Cho[3], Dr. Soosik Bang[2], Dr. Haejin Lee[1], Prof. Dongwhi Choi[3], Prof. Youngsuk Nam[2]; [1] *Samsung electronics Co., Ltd.,* [2] *Korea Advanced Institute of Science and Technology (KAIST),* [3] *Kyung Hee University*

03:15 PM **Embedded manifold microchannel cooling for chiplet thermal management**; ***Mr. Guoran Lu***[1], Dr. Yuxin Ye[1], Mr. Jie Wang[1], Dr. Binbin Jiao[1], Dr. Yanmei Kong[1], Dr. Ruiwen Liu[1]; [1] *Institute of Microelectronics of the Chinese Academy of Sciences*

TII-03 — TII-03 Data Center Thermal Management I — Breakout 2

Chairs: *Jessica Gullbrand (Intel Corporation)*

02:00 PM **A Server-Level Test System for Direct-To-Chip Two-Phase Cooling of Data Centers Using a Low Global Warming Potential Fluid**; ***Dr. Qingyang Wang***[1], Dr. Serdar Ozguc[1], Mr. Akshith Narayanan[1], Dr. Richard Bonner[1]; [1] *Accelsius*

02:15 PM **Research of Operation Reliability on Cold Plate Liquid Solution based on Data Center Deployment**; ***Mr. Wenbin Tian***[1], Mr. Chenglong Gui[2], Mr. Yulong Wang[2], Mr. Chen Shen[2], Mr. Bin Lin[2], Mr. Jialiang Xu[1], Mr. Zhiming Li[1], Mr. Kai Wang[1], Mr. Sandeep Ahuja[1], Mrs. Nishi Ahuja[1]; [1] *Intel Corporation,* [2] *Bytedance Technology*

02:30 PM **Power Supply Unit Cooling in a High Heat Capture Ratio Liquid Cooled Datacenter Server**; Dr. David Zhou[1], ***Dr. Prabhakar Subrahmanyam***[1], Mr. Guocheng Zhang[1], Ms. Na Chen[1], Mr. Tejas Shah[1], Mr. dongrui xue[1], Mr. Yanbing Sun[1]; [1] *Intel Corporation*

02:45 PM **Compact Modeling of Distributed Flow Resistances for Data Center CFD**; ***Dr. Wei Tian***[1], Mr. Jim VAN GILDER[1], Mr. Michael Condor[1]; [1] *Schneider Electric*

03:00 PM **Touch Temperature Safety Standards and their Impact on Server Design**; ***Dr. Milnes David***[1], Dr. Felipe Valenzuela-Gaete[1], Mr. Kenneth Arenella[1], Mr. John Werner[1], Dr. Dustin Demetriou[1], Mr. Cory VanDeventer[1], Mr. John Torok[1]; [1] *IBM Corp.*

03:15 PM **Effects of Datacenter Cooling Subsystems Performance on TUE: Air vs. Liquid vs. Hybrid Cooling**; ***Dr. Mark North***[1], Mr. Amit Kulkarni[1], Mr. David Haley[1]; [1] *NVIDIA*

TI-03B — TI-03B TIMs and Spreaders — Breakout 3

Chairs: *Travis Mayberry, Keiji Matsumoto (IBM Research-Tokyo)*

02:00 PM **Thermal Characterization of Contemporary Electrical Insulation Materials**; ***Ms. Shanmukhi Sripada***[1], Dr. Chelsea Davis[1], Prof. Amy Marconnet[1]; [1] *Purdue University*

02:15 PM **Temperature and pressure dependent thermal interface material characterization using packaged thermal test vehicle assemblies**; ***Dr. Onur Yenigun***[1], Dr. Vladimir Cherman[2], Dr. Herman Oprins[2], Dr. Geert Van der Plas[2], Dr. Eric Beyne[2], Prof. Ingrid De Wolf[1]; [1] *KU Leuven, imec,* [2] *imec*

02:30 PM **Thermal Interface Material Analyzer Test Method Development for Gap Fillers: Simultaneous Thermal and Mechanical Stress Cycling**; ***Dr. Stephanie Valenzuela***[1], Dr. Joe Sootsman[1]; [1] *Dow Chemical Company*

02:45 PM **Fabrication and Thermal Characterization of Copper Nano-wire (CuNWs) Thermal Interface Materials Tapes**; ***Ms. Kaiying Jiang***[1], Dr. Heungdong Kwon[1], Mr. Hansen Qiao[1], Ms. Yini He[1], Prof. Mehdi Asheghi[1], Prof. Kenneth Goodson[1]; [1] *Stanford university*

03:00 PM **INCREASING COOLING PERFORMANCE OF PHASE CHANGE MATERIALS WITH METAL FOAM STRUCTURES**; ***Mr. Orkun DOGU***[1], Mr. Ahmet KOYUNCU[1], Dr. Abdullah Berkan ERDOGMUS[1]; [1] *ASELSAN INC.*

03:15 PM **Hexagonal Boron Nitride Nanosheets Filler Infiltrated Polymer Composite Films for Thermal Management Applications**; ***Ms. VANMATHI Ravichandran***[1], Dr. Eswaraiah Varrla[1]; [1] *Sustainable Nanomaterials and Technologies Laboratory, Department of Physics and Nanotechnology, SRM institute of Science and Technology, Kattankulathur, Chengalpattu, Tamilnadu, India, 603203*

E-03 E-03 Heatpipes, Vapor Chambers and Wicks — Breakout 4

Chairs: *Tianli Feng (University of Utah)*

02:00 PM **An unsteady homogeneous two-phase flow model for microchannel oscillating heat pipes**; ***Mr. Qian Qian***[1], Dr. Md Emadur Rahman[1], Dr. Justin A. Weibel[1], Dr. Liang Pan[1]; [1] *Purdue University*

02:15 PM **Graphene-Enhanced Metal Condensers in Wick-Free Vapor Chambers for Thermal Management in Electronics**; ***Mr. Arani Mukhopadhyay***[1], Dr. Sungjoon Kim[1], Mr. Anish Pal[1], Dr. Roshan Nemade[1], Dr. Sreya Sarkar[1], Prof. Vikas Berry[1], Prof. Constantine Megaridis[1]; [1] *University of Illinois Chicago*

02:30 PM **Investigation of Flow and Thermal Performance in a Non-uniform Channel Pulsating Heat Pipe Additively Manufactured from High-temperature Resin**; ***Mr. Md. Jubayer Hossain***[1], Mr. Max Pawlick[1], Mr. Vu Tan Le[1], Mr. Amitav Tikadar[1], Mr. Xiangjin Zhang[1], Prof. Satish Kumar[1]; [1] *Georgia Institute of Technology*

02:45 PM **Experimental investigation of the heat spreading performance of oscillating heat pipes for electronics cooling applications**; ***Dr. Syed Faisal***[1], Dr. Rishav Roy[1], Dr. Sarwesh Parbat[1], Dr. David Apigo[1], Dr. Nagesh Basavanhally[1], Dr. Yang Liu[1], Dr. Mark Earnshaw[1], Dr. Todd Salamon[1]; [1] *Nokia Bell Labs*

03:00 PM **Experimental study of a 3D-printed wick condenser for enhanced condensation heat transfer**; Mr. Jay Saple[1], ***Mr. Behzad Ahmadi***[1], Dr. Mohammad Reza Shaeri[2], Prof. Sajjad Bigham[1]; [1] *North Carolina State University,* [2] *Advanced Cooling Technologies, Inc.*

03:15 PM **3D-printed Ceramic Oscillating Heat Pipes for Improved Electronic Thermal Management**; Mr. Priom Agrawal[1], ***Mr. Behzad Ahmadi***[1], Dr. Joseph Cesarano[2], Prof. Sajjad Bigham[1]; [1] *North Carolina State University,* [2] *Robocasting Enterprises*

Day 1: Wednesday, May 29th 04:00 PM–05:30 PM

TI-04 — TI-04 Heat Pipes and Vapor Chambers I — Breakout 1

Chairs: *David Coenen (imec), Michael Fish (CCDC US Army Research Laboratory)*

04:00 PM **Physical Based Model of Air-Cooled Thermosyphon**; ***Mr. Po-Jui Huang***[1], Dr. Hao-Yu Lin[1], Dr. Amawasee Rukruang[1], Prof. Chi-Chuan Wang[1]; *[1]Department of Mechanical Engineering, National Yang Ming Chiao Tung University*

04:15 PM **Evaluation of Vapor Chambers Incorporating Square-Shaped and Topology Optimized Pedestals**; Dr. Danny Lohan[1], Dr. Shailesh Joshi[1], ***Dr. Ercan Dede***[1]; *[1]Toyota Research Institute of North America*

04:30 PM **Optimizing the vapor chamber with liquid supply layers for high heat flux applications using an ANN-based multi-objective genetic algorithm**; ***Dr. Soosik Bang***[1], Mr. Seungwoo Kim[1], Dr. Seokkan Ki[1], Dr. Junyong Seo[1], Dr. Jaechoon Kim[2], Prof. Bong Jae Lee[1], Prof. Youngsuk Nam[1]; *[1]Korea Advanced Institute of Science and Technology (KAIST), [2]Samsung electronics Co., Ltd.*

