

FINAL PROGRAM

# SEMI-THERM<sup>®</sup>

## SEMI-THERM 39

The 39th Annual Thermal Measurement, Modeling  
and Management Symposium  
March 13 – 17, 2023

# 39

[WWW.SEMI-THERM.ORG](http://WWW.SEMI-THERM.ORG)

Your choice of Short Courses – included with your registration

### Keynote Presentation:

**Sustainable Solutions: Liquid Cooling in Data Centers**

Dr. Ashish Gupta, Intel Corporation

### Technical Sessions:

- Comfort and Compliance • Two-Phase Cooling I • Advanced Manufacturing and Materials
  - Two-Phase Cooling II • Emerging Technologies
- Immersion • Testing & Measurement Methods I • TIMS I • Testing & Measurement Methods II
  - TIMS II • Data Centers • Numerical Modeling Methods

**Exhibitor Reception 5:30 - 6:30 Wednesday, March 15**

**Career Trajectory Panel 5:00-6:00 Tuesday, March 14**

Taravat Khadivi, Meta, Consumer Electronics

Panel Members:

Ross Wilcoxon, Collins Aerospace

Yueming Li, Meta, Data Centers

Lieven Vervecken, Diabatix, Entrepreneur

Nicole Okamoto, San Jose State, Academia

### Thermal Hall of Fame Award:

Dr. Alfonso Ortega, Villanova University

### Thermi Award Presentation

**Dr. Veerendra Mulay, Meta**

“This Journey is 1% Finished”

### Harvey Rosten Award:

“Analysis of the Thermal Behavior of Li-Ion Pouch Battery Cell – Part II: Circuit-based Modeling for Fast and Accurate Thermo-Electrochemical Simulation”

All programming subject to change

## Welcome to SEMI-THERM 39!



**Marcelo del Valle**

Dear Colleagues,

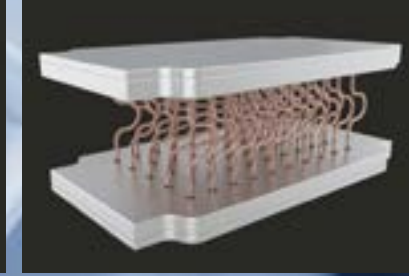
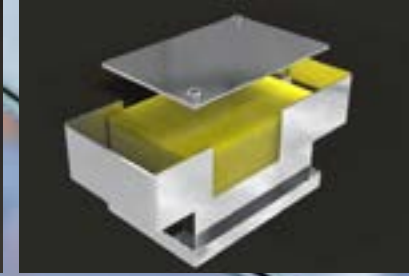
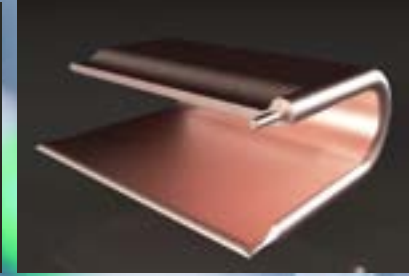
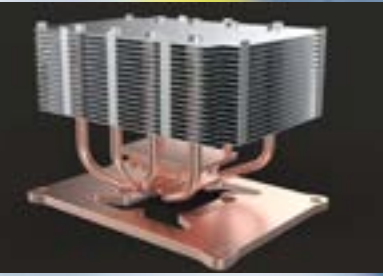
It is my pleasure to welcome you to the SEMI-THERM 39th annual symposium dedicated to thermal design, thermal management as well as measurement of semiconductor systems and components. The program committee led by Alex Ockfen, Meta, has coordinated a comprehensive program that adheres to SEMI-THERM's mission of providing a platform for discussion of the latest advancements in thermal management for both industry professionals and members of academia. This year's program consists of our keynote address; five short courses; forty-four technical papers; two luncheon speeches; one How-To tutorial; a Panel session on "Career Trajectories in Thermal Design"; Vendor workshops; two days of SEMI-THERM exhibits and our awards sessions including the THERMI, Harvey Rosten as well as Thermal Hall of Fame Award. As has been the tradition in prior years, all short courses are offered free of charge as part of the full technical conference pass. The courses are offered on the first day of SEMI-THERM on Monday, March 13th including morning and afternoon sessions. This year's keynote speech is from Dr. Ashish Gupta, Senior Director of Thermal Mechanical Solution group at Intel Corporation. The theme of Dr. Gupta's keynote speech is "Sustainable Solutions: Liquid Cooling in Data Centers".

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, Alex Ockfen, Meta and Dr. Lieven Vervecken, Diabatix, 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 and SEMI-THERM's co-founder Bernie Siegal. Thanks to all of you for your constant support of the SEMI-THERM program committee. Lastly, I want to give all my appreciation to Bonnie Crystall, Denise Rael and Robert Schuch for their tireless support of this year's SEMI-THERM symposium. 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.

Marcelo del Valle, General Chair SEMI-THERM 39



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### Program Chair

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### Program Vice-Chair

Lieven Vervecken, Diabatix  
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### Symposium Management:

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## SEMI-THERM 39 Chair Persons

### General Chair



**Marcelo del Valle, Infinera**

**Dr. Marcelo del Valle** is a Staff Hardware Development Engineer for the Optical Modules Group at Infinera Corporation. Before joining Infinera, he worked as Staff Thermal Engineer at ZT systems where he designed cooling solutions for rack mounted servers. Additionally he worked as a Thermal Mechanical Engineer at Intel corporation where he developed air and liquid cooling solutions for the Omni-Path HPC network equipment product line. Dr. Del Valle holds a B.S.M.E from Universidad de Santiago, Chile, a M.S.M.E. from University of Nevada, Reno and a Ph.D. in Mechanical Engineering from Villanova University. He has worked extensively in experimental measurements in the thermal sciences for more than 10 years. He has published and presented extensively in problems arising from thermal management of electronics, spanning from the chip/module to the facility level, single and two-phase cooling, and thermal management in energy systems.

### Program Chair



**Alex Ockfen, P.E., Meta**

**Alex Ockfen** is a simulation 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, and is a professional mechanical engineer. Currently he is serving as program chair of the SEMI-THERM conference, and is an associate technical editor for Electronics Cooling Magazine.

### Program Vice Chair



**Dr. Lieven Vervecken, CEO 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 advanced A.I. 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 and he is an experienced keynote speaker at national and international conferences.

## Short Courses

**Monday, March 13, 2023**

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**

### **Fundamentals of CFD for Heat Transfer Analysis: Governing Equations, Numerical Methods, and Applications**

Instructors: Ine Vandebeek, Head of R&D Diabatix and Dr. Lieven Vervecken, CEO, Diabatix

In this 4-hour short course, attendees will gain an in-depth understanding of the governing equations and numerical methods used in Computational Fluid Dynamics (CFD) simulations of heat transfer. The course will begin by introducing the fundamental equations of heat transfer, including convection, conduction, radiation and conjugate heat transfer. Attendees will also learn about the Boussinesq approximation and its role in heat transfer simulations.

