FINAL PROGRAM

SEMI-THERM®

40th ANNIVERSARY

SEMI-THERM 40

The 40th Annual Thermal Measurement, Modeling and Management Symposium

March 25 – 28, 2024

40

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Keynote Presentation:
Driving Sustainable Scaling of Compute to 2030

Tim Shedd, Engineering Technologist, Office of the CTIO at Dell
Engineering Technologist, Office of the CTIO at Dell

Technical Sessions:

- Consumer Electronics
- Data Centers / Immersion
- Testing and Measurement Methods
- CFD / Numerical Methods
- Thermal Interface Materials
- Emerging Technologies
- Two Phase Cooling I
- Two Phase Cooling II

Tuesday Panel Discussion:
Artificial Intelligence and its Implication for Thermal Engineers; Driving the Thermal Demand

Wednesday Panel Discussion:
Artificial Intelligence and its Implication for Thermal Engineers; Providing, Using, and Powering New Design Tools

Thermi Award Presentation
Wendy Luiten

Thermal Hall of Fame Award:
Bonnie Crystall and Walter Schuch

Harvey Rosten Award:
"Applicability of JESD51-14 to Clip-bonded, Discrete Power Devices"
Szilárd Zsigmond Szőke and Henrik Sebők

All programming subject to change

Welcome to SEMI-THERM 40!

Alex Ockfen

Dear Colleagues, it is my pleasure to welcome you to the SEMI-THERM 40th annual symposium dedicated to thermal design, thermal management, and thermal measurement of semiconductor systems and components. The program committee led by Lieven Vervecken, Diabatix, has coordinated a comprehensive program that captures SEMITHERM's mission of providing a platform for discussion on the latest advancements in thermal management for both industry professionals and members of academia.

This year's program consists of our keynote address; seven short courses; thirty-four technical papers; two luncheon speeches; two panel sessions on "Artificial Intelligence and its impacts on Thermal Design"; Vendor workshops; two days of SEMI-THERM exhibits and our awards sessions including the THERMI, Harvey Rosten, and Thermal Hall of Fame Award. As has been the tradition in prior years, the panel sessions are open to the public. The short courses are also offered as part of the full technical conference pass. The courses are split between morning and afternoon sessions on the first day of SEMI-THERM, Monday March 25th. This year's keynote speech is from Dr. Tim Shedd, Engineering Technologist, Office of the CTIO at Dell. The theme of keynote is "Driving Sustainable Scaling of Compute to 2030".

I would like to thank all those who participated in the publication review process. In particular, I would like to thank our Program and Vice Program Chairs, Lieven Vervecken, Diabatix and Navid Kazem, Arieca, for the outstanding technical and auxiliary program. Many thanks to both of you for your invaluable effort and the fantastic program we have this year. Organizing the SEMI-THERM symposium would not be possible without the experienced leadership provided by Ross Wilcoxon, Collins Aerospace, George Meyer, Celsia Technologies. Thanks to all of you for your constant support to the SEMI-THERM 40th program committee. Lastly, I want to give all my appreciation to Bonnie Crystall and Robert Schuch for their tireless support to make this year's SEMI-THERM symposium happen. It would be impossible to have our beloved conference without them as the cornerstone. I hope all of you have a great experience at this year's conference, not only for the quality of the great presentations, but also by re-connecting with old friends and colleagues and making new connections with leaders in the thermal management and electronics cooling community.

Alex Ockfen, General Chair SEMI-THERM 40

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SEMI-THERM SYMPOSIUM PERSONNEL

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SEMI-THERM 40 TOPIC CHAMPIONS

Mohamad Abo Ras	Nanotest	Sreekant Narumanchi	NREL
Marcelo del Valle	Infinera Corp.	Devin Pellicone	Advanced Cooling Technologies
Mark Hepokoski	ThermoAnalytics	Dave Saums	DS&A LLC
Sai Kiran Hota	Advanced Cooling Technologies	Pardeep Shahi	Nvidia
Saket Karajgikar	Meta	Jason Strader	Laird, a DuPont Business
Phil Marzolf	Arieca	Claire Wemp	DuPont
Kamal Mostafavi	CoolIT Systems	Ross Wilcoxon	Collins

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SEMI-THERM 40 PROGRAM REVIEW COMMITTEE

Mohamad Abo Ras	Nanotest
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Robin Bornoff	Siemens
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Sai Kiran Hota	Advanced Cooling Technologies
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Wendy Luiten	Consultancy
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Alex Ockfen	Meta
Sandeep Patil	Nissan
David Saums	DS&A LLC
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Tim Shedd	Dell
Jason Strader	Laird, a DuPont Business
Ross Wilcoxon	Collins
Jim Wilson	Raytheon (ret)
Wenying Zhang	Meta
Winston Zhang	Novark

SEMI-THERM 40 SESSION CHAIRS

Session 1: Consumer Electronics	Vikram Manthri, Amazon Lab126
Session 2: Data Centers / Immersion	Claire Wemp, DuPont
Session 3: Testing and Measurement Methods	Mohamad Abo Ras, Nanotest
Session 4: CFD / Numerical Methods	Navid Kazem, Arieca
Session 5: Thermal Interface Materials	Jason Strader, Laird, a DuPont Business
Session 6: Emerging Technologies	Sai Kiran Hota, Advanced Cooling Technologies
Sessions 7 & 8: Two-Phase Cooling I & II	Dave Saums, DS&A LLC

SEMI-THERM 40 Chair Persons

General Chair

Alex Ockfen, Meta

Alex Ockfen is a product design engineer at Meta (formerly Facebook), providing technical leadership for thermal and structural design of consumer electronics products. He held previous positions at Raytheon where he obtained experience in thermal management and electronics cooling of a wide range of aerospace and defense applications. He has more than 10 journal and conference publications, is an inventor on multiple patents, is a professional mechanical engineer, and is a technical editor for Electronics Cooling Magazine.

Program Chair

Lieven Vervecken

Dr. Lieven Vervecken is CEO and co-founder of Diabatix, a software company specialized in advanced thermal design. Prior to founding Diabatix, Lieven received a PhD in mechanical engineering from the renowned University of Leuven, in the field of numerical simulations. Lieven incorporated his expertise into the generative design technology that lies at the heart of Diabatix. What started out as a small venture has become a fast-growing SaaS company serving multinationals all over the world. Lieven is lead author of multiple peer-reviewed journal articles, he is an experienced keynote speaker at national and international conferences.

Program Vice Chair

Navid Kazem

Dr. Navid Kazem is CEO and co-founder of Arieca Inc. He completed his PhD in computational mechanics at Carnegie Mellon where he developed the core technology behind Liquid Metal Embedded Elastomers (LMEE). He is a former Swartz Center for Entrepreneurship Fellow at Tepper School of Business, with multiple high-impact publications and patents. His background combines a deep technical expertise with the capacity to convert cutting-edge scientific advancement into commercial technology. As a technical CEO at Arieca, Navid leads product development of LMEEs, commercial strategic partnerships, as well as fund raising.

Short Courses

Monday, March 25, 2024

These short courses provide practical, interactive training on a variety of specific skills on topics ranging from thermal design & modeling to system level validation testing. Some are designed for those who are relatively new to thermal management. As such, they focus on basic concepts and techniques. Other classes are meant for seasoned thermal engineers wanting to gain deeper insight into best-in-class tools and practices.

Short Course 1: 8:00 a.m. – 12:00 Noon **San Jose Room**

Semiconductor Packaging and Thermals: Upcoming Challenges

Instructor: Dr. Kyle Arrington, Intel

The upcoming challenges in next generation thermal are growing due to semi-conductor packaging and system level requirements and designs. 2.5D and 3D packaging, multichip packages, Si bridges, smaller Si nodes, and glass are all upcoming technologies that are and will continue to challenge the thermal demand in products. Here, we will cover these challenges and their interplay with thermal demand.

Dr. Kyle Arrington received his bachelor's degree from the University of Arizona and his Ph.D. in Polymer Chemistry from Virginia Tech where he studied polymer synthesis and molecular structure property relationships, completing 11 publications. After receiving his degree, he joined Materials Technology Development at Intel where he owned a variety of materials. Kyle has actively contributed to Intel's IP with 49 patent applications. In Kyle's free time, he enjoys playing with his dogs, mountain biking, and overclocking his desktop computer.

Short Courses

Short Course 2: 8:00 a.m. – 12:00 p.m. **Santa Clara Room**

Navigating Thermal and Reliability Challenges in Chip Components for Automotive High-Performance Compute Systems

Instructor: Dr. Fen Chen

The landscape of driving is rapidly shifting towards fully autonomous vehicles (AV). In the absence of human drivers, the functionality and performance of a Compute system become paramount requiring it to consistently outpace human response for driving safety. AV Compute systems typically consist of multiple larger-size PCBs housing redundant CPUs, AI processors, and crucial IC components to ensure higher performance, safety, and reliability of AV driving.

Throughout the rigorous AV Compute reliability qualification process, these systems undergo various thermal and mechanical stresses. Preventing chip thermal failure under these demanding environmental conditions is a critical concern. In this short course, we will delve into several key areas. In the initial segment, we'll review fundamental chip thermal design, cooling solutions, and chip-level reliability considerations. A spotlight will be cast on comparing lidded and lidless package thermal and reliability performances, along with exploring the latest trends in chip thermal management.

In the subsequent part, we will present the thermal mission profile and diverse stress test requirements for AV hardware validation, adhering to automotive industry standards. We'll shine a light on the thermal reliability challenges associated with qualifying vehicle Compute. Moving ahead, we'll delve into the most recent advancements in vehicle thermal management technologies. Moreover, we'll discuss the pivotal thermomechanical interaction between chips and systems during Compute validation tests and field operations. This interaction has the potential to exert mechanical loads on critical interfaces along the chip's thermal conduction path, resulting in thermal trip failures.

The fourth and final section will introduce strategies to achieve reliable high-performance liquid-cooled Compute. We'll explore how silicon-level, package-level, board-level, and system-level mitigations can collaboratively minimize chip thermal failure risks during vehicle field operations. The course will be substantiated with comprehensive published experimental data and simulation findings, illustrating chip thermal failure modes, effects, and the underlying mechanics in challenging environments.

Dr. Fen Chen is a highly experienced engineer with over 25 years of expertise in automotive and consumer electronics reliability and validation. He holds a Ph.D. in Electrical Engineering from the University of Delaware and has a proven track record of success in addressing critical reliability challenges across various semiconductor and product technologies. His extensive industry background includes roles such as Principal Reliability/Validation Engineer & TLM at Cruise LLC, where he focused on validations of electronic, optical, and electromechanical modules plus customized AI processors for Cruise AV hardware systems. As the Director of Quality and Reliability at Lumileds, Dr. Chen led the qualification of innovative µLED MCM products for automotive applications. He has also served as a Senior Reliability Engineer at Apple, ensuring the reliability of various consumer electronic products. Dr. Chen has made significant contributions to the semiconductor technology reliability challenges, with prior roles including Senior Reliability Engineer at IBM Microelectronics and Graduate Intern at Intel Component Research. He holds a portfolio of over 50 patents, has published more than 60 technical papers and book chapters, and has delivered invited talks/tutorials in various journals and conference proceedings.

