FINAL PROGRAM

SEMI-THERM®

SEMI-THERM 37
Virtual Symposium
March 22-26, 2021
ALL TIMES PDT

37

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Hear from Experts and Learn about Industry Innovations

Your choice of 4 short courses - Two courses are included with your registration

Liquid Cooling Panel Discussion

Keynote Presentation:
"Opening Opportunities for Thermal Design through Innovations in CFD"

Embedded Tutorial:
"Realistic Thermal Model for Human Skin in Contact with a Wearable Electronic Device"

8 Technical Sessions

- Consumer Electronics
- Automotive/Aerospace/Outdoor
- Two-Phase Cooling I
- Two-Phase Cooling II
- Data Centers
- Liquid Cooling
- Measurement Techniques / CFD
- Thermal Interface Materials

THERMI Award Presentation:
"Apollo - The Dawn of Semiconductor Thermal Management"

See the Latest Products and Solutions

A Virtual Exhibition is Accessible Throughout the Symposium

Six Focused Vendor Workshops are Being Conducted Over Three Days

All programming subject to change

Welcome to SEMI-THERM 37!

Pablo Hidalgo

Dear Colleagues,
It is my pleasure to welcome you to SEMI-THERM 37 annual symposium. 2020 has been a year full of hardship, difficulties and loss in many forms for everyone, but hopefully we will be seeing the light at the end of the tunnel soon.

The entire organizing team and I want to thank you for your participation in this year's event after having to cancel SEMI-THERM 36 due to the pandemic. This year the entire organizing team has worked the extra yard to make this virtual symposium possible and with the same quality as previous year's meetings. We hope you find the symposium extremely helpful and beneficial for your career and your business. The SEMI-THERM organization is dedicated to providing a platform for discussion on the latest advancements in thermal management for both industry professionals as well as members of academia so during the thermal week, all participants can share their knowledge and promote collaboration between entities.

In this edition, the Program Chair, Dr. Marcelo del Valle, the Program Vice-Chair, Prof. Joshua Gess and the entire program committee has assembled a superb list of presentations and papers with a particular emphasis on thermal management from die level to infrastructure level for data centers, as well as measurement techniques of semiconductors and components. The program consists of four short courses on Monday that will span the entire morning and then a Liquid Cooling Panel to round up the day. Presentations will be given every morning from Tuesday through Thursday. This year's Keynote speaker is Dr. Lieven Vervecken, co-founder and CEO of Diabatix and he will be talking about "Opening Opportunities for thermal Design though Innovations in CFD".

SEMI-THERM would not be successful or as valuable without the participation of the thermal industry vendors. We have nearly 20 exhibitors, who you can visit by clicking on the Exhibit Hall icon. Be sure to take a few minutes to visit their virtual booths. We also have 6 vendor workshops scheduled between the technical tracks. These 30-minute in-depth talks will cover various subjects of interest to industry professionals. New for this virtual event are ten-minute talks by exhibitors that will occur during scheduled breaks. These brief talks will keep you updated on the latest commercial developments in the field.

Continued

During the symposium, we will also have several awards and I would like to take this opportunity to congratulate every single one of the recipients for their achievements. The THERMI award, which this year is sponsored by The University of Texas in Arlington, recognizes the recipient's contributions to thermal issues and overcoming the challenges presented in electronics cooling. I am very pleased to announce that the 2020 THERMI award recipient is for Dr. Ross Wilcoxon from Collins Aerospace. SEMI-THERM also instituted the Thermal Hall of Fame Lifetime Achievement Award, which this year is sponsored by Celsia, and recognizes an individual in the thermal management field that has made significant contributions to the development and commercialization of thermal management technologies during their career. I am also very honored to announce that this distinguished award will be given to Prof. Dereje Agonafer from the University of Texas in Arlington.

SEMI-THERM won't be as successful as it is without all the individuals that devote their own personal time to help in the preparation and organization of this symposium. From reviewers to session chairs, organizing, steering and technical committee members, the unconditional guidance and support from Bonnie Crystall, Denise Rael and Robert Schuch and I cannot leave behind the continuous mentorship and influence by George Meyer and SEMI-THERM's co-founder Bernie Siegal. I would like to take this opportunity to acknowledge them and give thanks for all your support during the last year.

I hope that SEMI-THERM 37 leaves a positive impact on everyone that participates this year and that everyone takes away the main reason of the symposium's existence, education on the best and newest thermal technologies and the ability to build new connections with leaders in the thermal management community.

Please join me in congratulating the Program Chair, Dr. Marcelo del Valle, the Program Vice-Chair, Prof. Joshua Gess for putting together such an exceptional program and I will be looking forward to enjoy with every one of you a wonderful thermal week.

Sincerely,

Pablo Hidalgo
Symposium General Chair

SEMI-THERM 36/37 SYMPOSIUM PERSONNEL

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Mark Carbone	Intel
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Pablo Hidalgo	AMD
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Sandeep Patil	Nissan Technical Center of North America
Devin Pellicone	ACT
Adriana Rangel	Cisco Systems
Peter Rodgers	Khalifa University, Abu Dhabi, UAE
David Saums	DS&A LLC
Mohammad Reza Shaeri	STERIS Endoscopy
Tim Shedd	Motivair Corporatio
Jason Strader	Laird
Ross Wilcoxon	Collins Aerospace
Jim Wilson	Raytheon

SEMI-THERM 37 Chair Persons

General Chair

Pablo Hidalgo, AMD

Dr. Pablo Hidalgo is an MTS Product Development Engineer in the thermal group of the Client Compute Business Unit at AMD. Currently Pablo is working on the development and launch of new Ryzen products for ultra-thin mobile applications. Previously he held positions at Aavid working on the development of new products for consumer applications, military and aerospace industries, data centers and medical. Prior to Aavid, Pablo was a research engineer at the Georgia Institute of Technology, where he spent eight years in the department of mechanical engineering. During his tenure at Georgia Tech, he worked in thermal management of high power electronics using flow control and aerodynamic techniques. His professional experience and interests are single and two-phase cooling, heat pipes, vapor chambers, R&D, conjugate heat transfer modeling, experimental methods, flow control and fluid/structure interactions. Pablo holds a Ph.D. degree in Aerospace Engineering from The University of Alabama and M.S. and B.S in Aerospace Engineering from Saint Louis University.