04:45 PM **Revolutionizing Electronic Cooling: Ultra-short-pulsed Laser Processed Surfaces in Wick-Free Vapor Chambers**; ***Mr. Anish Pal***[1], Mr. Arani Mukhopadhyay[1], Mr. Graham Kaufman[2], Prof. George Gogos[2], Prof. Craig Zuhlke[2], Prof. Constantine Megaridis[1]; *[1]University of Illinois Chicago, [2]University of Nebraska-Lincoln*

05:00 PM **Mitigation of distortion in fiber laser welded ultra-thin vapor chamber**; ***Dr. Joseph Ahn***[1], Dr. Haejin Lee[1]; *[1]Samsung electronics Co., Ltd.*

05:15 PM **Forced air cooling thermal design with embedded heat pipes in a heatsink for GaN-based High Power RF Amplifier Applications**; ***Mr. Abdul Baba***[1], Mr. Oliver Silva[1], Mr. Bharathidasan Sugumaran[1], Mr. Wajid Khattak[1], Ms. Mae Almansoori[1], Mr. Ahmed Alebri[1], Dr. Felix Vega[1], Dr. Chaouki Kasmi[1]; *[1]Technology Innovation Institute*

TII-04 — TII-04 Immersion Cooling and Refrigeration I — Breakout 2

Chairs: *Sachin Deshmukh, Ved Soni (Auburn University)*

04:00 PM **Experimental Investigation on Single-phase Immersion Cooling Solution for Data Center Application**; ***Mr. Wenbin Tian***[1], Mr. Jianwu Zheng[2], Mr. Xiangwu Chen[2], Mr. Bing Cheng[2], Mr. Yongzhan He[2], Mr. Yipeng Zhong[1], Mr. Jiang Yu[1], Mrs. Ying He[1], Mr. Lihui Wu[1], Mrs. Nishi Ahuja[1]; *[1]Intel Corporation, [2]Baidu Inc.*

04:15 PM **Thermal Performance Characteristic of Single-phase Immersion Cooling on Servers with Optimized Heatsink Design**; ***Mr. Wenbin Tian***[1], Mr. Jin Wang[2], Mr. Shoubiao Xu[2], Mr. Linghao Fan[2], Ms. Maoju Gao[2], Mr. Yan Zhao[2], Mr. Lizhi Zhou[3], Mr. Chao Zhou[1], Mr. Xiaoguo Liang[1], Mrs. Nishi Ahuja[1]; *[1]Intel Corporation, [2]Tencent Cloud, [3]Inspur Electronic Information Industry*

04:30 PM **Analysis on Long Term Reliability of Single-phase Immersion Solution based on Data Center Deployment**; ***Mr. Wenbin Tian***[1], Mr. Yulong Wang[2], Mr. Chenglong Gui[2], Mr. Chen Shen[2], Mr. Bin Lin[2], Mr. Jialiang Xu[1], Mr. Zhiming Li[1], Mr. Kai Wang[1], Mr. Sandeep Ahuja[1], Mrs. Nishi Ahuja[1]; *[1]Intel Corporation, [2]Bytedance Technology*

04:45 PM **Cooling Capability Enhancement in Single-Phase Immersion using Targeted Flow**; ***Dr. Satyam Saini***[1], Mr. Eric McAfee[1], Mr. Casey Carte[1], Mr. Drew Damm[1], Ms. Suchismita Sarangi[1], Dr. Jessica Gullbrand[1], Dr. Mark Macdonald[1]; *[1]Intel Corporation*

05:00 PM **Server Level Impacts on CPU Cooling Capability in Single-Phase Immersion**; ***Ms. Suchismita Sarangi***[1], Dr. Satyam Saini[1], Mr. Eric McAfee[1], Dr. Jessica Gullbrand[1], Mr. Drew Damm[1], Mr. Casey Carte[1]; *[1]Intel Corporation*

05:15 PM **A Novel Design for Improving Heat Dissipation Capacity of Single-Phase Immersion Cooling System with the Perturbation Mechanism**; Dr. Po-Chien Hsu[1], Dr. Jiahong Wu[2], Dr. Chia-Lung Kuo[1], ***Ms. Carrie Chen***[2], Mr. JUN ZHANG[2], Ms. Ying-Shan Lo[2], Mr. Po-Tsang Huang[1]; *[1]Department of Mechanical Engineering, National Yunlin University of Science and Technology, [2]Intel Corporation*

M-04 M-04 Board Level Reliability — Breakout 3

Chairs: *David Huitink (University of Arkansas)*

04:00 PM **The Effect of Conformal Coating on QFN Assembly Reliability: Thermal Cycling and HALT**; ***Dr. Reza Ghaffarian***[1]; *[1] JPL*

04:15 PM **Effects of Temperature on Prepreg & Glass Style in Printed Circuit Board (PCB) - Impact on Solid State Drive**; Dr. VIGNESHWARRAM KUMARESAN[1], ***Dr. Mutharasu Devarajan***[1]; *[1] Western digital corporation*

04:30 PM **Dynamic Testing and Simulation of Chassis Attached Remote Modular Heat Sink**; ***Dr. Phil Geng***[1], Dr. Ligang Wang[1], Mr. Francisco Colorado[1], Dr. Min Pei[1], Mr. Wang Chuanlou[1], Mr. John He[1], Mr. Jimmy Chuang[1], Mr. Roger Liu[1], Mr. Ralph Miele[1], Dr. Sanjoy Saha[1], Mr. Jeffory Smalley[1], Dr. Ashish Gupta[1]; *[1] Intel Corporation*

04:45 PM **Explicit FE Failure Prediction of at Potted Assemblies Under Inclined High-G Shock Loads**; ***Prof. Pradeep Lall***[1], Mr. Aathi Raja Ram Pandurangan[1], Dr. Ken Blecker[2]; *[1] Auburn University, [2] US Army CCDC-AC*

05:00 PM **Reliability performance analysis of Magnetically-Oriented ACA for Flexible and Stretchable Electronics**; ***Prof. Pradeep Lall***[1], Mr. Yunli Zhang[1], Dr. Scott Miller[2]; *[1] Auburn University, [2] NextFlex*

E-04 E-04 Novel Materials and Fabrication Techniques — Breakout 4

Chairs: *Tiwei Wei (Purdue University)*

04:00 PM **Performance Enhancement of Advanced Integrated Circuits Via CVD Diamond Embedding in a Chip**; Mr. Danny Lipovitch[1], ***Dr. Shye shapira***[2]; *[1] Intel, [2] Phononics*

04:15 PM **Enhancing Thermal Conductivity in Bulk Polymer-Matrix Composites**; ***Ms. Angie Rojas Cardenas***[1], Prof. Amy Marconnet[1], Dr. Chelsea Davis[2]; *[1] Purdue University, [2] Department of Mechanical Engineering, University of Delaware, Newark DE*

04:30 PM **Resilient Polymer Nanocomposites for Type II Thermal Interface Materials**; ***Ms. GEETA POKHREL***[1], Dr. John Howarter[1], Dr. Michael Wilson[1], Dr. Chelsea Davis[2]; *[1] School of Materials Engineering, Purdue University, West Lafayette, IN 47907 USA, [2] Department of Mechanical Engineering, University of Delaware, Newark, DE 19716 USA*

04:45 PM **Optimization of Structurally Enhanced Solder Transient Liquid Phase Bonding**; ***Mr. John Harris***[1], Dr. David Huitink[1]; *[1] University of Arkansas*

05:00 PM **High power thermal energy storage from ordered-pore additively manufactured phase-transforming nickel-titanium porous cubes.**; ***Dr. Adam Wilson***[1], Dr. Mustafa Ozsipahi[2], Dr. Michael Fish[2], Dr. Darin Sharar[3], Mr. Andrew Bayba[2], Prof. Ibrahim Karaman[4], Prof. Raymundo Arroyave[4]; *[1] CDCC US Army Research Laboratory, [2] CCDC US Army Research Laboratory, [3] TauMat LLC, [4] Texas A&M University*

05:15 PM **PCM heat sinks for chip transient thermal management of GaN electronic chips**; ***Mr. Behzad Ahmadi***[1], Prof. Sajjad Bigham[1]; *[1] North Carolina State University*

Day 2: Thursday, May 30th 08:15 AM–09:15 AM

TI-05 — TI-05 Power Electronics Cooling — Breakout 1
Chairs: *Scott Schiffres (Binghamton University)*

08:15 AM **Droplet-Train Cooling of Electronic Substrates: Effects of Droplet Parameters, Substrate Wettability Distribution and Power Input**; Mr. Shashwata Moitra[1], ***Mr. Anish Pal***[1], Mr. Md Safwan Mondal[1], Mr. Arani Mukhopadhyay[1], Prof. Constantine Megaridis[1]; [1]*University of Illinois Chicago*

08:30 AM **An Evaluation of Microtube Array Density for Liquid Delivery in Pump-Assisted Capillary Loop Coolers**; ***Dr. Danny Lohan***[1], Dr. Bhaskarjyoti Sarma[2], Dr. Shailesh Joshi[1], Dr. Ercan Dede[1], Dr. Justin A. Weibel[3]; [1]*Toyota Research Institute of North America,* [2]*School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907 USA,* [3]*Purdue University*

08:45 AM **Thermal Characterization of Two-Phase Cooling using Embedded Microchannels in a High Current Density Electric Motor**; ***Mr. Ryan Regan***[1], Dr. Kimberly Saviers[2], Dr. Wenping Zhao[2], Mr. Andrzej Kuczek[2], Dr. Jagadeesh Tangudu[2], Dr. Justin A. Weibel[1]; [1]*Purdue University,* [2]*RTRC*