The course will then delve into the various numerical methods used to solve heat transfer problems in CFD, including the finite volume method. Attendees will also learn about the different algorithms and solvers used in heat transfer simulations.

It will also focus on the various applications of heat transfer in CFD, including best practices for conducting simulations. The course will also introduce the basics of topology optimization and its application in heat transfer problems.

Conclusion: A hands-on exercises on a 1D heat transfer problem, giving attendees the opportunity to apply the concepts and methods learned during the course. By the end of the course, attendees will have a solid understanding of the governing equations, numerical methods, and best practices used in CFD simulations of heat transfer and be able to apply these techniques to their own projects.



#### **Ine Vandebeek**

Ine Vandebeek is Head of R&D at Diabatix. She studied at the University of Ghent, where she obtained her degree in civil engineering. After graduation, she spent five years at the university as a researcher, during which time she investigated the numerical modeling of beach profile dynamics. Then she joined the Belgian company Diabatix as an R&D engineer. After two years, she was promoted to the position of 'Head of R&D.' In this role, she leads the in-house R&D team and is responsible for setting up and implementing the development roadmap.



#### **Dr. 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 advanced A.I. 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 and he is an experienced keynote speaker at national and international conferences.

## Short Courses

**Short Course 2: 8:00 a.m. – 12:00 Noon**

**Carmel Room**

### **Understanding, Applying and Estimating the Performance of Advanced Two-Phase Heat Pipe Systems**

Instructors: Olivier de Laet, Founder, Calyos SA and Vincent Dupont, CTO, Calyos SA

The course will start by providing an explanation of the physics behind heat pipes, and then using this foundational knowledge to explain micro-channel, loop and pulsating heat pipes. The lecturer will then present the trade-offs between the different heat pipe technologies including both thermal, mechanical, and environmental constraints. The course will then focus on applying the technologies to real-world applications, including presenting some concrete examples that Calyos has already worked on. The room will then break for a brainstorming session where attendees can take a real-world application they imagine (based on their expertise). They will then discuss with the people around them and select an appropriate heat pipe technology for their application and note down their reasoning. The lecturers will spread throughout the room, taking questions and supporting attendees in selecting and reasoning.

Following the brainstorming session, volunteers will be asked to come and present their application and chosen technology, explaining their reasoning. The lecturers and additional experts will discuss and evaluate the technologies learning as a group.

The next stage of the session will take three of the attendee applications and break down the thermal resistance chain. This is the first step in order to estimate/simulate the performance. The lecturer will explore the physics behind each step, discussing points to note with the attendees. By adding some basic parameters to the application and using typical HTC values the team can then begin to estimate the performance of a system and show how this can be taken further (i.e. With CFD, models, etc.).

#### **Olivier de Laet, Founder, Calyos SA**



With over 20 years of experience in two-phase technologies, Olivier was the CEO of Euro Heat Pipes which developed two-phase cooling solutions for satellite electronic applications. He sold this company to Airbus Defense and Space but kept the technology to address the cooling challenges of the non-space electronic applications. So he incorporated Calyos that adapted the technology to the non-space environment and is now targeting the e-mobility and computing markets mainly. Prior to Euro Heat Pipes and immersing in the two-phase technology, Olivier held various management positions in corporations and holds various Master Degrees in Finance and Business administration.

#### **Vincent Dupont, CTO, Calyos SA**



Vincent Dupont, CTO, PhD and senior researcher in diphasic cooling technologies with multiple publications, patents and awards in the area. Two-phase thermal specialist with more than 20 years of experience. He started his career in the industry at Euro Heat Pipes with Olivier and since 2013, Vincent is the CTO of Calyos adapting two-phase thermal technologies for specific applications for the aeronautics, rail and automotive and computing industries. Prior to Euro Heat Pipes, Vincent was a post-doctorate researcher at EPFL. Vincent holds a PhD in Energy Systems as well as a Master Degree in Mechanical Engineer (Toulouse III University).



## Short Courses

**Short Course 3: 8:00 a.m. – 12:00 Noon**

**Monterey Room**

### **Addressing Chip Component and System Thermal and Reliability Challenges for Qualification of Automotive-Grade High-Performance Compute Systems**

Instructor: Fen Chen, Principal Reliability Engineer, Cruise LLC

The future of driving is quickly evolving toward fully autonomous vehicles. Without a human driver, a computer system must be able to be functional with top performance and must always respond faster than the human driver during its entire life to guarantee driving safety. An AV Compute system usually is developed with multiple larger-size PCBs hosting multiple CPUs, AI processors, and other critical IC components as redundancy for high performance, high safety, and high-reliability AV driving. During the rigid AV Compute reliability qualification, various thermal and mechanical loads are imposed onto the Compute system. Chip thermal failure under such severe environmental loads is a critical concern. In this short course, during the first part, we will review the basic chip thermal design, cooling solution, and chip-level reliability issues. We will focus on comparing lidded and lidless package thermal and reliability performances. Chip thermal management hot trends will also be explored. During the second part, we will introduce the thermal mission profile and various reliability stress test requirements for AV hardware validation per automotive industry standards. Particularly, we will show the thermal reliability challenges to qualify vehicle Compute. During the third part, we will review the latest vehicle thermal management technologies, and cover the topics of the critical chip-system thermomechanical interaction during the Compute validation test and field operation. Such interaction can potentially impose a mechanical load on the critical interfaces along the chip thermal conduction path to cause thermal trip failures. Extensive published experimental data and simulation data will be reviewed to show chip thermal failure modes and effects, and the physics of failure in harsh environments. Lastly, during the fourth part, we will bring ideas on how to enable reliable high-performance liquid-cooled Compute by imposing silicon level, package level, board level, and system level mitigations to successfully reduce chip thermal failure risks during vehicle field operations.



**Fen Chen** received his Ph.D. degree in Electrical Engineering in 1998 from the University of Delaware. From 1997 to 1998, he was with Intel Component Research in Santa Clara, CA as a graduate intern working on IC interconnect reliability. He joined IBM microelectronics at Essex Junction, VT in 1998 and had worked on semiconductor technology reliability issues until 2015. From 2015 to 2019, he worked for Apple Inc at Cupertino, CA as a senior reliability engineer focusing on the qualifications of various consumer electronic products. In 2019, he joined Lumileds in San Jose, CA as the director of quality and reliability and was responsible for qualifying novel  $\mu$ LED MCM products for automotive applications. After 6-month of work at Lumileds, he joined GM Cruise in 2019 and currently is a principal reliability/validation engineer. He has been working on validations of electronic, optical, and electromechanical modules for groundbreaking Cruise AV hardware systems since he joined Cruise. He holds more than fifty-five patents and has published over 60 technical papers/invited talks in various journals and conference proceedings.

