

Final Conference Program

The 17th Intersociety Conference on Thermal
and Thermomechanical Phenomena
in Electronic Systems



May 29 – June 1, 2018
Sheraton Hotel & Marina
San Diego, CA, USA



30th Anniversary
1988-2018



WELCOME LETTER

On behalf of the organizing committee it is a great pleasure to welcome you to ITherm 2018, the leading international conference for scientific and engineering exploration of thermal, thermo-mechanical and emerging technology issues associated with electronic devices, packages, and systems. The first ITherm Conference was held in 1988, making this the 30th year of the conference series. ITherm 2018 is being held along with the 68th Electronic Components and Technology Conference (ECTC), a premier electronic packaging conference.

ITherm 2018 is packed with many activities, including 182 Technical Papers in 4 Technical Tracks; 3 Keynote Talks addressing the future of electronics cooling, electronic packaging, and research, such as cryogenic cooling of quantum computers and FPGA modules to accelerate artificial intelligence workloads; 5 Technical Panel Sessions for a highly interactive engagement with experts; 5 Technology-Talk Sessions providing deep dive talks on high profile topics; 65 Student Posters as a highly interactive forum on the latest research; 18 Professional Development Courses including 2 with heavy thermal content; and Vendor Exhibits and Gold/Silver Sponsor Stations. For ITherm 2018, several sessions have identified outstanding papers that will be featured in the sessions with longer presentation times. Other exciting developments are two joint ECTC/ITherm events including a joint Young Professionals Panel on Tuesday evening, and a joint ECTC/ITherm Women's Panel on Wednesday evening. Furthermore, a second Art-in-Science exhibition will be held during the conference and every vote counts.

Many thanks go to everyone who has contributed to the success of ITherm 2018. We recognize there is more work than any of us could ever hope to handle. Thus, taking time and contributing to ITherm over and above regular everyday responsibilities is highly appreciated. In particular, we would like to thank our track chairs and co-chairs, session chairs/co-chairs, panel/technology-talks organizers, and many others. Last, but not least, the support of our Executive Committee is highly appreciated. A list of key contributors is included later in this program.

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

Thank you for participating in the ITherm 2018 conference and making it possible by your attendance. We hope you will enjoy the conference. If this is not your first time attending ITherm, then welcome back and we hope you will establish new contacts and continue to expand your network of trust. Please help first-time attendees to meet others and generally make people feel at home here. Regardless of whether this is your first time with us or not, we will endeavor to have you come back again in the future. We hope that while you enjoy the wide variety of technical venues that ITherm 2018 offers, you can also take a little extra time to enjoy the uniqueness of the San Diego bay area. ITherm 2019 will be held in Las Vegas, NV on May 28-31, 2019, and we hope that you mark your calendars to be there as well.

Best wishes,



Thomas Brunschwiler, Ph.D.
General Chair



Jeffrey C. Suhling, Ph.D.
Program Chair



Vadim Gektin, Ph.D., P.E.
Vice Program Chair



Justin Weibel, Ph.D.
Communications Chair

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CONFERENCE DESCRIPTION

Sponsored by the IEEE Electronics Packaging Society (EPS), ITherm 2018 is an international conference for scientific and engineering exploration of thermal, thermomechanical, and emerging technology issues associated with electronic devices, packages and systems (<http://ieee-itherm.net>). ITherm 2018 is being held along with the 68th Electronic Components and Technology Conference (ECTC 2018 - <http://www.ectc.net>), a premier electronics packaging conference. Dual-registration for ITherm and ECTC is offered at a substantial discount. In addition to oral and poster presentations and vendor exhibits, ITherm 2018 includes panel discussions, keynote lectures by prominent speakers, Technology-Talks on cutting edge topics, and professional development short courses. The ITherm conference series began in 1988, and this year marks the 30th anniversary of ITherm.



GENERAL INFORMATION

REGISTRATION

Location: San Diego Sheraton Hotel & Marina, Bay Tower, Lobby Level, Bel Aire Foyer near Bel Aire Room

Opening Hours:

Tuesday, May 29	3:30 PM – 5:30 PM
Wednesday, May 30	6:30 AM – 5:30 PM
Thursday, May 31	7:00 AM – 5:30 PM
Friday, June 1	7:00 AM – 12:00 Noon

Conference Registration Includes:

- Admission to All Conference Sessions
- Luncheons (Wednesday/Thursday/Friday)
- Memory Stick Conference Proceedings

Fees (Onsite Registration)	IEEE/ASME Member Fee	Non-Member Fee	Student
Joint ITherm/ECTC Registration	1,125 USD	1,335 USD	
ITherm Registration	750 USD	900 USD	400 USD

Speakers: On the day of your talk/session, please attend the Speakers’ Breakfast in the Fairbanks Room from 7:00-7:45 AM to meet your session chairs and go over session procedures.

ITherm 2018, May 29 - June 1, 2018
Sheraton Hotel & Marina, San Diego, CA, USA



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GENERAL INFORMATION (CONTINUED)

MISCELLANEOUS INFORMATION

HOTEL AMENITIES

The San Diego Sheraton Hotel & Marina features:

- Two Towers: Bay (ITherm) and Marina (ECTC)
- Complimentary Airport Shuttle
- 24-Hour Front Desk
- Complimentary Wireless in Lobby Area
- Several Restaurants
- Valet and Self Service Parking (Fee)
- Business Center, Gift Shop, Guest Launderette
- Fitness Center, Pools, Game Rooms

EMERGENCY SERVICES

Automated External Defibrillators (AEDs) are located at the Front Desks. The hotel has a dedicated Emergency Response Team (ERT) that is composed of all hotel security officers and engineers. All members of the ERT are CPR and first aid certified as “first responders”. Several fire extinguishers are spread-out throughout the property. Security can be reached by calling “0” or ext. 2279. The Emergency extension is 2020 or by calling “0”.

COMMITTEE MEETINGS

ITHERM EXECUTIVE COMMITTEE

The ITherm Executive Committee meeting will take place in Del Mar (Lobby Level), on Wednesday May 30th, from 5:00 to 6:00 PM. *By invitation only.*

ASME K-16 COMMITTEE

The ASME K-16 Committee meeting will take place in Coronado A on Wednesday May 30th, from 7:30 to 8:30 PM. *Open to Committee Members and to all interested in becoming involved in Committee activities.*

ITHERM 2019 PROGRAM PLANNING

The ITherm 2019 Program Planning meeting will take place in Bel Aire, on Thursday May 31st, from 7:00 to 8:00 PM. *Open to all current and future contributors.*

ASME JOURNAL OF ELECTRONIC PACKAGING

An open meeting for those interested in the *Journal of Electronic Packaging* hosted by Editor Y. C. Lee will be held in Coronado A on Wednesday May 30th, and will start immediately following the ASME K-16 committee meeting. *Open to all.*

ITHERM 2018 ORGANIZERS DINNER

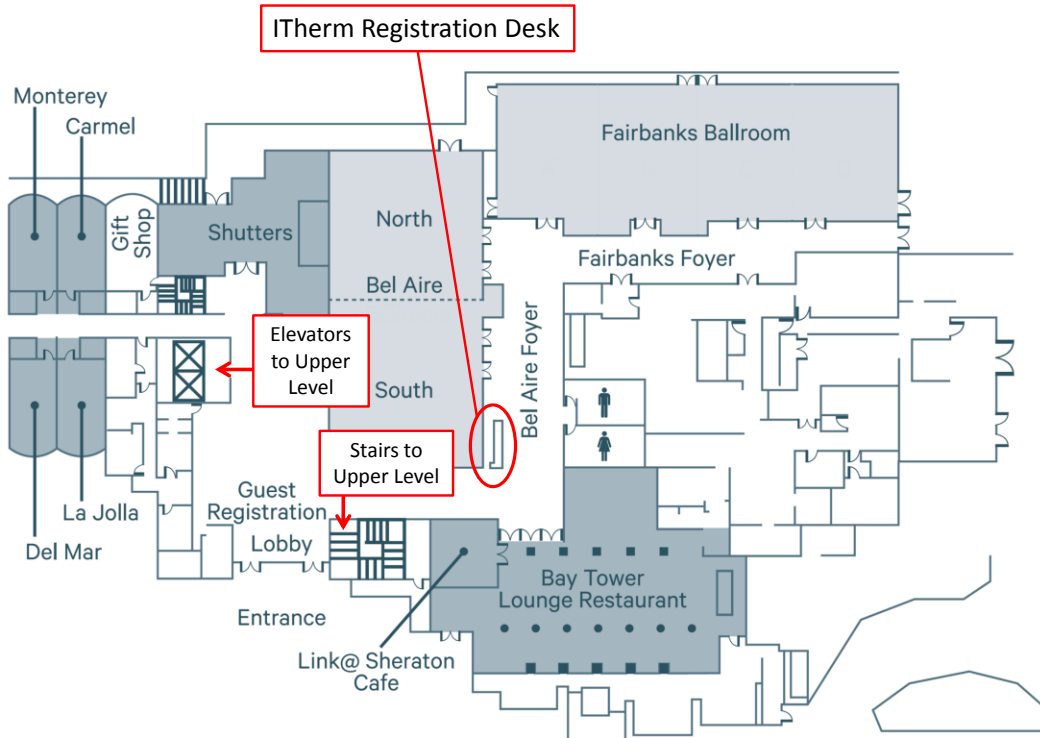
The ITherm 2018 Organizers Dinner will take place in the Harbor’s Edge Restaurant, Marina Tower, on Thursday May 31st, from 8:00 to 10:00 PM. *By invitation only.*

CONFERENCE SUMMARY

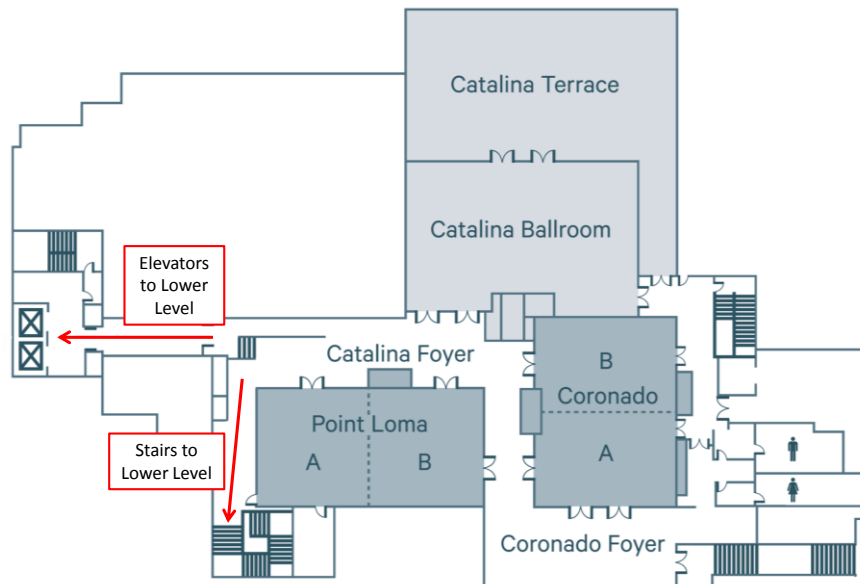
- 182 Technical Papers in 50 Sessions
- 3 Keynote Talks
- 5 Technical Panel Sessions
- 5 Technology-Talk Sessions
- 65 Student Posters
- 18 Professional Development Courses
- Vendor Exhibits and Sponsor Stations
- 36 Featured Presentations
- Art-in-Science Competition
- ECTC/ITherm Joint Women’s Panel
- ECTC/ITherm Young Professionals Panel
- Heterogeneous Integration Workshop

CONFERENCE SITE MAP

SHERATON BAY TOWER – LOBBY LEVEL MEETING ROOMS



SHERATON BAY TOWER – UPPER LEVEL MEETING ROOMS



CONFERENCE ORGANIZATION COMMITTEE

ORGANIZATION COMMITTEE

General Chair	Thomas Brunschwiler	IBM Research – Zurich
Program Chair	Jeffrey C. Suhling	Auburn University
Vice Program Chair	Vadim Gektin	Huawei Technologies
Communications Chair	Justin Weibel	Purdue University

COMPONENT-LEVEL THERMAL MANAGEMENT TRACK

Chair	Baris Dogruoz	Cisco
Co-Chair	Kamal Sikka	IBM Corporation
Co-Chair	Reza Khiabani	Google

SYSTEM-LEVEL THERMAL MANAGEMENT TRACK

Chair	Mehdi Saeidi	Qualcomm Technologies
Co-Chair	Ashish Gupta	Intel Corporation
Co-Chair	Ali Merrikh	Qualcomm Technologies
Co-Chair	Vivek Sahu	Apple

EMERGING TECHNOLOGIES & FUNDAMENTALS TRACK

Chair	Satish Kumar	Georgia Institute of Technology
Co-Chair	Amir H. Shooshtari	University of Maryland
Co-Chair	Banafsheh Barabadi	Massachusetts Institute of Technology
Co-Chair	Amy Marconnet	Purdue University

MECHANICS & RELIABILITY TRACK

Chair	Jin Yang	Intel Corporation
Co-Chair	Bernhard Wunderle	TU Chemnitz
Co-Chair	Krishna Tunga	IBM Corporation
Co-Chair	Pradeep Lall	Auburn University

SPECIAL TECHNICAL CONTRIBUTIONS

Keynote Chair	John Thome	EPFL
Keynote Co-Chair	Suresh Garimella	Purdue
Keynote Co-Chair	Lauren Boteler	US Army Research Laboratory
Technology-Talk Chair	Peter de Bock	GE Global Research
Technology-Talk Co-Chair	David H. Altman	Raytheon
Technology-Talk Co-Chair	Madhusudan Iyengar	Google
Panels Chair	Victor Chiriac	Qualcomm Technologies
Panels Co-Chair	Sung Jin Kim	KAIST
Student Poster Chair	Mahsa Ebrahim	Villanova University
Student Poster Co-Chair	Amir H. Shooshtari	University of Maryland
Student Poster Co-Chair	Milnes David	IBM Corporation
PDC Short Course Chair	Patrick McCluskey	University of Maryland
PDC Short Course Co-Chair	Jeffrey Suhling	Auburn University
Women's Panel Chair	Cristina Amon	University of Toronto



IBM Research – Zurich is one of 12 IBM Research laboratories around the globe. It was established in 1956 and is home to world-class scientists representing more than 45 nationalities. Cutting-edge research and outstanding scientific achievements—most notably two Nobel Prizes—are associated with this lab.

As the largest European branch of IBM Research, its mission—in addition to pursuing innovative research for tomorrow’s information technology—is to cultivate close relationships with academic and industrial partners.

IBM Research – Zurich strives to be one of the premier places for top researchers to work, to promote women in IT and science, and to help drive Europe’s innovation agenda.

A new facility for collaborative nano-scale research was opened on the IBM Zurich campus in 2011. The Binnig and Rohrer Nanotechnology Center (*top right*) is part of a strategic partnership in nanosciences with ETH Zurich, one of the world’s foremost science and engineering universities.



Campus of IBM Research – Zurich



Binnig and Rohrer Nanotechnology Center

IBM Research – Zurich at a glance

Founded: 1956

Director: Dr. Alessandro Curioni

Nationalities: 45+

Collaboration H2020: 50+ projects, 500+ partners

ERC Grants: 7

Nobel Laureates: 4

- 1986: Nobel Prize in Physics for the invention of the scanning tunneling microscope by Heinrich Rohrer and Gerd K. Binnig
- 1987: Nobel Prize in Physics for the discovery of high-temperature superconductivity by K. Alex Müller and J. Georg Bednorz

Research areas

- **Cognitive Computing & Industry Solutions**
Cognitive systems, foundations of cognitive solutions, information analytics, computational sciences, security & privacy, services research, systems biology.
- **Cloud & Computing Infrastructure**
Blockchain, Big Data, storage & memory technologies, security, MicroDataCenter, server I/O links, accelerator technologies.
- **Science & Technology**
Quantum technologies, electronic packaging, atom/molecule manipulation, silicon photonics, neuromorphic devices & systems, spin dynamics, nanotechnology, precision diagnostics, Binnig and Rohrer Nanotechnology Center.

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For more information:
www.zurich.ibm.com



CONFERENCE ORGANIZATION COMMITTEE (Continued)

SPECIAL TECHNICAL CONTRIBUTIONS (Continued)

Art-in-Science Chair	Mahsa Ebrahim	Villanova University
Art-in-Science Co-Chair	Amir H. Shooshtari	University of Maryland
Art-in-Science Co-Chair	Milnes David	IBM Corporation

ADMINISTRATIVE

Administrative Assistant	Damaris David	ITherm
Sponsoring & Exhibitor Chair	Joshua Gess	Oregon State University
Sponsoring & Exhibitor Co-Chair	Shlomo Novotny	Nortek
Sponsoring & Exhibitor Co-Chair	Michael Ellsworth	IBM Corporation
Finance Chair	Dustin Demetriou	IBM Corporation
Finance Co-Chair	Milnes David	IBM Corporation
Operations Chair	Pritish Parida	IBM Research
Operations Co-Chair	Yoonjin Won	University of California, Irvine

COMMUNICATION

Paper Management Database	Sandeep Tonapi	Anveshak
Paper Management Tool Accessibility	Jeffrey Suhling	Auburn University
Conference Proceedings Manager	Paul Wesling	ITherm
Technical Program and Design	Jeffrey C. Suhling	Auburn University
Technical Program and Design	Vadim Gektin	Huawei Technologies
Website Design	Sreekant Narumanchi	NREL
Webmaster	Shashank Thakur	Anveshak
Webmaster	Kedar Khire	Anveshak
Outreach & Engagement	Vaibhav Bahadur	University of Texas at Austin
Publicity	John (Jack) Maddox	University of Kentucky
Social & Social Media	Farah Singer	University of Maryland

AWARD COMMITTEE

Richard Chu ITherm Award Chair	Sushil Bhavnani	Auburn University
Richard Chu ITherm Award Co-Chair	Koneru Ramakrishna	Cirrus Logic
Best Paper Award Chair	Yogendra K. Joshi	Georgia Institute of Technology
Best Paper Award Co-Chair	Koneru Ramakrishna	Cirrus Logic

MOBILE APP AND LINKEDIN

A mobile app (iOS and Android) has been developed to assist you in scheduling your time at ITherm 2018. In addition, the app will provide several interactive social features to help you connect with other attendees. The app can be downloaded at no cost.

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

CONFERENCE EXECUTIVE COMMITTEE

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

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

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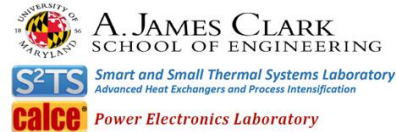
For more details on our ITherm 2018 Sponsors, Exhibitors, and Partners, please see http://iee-itherm.net/itherm/conference/sponsors_and_exhibitors

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PARTNERS

Electronic Components and Technology Conference (USA)



Thermal Investigations of ICs and Systems (Europe)



Electronics Packaging Technology Conference (Asia)





CONNECTIONS for LIQUID COOLING

LAST YEAR'S BEST PAPERS (ITHERM 2017)

EMERGING TECHNOLOGIES AND FUNDAMENTALS TRACK

BEST PAPER

Accurate Thermoreflectance Imaging of Nano-Features Using Thermal Decay

Dustin Kendig (Microsanj), Gregory Hohensee (Western Digital); Ella Pek (University of Illinois at Urbana-Champaign); Wan Kuang (Western Digital); Kazuaki Yazawa, Ali Shakouri (Purdue University)

OUTSTANDING PAPER

Design Considerations for a Miniaturized TIM Tester with Extremely High Measurement Resolution

Ronald J. Warzoha, Andrew Smith, Ashim Bajwa (United States Naval Academy); Lauren Boteler (Army Research Laboratory)

MECHANICS AND RELIABILITY TRACK

BEST PAPER

Non-destructive in-situ Monitoring of Delamination of Buried Interfaces by a Thermal Pixel (Thixel) Chip

Bernhard Wunderle, Daniel May (TU Chemnitz); Mohamad Abo Ras (Nanotest); Juergen Keller (AMIC)

OUTSTANDING PAPER

FE Analyses and Power Cycling Tests on the Thermo-Mechanical Performance of Silver Sintered Power Semiconductors with Different Interconnection Technologies

Ranier Dudek, R. Döring, A. Otto, S. Rzepka (Fraunhofer ENAS); S. Stegmeier, S. Kiefl (Siemens AG); A. Lunding (Philips Medical Systems DMC GmbH); R. Eisele (FH Kiel)

COMPONENT-LEVEL THERMAL MANAGEMENT TRACK

BEST PAPER

High Heat Flux Evaporation from Nanoporous Silicon Membranes

Jay Sircar, Daniel Hanks, Zhengmao Lu (Massachusetts Institute of Technology); Todd Salamon (Bell Labs Alcatel-Lucent); Kevin Bagnall, Dion Antao, Banafsheh Barabadi, Evelyn Wang (Massachusetts Institute of Technology)

OUTSTANDING PAPER

Thermal Model for Embedded Two-Phase Liquid Cooled Microprocessor

Pritish Parida, Arvind Sridhar, Augusto Vega, Mark Schultz (IBM Corporation); Michael Gaynes (Universal Instruments Corp); Ozgur Ozsun, Gerard McVicker, Thomas Brunswiler, Alper Buyuktosunoglu, Timothy Chainer (IBM Corporation)

SYSTEM-LEVEL THERMAL MANAGEMENT TRACK

BEST PAPER

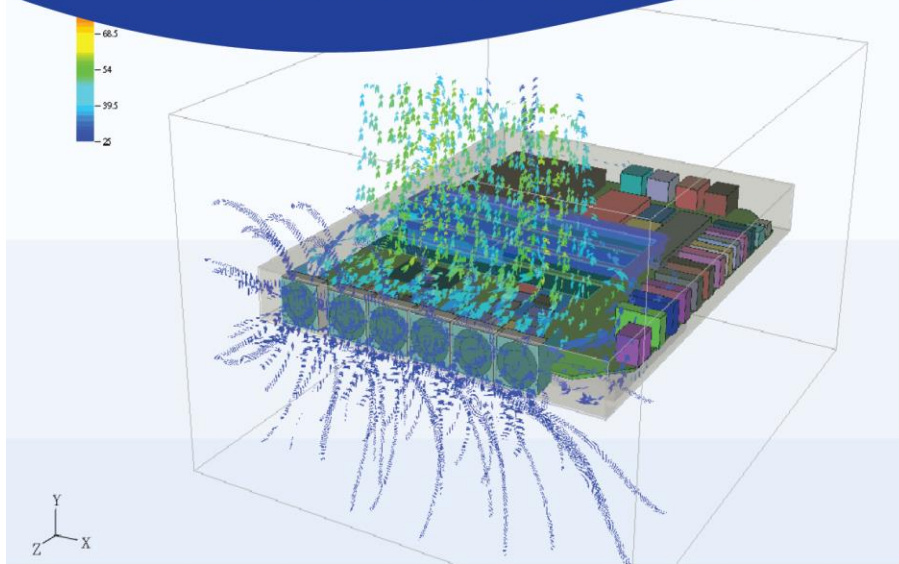
High Voltage Stacked Diode Package with Integrated Thermal Management

Lauren Boteler, Miguel Hinojosa, Valerie Niemann (US Army Research Laboratory); Steven Miner (US Naval Academy); David Gonzalez Nino (University of Puerto Rico)

OUTSTANDING PAPER

Quasi-Steady Modeling of Data Center Heat Exchanger under Dynamic Conditions

Marcelo Del Valle, Carol Caceres, Alfonso Ortega (Villanova University); Kourosh Nemati, Bahgat Sammakia (Binghamton University)



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ABOUT COFAN USA

COFAN leads the industry in customized thermal solutions. We are committed to serving our partner's needs. We service industries ranging from medical manufacturing, aerospace, telecommunications, networking, to electronic manufacturing services (EMS).