09:00 AM **Experimental Analysis of Heat Transfer and Pressure Drop in Aluminum Metal Foams Immersed in Dielectric Synthetic Fluid**; ***Dr. Pratik Bansode***[1], Mr. Gautam Gupta[1], Dr. Vivek Nair[1], Mr. Sai Abhideep Pundla[1], Dr. Satyam Saini[1], Dr. Pardeep Shahi[1], Dr. Dereje Agonafer[1], Dr. Yilma Birhane[2], Mr. Metodi Zlatinov[3], Mr. Denver Schaffarzick[3]; [1]*The University of Texas at Arlington,* [2]*Addis Ababa University,* [3]*ERG Aerospace*

TII-05 — TII-05 Thermal Management in Space and Aerospace — Breakout 2
Chairs: *Matthew Harrison, Andres Sarmiento (University of Maryland)*

08:15 AM **Thermal Management of Omnimagnet for Space Debris Mitigation**; ***Mr. Mason Pratt***[1], Dr. Tim Ameel[1], Dr. Sameer Rao[1]; [1]*University of Utah*

08:30 AM **Enclosure for data processing unit electronics (DPU) with integrated phase-change thermal capacitor for space applications - a design overview**; ***Mr. ARTUR JURKOWSKI***[1], Mr. Kamil Lysek[1], Mr. Marcin Wójcik[1], Prof. Adam Klimanek[2]; [1]*KP Labs sp. z o.o.,* [2]*Silesian University of Technology*

08:45 AM **Design and Testing of an Efficient and Rapid Electro-Thermal Pulsed Interfacial De-icing Framework for Electrified Aircraft**; ***Ms. Alexandra Solecki***[1], Mr. Siavash Khodakarami[1], Mr. Pouya Kabirzadeh[1], Dr. Muhammad Jahidul Hoque[1], Mr. Wentao Yang[1], Ms. Nicole Stokowski[1], Mr. Joshua Jacobs[2], Mr. Edward Lovelace[2], Prof. Andrew Stillwell[1], Prof. Nenad Miljkovic[1]; [1]*University of Illinois at Urbana-Champaign,* [2]*Ampaire Inc.*

09:00 AM **Characterizing Critical Interfaces in a Spacebourne Rotorcraft Avionics Unit: Comprehensive Thermal Testing and Model Correlation**; ***Ms. ALLISON ORR***[1], Mr. Christopher Kim[1], Ms. Amelia Cherian[1]; [1]*Johns Hopkins Applied Physics Lab*

M-05 — M-05 Thermal Interface Reliability — Breakout 3
Chairs: *Muhammad Ghufran (University of Arkansas)*

08:15 AM **Accelerated Testing of Thermal Grease Degradation: Combined Thermal Gradients and Forced Mechanical Cycling**; ***Mr. Pranay Nagrani***[1], Prof. Amy Marconnet[1]; [1]*Purdue University*

08:30 AM **IR and Optical Imaging Technique for Stability Analysis of Thermal Interface Materials Under Accelerated Power Cycling**; ***Mr. Peter McClure***[1], Dr. Ali Davoodabadi[1]; [1]*Universal Instruments Corporation*

08:45 AM **Accelerated test for thermal grease pump-out.**; ***Dr. Emma Gonzalez***[1], Dr. Peter Li[1], Dr. Dorab Bhagwagar[1], Dr. Trevor Ewers[1]; [1]*Dow Chemical Company*

09:00 AM **Thermal Conductivity and Interface Strength Evolution of TIM-Copper with Temperature and Humidity Conditioning**; ***Prof. Pradeep Lall***[1], Mr. Madhu Kasturi[1], Mr. Jaimal Williamson[2], Dr. Varughese Mathew[3]; *[1] Auburn University, [2] Texas Instruments, [3] NXP Semiconductor*

E-05 E-05 Phase Change on Enhanced Surfaces — Breakout 4

Chairs: *Luke Gregory, Sreya Sarkar (University of Illinois Chicago)*

08:15 AM **Characterization of Enhanced Two-Phase Jet Impingement on Femtosecond Laser Surface Processed (FLSP) Aluminum Surfaces**; ***Mr. Alexander Ceperley***[1], Dr. Gopinath Sahu[1], Mr. Andrew Reicks[2], Prof. Craig Zuhlke[2], Prof. George Gogos[2], Dr. Justin A. Weibel[1]; *[1] Purdue University, [2] University of Nebraska-Lincoln*

08:30 AM **Enhancing Minichannel Flow Boiling with Femtosecond Laser Surface Processed Stainless Steel Surfaces in Water**; ***Mr. Logan Pettit***[1], Mr. Josh Gerdes[1], Mr. Andrew Reicks[1], Prof. Craig Zuhlke[1], Prof. George Gogos[1]; *[1] University of Nebraska-Lincoln*

08:45 AM **Atmospheric Water Vapor Condensation on Ultra-short Pulsed Laser Surface-Processed Copper**; ***Mr. Arani Mukhopadhyay***[1], Mr. Anish Pal[1], Mr. Graham Kaufman[2], Prof. Craig Zuhlke[2], Prof. George Gogos[2], Prof. Ranjan Ganguly[3], Prof. Constantine Megaridis[1]; *[1] University of Illinois Chicago, [2] University of Nebraska-Lincoln, [3] Jadavpur University*

09:00 AM **Microchannel Flow Boiling Enhancement of PF-5060 with Femtosecond Laser Surface Processed 6061 Aluminum**; ***Mr. Josh Gerdes***[1], Mr. Logan Pettit[1], Mr. Andrew Reicks[1], Prof. Craig Zuhlke[1], Prof. George Gogos[1]; *[1] University of Nebraska-Lincoln*

Day 2: Thursday, May 30th 11:00 AM–12:30 PM

TI-06 — TI-06 Two-Phase Cooling I — Breakout 1

Chairs: *Nitin Karwa (Honeywell International Inc.), John Kim (Seguente, Inc.)*

11:00 AM **Experimental and Numerical Study of Two-Phase Immersion Cooling for High-Power Chips**; ***Mr. Cheng-Han Chiang***[1], Mr. Wei-Cheng Tan[2], Dr. Hua Chen[1], Prof. Yang-Yao Niu[2], Mr. Sheng-Yen Lin[1], Ms. TSEN_HSUAN Yen[1], Mr. Howard Chuang[1]; *[1] Wistron Corporation, [2] Tamkang University*

11:15 AM **Experimental Study on HFE-7000 Flow Boiling Heat Transfer in a Heat Sink with 8 Hot Spots for High-Power Defense Applications**; ***Dr. Murat PARLAK***[1], Dr. Abdolali K Sadaghiani[2], Mr. Behnam Parizad Benam[2], Prof. Ali KOŞAR[2], Mr. Vedat YAĞCI[1], Mr. Muhammed Çağlar Malyemez[1], Ms. Mandana Mohammadilooey[2]; *[1] ASELSAN INC., [2] SABANCI UNIVERSITY*

11:30 AM **Experimental Study on HFE-7100 Pool Boiling Heat Transfer in a Honeycomb Structures Produced by Additive Manufacturing**; ***Mr. Muhammed Çağlar Malyemez***[1], Dr. Murat PARLAK[1], Mr. Vedat YAĞCI[1]; *[1] ASELSAN INC.*

11:45 AM **Two-Phase Immersion Cooler for Medium-Voltage Silicon Carbide MOSFETs**; Mr. Hari Pandey[1], Mr. Xinyuan Du[1], Mr. Ethan Weems[1], Mr. Stephen Pierson[1], Mr. Ahmad Al-Hmoud[1], Dr. Yue Zhao[1], ***Dr. Han Hu***[1]; *[1] University of Arkansas*

12:00 PM **Performance Assessment of Hybrid Microchannel-Pin Fin Heat Sink for Hotspot Thermal Management Under Flow Boiling Conditions**; ***Mr. Amitav Tikadar***[1], Prof. Satish Kumar[1]; *[1] Georgia Institute of Technology*

12:15 PM **Surface-Enhanced Two-Phase Cold Plate Designs for High Power Dissipation in Data Centers**; ***Mr. Haoyun Qiu***[1], Mr. Pouya Kabirzadeh[1], Dr. David Apigo[2], Dr. Sarwesh Parbat[2], Dr. Syed Faisal[2], Dr. Rishav Roy[2], Mr. Bakhshish Preet Singh[1], Dr. Todd Salamon[2], Prof. Nenad Miljkovic[1]; *[1] University of Illinois Urbana-Champaign, [2] Nokia Bell Labs*

TII-06 — TII-06 Data Center Thermal Management II — Breakout 2

Chairs: *Christina Seeholzer, Gautam Gupta (The University of Texas at Arlington)*

11:00 AM **Air Cooling and Water Cooling for Data Center High-Speed I/O Interconnects**; ***Dr. TAOLUE ZHANG***[1], Mr. Nabhanshul Satra[1], Mr. Jalan Salter[1], Dr. Peerouz Amleshi[1]; *[1] Molex LLC*