## Short Courses

**Short Course 4: 1:30 p.m. – 5:30 pm**

**San Jose and Santa Clara Rooms**

### **Direct to Chip Liquid Cooling: Single Phase Water versus Pumped Two-Phase Refrigerant Cooling**

Instructor: Alfonso Ortega, Birlle Endowed Chair, Professor of Energy Technology, Villanova University

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 single-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 and the engineering thermo-fluid models and methodologies, and 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
- Traditional versus low global-warming potential “green” refrigerants
- System ramifications and trade-offs for using single phase liquid versus pumped two-phase refrigerant cooling

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



#### **Dr. Alfonso Ortega, Villanova University**

Dr. Alfonso Ortega is the James R. Birlle 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 to degree completion, 5 postdoctoral researchers, and more than 70 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. He will receive the 2023 SEMI-THERM Hall of Fame award for his career contributions to the field.

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

**Monterey Room**

## **Transient Thermal Analysis Using Linear Superposition**

Instructor: Roger Stout, Professional Engineer (Retired)

This course will present the basic principles of linear superposition in the context of thermal analysis. Subtopics will include:

Superposition as applied to steady state thermal analysis • Matrix representation • The method of images • Linear superposition in the transient domain • Thermal RC networks

Special case closed-form solutions • and the use of widely accessible tools such as SPICE, Excel, and VBA

### **Roger Stout**



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 Lab Patents and Publications:

6 patents issued, 80 technical publications over career, the majority related to thermal analysis of semiconductor packages.



### **SUBMIT A PAPER FOR SEMI-THERM 40!**

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, 2023).

We welcome your submissions! Visit us at [www.SEMI-THERM.org](http://www.SEMI-THERM.org).

SEMI-THERM 40 is March 23rd-29th, 2024 – be there!

## Schedule of Events

### Monday March 13, 2023

**8:00 a.m. – 5:30 p.m.**

**Short Courses**

**Room:**

**Short Course 1: 8:00 a.m. – 12:00 p.m.**

**Fundamentals of CFD for Heat Transfer Analysis: Governing Equations, Numerical Methods, and Applications**

Instructors: Ine Vandebek, Head of R&D, Diabatix, and Dr. Lieven Vervecken, CEO, Diabatix

**San Jose**

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

**Understanding, Applying and Estimating the Performance of Advanced Two-Phase Heat Pipe Systems**

Instructors: Olivier de Laet, Founder, Calyos SA and Vincent Dupont, CTO, Calyos SA

**Carmel**

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

**Addressing Chip Component and System Thermal and Reliability Challenges for Qualification of Automotive-Grade High-Performance Compute Systems**

Instructor: Fen Chen, Principal Reliability Engineer, Cruise LLC

**Monterey**

**Short Course 4: 1:30 p.m. – 5:30 p.m.**

**Direct to Chip Liquid Cooling: Single Phase Water versus Pumped Two-Phase Refrigerant Cooling**

Instructor: Alfonso Ortega, Birle Endowed Chair, Professor of Energy Technology, Villanova University

**San Jose and Santa Clara**

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

**Transient Thermal Analysis Using Linear Superposition**

Instructor: Roger Stout, Professional Engineer (Retired)

**Monterey**

**3:30 p.m. – 6:30 p.m.**

**Attendee Registration**

**Bayshore Foyer**

**6:30 p.m. – 8:00 p.m.**

**Pre-Conference Meeting**

**San Simeon**

### Tuesday, March 14, 2023

**7:00 a.m. – 6:00 p.m.**

**Attendee Registration**

**Bayshore Foyer**

**7:00 a.m. – 7:45 a.m.**

**Speakers' Breakfast (March 14 Speakers, Session Chairs and Co-Chairs only)**

**San Jose**

**8:00 a.m. – 8:10 a.m.**

**Opening Remarks:** Marcello del Valle, Infinera

**Oak and Fir**

## Schedule of Events

**Tuesday, March 14, 2023**

<b>8:10 a.m. – 9:30 a.m.</b> <b>Session 1 – Comfort and Compliance</b> Session Chair: Mark Hepwocoski, ThermoAnalytics	<b>Oak and Fir</b>
<b>8:10 a.m. – 8:30 a.m.</b> <b>Reduced-Order Modeling for Thermal Dose Forecasting in Wearable Devices</b> Harry Watson, Exponent	<b>Oak and Fir</b>
<b>8:30 a.m. – 8:50 a.m.</b> <b>Development of a Human Surrogate Measurement Device for Testing Infants Undergoing Therapeutic Hypothermia</b> Robert Shea, Belmont Medical Technologies	<b>Oak and Fir</b>
<b>8:50 a.m. – 9:10 a.m.</b> <b>Evaluation of Thermal Injury Level in the Event of Smartwatch Battery Failure</b> Mark Hepokoski, ThermoAnalytics, Inc.	<b>Oak and Fir</b>
<b>9:10 a.m. – 10:10 a.m.</b> <b>Keynote: Sustainable Solutions: Liquid Cooling in Data Centers</b> <b>Dr. Ashish Gupta</b> , Intel Corporation	<b>Oak and Fir</b>
<b>10:10 a.m. – 10:30 a.m.</b> <b>Break</b>	<b>Gateway Foyer</b>
<b>10:30 a.m. – 11:30 a.m.</b> <b>Parallel Session 2: Two-Phase I</b> Session Chair: Dave Saums, DS&A LLC	<b>Oak</b>
<b>10:30 a.m. – 10:50 a.m.</b> <b>Experimental Comparison on Thermal Performance of Pulsating Heat Pipe and Embedded Heat Spreaders</b> Sai Kiran Hota, Advanced Cooling Technologies	<b>Oak</b>
<b>10:50 a.m. – 11:10 a.m.</b> <b>Controlling Flow Instabilities in Direct-to-Chip Two-Phase Cooling for High Heat Flux Processors</b> Yaman Manaserh, NVIDIA	<b>Oak</b>
<b>11:10 a.m. – 11:30 a.m.</b> <b>Flow Boiling Heat Transfer Performance Comparison of Skived Straight and CNC Diverging Microchannels Heat Sinks</b> Chien-Yuh Yang, National Central University, Taiwan	<b>Oak</b>



## Keynote

Tuesday, March 14, 9:10 a.m.

### Sustainable Solutions: Liquid Cooling in Data Centers



**Presenter: Dr. Ashish Gupta**  
**Intel Corporation**

As data volumes continue to grow exponentially, the demand for high-performance computing is putting unprecedented pressure on data centers (cloud and edge) to process and store massive amounts of data. This has led to a surge in energy consumption and carbon emissions, making it more important than ever to adopt sustainable solutions. Liquid cooling is a promising technology that can significantly reduce energy consumption and carbon emissions while also improving computing performance. This keynote will explore the role of liquid cooling in driving sustainability in data centers, including the latest trends and innovations in liquid cooling technology. Attendees will gain insights into how liquid cooling can help meet the challenges of data growth and processing while also promoting environmental sustainability.