Technology



Quality



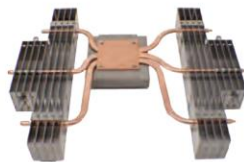
Cost



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PROFESSIONAL DEVELOPMENT COURSES

All Professional Development Courses will be held on Tuesday, May 29th in the Marina Tower of the Sheraton Hotel. The Morning (AM) Courses will be from 8:00 AM to 12:00 PM, and the Afternoon (PM) Courses will be from 1:15 PM to 5:15 PM. Separate registration (includes lunch) for the Tuesday PDC courses is required through the ECTC registration desk in the Marina Tower.

MORNING COURSES (8:00 AM – 12:00 PM)

PDC01: Achieving High Reliability of Lead-Free Solder Joints – Materials Considerations

Course Leader: Ning-Cheng Lee - Indium Corporation

PDC02: Introduction to Fan-Out Wafer Level Packaging

Course Leader: Beth Keser - Intel Corporation

PDC03: Fundamentals of Glass Technology and Applications for Advanced Semiconductor Packaging

Course Leader: Aric Shorey - Corning

PDC04: Future of Device and Systems Packaging in Post Moore's Law

Course Leader: Rao Tummala - Georgia Institute of Technology

PDC05: Introduction to Mechanics Based Quality and Reliability Assessment Methodology

Course Leaders: Shubhada Sahasrabudhe and Sandeep Sane - Intel Corporation

PDC06: Polymers and Nanocomposites for Electronic and Photonic Packaging

Course Leaders: C. P. Wong - Georgia Institute of Technology; Daniel Lu - Henkel Corporation

PDC07: Fundamentals of RF Design and Fabrication Processes of Fan-Out Wafer Level Packages and Interposers

Course Leaders: Ivan Ndip and Markus Wöhrmann - Fraunhofer IZM

PDC08: Reliability Mechanics and Modeling for IC Packaging – Theory, Implementation and Practices

Course Leaders: Ricky Lee - HKUST, and Xuejun Fan - Lamar University

PDC09: Integrated Thermal Packaging and Reliability of Power Electronics

Course Leader: Patrick McCluskey - University of Maryland

AFTERNOON COURSES (1:15 – 5:15 PM)

PDC10: Flip Chip Fabrication and Interconnection

Course Leaders: Eric Perfecto - GlobalFoundries; Shengmin Wen - Synaptics

PDC11: Wafer Level Chip Scale Packaging

Course Leader: Luu Nguyen - Texas Instruments

PDC12: Flexible Hybrid Technologies – Manufacturing and Reliability

Course Leader: Pradeep Lall - Auburn University

PDC13: Fan-Out Wafer-Level Packaging and 3D Packaging

Course Leader: John Lau - ASM Pacific Technology Ltd.

PDC14: Polymers for Electronic Packaging

Course Leader: Jeffrey Gotro - InnoCentrix, LLC

PDC15: Corrosion in Microelectronic Packages

Course Leader: Varughese Matthew - NXP Semiconductors

PDC16: Ageing of Polymers and the Influence on Microelectronic Package Reliability

Course Leaders: Tanja Braun and Ole Hölck - Fraunhofer IZM

PDC17: Package Failure Mechanisms, Reliability, and Solutions

Course Leader: Darwin Edwards - Edwards Enterprises

PDC18: Design and Optimization of Heat Sinks

Course Leaders: Marc Hodes - Tufts University; Georgios Karamanis - Transport Phenomena Technologies, LLC

HETEROGENEOUS INTEGRATION ROADMAP (HIR)

HIR ALL DAY WORKSHOP

TUESDAY, MAY 29, 8:00 AM – 5:00 PM, MARINA TOWER, EXECUTIVE CENTER 1&4

Coordinators: Bill Chen (ASE); Bill Bottoms (Fluence Analytics, Inc.)

All ITherm attendees are invited to attend the Heterogeneous Integration Roadmap (HIR) all-day workshop. This workshop is an important working session for our profession and for our industry, and attendance is complimentary and open to all ITherm and ECTC attendees. Heterogeneous Integration refers to the integration of separately manufactured components into a higher level assembly (SiP) that, in the aggregate, provides enhanced functionality and improved operating characteristics. In this definition components should be taken to mean any unit whether individual die, MEMS device, passive component and assembled package or sub-system that are integrated into a single package. The operating characteristics should also be taken in its broadest meaning including characteristics such as system level performance and cost of ownership.

Our Industry has reinvented itself through multiple disruptive changes in technologies, products and markets. With migration of logic, memory and applications to the Cloud, AI at the Edge, the Internet of Things (IoT) to internet of everything (IOE), smart devices everywhere, and autonomous automotive; the pace of innovation is increasing to meet these challenges. The mission of this Heterogeneous Integration Roadmap is to provide guidance to the profession, industry, academia and government to identify key technical challenges with sufficient lead time that they do not become roadblocks preventing the continued progress in electronics. That progress is essential to the future growth of the industry and the realization of the promise of continued positive impact on mankind. The approach is to identify the requirements for heterogeneous integration in the electronics industry through 2031, determine the difficult challenges that must be overcome to meet these requirements and, where possible, identify potential solutions. The Heterogeneous Integration Technology Roadmap is sponsored by the IEEE EPS Society, IEEE Electron Devices Society (EDS), and IEEE Photonics Society, together with SEMI and ASME EPPD.

For more information, please visit: <https://eps.ieee.org/technology/heterogeneous-integration-roadmap.html>



Bill Chen



Bill Bottoms



HETEROGENEOUS INTEGRATION ROADMAP

ECTC/ITHERM YOUNG PROFESSIONALS PANEL

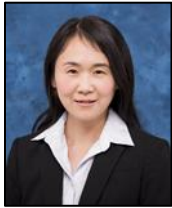
CAREER DEVELOPMENT FOR YOUNG PROFESSIONALS

TUESDAY, MAY 29, 7:00 – 7:45 PM, MARINA TOWER, HARBOR ISLAND 3

Chair: Yan Liu (Medtronic)

The Executive Committees of ECTC and ITherm cordially invite all young professionals (including current graduate students) to attend this Young Professionals networking event jointly organized by ITherm and ECTC and sponsored by EPS. The two panelists will talk about career development for young professionals based on their experiences and achievements in the industry and academia. A reception for panelists and attendees will follow.

Panelists: Steve Bezuk (Qualcomm); Kathleen Kramer (University of San Diego)



Yan Liu



Steve Bezuk



Kathleen Kramer

RICHARD CHU IThERM AWARD FOR EXCELLENCE

THE HEAT CONDUCTION RENAISSANCE

AWARD LUNCHEON AND TALK, WEDNESDAY, MAY 30, 12:00 PM – 1:30 PM, FAIRBANKS

Presented by 2018 Awardee Dr. Kenneth E. Goodson (Stanford University)

Abstract: Some of the most exciting recent advancements in heat conduction physics have been motivated, enabled, or achieved by the thermal management community that ITherm serves so effectively. In this talk we highlight the resulting renaissance in basic heat conduction research, which is linked to cooling challenges from power transistors to portables. Examples include phonon transport and scattering in nanotransistors, engineered high-conductivity composites, modulated conductivity through phase transitions, as well as the surprising transport properties of low-dimensional (1D and 2D) nanomaterials. This work benefits strongly from decades of collaboration and leadership from the semiconductor industry.

Dr. Kenneth E. Goodson chairs the Mechanical Engineering Department, and holds the Davies Family Provostial Professorship and a courtesy appointment in Materials Science at Stanford University. His lab has graduated 40 PhDs, nearly half of whom are professors at schools including MIT, Stanford, and UC Berkeley. Honors include the Kraus Medal, the Heat Transfer Memorial Award, the AIChE Kern Award, the SRC Technical Excellence Award, the InterPACK Achievement Award, and Fellow grade with ASME, IEEE, APS, and AAAS. Goodson co-founded Cooligy, which built computer heat sinks and was acquired by Emerson in 2006. At Stanford, serving as Mechanical Engineering Chair and Vice Chair since 2008, Goodson led two strategic plans and launched hiring of 15 faculty members who are transforming the department's scholarship and diversity.



CONFERENCE KEYNOTES



Ravi Kuppuswamy
Intel



Sean Ross
ARFL



Paolo Petagna
CERN

K-1: FPGAS: THE ACCELERATOR OF CHOICE FROM THE EDGE TO THE CLOUD

Presenter: Ravi Kuppuswamy (Intel)

Wednesday, May 30, 9:00-10:00 AM, Bel Aire

Abstract: The computing landscape is dynamically evolving and changing on a real-time basis. With the surge of mobile devices, network infrastructure requirements, edge and data center applications, the need to manage our data-centric connected world is exploding. FPGAs play a critical role in managing and accelerating hardware and software workloads across platforms, efficiently meeting the needs of customers to deliver rapid innovation in their markets. In particular, we're just now scratching the surface of what's possible with Artificial Intelligence (AI). From self-driving cars to precision medicine to military defense, AI is poised to impact every industry and facet of life. It has the potential to dramatically improve - and even save - lives for people in every part of the world. But before we can harness AI for the greater good of humanity, we'll need to turn theory into practice, bring machine learning models out of training, and put them to the test. In short, we need to understand how to make AI work in the field. This Conference keynote will cover how FPGAs help in deploying AI and accelerating the new ecosystem needed to support these applications.

Ravishankar (Ravi) Kuppuswamy is vice president and general manager of the Engineering in the Programmable Solutions Group at Intel. He is responsible for product engineering, organizational development, business-enabling operations, and innovation initiatives inside the FPGA business. Kuppuswamy served previously as vice president in the Intel Platform Engineering Group and director of Many Integrated Core and Intel® Xeon® processor product development. He first joined Intel in 1996 as an analog design engineer, and subsequently held various technical and management positions spanning five generations of Intel lead process technology microprocessors. In 2006, he relocated to Bangalore, India, to lead execution on the 6-core Intel Xeon processor for servers, formerly code-named "Dunnington." In 2008, India's National Association of Software and Services Companies bestowed its Innovation of the Year Award on the Dunnington program. From 2008 to 2010, Kuppuswamy served as design manager for the 10-core Intel Xeon processor for servers, formerly code-named "Eagleton." Before assuming his current role in 2014 and relocating to Oregon, he spent 3 years in the Intel Architecture Group as director of microprocessor and graphics product development in India. A frequent speaker and industry contributor in very-large-scale integrated circuit development, Kuppuswamy has two patents and several published papers in the field. He earned his bachelor's degree in electrical engineering and master's degree in chemistry, both from Birla Institute of Technology and Science in Pilani, India. He also holds a master's degree in electrical engineering from Arizona State University.

K-2: TRANSITIONING DIRECTED ENERGY WEAPONS FROM THE LABORATORY TO THE TACTICAL EDGE: THE THERMAL INTERFACE

Presenter: Sean Ross (Air Force Research Laboratory)

Thursday, May 31, 9:00-10:00 AM, Bel Aire

Abstract: Healthy systems engineering begins with an examination of the impact of the operating requirements on the components and interfaces of the proposed system. Thermal management leads the list of challenges to the integration of high energy laser systems on weight and volume constrained platforms, especially smaller aircraft. This presentation will introduce the generic architectures of High Energy Lasers and High Power Microwaves and cover the major issues and trades involved and summarize some current efforts to mature the Directed Energy system - thermal management interface.

Dr. Sean Ross has worked at the Air Force Research Laboratory, Directed Energy Directorate, since 1994. Currently, he is the directed energy deputy at the office of the Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering. Dr. Ross is a board member of the Directed Energy Professional Society. He is the author of "Laser Beam Quality Metrics" textbook and frequently teaches courses on the subject. Dr. Ross led the creation of the Environmental Laser Test Facility to test high-energy laser systems and components in simulated flight environments prior to flight testing. He has been involved in power, thermal, structural and other high-energy laser integration issues for over a decade. Dr. Ross holds a BS and MS in Physics from Brigham Young University, and a PhD in Optical Science and Engineering from the Center for Research and Education in Optics and Lasers (CREOL), College of Optics and Photonics, University of Central Florida.

K-3: DETECTOR THERMAL MANAGEMENT WITH CO₂ BOILING SYSTEMS AT CERN

Presenter: Paolo Petagna (CERN)

Friday, June 1, 9:00-10:00 AM, Bel Aire

Abstract: For the thermal management of silicon detectors in the next generation of particle physics experiments, total powers well in excess of 100 kW with volumetric densities up to 100 W/dm³ must be removed from sealed volumes, where the detectors are organized in convoluted surfaces. In order to ensure their required operational life of 10 years, the silicon sensors, submitted to high radiation levels, must be maintained at temperatures well below 0 °C. Furthermore, the mass of the support structures and ancillary systems must be minimized, while large temperature gradients, both in time and space, should be avoided. The most demanding applications already implement boiling flows of CO₂ in small diameter evaporators: CO₂ presents extremely favorable thermo-physical properties, is radiation hard and environmentally friendly. The typical geometry of a silicon detector's CO₂ evaporator is a few meters long pipe, 1.0 to 2.5 mm in I.D. However, after a recent successful application of silicon micro-structured cold plates in liquid phase, one experiment will implement for the first time in 2019 a cooling system based on CO₂ boiling in silicon micro-channels. The talk will review the achievements and the ongoing R&D at CERN on both the local evaporators and global system design.

Paolo Petagna received a Master's degree cum laude in Aeronautical Engineering from the University of Pisa in 1989, obtaining a research grant with the Department of Aerospace Engineering (DIA) on wake flows, 3D turbulent mixing and coaxial jets. In 1991, he founded ARIA (Aerodynamics Research for Industrial Applications), an applied research spin-off of DIA. From 1991 to 1995, he worked as consultant on applied R&D problems for industrial partners including Ferrari, Brembo, and Piaggio, among others. In 1996 Paolo joined CERN (the European Organization for Nuclear Research), where he participated in the design and commissioning of the Central Tracker Detector of the CMS experiment. As a member of the CMS, NA62 and ALICE collaborations at CERN, he co-authored more than 50 papers. From 2009, Petagna has led the Detector Cooling Project of the CERN Physics Department, with major R&D areas including CO₂-based cooling systems, micro-channel cooling devices, and optical fibre sensors for relative humidity. He has co-authored more than 30 publications in these research areas.

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ECTC/ITHERM JOINT WOMEN'S PANEL

ENHANCING WOMEN'S PARTICIPATION IN ENGINEERING – A VIEW AROUND THE GLOBE

WEDNESDAY, MAY 30, 6:30 – 7:30 PM, MARINA TOWER, HARBOR ISLAND 3

Moderators: Cristina Amon (University of Toronto); Tanja Braun (Fraunhofer IZM)

The Executive Committees of ECTC and ITherm cordially invite all ITherm attendees to our fourth annual Women's Panel and Reception jointly organized by ITherm and ECTC and sponsored by EPS. The four panelists will speak on their experiences and achievements in the microelectronics industry and provide insights into enhancing women's participation in engineering around globe. A Q&A session and reception for panelists and attendees will follow.

Panelists: Kawthar (Kat) Kasim (Engineer, Boeing Research and Technology, USA); Jayathi Murthy (Dean of Engineering, UCLA, USA); Ming Li (R&D Director, Enabling Technologies at ASM Pacific Technology, Hong Kong)



Cristina Amon



Tanja Braun



Kawthar Kasim



Jayathi Murthy



Ming Li

Panelists' Bios

Kawthar Kasim is a Thermal Design and Analysis Engineer at Boeing Research and Technology working on additive manufacturing of thermal management devices such as cold plates, heat exchangers, and heat pipes. She has been with the Boeing Company for 12 years and has worked in other positions at Boeing such as in the R&D Acoustics and Aerosciences Division and in the Flight and Controls Division of Boeing Satellites. She has a MS in Mechanical Engineering from Stanford University and BS in Applied Math from UC Berkeley

Jayathi Murthy is the Ronald and Valerie Sugar Dean of the Henry Samueli School of Engineering and Applied Science at the University of California, Los Angeles. Previously she held the Ernest Cockrell Jr. Chair and served as Department Chair of Mechanical Engineering at The University of Texas at Austin. She also served as Director of the Center Prediction of Reliability, Integrity, and Survivability of Microsystems (PRISM) at Purdue from 2008-2014. She received her Ph.D degree from the University of Minnesota in the area of numerical heat transfer and has worked in both academia and in industry. She was an early employee of Fluent Inc., where she developed the widely-used unstructured solution-adaptive finite volume methods that underlie their flagship software Fluent, and the electronics cooling software package ICEPAK. More recently, her research has addressed sub-micron thermal transport, multiscale multiphysics simulations of MEMS and NEMS and uncertainty quantification in these systems. She is the recipient of several awards including the 2012 ASME EPPD Clock Award, and 2016 ASME Heat Transfer Memorial Award, for her contributions to the development of advanced computational techniques.

Ming Li was awarded BSc and MSc in Materials Science and Engineering by Shanghai Jiao Tong University, China, and earned her PhD in Materials Science from the University of London, UK. Before joining ASM in June 2004, Dr Li worked in the University of London (UK), the Institute of Materials Research and Engineering (Singapore), and Chinese University of Hong Kong (Hong Kong). Currently, working in ASM as a R&D Director for Enabling Technology, Dr. Li is heading the Process and Packaging Technology Development Team to improve current processes and explore advanced packaging technologies. Dr. Li has published near 100 papers in leading journals and technical conferences.



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TECHNOLOGY-TALK SESSIONS

TT-3: CRYOGENIC COOLING FOR QUANTUM COMPUTING AND EMBEDDED COOLING ENABLED ELECTRIC MOTORS (MAY 30, WED, 1:30 – 3:00 PM), BEL AIRE SOUTH

Session Chairs: Thomas Brunschwiler (IBM); Peter de Bock (GE Global Research)

COOLING FOR QUANTUM COMPUTERS, TECHNOLOGY AND CHALLENGES

Speaker: Matti S. Manninen (BlueFors Cryogenics Oy, Finland)



Abstract: In this talk I will briefly introduce dilution refrigeration, the only continuous cooling technology to reach temperatures below 0.01 Kelvin. Dilution refrigerators are used in a wide range of applications from astronomy (to cool down detectors in telescopes), to the length scales of an atom (graphene, nanotubes). Currently, the research on solid state quantum computing is one of the main applications that uses this cooling technology. I will discuss general challenges related to the low temperature and also future challenges with the number of qubits in quantum computing going up.

Dr. Matti S. Manninen received his Ph.D degree from Aalto University in Finland for his research on superfluid helium and helium crystals at ultra-low temperatures. After completing his degree he started working as an R&D scientist for BlueFors. BlueFors is a Finland-based company that specializes in ultra-low temperature refrigeration with a strong focus on the field of quantum computing, where BlueFors has established themselves as the main cryogenic supplier.

HIGHLY EFFICIENT, DRIVE AND ELECTRONICS-INTEGRATED EMBEDDED COOLING ENABLED ELECTRIC MOTORS

Speaker: Michael Ohadi (Advanced Research Projects Agency-Energy (ARPA-e), US DoE)



Abstract: Electric motors are ubiquitous. It is estimated they consume nearly half of the electricity produced in the United States and their importance is expected to grow with the continued adoption of more electrification and automation in various sectors, including ground and air transportation. While they exhibit superior efficiency compared to thermal engines, electric motors still generate a sizable amount of heat that needs to be managed to preserve the motor's integrity. Until recently, air cooling was an adequate solution for constant speed motors. However, recent advances, including emerging variable speed motors require more robust thermal management solutions. In this presentation I will review the critical role of thermal management on electric motors' performance improvement and increased power density and volumetric specific power. Furthermore, will briefly discuss recent advances in compact, high-temperature, power electronics and how they can pave the way for complete drive and electronics integration with the motor, thereby enabling further performance improvement and compactness of next generation electric motors.

Dr. Michael Ohadi is serving as a Program Director at U.S. department of energy (ARPA-E division) while on assigned professional leave from the University of Maryland, College Park, where he serves as a professor of mechanical engineering. He is a Fellow of ASME and ASHRAE and Past Conference General Chair of ITherm.

TECHNOLOGY-TALK SESSIONS (Continued)

TT-5: HETEROGENEOUS INTEGRATION (MAY 31, THU, 8:00 – 9:00 AM), BEL AIRE

Session Chairs: David Altman (Raytheon); Madhusudan Iyengar (Google)

MATERIALS & MICROFLUIDICS – THERMAL STRATEGIES FOR HETEROGENEOUS INTEGRATION

Speaker: Ken Goodson (Stanford)



Abstract: Thermal management is a limiting challenge for the most important electronic components of our day, from portables to power devices, and poses barriers to the heterogeneous integration. This talk highlights recent enabling research based on materials engineering, with applications including improved heat spreaders, microfluidic heat sinks, thermal switches, and capillary devices. Highlights include a benchmark diamond-copper heat sink using laser etching, template-fabricated inverse opals, and 3D manifolding, as well as thermal regulators and switches for temperature management in power electronics based on phase change. Developed together with partner semiconductor companies, recent advances feature back-side (2D) embedded silicon microchannel cooling with vertical manifolds as well as and narrow gap embedded cooling (with TSV/pin fin array) module for 3D-chip stack for energy-efficient computing.

Prof. Ken Goodson chairs the Mechanical Engineering Department at Stanford, where he holds the Davies Family Provostial Professorship and a courtesy appointment in Materials Science. He specializes in electronics cooling from nano conduction and packaging to heat sinks. His lab has graduated 40 PhDs, nearly half of whom are professors at schools including MIT, Stanford, and UC Berkeley. Honors include the Kraus Medal, the Heat Transfer Memorial Award, the AIChE Kern Award, and Fellow grade with ASME, IEEE, APS, and AAAS. Goodson received the PhD (1993) from MIT and co-founded Cooligy, which built microfluidic cooling systems for the Apple G5 and was acquired by Emerson in 2006. At Stanford, serving as Mechanical Engineering Chair and Vice Chair since 2008, Goodson led two strategic plans and launched the hiring of 15 new faculty who are transforming the department's scholarship and diversity.