11:15 AM **A Heat Transfer Study of In-direct Two-phase Cold Plate Liquid Cooling Design for Data Center**; ***Mr. YUEHLIN TSAI***[1], Mr. JUN ZHANG[2], Mr. Hongxing Zhou[2], Mr. Ming Yi[2], Mr. Guilin Wang[3], Mrs. Nishi Ahuja[2]; *[1] jd.com, [2] Intel Corporation, [3] JD.COM*

11:30 AM **Long Term Reliability Test on an Air Assisted Liquid Cooling System**; ***Dr. Yin Hang***[1], Dr. Wenying Zhang[1], Ms. Grace Piette[1], Mr. Pradip Pichumani[1], Mr. Mahendra Lokhande[1], Mr. Joseph Tseng[2], Mr. Feroz Ahamed[3], Ms. Keegan Yaroch[4], Ms. Ellie Chen[1], Dr. John Fernandes[5], Ms. Yueming Li[1], Dr. Jiu Xu[1]; *[1] Meta, [2] Coolermaster, [3] Delta Electronics, [4] Dow Chemical Company, [5] Meta Platforms*

11:45 AM **Acoustics Analysis of Air and Hybrid Cooled Data Center**; Dr. Uschas Chowdhury[1], Dr. Jeremy Rodriguez[2], ***Dr. Mohammad Tradat***[1], Mr. Qusai Soud[2], Mr. Scott Wallace[1], Mr. Dennis O"Brien[1], Mr. Steven Hambruch[1], Dr. Ali Heydari[2], Dr. Vahideh Radmard[1], Dr. Pardeep Shahi[1]; *[1] NVIDIA, [2] Nvidia*

12:00 PM **Novel Subcooled Boiling Chamber With Submerged Condensation for High Heat Flux Removal for Data Center Application**; ***Mr. Maharshi Y. Shukla***[1], Prof. Satish Kandlikar[1]; *[1] Rochester Institute of Technology*

12:15 PM **Maximizing Cooling Potential: A Step-by-Step Guide to Commissioning Liquid-Cooled Data Centers**; ***Dr. Pardeep Shahi***[1], Dr. Ali Heydari[2], Mr. himanshu Modi[3], Mr. Lochan Sai Reddy Chinthaparthy[3], Mr. Anto Barigala[3], Dr. Bahareh Eslami[2], Dr. Mohammad Tradat[1], Dr. Dereje Agonafer[3], Dr. Jeremy Rodriguez[2]; *[1] NVIDIA, [2] Nvidia, [3] The University of Texas at Arlington*

M-06 — M-06 Board Level Reliability - BGAs — Breakout 3

Chairs: *Yuanchen Hu (IBM Corp.)*

11:00 AM **Evaluating Shear Properties of Individual Solder Joints in Ball Grid Arrays: The Impact of Ag and Bi Content**; ***Ms. Waad Tarman***[1], Dr. Ali Alahmer[1], Mr. Sergio Bolanos[1], Mr. Shaheen Pouya[1], Mr. Abdallah Alakayleh[1], Dr. Mohamed El Amine Belhadi[1], Dr. Sa'd Hamasha[1]; *[1]Auburn University*

11:15 AM **Drop Shock Testing of BGA Test Vehicles at Elevated Temperature**; ***Mr. Palash Pranav Vyas***[1], Mr. Sergio Bolanos[1], Mr. Shaheen Pouya[1], Mr. Saddam Daradkeh[1], Dr. Mohamed El Amine Belhadi[1], Dr. Ali Alahmer[1], Dr. Sa'd Hamasha[1]; *[1]Auburn University*

11:30 AM **Effect of Isothermal Aging on Anisotropic Creep Properties of SAC305 Single Crystals**; ***Mr. Aniket Bharamgonda***[1], Dr. Abhijit Dasgupta[1], Dr. Torsten Hauck[2], Dr. Yaxiong Chen[2], Mr. Johnathan Martin[1], Dr. Yongrae Jang[1]; *[1]University of Maryland, [2]NXP Semiconductor*

11:45 AM **Aging Effect on Drop-Shock Reliability of SnAgCu305 Solder Alloy**; ***Mr. Saddam Daradkeh***[1], Mr. Palash Pranav Vyas[1], Mr. Abdallah Alakayleh[1], Dr. Mohamed El Amine Belhadi[1], Mr. Sufyan Tahat[1], Dr. Ali Alahmer[1], Dr. Sa'd Hamasha[1]; *[1]Auburn University*

12:00 PM **Study of High-G Level Shock Damage-Accrual in Doped/Undoped SAC Solders during Prolonged Sustained Operation at 100oC**; ***Prof. Pradeep Lall***[1], Mr. Vishal Mehta[1], Dr. Jeff Suhling[1], Dr. David Locker[2]; *[1]Auburn University, [2]US Army CCDC-AvMC*

12:15 PM **Investigation of the Effects of Sustained High-Temperature on the Reliability of Lead-Free Solder Joint Assemblies in Vibration**; ***Prof. Pradeep Lall***[1], Mr. Vishal Mehta[1], Dr. Jeff Suhling[1], Dr. David Locker[2]; *[1]Auburn University, [2]US Army CCDC-AvMC*

E-06 — E-06 Sustainability and Additive Manufacturing — Breakout 4

Chairs: *Tiwei Wei (Purdue University)*

11:00 AM **Biodegradable Substrates For Sustainable Aerosol-Jet Additively Printed Electronics**; ***Prof. Pradeep Lall***[1], Mr. Daniel Karakitie[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

11:15 AM **Performance Analysis of Screen-Printed Functional Circuits on Biodegradable PET Substrates Using Low-Temperature ECA for SMD Component Attachment**; ***Prof. Pradeep Lall***[1], Mr. Shriram Kulkarni[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

11:30 AM **Impact of Thermal Cycling on In-Mold Flexible Substrates Fabricated via Direct-Write Printing**; ***Prof. Pradeep Lall***[1], Mr. Fatahi Musa[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

11:45 AM **Advancing Sustainability in Printed Electronics: Low-Temperature Interconnects and Water-Based Ink Performance**; ***Prof. Pradeep Lall***[1], Ms. Sabina Bimali[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

12:00 PM **Performance Comparison of Sustainable and Non-sustainable Silver Inks through a Printed Differentiator Circuit**; ***Prof. Pradeep Lall***[1], Ms. Sabina Bimali[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

12:15 PM **Sustainability and Life Cycling Investigation of Buck Charging Circuits Printed using Gravure Offset Printing**; ***Prof. Pradeep Lall***[1], Mr. Ved Soni[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

DAY 2: THURSDAY, MAY 30TH 02:00 PM–03:30 PM

TI-07A TI-07A TWO-PHASE COOLING II — BREAKOUT 1

Chairs: *Solomon Adera (University of Michigan), Filippo Cataldo (Wieland)*

02:00 PM **Single-Phase and Two-Phase Liquid Immersion Cooling of Data Center Power Supply Units for Heat Capture**; ***Mr. Haoyun Qiu***[1], Mr. Pouya Kabirzadeh[1], Mr. Vivek S. Garimella[1], Mr. Arjit Bali[1], Mr. Keerthivasan Gurusami[1], Mr. Kang Joon Lee[1], Prof. Andrew Stillwell[2], Dr. Todd Salamon[3], Prof. Nenad Miljkovic[1]; *[1]University of Illinois Urbana-Champaign, [2]University of Illinois at Urbana-Champaign, [3]Nokia Bell Labs*

02:15 PM **Experiments and Modeling of Two-phase Cooled IGBT Module for Rail Transit Applications**; Mr. Weiwei Gan[1], ***Dr. Zhaozan Feng***[2], Mr. Hui Wu[1], Mr. Liangjie Liu[2], Mr. Bin Liu[2], Mr. Chengxi Li[2]; *[1]Zhuzhou CRRC Times Electric Co.,Ltd, [2]Zhuzhou CRRC Times Electric UK Innovation Center*

02:30 PM **Effect of Micro-channel Cross-section and Coolant Pressure on Two-Phase Cooling**; ***Dr. Pritish Parida***[1]; *[1]IBM T.J. Watson Research Center*

02:45 PM **Thermal Management of Multiple High-Heat-Flux Heat Sources using Additively Manufactured Two-Phase Cold Plate**; ***Dr. Mohammad Reza Shaeri***[1], Mr. Maksym Demydovych[1]; *[1]Advanced Cooling Technologies, Inc.*

03:00 PM **An Integrated Simulation Framework for Thermal-Mechanical Performance Analysis of Two-phase Microchannel Evaporators**; ***Dr. Sarwesh Parbat***[1], Dr. David Apigo[1], Mr. Haoyun Qiu[2], Mr. Pouya Kabirzadeh[2], Dr. Rishav Roy[1], Dr. Syed Faisal[1], Prof. Nenad Miljkovic[2], Dr. Todd Salamon[1]; *[1]Nokia Bell Labs, [2]University of Illinois at Urbana-Champaign*

03:15 PM **Thermal Characterization of a Two-Phase Integrated Heat Sink with Different Heat Source Locations**; ***Dr. Roberta Perna***[1], Mr. Mohamed Hasan[2], Dr. Ahmed Elkholy[1], Mr. Jason Durfee[3], Dr. Roger Kempers[1]; *[1]Department of Mechanical Engineering, York University, Toronto, Canada, [2]York University, [3]Magna Internaitonal Inc, 337 Magna Drive, Aurora, Ontario, Canada*