Short Courses

Short Course 3: 8:00 a.m. – 12:00 p.m. **Carmel Room**

Fundamentals and Applications of Machine Learning in Thermal Management and Heat Transfer Technologies

Instructors: Professor Van P. Carey, UC Berkeley; Professor Alanna Cooney, San Francisco State University

The first half of this four-hour short course will focus on fundamentals of machine learning tools. This workshop will begin with a presentation that will aim to summarize the features and uses of data-science-based machine learning tools that may be relevant to researchers with interests in heat transfer, thermophysics, thermal management or energy technology development. Principles behind genetic algorithms and different neural network models will be discussed together with the features of heat transfer and associated energy technologies that can dictate the types of data science tools that are most useful. Pathways to access open-source python machine learning computational tools will be described, with recommendations on how novices can get started. Typical computer program algorithm structures will be described. The short course will aim to provide information that can be used to initiate research use of machine learning tools, with the target audience being young engineers or researchers who want to grow their knowledge of machine learning tools, or more senior technical staff who may want to provide a path to train researchers in their group. Several aspects of using machine learning tools will be described, including:

Physics based models and data science models of system behavior – can they be complementary perspectives?
Strategies to achieve a synergistic combination of physics-based modeling and machine learning tools that yield more than the sum of the parts
Use of machine learning tools for energy component/system design optimization
Machine-learning-based energy system adaptive control
Use of machine learning tools to make strategic choices in research experiments or device performance tests

There will be a 20-minute break after the two-hour fundamentals portion of the short course. The remainder of the course (~ 1.7 hours) will focus on applications. It will begin with a discussion of strategies for framing the modeling and organizing data for use of machine learning in an application. That initial discussion will be followed by a presentation of specific examples of ways machine learning can be used to enhance research and development for thermal management and heat transfer technologies. The examples may include:

- Machine-learning-enhanced modeling of complex boiling processes
- Optimizing natural convection air cooling of components on a circuit board
- Use of machine learning to enhanced heat pipe design for electronics cooling
- Machine-learning-enhanced adaptive thermal storage for thermal control applications
- Machine learning performance modeling for thermionic energy conversion
- Enhancing the performance of CFD modeling for electronics cooling
- Adaptive thermal control of electronics using infrared camera image analysis

The final 15 minutes or so of the course will be dedicated to some closing remarks and an opportunity for participant questions.

Short Courses

Van P. Carey: A. Richard Newton Chair in Engineering Distinguished Professor of Mechanical Engineering. Professor Carey is widely recognized for his research on near-interface micro/nanoscale thermophysics and transport in liquid-vapor systems, and computational modeling and simulation of energy conversion and transport processes. His research has frequently included modeling at multiple scales, ranging from the molecular level (molecular dynamics simulation of thermophysics) to the device and system level (multidevice system models). His research is also exploring the use of machine learning strategies to enhance performance of energy conversion and transport in applications and create energy technologies that can autonomously adapt to maximize their performance and reduce their environmental impact. Since joining the Berkeley faculty in 1982, Professor Carey's research has spanned a variety of applications areas, including high performance solar thermal power systems, building and vehicle air conditioning, smelting, and casting of aluminum, phase change thermal energy storage, heat pipes for aerospace applications, high heat flux cooling of electronics, data center thermal management, and energy efficiency of digital information systems. His research has also contributed to developing advanced heat rejection technologies for electronics cooling, building AC systems, and power plants, and developed performance models for Tesla turbine expanders for green energy conversion technologies and thermionic power generation technologies for space applications. Carey's current research emphasizes development of strategies to use machine learning tools to better understand and model flame spread processes in electronic systems and the physics of boiling heat transfer at surfaces covered with hydrophilic nanostructured coatings. This includes exploring innovative ways to combine advanced instrumentation data and machine learning image analysis to understand the physics of boiling processes. He is also using machine learning tools to enhance performance modeling of energy conversion devices, and developing machine-learning-based adaptive energy conversion systems that can autonomously adjust their operation to simultaneously maximize energy efficiency and meet operating requirements for the application of interest. Carey is a Fellow of the American Society of Mechanical Engineers (ASME) and the American Association for the Advancement of Science, and he has also served as the Chair of the Heat Transfer Division of ASME. Carey received the James Harry Potter Gold Medal in 2004 for his eminent achievement in thermodynamics, and the Heat Transfer Memorial Award in the Science category (2007) from the ASME. Carey is also a three-time recipient of the Hewlett Packard Research Innovation Award for his research on electronics thermal management and energy efficiency (2008, 2009, and 2010), and he received the 2014 Thermophysics Award from the American Institute of Aeronautics and Astronautics.

Professor Alanna Cooney joined San Francisco State University in 2023 as a faculty member in mechanical engineering. Dr. Cooney's current research focuses on using machine learning tools and exergy analyses to improve efficiency and performance of latent thermal energy storage systems. She is interested in developing energy storage solutions that could increase the utilization of renewable energy in thermal applications such as concentrated solar power plants and building heating and cooling systems. Prior to joining SFSU, Dr. Cooney worked in industry as a mechanical engineer designing mission critical HVAC systems for data centers, electronic trading firms, and financial institutions. She received a Certificate of Teaching and Learning in Higher Education from UC Berkeley where she taught Thermodynamics, Experimentation and Measurements, and Professional Communication as a lecturer. She has received multiple awards including the Art Rosenfeld Award for Energy Efficiency, an ARCS Foundation Fellowship, and the UC Berkeley Outstanding Graduate Student Instructor Award

Short Courses

Short Course 4: 8:00 a.m. – 12:00 p.m. **Monterey Room**

Passive Two-Phase Cooling: Pulsating Heat Pipes and Loop Thermosyphon

Instructor: Dr. John R. Thome

This 4-hour course will be split into two parts: In the first half the topic will be Pulsating Heat Pipes and the second half will be Loop Thermosyphons (LTSs). Pulsating heat pipes (PHPs) are a relatively new two-phase cooling technique in addition to the existing conventional wicked heat pipes and vapor chambers. PHPs are able to operate at high heat fluxes, spread heat and carry it a necessary distance to a second coolant. They are able to operate vertically, horizontally, inclined, and rotated orientations, and in some cases in inverted mode (evaporator above condenser), which makes their application quite versatile. In general, they are thin aluminum plates (2-3mm thick), and their condenser ends may be cooled by air, liquid, or a two-phase loop. Their equivalent thermal conductivities are typically 5-10 times or more that of copper. Loop thermosyphons, while having been around for many years, are another very highly performant two-phase cooling technique for micro-electronics. They can cool very high heat fluxes, very effectively cool and spread hot spots and carry heat from short to long distances for eventual dissipation to the environment or waste heat recovery system. Their evaporator plates can be horizontal or vertically oriented and their condensers can be air or water cooled. The course will cover a detailed description of the working principles of PHPs and LTSs, a review of their state-of-the-art, the status of thermal- hydraulic simulation and design, pros-and-cons of working fluids, and some case studies.

Professor Emeritus John R. Thome (EPFL) is technical director of JJ Cooling Innovation, developing/prototyping/testing numerous two-phase cooling technologies for datacenters, Edge computers, power electronics, 5G, etc. He has received ITHERM and InterPack awards and the Nusselt-Reynolds Prize with over 33,000 citations of his work.

SEMI-THERM®

SUBMIT A PAPER FOR SEMI-THERM 41!

As you further develop a technique or application, consider documenting it for the thermal community. SEMI-THERM 40 will begin accepting abstracts during the summer (deadline is September 15, 2024). We welcome your submissions! Visit us at www.SEMI-THERM.org. SEMI-THERM 41 is March 10th-14th, 2025 – be there!

Short Courses

Short Course 5: 1:30 p.m. – 5:30 p.m. **Carmel Room**

Thermal Challenges and Opportunities of Advanced Packages and Microelectronics Systems. Figure of Merit and Applications

Instructors: Dr. Victor Chiriac, Global Cooling Technology Group; Alex Ockfen, Meta

The short course will teach a variety of critical concepts related to the package and system level cooling applications for microelectronics. It will introduce a series of applications supported by a specific Figure of Merit to quantify the "goodness" of various thermal designs spanning from package to system level. Real-world examples will be provided that demonstrate how the thermal Figure of Merit can be used by thermal engineering community.

Dr. Victor Chiriac (ASME Fellow) is CEO and managing partner with Global Cooling Technology Group since 2019. Held technology and engineering leadership roles with Motorola (1999-2010), Qualcomm (2010 – 2018), Futurewei USA (2018 – 2019). Elected Chair of ASME K-16 Electronics Cooling and Arizona & New Mexico IMAPS Chapter President. Leading member of ASME InterPack, IMECE and IEEE/CPMT Itherm Conference Organizing committees, holds 21 U.S. patents, 2 US Trade Secrets, 1 Defensive Publication. Has published over 115 papers in scientific journals and at conferences.

Alex Ockfen is a simulation engineer at Meta, providing technical leadership for thermal and structural design of consumer electronics products. He held previous positions at Raytheon, where he obtained experience in thermal management and electronics cooling of a wide range of aerospace and defense applications. He has more than 10 journal and conference publications, is an inventor on multiple patents, is a professional mechanical engineer, and is currently serving as the General Chair of the SEMI-THERM conference.

Short Courses

Short Course 6: 1:30 p.m. – 5:30 p.m. **San Jose and Santa Clara Rooms**

Direct to Chip Liquid Cooling: Single Phase Water and Two-Phase Refrigerant Cooling with Pumped and Passive Systems

Instructors: Professor Alfonso Ortega, Villanova University; Dr. Luca Amalfi, Seguente Inc.

The capacity of liquid cooling systems to manage heat dissipation from electronics far exceeds the capacity of air-cooled systems, a fact that has been known and pursued for decades. The preference for air cooling is readily justified because of ease of use and compatibility with electronics and their reliability, but volumetric, acoustic, and flow rate limits have been reached in many cases for high power electronics. Transitioning to liquid cooling using water or refrigerants as the primary heat transfer medium requires more exacting design and adaptation of infrastructure at system and component levels to accommodate delivery of liquid flow to high power devices. This short course will introduce the physics and design of sinvgle-phase water-based cooling systems compared to pumped two-phase refrigerant-based cooling systems. The course will be useful for engineers who want to better understand the physics, the engineering thermo-fluid models and methodologies, and the available empirical evidence regarding the pros and cons of each approach.

Topics to be covered include the following:

- Physics and design principles for single phase liquid-cooled cold plate design at conventional scales and emerging principles and data for micro-scale heat sink design
- Limits of single-phase water cooling at the cold-plate level based on basic physical principles.
- Introduction to the physics and behavior of convective boiling in channels
- Emerging practices for engineering design of boilers/evaporators with refrigerants
- Design and tradeoffs of pumped and passive two-phase cooling systems
- Impacts of refrigerant selection
- Comparing single phase to two-phase cooling based on performance, complexity, and sustainability.

Useful suggested readings and references for further self-learning of the topics will be provided.

Dr. Alfonso Ortega is the James R. Birle Professor of Energy Technology at Villanova University and Professor of Mechanical and Sustainable Engineering. He is the Director of the Laboratory for Advanced Thermal and Fluid Systems which he has led for over 30 years. He is the Founding Director of the Villanova site of the NSF Center for Energy Smart Electronic Systems (ES2) founded in 2011. He currently is the co-Director of the Villanova Strategic Initiative for Climate, Justice, and Sustainability, a university wide academic initiative. Formerly he was the Associate Dean for Graduate Programs and Research in the College of Engineering and Villanova's inaugural Associate Vice President for Research and Graduate Programs. Dr. Ortega received his B.S. from The University of Texas-El Paso, and his M.S. and Ph.D. from Stanford University, all in Mechanical Engineering. He was on the faculty of the Department of Aerospace and Mechanical Engineering at The University of Arizona in Tucson for 18 years. For two years, he served as the Program Director for Thermal Transport and Thermal Processing in the Chemical and Transport Systems Division of The National Science Foundation, where he managed the NSF's primary program funding heat transfer and thermal technology research in U.S. universities. Dr. Ortega is a teacher of thermodynamics, thermal and energy sciences, thermal-fluid design, and experimental methods. He is an internationally recognized expert in thermal and energy management in electronic systems. He has supervised over 40 M.S. and Ph.D. candidates

Continued

Short Courses

to degree completion, 6 postdoctoral researchers, and more than 80 undergraduate research students. He is the author of over 300 journal and symposia papers, book chapters, and monographs and is a frequent short course lecturer and consultant on thermal and energy management and experimental measurements. He is a Fellow of the ASME and received the 2003 SEMITHERM THERMI Award and the 2017 ITHERM Achievement Award. In 2023 he received the SEMI-THERM Hall of Fame Award for his career contributions to the field.