**Dr. Ashish Gupta** is the Senior Director of Thermal Mechanical Solution group at Intel Corporation. His group is responsible for developing thermal and mechanical engineering in support of the Data Center Platform product roadmap. In his career, Ashish has managed numerous engineering teams across Data Center, Client Computing, and Assembly-Test organizations in US, Latin America, and Asia sites. Ashish has 9 patents and has published more than 80 papers at Intel and outside. Ashish holds a Ph.D. in Mechanical Engineering from Purdue University, USA and was awarded with Outstanding Mechanical Engineer award by Purdue University in 2022.

## How-To Presentation

Wednesday March 15, 4:00 p.m. – 5:00 p.m., Oak

### A Look at Acoustic Fundamentals and Designs as Applied to Air-Cooled Electronics

**Presenter: Herman Chu, Celestica**

As air-cooling design continues to increase in airflow requirement without much relieve in the overall equipment form factor, acoustic design considerations need to be actively engaged at the start of the product development cycle in order to clearly define expectations and deliver the best achievable sound quality. In this how-to session, the speaker will present acoustic design fundamentals, review logarithmic arithmetic used in calculating sound levels, and review pertinent industry standards in performing acoustic testing for product evaluation.



**Herman Chu** is classically trained in thermal fluid systems and has over 30 years of industry experience spanning from military aerospace applications to electronic cooling of consumer products, computers and computer servers, mainframes and NEBS compliant networking equipment. His career has taken him to deploy all different kinds of cooling technologies from air cooling to various forms of liquid cooling. His latest accomplishment is architecting the first active 2-Phase cooling for a commercial desktop AI supercomputer.

## Schedule of Events

**Tuesday, March 14, 2023**

**10:30 a.m. – 11:30 a.m.**

**Parallel Session 3: Advanced Manufacturing & Materials**

Session Chair: Jason Jones, Hybrid Manufacturing Technologies

**Fir**

**10:30 a.m. – 10:45 a.m.**

**Experimental Performance of Supercritical Carbon Dioxide within Cold Plates made with Additive Manufacturing Techniques**

Wyatt Stottlemeyre, Oregon State University

**Fir**

**10:45 a.m. – 11:00 a.m.**

**Is the Copper 3D Printing Technology Ready to Compete with Skived Heat Sinks?**

Suraj Dinkar Jadhav, Amnovis BV

**Fir**

**11:00 a.m. – 11:15 a.m.**

**Generative Design and Experimental Validation of a CPU Cooler AI-Backed 3D Copper Design**

Lieven Vervecken, Diabatix nv

**Fir**

## Luncheon Speaker

Tuesday, March 14  
**High Tech in High Heels**



**Presenter: Katrien Herdewyn  
Elegnano**

What do nanotechnology and shoes have in common? With climate change knocking on the door, the fashion industry is opening up to the possibilities technology has to offer: nanotechnology, digital fashion, 3D printing, biofabrication, etc. In this talk, I will shed light on high tech – often borrowed from other industries - finding its way into the fashion industry and the clothes and shoes we wear today or will be wearing in the future.

**Katrien Herdewyn** is the founder of Elegnano, a fashion tech company specializing in leather technology. Founded in 2014, Elegnano combines design, craftsmanship, and state-of-the-art innovation in commercial fashion products. Apart from an in-house footwear brand, the company also consults other technology and fashion companies worldwide in the development and commercialization of novel fashion-tech products. Katrien received a Bachelor's in Electrical Engineering & Material Sciences and a Master's in Nanotechnology from the University of Leuven. In 2022, Katrien was named Top 50 Women in European Tech by the Financial Times and InspiringFifty. She is also Honorary Professor at the Faculty of Engineering at the University of Leuven. Katrien has been on many national and international stages for conferences, institutions, and companies, including TEDx, imec, General Electric, and the European Union.

## Vendor Workshops

Tuesday March 14, 2023		Wednesday March 15, 2023	
<b>Oak</b> 2:00 p.m. Hexagon 3:00 p.m. Cadence Design Systems	<b>Fir</b> 2:00 p.m. Laser Thermal 3:00 p.m. Readore Technology	<b>Oak</b> 2:00 p.m. Hexagon 3:00 p.m. Dongguan Sheen Electronic Technology	<b>Fir</b> 2:00 p.m. COMSOL, Inc.

## Schedule of Events

**Tuesday, March 14, 2023**

- 11:15 a.m. – 11:30 a.m.** **Fir**  
**Assessing the Performance of Liquid Cooled Plates for Inverter Stacks Produced by CoreFlow™**  
Jason Jones, TWI Ltd.
- 11:30 a.m. – 12:30 p.m.** **Oak**  
**Parallel Session 4: Two-Phase II**  
Session Chair: Dave Saums, DS&A LLC
- 11:30 a.m. – 11:50 a.m.** **Oak**  
**Thermal Performance of Wickless Boiling-Driven Heat Spreader**  
Jungho Lee, Ajou University, ROK
- 11:50 a.m. – 12:10 p.m.** **Oak**  
**Dielectric Oscillating Heat Pipe Development for Printed Circuit Board Ground Plane, High Power Amplifier, and Radio Frequency Systems**  
Patrick Margavio, ThermAvant Technologies
- 12:10 p.m. – 12:30 p.m.** **Oak**  
**A Loop Heat Pipe for Vehicle CPU Cooling: Peak Performance, Partial Flooding and Dryout Regimes**  
Olivier de Laet, Calyos SA
- 11:30 a.m. – 12:30 p.m.** **Fir**  
**Parallel Session 5: Emerging Technology**  
Session Chair: Sai Kiran Hota, Advanced Cooling Technologies
- 11:30 a.m. – 11:50 a.m.** **Fir**  
**Evaluation of CVD diamond Heat-Spreaders for use with High Frequency MMICs**  
Firooz Faili, Element Six Technologies, USA
- 11:50 a.m. – 12:10 p.m.** **Fir**  
**Soft and Stretchable Composite Materials for Wearable Thermoelectric Body Thermoregulation and Energy Harvesting**  
Mason Zadan, Carnegie Mellon University
- 12:10 p.m. – 12:30 p.m.** **Fir**  
**Solid-State Portable Coolers and Warmers using Thermoelectric Systems**  
Brandon Noska, Sheetak, Inc
- 12:30 p.m. – 1:50 p.m.** **Pine and Cedar**  
**Luncheon: High-Tech in High Heels**  
Katrien Herdewyn
- 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**

Tuesday, March 14, 2023, 5:00 p.m - 6:00 p.m. Oak

## Career Trajectory Panel

The Career Trajectory panelists will share their insights on how to build a successful career in the electronics cooling industry. Each panelist will be asked to address the question:

“What do you know now that you wish you had been told when you started your career?”