TII-07 TII-07 IMMERSION COOLING AND REFRIGERATION II — BREAKOUT 2

Chairs: *Kanan Pujara, Arad Azizi (Honeywell International Inc.)*

02:00 PM **High Heat Flux Investigation of Copper-Nickel Alloys in R-1233zd(E) Pool Boiling**; ***Mr. Shau Wai Cheng***[1], Dr. Sumit Sharma[1], Mr. Cho-Hsin Yang[1], Dr. Chin-Shiang Shih[2], Dr. Yu-Lin Chung[2], Prof. CHI-CHUAN WANG[1]; *[1]Department of Mechanical Engineering, National Yang Ming Chiao Tung University, [2]Metal Industries Research & Development Centre, Kaohsiung, Taiwan*

02:15 PM **Immersion Oil Thermal Performance Characteristics and Comparisons**; ***Dr. Yuanchen Hu***[1], Dr. Milnes David[2]; *[1]IBM Systems Infrastructure, [2]IBM Corp.*

02:30 PM **An Advanced 48U Single Phase Immersion Cooling System Design for Commercial Data Center Deployments**; ***Mr. ALLEN LIANG***[1], Mr. Brant Chang[2], Mr. Jimmy Chang[2], Mr. JUN ZHANG[1], Dr. Jiahong Wu[1], Ms. Carrie Chen[3], Mr. Tang Hu[4], Mr. QingYi Kong[4]; *[1]Intel Corporation, [2]Inventec Corporation, [3]Intel, [4]OPPO*

02:45 PM **Simulation Study of Single-phase Immersion Cooling of a Single Server and a Cluster of Servers in a Tank**; ***Dr. Milnes David***[1], Mr. Pranay Nagrani[2], Dr. Anil Yuksel[1], Dr. Yuanchen Hu[1]; *[1]IBM Corp., [2]Purdue University*

03:00 PM **Low Electrical Conductivity Glycol Coolants as Alternative to Perfluorinated Fluids for Electronics Cooling Applications**; ***Mr. Carter Prokesch***[1], Dr. Sreya Dutta[1], Dr. Satish Mohapatra[1]; *[1]Dynalene Inc.*

03:15 PM **CFD Evaluation of Electrochemical Additively Manufactured Heatsinks for Single-Phase Immersion Cooling**; ***Mr. Joseph Herring***[1], Mr. Jacob Lamotte-Dawaghreh[1], Mr. Gautam Gupta[1], Dr. Dereje Agonafer[1], Mr. Joseph Madril[2], Mr. Tim Ouradnik[2], Mr. Michael Matthews[2], Mr. Ian Winfield[2]; *[1]The University of Texas at Arlington, [2]Fabric8Labs*

TI-07B — TI-07B Thermal Modeling and Analysis — Breakout 3

Chairs: *Rachel McAfee (CDCC US Army Research Laboratory), Risa Miyazawa (IBM Corp.)*

02:00 PM **Accelerating Thermal Analysis of Chiplet Designs by Embedding FANTASTIC BCI-ROMs in CFD models**; Mr. Byron Blackmore[1], ***Mr. John Wilson***[1]; *[1] Siemens DISW*

02:15 PM **Micro Scale Phosphor Particles in an LED Package: Heat Transfer, Fluid Dynamics, Optical Characteristics**; Mr. Erphan Safdari[1], ***Prof. Mehmet Arik***[2], Dr. Altug Melik Basol[3], Dr. Mete Budakli[3]; *[1] Evateg Center, Ozyegin University, Istanbul 34794, Turkey, [2] Auburn University, [3] Evateg Center, Ozyegin University*

02:30 PM **Modeling of Backside Power Delivery and Thermal Management in Semiconductor Die Packages**; ***Mr. Zekun Wu***[1], Dr. Xin Zhang[2], Ms. Shurong Tian[2], Mr. Ashwin Kidambi[1], Dr. Justin A. Weibel[3], Dr. Liang Pan[3]; *[1] School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907 USA, [2] IBM T. J. Watson Research Center, 1101 Kitchawan Rd, Yorktown Heights, NY 10598 USA, [3] Purdue University*

02:45 PM **Numerical Investigation of Flow Boiling in Fin-Enhanced Microgaps Using an Improved Lee Model**; Mr. Ammar Osman[1], ***Dr. Yogendra Joshi***[1]; *[1] Georgia Institute of Technology*

03:00 PM **The model and influence factors of thermal interaction in chiplet 2.5D integration**; ***Mr. Jianyu Feng***[1], Dr. chuan chen[1], Dr. Rong Fu[1], Prof. liqiang cao[1], Prof. qidong wang[1]; *[1] Institute of Microelectronics of the Chinese Academy of Sciences*

03:15 PM **The Study on Improving CFD Simulation Accuracy for Heat Sink Design Optimization in Single-Phase Immersion Cooling System**; Dr. Jiahong Wu[1], ***Ms. Carrie Chen***[2], Mr. Pang Wei[3], Mr. JUN ZHANG[1], Ms. Ying-Shan Lo[1], Mr. Checa Hung[1], Mr. Liwen Guo[4], Ms. Monica Zhang[5], Ms. Grace Yang[5], Mr. Jacky Wang[6], Mr. Wenming Zheng[7]; *[1] Intel Corporation, [2] Intel, [3] China Telecom Cloud Technology Co.,Ltd., [4] Shenzhen institute for Advanced Study, UESTC, [5] Foxconn Corporation, [6] Jotactic Automotive Consulting Corporation, [7] China Telecom Cloud Technology Co.,Ltd*

E-07 — E-07 Machine Learning and Predictive Analytics — Breakout 4

Chairs: *Gautam Gupta (The University of Texas at Arlington)*

02:00 PM **Image driven deep learning based compact model to predict critical heat flux in direct immersion cooling via pool boiling**; ***Mr. Pranay Nirapure***[1], Mr. Ayushman Singh[1], Dr. Srikanth Rangarajan[2], Prof. Bahgat Sammakia[3]; *[1] Graduate Student Researcher, [2] Co-Principal investigator, [3] Principal Investigator*

02:15 PM **Physics-informed Neural Network on Thin Film Evaporation**; ***Mr. Amirmohammad Jahanbakhsh***[1], Ms. Rojan Firuznia[1], Dr. Sina Nazifi[1], Prof. Hadi Ghasemi[1]; *[1] University of Houston*

02:30 PM **Applied Machine Learning for Enterprise SSDs Operating Curve Predictions**; ***Dr. Chaolun Zheng***[1], Dr. Hedan Zhang[1], Dr. Li Chen[1], Dr. Ning Ye[1]; *[1] Western digital corporation*

02:45 PM **Modeling Flow Boiling Utilizing Machine Learning Vision Data**; ***Dr. Cho-Ning Huang***[1], Mr. Sang Hyeon Chang[2], Dr. Youngjoon Su[3], Prof. Yoonjin Won[3], Prof. Chirag Kharangate[4]; *[1] Case western reserve university, [2] University of California, Irvine, [3] University of California Irvine, [4] Case Western Reserve university*

03:00 PM **CFD Surrogates for Data Center Sustainability Using 3D U-Net Convolutional Neural Network**; ***Mr. Soumyendu Sarkar***[1], Dr. Antonio Guillen-Perez[1], Mr. Zachariah Carmichael[1], Dr. Avisek Naug[1], Mr. Vineet Gundecha[1], Dr. Ricardo Luna[1], Dr. Ashwin Ramesh Babu[1], Mr. Cullen Bash[1]; *[1] Hewlett Packard Enterprise*

03:15 PM **Detection of Cooling Operational Statuses in Data Center Energy Management using Clustering Algorithms**; ***Dr. Vlatko Milic***[1], Dr. Maria Andersson[2], Mr. Linus Kåge[2], Prof. Patrik Thollander[1], Mr. Jim Enkel[3], Prof. Bahram Moshfegh[1]; *[1] Linköping University and University of Gävle, [2] Linköping University, [3] Ericsson AB*

Day 2: Thursday, May 30th 04:00 PM–05:30 PM

TI-08 TI-08 Heat Pipes and Vapor Chambers II — Breakout 1

Chairs: *Kevin McCarthy*

04:00 PM **Dependence of Oscillation Frequencies on Operating Conditions in an Oscillating Heat Pipe**; ***Dr. Rishav Roy***[1], Dr. Sarwesh Parbat[1], Dr. Todd Salamon[1]; *[1] Nokia Bell Labs*

04:15 PM **Enhancing Predictive Capabilities of Pulsating Heat Pipes (PHPs) Through Validation with Diverse Configurations**; Mr. Michael Bialocur[1], Mr. André Seuret[1], Dr. Jackson Marcinichen[1], ***Prof. John R. Thome***[1]; *[1] JJ Cooling Innovation SARL*

04:30 PM **Comparison of Cooling Methods for Underground Electric Vehicle Chargers**; ***Mr. Siddhesh Shinde***[1], Dr. Gautham Ram Chandra Mouli[1], Dr. Chiara Falsetti[2], Prof. Pavol Bauer[1]; *[1] Delft University of Technology, [2] Propulsion and Power, Delft University of Technology*