Dr. Raffaele Luca Amalfi is the CEO, Co-Founder and Chairman of SEGUENTE Inc., considered an Innovator, visionary, and industry influencer, he is driving the company's strategic business, technology & product roadmap, capital objectives, and financial growth goals. Prior to founding SEGUENTE, he had strategic roles in large corporate companies, leading R&D and commercialization activities in the field of thermal management, and advanced liquid-cooling technologies of high-performance communications and computing systems. He authored over 60 scientific publications in leading journals, conference proceedings, and handbooks, and over 20 patents. Dr. Amalfi is a member of the leadership committees for IEEE and ASME thermal conferences, OCP Heat Reuse Steering Committee, and he is the current Secretary of the ASME K-16 Heat Transfer Committee and a former guest editor for the ASME Journal of Electronic Packaging. Dr. Amalfi received numerous industry and government awards for groundbreaking innovations, including 2022 Internet 2.0 Outstanding Leadership Award and 2023 EPPD Engineer Award.

Short Course 7: 1:30 p.m. – 5:30 p.m. **Monterey Room**

Transient Thermal Analysis Using Linear Superposition

Instructor: Roger Stout

This course will present the basic principles of linear superposition in the context of thermal analysis and measurement.

Subtopics will include:

- Superposition as applied to steady state thermal analysis
- Matrix representation
- The method of images
- Kinear superposition in the transient domain
- Thermal RC networks
- Special case closed-form solutions
- The use of widely accessible tools such as SPICE, Excel, and VBA

Roger Stout, Professional Engineer Retired: Education: BSE (Mech) ASU 1977 MSME (Caltech) 1979 [Hughes Fellow (1977-1979)] Registered PE (Mech) AZ since 1983 Employment: Motorola 1979-1999 -various roles, ending at Senior Member of Technical Staff ON Semiconductor 1999-2020 -Senior Member of Technical Staff; managed Corp R&D Thermal/Mechanical Characterization LabPatents and Publications: 6 patents issued, 80 technical publications over career, the majority related to thermal analysis of semiconductor packages.

Schedule of Events

Monday March 25, 2024

8:00 a.m. – 5:30 p.m. — **Room:**
Short Courses

Short Course 1: 8:00 a.m. – 12:00 p.m. — **San Jose**
Semiconductor Packaging and Thermals: Upcoming Challenges
Instructor: Dr. Kyle Arrington, Intel

Short Course 2: 8:00 a.m. – 12:00 p.m. — **Santa Clara**
Navigating Thermal and Reliability Challenges in Chip Components for Automotive High-Performance Compute Systems
Instructor: Dr. Fen Chen

Short Course 3: 8:00 a.m. – 12:00 p.m. — **Carmel**
Fundamentals and Applications of Machine Learning in Thermal Management and Heat Transfer Technologies
Instructors: Professor Van P. Carey, UC Berkeley; Professor Alanna Cooney, San Francisco State University

Short Course 4: 8:00 a.m. – 12:00 p.m. — **Monterey**
Passive Two-Phase Cooling: Pulsating Heat Pipes and Loop Thermosyphon
Instructor: Dr. John R. Thome, JJ Cooling Innovation

Short Course 5: 1:30 p.m. – 5:30 p.m. — **Carmel**
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Instructors: Professor Alfonso Ortega, Villanova University; Dr. Luca Amalfi, Seguente Inc.

Short Course 7: 1:30 p.m. – 5:30 p.m. — **Monterey**
Transient Thermal Analysis Using Linear Superposition
Instructor: Roger Stout

3:30 p.m. – 6:30 p.m. — **Bayshore Foyer**
Attendee Registration

6:30 p.m. – 8:00 p.m. — **San Simeon**
Pre-Conference Meeting

Keynote
Tuesday, March 26, 2024

Driving Sustainable Scaling of Compute to 2030

Presenter: Tim Shedd
Engineering Technologist, Office of the CTIO at Dell

The SEMI-THERM 2024 Keynote talk is set to explore the key elements of Trends, Standards, and Sustainability in the realm of Data Centers, paving the way for a scalable and eco-friendly computing landscape until 2030 and beyond. The discussion on trends will spotlight the delicate balance between the growth of data center energy usage and the offset provided by increased productivity, emphasizing the impact on Processor and Rack power. Delving into standards, the keynote will illuminate the significance of the DC-MHS Standard, emphasizing sustainability, reuse, and silicon diversity, and will take a closer look at the role of Liquid Cooling in enhancing these standards. To underscore the sustainability aspect, the talk will employ mathematical models, demonstrating how these standards can guide us toward a resilient computing future, even amidst the challenges posed by emerging technologies like AI, fully self-driving vehicles, and High-Performance Computing (HPC). The overarching goal is to showcase a tangible path forward, supported by standards and sustainable practices, as we navigate the technological landscape up to the year 2030 and beyond.

Tim Shedd joined Dell Technologies in June of 2022 as an Engineering Technologist in the Office of the CTIO, working with others across the company to enable sustainable, efficient solutions for increasingly power-dense compute. Prior to this, he was Director of Research and Development at Motivair Corporation. Tim founded and ran a company, Ebullient, Inc., to cool electronics using dielectric liquids. He built a strong technical foundation in academia, first as a tenured Associate Professor of Mechanical Engineering at the University of Wisconsin-Madison, then as an Associate Professor of Mechanical Engineering, Director of the Graduate Program and Supervisor of the Entrepreneurship Program at Florida Polytechnic University. Tim is a Fellow of ASHRAE (the American Society of Heating, Refrigeration and Air-conditioning Engineers.

Schedule of Events

Tuesday, March 26, 2024

7:00 a.m. – 6:00 p.m. — **Bayshore Foyer**
Attendee Registration

7:00 a.m. – 7:45 a.m. — **San Jose**
Speakers' Breakfast (March 26 Speakers, Session Chairs and Co-Chairs only)

8:00 a.m. – 8:20 a.m. — **Oak and Fir**
Opening Remarks: Alex Ockfen, Meta, General Chair

8:20 a.m. – 9:00 a.m. — **Oak and Fir**
Session 1 – Consumer Electronics
Session Chair: Vikram Manthri, Amazon Lab126

8:20 a.m. – 8:40 a.m. — **Oak and Fir**
Investigation on Pulsating Heat Pipe (PHP) Plate Heat Spreader for Electronics Cooling
Sai Kiran Hota, Advanced Cooling Technologies

8:40 a.m. – 9:00 a.m. — **Oak and Fir**
Single- and Multi-Voltage IC Circuit Thermal; Runaway Analysis and Application
Sam Zhao, Broadcom

9:00 a.m. – 10:00 a.m. — **Oak and Fir**
Keynote Address: Driving Sustainable Scaling of Compute to 2030
Tim Shedd, Dell

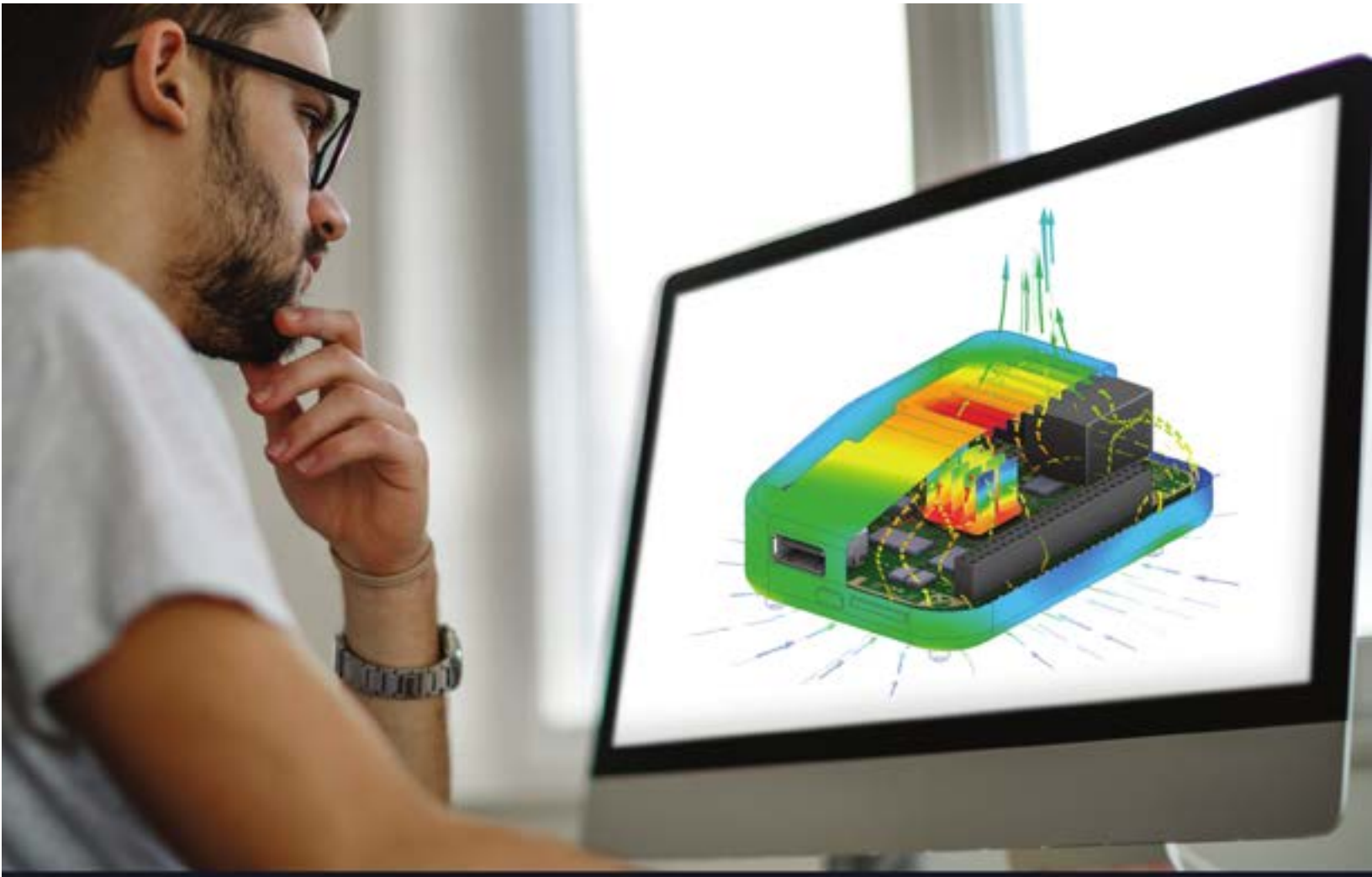
10:00 a.m. – 10:20 a.m. — **Gateway Foyer**
Break

10:20 a.m. – 12:00 p.m. — **Oak**
Parallel Session 2: Data Centers / Immersion
Session Chair: Claire Wemp, DuPont