THERMAL-MECHANICAL OPPORTUNITIES FOR HETEROGENEOUS INTEGRATION PACKAGING

Speaker: Kamal Sikka (IBM)



Abstract: Heterogeneous Integration Packaging involves integration of chips and packages into a singular package. The chips and packages can come from different technology nodes and from different vendors. In some ways, this creation of heterogeneous multi-chip packages (MCMs) harks back to the past where complex MCMS were used in high-end server systems. Starting with a history of the high-end server MCMS, the technical talk will focus on the challenges or opportunities associated with heterogeneous integration. These challenges include more-constrained thermal and mechanical applications, and new materials and metrology requirements. The talk will also describe how silicon-processing techniques are being increasingly used for package integration.

Dr. Kamal Sikka is a researcher at IBM's Semiconductor Technology Research Center in Albany, NY where he is focused on researching novel heterogeneous integration packaging techniques. Prior to that, he managed the Package-level Systems development team in East Fishkill, NY. He has been involved in interconnect pitch reduction, silicon and glass interposers, new laminate materials and thermal technology development. For the latter, projects have included introduction of new thermal interface and heat spreader materials, and techniques for interface gap reduction.

TECHNOLOGY-TALK SESSIONS (Continued)

TT-7: THERMAL MANAGEMENT IN AEROSPACE/AUTOMOTIVE (MAY 31, THU, 1:30 – 3:00 PM), BEL AIRE SOUTH

Session Chair: David Altman (Raytheon)

MORE ELECTRIC AIRCRAFT THERMAL CHALLENGES

Speaker: Ram Ranjan (UTRC)



Abstract: More electrification of aircrafts demands higher power density in electrical machines and power converters. The electric drive train or electric energy & power storage, conversion and distribution (ESC&D) system of a hybrid electric or more electric (HE/ME) aircraft, even at high efficiency, will reject significant heat at relatively low temperature. Thus, effective thermal management of the ESC&D system is critical to realizing the potential benefits of a HE/ME aircraft as the thermal management system (TMS) can add excessive weight (heat exchangers and pumps) and impose excessive parasitic power consumption (pumps and fans) and drag (engine fan stream air and ram air) on the aircraft. This talk will discuss the challenges and approaches for cooling the electric drive train, including motor drives, motors, and batteries of a ME/HE aircraft. Particular focus will be spent on advanced thermal architectures for power converters which can improve their power density by 5X over SOA.

Dr. Ram Ranjan is a Principal Engineer and Project Leader in the UTC Aerospace Systems program office at UTRC. Over the past several years, he has been leading the development of advanced component design methods and power electronics thermal management technologies for UTC businesses. He received a Ph.D. in Mechanical Engineering from Purdue University in 2011 and his BS/MS degrees in Mechanical Engineering from the Indian Institute of Technology Kanpur in 2007. Dr. Ranjan has published his research findings in more than 25 peer-reviewed journal and conference articles, and holds several patents in the area of thermal management technologies.

THERMAL DESIGN OPTIMIZATION IN ELECTRONIC SYSTEMS

Speaker: Ercan Dede (Toyota)



Abstract: Higher power with increased efficiency in a smaller space is a predominant theme for future vehicle electronic systems. To enable greater integration and electronics power density plus high temperature operation, design optimization is a critical tool in maximizing functionality within a given volume. In this technology talk, these challenges and opportunities are briefly outlined. Then, structural topology optimization for thermal design in electronics is explained including applications to planar circuit board heat spreader layout, three-dimensional (3-D) heat flow structure synthesis, and 3-D air-cooled heat sink design. Extension of the method to additional single-physics (e.g., fluid flow) and multi-physics (e.g., electro-thermal) design problems is further covered. Finally, a concise survey of recent major advancements available in the state-of-the-art literature for thermal design optimization in electronic systems is provided to motivate future research efforts in this field.

Dr. Ercan M. Dede received his B.S. degree and Ph.D. in mechanical engineering from the University of Michigan and an M.S. degree in mechanical engineering from Stanford University. Currently, he is a Senior Research Manager in the Electronics Research Department at the Toyota Research Institute of North America. His group focuses on vehicle systems involving power semiconductors, advanced circuits, packaging, and thermal

TECHNOLOGY-TALK SESSIONS (Continued)

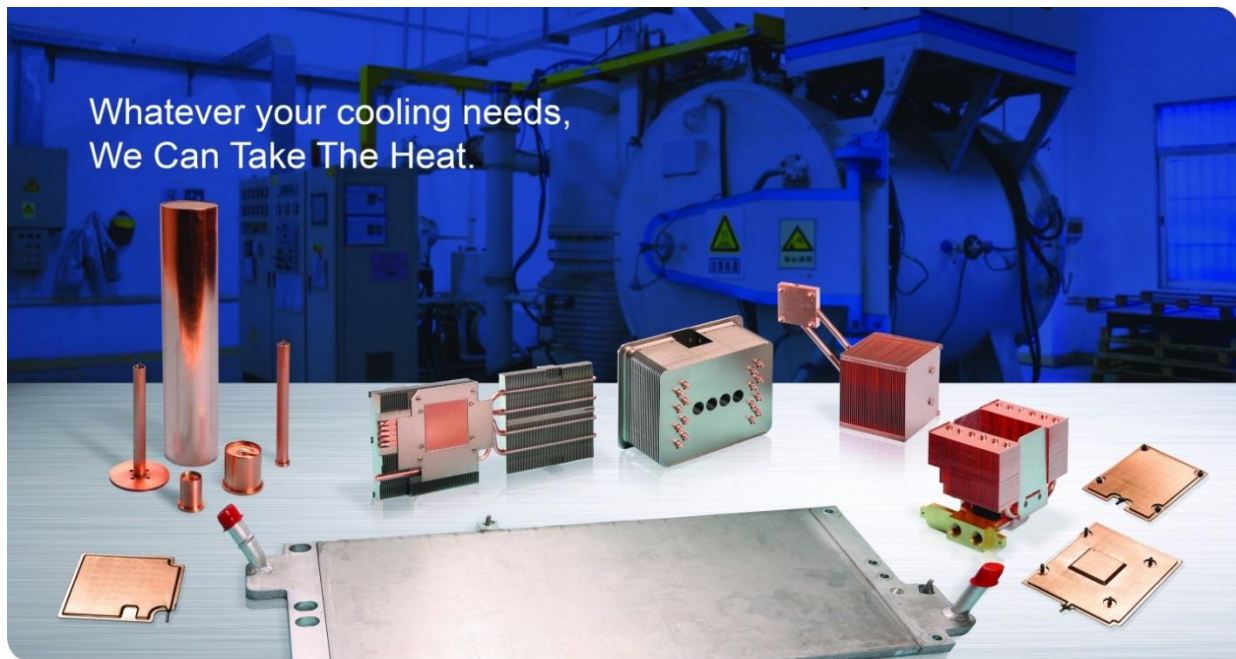
management technology. He has over 50 issued patents and has published more than 50 articles in archival journals and conference proceedings on topics related to design and structural optimization of thermal, mechanical, and electromagnetic systems. He is an author of a book entitled, *Multiphysics Simulation: Electromechanical System Applications and Optimization*. His team has received two R&D 100 Awards for the development of technologies related to next-generation power electronics for electrified vehicles.

THERMAL CHALLENGES FOR FUTURE MILITARY PLATFORMS

Speaker: Mark Spector (ONR)



Dr. Mark S. Spector is a Program Officer in the Ship Systems and Engineering Research Division at the Office of Naval Research where he manages programs in thermal science, metamaterials, and energy conversion. In addition, he sits on the Steering Committee of the Department of Defense Energy and Power Community of Interest, the Interagency Advanced Power Group, and the NATO Applied Vehicle Technology Power and Propulsion Systems Technical Committee. Previously, he worked as a Research Physicist in the Center for Bio/Molecular Science and Engineering at the Naval Research Laboratory. He received his Ph.D. in Physics from the Massachusetts Institute of Technology and his A.B. in Physics and Applied Mathematics from University of California at Berkeley. Dr. Spector has coauthored 52 journal publications, 3 invited book chapters, and holds 4 patents.



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TECHNOLOGY-TALK SESSIONS (Continued)

TT-9: ADDITIVE MANUFACTURING/THERMAL TOPOLOGY OPTIMIZATION (JUNE 1, FRI, 8:00 – 9:00 AM), BEL AIRE

Session Chair: William D. Gerstler (GE Global Research)

MULTI-PHYSICS TOPOLOGY OPTIMIZATION AND ADDITIVE MANUFACTURING

Speaker: Xiaoping Qian (University of Wisconsin-Madison)



Abstract: Topology optimization and additive manufacturing have the potential to fundamentally transform our thermal management systems, due to their capabilities in designing and fabricating structures of complex shapes and topologies. I show how to conduct multi-physics topology optimization, including optimization of thermoelastic and thermofluid systems. I will also describe how to account for additive manufacturing constraints during topology optimization. Examples on controlling the undercut and the overhang angle in realizing self-supporting structures will be demonstrated.

Prof. Xiaoping Qian is a full professor in the Department of Mechanical Engineering at the University of Wisconsin-Madison. His research interests focus on computational design of multi-physics systems, topology optimization, shape optimization, digital design and manufacturing. He has served as an associate editor for several ASME journals. He is an ASME fellow.

TOPOLOGY OPTIMIZATION OF FLUID-BASED AND CONJUGATE HEAT TRANSFER PROBLEMS

Speaker: Joe Alexandersen (Technical University of Denmark (DTU))



Abstract: Increased power density and performance of electronic components increases the need for efficient cooling. This spans computers, consumer electronics, tele-communication devices, and lighting. Topology optimization provides the ultimate design freedom and provides insight into optimal design of heat sinks and other thermal and uid-based applications. The presentation covers topology optimization of fluid-based and conjugate heat transfer problems. It will focus on applications and work on large-scale high-performance computations, but also the need for interactivity and user-friendly dissemination to industry. Combining the thoughts behind our apps with conjugate heat transfer is the ultimate dream. Thus, simplified models and efficient computational methods are thus important.

Dr. Joe Alexandersen is a Postdoctoral Researcher at the Technical University of Denmark (DTU). He has been part of Professor Old Sigmunds TopOpt-group for 8 years. He completed his Ph.D. degree in 2016, and researches topology optimization of thermal energy systems, with special focus on natural convection and passive cooling. He performs research within method development and high-performance computing, as well as applies the developed methodologies to practical problems. He received the 2015 ISSMO-Springer Prize for Young Scientists as well as a 2017 DTU Young Researcher Award.

TECHNOLOGY-TALK SESSIONS (Continued)

ADDITIVE MANUFACTURED THERMAL MANAGEMENT PRODUCTS AND FEATURES: EXPERIENCES AND FUTURE CHALLENGES

Speaker: Jared Wolfe (GE Additive)



Abstract: Additive manufacturing is a game changer for thermal management products, unlocking design freedoms that enable improved performance, reliability, and speed to market. The presentation will cover trends for thermal management applications in aerospace, such as performance compared to conventionally manufactured products, considerations for using additive effectively, and limitations with today's technology.

Jared Wolfe joined GE in 2005 with a Bachelor's Degree in Mechanical Engineering from the University of Kentucky. Since joining GE, Jared has fulfilled roles of increasing responsibilities in the design and qualification of aircraft engine components. He has worked in the additive technology field by designing additive components since 2012. In his current role, Jared is an Engineering Leader with GE Additive focused on accelerating the adoption of additive, specifically in the area of thermal management where he leads a team of designers including mechanical, aero, and thermal design engineers.



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TECHNOLOGY-TALK SESSIONS (Continued)

TT-11: NEXT GENERATION CHALLENGES IN NUMERICAL MODELING: SPECIAL TECH-TALKS IN HONOR OF PROF. JAYATHI MURTHY (JUNE 1, FRI, 1:30 – 3:00 PM), BEL AIRE SOUTH

Session Chairs: Cristina Amon (University of Toronto); Tim Fisher (UCLA)

VALIDATION OF DIRECT NUMERICAL SIMULATIONS OF TWO-PHASE SLUG FLOW BOILING

Speaker: Suresh Garimella (Purdue)



Abstract: The insertion of embedded two-phase microchannel cooling technologies requires the development of multiphase numerical simulations that account for complex vapor-liquid interfacial transport phenomena, which can improve the understanding of key transport mechanisms as well as accurately predict heat sink performance. Further, there is a clear need for high-fidelity benchmark experimental data that can be used as a common basis for validation of flow boiling models. Our numerically-stabilized saturated-interface-volume phase change model is implemented to predict phase change at the interface in order to simulate two-phase flow heat transfer in microchannels at low computational cost. A test facility is developed that has the unique ability to generate microchannel slug flow in a precisely controlled manner that is free from flow instabilities, which enables direct comparison to numerical flow boiling models. An approach for direct comparison of the benchmark experimental data to numerical flow boiling simulations is demonstrated.

Prof. Suresh V. Garimella is Purdue University's Executive Vice President for Research and Partnerships, and the Goodson Distinguished Professor of Mechanical Engineering. He is also Director of the NSF Cooling Technologies Research Center. The co-author of over 525 widely cited archival publications and 13 patents, Garimella is an expert in micro- and nano-scale transport phenomena, thermal management and energy efficiency in electronics systems, and renewable and sustainable energy systems technology and policy. He is Fellow of the NAI, AAAS, and ASME. He received the 2016 ITherm Achievement Award.

NEXT GENERATION ATOMISTIC MODELING OF THERMAL TRANSPORT

Speaker: Alan McGaughey (CMU)



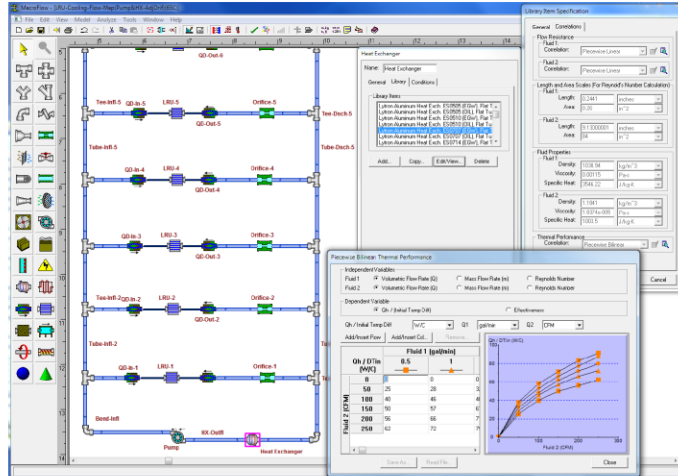
Abstract: Accurate device-level thermal models require specification of the thermal conductivities of the constituent materials and the thermal conductances of the interfaces between them. The use of first principles density functional theory calculations and the advent of new theoretical formulations based in lattice dynamics calculations and the Boltzmann transport equation have revolutionized thermal conductivity prediction. These calculations provide key insights into the how thermal conductivity is controlled by crystal structure, defects, nanostructuring, and boundaries. Progress on predicting interface thermal conductance, however, has been much slower. As feature sizes push well below 100 nm, interfaces may dominate thermal resistance and accurate predictions are central to designing effective thermal management strategies. I will discuss the challenges associated with building realistic interface structures, the limitations of available theories and computational techniques, and the advances that need to be made.

Prof. Alan McGaughey is a Professor of Mechanical Engineering at Carnegie Mellon University with a courtesy appointment in Materials Science & Engineering. He holds B.Eng., M.A.Sc. and Ph.D. degrees in mechanical engineering from McMaster University, the University of Toronto, and the University of Michigan. He won the Air Force Office of Scientific Research Young Investigator Program award, was a Harrington Faculty Fellow at the University of Texas at Austin, and won the Teare Teaching Award at CMU. He was voted "Professor of the Year" by the CMU mechanical engineering senior class in 2012, 2015, and 2017.



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PANEL SESSIONS

P-2: MICRO-TWO-PHASE LIQUID COOLING SYSTEMS FOR ELECTRONICS (MAY 30, WED, 10:30 AM – 12:00 PM), BEL AIRE SOUTH

Moderator: John R. Thome (Ecole Polytechnique Federale de Lausanne)

MICRO-TWO-PHASE LIQUID COOLING SYSTEMS FOR ELECTRONICS

Abstract: Two-phase cooling continues to gain traction in the cooling of electronics (IGBT's, CPU's, LED's, optical lasers, etc.). The panel will address technical developments, special issues and concerns on two-phase cooling systems. The panel will also cover some case studies on existing and pending applications and an overview of methods and simulators for designing of two-phase cold plates and their cooling systems (thermosyphon and pump-driven systems). The panel will furthermore address the pros/cons when choosing the best working fluid for applications.

Panelists: Scott Holland (Wolverine Microcool)
Paolo Petagna (CERN)
Samuel Yana Motta (Honeywell)

Devdatta Kulkarni (Intel)
Todd Salamon (Nokia Bell Labs)
Ahmed Zaghlol (Mersen)



P-4: THERMO-FLUIDIC CHALLENGES IN HEALTHCARE (MAY 30, WED, 3:30 – 5:00 PM), BEL AIRE SOUTH

Moderators: Peter de Bock (GE Global Research); Ali Khounsary (Illinois Institute of Technology)

THERMO-FLUIDIC CHALLENGES IN HEALTHCARE

Abstract: Thermofluidics are an integral part of most biological systems and are present in a significant number of the systems and devices used in medicine. For example, the PCR (Polymerase Chain Reaction) technique used to reproduce millions of DNA copies from one or a few samples is principally a thermal process (Nobel Prize in chemistry 1973) while the dialysis system (artificial kidney) is essentially a fluidic system. This panel session focuses on several thermal and fluidic challenges in the development of novel medical devices and techniques, presents the current status, and provides an opportunity for the panelists and the audience to brainstorm about possible solutions.

Panelists: Guillermo Aguilar (U of California, Riverside)
Sung Jin Kim (KAIST)

Bruce Guenin (Consultant)
Y. C. Lee (University of Colorado)



PANEL SESSIONS (Continued)

P-6: THERMAL MANAGEMENT OF MOBILE/IOT DEVICES (MAY 31, THU, 10:30 AM – 12:00 PM), BEL AIRE SOUTH

Moderator: Victor Chiriac (Qualcomm)

THERMAL MANAGEMENT OF MOBILE/IOT DEVICES

Abstract: In the last few years there has been a significant growth in computing platforms ranging from handhelds to IoT devices and everything in between. In the mobile/portable space, the device skin is equally challenging to cool. In handheld devices, passive dissipation is the most preferred, and sometimes the only possible cooling solution available. A different thermal landscape is now opening with the IoT devices and other adjacent high power areas. A panel of experts will discuss these aspects and will share their vision on the future of small to large electronics thermal management and other advanced system level cooling solutions.

Panelists: Rick Beyerle (NeoGraf Solutions)
Yogendra Joshi (Georgia Tech)
Ioan Sauciuc (Intel)

Ken Goodson (Stanford University)
Mark Hartman (Outlast Technologies)
John Thome (EPFL)



P-8: EMERGING TRENDS IN ENERGY MANAGEMENT AND THERMAL PACKAGING OF DATA CENTERS (MAY 31, THU, 3:30 – 5:00 PM), BEL AIRE SOUTH

Moderator: Yogendra Joshi (Georgia Institute of Technology)

EMERGING TRENDS IN ENERGY MANAGEMENT AND THERMAL PACKAGING OF DATA CENTERS

Abstract: This panel will explore multi-scale challenges in data centers being driven simultaneously by the rapid expected growth of internet of things (IOT), and computing hardware trends such as heterogeneous integration. Approaches for computing load balance, and improvement of energy efficiency, under realistic data center operational scenarios will be explored. The panel will also discuss recent advances in heterogeneous integration. Advances in thermal management technologies to enable future computing hardware will be presented.

Panelists: Muhannad Bakir (Georgia Tech)
Saeed Moghaddam (University of Florida)
Herman Oprins (IMEC)

Ali Merrikh (Qualcomm)
Hiroaki Nishi (Keio University)



PANEL SESSIONS (Continued)

P-10: THERMAL MANAGEMENT IN ELECTRONICS: MATERIALS, DEVICES, AND DATA CENTERS: SPECIAL PANEL IN HONOR OF PROF. JAYATHI MURTHY (JUNE 1, FRI, 10:30 AM – 12:00 PM), BEL AIRE SOUTH

Moderator: Dhruv Singh (GlobalFoundries)

THERMAL MANAGEMENT IN ELECTRONICS: MATERIALS, DEVICES, AND DATA CENTERS: SPECIAL PANEL IN HONOR OF PROF. JAYATHI MURTHY

Abstract: This special panel is a part of Prof. Jayathi Y. Murthy's 60th birthday celebration at ITherm 2018, commemorating her numerous contributions and fundamental developments to heat transfer and thermal management. Over the past decades, research progress from her team has touched every facet of electronics thermal management – from fundamental physics of energy transport in materials, electron-phonon transport in ultrascaled devices to electronics cooling solutions spanning myriad applications. In tandem, the advances led by her in the development of large scale numerical methods have brought software tools to the forefront of industry enabling the necessary cross-disciplinary solutions. The panel puts forth a discussion of these challenges in the domain of electronics thermal management from transistors to data centers, their implications and a hierarchical view of scientific and engineering solutions needed to achieve them.

Panelists: Vaibhav Bahadur (University of Texas)
Satish Kumar (Georgia Tech)
Sreekant Narumanchi (NREL)

Madhusudan Iyengar (Google)
Amy Marconnet (Purdue University)
Metin Ozen (Ozen Engineering)



Smart and Small Thermal Systems Laboratory (S2TS) **CEEE**
Center for Environmental Energy Engineering

PI: Prof. Michael M. Ohadi; University of Maryland
 ohadi@umd.edu

A. JAMES CLARK
SCHOOL OF ENGINEERING

S2TS Laboratory at the University of Maryland, College Park, utilize innovative design/optimization, materials, and manufacturing techniques to introduce the next generation thermal management systems. S2TS R&D areas of focus:

- ❖ Advanced heat exchangers
- ❖ Electronics cooling
- ❖ Micro/Nano systems for process intensification/optimization

If you can imagine it we can deliver it!