04:45 PM **Thermal Behavior and Visualization of Electrochemical Additive Manufactured Copper Lattice Wicks in a Flat Heat Pipe**; ***Mr. Mohamed Hasan***[1], Dr. Roberta Perna[1], Mr. Ian Winfield[2], Mr. Michael Matthews[2], Mr. Joseph Workman[2], Mr. Jason Durfee[3], Dr. Roger Kempers[1]; *[1] Department of Mechanical Engineering, York University, Toronto, Canada, [2] Fabric8Labs, 10788 Roselle Street, Suite 101, San Diego, CA 92121, [3] Magna Internaitonal Inc, 337 Magna Drive, Aurora, Ontario, Canada*

05:00 PM **Experimental and Numerical study of Ultra-Thin Heat Pipes for thin and light segment laptops.**; ***Dr. Ritu Bawa***[1], Mr. Manfred Hernandez[1], Mr. Chethan Holla[1]; *[1] Intel Corporation*

TII-08 TII-08 Phase Change Materials and Novel Cooling Techniques — Breakout 2

Chairs: *Solomon Adera (University of Michigan), Xiang Zhang (Oregon State University)*

04:00 PM **Thermal Performance of 0.7mm-Thick Ultra-Thin Vapor Chambers with Composite Mesh-Groove Wick**; Mr. Kuan-Wei Tseng[1], Prof. Shwin-Chung Wong[1], ***Mr. Chih-Yuan Fu***[2], Mr. Lian-Qi Huang[2], Dr. Chih-Chao Hsu[3], Dr. Chung-Yen Lu[3]; *[1] National Tsing Hua University, Hsin-Chu, [2] National Tsing Hua University, Department of Power Mechanical Engineering, Hsin-Chu, [3] National Chung-Shan Institute of Science & Technology, Taoyuan*

04:15 PM **Comparison of Single and Dual Orifice Synthetic Jets for Flow Structure and Heat Transfer**; ***Mr. Faisal Ahmed***[1], Mr. Mohammad Azarifar[1], Dr. Muhammad Ikhlaq[2], Prof. Mehmet Arik[1]; *[1] Auburn University, [2] Dyson Institute of Engineering and Technology*

04:30 PM **Experimental Measurements of the Effective Thermal Conductivity and Contact Resistance of Compressed and Uncompressed Metal Foam for Applications to Cold Plates**; ***Mr. Bolape Alade***[1], Prof. Alfonso Ortega[1], Mr. Metodi Zlatinov[2], Mr. Denver Schaffarzick[2]; *[1] Villanova University, [2] ERG Aerospace*

04:45 PM **Methodology to evaluate the thermal performance of the encapsulated phase change materials based nanofluid coolant**; ***Mr. Muhammad Ghufran***[1], Dr. David Huitink[1]; *[1] University of Arkansas*

05:00 PM **Analysis of Additively Manufactured Phase Change Heatsinks for Transient Thermal Management**; ***Dr. Michael Manno***[1], Mr. Cole Lahmann[1]; *[1] Johns Hopkins Applied Physics Lab*

05:15 PM **Design and Characterization of a Thermal Test Vehicle with Embedded Phase Change Material**; ***Mr. Meghavin Bhatasana***[1], Prof. Amy Marconnet[1]; *[1] Purdue University*

M-08 M-08 Solder Metallurgy — Breakout 3

Chairs: *Paul Paret (National Renewable Energy Laboratory)*

04:00 PM **The Effect of Bi Content and Strain Rate on Tensile Properties of SnAgCu-Bi Alloys**; ***Mr. Sergio Bolanos***[1], Dr. Ali Alahmer[1], Mr. Abdallah Alakayleh[1], Mr. Shaheen Pouya[1], Mr. Palash Pranav Vyas[1], Dr. Mohamed El Amine Belhadi[1], Dr. Sa'd Hamasha[1]; *[1] Auburn University*

04:15 PM **Shear Strength Analysis of Aging SAC-Bi Solder Joints with Different Solder Paste Volumes**; ***Mr. Shaheen Pouya***[1], Mr. Sergio Bolanos[1], Mr. Sufyan Tahat[1], Ms. Waad Tarman[1], Dr. Mohamed El Amine Belhadi[1], Dr. Ali Alahmer[1], Dr. Sa'd Hamasha[1]; *[1] Auburn University*

04:30 PM **Microhardness Analysis of Reflowed Solder Joints: Effect of Paste Alloy and Paste Volume**; ***Mr. Abdallah Alakayleh***[1], Mr. Sufyan Tahat[1], Dr. Mohamed El Amine Belhadi[1], Mr. Sergio Bolanos[1], Mr. Saddam Daradkeh[1], Ms. Waad Tarman[1], Mr. Qais Qasaimeh[1], Dr. Ali Alahmer[1], Dr. Sa'd Hamasha[1]; *[1] Auburn University*

04:45 PM **Effects of Combined Isothermal Aging and Mechanical Cycling Exposures on the Mechanical Behavior of Lead Free Solder Alloys**; ***Mr. Mahbub Alam Maruf***[1], Mr. Golam Rakib Mazumder[1], Mr. Souvik Chakraborty[1], Prof. Jeffrey Suhling[1], Prof. Pradeep Lall[1]; *[1] Auburn University*

05:00 PM **Characterization of the Mechanical Response and Microstructure of iSAC Lead-Free Solder**; ***Mr. Golam Rakib Mazumder***[1], Mr. Mahbub Alam Maruf[1], Mr. Souvik Chakraborty[1], Prof. Jeffrey Suhling[1], Prof. Pradeep Lall[1]; *[1] Auburn University*

05:15 PM **Constitutive Behaviors for Sn58Bi, Sn57Bi-1Ag and other Low Temperature Alloys**; ***Mr. Sean Y. Lai***[1], Ms. Lijia Xie[2], Dr. Sukshitha Achar P. L.[1], Dr. Morgana Ribas[3], Dr. John Blendell[2], Dr. Carol Handwerker[2], Dr. Ganesh Subbarayan[1]; *[1] School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907 USA, [2] School of Materials Engineering, Purdue University, West Lafayette, IN 47907 USA, [3] MacDermid Alpha Electronics Solutions*

E-08 E-08 Two-Phase Cooling — Breakout 4

Chairs: *Sreya Sarkar (University of Illinois Chicago)*

04:00 PM **Embedded Microchannel Cryogenic Cooling for Silicon Crystal Monochromators using Liquid Nitrogen and Liquid Argon**; ***Prof. Tiwei Wei***[1], Dr. Lin Zhang[2], Prof. Mehdi Asheghi[3], Prof. Kenneth Goodson[3]; *[1] Purdue University, [2] SLAC National Accelerator Laboratory, [3] Stanford university*

04:15 PM **Direct-On-Chip Hotspot Targeted Microjet Cooling for Ultra-fast Inference at Scale Running on Groq Language Processing Unit (LPU™)**; Mr. Feifan Xie[1], ***Mr. SHUHANG Lyu***[1], Dr. Zhi Yang[2], Prof. Tiwei Wei[1]; *[1] Purdue University, [2] Groq Inc*

04:30 PM **The Impact of Liquid Supply Delivery Methods on the Thermal Performance of a Capillary-based Two-phase Micro-cooler for the Power Electronics**; ***Mr. YUJUI LIN***[1], Dr. Heungdong Kwon[1], Dr. Hao Chen[2], Dr. Man Prakash Gupta[3], Dr. Michael Degner[3], Prof. Mehdi Asheghi[1], Prof. Alan Mantooth[2], Prof. Kenneth Goodson[1]; *[1] Stanford university, [2] University of Arkansas, [3] Ford Motor Company*

04:45 PM **Pulsed flash boiling for high heat flux electronics cooling**; ***Mr. Rishi Pugazhendhi***[1], Dr. Timothy S. Fisher[1], Dr. Subramanian S. Iyer[2]; *[1] Department of Mechanical and Aerospace Engineering, University of California Los Angeles (UCLA), California 90095, United States, [2] Department of Electrical and Computer Engineering, University of California Los Angeles (UCLA), California 90095, United States*

05:00 PM **Pseudo-boiling of CO2 inside a parallel-flow microchannel and an array of micro jets impingement device**; ***Mr. PRANZAL AHMED***[1], Dr. Stephen Adeoye[1], Dr. Anatoly Parahovnik[1], Dr. Uday Manda[1], Prof. Yoav Peles[2]; *[1] University of Central Florida, [2] Professor, Chair*

05:15 PM **Capillary Suction for Evaporative Cooling**; Prof. Sylvie Lorente[1], ***Mx. Xuewei Zhang***[1]; *[1] Villanova University*

Day 3: Friday, May 31st 08:15 AM–09:15 AM

TI-09 — TI-09 Heatsinks and Coldplates II — Breakout 1

Chairs: *Rinaldo Miorini (GE Research)*

08:15 AM **Thin Form Factor Tunable Cold-Plates and Locking Tensioner Cooling Assemblies for Next Generation Memory Modules**; ***Dr. Prabhakar Subrahmanyam***[1], Dr. Ying-Feng Pang[1], Mr. Vishnu Prasadh Sugumar[1], Dr. Tong Wa Chao[1], Dr. Ridvan Sahan[1]; [1] *Intel Corporation*

08:30 AM **Hydraulic Performance Analysis of an Additively Manufactured Multipass Microchannel Heat Exchanger**; ***Mr. Zhengda Yao***[1], Dr. Andres Sarmiento[1], Dr. Amir Shooshtari[1], Dr. Hugh Bruck[1], Dr. Michael Ohadi[1]; [1] *University of Maryland*