10:20 a.m. – 10:40 a.m. — **Oak**
Datacenter PUE Comparison: Direct Liquid Cooling vs. 2-Phase Immersion Cooling
Mark North, NVIDIA

10:40 a.m. – 11:00 a.m. — **Oak**
One Dimensional Flow Analysis and Experimental Investigation of Server Liquid Cooling System
Bharath Ram Ravi, Celestica

11:00 a.m. – 11:20 a.m. — **Oak**
Filter Characterization for Liquid Cooled Data Center
Himanshu Modi, University of Texas at Arlington



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Schedule of Events

Tuesday, March 26, 2024

11:20 a.m. – 11:40 a.m. — **Oak**
Improved PIDNN for Server Fan Speed Control
Nishi Ahuja, Intel

11:40 a.m. – 12:00 p.m. — **Oak**
Investigation of Flow Restrictors for Rack Level Two-Phase Cooling under Nonuniform Heating
Serdar Ozguc, Accelsius

10:20 a.m. – 12:00 p.m. — **Fir**
Parallel Session 3: Testing and Measurement Methods
Session Chair: Mohamad Abo Ras, Nanotest

10:20 a.m. – 10:40 a.m. — **Fir**
Investigation of Relaxation and Recovery Effects in Solid Thermal Interface Materials Under Operation Conditions
Antonio Harder, Nanotest

10:40 a.m. – 11:00 a.m. — **Fir**
Thermal Test Vehicle for Investigation of Thermal Path in Large Die Area Packages by Thermal Transient Impedance Analysis
Mohamad Abo Ras, Nanotest

11:00 a.m. – 11:20 a.m. — **Fir**
Development of a Controlled Warpage Thermal Test Vehicle
Shourya Jain, Laird Performance Materials, DuPont

11:20 a.m. – 11:40 a.m. — **Fir**
Thermal Characterization of Multi-Source Devices: Dealing with Non-Linear Behavior
Dirk Schweitzer, Infineon Technologies AG

12:00 p.m. – 1:30 p.m. — **Pine and Cedar**
Luncheon: U.S. Domestic Packaging and Test: The Difficulty and The Opportunity
Mr. Ken Joyce

1:30 p.m. – 6:00 p.m. — **Bayshore Ballroom**
Vendor Exhibits

2:00 p.m. – 5:00 p.m. — **Oak and Fir**
Vendor Workshops

Continued

Schedule of Events

Tuesday, March 26, 2024

6:00 p.m. – 7:30 p.m. **Oak and Fir**
Panel Discussion: Artificial Intelligence and its implication for Thermal Engineers: Driving the Thermal Demand
Moderator: **Navid Kazem, Arieca Inc.**

7:30 p.m. – 9:00 p.m. **Pine**
Dinner

Luncheon Speaker
Tuesday, March 26, 2024

U.S. Domestic Packaging and Test
The Difficulty and The Opportunity

Presenter: Ken Joyce

"The pessimist sees the difficulty in every opportunity; the optimist sees the opportunity in every difficulty".

- Winston Churchill

There are a host of technical, economic, commercial and people issues for government, academia, and industry in the United States to address with respect to:

a. Building upon existing domestic Packaging and Test manufacturing capabilities; and
b. Developing a viable economic path to reshore High-Volume-Manufacturing of leading-edge Packaging and Test technologies from Asia to the United States.

With an understanding that there are many reports and opinions suggesting different approaches to addressing these issues, this presentation will focus on some of the key economic and commercial considerations.

Ken Joyce is a semiconductor industry assembly, packaging and test veteran. He currently serves as an independent executive advisor to Brewer Science, Inc., a global provider of materials science solutions to the microelectronics industry. He is also an independent Board Member of Arieca, Inc., an advanced materials start-up. In 2022 he was appointed an inaugural member of the Industrial Advisory Committee created by the CHIPS Act to advise the federal government on microelectronics. Previously, Ken spent 15 years with Amkor Technology, Inc., a leading OSAT provider of semiconductor packaging design, assembly, packaging, and test services where he held senior management positions including, CFO, COO, and President and CEO. During his tenure at Amkor, he lead his team in forming J-Devices, Inc, Japan's largest OSAT company. Throughout his career, he has served on the Board of Directors of a number of Public, Private and Not-For-Profit organizations, including the Global Semiconductor Alliance, "GSA". He has been designated a Board Leadership Fellow by the National Association of Corporate Directors.

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Making Hot Technology Cooler

Panel Discussion
Tuesday March 26, 2024, 6:00 p.m. - 7:20 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Driving the Thermal Demand

Moderator: Navid Kazem, Arieca Inc.

Artificial Intelligence is set to revolutionize every aspect of our lives, from streamlining the customer service interactions and recommending personalized movie selections to accelerating advances in material design and drug discovery to even, as argued by some authors and technologists, an emerging entity surpassing human intelligence (although we are not yet fully convinced).

Thermal engineers are the unsung heroes facilitating continuous innovation and progress in achieving the auspicious goals of Artificial Intelligence. Continuous progress depends on effective and efficient heat management of the ever growing computational needs of the microprocessors. In this panel we discuss the perspective of forefront engineers from leading semiconductor manufacturing, designs, and electronics companies on the thermal challenges of AI specific workloads. The panelists focus on the following key areas:

Challenges in AI-Specific Chip Architectures: Explore the unique thermal challenges inherent to AI-focused chip architectures, including the need for HBM on chip, the increasing power densities, and potential for spatial hotspots resulting from intensive compute workloads and complex neural network structures.

Implications of AI for Advanced Packaging: Probe into how these thermal challenges drive the evolution of advanced packaging technologies. Examine the transition from traditional chip packaging to cutting-edge approaches such as 2.5D, 3D stacking, and heterogeneous integration. Provide insights into the next generation cooling solutions, materials, and design methodologies tailored to mitigate thermal constraints while maximizing performance and energy efficiency.

System-Level Challenges and Solutions for AI-enabled Devices: Navigate the system-level implications of AI-specific chip architectures and advanced packaging on device performance, reliability, and form factor. Explore how thermal engineers collaborate across interdisciplinary boundaries to address thermal-induced bottlenecks in AI-PC and Laptops, smartphones, and emerging AI-driven applications.

Continued

Panel Discussion

Tuesday March 26, 2024, 6:00 p.m. - 7:20 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Driving the Thermal Demand

Panelists

Padam Jain , NVIDIA

Dr. Padam Jain, an accomplished expert in semiconductor packaging with approximately 15 years of experience in developing IC packages for consumer and data center applications. Dr. Jain's technical acumen spans a wide range of packaging architectures and interdisciplinary areas, including thermal management, materials, and mechanical solutions. Currently at NVIDIA, Dr. Jain spearheads the package definition and advance packaging technologies for cutting-edge Machine Learning products. Previously, at Google, he played a pivotal role in the qualification of data-center ASICs including Tensor Processing Units (TPUs) and led pioneering efforts in thermal solution pathfinding. Dr. Jain's academic credentials include a Ph.D. in Materials Science from Brown University and an integrated Bachelor's and Master's degree from the Indian Institute of Technology (IIT Bombay). Dr. Jain's industry contributions are highlighted by over 15 patents in semiconductor packaging.

Kyle Arrington, Intel

Dr. Kyle Arrington received his bachelor's degree from the University of Arizona and his Ph.D. in Polymer Chemistry from Virginia Tech where he studied polymer synthesis and molecular structure property relationships, completing 11 publications. After receiving his degree, he joined Materials Technology Development at Intel where he has owned a variety of materials. Kyle has actively contributed to Intel's IP with 49 patent applications. In Kyle's free time, he enjoys playing with his dogs, mountain biking, and overclocking his desktop computer.

Continued

Panel Discussion

Tuesday March 26, 2024, 6:00 p.m. - 7:20 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Driving the Thermal Demand

Panelists

Nader Nikfar, Qualcomm

Nader Nikfar is a seasoned engineer with 30 years of experience in thermal management of electronics and mechanical design. He currently serves as Director of Technology at Qualcomm Inc. focusing on thermal management of semiconductor packages and systems across various BUs such as Mobile, Compute, Auto, and IOT. Prior to joining Qualcomm and since he received his BSME and MSME from University of Illinois, he has held engineering positions at Motorola, Ericsson, Powerwave Technologies, and MTI Mobile.

Tim Shedd, Dell

Dr. Tim Shedd joined Dell Technologies in June of 2022 as an Engineering Technologist in the Office of the CTIO, working with others across the company to enable sustainable, efficient solutions for increasingly power-dense compute. Prior to this, he was Director of Research and Development at Motivair Corporation. Tim founded and ran a company, Ebullient, Inc., to cool electronics using dielectric liquids. He built a strong technical foundation in academia, first as a tenured Associate Professor of Mechanical Engineering at the University of Wisconsin-Madison, then as an Associate Professor of Mechanical Engineering, Director of the Graduate Program and Supervisor of the Entrepreneurship Program at Florida Polytechnic University. Tim is a Fellow of ASHRAE (the American Society of Heating, Refrigeration and Air-conditioning Engineers.

Continued

Panel Discussion

Tuesday March 26, 2024, 6:00 p.m. - 7:20 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Driving the Thermal Demand

Moderator:

Navid Kazem, Arieca Inc.

Dr. Navid Kazem is CEO and co-founder of Arieca Inc. He completed his PhD in computational mechanics at Carnegie Mellon where he developed the core technology behind Liquid Metal Embedded Elastomers (LMEE). He is a former Swartz Center for Entrepreneurship Fellow at Tepper School of Business, with multiple high-impact publications and patents. His background combines a deep technical expertise with the capacity to convert cutting-edge scientific advancement into commercial technology. As a technical CEO at Arieca, Navid leads product development of LMEEs, commercial strategic partnerships, as well as fund raising, and is currently serving as program vice chair of the SEMI-THERM conference.