Contact Prof. Michael M. Ohadi: ohadi@umd.edu
 Dr. Farah Singer: fsinger@umd.edu

Additively Manufactured Record High Thermal Conductivity Polymer Composite Heat Exchanger for Dry Cooling Applications

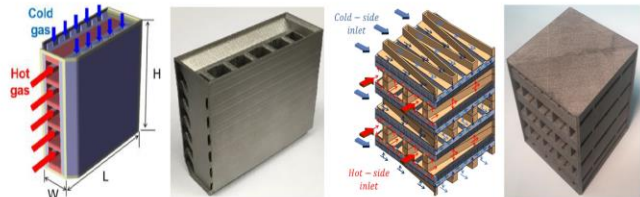
OBJECTIVE: Develop a novel composite polymer based air-cooled heat exchanger using Novel additive manufacturing machine, for indirect dry cooling for power plants, HVAC systems, electronics cooling, and waste heat recovery. Cu-Abs & Al-Abs heat exchangers are fabricated with performance exceeding that of conventional heat exchangers by multiple orders of magnitude and significant reduction in mass and weight.



Additively Manufactured High Temperature Manifold-Microchannel Heat Exchangers for Aerospace Applications

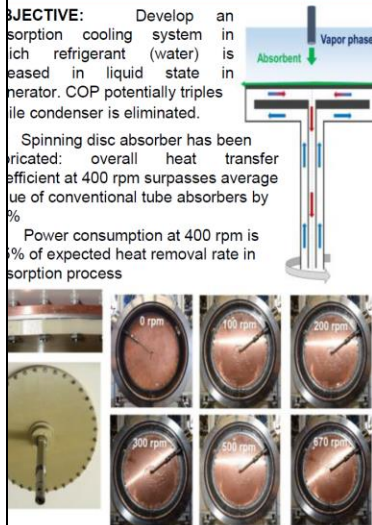
OBJECTIVE: Develop next-generation pre-cooler heat exchangers for aircrafts and dry cooling applications using additive manufacturing. An innovative high temperature gas-to-gas cross flow heat exchanger of operating temperatures 600°C to 1000°C using was designed and developed using additive manufacturing for Waste heat recovery, Power generation, and Pre-cooler HX.

- ❖ Successfully designed, fabricated, and tested Manifold Microchannel HX with thermal resistance reduced by 50% compared to conventional HXs.



A Rotary Absorber For Enhanced Heat/Mass Transfer in Absorption Systems

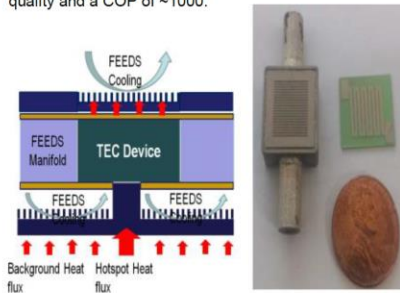
OBJECTIVE: Develop an absorption cooling system in which refrigerant (water) is phase-changed in liquid state in generator. COP potentially triples as the condenser is eliminated. Spinning disc absorber has been fabricated: overall heat transfer coefficient at 400 rpm surpasses average value of conventional tube absorbers by 100%. Power consumption at 400 rpm is 10% of expected heat removal rate in absorption process



Embedded Cooling of High Flux Electronics via Micro-Enabled Surfaces

OBJECTIVE: Develop a two-phase, embedded manifold-microchannel cooler for cooling of high, heat-flux electronics. Microchannels are embedded directly onto the back of an electronic chip to eliminate thermal resistance and a specially designed manifold-microchannel named FEEDS (Film-Evaporation and Enhanced fluid Delivery System) is used to improve the cooling capacity even further.

❖ A heat flux of 1 kW/cm² was achieved at 90% vapor quality and a COP of ~1000.

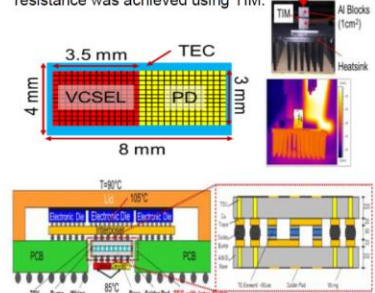


Packaging and Thermal Decoupling of Optical Array using

OBJECTIVE: Use thermoelectric cooler (TEC) to thermally-decouple and cool an optical array (85°C) from an electronic die (105°C).

Applications: Overcool electronic die (lid T~65°C) and active cooling using TEC (lid T~90°C).

- ❖ Device- and System-Level Models were developed and novel solutions to thermal short-circuiting were identified. The COP requirement was exceeded and necessary interfacial resistance was achieved using TIM.



STUDENT POSTER & NETWORKING SESSION

THURSDAY, MAY 31, 5:15 – 7:00 PM, FAIRBANKS

The Student Poster and Networking Session is a forum for students to present their research and interact with other conference attendees from industry and academia. In addition, interested students will have their resume available to get connected to potential employers from industry. The event features a poster contest where the outstanding posters will be recognized by the conference. Evaluation of the posters is conducted in two rounds. The first round was conducted in advance of the conference and involves evaluation of the posters in electronic format. In the second round, on-site evaluations are performed of the student presentations during the poster session event. The posters are judged based on technical merit, clarity and self-sufficiency of the content, originality of the work, visual presentation and impact of the poster display, and oral presentation at the poster session. A combination of the scores received in both rounds is used to determine the winners. In addition, travel grants for the student poster presenters have been provided by the conference sponsors in the form of several nights of hotel accommodations at the conference hotel. All conference attendees are invited to attend the session and get involved in discussion with the next generation of thermal, reliability, and electronic packaging experts!



Student Poster Presenters from ITherm 2017



Student Posters and Presenters

Poster Number	Student Name	School	ITherm Paper No.	Paper Title
1	Amrit Abrol	Auburn University	P304	Flexible Power-Source Survivability Assurance under Bending Loads and Operating Temperatures Representative of Stresses of Daily Motion
2	Sudan Ahmed	Auburn University	P337	Evaluation of Aging Induced Microstructural Evolution in Lead Free Solders Using Scanning Probe Microscopy
3	Ahmed Al khazraji	University of Texas at Arlington	P377	Experimental Characterization of Vertically Split Distribution Wet- Cooling Media Used in the Direct Evaporative Cooling
4	Mohammad Alam	Auburn University	P338	A Comparative Study of the High Temperature Mechanical Behavior of Lead Free Solders
5	Yeasir Arafat	Washington State University	P210	Highly Stretchable Metal Films on Polymer Substrates: Mechanics and Mechanisms
6	Sebastian Araya	Villanova University	P250	Organic rankine cycle as waste heat recovery system in data center, design and construction of a prototype
7	Jayati Athavale	Georgia Institute of Technology	P288	Artificial Neural Network Based Prediction of Temperature and Flow Profile in Data Centers
8	Fabio Battaglia	University of Maryland	P189	Modeled and Experimentally Validated Retrofit of high consumption Data Centers on an Academic Campus
9	Carol Caceres	Villanova University	P355	Thermal and Exergy Analysis in UPS and Battery Rooms by Numerical Simulations

Student Posters and Presenters (Continued)

Poster Number	Student Name	School	ITherm Paper No.	Paper Title
10	Jiahui Cao	University of California, Irvine	P263	Optimization of TEG for Human Body Powered Mobile Devices
11	Joel Chapman	Georgia Institute of Technology	P114	Nanoelectrosprayed Liquid Jets for Evaporative Heat Transfer Enhancement
12	Chienchih Chen	Auburn University	P339	Improved Submodeling Finite Element Simulation Strategies for BGA Packages Subjected to Thermal Cycling
13	Jun Chen	Auburn University	P340	Moisture-Induced Die Stresses in PBGA Packages
14	Promod Chowdhury	Auburn University	P342	Mechanical Characterization of Solder Mask Materials
15	Md. M. R. Chowdhury	Auburn University	P397	Effects of Mechanical Cycling on the Microstructure of SAC305 Lead Free Solder
16	Matthew Clark	Purdue University	P136	Identification of the dominant heat transfer mechanisms during confined two-phase jet impingement
17	Ivel Collins	Purdue	P135	Experimental Characterization of Microchannel Heat Sinks made by Additive Manufacturing
18	Rachid Darbali-Zamora	University of Puerto Rico - Mayaguez	P232	Design Considerations Based on the Effects of Varying Temperature Conditions on the Efficiency of Size Constrained Electronic Power Supplies for CubeSat Applications
19	Jyotirmoy Denria	University of Texas at Arlington	P312	Board Level Solder Joint Reliability Assessment Study of Megtron 6 Vs FR-4 Under Power Cycling and Thermal Cycling
20	Abhishek Deshpande	University of Maryland	P267	A joint-scale test specimen for tensile properties of solder alloys
21	Shantanu Deshpande	Auburn University	P325	Effect of green EMCs on fatigue reliability of molded Cu wirebonded systems
22	Mangesh Dhadve	University of Texas at Arlington	P357	CFD simulation and optimization of the cooling of open compute machine learning big sur server
23	Kalyan Dornala	Auburn University	P320	Measurement and Prediction of Interface Crack Growth at the PCB-Epoxy interfaces
24	Metehan Elibol	Özyeğin University	P265	Development of a Computational Modeling and
25	Abdullah Fahim	Auburn University	P346	Mechanical Characterization of Intermetallic Compounds in SAC Solder Joints at Elevated Temperatures
26	Shiva Farzinazar	University of California Irvine	P201	Thermal Conductivity of Graphite Microlattices
27	Laia Ferrer-Argemi	University of California Irvine	P148	Thermal and electrical characterization of electro-mechanically spun carbon nanowires
28	Thomas Germain	University of Central Florida	P269	Heat Transfer Coefficient Mapping of Impingement Jet Cooling at High Reynolds Numbers
29	Carlos Gonzalez-Valle	Pennsylvania State University	P383	Temperature Dependence of the Three-Dimensional Structure of Thin Liquid Film on SiC Surfaces
30	Kartik Goyal	Auburn University	P322	Thermo-mechanical Deformation in Flexible-Board Assemblies during Reflow and Post-Assembly Usage
31	Kshitij Gupta	University of Toronto	P344	Liquid Cooling Solutions for a High-frequency, Bi-directional, On-Board Electric Vehicle Power-hub
32	Matt Harrison	Oregon State University	P216	A Combined Two-Phase PIV and thermal-LIF Technique for Determination of the Net Coolant Requirements to a High Heat Flux Surface
33	KM Rafidh Hassan	Auburn University	P349	The Influence of Poisson's Ratio on the Reliability of SAC Lead Free Solder Joints
34	Michael Henry	Auburn University	P123	Staggered and In-line submerged liquid jet arrays for power electronics using variable area discharge manifolds: Part I- Experiments
35	Mohd Aminul Hoque	Auburn University	P396	Evolution of the Cyclic Stress-Strain and Constitutive Behaviors of Doped Lead Free Solders During Fatigue Testing
36	Yuanchen Hu	Georgia Institute of Technology	P234	Design and Optimization of Microfluidic Cooling Manifold for 2.5D-SiCs with Dielectric Coolant
37	Hao Huang	University of Maryland	P315	Mechanical Response of Assemblies Bonded with Double-Layered Pressure-Sensitive Adhesives (PSAs)
38	QI Jin	Rensselaer Polytechnic Institute	P226	Analysis and active control of pressure drop oscillation in microchannel vapor compression cycle

Student Posters and Presenters (Continued)

Poster Number	Student Name	School	ITherm Paper No.	Paper Title
39	George Karamanis	Tufts University	P225	Algorithm for Simultaneous Optimization of an Array of Heat
40	Rajesh Kasukurthy	University of Texas at Arlington	P359	Flow Analysis and Linearization of Rectangular Butterfly Valve Flow Control Device for Liquid Cooling
41	Joseph Katz	Stanford University	P272	Thermal Conductivity Anisotropy in Polystyrene Thin Films Using the 3w Method
42	Sadegh Khalili	State University of New York at Binghamton	P259	An Experimental Analysis of Hot Aisle Containment Systems
43	nakul kothari	Auburn University	P323	Analysis of progressive damage in fuze electronics using micro-computed tomography and finite element models
44	Anirudh Krishna	University of California, Irvine	P209	Morpho Butterfly-Inspired Spectral Emissivity of Metallic Microstructures for Radiative Cooling
45	Rahul Lall	Stanford University	P331	Novel Flexible Bioelectronics Device and Software
46	Jonggyu Lee	University of California, Irvine	P163	Two-Level Copper Nanostructure Structures for Condensation Heat Transfer
47	Yupu Ma	Huazhong University of Science and Technology	P186	A comparative study of reflective and trans-missive phosphor-converted laser-based white lighting
48	Collier Miers	Purdue University	P134	Uncertainty Quantification for a High Temperature Z-Meter Thermoelectric Characterization System
49	Kimia Montazeri	University of California Irvine	P248	Atomistic Calculations of Meniscus Formation on Nanostructured Surfaces
50	Jinesh Narangaparambi	Auburn University	P305	Development of Test Protocols for the Flexible Substrates in Wearable Applications
51	Georges Pavidis	Georgia Institute of Technology	P307	Improving the Transient Thermal Characterization of GaN
52	Quang Pham	University of California, Irvine	P122	Boiling Heat Transfer Performance of Three-dimensionally Ordered Microporous Copper with Modulated Pore Diameters
53	Kayla Reid	Auburn University	P192	Staggered and in-line submerged liquid jet arrays for power electronics using variable area discharge manifolds: Part II: Numerical
54	Zongqing Ren	University of California, Irvine	P196	Thermoelectric Cooling Device Based on Holey Silicon
55	Ashwin Siddarth	University of Texas Arlington	P356	Impact of static pressure differential between supply air and return exhaust on server level performance
56	Sinan Su	Auburn University	P253	Fatigue Properties of Lead-free Doped Solder Joints
57	Jonathan Sullivan	University of California, Irvine	P274	Porous Nickel as a Selective Emitter for Surface Cooling in Various Environments
58	Tony Thomas	Auburn University	P327	Feature Extraction and RUL prediction of SAC Solder alloy packages by different statistical and time-frequency
59	Qingyang Wang	University of California, San Diego	P164	High Heat Flux Boiling Heat Transfer Through Nanoporous Membranes
60	Jui-Hung Wang	National Chiao Tung University	P180	A System-Level Thermal Simulator with Automatic Meshing Techniques
61	Jing Wu	Auburn University	P352	Investigation and Comparison of Aging Induced Microstructural Evolution of Doped SAC+X Solders
62	Vikas Yadav	Auburn University	P329	Reliability of SAC leadfree solders in automotive underhood temperature-vibration
63	Luke Yates	Georgia Institute of Technology	P311	Electrical and Thermal Analysis of Vertical GaN-on-GaN P-N Diodes
64	Ziqi Yu	University of California, Irvine	P206	Temperature-dependent Thermoelectric Properties of Electrodeposited Antimony Telluride Films
65	Shi Zeng	National University of Singapore	P111	A header design method for target flow distribution among parallel channels based on topology optimization

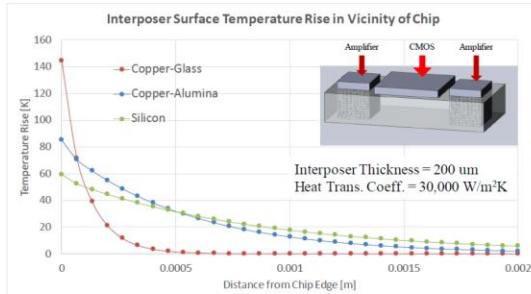


UNIVERSITY OF
MARYLAND

calce[®]

Center for Advanced Life Cycle Engineering

Power Electronics Integrated Thermal Packaging Reliability Research



Glass Interposer Thermal Isolation Research: Low-k glass interposers equipped with copper thermal vias are being developed as part of a 2.5D packaging approach to inhibit lateral spreading of heat between devices, facilitating heterogeneous integration.



Erosion/Corrosion and Clogging/Fouling:

Micro-channel coolers are susceptible to erosion/corrosion and clogging/fouling that change the shape, size, roughness, and thus heat transfer of channels. Research and test capabilities to address these failure mechanisms are present at the university, including a slurry erosion test apparatus that exposes metal, ceramic, and semiconductor channels to slurries of abrasive particles from 0.1 to 10 μm in size at speeds of 5-60 m/s.



Thermo-mechanical and Vibration Testing: University of Maryland/CALCE has a full suite of environmental testing equipment to provide thermal cycling, power cycling, temperature aging, temperature-humidity-bias, thermal cycling with vibration, shock, 1D and 6D electrodynamic vibration and altitude cycling with electrical and thermal characterization using the T3ster and Keysight 1505A curve tracer.

Prognostics and Health Management: CALCE has unique capabilities for assessing the health status of power electronics and determining remaining unit life by fusing fundamental failure physics with data analytics.

Structural Incorporation: Reliability of various attachment methods and additive manufacturing techniques for incorporating thermal management devices into 3D power packaging are being investigated.

For further information, contact: Dr. Patrick McCluskey (mclupa@umd.edu)

ART-IN-SCIENCE EXHIBITION

MAY 30 THROUGH JUNE 1, CATALINA

The second annual Art-in-Science exhibition provides a fun opportunity for the ITherm community to showcase the artistic side of their work. Authors share their joy and excitement through images and artwork produced during the course of scientific explorations and technical implementations, displaying heat and mass transfer, as well as thermo-mechanical phenomena. Entries will be judged on several criteria such as originality and creativity, aesthetics, visual impact and relevance. Conference attendees will be able to vote for their favorite artwork using the conference mobile App. Winners will be announced during the awards luncheon on Friday.

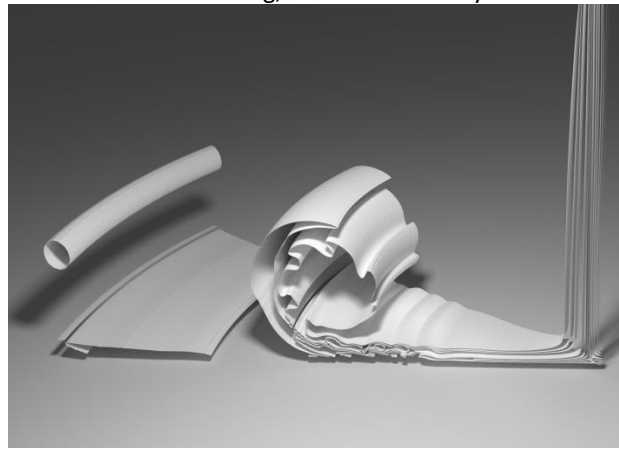
ITherm 2017 Art-in-Science Winners

Katherine Copenhaver, GTRI



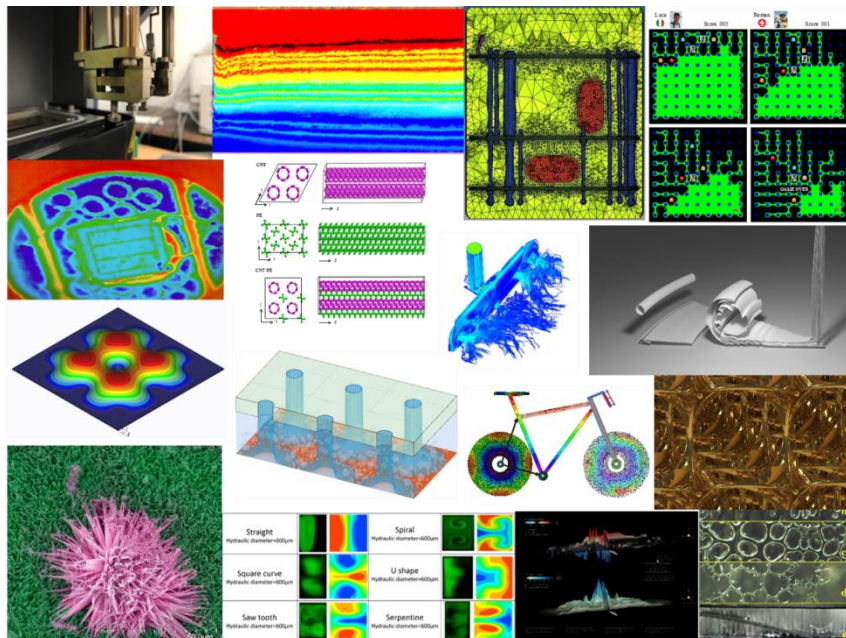
Crystallites in devitrified sodium borosilicate and annealed pyrolytic graphite glass composite

Johannes Jörg, Aachen University



“Birth of Vortices” in the wall shear layer of an originally undisturbed submerged laminar impinging jet

Art-in-Science Entries from ITherm 2017



PAPER REVIEWERS

Aaron Wemhoff	Brian Foley	Ji Zhang	Mohammad Parhizi	S. Harish
Aashutosh Mistry	C. Gonzalez Valle	Jiajun Xu	M. R. Kholghy	Solomon Adera
Abdy Fazeli	Chao Yuan	Jiamin Ni	M. R. Shaeri	Srinivas Damaraju
Abhijit Dasgupta	Charandeep Singh	Jihoon Jeong	M. Ababneh	Stephanie Allard
A. Sirimamilla	Charles Reynolds	Jin Yang	Monika Sharma	Stephen A Solovitz
Abhra Chatterjee	Chingchi Chen	Joe Ross	Munshi Basit	Subhasis Mukherjee
A. Tamraparni	Chris Healey	John Tencer	Mustafa Akbulut	S. Sadasiva
Ajay Vadakkepatt	Daijiao Wang	Jon Summers	Mustafa Koz	Sukesh Shenoy
Ajit Vallabhaneni	Damena Agonafer	Jonathan Felts	Navin Kumar	Sukwon Choi
Akhilesh Rallabandi	Daniel Bae	Joshua Gess	Nazli Donmezer	Suraush Khambati
Alberto Bassanese	D. Juarez-Robles	Kalyan Dornala	Nenad Miljkovic	S. Parameswaran
Alex Massicotte	Daniel Moser	Kamal Sikka	Nicholas Neal	Sushil Bhavnani
Ali Akbar Merrikh	Darin Sharar	Karthik Remella	Nitish Kumar	Sylvain Ouimet
Ali Ebrahimi	Darrel Frear	Kaushik Mysore	Pablo Hidalgo	Sylvain Pharand
Ali Kalantarian	David B. Brown	Ke Chen	Pascale Gagnon	Tao Song
Ali Moradi	David Danovitch	Kerry Maize	Patrick Shamberger	Taravat Khadivi
Alicja Palczynska	David Deisenroth	Kevin Drummond	Peng Wang	Thaer Alghoul
Alison Hoe	Dustin Demetriou	Khosrow Ebrahimi	Pengtao Wang	Thomas Lombardi
Allison Mahvi	E. Del Los Heros	Kimia Montazeri	Phil Barletta	Thomas Sarvey
Alperen Gunay	Edvin Cetegen	K. Ramachandran	Philip Piper	Tony Chao
Amir Shoostari	Emad Al-Momani	Koustav Sinha	P. Marepalli	Tuhin Sinha
Amy Xia	Emil Rahim	Krishna Tunga	P. Subrahmanyam	Vaibhav Agrawal
An Zou	Emily Cousineau	Krishna Valavala	Prahlad Kulkarni	Vaibhav Arghode
Andrew Poynot	Eric Heller	Kritika Upreti	Pritish Parida	Valerie Oberson
Anil Yuksel	Erich Ewy	Kuan-Lin Lee	Promod Chowdhury	Vibhash Jha
Ankit Verma	Evan Fleming	Kyosung Choo	P. Gromala	Vijay Subramanian
Ankur Jain	Feng He	Lakshmi Maganti	Raj Ganguli	Vivek Khaire
Anurag Goyal	Frank Robinson	Lee Jones	Ralph Schacht	Vivek Sahu
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A. Sengupta	Genevieve Martin	Luis Silva-Llanca	Ratnesh Tiwari	Wei Xing
Arnab Roy	Georges Pavlidis	Luisa C. Maynez	Ridvan Sahan	Wenming Li
Arpit Dwivedi	Guoping Xu	Maan Kokash	Robert Bennett	Wenqing Shen
A. Krishnamoorthy	Hadi Ghasemi	Mahsa Ebrahim	Robert Wang	Xiangfei Yu
Arunima Panigrahy	Hao Wang	Mandar Kulkarni	Roosbeh Salary	Xianghai Meng
Ashish Sinha	Harish Ganapathy	M. C. Rajagopal	Ross Wilcoxon	Yaguo Wang
Ashwin Vutha	Heidi Clarke	Marc Hodes	Ryan Enright	Yangying Zhu
Atul Bhargav	Herman Oprins	Marcelo Delvalle	Sameer Rao	Yaser Hadad
Aydin Nabovati	Howard Pearlman	Marcin Janicki	Sameh Saad	Yi Xu
Babak Fakhim	Huayan Wang	M-C. Paquet	Sami Alkharabsheh	Ying Feng Pang
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Benson Chan	Jacob Vehonsky	Max Cioban	Sevket U. Yuruker	Youmin Yu
Bernhard Wunderle	Jaeho Lee	Mehmet Arik	Shailesh Joshi	Yuanchen Hu
Betty Yeung	James Pomeroy	Michael Deckard	Shankar Narayanan	Yuqiang Zeng
Bharat Penmecha	James Petroski	M. J. Ellsworth	Shanshan Xu	Zeyong Wang
B. Ramakrishnan	Javier Avalos Garcia	M. Van Soestbergen	Shidong Li	Zhengmao Lu
Bingxiao Zhao	Jayati Athavale	Milad Yarali	Shitiz Sehgal	Zhimin Wan
Bladimir Alvarado	Jeffrey Zitz	Milnes David	S. Bindiganavale	Zhou Yang
Bohan Yan	Jeroen Zaal	M. Hamdan	S. Swaminathan	Ziqi Yu