08:45 AM **Study of Aluminum Foam Material for Heat Dissipation of Heat Source at Varying Heat Generation**; ***Mr. Ethan Trulson***[1], Prof. Gerardo Carbajal[1], Prof. Edwar Romero-Ramirez[1], Prof. Younggil Park[1], Ms. Emily Geiger[1]; [1] *Florida Polytechnic University*

09:00 AM **Investigation of Rib Characteristics in Structured Cooling Channels**; Mr. Arturo Garcia[1], ***Dr. Shadi Mahjoob***[1]; [1] *California State University Northridge*

TII-09 — TII-09 Mobile and Internet of Things — Breakout 2

Chairs: *Phil Geng (Intel Corporation), himanshu Modi (The University of Texas at Arlington)*

08:15 AM **Experimental analysis and measurement of hotspot location with thermal test vehicle in mobile SOC**; ***Mr. Youngsang Cho***[1], Mr. Heonwoo Kim[1], Mr. Wonsik Shin[1], Dr. Jun So Pak[1], Dr. Seungwook Yoon[1]; [1] *Samsung electronics Co., Ltd.*

08:30 AM **Digital twin in manufacturing: Transient Thermo-Mechanical Simulations**; ***Mr. Alireza Ameli***[1], Mr. Markus Mäkeläinen[1], Mr. Jari Huttunen[1], Mr. Davide Frigerio[2], Mr. Andreas Rydin[2], Mr. Kelvin Qin[2]; [1] *Nokia,* [2] *ANSYS*

08:45 AM **Robust Pothole Detection in Adverse Weather Conditions using Thermal Imaging and Image Processing**; ***Dr. Pathmanaban P***[1], Dr. GNANAVEL B K[2]; [1] *SRM Easwari Engineering College,* [2] *Faculty of Engineering and Technology, SRM Institute of Science and Technology,*

09:00 AM **Thermal Testing and Analysis of On-the-Market Smartwatches**; ***Mr. Guy Wagner***[1], Mr. Kevin Ibarra[1], Mr. Amith Mathew[1]; [1] *Electronic Cooling Solutions, Inc.*

TII-09B — TII-09B Thermal Management — Breakout 3

Chairs: *Vivek Nair (The University of Texas at Arlington), Karthik Kumar (Amazon)*

08:15 AM **Ultrathin blowers: A study on parameters influencing flow and thermal performance in notebook applications**; ***Mr. RAVISHANKAR SRIKANTH***[1], Mr. AMIT KUMAR[1], Mr. Arnab Sen[1]; [1] *Intel Corporation*

08:30 AM **Experimental and Numerical study of thin vapor chambers for dual heat sources in gaming notebooks.**; ***Dr. Ritu Bawa***[1], Mr. Chethan Holla[1], Mr. RAVISHANKAR SRIKANTH[1], Mr. Doddi Raghavendra[1], Mr. Manash Lekharu[2]; [1] *Intel Corporation,* [2] *IIT Bhilai*

08:45 AM **Modularized thermal and mechanical cold plate based high power memory liquid cooling solution**; ***Mr. Yuehong Fan***[1], Mr. Xiang Que[1], Mr. Wang Chuanlou[1], Mr. Ming Zhang[1], Mr. Yanbing Sun[1], Ms. Qing Jiang[1], Mr. Jinbo Li[2], Mr. Guangzhi Liu[3], Mr. Shaonan Jiang[3], Mr. Xiaowei Zhang[3]; [1] *Intel Corporation,* [2] *IEI system,* [3] *IEI System*

09:00 AM **Cold plate liquid cooling solution for hot-swapped components in server system**; ***Mr. Yuehong Fan***[1], Mr. Guocheng Zhang[1], Mr. Yanbing Sun[1], Ms. Na Chen[1], Mr. Jinbo Li[2], Mr. Guangzhi Liu[3], Mr. Shaonan Jiang[3], Mr. Xiaowei Zhang[3]; [1] *Intel Corporation,* [2] *IEI system,* [3] *IEI System*

Day 3: Friday, May 31st 11:00 AM–12:30 PM

TI-10 — TI-10 Packaging and Thermal Management — Breakout 1

Chairs: *Aakrati Jain (IBM Research), Muhammad Ikhlaq (Newcastle University)*

11:00 AM **3D modeling and mitigation strategies in the thermal runaway of single-cell and modular Lithium-ion batteries architectures**; ***Prof. Jiajun Xu***[1], Dr. Faridreza Attarzadeh[2], Ms. Tanjee Afreen[2]; *[1]University of the District of Columbia, [2]UDC CAMSTAR*

11:15 AM **Immediate thermal evaluation of power modules independent of the number and placement of chips**; ***Mr. Sudo Tomoya***[1], Mr. Gakuto Hiraoka[1], Prof. Qiang Yu[2], Mr. Wei Liu[3], Mr. Mitsutoshi Muraoka[3], Mr. Yuji Komatsu[3]; *[1]Yokohama National University, [2]Department of Mechanical Engineering, Yokohama National University, [3]ZF Japan Co., Ltd*

11:30 AM **Thermal Management and Integrated Heat Spreader Assembly Challenges of Products with Variable Die Heights**; ***Dr. Arifur Chowdhury,***[1], Dr. Dr. Krishna Vasanth Valavala[1], Dr. Amitesh Saha[1], Mr. Sergio A Chan Arguedas[1], Dr. Shenavia S Howell[1], Dr. Peng Li[1]; *[1]Intel Corporation*

11:45 AM **Accurate Temperature Prediction of Complex Die Power Maps using Quadtree Based Surrogate**; ***Mr. John Wilson***[1]; *[1]Siemens DISW*

12:00 PM **Multi-resolution method for thermal resistance matrix based on 2D Haar wavelet**; ***Dr. Heeseok Lee***[1], Dr. Jun So Pak[1], Dr. Kisu Joo[1], Mr. Heonwoo Kim[1], Mr. Youngsang Cho[2]; *[1]Samsung electronics Co., Ltd., [2]Samsung electronics*

12:15 PM **3D-IC In-Design Thermal Analysis and Optimization**; ***Dr. Li Lu***[1], Mr. Jinbiao Zhu[1], Dr. Yixing Li[1], Dr. Anand Nagarajan[1], Mr. Jarod Liu[1], Ms. Shinyu Shiau[1], Dr. Xin Ai[1]; *[1]Cadence Design Systems*

TII-10 — TII-10 Liquid Cooling Solutions — Breakout 2

Chairs: *Adam Wilson (CDCC US Army Research Laboratory)*

11:00 AM **Hydrothermal characteristics of P2P loop with ribbed spiral channel in evaporator**; Prof. Shyy-Woei Chang[1], Ms. Shu-Jung Tsai[1], ***Mr. Tzu-An Wang***[1]; *[1]National Cheng Kung University*

11:15 AM **The study of liquid cooling solution on 51.2T switch**; ***Mr. Yaoyin Fan***[1], Mr. peng Xiao[1], Ms. Yan Liu[1]; *[1]Celestica*

11:30 AM **The Study on cold plate liquid cooling solution for high performance server**; ***Mr. Yaoyin Fan***[1], Mr. Liang Ji[1], Mr. Colin Yu[1], Mr. Minquan Fang[1]; *[1]Celestica*

11:45 AM **System-Level Assessment of Green Refrigerant Replacements for Direct-to-Chip Two-Phase Cooling**; Dr. Ali Heydari[1], ***Mr. Omar Al-Zu'bi***[2], Dr. Yaman Manaserh[1], Mr. Mehdi Mehrabikermani[3], Ms. Farzaneh Hosseini[2], Dr. Jeremy Rodriguez[1], Prof. Bahgat Sammakia[4]; *[1]Nvidia, [2]Binghamton University, [3]Villanova University, [4]Principal Investigator*

12:00 PM **CFD STUDY OF ELECTROCHEMICAL ADDITIVE MANUFACTURING BASED COLD PLATE DESIGNS FOR ENHANCED ELECTRONICS COOLING**; ***Mr. Jacob Lamotte-Dawaghreh***[1], Mr. Joseph Herring[1], Mr. Gautam Gupta[1], Dr. Dereje Agonafer[1], Mr. Joseph Madril[2], Mr. Tim Ouradnik[2], Mr. Ian Winfield[2], Mr. Michael Matthews[2]; *[1]The University of Texas at Arlington, [2]Fabric8Labs*

12:15 PM **Liquid to Refrigerant Cooling System Challenges, Characterization, and Operational Limits: A Case Study**; Dr. Ali Heydari[1], ***Mr. Qusai Soud***[1], Dr. Mohammad Tradat[2], Mr. Ahmad Gharaibeh[1], Dr. Pardeep Shahi[2], Dr. Bahareh Eslami[1], Dr. Uschas Chowdhury[2], Prof. Bahgat Sammakia[3], Dr. Jeremy Rodriguez[1]; *[1]Nvidia, [2]NVIDIA, [3]Principal Investigator*

M-10 — M-10 Accelerated Testing and Novel Reliability Methods — Breakout 3

Chairs: *Phil Geng (Intel Corporation)*

11:00 AM **Pool Boiling Reliability Tests and Degradation Mechanisms of Microporous Copper Inverse (CuIOs) Structures**; ***Ms. Kaiying Jiang***[1], Dr. Daeyoung Kong[2], Mr. Kiwan Kim[2], Dr. Sreekant V.J. Narumanchi[3], Prof. James Palko[4], Dr. Ercan Dede[5], Mr. Chulmin Ahn[6], Prof. Hyoungsoon Lee[2], Prof. Mehdi Asheghi[1], Prof. Kenneth Goodson[1]; *[1]Stanford university, [2]Chung-Ang University, [3]National Renewable Energy Laboratory, [4]University of California, Merced, [5]Toyota Research Institute of North America, [6]Hyundai Motor Company*