SEMI-THERM

Vendor Workshops

Tuesday March 26, 2024	
Oak	**Fir**
2:00 p.m. Laser Thermal	**2:00 p.m.** Siemens
3:00 p.m. CPC	**3:00 p.m.** Linseis
4:00 p.m. Fralock	**4:00 p.m.** Sheen

Wednesday March 27, 2024	
Oak	**Fir**
2:00 p.m. Sheen	**2:00 p.m.** Siemens
	3:00 p.m. Diabatix
4:00 p.m. Ansys	**4:00 p.m.** Stellar Industries

Schedule of Events

Wednesday, March 27, 2024

7:00 a.m. – 6:00 p.m. — **Bayshore Foyer**
Attendee Registration

7:00 a.m. – 7:45 a.m. — **San Jose**
Speakers' Breakfast (March 27 Speakers, Session Chairs and Co-Chairs only)

8:00 a.m. – 8:20 a.m. — **Oak and Fir**
Opening Remarks: Lieven Vervecken, Diabatix, Program Chair

8:20 a.m. – 10:00 a.m. — **Oak and Fir**
Session 4: CFD / Numerical Methods
Session Chair: Navid Kazem, Arieca

8:20 a.m. – 8:40 a.m. — **Oak and Fir**
Simulation of Solder Fatigue Effects on Typical BGA Package due to Material and Temperature Variations
James Petroski, Design by Analysis Technical Consulting

8:40 a.m. – 9:00 a.m. — **Oak and Fir**
Accurate Thermal Design of Chiplets in Heterogeneous Packaging by Embedding FANTASTIC BCI-ROMs in CFD Models
John Wilson, Siemens Digital Industries Software

9:00 a.m. – 9:20 a.m. — **Oak and Fir**
Evaluating the Thermal Performance of TPMS Structures: A Comparative Study between Pins, Fins and Gyroids in Electronics Cooling
Lieven Vervecken, Diabatix

9:20 a.m. – 9:40 a.m. — **Oak and Fir**
Modeling the Impact of Thermal Management on Electric Vehicle Energy Consumption and Driving Range
Timofey Golubev, ThermoAnalytics

10:00 a.m. – 10:20 a.m. — **Gateway Foyer**
Break

10:20 a.m. – 12:00 p.m. — **Oak**
Parallel Session 5: Thermal Interface Materials
Session Chair: Jason Strader, Laird, a DuPont Business

10:20 a.m. – 10:40 a.m. — **Oak**
Graphene Enhanced Thermal Interface Materials for Electronics Cooling Applications
Johan Liu, SHT Smart High Tech AB

Continued

Schedule of Events

Wednesday, March 27, 2024

10:40 a.m. – 11:00 a.m. **Oak**
Liquid Metal Embedded Elastomers as Low-BLT Thermal Interface Materials
Keyton Feller, Arieca

11:00 a.m. – 11:20 a.m. **Oak**
Innovative Metal TIM Technology for TIM1 in BGA Style Semiconductor Packages
Timothy Jensen, Indium Corporation

11:20 a.m. – 11:40 a.m. **Oak**
Integration of Thermally Conductive Tacky Agents With Compressible Thermal Interface Materials (TIMs) to Improve Thermal Performance
Miloš Lazić, Indium Corporation

11:40 a.m. – 12:00 p.m. **Oak**
Advancements in Thermal Management Solutions for Electronics: The Role of Extrude to Fill (X2F) Technology
Troy Diaz, X2F

10:20 a.m. – 12:00 p.m. **Fir**
Parallel Session 6: Emerging Technologies
Session Chair: Sai Kiran Hota, Advanced Cooling Technologies

10:20 a.m. – 10:40 a.m. **Fir**
Aluminum Boiling-driven Heat Spreader for High Heat Dissipation
Jungho Lee, Ajou University

10:40 a.m. – 11:00 a.m. **Fir**
Thermal Management of Wide-Bandgap Semiconductor Amplifiers used for Plasma Heating and Control
Sangeeta Vinoth, Princeton Fusion Systems

11:00 a.m. – 11:20 a.m. **Fir**
Benefits and Challenges of PCM-based Thermal Management at the Die and Component Level
Meghavin Bhatasana, Purdue University

11:20 a.m. – 11:40 a.m. **Fir**
Intrachip Cooling Channel Fabrication Using Photo-Electro-Chemical Etching
Stephen Schultz, Brigham Young University

12:00 p.m. – 1:30 p.m. **Pine and Cedar**
Luncheon: Professional Approaches to Scientific Communication and Digital Engagement
Sarah da Silva Andrade

Continued

Schedule of Events

Wednesday, March 27, 2024

1:30 p.m. – 6:30 p.m. — **Bayshore Ballroom**
Vendor Exhibits

2:00 p.m. – 5:00 p.m. — **Oak and Fir**
Vendor Workshops

5:15 p.m. – 6:30 p.m. — **Bayshore Ballroom**
Exhibitor Reception

6:30 p.m. – 7:50 p.m. — **Oak and Fir**
Panel Discussion: Artificial Intelligence and its implication for Thermal Engineers: Providing, Using, and Powering New Design Tools
Moderator: Alex Ockfen, Meta

Luncheon Speaker
Wednesday, March 27, 2024

Professional Approaches to Scientific Communication and Digital Engagement

Presenter: Sarah da Silva Andrade

Academics are faced with the challenge of not only producing impactful research but also ensuring it resonates with a diverse audience. This luncheon presentation offers a fresh perspective on bridging the gap between complex scientific insights and engaging storytelling.

Designed for scholars who want to increase the reach and impact of their research, this presentation emphasizes the importance of communication as a key tool in the modern academic's arsenal. It explores some details of making complex research understandable and engaging, helping to establish connections with audiences outside the academic domain.

Attendees will be encouraged to reconsider how they share their work by incorporating the power of narrative and digital engagement. The presentation will end with an interactive Q&A session, bringing the opportunity for more discussions on the topic.

Sarah da Silva Andrade is the Marketing Engineer at Diabatix, a software company specialized in advanced thermal design. She holds a B.Sc. and M.Sc. in Civil Engineering from the University of Campinas in Brazil, awarded in 2016 and 2019. Prior to her role at Diabatix, Ms. Andrade worked as a research assistant in the Civil Engineering Department at KU Leuven.

Panel Discussion

Wednesday March 27, 2024, 6:30 p.m. - 7:50 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Providing, Using, and Powering New Design Tools

Moderator: Alex Ockfen, Meta

Artificial Intelligence is set to revolutionize every aspect of our lives, from streamlining the customer service interactions and recommending personalized movie selections to accelerating advances in material design and drug discovery to even, as argued by some authors and technologists, an emerging entity surpassing human intelligence (although we are not yet fully convinced).

Thermal engineers are playing a key role in the rapid evolution of Artificial Intelligence. In this panel we discuss the perspective of leading engineers from academia, software developers, and technology companies on how AI is influencing the challenges in the thermal industry, how artificial intelligence can be incorporated in thermal design tools to improve our efficiency, and the infrastructure requirements to drive those tools. The panelists will focus on the following key areas:

AI as a Thermal Design Tool: Explore how AI is currently being used as a design tool by thermal engineers, including the opportunities it provides over conventional design methods to increase engineering efficiency and creativity. The panel will also discuss the current limitations of AI as a design tool, and what the thermal community should expect next as it continues to rapidly evolve.

Thermal Infrastructure Required to Enable AI tools: Discuss the critical role of data center cooling strategies in supporting the growing demand for artificial intelligence (AI). Panelists will discuss the challenges of managing heat dissipation in high-density computing environments and the opportunities to use AI to assist in developing innovative cooling solutions that can support the increasing power demands of AI.

Educating Thermal Engineers on AI: Discuss how the practicing thermal engineer, who may not have had AI as a topic in their academic curriculum, can begin to familiarize themselves with AI and start using the design tools discussed. Likewise, discuss how AI fits into the development of the next generation of thermal engineers.

Continued

Panel Discussion

Wednesday March 27, 2024, 6:30 p.m. - 7:50 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Providing, Using, and Powering New Design Tools

Panelists

Lieven Vervecken, Diabatix

Dr. Lieven Vervecken is CEO and co-founder of Diabatix, a software company specialized in advanced thermal design. Prior to founding Diabatix, Lieven received a PhD in mechanical engineering from the renowned University of Leuven, in the field of numerical simulations. Lieven incorporated his expertise into the generative design technology that lies at the heart of Diabatix. What started out as a small venture has become a fast-growing SaaS company serving multinationals all over the world. Lieven is lead author of multiple peer-reviewed journal articles, he is an experienced keynote speaker at national and international conferences, and this year's SEMI-THERM Program Chair.

Professor Van Carey, UC Berkeley

Prof. Van P. Carey, a Professor in the Mechanical Engineering Department, holds the A. Richard Newton Chair in Engineering at the University of California at Berkeley. Carey's research has included fundamental studies in the areas of micro- and nanoscale thermophysics, interfacial phenomena, and transport in liquid-vapor phase-change processes. His research interests also include development of new methods for computational modeling and simulation of energy conversion and transport processes in applications such as data center and vehicle air conditioning, high heat flux cooling of electronics, energy efficiency

Continued

Panel Discussion

Wednesday March 27, 2024, 6:30 p.m. - 7:50 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Providing, Using, and Powering New Design Tools

Panelists (continued)

of information processing systems, industrial waste heat recovery, and microgravity boiling in spacecraft thermal management. His recent research has focused on the physics of water vaporization processes on surfaces with nanoporous coatings, adaptive thermal energy storage, and use of machine learning tools in phase change heat transfer research. Carey is a Fellow of the American Society of Mechanical Engineers (ASME) and the American Association for the Advancement of Science, and he is a former Chair of the Heat Transfer Division of ASME. Carey has received the ASME James Harry Potter Gold Medal in 2004 for eminent achievement in thermodynamics, and the Heat Transfer Memorial Award in the Science category (2007) from the ASME. Carey is also a three-time recipient of the Hewlett Packard Research Innovation Award for his research on electronics thermal management and energy efficiency (2008, 2009, and 2010), and Carey received the 2014 Thermophysics Award from the American Institute of Aeronautics and Astronautics.

Cheng Chen, Meta

Dr. Cheng Chen is a Thermal Mechanical Engineer from Meta Hardware Team. He works on development of AI/ML platforms and advanced cooling technology roadmap. Dr. Chen received his Ph.D's degree in Mechanical Engineering from SUNY Binghamton in 2015, and has been an active member in OCP collaborations and ASME conferences.

Continued

Panel Discussion

Wednesday March 27, 2024, 6:30 p.m. - 7:50 p.m.

Artificial Intelligence and its Implication for Thermal Engineers; Providing, Using, and Powering New Design Tools

Panelists

Mehdi Abarham, Ansys

Dr. Mehdi Abarham is a principal application engineer and a solution architect at ANSYS. His primary focus is on electronics thermal management. In recent years, he has been employing machine learning techniques to advance predictive capabilities in modeling and simulation. Prior to ANSYS, he worked at Ford Motor Company Research and Innovation Center for two years. He received his Ph.D. in Mechanical Engineering from University of Michigan-Ann Arbor. He holds eight patents and has authored over twenty technical papers.

Moderator:

Alex Ockfen, Meta

Alex Ockfen is a product design engineer at Meta (formerly Facebook), providing technical leadership for thermal and structural design of consumer electronics products. He held previous positions at Raytheon where he obtained experience in thermal management and electronics cooling of a wide range of aerospace and defense applications. He has more than 10 journal and conference publications, is an inventor on multiple patents, is a professional mechanical engineer, is a technical editor for Electronics Cooling Magazine, and is currently serving as general program chair of the SEMI-THERM conference.

Schedule of Events

Thursday, March 28, 2024

7:00 a.m. – 12:00 p.m. — **Gateway Foyer**
Attendee Registration

7:00 a.m. – 7:45 a.m. — **San Jose**
Speakers' Breakfast (March 28 Speakers, Session Chairs and Co-Chairs only)

8:00 a.m. – 8:20 a.m. — **Oak and Fir**
Opening Remarks: Navid Kazem, Arieca, Program Vice Chair

8:20 a.m. – 10:00 a.m. — **Oak and Fir**
Session 7 – Two Phase Cooling I
Session Chair: Dave Saums, DS&A LLC

8:20 a.m. – 8:40 a.m. — **Oak and Fir**
Innovative Examination of Composite PCM Capacitor
Raizner Motti, Rafael – Advanced Defense Systems

8:40 a.m. – 9:00 a.m. — **Oak and Fir**
Evaluation of Sub-Millimeter Thick Oscillating Heat Pipes for Space Constrained Electronics Applications
Corey Wilson, ThermAvant

9:00 a.m. – 9:20 a.m. — **Oak and Fir**
New Edge Micro Data Center and its Passive Thermosyphon Cooling System at TUe: Cooling System Thermal Performance Tests
John R. Thome, JJ Cooling Innovation Sàrl

9:20 a.m. – 9:40 a.m. — **Oak and Fir**
Heat Spreading Using Bubble Pumping in a Thermal Ground Plane
Jungho Lee, Ajou University

9:40 a.m. – 10:00 a.m. — **Oak and Fir**
A Thermal Performance Characterization Method for Thin Vapor Chambers by Photonics Technologies
Kuang-Yu Hsu, T-Global Technology Co.