CONFERENCE TECHNICAL PROGRAM

TRACKS & SESSIONS

COMPONENT-LEVEL THERMAL MANAGEMENT

- TI-1A: 3D Packaging / 3D Embedded Cooling I
- TI-1B: Vapor Chambers and Heat Pipes
- TI-2: 3D Packaging / 3D Embedded Cooling II
- TI-3: Single/Multi Chip Module (MCM) and System in Package (SIP) I
- TI-4: Single/Multi Chip Module (MCM) and System in Package (SIP) I
- TI-5: Hot Spot Cooling and Jet Impingement I
- TI-6: Hot Spot Cooling and Jet Impingement II
- TI-7A: Thermal Interface Materials, Heat Spreaders, and Thermal Ground Planes
- TI-7B: Air Cooling and Heat Exchangers
- TI-8A: Novel Air Cooling Devices and Systems
- TI-8B: Characterization of Materials and Structures for Thermal Management of Electronics
- TI-9: Board-Level Liquid Cooling Solutions
- TI-10: Boiling, Condensation, Evaporation, and Microgap Cooling I
- TI-11: Boiling, Condensation, Evaporation, and Microgap Cooling II
- TI-12A: Single/Two-Phase Flow in Microchannels and Cold Plates
- TI-12B: Thermoelectricity, TEC, and Peltier Devices

SYSTEM-LEVEL THERMAL MANAGEMENT

- TII-1: Data Center Energy Efficiency I
- TII-2: Data Center Energy Efficiency II
- TII-3: LEDs and Photovoltaics
- TII-4: Power Electronics
- TII-5: Immersion Cooling and Refrigeration
- TII-6: Data Center and Energy Efficiency III
- TII-8: Space, Aerospace, and Telecommunications
- TII-9: Automotive, Batteries, and Thermal Storage
- TII-10: Data Center Energy Efficiency IV
- TII-11: Mobile, Internet of Things I
- TII-12: Mobile, Internet of Things II

EMERGING TECHNOLOGIES & FUNDAMENTALS

- E-1: Fundamentals of Boiling and Condensation
- E-2: Flexible Electronics
- E-3: Thermal Transport in Nanotechnology
- E-4: Thermal Numerical Methods, Nano-To-Macro Scale
- E-5: Thermal Interface Materials and Phase Change Materials I
- E-6: Thermal Interface Materials and Phase Change Materials II
- E-7: Convection in Channels and Jets
- E-9: Thermal Experimental Methods, Nano-To-Macro Scale I
- E-10: Thermal Experimental Methods, Nano-To-Macro Scale II
- E-11: Emerging Materials and Thermal Phenomena I
- E-12: Emerging Materials and Thermal Phenomena II

MECHANICS & RELIABILITY

- M-1: Applied Reliability and Failure Analysis
- M-2: Advanced Methodologies for Reliability
- M-3: Mechanics in Assembly and Packaging I
- M-4: Mechanics in Assembly and Packaging II
- M-5: Modeling and Analytical Methods for Mechanics and Reliability of Electronic Packaging I
- M-6: Modeling and Analytical Methods for Mechanics and Reliability of Electronic Packaging II
- M-7: Solder Joint Reliability I
- M-8: Solder Joint Reliability II
- M-9: Solder Characterization and Modeling I
- M-10: Solder Characterization and Modeling II
- M-11: Thermal-Mechanical Interactions in Microelectronics Packages and Systems
- M-12: Thermal-Mechanical Interactions in Microelectronics Packages and Systems II

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 7:00 - 10:30 AM

7:00 AM	Speakers' Breakfast, Fairbanks	
	E-1: Fundamentals of Boiling and Condensation Point Loma B	TI-1A: 3D Packaging / 3D Embedded Cooling I Coronado A
	Session Chairs: <i>Amir Shooshtari (University of Maryland), Farah Singer (University of Maryland)</i>	Session Chairs: <i>Bidzina Kekelia (NREL), Timothy Chainer (IBM Research)</i>
8:00 AM	Boiling Heat Transfer Performance of Three-dimensionally Ordered Microporous Copper with Modulated Pore Diameters (p122) Quang Pham, Shiwei Zhang, Lin Cheng-Hui, Shuai Hao, Yoonjin Won (University of California, Irvine)	Sim2Cool: A Two-Phase Cooling System Simulator and Design Tool (p268) Pritish Parida, Mark Schultz, Timothy Chainer (IBM Research)
8:20 AM	Physics of Transition to Annular Flow in Microchannel Flow Boiling Process (p343) Meisam Habibimatin, Abdolreza Fazeli, Saeed Moghaddam (University of Florida)	Thermal Performance Comparison of Advanced 3D Packaging Concepts for Logic and Memory Integration in Mobile Cooling Conditions (p139) Herman Oprins, Vladimir Cherman, Eric Beyne (IMEC)
8:40 AM	Two-Level Copper Oxide Nanostructured Surfaces for Condensation Heat Transfer (p163) Jonggyu Lee, Bowen Shao, Yoonjin Won (University of California, Irvine)	Embedded Fluid Cooling of Close-packed Via Arrays in Glass (p319) Michael Fish, Bradley Martinis, Patrick McCluskey, Avram Bar-Cohen (University of Maryland)
9:00 AM	<p align="center">K-1 Keynote: FPGAS: The Accelerator of Choice from the Edge to the Cloud</p> <p align="center">Bel Aire Ravi Kuppuswamy (Intel)</p> <div style="display: flex; align-items: flex-start;">  <div style="flex-grow: 1;"> <p>Ravishankar (Ravi) Kuppuswamy is vice president and general manager of the Engineering in the Programmable Solutions Group at Intel. He is responsible for product engineering, organizational development, business-enabling operations, and innovation initiatives inside the FPGA business.</p> <p>Kuppuswamy served previously as vice president in the Intel Platform Engineering Group and director of Many Integrated Core and Intel® Xeon® processor product development. A frequent speaker and industry contributor in very-large-scale integrated circuit development, Kuppuswamy has two patents and several published papers in the field. He earned his bachelor's degree in electrical engineering and master's degree in chemistry, both from Birla Institute of Technology and Science in Pilani, India. He also holds a master's degree in electrical engineering from Arizona State University.</p> </div> </div>	
10:00 AM	Refreshment Break, Catalina Ballroom	

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 7:00 - 10:30 AM

Speakers' Breakfast, Fairbanks

<p>TI-1B: Vapor Chambers and Heat Pipes Bel Aire</p>	<p>TII-1: Data Center Energy Efficiency I Coronado B</p>	<p>M-1: Applied Reliability and Failure Analysis Point Loma A</p>
<p>Session Chairs: <i>Sukhvinder Kang (Boyd), Kamal Sikka (IBM)</i></p>	<p>Session Chairs: <i>Ali Akbar Merrih (Qualcomm), Ali Kalantarian (Advanced Micro Devices)</i></p>	<p>Session Chairs: <i>Tuhin Sinha (IBM), Kritika Upreti (Intel)</i></p>
<p>2D Design of Channels in Vapor Chamber with Topological Optimization (p182) Hao You, Wen Wang (Shanghai Jiao Tong University)</p>	<p>A Compact Cooling-System Model for Transient Data Center Simulations (p157) James VanGilder, Christopher Healey, Michael Condor, Wei Tian, Quentin Menuisier , (Schneider Electric)</p>	<p>Flexible Power-Source Survivability Assurance under Bending Loads and Operating Temperatures Representative of Stresses of Daily Motion (p304) Pradeep Lall, Amrit Abrol (Auburn University); Ben Leever (USAF Research Labs); Jason Marsh (Auburn University)</p>
<p>Performance Evaluation of Bent Heat Pipes (p260) Agile Johns, Fred Barez , Ernie Thurlow, Younes Shabany (San Jose State University)</p>	<p>Data Driven Prediction Model (DDPM) for Server Inlet Temperature Prediction in Raised-Floor Data Centers (p184) Raymond Lloyd (IBM Research Ireland), Marek Rebow (Dublin Institute of Technology)</p>	<p>Reliability Evaluation of BGA Solder Joints in Vision Processor by Passive Cooling (p172) Kaito Uehata, Ryosuke Yano, Qiang Yu (Yokohama National University)</p>
<p>Characterization of a Heat Sink with Embedded Heat Pipe with Variable Heat Dissipating Source Placement for Power Electronics Applications (p384) Neda Mansouri, Cliff Weasner, Ahmed Zaghlol (Mersen Canada Toronto)</p>	<p>Modeled and Experimentally Validated Retrofit of High Consumption Data Centers on an Academic Campus (p189) Fabio Battaglia, Raja Maheedhara, Amar Krishna, Farah Singer, Michael Ohadi (University of Maryland)</p>	<p>Effect of Green EMCs on Fatigue Reliability of Molded Cu Wirebond System (p325) Pradeep Lall, Shantanu Deshpande, Nakul Kothari (Auburn University); Luu Nguyen (Texas Instruments)</p>

K-1 Keynote: FPGAs: The Accelerator of Choice from the Edge to the Cloud

Bel Aire

Ravi Kuppuswamy (Intel)

Abstract: The computing landscape is dynamically evolving and changing on a real-time basis. With the surge of mobile devices, network infrastructure requirements, edge and data center applications, the need to manage our data-centric connected world is exploding. FPGAs play a critical role in managing and accelerating hardware and software workloads across platforms, efficiently meeting the needs of customers to deliver rapid innovation in their markets.

In particular, we're just now scratching the surface of what's possible with Artificial Intelligence (AI). From self-driving cars to precision medicine to military defense, AI is poised to impact every industry and facet of life. It has the potential to dramatically improve - and even save - lives for people in every part of the world. But before we can harness AI for the greater good of humanity, we'll need to turn theory into practice, bring machine learning models out of training, and put them to the test. In short, we need to understand how to make AI work in the field.

This Conference keynote will cover how FPGAs help in deploying AI and accelerating the new ecosystem needed to support these applications.

Refreshment Break, Catalina Ballroom

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 10:30 – 1:30 PM

	<p>E-2: Flexible Electronics Point Loma B</p> <p>Session Chairs: <i>Banafsheh Barabadi (MIT), Mahsa Ebrahim (Villanova University), Aydin Nabovati (Tesla)</i></p>	<p>TI-2: 3D Packaging / 3D Embedded Cooling II Coronado A</p> <p>Session Chairs: <i>Timothy Chainer (IBM Research), Bidzina Kekelia (NREL)</i></p>
<p>10:30 AM</p>	<p>Featured Paper Presentation Thermo-mechanical Deformation in Flexible-board Assemblies during Reflow and Post-assembly Usage (p322) Pradeep Lall, Kartik Goyal (Auburn University); Ben Leever (US Air Force Research Labs); Jason Marsh (NextFlex)</p>	<p>Featured Paper Presentation Dual-Side Heat Removal by Silicon Cold Plate and Interposer with Embedded Fluid Channels (p121) Thomas Brunschwiler (IBM Research Zurich); Wolfram Steller, Hermann Oppermann, Jessica Kleff (Fraunhofer); Stephen Robertson (Optocap Ltd); Raul Mrossko, Juergen Keller (AMIC); Gerd Schlottig (IBM Research Zurich)</p>
<p>11:00 AM</p>	<p>Kapton RS Flexible Heaters – Design and Applications (p126) Kalyan Rapolu, Shannon Dugan, Matthew Manelis, Jonathan Weldon, Richard Wessel (DuPont)</p>	<p>Two-Phase Flow Characteristics in Radial Expanding Channels with Embedded Pin Fins (p270) Mark Schultz (IBM Research); Michael Gaynes (Universal Instruments); Pritish Parida (IBM Research); Fanghao Yang (Princeton Plasma Physics Lab); Gerard McVicker (IBM Research); Ozgur Ozsun (IBM Research Zurich); Timothy Chainer (IBM Research)</p>
<p>11:20 AM</p>	<p>Highly Stretchable Metal Films on Polymer Substrates: Mechanics and Mechanisms (p210) Yeasir Arafat (Washington State University); Rahul Panat (Carnegie Mellon University); Indranath Dutta (Washington State University)</p>	<p>Methodology for 3D Package Selection Using a Power-temperature Distribution Map (p308) Yunhyeok Im, Kyoung Min Lee, Heeseok Lee, Junho Huh (Samsung Electronics)</p>
<p>11:40 AM</p>	<p>Novel Flexible Bioelectronics Device and Software Application for Prevention of Sudden Causes of Death (p331) Pradeep Lall, Hao Zhang (Auburn University); Rahul Lall (Stanford University)</p>	<p>Cooling of Miniature Electronic Systems Using Diamond Circuit Boards (p158) Nicholas Apollo, Arman Ahnood, Hualin Zhan, Kumar Ganesan, Alan Smith, Steven Praver, David Garrett (University of Melbourne)</p>
<p>12:00 PM</p>	<p>Luncheon & Richard Chu ITherm Award for Excellence Presentation, Fairbanks Ken Goodson (Stanford University)</p> <div style="display: flex; align-items: flex-start;">  <div> <p>Ken Goodson chairs the Mechanical Engineering Department and holds the Davies Family Provostial Professorship and a courtesy appointment in Materials Science at Stanford University. His lab has graduated 40 PhDs, nearly half of whom are professors at schools including MIT, Stanford, and UC Berkeley. Honors include the Kraus Medal, the Heat Transfer Memorial Award, the AIChE Kern Award, the SRC Technical Excellence Award, the INTERPACK Achievement Award, and Fellow grade with ASME, IEEE, APS, and AAAS. Goodson co-founded Cooligy, which built computer heat sinks and was acquired by Emerson in 2006. At Stanford, serving as Mechanical Engineering Chair and Vice Chair since 2008, Goodson led two strategic plans and launched hiring of 15 faculty who are transforming the department's scholarship and diversity.</p> </div> </div>	

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 10:30 – 1:30 PM

TII-2: Data Center Energy Efficiency II

Coronado B

Session Chairs:

Ajay Vadakkepatt (Qualcomm), Rajat Mittal (Oculus)

M-2: Advanced Methodologies for Reliability

Point Loma A

Session Chairs:

Przemyslaw Gromala (Robert Bosch GmbH), Jin Yang (Intel)

P-2: Micro-two-phase Liquid Cooling Systems for Electronics

Bel Aire South

Moderator:

John R. Thome (Ecole Polytechnique Federale de Lausanne)

Featured Paper Presentation

An Experimental Analysis of Hot Aisle Containment Systems (p259)

Sadegh Khalili (Binghamton University); Husam Alissa (Microsoft); Anuroop Desu, Bahgat Sammakia, Kanad Ghose (Binghamton University)

Featured Paper Presentation

A Novel Concept for Accelerated Stress Testing of Thermal Greases and In-situ Observation of Thermal Contact Degradation (p170)

Bernhard Wunderle, Daniel May, Jens Heilmann, Joerg Arnold, Josef Hirscheider (Chemnitz University of Technology); Joerg Bauer (Fraunhofer IZM); Mohamad Abo Ras (Berliner Nanotest and Design GmbH)

Micro-two-phase Liquid Cooling Systems for Electronics

Abstract: Two-phase cooling continues to gain traction in the cooling of electronics (IGBT's, CPU's, LED's, optical lasers, etc.). The panel will address technical developments, special issues and concerns on two-phase cooling systems. The panel will also cover some case studies on existing and pending applications and an overview of methods and simulators for designing of two-phase cold plates and their cooling systems (thermosyphon and pump-driven systems). The panel will furthermore address the pros/cons when choosing the best working fluid for applications.

Algorithm for Simultaneous Optimization of an Array of Heat Sinks (p225)

Georgios Karamanis, Marc Hodes (Tufts University)

Damage Evolution in MEMS Pressure Sensors during High Temperature Operating Life and Prolonged Storage at Sub-Zero Temperature (p318)

Pradeep Lall, Amrit Abrol (Auburn University); David Locker, Bruce Hughes (US Army AMRDEC)

Panelists:

Scott Holland (Wolverine Microcool)
Devdatta Kulkarni (Intel)
Paolo Petagna (CERN)
Todd Salamon (Nokia Bell Labs)
Samuel Yana Motta (Honeywell)
Ahmed Zaghlool (Mersen)

A Test Study of Technology Cooling Loop in a Liquid Cooling System (p246)

Tianyi Gao, Hu Tang, Yan Cui, Zhiming Luo (Baidu)

Evaluation of Aging Induced Microstructural Evolution in Lead Free Solders Using Scanning Probe Microscopy (p337)

Sudan Ahmed, Jeffrey Suhling, Pradeep Lall (Auburn University)

Exploration of a Hybrid Analytical Thermal Topology Optimization Method for an Additively Manufactured Heat Sink (p379)

Peter de Bock (GE Global Research)

Mechanical Characterization of Intermetallic Compounds in SAC Solder Joints at Elevated Temperatures (p346)

Abdullah Fahim, Sudan Ahmed, Jeffrey Suhling, Pradeep Lall (Auburn University)

Luncheon & Richard Chu ITherm Award for Excellence Presentation

Fairbanks

Ken Goodson (Stanford University)

The Heat Conduction Renaissance

Some of the most exciting recent advancements in heat conduction physics have been motivated, enabled, or achieved by the thermal management community that ITherm serves so effectively. In this talk we highlight the resulting *renaissance* in basic heat conduction research, which is linked to cooling challenges from power transistors to portables. Examples include phonon transport and scattering in nanotransistors, engineered high-conductivity composites, modulated conductivity through phase transitions, as well as the surprising transport properties of low-dimensional (1D and 2D) nanomaterials. This work benefits strongly from decades of collaboration and leadership from the semiconductor industry.