Program 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 Vice Chair

Dr. Joshua Gess, OSU

Dr. Joshua Gess is an Assistant Professor at Oregon State University (OSU) in Thermal Fluid Sciences. He was recognized as a 2019 Outstanding Student Branch Counselor for his leadership of OSU Overclocking, a student group focused on applying thermal management principles learned in the classroom to competitive computer overclocking. Dr. Gess was the winner of 2020 ASME K-16 Early Faculty Career in Thermal Management Award. He is the Competition Chair for the annual ASME K-16 and IEEE EPS co-sponsored Student Design Challenge where students from around the world submit their best heat sink designs made with Additive Manufacturing. Dr. Gess is also the coach of the OSU Rolling Beavers Wheelchair Basketball team and a former MVP of the Auburn University Wheelchair Basketball Team.

Short Courses

Short Course 1 **7:00 a.m.**

Let's Work Together: How Co-Design Leads to Better Solutions in Thermal Management

Lauren Boteler, Army Research

Moderator: Josh Gess, Oregon State University

Laboratory Optimization studies are generally done intradisciplinary rather than interdisciplinary, and this leads to conflict as different fields have different values when it comes to what they want in a packaged solution. Heat sinks in energy dense power electronics are an excellent example of where better communication and co-design models can yield significant improvements to fielded performance with just a small amount of preparation during the design phase. Parameterization and Figure of Merit (FOM) definitions that encapsulate electrical/ thermal/ mechanical properties pare down the solution space to a set that represents what all fields want rather than cyclically proposing "optimal" solutions that one or more fields can't possibly accommodate. This course will examine how fielded solutions were truly optimized using novel co-design tools and optimization techniques which span multiple disciplines. The case studies examined will show marked improvement beyond what single-track minded approaches yield, and lessons learned from this course will translate directly to better solutions in your workplace.

Dr. Lauren Boteler leads the thermal and packaging research programs as part of the Advanced Power Electronics group at the U.S. Army Research Laboratory (ARL). She received her Ph.D. degree in mechanical engineering from the University of Maryland. Her work at ARL, beginning in 2005, has focused on electronics packaging and thermal management solutions for a wide range of Army applications. She designs thermal and packaging solutions including 3D chip stacking, power electronics, laser diodes, RF HEMT devices, top side cooling, phase change materials, and additive manufacturing. More recently, she has initiated a research program in Advanced Power Electronics Packaging and Thermal Management which focuses on four main challenges of power electronics packaging: transient thermal mitigation, additive manufacturing, coengineering/ codesign, and high-voltage packaging. She was also awarded the 2018 ASME EPPD Woman Engineer of the Year award for her contributions to the electronics packaging community.

Short Courses

Short Course 2 **7:00 a.m.**
Design and Optimization of Heat Sinks
Marc Hodes and Georgios Karamanis, Transport Phenomena Technologies, LLC
Moderator: Pablo Hidalgo, AMD

This course provides the audience with an understanding of heat sink design and optimization in the context of thermal management of electronics. The course has two parts. The first part begins with an overview of common methods to manufacture heat sinks and discusses their advantages and disadvantages with respect to cost and fin geometry. Then, the theory of spreading resistance is presented and how to minimize it to properly size the thicknesses of the bases of heat sinks. Next, the theory of the operation of tubular and flat (vapor chamber) heat pipes is presented. In the second part of the course, single-phase conjugate heat transfer through longitudinal-fin heat sinks is highlighted. We discuss why the constant heat transfer coefficient assumption tends to be an invalid one in practice via real-world examples. Then, the use of CFD to optimize a single heat sink is considered. Next, an overview of Flow Network Modeling (FNM) for circuit packs is provided. Finally, we present an example where the fin geometries of an array of heat sinks in a circuit pack are simultaneously optimized using FNM and multi-variable optimization.

Marc Hodes is a Professor of Mechanical Engineering at Tufts University and the CTO of Transport Phenomena Technologies, LLC. He received his B.S., M.S. and Ph.D. degrees in Mechanical Engineering, the latter from MIT in 1998. He held a succession of appointments at Alcatel-Lucent's (now Nokia's) Bell Laboratories from Postdoctoral Scientist to Manager of a Thermal Management Research Group between 1998 and 2008, when he joined Tufts University.

Georgios (George) Karamanis is a Co-Founder and Senior Engineer in Transport Phenomena Technologies, LLC. He received his Ph.D. and M.S. in Mechanical Engineering from Tufts University. He has expertise in analytical, numerical and experimental techniques relevant to convective transport. He is the PI in a NSF Phase II SBIR awarded to Transport Phenomena Technologies, LLC, to develop specialized thermal modeling software and hardware for Data/Telco centers.

Short Courses

Short Course 3 **9:20 a.m.**
Micro-Two-Phase Electronics Cooling…Getting it on its Way
John R. Thome, EPFL
Moderator: Pablo Hidalgo, AMD

Two-phase flow and flow boiling heat transfer can reliably cool heat fluxes in excess of 500 W/cm2 with heat transfer coefficients nearing 100 kW/m2K with respect to the cold plate's base area. Yet, industry is hesitant to accept this technology on a large scale. Most of the reservations about this approach are easily mitigated with proper design/planning, and the benefits are substantial. In general, a micro-thermosyphon that works passively with gravity-driven flow is used with heat dissipation to a compact air coil. Due to the new "form factor" and huge surface area of the coil compared to an air-cooled heat sink, energy consumption by the fans is greatly reduced. Furthermore, a thermosyphon (no electrical driver or flow controllers) provides high reliability that is commonplace with packages which use two-phase thermal management. This lecture will recount the history and background of two-phase cooling, noting lessons learned along the way. Several case studies will be presented where performance will be highlighted. At the end of this course, you will be able to successfully understand the ins-and-outs of a two-phase cold plate cooled system which improves the reliability, cost of operation, and longevity of your devices.