10:00 a.m. – 10:20 a.m. — **Gateway Foyer**
Break

10:20 a.m. – 11:00 a.m. — **Oak and Fir**
Session 8 – Two Phase Cooling II
Session Chair: Dave Saums, DS&A LLC

Continued

Thursday March 28, 2024 12:30 p.m.

The 2023 Harvey Rosten Award

Sponsored by Siemens Digital Industries Software

For Outstanding Work in the Field of Thermal Analysis of Electronic Equipment:

Applicability of JESD51-14 to Clip-bonded, Discrete Power Devices

29th THERMINIC Workshop, Budapest, Hungary, September 2023

Szilárd Zsigmond Szőke

Henrik Sebők

Szilárd Zsigmond Szőke is working at the Engineering Center Budapest of Robert Bosch Kft. as senior expert for power electronics and thermal behaviour of electronic components. His team (ThID) performs thermal measurements and simulations of components, modules, and full automotive control units, focusing on matching models with reality. Szilárd received his Electrical Engineering diploma from the "Politechnica" University of Timisoara (Romania) in 2004, and worked there as teaching assistant, before joining Bosch in 2007. Since then, he was involved in development of start-stop and generator control units, blower controllers, and various actuators for automotive use. Szilárd has published 7 research papers and holds 4 patents.

Henrik Sebők graduated at Budapest University of Technology and Economics as mechanical engineer (2022 BS). He's been working at Engineering Center Budapest of Robert Bosch Kft. as thermal simulation engineer since 2019. His main interest is creating validated component models, ECU level simulations, as well as thermal measurements. So far, he involved in the publication of 1 research paper.

The Harvey Rosten Award

The Award is for outstanding work, recently published or in the public domain, which advances the analysis or modeling of thermal or thermomechanical effects in electronic equipment or components, including experiments aimed specifically at the validation of numerical models. The award is in the form of a plaque and a $1000 cash prize. The Award was established by the family and friends of Harvey Rosten, to commemorate his achievements in the field of thermal analysis of electronics equipment, and the thermal modeling of electronics parts and packages. The Award is made annually to encourage innovation and excellence in these and closely related fields.
The recipient is selected by the Selection Committee, made up of eminent practitioners in the electronics-thermal field. The criteria for selection are that the work: represents an advance in thermal analysis or thermal modeling of electronics equipment or components, including experiments aimed specifically at validating numerical models; demonstrates clear application to practical electronics design; demonstrates insight into the physical processes affecting the thermal behavior of electronics components, parts and systems; is innovative in embodying this understanding in either thermal analysis or thermal modeling; takes a pragmatic approach.

THERMI PRESENTATION
Thursday, March 28, 2024

THERMI Award

Each year, SEMI-THERM honors a person as a Significant Contributor to the field of semiconductor thermal management. The THERMI award is intended to recognize a recipient's history of contributions to crucial thermal issues affecting the performance of semiconductor devices and systems.
The voting body of past THERMI winners and the current year General Chair are pleased to present the 2021 THERMI Award to:

Wendy Luiten

Wendy Luiten is a Thermal Consultant and Certified Design for Six Sigma Master Black Belt with 40 years industry experience. She worked in various roles in Philips R&D for 30+ years, among others in Flat TV. She developed and delivered thermal, statistics and DfSS training at various in-company courses, and at the High-Tech Institute in Eindhoven. Luiten authored 25+ papers, holds several patents and lectured all over the world. Her current research interest is digital innovation – exploring design methodologies that combine advanced statistical tools and (thermal) computer simulations. Wendy Luiten was program co-chair of the IEEE Therminic conference 2017 in Amsterdam, serves at the program comittee of the SEMI-THERM and Therminic conferences, and is a member of the Therminic steering comittee. She received the SEMI-THERM Best Paper award 2002, the Harvey Rosten award for Excellence in 2013, and Philips Research Outstanding Achievement Award 2015.

Schedule of Events

Thursday, March 28, 2024

10:20 a.m. – 10:40 a.m. — **Oak and Fir**
In Vehicle Validation of a Loop Heat Pipe Used for Cooling an ADAS Compute Module
Olivier de Laet, Calyos

10:40 p.m. – 11:00 a.m. — **Oak and Fir**
A Gallium Liquid Metal Phase Change Composite for Transient Thermal Management
Rachel C. McAfee, DEVCOM US Army Research Laboratory

11:00 a.m. – 12:00 p.m. — **Oak and Fir**
THERMI Award
Wendy Luiten

12:00 p.m. – 2:00 p.m. — **Pine and Cedar**
Awards Luncheon

SEMI-THERM

MAE
Mechanical & Aerospace Engineering
The University of Texas at Arlington

UNIVERSITY OF TEXAS ARLINGTON

We are proud to sponsor:

The SEMI-THERM Educational Foundation
Thermal Hall of Fame

Lifetime Achievement Award

Presented To

Bonnie Crystall and Walter Schuch

In Recognition of Significant Contributions to the Field of Electronics Thermal Management

Bonnie Crystall and Walter Schuch, along with Bernie Siegal, laid the foundation for SEMI-THERM in 1984 as its founders. Bernie Siegal was inducted into the Thermal Hall of Fame in 2018 in recognition of his significant contributions to the field of Electronics Thermal Management.

The Thermal Hall of Fame honors individuals within the electronics thermal management sector who have made substantial advancements in the development and implementation of thermal management technologies throughout their professional journeys. These esteemed members demonstrate an entrepreneurial spirit, continuously pushing innovation boundaries while also guiding and educating others in the field. Their expertise is widely recognized through various channels such as technical papers, presentations, teaching engagements, and active participation in industry events like conferences and symposia.

Walter J. Schuch
Walter brings a wealth of experience to the table, with a Bachelor of Arts in Journalism from Marquette University and a background as a Public Relations Specialist in the US Army. After the army he served as public relations director for the American Red Cross. He later served as Corporate Public Relations Director at Motorola Inc. in Chicago, Illinois, before assuming the role of Director of Communications at the Semiconductor Products Sector in Phoenix, Arizona and later joining forces with Bonnie in establishing C/S Communications in Tempe, AZ.

Bonnie L. Crystall
Bonnie Leigh Crystall 's journey begins with her academic pursuits, first earning a Bachelor of Education at the University of Arizona, followed by a Master of Education from Arizona State University. Her early exposure to entrepreneurship began at her grandparents' noodle factory in Tucson, AZ, where she bagged and labeled noodles and listened to old time radio, "The Shadow Knows." Later, she managed her parents' Big Band radio station in Green Valley, AZ. She served as a high school reading teacher and then reading department head, sharpening her abilities in educational communication. She got the tradeshow bug when working at Fairchild Advertising in Mt. View CA, assisting her boss with Fairchild's presence at SEMI-CON West. As the president of C/S Communications, Inc., Bonnie's expertise in meeting planning and tradeshow management is instrumental in the success of numerous events, notably the prestigious SEMI-THERM annual symposium.

For Bonnie and Walter, SEMI-THERM is more than just a professional endeavor—it holds deep personal significance. Walter, the creator of the term 'SEMI-THERM' has been an integral part of the event's history. With his engaging and welcoming personality, he became synonymous with SEMI-THERM, embodying the spirit of PR and fostering a sense of community among attendees. Bonnie brings her passion for meeting planning and her background in education to SEMI-THERM, offering attendees a unique educational experience in the thermal field. Her commitment to treating each participant as a valued guest has transformed SEMI-THERM into a familial gathering.

SEMI-THERM takes place at:
DoubleTree by Hilton San Jose
2050 Gateway Place, San Jose, CA 95110
Phone: 1 (408) 453-4000

For program details, registration, exhibition and hotel information visit
WWW.SEMI-THERM.ORG today!

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EXHIBITOR LISTINGS

Alpha Novatech, Inc. **403**

Alpha Novatech, Inc. is your partner for Thermal Solutions. We offer a wide variety of standard heat sinks and accessories. Our product line includes natural convection, forced convection, and active heat sinks. We also offer various attachment methods and hardware for almost any application. In addition, we can offer free heat sink thermal simulations. Standard or custom heat sinks in prototype to production quantities Quick and easy customization without NRE fees. Standard parts are carried in stock. Lead time for custom parts of 1-2 weeks is possible for initial quantities.
www.alphanovatech.com

Ansys **206**

Our Mission: Powering Innovation That Drives Human Advancement™
When visionary companies need to know how their world-changing ideas will perform, they close the gap between design and reality with Ansys simulation. For more than 50 years, Ansys software has enabled innovators across industries to push boundaries by using the predictive power of simulation. From sustainable transportation to advanced semiconductors, from satellite systems to life-saving medical devices, the next great leaps in human advancement will be powered by Ansys. https://www.ansys.com/

Analysis Tech **502**

Semiconductor Thermal Testers
Complete measurement systems for device thermal resistance, impedance, & die-attach quality using transient & steady state electrical-junction temperature-measurement. Transient structure function analysis is used to delineate internal-package resistances & measure Rjc via JEDEC 51-14. Test services offered.
Thermal Interface Material Testers
ASTM D5470 based testers offering fast & accurate measurement of thermal conductivity & contact resistance of electronic-packaging materials over a wide range of thickness, pressure, & temperature. Test services offered.
Event Detectors
Electrical reliability-testers for passive interconnects including solder joints & connectors, with easy integration to thermal-cycle, drop-test, shock, and vibration gear; based on JEDEC and IPC standards for interconnect reliability testing.
www.analysistech.com

Arieca **Sponsor**

Arieca is an advanced materials start-up that is pushing the boundaries of materials functionalities in the most demanding applications. Our proprietary Liquid Metal Embedded Elastomer (LMEE) technologies allow for unprecedented performances in applications across semiconductor, automotive, and healthcare industries.
Our flagship products, TIMbber® and Thubber®, represent seminal advancements in material science. TIMbber stands as the most adaptable thermal interface material (TIM) for high performance advanced semiconductor packaging. Utilizing liquid metals as filler technology, it ensures the highest thermal performance while maintaining reliability in critical applications. Meanwhile Thubber is a soft, stretchable, and thermally conductive elastomer ideal for applications demanding both flexibility and heat management.
Founded in 2018 as a spin-out from Carnegie Mellon University, Arieca combines cutting-edge research with the most advanced technologies to deliver innovative solutions to our partners and customers.
https://www.arieca.com

EXHIBITOR LISTINGS

Binghamton University S3IP **408**

S3IP brings together teams of experts from industry and academia to address pressing real-world problems in electronics manufacturing. Our research centers focus on packaging and thermal management, heterogeneous integration, energy-efficient electronic systems and energy harvesting and storage. Li-ion battery research is conducted by Dr. M. Stanley Whittingham, 2019 Nobel Laureate. Binghamton University, the premier public university in the Northeast, is home to S3IP, a New York State Center of Excellence. Our PhD-degreed staff members and affiliated faculty, in 6 constituent research centers and 9 laboratories, are ready to assist companies with collaborative problem solving. As a result of our combined efforts, our industry partners have reported over $1.9 billion of economic benefit.
https://www.binghamton.edu/s3ip/index.html

Calyos **409**

Calyos specializes in the design and manufacturing of two-phase thermal management systems, harnessing our expertise to create innovative solutions within E-Mobility and Computing sectors. Our focus is on overcoming thermal management challenges brought forth by electrification and data processing, through the adoption of superior passive cooling systems. Calyos' primary technologies include loop heat pipes, micro-channel heat pipes, and pulsating heat pipes. Our systems are typically engineered to enhance thermal performance across applications in power electronics, processors, and batteries, but can also be customised to other applications. Our systems offer high heat transfer coefficients (due to vaporisation) without the complexity or energy consumption of active cooling methods. By remaining passive and pump-free our systems are ultra-reliable and long-lasting with zero maintenance requirements over their lifetime. Calyos is dedicated to propelling the industry towards passive and therefore the most sustainable thermal management solutions.
www.calyos.com