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 1:30 – 3:30 PM

	<p>E-3: Thermal Transport in Nanotechnology</p> <p>Point Loma B</p>	<p>TI-3: Single/Multi Chip Module (MCM) and System in Package (SIP) I</p> <p>Coronado A</p>
	<p>Session Chairs: <i>Sukwon Choi (Pennsylvania State University), Yaguo Wang (University of Texas at Austin)</i></p>	<p>Session Chairs: <i>Stephanie Allard (IBM), Sami Alkharabsheh (Ford)</i></p>
<p>1:30 PM</p>	<p>Featured Paper Presentation Thermal Boundary Conductance Mapping at Metal-MoSe₂ Interface (p373) David B. Brown (Georgia Institute of Technology); Xufan Li, Kai Xiao, David B. Geohegan (Oak Ridge National Laboratory); Satish Kumar (Georgia Institute of Technology)</p>	<p>Featured Paper Presentation Thermal Co-design of Exascale Computing System in Packages (SiPs) (p127) Koosha Nassiri Nazif (Stanford University); Niru Kumari, Sarah Silverthorn (Hewlett Packard Enterprise)</p>
<p>2:00 PM</p>	<p>Uncertainty Analysis of Near-Field Thermal Energy within Nanoparticle Packings (p195) Anil Yuksel, Edward Yu, Michael Cullinan (University of Texas at Austin); Jayathi Murthy (UCLA)</p>	<p>Novel Programmable Package-level Thermal Evaluation System (p380) Suresh Parameswaran, Gamal Refai-Ahmed, Suresh Ramalingam, Boon Ang (Xilinx)</p>
<p>2:20 PM</p>	<p>Thermal Transport Analysis of Heterostructured Nanowires with Metal-Semiconductor Interfaces (p198) Nadjia Motley, Jaeho Lee (University of California, Irvine)</p>	<p>Warping Management for Fan-Out Packaging Moving from Wafer Level to Panel Level (p146) Mei-Chien Lu (Monte Rosa Technology)</p>
<p>2:40 PM</p>	<p>Optical Pump-Probe Thermoreflectance Imaging for Anisotropic Heat Diffusion (p240) Kazuaki Yazawa (Microsanj); Jesus Armando Leon Gil (CIMAV); Kerry Maize (Purdue University); Dustin Kendig (Microsanj); Ali Shakouri (Purdue University)</p>	<p>Hybridizing Nature-inspired Algorithms to Derive Accurate Surrogate Thermal Model: Genetic Algorithm and Particle Swarm Optimization (p199) Eric Monier-Vinard, Olivier Daniel, Valentin Bissuel, Brice Rogié, Minh-Nhat Nguyen (Thales Corporate Engineering); Brice Rogié, Minh-Nhat Nguyen, Najib Laraqi (Université Paris Ouest); Ismaël Aliouat (Université Paris-Saclay)</p>
<p>3:00 PM</p>	<p>Refreshment Break, Catalina Ballroom</p>	

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 1:30 – 3:30 PM

<p>TII-3: LEDS and Photovoltaics</p> <p>Coronado B</p>	<p>M-3: Mechanics in Assembly and Packaging I</p> <p>Point Loma A</p>	<p>TT-3: Cryogenic Cooling for Quantum Computing and Embedded Cooling Enabled Electric Motors</p> <p>Bel Aire South</p>
<p>Session Chairs: <i>Ashish Gupta (Intel), Vibhash Jha (NXP Semiconductors), Vikram Manthri (Amazon)</i></p>	<p>Session Chairs: <i>Bernhard Wunderle (Chemnitz University of Technology), Vibhash Jha (NXP Semiconductors), Sami Alkharabsheh (Ford)</i></p>	<p>Session Chairs: <i>Thomas Brunschwiler (IBM); Peter de Bock (GE Global Research)</i></p>
<p>Featured Paper Presentation A Comparative Study of Reflective and Transmissive Phosphor-converted Laser-based White Lighting (p186) Yupu Ma, Xiaobing Luo (Huazhong University of Science and Technology)</p>	<p>Featured Paper Presentation Strength Analysis of Resin Delamination of Packaging Structure of Power Module (p176) Sho Teradaira, Yukichi Furuyama, Qiang Yu (Yokohama National University)</p>	<p>Cooling for Quantum Computers, Technology and Challenges</p> <p>Matti S. Manninen (BlueFors Cryogenics Oy, Finland)</p>
<p>Experimental Determination of Junction-to-Case Thermal Resistance in LED Compact Thermal Models (p171) Tomasz Torzewicz, Marcin Janicki, Andrzej Napieralski Napieralski (Lodz University of Technology)</p>	<p>Measurement and Prediction of Interface Crack Growth at the PCB-epoxy Interfaces under High-G Mechanical Shock (p320) Pradeep Lall, Kalyan Dornala (Auburn University); John Deep (US AFRL); Ryan Lowe (ARA Associates)</p>	
<p>Design Considerations Based on the Effects of Varying Temperature Conditions on the Efficiency of Size Constrained Electronic Power Supplies for CubeSat Applications (p232) Rachid Darbali-Zamora, Nicolas Cobo-Yepes, Eduardo Ortiz-Rivera (University of Puerto Rico Mayaguez)</p>	<p>Reaction Kinetics and Rheological Model Coefficient Extraction for Epoxy Mold Compounds (p251) A. R. Nazmus Sakib, Vibhash Jha, Amar Mavinkurve (NXP Semiconductors)</p>	<p>Highly Efficient, Drive and Electronics-Integrated Embedded Cooling Enabled Electric Motors</p> <p>Michael Ohadi (Advanced Research Projects Agency-Energy (ARPA-e), US DoE)</p>
<p>Optimization of an Organic Rankine Cycle Through a Control Strategy for Waste Heat Recovery (p300) Luis Silva-Llanca, Carolina Ponce, Manuel Araya (Universidad de la Serena); Andres J. Diaz (Universidad Diego Portales)</p>	<p>Moisture-induced Die Stresses in PBGA Packages Exposed to Various Environments (p340) Jun Chen, Quang Nguyen, Jordan Roberts, Jeffrey Suhling, Richard Jaeger, Pradeep Lall (Auburn University)</p>	

Refreshment Break, Catalina Ballroom

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 3:30 – 7:30 PM

	<p>E-4: Thermal Numerical Methods, Nano-to-macro Scale</p> <p>Point Loma B</p>	<p>TI-4: Single/Multi Chip Module (MCM) and System in Package (SIP) II</p> <p>Coronado A</p>
	<p>Session Chairs: <i>Bladimir Ramos-Alvarado (Penn State University), Farah Singer (University of Maryland)</i></p>	<p>Session Chairs: <i>Sami Alkharabsheh (Ford), Stephanie Allard (IBM)</i></p>
<p>3:30 PM</p>	<p>Featured Paper Presentation Interfacial Liquid Structuring at SiC-water Interfaces and its Effects on Heat Transfer (p383) C. Ulises Gonzalez-Valle, Bladimir Ramos-Alvarado (Penn State University)</p>	<p>Featured Paper Presentation Analysis of Thermal Characteristics of Gallium Oxide Field-effect-transistors (p256) Jialuo Chen, Satish Kumar (Georgia Institute of Technology); Zhanbo Xia, Siddharth Rajan (Ohio State University)</p>
<p>4:00 PM</p>	<p>Experimental and Numerical Investigation on Liquid Assisted Air Cooling Solution (p168) Wenbin Tian, Devdatta Kulkarni, Ming Zhang, Yuehong Fan (Intel)</p>	<p>Design and Parametric Study of Microfluidic Cooling Manifold for 2.5D-SiCs with Dielectric Coolant (p234) Yuanchen Hu, Thomas Sarvey, Muhannad Bakir, Yogendra Joshi (Georgia Institute of Technology)</p>
<p>4:20 PM</p>	<p>Morpho Butterfly-inspired Spectral Emissivity of Metallic Microstructures for Radiative Cooling (p209) Anirudh Krishna, Jonathan Sullivan, Shiva Farzinazar, Jaeho Lee, Anirudh Krishna (University of California, Irvine)</p>	<p>An Innovative Heterogeneous SoC Thermal Model for Smartphone System (p239) Sheng-Liang Kuo, Chi-Wen Pan, Pei-Yu Huang, Chien-Tse Fang, Shin-Yu Hsiau, Tai-Yu Chen (MediaTek)</p>
<p>4:40 PM</p>		<p>Model-based Comparison of Thermo-hydraulic Performance of Various Cooling Methods for Power Electronics of Electric Vehicles (p273) Jasper Nonneman, Ilya Tjollyn, Nils Clarie (Ghent University); Sam Weckx (Flanders Make); Peter Sergeant, Michel De Paepe (Ghent University)</p>
<p>6:30 PM</p>	<p style="text-align: center;">ECTC/ITherm Joint Women’s Panel & Reception, Marina Tower, Harbor Island 3 Moderators: Cristina Amon (University of Toronto); Tanja Braun (Fraunhofer IZM)</p> <p>The Executive Committees of ECTC and ITherm cordially invite all ITherm attendees to our fourth annual Women’s Panel and Reception jointly organized by ITherm and ECTC and sponsored by EPS. The four panelists will speak on their experiences and achievements in the microelectronics industry and provide insights into enhancing women’s participation in engineering around globe. A Q&A session and reception for panelists and attendees will follow.</p> <p>Panelists: <i>Kawthar (Kat) Kasim (Boeing Research and Technology, USA); Jayathi Murthy (UCLA Dean of Engineering, USA); Li Ming (R&D Director, Enabling Technologies at ASM Pacific Technology, Hong Kong)</i></p>	

DAY 1 SESSIONS: WEDNESDAY, MAY 30, 3:30 – 7:30 PM

<p>TII-4: Power Electronics</p> <p>Coronado B</p>	<p>M-4: Mechanics in Assembly and Packaging II</p> <p>Point Loma A</p>	<p>P-4: Thermo-fluidic Challenges in Healthcare</p> <p>Bel Aire South</p>
<p>Session Chairs: <i>Taravat Khadivi (Qualcomm), Ali Akbar Merrikh (Qualcomm)</i></p>	<p>Session Chairs: <i>Bernhard Wunderle (Chemnitz University of Technology), Vibhash Jha (NXP Semiconductors), Sami Alkharabsheh (Ford)</i></p>	<p>Moderators: <i>Peter de Bock (GE Global Research), Ali Khounsary (Illinois Institute of Technology)</i></p>
<p>Featured Paper Presentation Electrical and Thermal Analysis of Vertical GaN-on-GaN PN Diodes (p311) Luke Yates, Georges Pavlidis, Samuel Graham (Georgia Institute of Technology); Shigeyosi Usami, Kentaro Nagamatsu, Yoshio Honda; Hiroshi Amano (Nagoya University)</p>	<p>Featured Paper Presentation Mechanical Response of Assemblies Bonded with Double-layered Pressure-sensitive Adhesives (PSAs) (p315) Hao Huang, Abhijit Dasgupta (University of Maryland); Ehsan Mirbagheri, Krishna Darbha (Microsoft)</p>	<p>Thermo-fluidic Challenges in Healthcare</p> <p>Abstract: Advances in medicine and the development of many novel diagnostic and therapeutic modalities have brought about a slew of challenges in many engineering fields including thermofluidics. As they relate to human health and well-being on the one hand, and to the biological systems on the other, these challenges are both critical and complex when compared to the electronic systems that are the main focus of ITherm conferences.</p> <p>Thermofluidics are an integral part of most biological systems and are present in a significant number of the systems and devices used in medicine. For example, the PCR (Polymerase chain reaction) technique used to reproduce millions of DNA copies from one or a few samples is principally a thermal process (Nobel Prize in chemistry 1973) while the dialysis system (artificial kidney) is essentially a fluidic system. This panel session focuses on several thermal and fluidic challenges in the development of novel medical devices and techniques, presents the current status, and provides an opportunity for the panelists and the audience to brainstorm about possible solutions.</p> <p>Panelists: Guillermo Aguilar (UC Riverside) Bruce Guenin (Consultant) Sung Jin Kim (KAIST) Y. C. Lee (University of Colorado)</p>
<p>Waste Heat Recovery from Distributed Rack-based Fuel Cells Using Thermoelectric Generators (p145) Khosrow Ebrahimi (Boise State University), Alfonso Ortega (Santa Clara University), Calvin Li (Villanova University), Kazuaki Yazawa (Purdue University), Sean James (Microsoft)</p>	<p>Development of Test Protocols for the Flexible Substrates in Wearable Applications (p305) Pradeep Lall, Jinesh Narangaparambil, Amrit Abrol (Auburn University); Ben Leever (USAF Research Labs); Jason Marsh (NextFlex Manufacturing Institute)</p>	
<p>Simulation, Testing and Implementation of Temperature-reduction Solutions on a High-power Thermal Demonstrator (p179) Andy Heinig, Dimitrios Papaioannou (Fraunhofer Institute, EAS)</p>	<p>Mechanical Characterization of Solder Mask Materials (p342) Promod Chowdhury, Jeffrey Suhling, Pradeep Lall (Auburn University)</p>	
<p>Co-designed High Voltage Module (p310) Lauren Boteler (US Army Research Laboratory), Steven Miner (US Naval Academy), Miguel Hinojosa (US Army Research Laboratory)</p>	<p>Simulation Improved Testing of Fan-out Packaging (p282) Chun-Wei Hsiao, Mei-Ling Wu (National Sun Yat-Sen University); Shang Lee, Shiny Huang, Chiyu Wang, Brain Wu (Advanced Semiconductor Engineering)</p>	

ECTC/ITherm Joint Women's Panel & Reception,


Marina Tower, Harbor Island 3

Moderators: Cristina Amon (University of Toronto); Tanja Braun (Fraunhofer IZM)

The Executive Committees of ECTC and ITherm cordially invite all ITherm attendees to our fourth annual Women's Panel and Reception jointly organized by ITherm and ECTC and sponsored by EPS. The four panelists will speak on their experiences and achievements in the microelectronics industry and provide insights into enhancing women's participation in engineering around globe. A Q&A session and reception for panelists and attendees will follow.

Panelists: *Kawthar (Kat) Kasim (Boeing Research and Technology, USA); Jayathi Murthy (UCLA Dean of Engineering, USA); Li Ming (R&D Director, Enabling Technologies at ASM Pacific Technology, Hong Kong)*

DAY 2 SESSIONS: THURSDAY, MAY 31, 7:00 - 10:30 AM

7:00 AM	Speakers' Breakfast, Fairbanks	
	<p>E-5: Thermal Interface Materials and Phase Change Materials I</p> <p>Point Loma B</p>	<p>TI-5: Hot Spot Cooling and Jet Impingement I</p> <p>Coronado A</p>
	<p>Session Chairs: <i>Amy Marconnet (Purdue University), Leila Choobineh (SUNY Polytechnic Institute)</i></p>	<p>Session Chairs: <i>Nicholas Haehn (Intel), Mohammed Ababneh (ACT)</i></p>
8:00 AM	<p>Phase Change Materials for Thermal Peak Management Applications with Specific Temperature Ranges (p211)</p> <p>Jacob Maxa, Andrej Novikov, Mathias Nowottnick (Rostock University); Matthias Heimann, Kay Jarchoff (Siemens AG)</p>	<p>Staggered and In-line Submerged Liquid Jet Arrays for Power Electronics Using Variable Area Discharge Manifolds: Part I – Experimental (p123)</p> <p>Michael Henry, Kayla Reid, Sushil Bhavnani, Roy Knight, William D. Brannon (Auburn University); John Maddox (University of Kentucky)</p>
8:20 AM	<p>Chemical Modification of High Performance Metal-based Nanocomposite Thermal Interface Materials Toward Efficient Cooling in Electronic Systems (p275)</p> <p>Cengiz Yegin, Nirup Nagabandi, Kevin Holder, Elisa Teipel (Incendium Technologies LLC); Mustafa Akbulut (Texas A&M University)</p>	<p>Staggered and In-line Submerged Liquid Jet Arrays for Power Electronics Using Variable Area Discharge Manifolds: Part II – Numerical (p192)</p> <p>Kayla Reid, Michael Henry, Roy Knight, Sushil Bhavnani (Auburn University); John Maddox (University of Kentucky)</p>
8:40 AM	<p>Cooling Power and Thermal Buffering in Composite Heatsinks (p285)</p> <p>Michael Deckard, Jonathan Felts, Patrick Shamberger (Texas A&M University)</p>	<p>Identification of the Dominant Heat Transfer Mechanisms During Confined Two-phase Jet Impingement (p136)</p> <p>Matthew Clark, Justin Weibel, Suresh Garimella (Purdue University)</p>
9:00 AM	<p align="center">K-2 Keynote: Transitioning Directed Energy Weapons from the Laboratory to the Tactical Edge: The Thermal Interface</p> <p align="center">Bel Aire</p> <p align="center">Sean Ross (Air Force Research Laboratory)</p> <div style="display: flex; align-items: flex-start;">  <div style="flex-grow: 1;"> <p>Dr. Sean Ross has worked at the Air Force Research Laboratory, Directed Energy Directorate, since 1994. Since July 2017, he has been the directed energy deputy at the office of the Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering. Dr. Ross is a board member of the Directed Energy Professional Society. He is the author of <i>Laser Beam Quality Metrics</i> textbook and frequently teaches courses on the subject. Dr. Ross led the creation of the Environmental Laser Test Facility to test high-energy laser systems and components in simulated flight environments prior to flight testing. He has been involved in power, thermal, structural and other high-energy laser integration issues for over a decade. Dr. Ross holds a BS and MS in Physics from Brigham Young University and a PhD in Optical Science and Engineering from the Center for Research and Education in Optics and Lasers, College of Optics and Photonics, University of Central Florida.</p> </div> </div>	
10:00 AM	Refreshment Break, Catalina Ballroom	

DAY 2 SESSIONS: THURSDAY, MAY 31, 7:00 - 10:30 AM

Speakers' Breakfast, Fairbanks

<p>TII-5: Immersion Cooling and Refrigeration</p> <p>Coronado B</p>	<p>M-5: Modeling and Analytical Methods for Mechanics and Reliability of Electronic Packaging I</p> <p>Point Loma A</p>	<p>TT-5: Heterogeneous Integration</p> <p>Bel Aire</p>
<p>Session Chairs: <i>Andrew McNamara (Advanced Micro Devices), Vivek Sahu (Apple), Ajay Vadakkepatt (Qualcomm)</i></p>	<p>Session Chairs: <i>Shidong Li (IBM), Meriem Akin (IMPT)</i></p>	<p>Session Chairs: <i>David Altman (Raytheon); Madhusudan Iyengar (Google)</i></p>
<p>Hydrodynamic Patterns of a Droplet Train Impinging onto Superheated Nanotube Surfaces (p162)</p> <p>Wei Tong, Zhen Qin, Fei Duan (Nanyang Technological University)</p>	<p>Improved Submodeling Finite Element Simulation Strategies for BGA Packages Subjected to Thermal Cycling (p339)</p> <p>Chienchih Chen, Jeffrey Suhling, Pradeep Lall (Auburn University)</p>	<p>Materials & Microfluidics – Thermal Strategies for Heterogeneous Integration</p> <p>Ken Goodson, Stanford</p>
<p>Analysis and Active Control of Pressure Drop Oscillation in Microchannel Vapor Compression Cycle (p226)</p> <p>Jin Qi, John Wen, Shankar Narayanan (Rensselaer Polytechnic Institute)</p>	<p>Meshless Computational Tools for Damage and Failure Modeling (p293)</p> <p>Srujan Rokkam, Quang Truong (Advanced Cooling Technologies); Max Gunzburger (Florida State University)</p>	<p>Thermal-Mechanical Opportunities for Heterogeneous Integration Packaging</p> <p>Kamal Sikka, IBM</p>
<p>Organic Rankine Cycle as Waste Heat Recovery System in Data Centers: Design and Construction of a Prototype (p250)</p> <p>Sebastian Araya, Gerard Jones, Amy Fleischer (Villanova University)</p>	<p>Analysis of Progressive Damage in Fuze Electronics using Micro-computed Tomography and Finite Element Models (p323)</p> <p>Pradeep Lall, Nakul Kothari (Auburn University); John Deep (US AFRL); Ryan Lowe (ARA Associates)</p>	

K-2 Keynote: Transitioning Directed Energy Weapons from the Laboratory to the Tactical Edge: The Thermal Interface

Bel Aire

Sean Ross (Air Force Research Laboratory)

Abstract: Abstract: Healthy systems engineering begins with an examination of the impact of the operating requirements on the components and interfaces of the proposed system. Thermal management leads the list of challenges to the integration of high energy laser systems on weight and volume constrained platforms, especially smaller aircraft. This presentation will introduce the generic architectures of High Energy Lasers and High Power Microwaves and cover the major issues and trades involved and summarize some current efforts to mature the Directed Energy system - thermal management interface.

Refreshment Break, Catalina Ballroom

DAY 2 SESSIONS: THURSDAY, MAY 31, 10:30 – 1:30 PM

	<p>E-6: Thermal Interface Materials and Phase Change Materials II</p> <p>Point Loma B</p> <p>Session Chairs: <i>Amy Marconnet (Purdue University), Leila Choobineh (SUNY Polytechnic Institute)</i></p>	<p>TI-6: Hot Spot Cooling and Jet Impingement II</p> <p>Coronado A</p> <p>Session Chairs: <i>Mohammed Ababneh (ACT), Nicholas Haehn (Intel)</i></p>
<p>10:30 AM</p>	<p>Featured Paper Presentation Influence of Structure and Wettability of Porous Silver Surfaces on Enhancing Phase Change Heat Transfer (p159) Gideon Gouws, Ben Sherson, Arwin Sinnathambi, Roshni Babu, Ciaran Moore (Victoria University of Wellington)</p>	<p>Featured Paper Presentation Measuring Heat Transfer Coefficients for Microchannel Jet Impingement Using Time-domain Thermoreflectance (p269) Thomas Germain, Tanvir Chowdhury, Jake Carter, Shawn Putnam (University of Central Florida)</p>
<p>11:00 AM</p>	<p>Experimental Measurement of Corrosion Involving Inorganics (Salt Hydrates) Phase Change Materials (PCM) for Thermal Energy Storage (TES) Applications (p138) Navin Kumar, Reynaldo Chavez Jr, Debjyoti Banerjee (Texas A&M University)</p>	<p>Impingement Cooling Using a Variable-diameter Synthetic Jet (p124) Alexander Zielinski, Monique Embury, Stephen Solovitz (Washington State University Vancouver)</p>
<p>11:20 AM</p>	<p>Design Architectures for Compliant High Temperature Thermal Interface Materials (p147) Mei-Chien Lu (Monte Rosa Technology)</p>	<p>Flow Field Characteristics of Multiple Impinging Tapered Nozzles in Confined Channels for High Heat Flux Applications (p284) Prabhakar Subrahmanyam, Arun Krishnamoorthy (Intel); Jared Harvest (ANSYS)</p>
<p>11:40 AM</p>	<p>Numerical and Experimental Investigation of Vertically Aligned Carbon Nanotube-phase Change Material Composites for Thermal Management of Electronics (p400) Makita Phillips, Craig Green, Baratunde Cola (Carbice)</p>	<p>Numerical Investigation of Thermal Transport in Confined Single and Multiple Jet Impingements Through Porous Filled Non-uniform Cross Section Channels (p314) Carlos Zing, Shadi Mahjoob (California State University Northridge)</p>
<p>12:00 PM</p>	<p>Luncheon: ITherm Sponsors, Exhibitors, and Partners Fairbanks</p>	

DAY 2 SESSIONS: THURSDAY, MAY 31, 10:30 – 1:30 PM

<p>TII-6: Data Center Energy Efficiency III</p> <p>Coronado B</p>	<p>M-6: Modeling and Analytical Methods for Mechanics and Reliability of Electronic Packaging II</p> <p>Point Loma A</p>	<p>P-6: Thermal Management of Mobile / IoT Devices</p> <p>Bel Aire South</p>
<p>Session Chairs: <i>Ajit Vallabhaneni (Qualcomm), Mehdi Saeidi (Qualcomm)</i></p>	<p>Session Chairs: <i>Shidong Li (IBM), Meriem Akin (IMPT)</i></p>	<p>Moderator: <i>Victor Chiriac (Qualcomm)</i></p>
<p>Featured Paper Presentation An Advanced Data Center Multi-chiller Dynamic Load Distribution Methodology and Engineering Practice (p205) Yiming Luo, Jianchao Cao, Biao Li, Yahui Zhao, Tangbo Jing, Lifei Zhang (Baidu); Nishi Ahuja, Jun Zhang, Yuyang Xia, Xiang Zhou (Intel)</p>	<p>Featured Paper Presentation Fatigue Life Predictive Model and Acceleration factor Development for Decoupling Capacitors (p241) Krishna Tunga, Joseph Ross, Kamal Sikka, Thomas Lombardi, Bakul Parikh, Eric Turcotte, Catherine Dufort, David Turnbull (IBM)</p>	<p>Thermal Management of Mobile / IoT Devices</p> <p>Abstract: In the last few years there has been a significant growth in computing platforms ranging from handhelds to IoT devices and everything in between. This is associated with increasingly high thermal management and other packaging issues ranging from low to high form factors. Majority of research today is CPU-centric whereas in the mobile/portable space, the device skin as well as the other components, which do not have dedicated thermal solutions, are equally challenging to cool. In products like handheld devices and mobile phones, passive dissipation is the most preferred and sometimes, the only possible cooling solution available. A different thermal landscape is now opening with the IoT devices and other adjacent high power areas. A panel of experts will discuss these aspects and will share their vision on the future of small to large electronics thermal management and other advanced system level cooling solutions.</p> <p>Panelists: Rick Beyerle (NeoGraf Solutions) Ken Goodson (Stanford University) Yogendra Joshi (Georgia Tech) Mark Hartman (Outlast Technologies) Ioan Sauciuc (Intel) John Thome (EPFL)</p>
<p>Transient Data Center Temperatures after a Primary Power Outage (p283) Christopher Healey, James VanGilder, Michael Condor, Wei Tian (Schneider Electric)</p>	<p>A Novel Numerical Multiphysics Framework for the Modeling of Cu-Al Wire Bond Corrosion under HAST Conditions (p330) Pradeep Lall, Yihua Luo (Auburn University); Luu Nguyen (Texas Instruments)</p>	
<p>Artificial Neural Network Based Prediction of Temperature and Flow Profile in Data Centers (p288) Jayati Athavale, Yogendra Joshi, Minami Yoda (Georgia Institute of Technology)</p>	<p>Development of a Computational Modeling and Experimental Validation Approach for KSF LED Packages in a 65" Ultra-Thin LED TV System (p265) Metehan Elibol, Mustafa Caglar Ozaydin (Vestel Electronics); Mehmet Arik (Ozyegin University)</p>	
<p>Thermoelectric On-spot Energy Harvesting for Diagnostics of Water Service Pipelines (p183) Kazuaki Yazawa (Purdue University), Katsuhiko Tanaka, Takashi Yajima (Tokyo Electric Power Company)</p>	<p>Comparison of FEA Modeling Techniques for Plastic Ball Grid Array Assemblies (p395) Chienchih Chen, Jeffrey Suhling, Pradeep Lall (Auburn University)</p>	