The goals of these presentations are to inform, entertain and stimulate active, discussion with attendees.

### Moderator:

Taravat Khadivi, Meta, Consumer Electronics

### Panelists:

Ross Wilcoxon, Collins Aerospace

Yueming Li, Meta, Data Centers

Lieven Vervecken, Diabatix, Entrepreneur

Nicole Okamoto, San Jose State, Academia

## Schedule of Events

### Wednesday, March 15, 2023

7:00 a.m. – 6:00 p.m.  
Attendee Registration

Bayshore Foyer

7:00 a.m. – 7:45 a.m.  
Speakers' Breakfast (March 15 Speakers, Session Chairs and Co-Chairs only)

San Jose

8:00 a.m. – 8:10 a.m.  
Opening Remarks

Oak and Fir

8:10 a.m. – 9:30 a.m.  
Session 6: Immersion, Session Chair: Dave Saums, DS&A LLC

Oak and Fir

8:10 a.m. – 8:25 a.m.  
Understanding Boiling Crisis using High-Speed Measurements of Temperature and Phase Distribution to Enable High-Power-Density Immersion Cooled Electronics  
Justin A. Weibel, Purdue University

Oak and Fir



## Schedule of Events

**Wednesday, March 15, 2023**

<b>8:25 a.m. – 8:40 a.m.</b> <b>Air vs. Single-Phase Immersion Cooling</b> Guy Wagner, Electronic Cooling Solutions Inc.	<b>Oak and Fir</b>
<b>8:40 a.m. – 8:55 a.m.</b> <b>Exploration of Boiling Enhancement Coating Designs in High-Power Chip/Server Cooling using Two-Phase Immersion Cooling Technique</b> Vaidehi Oruganti, Microsoft	<b>Oak and Fir</b>
<b>8:55 a.m. – 9:10 a.m.</b> <b>Thermal Interface Materials in Liquid Immersion for Computing and Power Electronics</b> Dave Saums, DS&A LLC	<b>Oak and Fir</b>
<b>9:10 a.m. – 10:10 a.m.</b> <b>Thermi Award Recipient Presentation – This Journey is 1% Finished</b> Dr. Veerendra Mulay, Meta Platforms, Inc.	<b>Oak and Fir</b>
<b>10:10 a.m. – 10:30 a.m.</b> <b>Break</b>	<b>Gateway Foyer</b>
<b>10:30 a.m. – 11:30 a.m.</b> <b>Parallel Session 7: Testing &amp; Measurement Methods I</b> Session Chair: Mohamad Abo Ras, Berliner Nanotest und Design GmbH	<b>Oak</b>
<b>10:30 a.m. – 10:50 a.m.</b> <b>The Validity of JESD51-14 for Differing Package Styles</b> Robin Bornoff, Siemens	<b>Oak</b>
<b>10:50 a.m. – 11:10 a.m.</b> <b>Subpixel Cross Correlation Registration for High Spatial Resolution Thermal Image on IGBT Emitter Metallization by Thermoreflectance Measurements</b> Thierry Kociniewski, Groupe d'Etude de la Matière Condensée, CNRS and University of Versailles St Quentin	<b>Oak</b>
<b>11:10 a.m. – 11:30 a.m.</b> <b>Thermal Test Vehicles for Evaluation and Qualification of Advanced Packages</b> Mohamad Abo Ras, Berliner Nanotest und Design GmbH	<b>Oak</b>
<b>10:30 a.m. – 11:30 a.m.</b> <b>Parallel Session 8: TIMS I</b> Session Chair: Navid Kazem, Arieca Inc.	<b>Fir</b>

## THERMI PRESENTATION

Wednesday, March 15, 2023

"This journey is 1% finished"

This is my perspective on my engineering journey so far.

### 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:



**Dr. Veerendra Mulay**

Meta



**Dr. Veerendra Mulay** is a senior R&D engineer in Meta Platforms Inc.'s technical strategy team in Infra Data Center (IDC) group and is responsible for driving the strategy for data center mechanical systems worldwide, including research, engineering and support for construction and delivery. Since his joining Meta (then Facebook) in 2009, Veerendra has been a key member of small team that tackled the big challenge of scaling Meta's computing infrastructure in most efficient and economical way.

Veerendra received his Ph.D. in Mechanical Engineering from the University of Texas at Arlington. He has authored numerous technical papers and articles. Veerendra received ASME EPPD's Young Engineer Award in 2015 and was elected Fellow of ASME in 2021.

## Schedule of Events

**Wednesday, March 15, 2023**

**10:30 a.m. – 10:45 a.m.**

**Thermal Conductivity is NOT the Only Deciding Factor: A Guide to Understanding Unaddressed Challenges with Liquid Metals TIMs**

Claire Wemp and John Hodul, DuPont

**Fir**

**10:45 a.m. – 11:00 a.m.**

**Liquid Metal Embedded Elastomers as TIM2 Materials**

Dylan Shah, Arieca, Inc.

**Fir**

**11:00 a.m. – 11:15 a.m.**

**Innovative Next Generation Metal TIM Technology for HPC Applications**

Timothy Jensen, Indium Corporation

**Fir**

*Continued*

## Luncheon Speaker

**Wednesday, March 15, 2023**



**Presenter: Jousef Murad**  
**Host of Engineered-Mind Podcast**

In today's digital age, social media has become an important platform for professionals to share their knowledge and expertise with the world. The engineering space is no exception, as engineers are increasingly using social media to share their experiences and connect with like-minded individuals. This has given rise to a new class of professionals known as engineering influencers, who use social media to influence and shape the opinions of their followers.

**Jousef Murad** is founder of APEX, a marketing agency accelerating marketing for tech companies in the digital renaissance. As an engineer and podcast host, he delves into the latest developments in science topics and discuss their impact on society and how the digital renaissance is shaping our world.

Thursday March 16, 2023 12:30 p.m.

## The 2022 Harvey Rosten Award Sponsored by Siemens Digital Industries Software

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

### Analysis of the Thermal Behavior of Li-Ion Pouch Battery Cell – Part II: Circuit-based Modeling for Fast and Accurate Thermo-Electrochemical Simulation



**Antonio  
Pio Catalano**



**Ciro  
Scognamillo**



**Francesco  
Piccirillo**



**Pierluigi  
Guerriero**



**Vincenzo  
D'Alessandro**



**Lorenzo  
Codecasa**

**Antonio Pio Catalano** is an assistant professor with the University of Naples Federico II, Italy. His research interests include the modeling of thermal and electrothermal effects in electronic devices and circuits. His contributions also fall in the scenario of renewable energies.

**Ciro Scognamillo** is a post-doctoral researcher with University of Naples Federico II, Italy. His research is focused on state-of-the-art technologies for power modules, as well as on electrothermal simulations of semiconductor devices for radiofrequency applications.