Cadence **308**

Cadence is a pivotal leader in electronic systems design, building upon more than 30 years of computational software expertise. The company applies its underlying Intelligent System Design strategy to deliver software, hardware, and IP that turn design concepts into reality.
Cadence customers are the world's most innovative companies, delivering extraordinary electronic products from chips to boards to complete systems for the most dynamic market applications including hyperscale computing, 5G communications, automotive, mobile, aerospace, consumer, industrial, and healthcare.
www.cadence.com

Celsia **503**

Celsia specializes in custom heat sink design and manufacturing using liquid two-phase devices: heat pipes and vapor chambers. Through its US headquarters and Taiwan design & production facility, the company's goal is to deliver fast, affordable, and reliable thermal solutions for the most demanding applications including high density electronics, performance CPU / GPU, amplifiers, HBLEDs, ASICS, and rugged systems. In recent years, Celsia has shipped over 2.5 million thermal assemblies to a global custom base in the telecommunications, computer, test equipment, defense, laser, and medical markets.
https://celsiainc.com/

EXHIBITOR LISTINGS

CEJN North America **505**

CEJN North America, Your choice for sustainable quick connect solutions, delivers couplings for your liquid cooling needs. Our Leak-free, Non-drip coupling series offers high flow and minimal pressure drop; and Blind-mate options range from DN-3 to DN-19. CEJN's UltraFLOW Series features an extremely high flow combined with an unequalled low pressure drop. Customized solutions are also available. At CEJN, we develop our products for a future in liquid cooled data centers.
Contact us: 1-800-222-2356; customer.service.usa@cejn.com; www.cejn.com.

COMSOL, Inc. **Sponsor**

COMSOL Multiphysics® is a software platform used to simulate designs, devices, and processes in all fields of engineering, manufacturing, and scientific research. COMSOL Multiphysics® enables you to create physics-based models and simulation applications that account for multiphysics phenomena. Expand your analyses with add-on products for electrical, mechanical, fluid flow, and chemical phenomena, as well as interfacing products for a variety of CAD and CAE tools. Simulation experts can use COMSOL Server™ and COMSOL Compiler™ to deploy simulation applications to design teams, manufacturing departments, test laboratories, and customers worldwide.
https://www.comsol.com/comsol-multiphysics

CoolIT **Sponsor**

CoolIT Systems specializes in scalable liquid cooling solutions for the world's most demanding computing environments. In the desktop enthusiast market, CoolIT provides unparalleled performance for a range of gaming systems. In the enterprise data center and high performance computing markets, CoolIT partners with global leaders in OEM server design to develop the most efficient and reliable liquid cooling solutions for their own leading-edge products. Through it's Direct Liquid Cooling technology, CoolIT enables dramatic increases in rack densities, component performance and power efficiencies. Together, CoolIT and its partners are leading the way for widespread adoption of high-performance computing.
https://www.coolitsystems.com/

Cofan USA **301**

At COFAN USA, we keep your hot technology cool. COFAN USA is an industry leading manufacturer in thermal management solutions with inhouse thermal engineering team providing thermal simulation service and consultation to our customers. With more than 20 years of expertise, we've had the pleasure of serving a diverse customer base in many industries. We offer quick turnaround product inquiries and prototyping services. We pride ourselves in giving the best possible customer service, the highest quality products with the shortest lead time, and competitive pricing in the industry. To learn more about us, please visit www.cofan-usa.com

CPC **303**

CPC thinks beyond the point of connection to help protect valuable electronics. Designed specifically for liquid cooling applications, rugged couplings withstand long periods of connection yet disconnect reliably without drips.
https://www.cpcworldwide.com/liquid-cooling

EXHIBITOR LISTINGS

Diabatix **Sponsor**

Diabatix is a pioneering Belgian software company at the forefront of generative design for thermal management. In an era of increasingly compact electronic devices, escalating computing power, urgent reduction of greenhouse gases, and the rapid adoption of renewable energy technologies, the demand for super-efficient cooling components has become paramount for streamlined product development. Diabatix rises to this challenge with its groundbreaking software solution, ColdStream.

ColdStream empowers businesses to optimize their products by achieving maximum heat transfer, unrivaled efficiency, and reduced material usage, all with minimal effort. Our cutting-edge software revolutionizes the thermal management design process, allowing companies to stay ahead in the competitive landscape. By leveraging the power of ColdStream, businesses can design and develop next-generation cooling solutions that not only enhance performance but also contribute to a sustainable future.

www.diabatix.com

Electronic Cooling Solutions **501**

ECS, founded in 1998, was formed with the vision of providing the best thermal management consulting services to the industry world-wide. This vision continues to be the driving force for the company and its team.

Based in the heart of Silicon Valley, ECS has established a reputation for high-quality and cost-effective solutions for its clients. Members of the team bring a combination of design, simulation, and experimental skills to the table required to address the thermal design issues faced by our clients. We have clients and business relationships throughout the United States as well as internationally, and work with some of the biggest names in the electronics industry.

Overview

ECS provides thermal design services to companies in the electronics industry. We are vested in thermal design for automotive, telecommunications, computing, networking, medical, automotive, and consumer products. We also have thermal design experience for avionics, military equipment, solar and alternative energy systems. Our capabilities include datacenter, room, system, board, and package level thermal analysis and design.

https://ecooling.com/

Electronics Cooling Magazine **Sponsor**

Electronics Cooling magazine has been providing a technical data column since 1997 with the intent of providing you, the readers, with pertinent material properties for use in thermal analyses. We have largely covered the most common materials and their associated thermal properties used in electronics packaging.

ITEM Media publishes a portfolio of digital and print magazines within the electronics industry. Our titles are available in a variety of electronic and printed media formats, including digital magazines, e-newsletters, social media feeds, forums, content marketing tools and printed magazines.

https://www.electronics-cooling.com/

EXHIBITOR LISTINGS

Element Six **404**

Element Six (E6), part of the De Beers Group, is a world leader in the development and production of synthetic diamond solutions.

Since 1959, E6's focus has been on engineering diamond materials to unlock innovative applications, including thermal management, optics, quantum and sensing.

Chemical vapour deposition (CVD) diamond is used as a thermal heat spreader to manage the huge power densities (>4 kW/cm2) associated with modern semiconductor devices, underpinning the exponential demand in internet bandwidth. Thanks to a thermal conductivity up to x10 higher than other solutions, diamond acts as the perfect platform to mount devices on. For example, gallium nitride power amplifiers mounted on diamond can be optimised to drop junction temperatures by >30%.

Our patented technology places us at the forefront of synthetic diamond innovation, enabling us to deliver competitive advantage to our customers through diamond-enabled solutions.

Find out more at e6.com and contact us at ustechnologies@e6.com

Exatron **300**

Since 1974, Exatron has designed and built innovative, efficient, dependable handler systems for the semiconductor, medical, automotive, gaming, and solar industries. From simple standalone machines to fully integrated systems, all handlers are built in-house using Exatron's modular "building blocks" concept, allowing customers the widest variety of configurations possible to suit every need. Our extensive inventory of automated building blocks includes gravity feed, pick-and-place, conveyor, rotary, and tape and reel. Additional options like dispensers, laser welders/markers, label applicators, machine vision, and bowl feeders are fully integrated into Exatron's in-house automation software and are all designed, machined, and assembled on the Exatron factory floor.

Exatron – building beyond customers' expectations since 1974.

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- Semiconductor Components, Equipment, and Services
- Testing, Inspection, and QA/QC Equipment & Services

https://www.exatron.com/

FRD **209**

Shenzhen FRD Science & Technology Co., Ltd., founded in Shenzhen in 1993, is a national high-tech enterprise. Its main products are electromagnetic shielding materials and devices, thermal materials and devices and other electronic devices. It is a leading and innovative professional electromagnetic shielding and thermal solution service provider in China. The company has passed the certification of ISO9001 international quality management system, ISO14001 international environmental management system, QC080000 hazardous substance process management system, ISO45001 occupational health and safety management system, IATF16949 automobile industry quality management system, etc.

http://en.frd.cn/

EXHIBITOR LISTINGS

Fralock **511**

Fralock is a provider of custom passive thermal management component solutions. We design, engineer, and manufacture thermal gap pads used in several industries for a wide array of applications. Our components are typically made with materials such as graphite, carbon-filled silicone, and silicone with metal cores such as aluminum. They are flexible and compressible to fill air gaps between two surfaces for efficient heat transfer.

Our material science engineers can specify the best materials for your application. Our manufacturing capabilities include high-precision die-cutting, UV and C02 laser cutting, machining, slitting, heat press, laminating, adhesive lamination, welding, assembly and more.
https://www.fralock.com/

USA Hongfuhan Technology Co. **401**

HongFuHan [HFH] is a publicly listed company in Shenzhen with manufacturing sites and sales offices located in China, Vietnam, India, and the USA. HFH offers a wide variety of breakthrough thermal solutions for the market including TIMs as well as customized hardware solutions from design to mass production.
https://www.hongfuhan.cn/

Fujipoly America Corp **402**

Fujipoly is a world leader in the manufacture of Sarcon® Thermal Interface Materials, which are used to help keep sensitive electronic components cool by eliminating the air gap between the component and heat sink. Our products range in thermal conductivity from 1.0m watt/m-K to 17 watt/m-K, offering some of the lowest thermal resistance in the industry. Our product line-up consists of soft Gap Filler Pads, Conformable Putties, Form-In-Place Gap Fill Materials, as well as custom and standard die-cut thin film materials. Our wide range of material types, coupled with the widest range of thermal conductivity, allows us to meet most design criteria. Fujipoly has nine locations in North America, Europe, and Asia making it easy for us to assist our customers at the local level.
www.fujipoly.com

Indium Corporation **307**

Indium Corporation is a premier materials manufacturer and supplier to the global electronics, semiconductor, thin-film, and thermal management markets. Products include solders and fluxes; brazes; thermal interface materials; sputtering targets; indium, gallium, germanium, and tin metals and inorganic compounds; and NanoFoil®. Founded in 1934, Indium has global technical support and factories located in China, Malaysia, Singapore, South Korea, the United Kingdom, and the USA.