John R. Thome is co-owner of JJ Cooling Innovation, a consulting/thermal engineering software company Sàrl based in Lausanne, Switzerland. From 1998 to 2018 he was Professor-Emeritus of Heat and Mass Transfer at the Ecole Polytechnique Fédérale de Lausanne (JJ Cooling Innovation), Switzerland. He is also a visiting professor at Brunel University in London and an Honorary professor at the University of Edinburgh. He obtained his PhD at Oxford University in 1978. He recently received the 2019 IEEE Richard Chu ITHERM Award for Excellence in Thermal and Thermo-Mechanic Management of Electronics and the 2019 ASME Allan Krause Thermal Management Medal at InterPack. He is the author of five books on two-phase heat transfer and flow and has over 245 journal papers on macroscale and mircoscale two-phase flow, flow visualization, boiling/condensation heat transfer, flow pattern-based models, and micro-two-phase cooling systems for electronics cooling. He has done numerous sponsored projects with IBM, ABB, Nokia Bell Labs, Carl Zeiss, CERN, etc. He is editor-in-chief of the 16-volume series Encyclopedia of Two-Phase Heat Transfer and Flow (2016-2018). He founded the Virtual International Research Institute of Two-Phase Flow and Heat Transfer in 2014, now with 25 participating universities to promote research collaboration, sharing of experimental and numerical data, and education.

Short Courses

Short Course 4 **9:20 a.m.**
Introduction to Electronics Cooling
Patrick Loney, Northrop Grumman Mission Systems
Moderator: Josh Gess, Oregon State University

As electronic packages get smaller and the power dissipations increase, performing robust thermal analyses is an increasingly important step in the electronics packaging design process. This course will focus on the component level of the electronics assembly. Thermal management, proper cooling techniques, component attachment, and analytical modeling methods will be presented. How to decipher vendor datasheets will be discussed as well as the basics of how to model custom components. Best practices for steady state and transient operational modes are included. Process development will also be presented along with discussions on requirements compliance. Students will finish the course with an understanding of how to determine the limits and requirements of an electronics component, assess the thermal performance, how to integrate the performance model into a Next Higher Assembly (NHA) thermal model, and most importantly, how to communicate this information to their internal and external customers who are dependent on this data.

Patrick Loney recently celebrated his 30th anniversary with Northrop Grumman Corporation. He has over 35 years of experience in the thermal engineering/electronics cooling industry. He received his Bachelor of Sciences degree in Nuclear Engineering from the University of Illinois and his Masters of Sciences degree in Mechanical Engineering from Cleveland State University. He holds several US Patents and Trade Secrets, mostly dealing with thermal management and electronics cooling techniques. He was recently selected for the NGC Technical Fellow program. He has presented similar courses to internal customers as well as the 2019 IPC AMEX Expo.

Schedule of Events

Monday March 22, 2021
All times PDT

7:00 a.m. – 9:00 a.m.
Morning Short Courses
Moderators: Josh Gess, Oregon State University and Pablo Hidalgo, AMD

Short Course 1: Let's Work Together: How Co-Design Leads to Better Solutions in Thermal Management
Lauren Boteler, Army Research
Moderator: Josh Gess, Oregon State University

Short Course 2: Design and Optimization of Heat Sinks
Marc Hodes and Georgios Karamanis, Transport Phenomena Technologies, LLC
Moderator: Pablo Hidalgo, AMD

9:00 a.m. – 9:20 a.m.
Break

9:20 a.m. – 11:20 a.m.
Short Course 3: Micro-Two-Phase Electronics Cooling…Getting it on its Way
John R. Thome, EPFL
Moderator: Pablo Hidalgo, AMD

Short Course 4: Introduction to Electronics Cooling
Patrick Loney, Northrop Grumman Mission Systems
Moderator: Josh Gess, Oregon State University

11:20 a.m. – 11:40 a.m.
Break

11:40 a.m. – 1:00 p.m.
Liquid Cooling Panel
Moderator: Tim Shedd, Ph.D.
Director of R&D, Motivair Corporation

Panelists:
Emre Gurpinar, Ph.D.
R&D Staff, Oak Ridge National Laboratory

Alfonso Ortega Ph.D.
James R. Birle Endowed Chair Professor of Energy Technology, Villanova University Director, Villanova site of the NSF Center for Energy Smart Electronic Systems

Suresh Pichai
Director, Innovation and Development
Equinix Data Centers

Debabrata Pal, Ph.D.
Technical Fellow
Collins Aerospace

Bapi Surampudi, Ph.D.
Staff Engineer, Electric Powertrain
Southwest Research Institute

1:00 p.m.
Closing Remarks: Tim Shedd, Motivair

Liquid Cooling Panel

Monday March 22, 11:40 a.m.

This panel will provide a broad perspective on the current usage of liquid cooling across a range of industries, including data centers, ground vehicles and aerospace. We will also look forward to the near-term trends according to these experts, then looking further out, with each panelist given the opportunity to describe the technological advances in liquid cooling that they would most like to see.

Panelists

Moderator: Dr. Timothy A. Shedd

Dr. Timothy A. Shedd is currently Director of Research and Development for Motivair Corporation. Dr. Shedd has spent 17 years as a professor, most recently as the Director of the Graduate Program, Supervisor of Entrepreneurship Programs and an Associate Professor of Mechanical Engineering at Florida Polytechnic University. He was an Assistant, then Associate, Professor of Mechanical Engineering at the University of Wisconsin from 2001 to 2016. In 2012, while still a faculty member, Shedd founded Ebullient, Inc., to commercialize a two-phase cooling system for data centers. He holds a B.S. in Electrical Engineering from Purdue University and M.S. and Ph.D. degrees in Mechanical Engineering from the University of Illinois at Urbana-Champaign. Most recently (2016), Dr. Shedd has been named a Fellow of ASHRAE (the American Society of Heating, Refrigeration and Air-conditioning Engineers).