Luncheon: ITherm Sponsors, Exhibitors, and Partners
Fairbanks

DAY 2 SESSIONS: THURSDAY, MAY 31, 1:30 – 3:30 PM

	<p>E-7: Convection in Channels and Jets</p> <p>Point Loma B</p>	<p>TI-7A: Thermal Interface Materials, Heat Spreaders, and Thermal Ground Planes</p> <p>Coronado A</p>
	<p>Session Chairs: <i>Bladimir Ramos-Alvarado (Penn State University); Farah Singer, Amir Shooshtari (University of Maryland)</i></p>	<p>Session Chairs: <i>Ridvan Sahar (Intel), Baris Dogruoz (Cisco)</i></p>
<p>1:30 PM</p>	<p>Featured Paper Presentation Experimental Characterization of a Microchannel Heat Sink Made by Additive Manufacturing (p135) Ivel Collins, Justin Weibel, Liang Pan, Suresh Garimella (Purdue University)</p>	<p>Featured Paper Presentation Highly Anisotropic Thermal Conductivity in Spin-cast Polystyrene Nano-films (p272) Joseph Katz (Stanford University); Michael Barako (Northrop Grumman); Woosung Park, Aditya Sood, Mehdi Asheghi, Kenneth E. Goodson (Stanford University)</p>
<p>2:00 PM</p>	<p>A Heat Spreading Model for Double-sided, Cross-flow, Manifold-microchannel Heat Exchangers (p228) Raphael Mandel, Martinus Arie, Amir Shooshtari, Michael Ohadi (University of Maryland)</p>	<p>Combined Experimental-numerical Investigation of Metal-wax Interactions for Phase Change Thermal Energy Storage (p151) Prahlad Kulkarni, Prachi Kale, Collier Miers, Amy Marconnet (Purdue University)</p>
<p>2:20 PM</p>	<p>A Header Design Method for Target Flow Distribution among Parallel Channels Based on Topology Optimization (p111) Shi Zeng, Poh Seng Lee (National University of Singapore)</p>	<p>Investigation of Atomistic-scale Thin-film Evaporation (p248) Kimia Montazeri, Shiwei Zhang, Mohammad Javad Abdolhosseini Qomi, Yoonjin Won (University of California, Irvine)</p>
<p>2:40 PM</p>	<p>Impact of Orifice Size over Mechanical, Flow and Thermal Performances of Synthetic Jets (p120) Onuralp Isil, Bogac Yucesan, Mehmet Arik (Ozyegin University)</p>	<p>Synthesis of Thermal Compound and Its Application as a Thermal Interface Material of Power Module (p398) Seonja Song, Changkook Jang (Youngyiel Precision Co Ltd); Kyeongho Shin, Joohyung Kim (Inha University); Youngseok Kim (Hyundai Motor Company); Jaeuk Chu (Youngyiel Precision Co Ltd)</p>
<p>3:00 PM</p>	<p>Refreshment Break, Catalina Ballroom</p>	

DAY 2 SESSIONS: THURSDAY, MAY 31, 1:30 – 3:30 PM

<p>TI-7B: Air Cooling and Heat Exchangers</p> <p>Bel Aire North</p>	<p>M-7: Solder Joint Reliability I</p> <p>Point Loma A</p>	<p>TT-7: Thermal Management in Aerospace/Automotive</p> <p>Bel Aire South</p>
<p>Session Chairs: <i>Ashish Sinha (Chowbotics), Salih Erden (Istanbul Technical University)</i></p>	<p>Session Chairs: <i>Chandradip Patel (Schlumberger), Quang Nguyen (Micron)</i></p>	<p>Session Chair: <i>David Altman (Raytheon)</i></p>
<p>Featured Paper Presentation Two-phase Flow Simulations Within Plate Heat Exchangers (p105) Raffaele Luca Amalfi, John Richard Thome (Ecole Polytechnique Federale de Lausanne)</p>	<p>Featured Paper Presentation Investigation of Microstructural Evolution in SAC Solders Exposed to Short-term and Long-term Aging (p352) Jing Wu, Jeffrey Suhling, Pradeep Lall (Auburn University)</p>	<p>More Electric Aircraft Thermal Challenges Ram Ranjan (UTRC)</p>
<p>Experimental and Numerical Investigation of Liquid-to-Air Heat Exchangers (p154) Jaime Sanchez, Devdatta Kulkarni, Xudong Tang, Casey Winkel (Intel)</p>	<p>The Influence of Poisson's Ratio on the Reliability of SAC Lead Free Solder Joints (p349) KM Rafidh Hassan, Jeffrey Suhling, Pradeep Lall (Auburn University)</p>	<p>Thermal Challenges for Future Military Platforms Mark Spector (ONR)</p>
<p>Development of Hybrid Optimal Controller for Building AC Compressors (p286) Matthew Blaser, Agustinus Lawandy, Bahman Abbasi (Oregon State University)</p>	<p>Solder Joint Reliability of BGA Package for High Frequency Laminates under Power Cycling (p294) Mahesh Pallapothu, Mugdha Chaudhari, Unique Rahangdale, Abel Misrak, Dereje Agonafer (University of Texas at Arlington)</p>	<p>Thermal Design Optimization in Electronic Systems Ercan Dede (Toyota)</p>
<p>A Numerical Study of Heat Transfer and Fluid Flow in a Channel with an Array of Pin Fins in Aligned and Staggered Configurations (p361) Johnny Issa, Najib Saliba (University of Balamand); Amina El Cheikh (Lebanese American University)</p>	<p>SMT/PTH Solder Joint Reliability under Extreme Cold Thermal Cycles (p150) Reza Ghaffarian (JPL)</p>	

Refreshment Break, Catalina Ballroom

DAY 2 SESSIONS: THURSDAY, MAY 31, 3:30 – 7:00 PM

	<p>TI-8A: Novel Air Cooling Devices and Systems</p> <p>Coronado A</p>	<p>TI-8B: Characterization of Materials and Structures for Thermal Management of Electronics</p> <p>Bel Aire North</p>
	<p>Session Chairs: <i>Bladimir Ramos-Alvarado (Penn State Salih Erden (Istanbul Technical University), Ashish Sinha (Chowbotics)</i></p>	<p>Session Chairs: <i>Baris Dogruoz (Cisco), Ridvan Sahan (Intel)</i></p>
<p>3:30 PM</p>	<p>Featured Paper Presentation Fluid Dynamics and Heat Transfer Generated by a Pair of Adjacent Impinging Synthetic Jets (p302) Jean Paul D’Alencon, David Gallardo, Luis Silva-Llanca (Universidad de la Serena)</p>	<p>Featured Paper Presentation Rapid Thermal Characterization of Materials with Ultra-high Resolution of Droplet Size Specimens Using the Three Omega Method (p392) Corinna Grosse, Mohamad Abo Ras, Daniel May, Karim Elabshihy (Berliner Nanotest und Design GmbH); Kestutis Grigoras, Aapo Varpula, Mika Prunnila (VTT Technical Research Centre of Finland Ltd); Daniel May, Bernhard Wunderle (Chemnitz University of Technology)</p>
<p>4:00 PM</p>	<p>Thermal and Exergy Analysis in UPS and Battery Rooms by Numerical Simulations (p355) Carol Caceres (Villanova University); Alfonso Ortega (Santa Clara University); Luis Silva-Llanca (Universidad de la Serena); Gerard Jones (Villanova University); Nicholas Sapia (Verizon Wireless)</p>	<p>Thermal Management Technologies for Embedded Cooling Application (p292) Andy Slippey, William Anderson, Michael Ellis, Clayton Hose, James Schmidt, Jens Weyant (ACT)</p>
<p>4:20 PM</p>	<p>Impact of Orifice Location on the Mechanical Response of Side and Central Orifice Synthetic Jets (p112) Mohammad Zohaib Naseem, Polat Sendur, Mehmet Arik (Ozyegin University)</p>	<p>Thermal Conductance of Beta-Ga₂O₃/Metal Interfaces (p401) Henry Aller, Xiaoxiao Yu, Andrew Gellman, Jonathan Malen, Alan McGaughey (Carnegie Mellon University)</p>
<p>4:40 PM</p>	<p>An Investigation of Performance of Synthetic Jets Emanating from Circular, Elliptical and Rectangular Nozzles (p386) Onuralp Isil (Ozyegin University); Baris Dogruoz (Cisco); Mehmet Arik (Ozyegin University)</p>	<p>Uncertainty Quantification for a High Temperature Z-meter Characterization System (p134) Collier Miers, Amy Marconnet (Purdue University)</p>
<p>5:00 PM</p>	<p>Student Poster Networking Session and Reception, Fairbanks</p>	

DAY 2 SESSIONS: THURSDAY, MAY 31, 3:30 – 7:00 PM

<p>TII-8: Space, Aerospace, and Telecommunications</p> <p>Coronado B</p>	<p>M-8: Solder Joint Reliability II</p> <p>Point Loma A</p>	<p>P-8: Emerging Trends in Energy Management and Thermal Packaging of Data Centers</p> <p>Bel Aire South</p>
<p>Session Chairs: <i>Shima Hajimirza (Texas A&M University), Andrew Poynot (Signature Science, LLC)</i></p>	<p>Session Chairs: <i>Chandradip Patel (Schlumberger), Cong Zhao (Apple)</i></p>	<p>Moderator: <i>Yogendra Joshi (Georgia Institute of Technology)</i></p>
<p>Featured Paper Presentation Transient Electro-thermal Coupled System Simulation – Modeling Approach and Experimental Validation (p109) Ralph Schacht (Brandenburg Technology University); Sven Rzepka (Fraunhofer Institute ENAS)</p>	<p>Featured Paper Presentation Reliability of SAC Leadfree Solders in Automotive Underhood Temperature-Vibration (p329) Pradeep Lall, Vikas Yadav, Di Zhang, Jeff Suhling (Auburn University)</p>	<p>Emerging Trends in Energy Management and Thermal Packaging of Data Centers</p> <p>Abstract: This panel will explore multi-scale challenges in data centers being driven simultaneously by the rapid expected growth of internet of things (IOT), and computing hardware trends such as heterogeneous integration. Approaches for computing load balance, and improvement of energy efficiency, under realistic data center operational scenarios will be explored. The panel will also discuss recent advances in heterogeneous integration in computing hardware. Advances in thermal management technologies to enable future computing hardware will be presented.</p> <p>Panelists: Muhannad Bakir (Georgia Tech) Ali Merrikh (Qualcomm) Saeed Moghaddam (Univ. of Florida) Hiroaki Nishi (Keio University) Herman Oprins (IMEC)</p>
<p>A Novel Networking Box System Architecture and Design for Data Center Energy Efficiency (p187) Chuansheng Cheng, Hua Chen, Biquan Liang, Ning Liu, Chao Liu (Baidu); Jun Zhang, Nishi Ahuja, Jialiang Xu, Xiang Zhou (Intel)</p>	<p>Life Expectancies of Ni-doped SAC Solder Alloy Subjected to Drop Test Loading (p280) Jia-Shen Lan, Mei-Ling Wu (National Sun Yat-Sen University)</p>	
<p>Thermal Interface Material Enablement of Off-board Two-phase Cooling (p220) Matthew Smith (Georgia Institute of Technology); Raffaele Amalfi (Ecole Polytechnique Federale de Lausanne); Todd Salamon (Nokia Bell Labs); John Thome (Ecole Polytechnique Federale de Lausanne)</p>	<p>Fatigue Properties of Lead-free Doped Solder Joints (p253) Sinan Su, Francy Akkara, Mohammed Abueed, Minghong Jian, Sa'd Hamasha, Jeffrey Suhling, Pradeep Lall (Auburn University)</p>	
<p>Porous Nickel as a Selective Emitter for Surface Cooling in Various Environments (p274) Jonathan Sullivan, Anirudh Krishna, Jaeho Lee (University of California, Irvine)</p>		

Student Poster Networking Session and Reception, Fairbanks

DAY 3 SESSIONS: FRIDAY, JUNE 1, 7:00 - 10:30 AM

7:00 AM	Speakers' Breakfast, Fairbanks	
	<p>E-9: Thermal Experimental Methods, Nano-to-macro Scale I</p> <p>Point Loma B</p>	<p>TI-9: Board-level Liquid Cooling Solutions</p> <p>Coronado A</p>
	<p>Session Chairs: <i>Amy Marconnet (Purdue University), Patrick Shamberger (Texas A&M University)</i></p>	<p>Session Chairs: <i>Anil Yuksel (IBM), Prabhakar Subrahmanyam (Intel)</i></p>
8:00 AM	<p>Estimation of Measurement Uncertainties for Thermal Conductivity of Nanofluids Using Transient Plane Source (TPS) Technique (p137)</p> <p>Binjian Ma, Navin Kumar, Aditya Kuchibhotla, Debjyoti Banerjee (Texas A&M University)</p>	<p>Analytical Design Methodology for Liquid Based Cooling Solution for High TDP CPUs (p132)</p> <p>Yuehong Fan, Casey Winkel, Devdatta Kulkarni, Wenbin Tian (Intel)</p>
8:20 AM	<p>Measurement of Intrinsic Meniscus Profile near an Evaporating Contact Line in Partial Wetting Regime (p375)</p> <p>Abbasali Mehrizi, Hao Wang (Peking University)</p>	<p>Design of a Two-phase Gravity-driven Micro-scale Thermosyphon Cooling System for High-performance Computing Data Centers (p177)</p> <p>Andre Seuret, Arman Iranfar, Marina Zapater, John Richard Thome, David Atienza (Ecole Polytechnique Federale de Lausanne)</p>
8:40 AM	<p>CTE-Matched Cantilevers for Improved Heated Atomic Force Microscopy and Passive-mode Scanning Thermal Microscopy (p243)</p> <p>Darin Sharar (General Technical Services); Adam Wilson (National Academy of Sciences, National Research Council)</p>	<p>Experimental Study of Two-phase Cooling to Enable Large-scale System Computing Performance (p200)</p> <p>Devdatta Kulkarni, Xudong Tang, Sandeep Ahuja, Richard Dischler, Ravi Mahajan (Intel)</p>
9:00 AM	<p align="center">K-3 Keynote: Detector Thermal Management with CO2 Boiling Systems at CERN</p> <p align="center">Bel Aire Paolo Petagna (CERN)</p> <div style="display: flex; align-items: flex-start;">  <div> <p>Paolo Petagna received a Master's degree cum laude in Aeronautical Engineering from the University of Pisa in 1989, obtaining a research grant with the Department of Aerospace Engineering (DIA) on wake flows, 3D turbulent mixing and coaxial jets. In 1991, he founded ARIA (Aerodynamics Research for Industrial Applications), an applied research spin-off of DIA. From 1991 to 1995, he worked as consultant on applied R&D problems for industrial partners including Ferrari, Brembo, and Piaggio, among others. In 1996 Paolo joined CERN (the European Organization for Nuclear Research), where he participated in the design and commissioning of the Central Tracker Detector of the CMS experiment. As a member of the CMS, NA62 and ALICE collaborations at CERN, he co-authored more than 50 papers. From 2009, Petagna has led the Detector Cooling Project of the CERN Physics Department, with major R&D areas including CO2-based cooling systems, micro-channel cooling devices, and optical fibre sensors for relative humidity. He has co-authored more than 30 publications in these research areas.</p> </div> </div>	
10:00 AM	Refreshment Break, Catalina & Coronado Foyers	

DAY 3 SESSIONS: FRIDAY, JUNE 1, 7:00 - 10:30 AM

Speakers' Breakfast, Fairbanks

<p>TII-9: Automotive, Batteries, and Thermal Storage</p> <p>Coronado B</p>	<p>M-9: Solder Characterization and Modeling I</p> <p>Point Loma A</p>	<p>TT-9: Additive Manufacturing/Thermal Topology Optimization</p> <p>Bel Aire</p>
<p>Session Chairs: <i>Aydin Nabovati (Tesla), Man Prakash Gupta (Ford)</i></p>	<p>Session Chairs: <i>Krishna Tunga (IBM), Sandeep Shantaram (NXP Semiconductors)</i></p>	<p>Session Chair: <i>William D. Gerstler (GE Global Research)</i></p>
<p>Thermal Management within Multi-disciplinary System Design of a Rubik's-cube-sized 2kW Power Inverter (p362) David Guirguis, Miad Nasr, Samantha Murray, Hirokazu Matsumoto, Olivier Trescases, Cristina Amon (University of Toronto)</p>	<p>Feature Extraction and RUL Prediction of SAC Solder Alloy Packages by Different Statistical and Time-frequency Analysis Techniques under Simultaneous Temperature-vibration Loads (p327) Pradeep Lall, Tony Thomas, Jeff Suhling (Auburn University)</p>	<p>Multi-physics Topology Optimization and Additive Manufacturing Xiaoping Qian (University of Wisconsin-Madison)</p>
<p>Experimental Validation of Thermal Performance of a Plate Heat Exchanger (PHX) with Phase Change Materials (PCM) for Thermal Energy Storage (TES) (p141) Navin Kumar, Reynaldo Chavez, Debjyoti Banerjee (Texas A&M University)</p>	<p>Temperature-dependent Electrical and Thermal Conductivity of Glassy Carbon Wires (p148) Laia Ferrer-Argemi, Albert Cisquella-Serra, Marc Madou, Jaeho Lee (University of California, Irvine)</p>	<p>Topology Optimization of Fluid-based and Conjugate Heat Transfer Problems Joe Alexandersen (Technical University of Denmark (DTU))</p>
<p>Thermal Management Strategies for a High-frequency, Bi-directional, On-board Electric Vehicle Charger (p344) Kshitij Gupta, Carlos Da Silva, Miad Nasr, Amir Assadi, Hirokazu Matsumoto, Olivier Trescases, Cristina Amon (University of Toronto)</p>	<p>Board Level Solder Joint Reliability Assessment Study of Megtron 6 vs. FR-4 under Power Cycling and Thermal Cycling (p312) Jyotirmoy Denria, Pavan Rajmane, Dereje Agonafer (University of Texas at Arlington)</p>	<p>Additive Manufactured Thermal Management Products and Features: Experiences and Future Challenges Jared Wolfe (GE Additive)</p>

K-3 Keynote: Detector Thermal Management with CO₂ Boiling Systems at CERN

Bel Aire

Paolo Petagna (CERN)

Abstract: For the thermal management of silicon detectors in the next generation of particle physics experiments, total powers well in excess of 100 kW with volumetric densities up to 100 W/dm³ must be removed from sealed volumes, where the detectors are organized in convoluted surfaces. In order to ensure their required operational life of 10 years, the silicon sensors, submitted to high radiation levels, must be maintained at temperatures well below 0° C. Furthermore, the mass of the support structures and ancillary systems must be minimized, while large temperature gradients, both in time and space, should be avoided.

The most demanding applications already implement boiling flows of CO₂ in small diameter evaporators: CO₂ presents extremely favourable thermo-physical properties, is radiation hard and environmentally friendly. The typical geometry of a silicon detector's CO₂ evaporator is a few metres long pipe, 1.0 to 2.5 mm in I.D. However, after a recent successful application of silicon micro-structured cold plates in liquid phase, one experiment will implement for the first time in 2019 a cooling system based on CO₂ boiling in silicon micro-channels.

The talk will review the achievements and the ongoing R&D at CERN on both the local evaporators and global system design.