For more information about Indium Corporation, visit www.indium.com or email abrown@indium.com. You can also follow our experts, From One Engineer To Another® (#FOETA), at www.facebook.com/indium or @IndiumCorp.
www.indium.com

EXHIBITOR LISTINGS

Infra Tec Infrared LLC **203**

InfraTec's Infrared Measurement Division is one of the leading suppliers of commercial thermal imaging technology for thermographic temperature measurement. The wide range of high-performance cameras like its ImageIR® series together with InfraTec's efficient and convenient thermographic software IRBIS® will make electronics testing also at a µm scale fast and precise. Additional lock-in routines allow for the detection of failures resulting only in smallest thermal differences in the µK range. The fully integrated solution E-LIT will most effectively run complex testing routines of PCB, chips or components based on specific customer demands.
www.infratec-infrared.com

Ironwood Electronics **304**

Since 1986, Ironwood Electronics has been the go-to source for advanced adapters, sockets, and modules. Our adapters convert package and pitch between devices, our modules offer complete fully tested assemblies for component replacement and upgrade, and our sockets allow for complete component and assembly testing - from new silicone characterization and validation, all the way thru burn-in and high volume automated testing – always with the highest performance and lowest possible footprint in the industry.
Now in its 37th year with over 65 employees, Ironwood brings a combined knowledge of hundreds of years of engineering and manufacturing expertise, all under one roof in our state of the art 25,000 sq. foot facility just outside Minneapolis, Minnesota. Combined with our recent acquisition of the Grypper socket line, our continuous new product development demonstrates our on-going commitment to both our customers and the industry we serve.
https://www.ironwoodelectronics.com/

Laser Thermal **405**

Laser Thermal provides accessible thermal property measurements of materials, focusing on thin films from nanometers in thickness up through micron thick coatings. Utilizing optical technologies, we provide simple, accurate, and rapid measurements of thermal properties, leading to increased knowledge of material properties. Offering both contract testing services and our flagship tool SSTR-F for sale, Laser Thermal can serve all of your thermal property testing needs.
https://laserthermal.com/sstr-f/

Linseis Inc. **407**

Linseis offers a product lineup for the measurement of the thermal and electrical transport properties of thin films from the nanometer to the micrometer in a wide range of temperatures.
The TFA – Thin Film Analyzer, chip-based platform simultaneously measures a thin film's thermal conductivity, in-plane electrical conductivity, Seebeck coefficient and Hall constant from -170°C up to 280°C and in a magnetic field of up to 1 T.
The TF-LFA, using LaserFlash technology measures the thermal diffusivity of materials (FDTR – Frequency-domain thermoreflectance). This optical measurement technique allows the characterization of nm to µm thin films and coatings as well as the characterization of high conductive bulk materials.
The HCS - Hall Characterization System with a permanent or electromagnet measures the electrical transport properties (Resistivity, Hall Constant, Charge Carrier Concentration, Hall Mobility) of thin films or bulk samples in a temperature range from -196°C up to +700°C.
The LSR – measures thin film Resistivity and Seebeck Coefficient from -100°C up to +1500°C. The device can be equipped with adapters for thin films, free standing films and foils as well as an adapter to measure zT directly, using the Harman technique.
The LFA – LaserFlash Analyzer, measures the thermal diffusivity of thicker films and coatings in the tens to hundreds of µm range. Measurements up to temperatures of +2800°C.
https://www.linseis.com/en/products/thin-film-analyzer/
https://www.linseis.com/

EXHIBITOR LISTINGS

LISAT **400**

LISAT, manufacturer of Thermal Interface Material & EMI products. HQ in U.S., LISAT have operations in Asia. In U.S., we provide Thermal Management Solution to customers & work with R&D Engineers at Design Centres. We provide technical support & samples to our customers to test our materials. Our Asia operations provide manufacturing, converting, technical & sales to customers' worldwide. Our products : TIM Pad, Insulator, Silicon Free TIM, Gel, Grease, Mylar, Graphite, Conductive Plastic, Conductive Elastomer, Fabric-Over-Foam, Microwave Absorbing Material, Metal Finger Stock, EMI Shielding Solution, Switching Power Supply, Desktop & Wall Mount Adaptor, Metal Core PCB, Ceramic PCB.
https://lisat.net/

Nanotest **500**

NANOTEST | The Berliner Nanotest und Design GmbH is German engineering company with scientific lab that provides services and products for failure analysis and thermal characterization and to measure, improve and maintain reliability. For all facets of the electronics industry, from RF to high power, from automotive to space applications, NANOTEST supplies solutions that empower material and system manufacturers to improve their productsâ€™ quality, performance, and reliability.

NANOTEST products are highly scientific, yet convenient stand-alone systems that offer a wide range of features, from simple single measurements to partly automated inline testing, aging investigations, and failure analyses. By staying active in research and keeping a close link to various institutes, universities, and industries, NANOTEST solutions are always up to date with latest scientific and methodological developments and offer the edge over other comparable solutions.
https://nanotest.eu

MALICO INC. **508**

Malico was founded in 1983 as an advanced thermal solution provider and has expanded to become a major metal forming company in Taiwan. The in-house factory is equipped with a wide range of facilities including high-precision CNC center, die casting center, metal injection molding center, painting center (powder and liquid coating), and core thermal solution to satisfy diverse customer demands. Quality is core value of Malico, with certificates including ISO 9001, ISO 14001, IATF 16949, and RoHS compliance. Malico offers customized solutions, quick response, short lead times, and best quality to maintain long-term customer partnerships. Localized North American sales offices ensure timely support and communication with customers. Additional information is available upon request.
https://www.malico.com/

Novark Technologies **Sponsor**

Novark's team of highly skilled experts and nearly 1000 employees focus on the custom design, development, and manufacturing of Novark's three product families. Novark supports thermal solutions in a wide variety of markets, including PC, telecom, industrial power, servers, data centers, transportation, LED Lighting, and many more. Novark also supports scientific research at many universities, and frequently supplies materials and prototypes to researchers.
https://www.novarktechnologies.com/

EXHIBITOR LISTINGS

Parker Chomerics **207**

Chomerics is a division of Parker Hannifin Corporation (NYSE: PH) and is part of its Engineered Materials Group. It is the global leader in the development and application of electrically and thermally conductive materials for consumer electronics, automotive, aerospace, defense, telecommunications, and alternative energy systems. With a global R&D and manufacturing footprint, Chomerics specializes in the manufacture of thermal interface materials such as gap filler pads, dispensable gels, two-component cure-in-place thermal compounds, and phase change materials. These materials deliver lower thermal impedance, higher reliability, and greater compliance and conformability for both microelectronics and large-scale electronics.
https://www.parker.com

Sekisui **406**

SEKISUI is a Japanese chemical manufacturing company with a history of 76 years. We provide a variety of products to meet the most frontier needs of electronic market. For the thermal management products, as SEKISUI Polymatech, we manufacture and sell thermal gap fillers and thermal pads. Our TIMs hava unique and high heat dissipation using carbon fiber and used in high-spec ICs, etc. SEKISUI offers customized solutions for IC technology challenges.
https://polymatech.co.jp/english/

Readore Tech **306**

Readore Technology has 25 years in thermal products and 10 years on 3 dimensions vapor chamber research and development, we are focus on high power chips thermal solutions and provide customer on high efficiency and consistence products from R&D stage to mass production. We will present the thermal solution on how to resolve the 500wts, 700wts and 1Kwts above. The 3DVC thermal module and liquid cooling products and technologies will present.
http://readore.com/en/company.asp

Sheen Electronic Technology Co., Ltd **506**

Sheen Electronic Technology Co., Ltd is a high-tech enterprise which is dedicated to develop and produce thermally conductive materials and thermal insulation materials. Currently our main products are thermally conductive pads, thermally conductive gels, thermal grease, phase change thermal grease, phase change thermal interface materials, thermally conductive tape, foam silicone sheets, thermal silicone adhesive, thermal insulation materials. All are widely used in cell phones, power supplies, LED lights, computers, automotive electronics, network communications, electrical and mechanical equipment, instrumentation, electrical and electronic fields and so on.
www. http://www.usheenthermal.com/

EXHIBITOR LISTINGS

Shin-Etsu MicroSi, Inc. **200**

Shin-Etsu MicroSi is the leader in Thermal Interface Material, and we have developed an extensive line of Molding Compounds, Encapsulents, Silicon and Epoxy coatings along with die Attachment Materials. The quality of our thermal interface material is among the most advanced in semiconductor manufacturing and has a wide range of use in thermal interface material applications. Some of which include thermal gels and grease, phase change materials, and high hardness silicone rubber pads. Shin-Etsu products are delivered globally to many major and minor companies involved in the fabrication process of electronics and microelectronics.
www.microsi.com

Smart High Tech **509**

Smart High Tech offers graphene enhanced thermal interface material in sheets that does not pump out, dry out, or chemically interact with either the application or the heatsink. Based on the research by prof. Johan Liu and manufactured in Sweden, our GT-TIM products offer record breaking 90W/mK thermal conductivity through plane. Our aim is to make sure that high power electronics installed today will continue performing reliably and optimally over the coming decades.https://https://smarthightech.com/

Siemens **507**

Siemens Digital Industries Software is driving transformation to enable a digital enterprise where engineering, manufacturing and electronics design meet tomorrow. The Xcelerator portfolio helps companies of all sizes create and leverage digital twins that provide organizations with new insights, opportunities and levels of automation to drive innovation. For more information on Siemens Digital Industries Software products and services, visit www.sw.siemens.com or follow us on LinkedIn, Twitter, Facebook and Instagram.
https://plm.sw.siemens.com/en-US/simcenter/simulation-test/electronics-cooling-simulation/

Stäubli **202**

Stäubli, a leading global manufacturer of quick-release coupling systems for use in IT/liquid cooling will be exhibiting at Semi-Therm this year. Our products have been designed for perfect integration in installations such as data centers or super computers. Stäubli North America has more than 200 employees supporting Connectors, Robotics, and Textiles customers. The company's North American headquarters is in Duncan, South Carolina. Stäubli has a global workforce of over 5,500 employees, 14 production sites across the globe, and is supported by a comprehensive distribution network in 50 countries worldwide.
www.staubli.com

EXHIBITOR LISTINGS

Stellar **208**

Stellar Industries is an industry leader in manufacturing metalized ceramics and microchannel coolers. Our products enable thermal management and electrical isolation for a multitude of demanding applications in the aerospace, photonics, and electronics industries. Stellar's products and services are based on proprietary direct bond copper (DBC), thin film, and thick film processes, enabling a wide variety of geometries and configurations. Stellar was founded in 1985, and since 2019 has been a member of the TRUMPF Group, a world leader in lasers and machine tools
www.stellarind.com

Stirweld **205**

Stirweld introduces an FSW head enabling direct welding from CNC machines, optimizing your machinery. This technology welds all aluminium alloys, offering enhanced capabilities. Our FSW head delivers the performance of specialized machines, including effort control and quality recording.
https://stirweld.com/en/home-2/

T-Global **302**

The T-Global team can provide you with prompt and agile service, working with partners to ensure that T-Global products and services solve your heat dissipation problems. We pride ourselves on our culture of being forward-looking, targeting the future of new energy, 5G, electric vehicles and other emerging technologies, and focusing on building long-term, stable relationships with our partners to earn the trust of our customers, partners and employees.
https://www.tglobaltechnology.com

Thermal Engineering Associates **501**

TEA is a company founded by Bernie Siegal, a 35+-year veteran and recognized technical leader in the semiconductor thermal field. The company's mission is to provide a central source for the products and services necessary for proper semiconductor thermal measurement and modeling and solutions to attendant thermal management problems. Through its own products and services, augmented by an extensive network of technical experts around the world, TEA can assist customers in finding solutions. The Tech Briefs and Hot Links pages provide useful information to those interested in semiconductor and electronics thermal issues. We welcome the opportunity to discuss your thermally-related measurement, modeling and/or management requirements.
https://www.thermengr.net/

ThermoAnalytics **201**

ThermoAnalytics (TAI) is a global thermal, fluid-flow, and infrared modeling software developer whose software products and services help engineers in automotive, aerospace, defense, manufacturing, and textiles organizations worldwide to optimize product concepts early in the design process. ThermoAnalytics is committed to mastering thermal management challenges by applying the most sophisticated technology to identify design challenges and opportunities earlier, faster, more reliably, and at a lower cost. Over 25 years of experience has contributed to the evolution of their software. Applications include underhood models, exhaust and underbody simulation, HVAC, cabin, transient brakes, battery packs for HEV/EV, electronics, and other thermally sensitive components. For more information, go to www.thermoanalytics.com.