Dr. Emre Gurpinar Ph. D.

Dr. Emre Gurpinar received the B.Sc. degree from Istanbul Technical University, Istanbul, Turkey, in 2009, a M.Sc. degree from the University of Manchester, Manchester, U.K., in 2010, and a Ph.D. degree the University of Nottingham, Nottingham, U.K., in 2017, all in electrical engineering.

In May 2017, he joined Oak Ridge National Laboratory, Oak Ridge, TN, USA. From August 2015 to October 2015, he was a Visiting Ph.D. Student in the Department of Energy Technology, Aalborg University, Aalborg, Denmark. From October 2011 to July 2013, he was a Research and Development Power Electronics Engineer with General Electric, U.K. His current research focuses on power electronic systems, with special focus on wide-bandgap-based power semiconductor devices and their integration.

Liquid Cooling Panel

Panelists

Dr. Alfonso Ortega

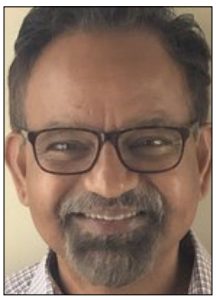
Dr. Alfonso Ortega is the James R. Birle Professor of Energy Technology at Villanova University. He is the Director of the Laboratory for Advanced Thermal and Fluid Systems and the Founding Director of the Villanova site of the NSF Center for Energy Smart Electronic Systems (ES2) founded in 2011.
He 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 thermal sciences and experimental methods. He is an internationally recognized expert in thermal 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 management and experimental measurements.
He is a Fellow of the ASME and received the 2003 SEMI-THERM THERMI Award and the 2017 ITHERM Achievement Award in recognition of his contributions to the field of electronics thermal measurements.

Dr. Debabrata Pal

Dr. Debabrata Pal is a technical fellow in aero thermal fluids discipline. Debabrata has a Ph.D. in mechanical engineering from University of Maryland, College Park. His career path took him to innovate, analyze and test various thermal management systems and methods for aircraft applications. He has been with Collins aerospace for 19 years. Prior to Collins, Debabrata worked at Motorola for 5.5 years working on two-phase cooling of electronics.

Liquid Cooling Panel

Panelists



Suresh Pichai

Suresh Pichai is Director, Innovation & Development at Equinix. Suresh's team works on future technologies for data centers and cost efficiencies through productization and supply chain optimization. He has patents pending and issued in the area of energy efficient data center cooling products and others.
Prior to Equinix, Suresh has worked for Intel and major engineering consulting firms such as CH2M Hill and Jacobs Engineering (Sverdrup) in the areas of design, design-build and facilities management. Suresh holds a MS degree from the University of Illinois and is a registered Mechanical Engineer in the state of California

Dr. Bapi Surampudi

Dr. Bapi Surampudi has more than 24 years of experience in powertrain controls and 14 years of experience with electric vehicles and various forms of lithium ion batteries. In addition to the 24 years on the staff of Southwest Research Institute (SwRI), he worked at Caterpillar, Combat Vehicle Research and Development in India and Tata consulting Engineers in India. His role at SwRI has been to build control systems for engines, transmissions, hybrid vehicles and autonomous vehicles. He has also provided leadership for the SwRI battery consortium for the last eight years. He is currently involved in research involving immersive coolants for batteries and motors, lithium plating and fast charging. He currently serves as a staff engineer for powertrain development at SwRI. He has a PhD from Texas A&M University, MTech from IIT Madras India. He is a senior member of IEEE and a member of SAE. He holds 14 patents and has published frequently in peer reviewed journals and conferences.

Schedule of Events

Tuesday, March 23, 2021
All times PDT

7:00 a.m. – 7:10 a.m.
Welcome Message: General Chair, Pablo Hidalgo, AMD
Moderators: Pablo Hidalgo, AMD, and Alex Ockfen, Facebook

7:10 a.m. – 8:10 a.m.
Session 1: Consumer Electronics

7:10 a.m. – 7:30 a.m.
Increased System Performance and Reduced Surface Touch (Skin) Temperature in Mobile Electronics Utilizing Composites of Graphite with Ultra-High Spreading Capacity and Insulation with Ultra-Low Thermal Conductivity
Mitchell Warren[1], Julian Norley[2] , John Allen[1], Jonathan Taylor[2], Lindsey Keen[1]
[1]W. L. Gore & Associates, [2]NeoGraf Solutions, LLC

7:30 a.m. – 7:50 a.m.
An Analysis of Temperature Variation Effect on Response and Performance of Capacitive Microaccelerometer Inertial Sensors
Jacek Nazdrowicz and Andrzej Napieralski
Lodz University of Technology

7:50 a.m. – 8:10 a.m.
Thermal Acceptability Limits for Wearable Electronic Devices **
Mark Andrew Hepokoski[1], Allen Curran[1], Timothy Viola[1], and Alex Ockfen[2], [1]ThermoAnalytics, [2]Facebook

8:10 a.m. – 8:40 a.m.
Vendor Workshop
Future Facilities - Perfecting the Art of Thermal Simulation of Electronics with 6SigmaET R15

8:40 a.m. – 9:00 a.m.
Break

*This presentation has no formal paper. **Extended Abstract only

Continued

Keynote
Tuesday, March 23, 9:00 a.m.

Opening Opportunities for Thermal Design through Innovations in CFD

Presenter: Lieven Vervecken
Diabatix

Over the past decades, computational fluid dynamics (CFD) has evolved from a purely research discipline to a reliable engineering practice. This evolution was driven by continued innovation in multiple domains, ranging from hardcore mathematics to HPC architecture development. Concurrently with this evolution, CFD has gradually taken on great importance in the thermal design process which has resulted in a countless number of products that could not have been realized otherwise. Yet, the potential for discovering new possibilities in thermal design through innovations in CFD remains enormous. This talk touches on a number of recent and upcoming innovations in CFD which have the potential to set this in motion.