Refreshment Break, Catalina & Coronado Foyers

DAY 3 SESSIONS: FRIDAY, JUNE 1, 10:30 – 1:30 PM

	<p>E-10: Thermal Experimental Methods, Nano-to-macro Scale II</p> <p>Point Loma B</p> <p>Session Chairs: <i>Amy Marconnet (Purdue University), Patrick Shamberger (Texas A&M University)</i></p>	<p>TI-10: Boiling, Condensation, Evaporation, and Microgap Cooling I</p> <p>Coronado A</p> <p>Session Chairs: <i>Mehmet Arik (Ozyegin University), Emil Rahim (Google)</i></p>
10:30 AM	<p>Featured Paper Presentation Improving the Transient Thermal Characterization of GaN HEMTs (p307) Georges Pavlidis, Dustin Kendig, Luke Yates, Samuel Graham (Georgia Institute of Technology)</p>	<p>Featured Paper Presentation Nanoelectrosprayed Liquid Jets for Evaporative Heat Transfer Enhancement (p114) Joel Chapman, Peter Kottke, Andrei Fedorov (Georgia Institute of Technology)</p>
11:00 AM	<p>Measurement and Modeling of Heat Conduction in MEMS Nanostructures (p174) Marcin Janicki, Piotr Pietrzak, Piotr Zajac, Grzegorz Jablonski (Lodz University of Technology); Pawel Janus (Institute of Electron Technology)</p>	<p>3D Numerical Analysis of Phase Change Immersion Cooling for Electronic Components (p115) Xudong An, Manish Arora, Wei Huang, William C. Brantley, Joseph L. Greathouse (Advanced Micro Devices)</p>
11:20 AM	<p>Temperature and Stress Metrology of Ultra-wide Bandgap β-Ga₂O₃ Thin Films (p289) Bikramjit Chatterjee (Pennsylvania State University); Jacob Leach (Kyma Technologies); Sarit Dhar (Auburn University); Sukwon Choi (Pennsylvania State University)</p>	<p>High Heat Flux Boiling Heat Transfer Through Nanoporous Membranes (p164) Qingyang Wang, Renkun Chen (University of California San Diego)</p>
11:40 AM	<p>Investigation of Elastic Modulus and Thermal Conductivity of Rough Silicon Nanowires (p391) Kenny Huynh, Majed Madani, Jaeho Lee (University of California, Irvine)</p>	<p>Study on the Heat Transfer Mechanism in Nucleate Boiling of Water by Measuring Local Heat Flux and Temperature (p202) Minchang Kim, Sung Jin Kim (KAIST)</p>
12:00 PM	<p>Luncheon: ITherm Best Paper Awards & Organizer Recognitions Fairbanks</p>	

DAY 3 SESSIONS: FRIDAY, JUNE 1, 10:30 – 1:30 PM

TII-10: Data Center Energy Efficiency IV

Coronado B

Session Chairs:

Prabhakar Marepalli (Intel), Mehdi Saeidi (Qualcomm)

M-10: Solder Characterization and Modeling II

Point Loma A

Session Chairs:

Krishna Tunga (IBM), Sandeep Shantaram (NXP Semiconductors)

P-10: Thermal Management in Electronics: Materials, Devices, and Data Centers: Special Panel in Honor of Prof. Jayathi Murthy

Bel Aire South

Moderator:

Dhruv Singh (GlobalFoundries)

Featured Paper Presentation
Impact of Static Pressure Differential between Supply Air and Return Exhaust on Server Level Performance (p356)
 Ashwin Siddarth, Richard Eiland, John Fernandes, Dereje Agonafer (University of Texas at Arlington)

Featured Paper Presentation
A Comparative Study of the High Temperature Mechanical Behavior of Lead Free Solders (p338)
 Mohammad Alam, Jeffrey Suhling, Pradeep Lall (Auburn University)

Thermal Management in Electronics: Materials, Devices, and Data Centers: Special Panel in Honor of Prof. Jayathi Murthy

Abstract: This special panel is a part of Prof. Jayathi Y. Murthy’s 60th birthday celebration at ITherm 2018, commemorating her numerous contributions and fundamental developments to heat transfer and thermal management. Over the past decades, research progress from her team has touched every facet of electronics thermal management – from fundamental physics of energy transport in materials, electron-phonon transport in ultrascaled devices to electronics cooling solutions spanning myriad applications. In tandem, the advances led by her in the development of large scale numerical methods have brought software tools to the forefront of industry enabling the necessary cross-disciplinary solutions. The panel puts forth a discussion of these challenges in the domain of electronics thermal management from transistors to data centers, their implications and a hierarchical view of scientific and engineering solutions needed to achieve them.

The Impact of Cold Aisle Containment Pressure Relief on IT Availability (p324)
 Mohammad Tradat, Udaya Puvvadi, Bahgat Sammakia, Kanad Ghose (SUNY Binghamton); Mahmoud Ibrahim, Andrew Calder, Thomas Peddle (Panduit); Mark Seymour (Future Facilities); Husam Alissa (Microsoft)

Effect of Prolonged Storage on High Strain Rate Mechanical Properties of SAC-Q Leadfree Solder at High Operating Temperature (p328)
 Pradeep Lall, Vikas Yadav, Jeff Suhling (Auburn University); David Locker (US Army AMRDEC)

CFD Simulation and Optimization of the Cooling of Open Compute Machine Learning “Big Sur” Server (p357)
 Mangesh Dhadve, Jimil Shah, Dereje Agonafer (University of Texas at Arlington)

A Joint-Scale Test Specimen for Tensile Properties of Solder Alloys (p267)
 Abhishek Deshpande, Qian Jiang, Abhijit Dasgupta (University of Maryland)

Experimental Characterization of Vertically Split Distribution Wet-cooling Media Used in the Direct Evaporative Cooling of Data Centers (p377)
 Ahmed Al Khazraji, Ashwin Siddarth, Mullaivendhan Varadharasan (University of Texas at Arlington); Abhishek Guhe (Mestek); Dereje Agonafer (University of Texas at Arlington); James Hoverson, Mike Kaler (Mestek)

Effects of Mechanical Cycling on the Microstructure of SAC305 Lead Free Solder (p397)
 Md Mahmudur Chowdhury, Nianjun Fu, Mohd Aminul Hoque, Sudan Ahmed. Jeffrey Suhling, Sa’d Hamasha, Pradeep Lall (Auburn University)

Panelists:

Vaibhav Bahadur (University of Texas)
 Madhusudan Iyengar (Google)
 Satish Kumar (Georgia Tech)
 Amy Marconnet (Purdue University)
 Sreekant Narumanchi (NREL)
 Metin Ozen (Ozen Engineering)

Luncheon: ITherm Best Paper Awards & Organizer Recognitions

Fairbanks

DAY 3 SESSIONS: FRIDAY, JUNE 1, 1:30 – 3:30 PM

	<p>E-11: Emerging Materials and Thermal Phenomena I</p> <p>Point Loma B</p>	<p>TI-11: Boiling, Condensation, Evaporation, and Microgap Cooling II</p> <p>Coronado A</p>
	<p>Session Chairs: <i>Banafsheh Barabadi (MIT), Taravat Khadivi (Qualcomm)</i></p>	<p>Session Chairs: <i>Emil Rahim (Google), Mehmet Arik (Ozyegin University)</i></p>
<p>1:30 PM</p>	<p>Featured Paper Presentation Thermal Conductivity of Electrically Conductive Highly Boron Doped Diamond and its Applications at High Frequencies (p213) Gruffudd Williams (Element Six Technologies); Julian Anaya Calvo (J. Anaya Calvo Scientific Consultancy); Firooz Faili, Joe Dodson, Thomas Obeloer, Daniel Twitchen (Element Six Technologies)</p>	<p>Featured Paper Presentation Physics of Thin Film Formation in Microchannels: New Physical Insights and Governing Correlations (p223) Abdolreza Fazeli, Meisam Habibi Matin, Saeed Moghaddam (University of Florida)</p>
<p>2:00 PM</p>	<p>First Demonstration of a Bending-Mode Elastocaloric Cooling 'Loop' (p116) Darin Sharar (General Technical Services); Brendan Hanrahan (U.S. Army Research Laboratory); Joshua Radice, Ronald Warzoha (United States Naval Academy); Benjamin Chang (University of Maryland)</p>	<p>Flow Boiling Heat Transfer of HFE7000 in Manifold Microchannels Through Integrating Three-dimensional Flow and Silicon Nanowires (p185) Sheng Wang, Hsiu-Hung Chen, Chung-Lung (C.L.) Chen (University of Missouri)</p>
<p>2:20 PM</p>	<p>Temperature-dependent Thermoelectric Properties of Electrodeposited Antimony Telluride Films upon Thermal Annealing (p206) Ziqi Yu, Laia Ferrer-Argemi, Jaeho Lee (University of California, Irvine)</p>	<p>Two-phase Thermosiphon Cooling Using Integrated Heat Spreaders with Copper Microstructures (p216) Vasco Abreu, Matthew Harrison, Joshua Gess, Ana S. Moita (Oregon State University)</p>
<p>2:40 PM</p>	<p>Temperature-dependent Adhesion Mechanisms of Metal and Insulator Probe-sample Contact Pairs (p242) Adam Wilson (National Academy of Sciences, National Research Council); Darin Sharar (General Technical Services)</p>	
<p>3:00 PM</p>	<p>Refreshment Break, Catalina & Coronado Foyers</p>	

DAY 3 SESSIONS: FRIDAY, JUNE 1, 1:30 – 3:30 PM

<p>TII-11: Mobile, Internet of Things I</p> <p>Coronado B</p>	<p>M-11: Thermal-mechanical Interactions in Microelectronics Packages and Systems I</p> <p>Point Loma A</p>	<p>TT-11: Next Generation Challenges in Numerical Modeling: Special Tech-Talk in Honor of Prof. Jayathi Murthy</p> <p>Bel Aire South</p>
<p>Session Chairs: <i>Krishna Valavala (Intel), Youmin Yu (Qualcomm)</i></p>	<p>Session Chairs: <i>Vibhash Jha (NXP Semiconductors), Jaeho Lee (UC Irvine), Yingying Wang (Qualcomm)</i></p>	<p>Session Chairs: <i>Cristina Amon (University of Toronto); Tim Fisher (UCLA)</i></p>
<p>Featured Paper Presentation A System-Level Thermal Simulator with Automatic Meshing Techniques (p180) Jui-Hung Wang, Yu-Min Lee, Hsuan-Hsuan Hsiao (National Chiao Tung University); Liang-Chia Cheng (Industrial Technology Research Institute)</p>	<p>Featured Paper Presentation A Study on Die Stresses in Flip Chip Packages Subjected to Various Hygrothermal Exposures (p399) Quang Nguyen, Jordan Roberts, Jeffrey Suhling, Richard Jaeger, Pradeep Lall (Auburn University)</p>	<p>Validation of Direct Numerical Simulations of Two-phase Slug Flow Boiling</p> <p>Suresh Garimella (Purdue)</p>
<p>Experimental Determination of Junction-Thermal Challenges and Solutions of M.2 Solid State Drive (p129) Ning Ye, Yangming Liu, Zhongli Ji, Dmitry Vaysman, In-Soo Yoon, Hem Takiar (Western Digital)</p>	<p>Thermal Expansion Investigation of Liquid Cold Plate with Varying Ambient Temperature at Storage (p108) Murat Parlak (Aselsan / University of Gazi-Ankara); Vedat Yagci (Aselsan / Middle East Technical University-Ankara)</p>	
<p>Designing a Temperature Model to Understand the Thermal Challenges of Portable Computing Platforms (p118) Ying-Ju Yu, Carole-Jean Wu (Arizona State University)</p>	<p>Thermal Performance Evaluation and Reliability Analysis of Air-cooled Power Modules (p173) Koichi Ishiyama, Shingo Nakayama, Qiang Yu (Yokohama National University)</p>	<p>Next Generation Atomistic Modeling of Thermal Transport</p> <p>Alan McGaughey (CMU)</p>
<p>Impact of Chipset Configuration on Thermal Performance in Smartphones (p247) Youmin Yu, Nader Nikfar, Todd Sutton (Qualcomm)</p>	<p>Effect of Thermal Cycling on Reliability of QFN Packages (p326) Pradeep Lall, Shantanu Deshpande, Nakul Kothari (Auburn University); Luu Nguyen (Texas Instruments)</p>	

Refreshment Break, Catalina & Coronado Foyers

DAY 3 SESSIONS: FRIDAY, JUNE 1, 3:30 – 5:00 PM

	<p>E-12: Emerging Materials and Thermal Phenomena II</p> <p>Point Loma B</p> <p>Session Chairs: <i>Sukwon Choi (Pennsylvania State University), Yaguo Wang (UT Austin), and Banafsheh Barabadi (MIT)</i></p>	<p>TI-12A: Single/Two-phase Flow in Microchannels and Cold Plates</p> <p>Coronado A</p> <p>Session Chairs: <i>Prabhakar Subrahmanyam (Intel), Anil Yukse (IBM)</i></p>
<p>3:30 PM</p>	<p>Featured Paper Presentation</p> <p>LED Characterization within the Delphi4LED Project (p393)</p> <p>Gabor Farkas, Lajos Gaal, Marton Bein, Andras Poppe, Sandor Ress, Marta Rencz (Mentor)</p>	<p>Featured Paper Presentation</p> <p>Experimental Characterization of Cold Plates Used in Cooling Multi Chip Server Modules (MCM) (p227)</p> <p>Bharath Ramakrishnan, Yaser Hadad (SUNY Binghamton); Sami Alkharabsheh (Ford); Paul Chiarot, Kanad Ghose, Bahgat Sammakia (SUNY Binghamton); Vadim Gektin, Wang Chao (Huawei Technologies)</p>
<p>4:00 PM</p>	<p>Experimental Measurement of the Effect of Particle Concentration on the Specific Heat Capacity of Silica Nanofluids (p143)</p> <p>Binjian Ma, Navin Kumar, Aditya Kuchibhotla, Debjyoti Banerjee (Texas A&M University)</p>	<p>Maldistribution of Two-Phase Flow in Parallel Channel Heat Sinks: Effects of Thermal Connection between Channels (p128)</p> <p>Gaurav Patankar, Todd Salamon (Nokia Bell Labs)</p>
<p>4:20 PM</p>	<p>Thermal Conductivity of Graphite Microlattices (p201)</p> <p>Shiva Farzinazar, Zongqing Ren, Jaeho Lee (University of California, Irvine)</p>	<p>Geometric Optimization of an Impinging Cold-Plate with a Trapezoidal Groove Used for Warm Water Cooling (p229)</p> <p>Yaser Hadad, Reza Pejman, Bharath Ramakrishnan, Paul Chiarot, Bahgat Sammakia (SUNY Binghamton)</p>
<p>4:40 PM</p>	<p>Non-Invasive Thermal Resistance Measurement for GaN Wafer Process Control and Optimization (p249)</p> <p>Chao Yuan, James Pomeroy, Martin Kuball (University of Bristol)</p>	<p>Flow Analysis and Linearization of Rectangular Butterfly Valve Flow Control Device for Liquid Cooling (p359)</p> <p>Rajesh Kasukurthy, Pencala Sumanth Challa, Rishi Ruben Palanikumar, Barath Ragul Manimaran, Dereje Agonafer (University of Texas at Arlington)</p>

DAY 3 SESSIONS: FRIDAY, JUNE 1, 3:30 – 5:00 PM

<p>TI-12B: Thermoelectricity, TEC, and Peltier Devices</p> <p>Bel Aire North</p>	<p>TII-12: Mobile, Internet of Things II</p> <p>Coronado B</p>	<p>M-12: Thermal-mechanical Interactions in Microelectronics Packages and Systems II</p> <p>Point Loma A</p>
<p>Session Chairs: <i>Amy Xia (Intel), Mark North (Aavid)</i></p>	<p>Session Chairs: <i>Youmin Yu (Qualcomm), Krishna Valavala (Intel)</i></p>	<p>Session Chairs: <i>Vibhash Jha (NXP Semiconductors), Jaeho Lee (UC Irvine), Yingying Wang (Qualcomm)</i></p>
<p>Featured Paper Presentation Packaging and Thermal Decoupling of an Optical Array Using a Thermoelectric Cooler (p279) Sevket Umut Yuruker, Raphael Mandel, Daniel Bae, Michael Ohadi (University of Maryland), Vadim Gektin (Huawei Technologies)</p>	<p>Featured Paper Presentation Fast Prediction of Thermal Throttling Design in M.2 Solid State Drive (p131) Yangming Liu, Ernold Thompson (SanDisk); Ning Ye, Dmitry Vaysman, In-Soo Yoon, Hem Takiar (Western Digital)</p>	<p>Coupled Thermal and Thermo-mechanical Simulation for Flip-chip Component Level Copper Pillar Bump Fatigue (p255) Sandeep Shantaram, A. R. Nazmus Sakib, Nishant Lakhera (NXP Semiconductors)</p>
<p>Transient Heat Transfer Analysis of Thermo-Electric Cooler Thermal Tools (p153) Jaime Sanchez (Intel)</p>	<p>Optimization of TEG for Human Body Powered Mobile Devices (p263) Jiahui Cao (University of California, Irvine)</p>	<p>Simulation Driven Design of Novel Integrated Circuits – Part 4: Method of Validation of Coupled Thermal And Thermo-mechanical Simulation (p276) Przemyslaw Gromala, Alicja Palczynska (Robert Bosch GmbH); Bulong Wu, Bongtae Han (University of Maryland)</p>
<p>Thermoelectric Cooling Device Based on Holey Silicon (p196) Zongqing Ren, Jaeho Lee (University of California, Irvine)</p>	<p>Transient Thermal Analysis for M.2 SSD Thermal Throttling: Detailed CFD Model vs. Network-based Model (p130) Hedan Zhang (Western Digital); Hainan Wang (Cadence); Shay Braha, Ernold Thompson, Ning Ye (Western Digital); Nathan Ai, C. T. Kao (Cadence); Nir Amir (Western Digital)</p>	<p>Effect of Solder Sphere Alloys and Surface Finishes on the Reliability of Lead-free Solder Joints in Accelerated Thermal Cycling (p258) Francy John Akkara, Cong Zhao, Raed Alathamneh, Sinan Su, Mohammed Abueed, Sa'd Hamasha, Jeff Suhling, Pradeep Lall (Auburn University)</p>
		<p>Evolution of the Cyclic Stress-strain and Constitutive Behaviors of Doped Lead Free Solders During Fatigue Testing (p396) Mohd Aminul Hoque, Md Mahmudur Chowdhury, Nianjun Fu, Jeffrey Suhling, Sa'd Hamasha, Pradeep Lall (Auburn University)</p>

ITherm 2018, May 29 - June 1, 2018
Sheraton Hotel & Marina, San Diego, CA, USA

NOTES

Abstracts Due: September 3, 2018



18th Intersociety Conference on Thermal and Thermomechanical Phenomena in Electronic Systems

ITherm 2019 is the leading international conference for scientific and engineering exploration of thermal, thermomechanical and emerging technology issues associated with electronic devices, the 69th ECTC 2019, at the Cosmopolitan of Las Vegas. Joint registrations are available at a discounted rate.



Call for Abstracts

All papers will be peer reviewed and published in the ITherm proceedings. Student first authors will have the opportunity to apply for ITherm travel grants in order to make an oral presentation and participate in a Student Poster and Networking Session. In addition to paper presentations and vendor exhibits, ITherm 2019 will have panel discussions, keynote lectures by prominent speakers, invited Tech Talks, and professional short courses. Original papers are solicited in the following general areas of interest (but not limited to):

Component-Level Thermal Management

- Single/Multi Chip Module & System in Package
- 3D Packaging & Embedded Cooling
- Hotspot & Impingement Cooling
- Passive Two-Phase Cooling: Heat Pipes, Vapor Chambers, & Thermosyphons
- Pulsating/Oscillating & Non-Conventional Heat Pipes
- Thermal Interface Materials and Heat Spreaders
- Thermoelectricity & Peltier Devices
- Novel Air Cooling Techniques & Heat Exchangers
- Pumps, Compressors, Fans & Blowers
- Single-Phase Liquid & Two-Phase Cold Plates
- Boiling/Evaporation/Condensation, Microgap Cooling

System-Level Thermal Management

- Data Center Energy Efficiency
- Thermal Storage
- Immersion Cooling, Refrigeration
- Mobile, Internet of Things, MEMS
- Telecommunication Systems
- Automotive; Space and Aerospace
- Power Electronics
- LEDs
- Photovoltaics
- RF Electronics
- Batteries

Mechanics & Reliability

- Thermo-Mechanical Modeling and Simulation of Devices, Components, Boards, and Systems
- Mechanics and Reliability of Solder Joints & Interconnects
- Materials Characterization, Processing, Constitutive Models
- Failure Mechanics, Fatigue, Damage Modeling
- Experimental Techniques for Packaging Deformations, Strains, and Stresses
- Shock, Drop, and Vibrational Analysis of Packages, Sub-Systems, and Systems
- TSV / 3D Reliability and Packaging Challenges
- Mechanics Issues in Assembly and Manufacturing
- Applied Reliability for Failure Detection and Characterization
- Process-Structure-Property Correlations / Multi-Scale Analyses for Degradation and Failure
- Accelerated Stress Testing and Modelling
- Lifetime Prognostics and Condition Monitoring

Emerging Technologies and Fundamentals

- Numerical Methods from Nano-to-Macro Scale
- Experimental Methods from Nano-to-Macro Scale
- Nanotechnology Including 1-D and 2-D Materials
- Thermal Interface Materials and Phase Change Materials
- Embedded Cooling
- Transistor Technology
- Novel Materials and Fabrication Techniques
- Measurement and Instrumentation Techniques
- Prognostic Health Management and Reliability Analysis
- Flexible Electronics

ITherm provides an opportunity for industrial and university participation in the form of financial support to ITherm 2019. All contributors will be given strong recognition both onsite and in the conference materials.



Program Inquiries To:
Dr. Vadim Gektin, Program Chair, Vadim.Gektin@huawei.com
Prof. Justin A. Weibel, Vice Program Chair, jaweibel@purdue.edu



Prof. Jeffrey C. Suhling, General Chair, jsuhling@auburn.edu
ITherm Website: <http://ieee-itherm.net/>



ITHERM 2018 CONFERENCE SCHEDULE

ITherm 2018: Program Overview											
Emerging	Thermal I	Thermal II	Mechanics	Keynote	Tech-Talk	Panel	Meetings	Meals	Special Event	PDC	
7:00 - 8:00	8:00 - 9:00	9:00 - 10:00	10:00 - 10:30	10:30 - 12:00	12:00 - 1:30	1:30 - 3:00	3:00 - 3:30	3:30 - 5:00	5:00 - 7:00	7:00 - 8:00	8:00 - 9:00
Day-0: Tuesday, May 29, 2018											
ECTC/ITherm Joint Professional Development Courses											
ECTC/ITherm Joint Professional Development Courses 10-18											
Heterogeneous Intergration Roadmap Workshop (8:00 - 5:00)											
Day-1: Wednesday, May 30, 2018											
Speakers' Breakfast	E-1	K-1 Keynote	Coffee Break	E-2	Luncheon	E-3	Coffee Break	E-4	Meeting	ECTC/ITherm Women's Panel and Reception 6:30-7:30	Meetings
	TI-1A			TI-2	Richard Chu	TI-3		ITherm Executive Committee 5:00-6:00	ASME K-16 and Journal of Electronic Packaging 7:30-9:00		
	TI-1B			TI-2	ITherm Award Presentation	TI-3		ITherm Sponsors & Exhibits			
	TI-1			M-2		M-3					
	M-1			P-2		TT-3					
Day-2: Thursday, May 31, 2018											
Speakers' Breakfast	E-5	K-2 Keynote	Coffee Break	E-6	Luncheon	E-7	Coffee Break	TI-8A	Student Poster Networking Session and Reception	ITherm 2019 Program Planning	ITherm Organizers Dinner (by invitation)
	TI-5			TI-6	ITherm	TI-7A		ITherm Sponsors & Exhibits			
	TI-5			TI-6	Sponsors and Partners	TI-7B					
	M-5			M-6		M-7					
	TT-5			P-6		TT-7					
Day-3: Friday, June 1, 2018											
Speakers' Breakfast	E-9	K-3 Keynote	Coffee Break	E-10	Luncheon	E-11	Coffee Break	E-12	ITherm Sponsors/Exhibits	ITherm Sponsors/Exhibits	ITherm Sponsors/Exhibits
	TI-9			TI-10	ITherm Best	TI-11					
	TI-9			TI-10	Paper Awards & Organizer	TI-11					
	M-9			M-10	Recognitions	M-11					
	TT-9			P-10		TT-11					