11:15 AM **Altering Electromigration Response in Aluminum Wire Bonds through Heat Treatment**; ***Mr. Whit Vinson***[1], Ms. Frida Torres[1], Dr. David Huitink[1]; *[1]University of Arkansas*

11:30 AM **Development and Performance Evolution of Thermoformed In-Mold Gravure Offset Printed Band-Pass Filters due to Thermal Cycling**; ***Prof. Pradeep Lall***[1], Mr. Padmanava Choudhury[1], Mr. Ved Soni[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

11:45 AM **Assessment and Comparison of Interface Fracture Toughness in Potting/Substrate Material Systems using ENF and CNF Bi-material Specimen**; ***Prof. Pradeep Lall***[1], Mr. Padmanava Choudhury[1], Mr. Aathi Raja Ram Pandurangan[1], Dr. Ken Blecker[2]; *[1]Auburn University, [2]US Army CCDC-AC*

12:00 PM **Reliability Analysis of Sintered Silver (S-Ag) for Die Attachment Using a Four-Point Cyclic Isothermal Bend Test Approach at High Temperature and Strain Rates**; ***Mr. Saroj Majakoti***[1], Dr. Mohammad Bakhtiyar[1], Dr. David Huitink[1]; *[1]University of Arkansas*

12:15 PM **Quantile-based LSTM Remaining Useful Life prediction of MOSFETs**; ***Dr. Yonatan Saadon***[1], Dr. Noam Auslander[2], Dr. Patrick McCluskey[1]; *[1]University of Maryland, [2]Wistar*

E-10 E-10 Packaging and MEMS — Breakout 4

Chairs: *Tianli Feng (University of Utah)*

11:00 AM **Experimental thermal characterization of thin film low-k dielectric materials**; ***Dr. Herman Oprins***[1], Dr. Vladimir Cherman[1], Dr. Bjorn Vermeersch[1], Ms. Xinyue Chang[2], Ms. Valeria Founta[2], Ms. Youqi Ding[2], Ms. Federica Luciano[2], Dr. Christoph Adelmann[1], Dr. Zsolt Tokei[1]; *[1]imec, [2]KU Leuven, imec*

11:15 AM **Predicting Accurate Hot Spots in a More Than Ten-Thousand-Core GPU with a Million-Time Speedup over FEM Enabled by a Physics-based Learning Algorithm**; Dr. Lin Jiang[1], Prof. Yu Liu[2], ***Prof. Ming-Cheng Cheng***[2]; *[1]Hong Kong University of Science and Technology, [2]Clarkson University*

11:30 AM **Static and Dynamic Thermal Modelling of Si Photonic Thermo-Optic Phase Shifter**; ***Mr. David Coenen***[1], Dr. Minkyu Kim[1], Dr. Herman Oprins[1], Dr. Kristof Croes[1], Dr. Peter De Heyn[1], Dr. Joris Van Campenhout[1], Prof. Ingrid De Wolf[2]; *[1]imec, [2]KU Leuven, imec*

11:45 AM **Maximizing the Thermal Performance of Microheaters for Non-Volatile Phase Change Photonics: A Comparative Study of Pulse Width Parameter Effects**; ***Mr. Francis Vasquez***[1], Mr. Hongyi Sun[2], Ms. Chuanyu Lian[2], Mr. Yi-Siou Huang[2], Dr. Steven Vitale[3], Prof. Ichiro Takeuchi[2], Prof. Juejun Hu[4], Prof. Nathan Youngblood[5], Prof. Carlos A. Rios Ocampo[2], Prof. Georges Pavlidis[1]; *[1]University of Connecticut, [2]University of Maryland, [3]MIT Lincoln Laboratory, [4]Massachusetts Institute of Technology, [5]The University of Pittsburgh*

12:00 PM **Important factors in the design of systems containing a MEMS sensor and ASIC in relation to a variable temperature environment**; ***Dr. Jacek Nazdrowicz***[1], Dr. Mariusz Jankowski[1]; *[1]Lodz University of Technology*

12:15 PM **Changes in the response of an inertial MEMS sensor due to changes in the temperature of the working environment.**; ***Dr. Jacek Nazdrowicz***[1], Dr. Mariusz Jankowski[2]; *[1]lodz University of Technology, [2]Lodz University of Technology*

Day 3: Friday, May 31st 02:00 PM–03:30 PM

E-11 E-11 Additively Printed Electronics and Two-Phase Fundamentals — Breakout 4

Chairs: *Sreya Sarkar (Stealth Startup), Gautam Gupta (The University of Texas at Arlington), Georges Pavlidis (University of Connecticut)*

02:00 PM **Development of In-Mold Integration of EDA Sensors Via Additive Printing**; ***Prof. Pradeep Lall***[1], Mr. Hyesoo Jang[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

02:15 PM **Process-Performance Interaction of In-Mold Electronics for Signal Processing Applications**; ***Prof. Pradeep Lall***[1], Mr. Fatahi Musa[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

02:30 PM **Development and Performance Evaluation of Additively Printed In-Mold-Electronic Sensors**; ***Prof. Pradeep Lall***[1], Mr. Ved Soni[1], Dr. Scott Miller[2]; *[1]Auburn University, [2]NextFlex*

02:45 PM **Modification of Flow Boiling Regimes and Mechanisms in Near-Critical Flows**; ***Mr. Trevor Whitaker***[1], Dr. Sameer Rao[1]; *[1]University of Utah*

03:00 PM **Transport mechanisms governing the evaporation of a sessile droplet in its pure vapor environment**; ***Mr. ERDEM OMER DEMIRCI***[1], Dr. Osman Akdag[1], Dr. Yigit Akkus[1]; *[1]ASELSAN INC.*

03:15 PM **Assessment of bubble pump model for fluid directional motion from asymmetric heated ratchets**; ***Mr. FNU GUTTA PRUDHVI REDDY***[1], Dr. Ramuel Safarkoolan[1], Prof. Sushil Bhavnani[2], Prof. Vinod Narayanan[1]; *[1]University of California Davis, [2]Auburn University*

Conference Program Overview

Day-0: Tuesday, May 28, 2024

8:00 - 12:00	12:00 - 1:30	1:30 - 5:30
ECTC/ITherm Joint Professional Development Courses (PDC)	Luncheon for PDC Course Attendees	ECTC/ITherm Joint Professional Development Courses (PDC)
HIR Workshop		

Day-1: Wednesday, May 29, 2024

7:15 - 8:15	8:15 -9:15		9:30-10:30		11:00 - 12:30	12:30 - 2:00	2:00 - 3:30		4:00 - 5:30	5:30 - 6:20	6:30 - 7:30		7:45 - 9:00
Breakfast	TI-01	BREAK	K-1 Keynote	COFFEE BREAK	TI-02	**Luncheon** Richard Chu ITherm Award Presentation	TI-03A	COFFEE BREAK	TI-04	Student Heat Sink Design Challenge	ECTC / ITherm Diversity & Career Growth Panel and Reception	BREAK	ASME K-16 and Journal of Electronic Packaging Meetings (open)
	TII-01				TII-02		TII-03		TII-04				
	M-01				M-02		TI-03B		M-04				
	E-01				E-02		E-03		E-04				
	TT-01				P-02		TT-03		P-04				
							ITherm Sponsors & Exhibits						

Day-2: Thursday, May 30, 2024

7:15 - 8:15	8:15 -9:15		9:30-10:30		11:00 - 12:30	12:30 - 2:00	2:00 - 3:30		4:00 - 5:30	5:30 - 7:00	7:00 - 8:00	
Breakfast	TI-05	BREAK	K-2 Keynote	COFFEE BREAK	TI-06	**Luncheon** ITherm Sponsors and Partners	TI-07A	COFFEE BREAK	TI-08	Student Poster Networking Session and Reception	ITherm 2025 Program Planning (open)	ITherm Organizers' Dinner (by Invitation)
	TII-05				TII-06		TII-07		TII-08			
	M-05				M-06		TI-07B		M-08			
	E-05				E-06		E-07		E-08			
	TT-05				P-06		TT-07		Fed. Funding Landscape			
		ITherm Sponsors & Exhibits					ITherm Sponsors & Exhibits					
									Ex Comm Mtg			

Day-3: Friday, June 1, 2024

7:15 - 8:15	8:15 -9:15		9:30-10:30		11:00 - 12:30	12:30 - 2:00	2:00 - 3:30
Breakfast	TI-09	BREAK	K-3 Keynote	COFFEE BREAK	TI-10	**Luncheon** ITherm Awards & Organizer Recognitions	
	TII-09A				TII-10		
	TII-09B				M-10		
					E-10		E-11
	TT-09				P-10		P-11
		ITherm Sponsors & Exhibits					

Legend:

TI: Component Thermal	Keynote
TII: System Thermal	Special Events
M: Mech & Reliabiltiy	Meetings
E: Emerging Tech.	PDCs
TT: Tech Talks	P: Panels

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