Lieven Vervecken Is co-founder and CEO of Diabatix nv where he is responsible for the general management development of the company. Diabatix is a Belgian technology scale-up specialized in generative design for cooling components that helps multinationals all over the world to push the boundaries in thermal design. What makes Diabatix unique is the implementation of AI in the designing process, both improving efficiency and saving time for engineers. Through this aspect Diabatix is a pioneer in the market.
Lieven's mission , which he is realizing through Diabatix, is developing the next generation of design tools for designing cooling components. The goal is to completely remove the human interaction in this process and let the AI automatize the designing process from start to finish.
Before devoting his work full-time to Diabatix, Lieven completed two master's degrees, one in mechanical engineering and one in nuclear engineering. After acquiring these master's degrees he also did a PhD in the field of Computational Fluid Dynamics at the University of Leuven. Being fluent in multiple languages, Lieven is an experienced speaker at both national and international conferences. He is also a former lecturer at the University of Leuven and has written multiple publications. He is passionate about the limitless possibilities of combining engineering with artificial intelligence technology and takes every opportunity to expand his knowledge in this field. When Lieven is not working you can also find him in the kitchen, on his bike or enjoying a good book.

Schedule of Events

Tuesday, March 23, 2021
All times PDT

9:00 a.m. – 10:00 a.m.
Keynote Presentation
Opening Opportunities for Thermal Design through Innovations in CFD
Presenter: Lieven Vervecken, Diabatix

10:00 a.m. – 10:20 a.m.
Break
Break Talk: Beth Langer, CPC - Anatomy of a QD

10:20 a.m. – 11:00 a.m.
Session 2: Automotive/Aerospace/Outdoor

10:20 a.m. – 10:40 a.m.
Effects of Solder Voiding on the Reliability and Thermal Characteristics of Quad Flatpack No-lead (QFN) Components
Ross Wilcoxon, Dave Hillman and Tim Pearson, Collins Aerospace

10:40 a.m. – 11:00 a.m.
Characteristics of Practical CTE-Matched Composites for Electronics Thermal Management: Comparative Study *
Dave Saums, DS&A LLC

11:00 a.m. – 11:30 a.m.
Vendor Workshop
Boyd Corp – Closed Loop Liquid Cooling in Enterprise Equipment

11:30 a.m. – 11:50 a.m.
Break
Break Talk: Cadence - Introducing Celsius Thermal Solver

11:50 a.m. – 12:30 p.m.
Session 3: Two-Phase Cooling I

11:50 a.m. – 12:10 p.m.
Numerical Investigation of Coolants for Chip-embedded Two-Phase Cooling
Pritish R. Parida and Timothy Chainer, IBM T.J. Watson Research Center

12:10 p.m. – 12:30 p.m.
Numerical Investigation of Thermal Spreading Resistance of Vapor Chambers *
Farzan Kazemifar, San Jose State University

12:30 p.m. – 1:00 p.m.
Vendor Workshop
Siemens Digital Industries – Simulation and Test Update: Electrothermal Modeling, Reduced Order Models, Thermo-Mechanical Analysis Workflows and Package Thermal Quality Assessment
John Wilson, Siemens Digital Industries

*This presentation has no formal paper. **Extended Abstract only

Schedule of Events

Wednesday, March 24, 2021
All times PDT

7:00 a.m. – 7:10 a.m.
Welcome Message: Marcelo del Valle, Infinera Corporation
Moderators: Marcelo del Valle, Infinera Corporation, and Dave Saums, DS&A LLC

7:10 a.m. – 8:10 a.m.
Session 4: Data Center

7:10 a.m. – 7:30 a.m.
Determination of Cost Savings using Variable Speed Fans for Cooling Servers
Minh Tran[1], Nicole Okamoto[2], Hussammedine Kabbani[2], Saeid Bashash[2]
[1]Velodyne Lidar, [2]San Jose State University

7:30 a.m. – 7:50 a.m.
Effects of Different Coolants on the Cooling Performance of an Impingement Microchannel Cold Plate
Cong Hiep Hoang[1], Ghazal Mohsenian[1], Najmeh Fallatafti[1], Vahideh Radmard[1], Srikanth Rangarajan[1], Charles Arvin[2], Kamal Sikka[2], Scott Schiffres[1], Bahgat Sammakia[1]
[1]Binghamton University, [2]IBM Corp.

7:50 a.m. – 8:10 a.m.
Sensitivity Analysis of a Calibrated Data Center Model to Minimize the Site Survey Effort
Saurabh Singh[1], Kourosh Nemati[2], Vibin Simon[1], Ashwin Siddarth[1], Mark Seymour[2] and Dereje Agonafer[1]
[1]University of Texas, Arlington, [2]Future Facilities Ltd.

8:10 a.m. – 8:40 a.m.
Vendor Workshop
Infratec - Thermography Solutions for Electronics Testing
Sven A. Wode

8:40 a.m. – 9:00 a.m.
Break
Break Talk: Jetcool - Warmer Coolants for Enhanced Data Center Sustainability

9:00 a.m. – 10:00 a.m.
THERMI Award Presentation: Dr. Ross Wilcoxon, Collins Aerospace
Apollo – The Beginning of Semiconductor Thermal Management

10:00 a.m. – 10:20 a.m.
Break
Break Talk: Indium - Metal TIM Innovations for High-Performance Applications

Continued

Wednesday, March 24, 2021
THERMI Award Presentation:

SEMI-THERM® 37

MAE
Mechanical & Aerospace Engineering
The University of Texas at Arlington

UNIVERSITY OF TEXAS ARLINGTON

UTA proudly sponsors the 2021
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 2021 THERMI award is proudly presented to:

Dr. Ross Wilcoxon
Collins Aerospace

Ross Wilcoxon is an Associate Director with Collins Aerospace, a Raytheon Technologies subsidiary. He is part of the Mission Systems / Advanced Technology group in Cedar Rapids, Iowa where he conducts research and supports the development of prototype and production avionics systems for communication, processing, displays and radars. His work is generally related to component reliability, electronics packaging and thermal management with specific areas of research including the development and implementation of glass-based composite coatings, liquid metal cooling, integration of commercial heat pipes into avionics, and determining the reliability of commercial microelectronic components. Dr. Wilcoxon has been a Principal Investigator for research funded by the Office of Naval Research and the Defense Advanced Research Projects Agency. He has 30 US Patents, primarily in microelectronics packaging and thermal management.
Over the past 18 years, Dr. Wilcoxon has served in multiple roles on the SEMI-THERM program committee, including Vice-Program/Program/General Chair, Chair of the Technical Committee, head of the Best Paper selection team, and editor for Peer Reviewed papers. He has been an invited speaker at SEMI-THERM, ITherm, IMAPS Thermal ATW and THERMES and has more than forty publications in journals, technical magazines and conferences. Dr. Wilcoxon is also an editor for Electronics Cooling Magazine and has served on engineering advisory boards for South Dakota State University and the University of Iowa. He received a BS in Mechanical Engineering and MS in Engineering from South Dakota State University and a PhD from the University of Minnesota. Prior to joining Rockwell Collins (now Collins Aerospace) in 1998, he was an assistant professor at South Dakota State University.

Wednesday, March 24, 2021
THERMI Presentation:

Apollo - The Dawn of Semiconductor Thermal Management

By Ross Wilcoxon

Over fifty years ago, the majority of the world's production of integrated circuits were used by a single project: the Apollo program that led to the first humans on the moon. Effective thermal management of the electronics used in Apollo played a critical role its ultimate success. This presentation provides a brief overview of the state of technology for electronics design and testing at the time of Apollo, describes electronic packaging and thermal management approaches used in Apollo systems, and talks about ways that the field of electronics cooling has changed, and not changed, over the past five decades.

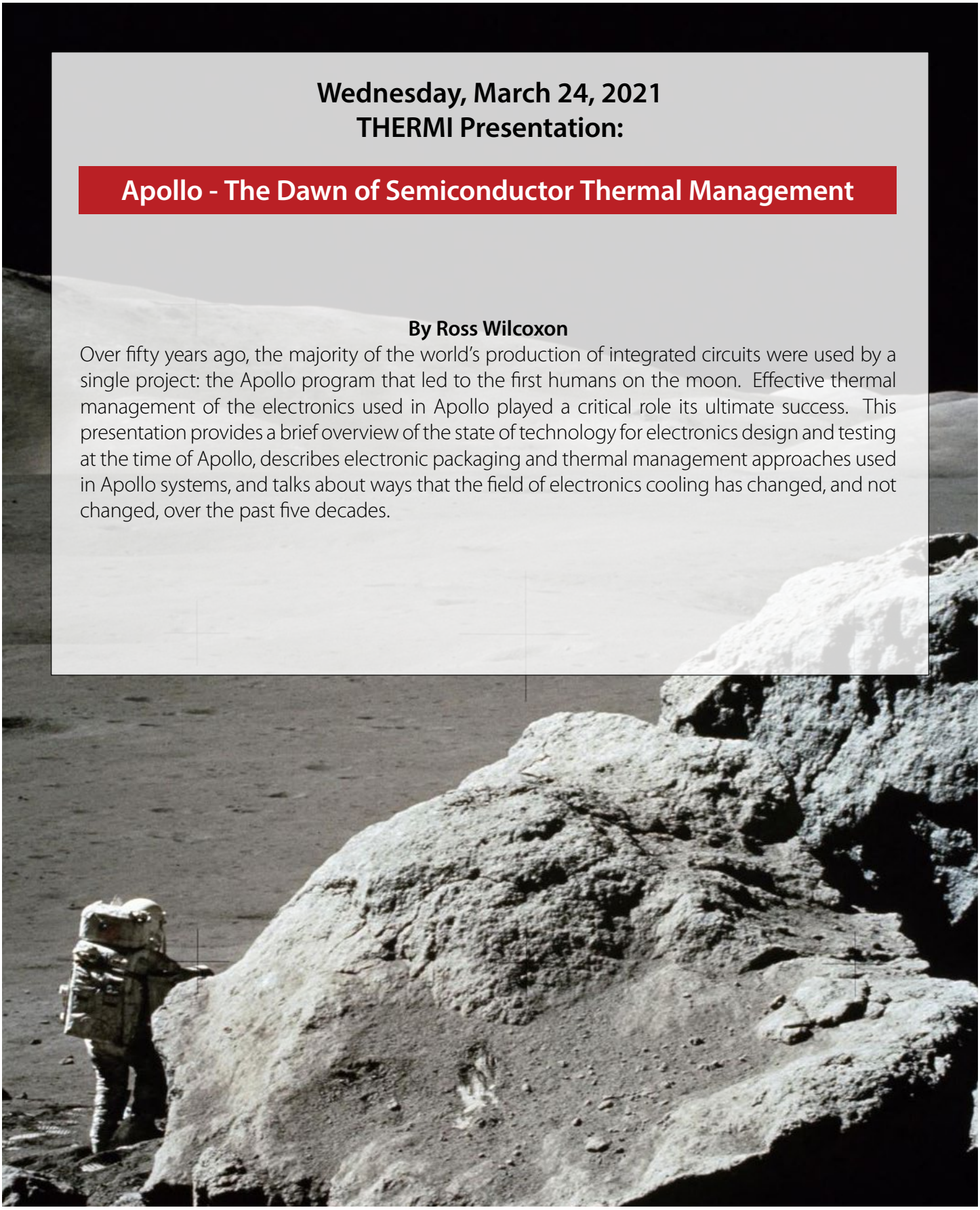


Photo courtesy NASA

Schedule of Events

Wednesday, March 24, 2021
All times PDT

10:20 a.m. – 11:00 a.m.
Session 5: Liquid Cooling

10:20 a.m. – 10:40 a.m.
Unified Approach to Model Closed-Loop Liquid Cooling
Albert Chan, Don Nguyen and Michael Brooks, Cisco Systems, Inc.