**Francesco Piccirillo** received the M. Sc. degree Magna cum Laude in mechanical engineering from the University of Naples Federico II, Italy. His M. Sc. thesis concerned numerical modeling of Li-ion batteries. He is currently working with FEV Italia as control systems engineer.

**Pierluigi Guerriero** is currently an associate professor with the University of Naples Federico II, Italy. His research concerns modeling and characterization devices and systems, design of converters for renewable energy applications, and development of embedded systems for monitoring and diagnostic in photovoltaic plants.

**Vincenzo d'Alessandro** is currently an associate professor with the University of Naples Federico II, Italy. His main research interests focus on the simulation, modeling, and experimental characterization of electrothermal effects in a large variety of semiconductor devices, circuits, and systems, as well as on the modeling and simulation of energy yield reduction in photovoltaic plants.

**Lorenzo Codecasa** is an associate professor with Politecnico di Milano, Italy. His main research contributions are in the theoretical analysis and in the computational investigation of electric circuits and electromagnetic fields. He is particularly active in the research of heat transfer and thermal management of electronic devices and systems.

#### 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.

## Schedule of Events

Wednesday, March 15, 2023

- 11:15 a.m. – 11:30 a.m.** **Fir**  
**Metal Gel Material: A Novel Liquid Metal Paste for Thermal Management Applications**  
Taylor Neumann, Liquid Wire
- 11:30 a.m. – 12:30 p.m.** **Oak**  
**Parallel Session 9: Testing & Measurement Methods II**  
Session Chair: Mohamad Abo Ras, Berliner Nanotest und Design GmbH
- 11:30 a.m. – 11:45 a.m.** **Oak**  
**Measurement of the Effective Thermal Diffusion Conductivity of Vapor Chamber**  
Professor Wei – Keng Lin, T – Global Technology Co., Ltd
- 11:45 a.m. – 12:00 p.m.** **Oak**  
**A De-embedded Pressure Drop Measurement Technique Coupled with Flow Network Analysis Software to Evaluate Pressure Drop Performance Curves for Direct Liquid Cooling Thermal Management Applications**  
Stephen Polzer, Mayo Clinic
- 12:00 p.m. – 12:15 p.m.** **Oak**  
**Study of Temperature Measurement Accuracy by Using Different Mounting Adhesives on Plastics**  
Dr. Jeevan Kanesalingam, Motorola Solutions
- 12:15 p.m. – 12:30 p.m.** **Oak**  
**Fractional Thermal Runaway Calorimetry: A Novel Tool to Assess Battery Thermal Runaway Energy**  
May Yen, Exponent
- 11:30 a.m. – 12:10 p.m.** **Fir**  
**Parallel Session 10: TIMS II**  
Session Chair: Navid Kazem, Arieca Inc.
- 11:30 a.m. – 11:50 a.m.** **Fir**  
**A New Generation of Thermal Interface Materials**  
Rafael Padilla, Boston Materials
- 11:50 a.m. – 12:10 p.m.** **Fir**  
**Aging Investigations Under Mechanical Stress on Thermal Interface Materials**  
Antonio Harder, Berliner Nanotest und Design GmbH
- 12:30 p.m. – 1:50 p.m.** **Pine and Cedar**  
**Luncheon: Jousef Murad, Host of the Engineered-Mind Podcast**



# SEMI-THERM 39

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**Wednesday, March 15, 2023**

**1:50 p.m. – 2:00 p.m.**

**Break**

**1:30 p.m. – 6:30 p.m.**

**Vendor Exhibits**

**Bayshore Ballroom**

**2:00 p.m. – 4:00 p.m.**

**Vendor Workshops**

**Oak and Fir**

**4:00 p.m. – 5:00 p.m.**

**How-To Course: A Look at Acoustic Fundamentals and Designs as Applied to Air – Cooled Electronics**

Presented by Herman Chu, Celestica

**Oak**

**5:15 p.m. – 6:30 p.m.**

**Exhibit Reception**

**Bayshore Ballroom**

**Thursday, March 16, 2023**

**7:00 a.m. – 12:00 p.m.**

**Attendee Registration**

**Bayshore Foyer**

**7:00 a.m. – 7:45 a.m.**

**Speakers' Breakfast (March 16 Speakers, Session Chairs and Co-Chairs only)**

**San Jose**

**8:00 a.m. – 8:10 a.m.**

**Opening Remarks**

**Oak and Fir**

**8:10 a.m. – 10:10 a.m.**

**Session 11 – Data Centers**

Session Chair: Jason Strader, Laird

**Oak and Fir**

**8:10 a.m. – 8:30 a.m.**

**Impact of Rack Thermal Management Architecture on Data Center Energy Consumption**

Tim Shedd, Dell Technologies

**Oak and Fir**

**8:30 a.m. – 8:50 a.m.**

**Performance Comparison of Five Data Center Server Thermal Management Technologies**

Tim Shedd, Dell Technologies

**Oak and Fir**

**8:50 a.m. – 9:10 a.m.**

**Corrosion: A Localized Problem with Broad Impact – A Case Study on Surface Characterization of Eroded Metal Plating via Elemental Analysis**

**Oak and Fir**

# SEMI-THERM®



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



**Dr. Alfonso Ortega**

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

**Dr. Alfonso Ortega** is the James R. Birlle 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 to degree completion, 5 postdoctoral researchers, and more than 70 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 Thermie Award and the 2017 IThERM Achievement Award in recognition of his contributions to the field of electronics thermal management. He will receive the 2023 SEMITHERM Hall of Fame Award for his career contributions to the field.

**Thermal Management of Electronic Systems 1970-2023:  
An Academic Perspective  
Dr. Alfonso Ortega**

James R. Birle Professor of Energy Technology  
Director, Laboratory for Advanced Thermal and Fluid Systems  
Director, Villanova Site National Science Foundation Industry/University Cooperative Research Center on  
Energy Smart Electronic Systems

**Abstract**

Having received a Ph.D. in research related to passive air cooling of electronic systems in 1981, I have had a rare opportunity to closely follow developments and participate and lead research in thermal management for electronic systems for the past 40 years. In this presentation I will trace the trajectory of thermal management needs, primarily for computing systems, since 1970, and discuss the evolution of cooling technology to meet those needs, as I have personally encountered it. In discussing this decades long path of technology development, I will illustrate the role of academic research by selective examples of problems that have been studied in the HTTM research group at Stanford University and The Laboratory for Advanced Thermal and Fluid Systems at The University of Arizona and Villanova University, from 1981 to the present day. I will also discuss important contributions from other academic research teams that have inspired me as a researcher and have moved technology forward. In this personal journey through cooling technology development and research, I will start with the needs for high reliability passive air cooling in telecom equipment from the 1970's, early work in liquid cooling systems in the 70's and 80's, the discovery of microchannels in the 80's, the search for increasingly effective forced air cooling including the introduction of hybrid heat pipe assisted systems through the 90's and 00's, and the "re-birth" of liquid cooling in all of its forms in the 2010's and 20's including direct to chip water cooling, two-phase refrigerant cooling, and immersion cooling.

## Schedule of Events

**Thursday, March 16, 2023**

Andres Abraham, Colder Products Company

**9:10 a.m. – 9:30 a.m.**

**Oak and Fir**

**A Transient CFD Study on Implementation of Dynamic Liquid Cooling for Series and Parallel Arrangement of Components in a Server at Rack Level**

Himanshu Modi, The University of Texas At Arlington

**9:30 a.m. – 9:50 a.m.**

**Oak and Fir**

**Coolant Considerations for Liquid Cooling**

Albert Chan, Cisco Systems, Inc.

**9:50 a.m. – 10:10 a.m.**

**Oak and Fir**

**Air-Immersion Solution, Maximizing Data Centers Heat Reuse, Using Hybrid Cooling Approach Combining Two-Phase Direct on Chip Dielectric Liquid and Air-Based Chip Cooling**

Shahar Belkin, ZutaCore

**10:10 a.m. – 10:30 a.m.**

**Gateway Foyer**

**Break**

**10:30 a.m. – 11:30 a.m.**

**Oak and Fir**

**Session 12 – Numerical Modeling Methods**

Session Chair: Menasa Sahini, Meta

**10:30 a.m. – 10:50 p.m.**

**Oak and Fir**

**Evaluation of Embeddable FANTASTIC BCIV-ROMs as Compact Thermal Models**

Mahmood Alkhenazi, Siemens Digital Industry

**10:50 p.m. – 11:10 p.m.**

**Oak and Fir**

**Transient Thermal Control Simulation and Analysis Using Reduced Order Modeling of An Automotive Package Test System**

Christopher W Argento, NXP Semiconductors

**11:10 p.m. – 11:30 p.m.**

**Oak and Fir**

**Thermal Analysis and Optimization of Electric Vehicle Power Control Unit**

Anup Paul, Hexagon Manufacturing Intelligence

**11:30 a.m. – 12:15 p.m.**

**Oak and Fir**

**Hall of Fame Talk: Alfonso Ortega**

Alfonso Ortega, Birle Endowed Chair Professor of Energy Technology, Villanova University

**12:15 p.m. – 2:00 p.m.**

**Pine and Cedar**

**Awards Luncheon**

Marcelo del Valle, Infinera and Alex Ockfen, Meta

## Schedule of Events

**Friday, March 17, 2023**

**8:00 a.m. – 12:30 p.m.**  
**Thermal Workshop**

**San Martin**

**2:00 p.m. – 5:00 p.m.**  
**JEDEC JC 15 Meeting**

**San Martin**

Thermal Characterization Techniques for Semiconductor Packages Activities within JC-15's scope include the standardization of thermal characterization techniques, both testing and modeling, for electronic packages, components, and materials for semiconductor devices.

### **Thermal Workshop: Development of Thermal Characterization Standards for Electronic Industry**

**Friday, March 17, 2023, 8:00 a.m. – 12:30 p.m., San Martin**

Technical standards are an essential component for building commonality for the exchange of information between suppliers and users of electronic components. The JC15 thermal standards committee develops thermal characterization techniques for semiconductor packages by following a set of principles including; shall be meaningful, consistent, and shall be proven to be scientifically sound. From the first standards developed in the 1990s, addressing experimental methods for single die packages, to more recent standards addressing the provision of neutral file format thermal models, the JC15 committee has provided the guidance on thermal characterization best practices.

This open thermal workshop will provide a will provide a historical view of standards develop over the past 30 years and an assessment of future needs as electronic package characterization become more complex including multi- die operating under transient conditions. With simulation needs in mind, two areas will be discussed in more detail. The first topic is boundary condition independent thermal modeling considerations. The second topic is the importance of local power maps on device reliability measurements and thermal predictions. Please join us in discussing the ever-growing need for thermal standards to characterize more complex electronic packages.

<b>Coffee and Introduction</b>	<b>8:00 a.m. – 8:30 a.m.</b>
<b>Standardization in the Electronics Industry: Yesterday, Today, Tomorrow</b>	<b>8:30 a.m. – 9:30 a.m.</b>
<b>Boundary Condition Independent Thermal Modeling Considerations</b>	<b>9:30 a.m. – 10:45 a.m.</b>
<b>Break</b>	<b>10:45 a.m. – 11:00 a.m.</b>
<b>Importance of Local Power Maps on Device Reliability Measurements and Thermal Predictions</b>	<b>11:00 a.m. – 12:00 p.m.</b>
<b>How Good is That Thermal Measurement? – Statictics and Implications?</b>	<b>12:00 p.m. – 12:30 p.m.</b>

## EXHIBITOR LISTINGS

### ALPHA

#### **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](http://www.alphanovatech.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.analysisistech.com](http://www.analysisistech.com)



#### **Anemoi Software Inc**

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Anemoi Software Inc. is a provider of Thermal and Power design and simulation tools and solutions for the growing market of Heterogeneously Integrated 3D IC market. Our solutions enable Architects and Designer to explore, analyze and optimize their systems.

Anemoi Software Inc. is a founding member of the American Chiplet.US Alliance (<https://chiplet.us>) which strives to accelerate the design and manufacturing of Heterogeneously Integrated Chiplet System on American soil.



### NANOTEST

Berliner Nanotest und Design GmbH

#### **Berliner Nanotest und Design GmbH**

**500**

NANOTEST | The Berliner Nanotest und Design GmbH is German engineering company with scientific lab that provides services and products for 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 products' 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 series testing, aging investigations and failure analyses. By staying active in research and keeping a close link to various institutes and universities, Nanotest solutions are always up to date with latest scientific and methodological developments and offer the edge over other comparable solutions.

<https://nanotest.eu>



## EXHIBITOR LISTINGS



### **Binghamton University S3IP 507**

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 509**

Calyos is a leading expert in the design and manufacture of two-phase thermal management systems. Calyos specifically focuses on loop heat pipes, micro-channel heat pipes and pulsating heat pipes. Calyos has developed several solutions for three specific cooling applications: power electronics, processors, and batteries. Calyos also develops custom solutions beyond those applications for example, engine oil heat recovery. Calyos primarily targets the E-Mobility and Computing markets, where electrification and data processing are creating ever-rising demand for new, disruptive thermal solutions. Our mission is to solve the greatest thermal challenges by enabling the adoption of the best, passive two-phase cooling solutions. Ensuring and delivering a sustainable approach to thermal management in the data-driven and electrified world we are creating.

<https://www.calyos-tm.com/>



Making Hot Technology Cooler



### **Cadence Design Systems 206**

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](http://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.