10:40 a.m. – 11:00 a.m.
Thermohydraulic Performance of Heat Sink with Sinusoidal Microchannels Embedded with Pin-Fins for Liquid Cooling of Microelectronic Chips
Anas Alkhazaleh, Fadi Alnaimat, Mohamed Younes El-Saghir Selim, Bobby Mathew, United Arab Emirates University

11:00 a.m. – 11:30 a.m.
Presentation of THERMI award: Jim Wilson, Raytheon, to Ross Wilcoxon, Collins Aerospace

11:30 a.m. – 11:50 a.m.
Break

11:50 a.m. – 12:30 p.m.
Session 6: Measurement Techniques/CFD

11:50 a.m. – 12:10 p.m.
Cross Correlation Method for Images Alignment: Application to 4 Buckets Calculation in Thermoreflectance
Metayrek Youssef[1], Kociniewski Thierry[2], Khatir Zoubir[1]
[1]Universitè Gustave Eiffel, [2]University of Versailles St. Quentin

12:10 p.m. – 12:30 p.m.
Including Electrothermal Effects in Electronics Design with Connected FANTASTIC BCI-ROMs
Byron Blackmore, Mike Donnelly and Mahmood Alkhenaizi, Siemens Digital Industries Software

12:30 p.m. – 1:00 p.m.
Vendor Workshop
Hexagon MSC Software - Hexagon: Electronics Everywhere

Embedded Tutorial
Thursday March 25, 9:00 a.m.

Realistic Thermal Model for Human Skin in Contact with a Wearable Electronic Device

Presenter: Dr. Bruce Guenin, Ph.D.

Makers of electronic devices try to provide as much performance and functionality in them as possible, consistent with certain limits for internal chip temperatures. For wearables, the external temperatures of these devices are also critical for user comfort and safety. For accuracy in a thermal model for the wearable device, it is necessary to accurately account for the transfer of heat into human skin. The commonly used ad-hoc assumption of an isothermal boundary condition representing the region of contact between a wearable device and human skin is no longer adequate. In the medical and biological fields, modeling the transfer of heat into or out of living tissue is a mature area of study. The dominant methodology in this regard is referred to as the Pennes biothermal model, named after its creator. It is a conduction model supplemented by a mechanism for cooling the tissue by blood flow, which Pennes called "perfusion." The application of the Pennes model requires that certain specified material properties be measured for each of the different tissue types involved in the heat flow, namely: thickness, thermal conductivity, specific heat, and perfusion rate. In the case of human skin all three layers (epidermis, dermis, and hypodermis) are separately represented. Despite its wide use in the life sciences, the Pennes biothermal model is virtually unknown in the electronics cooling sector. It's the intent of this presentation to provide sufficient background information and details in its implementation that the attendees will be able to apply it immediately to their work.

Dr. Bruce Guenin has spent many years in the electronics and computer industries, which has given him a broad perspective on macro trends in these fields. His previous affiliations include Oracle, Sun Microsystems, and Amkor. Currently, he is a consultant working with Electronic Cooling Solutions. He is a past chairman of the JEDEC JC-15 Thermal Standards Committee and the SEMI-THERM Conference. He was an editor of Electronics Cooling from 1997 to 2020. His contributions to the thermal sciences have been recognized by receiving the Harvey Rosten Award in 2004 and the THERMI Award in 2010. He received a B.S. degree in Physics from Loyola University, New Orleans, and a Ph.D. in Physics from the University of Virginia. He has authored and co-authored over 90 papers and articles in the areas of thermal and stress characterization of microelectronic packages, electrical connectors, solid state physics, and fluid dynamics and has been awarded 18 patents in these areas.

Schedule of Events

Schedule of Events Thursday, March 25, 2021
All times PDT

7:00 a.m. – 7:10 a.m.
Welcome Message: Ross Wilcoxon, Collins Aerospace
Announcement of Harvey Rosten Award Winners for 2019
Moderators Ross Wilcoxon, Collins Aerospace, and Devin Pellicone, Advanced Cooling Technologies Inc.

7:10 a.m. – 8:10 a.m.
Session 7: Thermal Interface Materials

7:10 a.m. – 7:30 a.m.
CVD Polycrystalline Diamond for Laser Diode Applications *
Firooz Faili, Element Six Technologies

7:30 a.m. – 7:50 a.m.
Experimental Investigation of the Impact of Squeezing Process on the Microstructure and Performance of Thermal Interface Materials (TIMs) *
Rajath Kantharaj, Purdue University

7:50 a.m. – 8:10 a.m.
Metallic TIMs for Liquid Immersion Cooling and Cryogenic Temperatures for Quantum Computing *
Dave Saums, DS& A LLC

8:10 a.m. – 8:40 a.m.
Vendor Workshop
AR Brown - High Performance Aluminum Nitride for Thermal Conductive Fillers

8:40 a.m. – 9:00 a.m.
Break
Break Talk: Nanoramics - High Thermal Conductivity TIMs for Efficient Heat Removal in Electronic Devices

9:00 a.m. – 10:00 a.m.
Embedded Tutorial
Realistic Thermal Model for Human Skin in Contact with a Wearable Electronic Device
Dr. Bruce Guenin, Ph.D.

10:00 a.m. – 10:20 a.m.
Break
Break Talk: Nanoramics - High Thermal Conductivity TIMs for Efficient Heat Removal in Electronic Devices
John Grillo

10:20 a.m. – 11:00 a.m.
Session 8: Two-Phase Cooling II

10:20 a.m. – 10:40 a.m.
Design and Optimization Array of Micropillar Structures for Enhanced Evaporative Cooling of High Powered Electronics **
Kidus Guye, Mun Mun Nahar, Quan Chau, Damena Agonafer, Washington University in St. Louis

*This presentation has no formal paper. **Extended Abstract only

Continued

Thursday March 25th, 11:50 a.m.