### **Cofan USA**

**301**

At COFAN USA, we keep your hot technology cool. COFAN USA is an industry leading manufacturer in thermal management solutions with in-house 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](http://www.cofan-usa.com)



### **CHROMA ATE Inc.**

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Chroma ATE Inc. Irvine Ca., is celebrating its 30th year in the US as a world-leading designer and manufacturer of complete turn-key IC thermal management and automated IC Handling solutions. Specializing in integrated and fully automated turn-key electronic test and MES solutions for the semiconductor, front and back-end test spaces. Chroma is driven to provide unique, tailored solutions, and technical support to help our US-based customers excel in today's high demanding environment.



### **COMSOL, Inc.**

**402**

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.

## EXHIBITOR LISTINGS



### **Dongguan Sheen Electronic Technology Co., Ltd**

Dongguan Sheen Electronic Technology Co., Ltd is a high-tech enterprise which dedicates to develop, produce and sale of thermally conductive materials and thermal insulation materials. For now the main products are thermally conductive pad, thermally conductive gel, thermal grease, phase change thermal grease, phase change thermal interface materials, thermally conductive tape, foam silicone sheet, thermal silicone adhesive, thermal insulation materials, they are widely used in cell phones, power supplies, LED lights, computers, automotive electronics, network communications, electrical and mechanical equipment, instrumentations, electrical and electronic fields and so on.

www. <http://www.usheenthermal.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.



### **Electronics Cooling Magazine**

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

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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/cm<sup>2</sup>) 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](http://e6.com) and contact us at [ustechnologies@e6.com](mailto:ustechnologies@e6.com)

[www.e6.com](http://www.e6.com)



### Fujipoly America Corp

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Fujipoly is a world leader in the manufacture of Sarcon<sup>®</sup> 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](http://www.fujipoly.com)



## HEXAGON

### Hexagon

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Hexagon is a global leader in sensor, software and autonomous solutions. Hexagon's Manufacturing Intelligence division uses data from design and engineering, production and metrology to make manufacturing smarter. Our CAE solutions, developed through the acquisition of the MSC Software portfolio, help engineers accelerate product innovation. For more information, visit [hexagonmi.com/mscsoftware](http://hexagonmi.com/mscsoftware).

## EXHIBITOR LISTINGS



### Indium Corporation

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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](http://www.indium.com) or email [abrown@indium.com](mailto:abrown@indium.com). You can also follow our experts, From One Engineer To Another® (#FOETA), at [www.facebook.com/indium](http://www.facebook.com/indium) or @IndiumCorp.

[www.indium.com](http://www.indium.com)



### Infra Tec Infrared LLC

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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 Imager® series together with InfraTec's efficient and convenient thermographic software IRBIS® will make electronics testing also at a  $\mu\text{m}$  scale fast and precise. Additional lock-in routines allow for the detection of failures resulting only in smallest thermal differences in the  $\mu\text{K}$  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](http://www.infratec-infrared.com)



### Laser Thermal

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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/>



### LISAT

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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/>



## EXHIBITOR LISTINGS



### **MALICO INC.**

Malico is an advanced thermal solution provider, a major metal forming company in Taiwan. Factory is equipped with precision CNC center, casting center, metal injection molding center, and cold forge center. Quality has always been Malico's core value. We're committed providing premium quality services, cost-effective product variability, and long-term customer partnerships.

<https://www.malico.com/>

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### **Novark Technologies**

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/>



### **Man Zai Industrial Co., Ltd.**

Man Zai is a leading manufacturer of water-cooled modules, with comprehensive applications covering CPU, VGA, LED and auto-electric cooling modules. R&D Team of Man Zai possesses well equipped laboratories and thermal analysis programs, therefore owing opportunities of long-term cooperation with major manufacturers all over the world.

<https://www.manzai.com.tw/index.php?lang=en>

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### **Readore Tech**

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>

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## EXHIBITOR LISTINGS



### **Schlegel Electronic Materials 304**

Schlegel Electronic Materials is a trusted industry leader and pre-eminent manufacturer of thermal interface materials.

The OpTIM® thermal interface materials by Schlegel offer a wide range of thermal performance and physical properties and can resolve even the most challenging thermal problems. As a result, designers use our TIMs widely for demanding applications, including advanced microprocessors, high-speed memory modules, micro heat pipe assemblies, and LED lighting.

OpTIM thermal interface materials include:

- Gap Fillers
- Phase Change
- Insulator
- Conductive
- Thermal Grease
- Thermal Putty

Schlegel is also proud to introduce TimSorb Hybrid Thermal / EMI Absorber to tackle the Increased demand for thermal management.

See product catalog for more details: <https://www.flipsnack.com/schlegelemi/optim-thermal-interface-material-product-catalogue/full-view.html>

Contact our expert team:

Schlegel Electronic Materials, Inc.

1600 Lexington Ave

Suite 236A

Rochester, NY 14606

Tel: +1 585-643-2000

E: [schlegelemi.na@schlegelemi.com](mailto:schlegelemi.na@schlegelemi.com)

[www.schlegelemi.com](http://www.schlegelemi.com)

### **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](http://www.microsi.com)



### **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](http://www.staubli.com)

## EXHIBITOR LISTINGS



### Stirweld

308

Stirweld team has developed a technology allowing the use of friction stir welding (FSW) on all types of CNC machine or industrial robot. We support you in the optimisation of your machine park and the integration of a new know-how to offer to your customers. Our FSW equipment's for CNC or industrial robot offers identical performances as a special FSW machine or robot (effort control, quality recording...). Their other advantages:

- Low investment cost compared to special machines or FSW robotic stations.

- Adaptability: despite the absence of standard machining centres or robot, Stirweld

FSW equipment's can be adapted to all CNC machine types and high payload robots.

- Easy to use and to install: Only 3 days of training are needed to familiarise yourself with the FSW Stirweld equipment.

We work with the automotive, space, aerospace, and metal working industries. We have a wide range of FSW equipment: FSW head for CNC machine, FSW head for



### T-Global

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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

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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

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ThermoAnalytics provides thermal solutions for complex vehicle engineering simulation. Our software, TAItherm, is the industry's most complete and flexible thermal modeling software, one that can predict the full range of temperature distribution in your product or system. TAItherm can model a variety of thermally sensitive components including transient brakes, underhood, exhaust and underbody simulation, HVAC, cabin, battery packs for HEV/EV, and more. ThermoAnalytics' rapid transient thermal analysis can couple to FEA and CFD software, a key component to an efficient design process. Our software is commonly used in the automotive, aerospace, heavy vehicle, and railway industry. ThermoAnalytics also offers advanced consulting services with our engineering teams that specialize in thermal, CFD, infrared simulation and testing.

<https://thermoanalytics.com/>

## EXHIBITOR LISTINGS



**USA Hongfuhan Technology Co.**

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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/>