SEMI-THERM®

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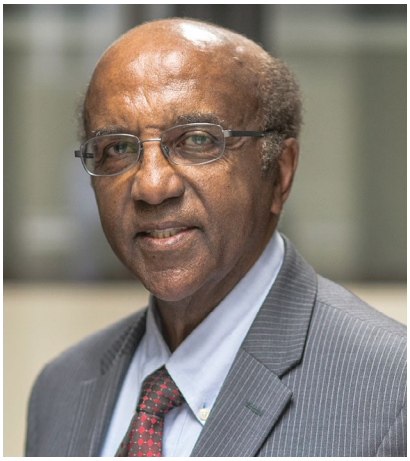
Making Hot Technology Cooler™

We are proud to sponsor:

The SEMI-THERM Educational Foundation
Thermal Hall of Fame

Lifetime Achievement Award

Presented To



Dr. Dereje Agonafer

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

Dereje Agonafer is a Presidential Distinguished Professor in MAE at University of Texas at Arlington (UTA) where he heads two centers: Site Director of NSF I/UCRC in Energy Efficient Systems and Director of Electronic Packaging. After receiving his PhD at Howard University, he worked for 15 years at IBM. In 1991, his work was recognized by being awarded the "IBM Outstanding Technical Achievement Award in Appreciation for Computer Aided Thermal Modeling." Since joining UTA in 1999, he has graduated 234 graduate students including 25 PhDs and currently advising 16 PhDs and 8 MS students. His new initiative is to start a new center called RAMPES (Center for Reliability Assessment in Micro and Power Electronic Systems) focusing amongst other on thermo/mechanical challenges in heterogenous integrated systems. For this new initiative, he has received significant equipment funding, 3000 sq ft of new lab space, Assistant and Associate Professor openings, and research engineer among others. For his contributions, he has received numerous awards including the

Continued

2008 THERMI Award, the 2009 InterPACK Excellence Award, the 2014 ITHERM Achievement Award, and the 2019 ASME Heat Transfer Memorial Award. Professor Agonafer was a Martin Luther King Visiting Professor at MIT during the 2007 academic year. He is a fellow of the National Academy of Inventors, the American Association for the Advancement of Science and the American Society of Mechanical Engineers. In 2019, he was elected to the National Academy of Engineering and according to Dean Crouch, "the first current faculty member elected to the Academy." Professor Agonafer is married to his wife Carolyn and they have two children; a son, Dr. Damena Agonafer who is Professor of Mechanical Engineering & Materials Science at Washington University in St. Louis, and daughter, Dr. Senayet Agonafer, a Radiologist, who works at Lennox Hill Radiology in New York City.

Dynamic Liquid Cooling at Device and Server Level for High and Non-Uniform Powered Data Center Servers

Dereje Agonafer, Presidential Distinguished Professor
The University of Texas at Arlington

Direct Liquid Cooling using cold plates, provisioned with water-based coolants, is becoming one of the prominent cooling solutions for high heat flux applications in the electronic cooling industry. A very effective way to conserve pumping power and address hotspots on single or multi-chip modules (MCM) is by targeted delivery of coolant. One way to enable such targeted delivery of coolant is by using dynamic cold plates (DCP) coupled with self-regulating flow control mechanism that can control flow rate based on localized device temperatures. The strategy of targeted coolant delivery at the rack level can be achieved by using either an active or passive flow control device that responds to the server coolant outlet temperature. This device can be actively controlled using an algorithm or could be a self-reliant device made using smart materials. The power savings can be achieved by actively controlling pumps at the rack level based on the distributed workloads across the servers. The servers operating at higher workloads will demand greater flow rates that will change the rack level pressure drop, and correspondingly the pumping power. At component level, this can be achieved by using smart/temperature sensitive materials within the cold plate for targeted coolant delivery to the hot spots on the single or MCM modules. This will reduce the overall thermal gradient on the component, thus, reducing the failure rates and providing a more isothermal temperature profile. We have been able to reduce the overall cost of such flow control devices to below $1 per device using 3-D printing. For mass production and implementation at the data center level, it is projected that it can be manufactured at an approximate cost of 70 cents.

The 2019 Harvey Rosten Award

Sponsored by Simcenter Simulation and Test Solutions, Siemens Digital Industries Software

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

A Generic Processor Temperature Estimation Method




Baver Ozceylan*[1], Boudewijn R. Haverkort[2], Maurits de Graaf[3], Marco E. T. Gerards[1]

[1]University of Twente, Enschede, the Netherlands, [2]Tilburg University, Tilburg, the Netherlands, [3]Thales Nederland B.V., Huizen, the Netherlands
*Corresponding Author

Baver Ozceylan is a graduate of Middle East Technical University (METU), Turkey (2014, BS and 2017, MS). From 2014 to 2018, he was with the Department of Electrical and Electronics Engineering at METU. Since 2018 he has been a PhD candidate at the Design and Analysis of Communication Systems Group of the University of Twente, The Netherlands. His research interests include mathematical modeling and analyzing, wireless commination systems, energy-efficient and energy-aware algorithms and scheduling, thermal modeling and temperature-aware scheduling.

Boudewijn R. Haverkort (Master and Phd, University of Twente, 1986 and 1991, respectively) is full professor and Dean of the Tilburg School of Humanities and Digital Sciences at Tilburg University, Netherlands. Since 2019. Before moving to Tilburg University, he was a full professor at the University of Twente since 2003, and from 1995 to 2002 he was a professor at RWTH Aachen, Germany. From 2009 to 2013 he was scientific director of the public-private Embedded Systems Institute, an applied research institute focusing on high-tech systems design. His field of interest is very wide, encompassing internet technology, cyber-physical systems, smart energy systems, energy management in data centers, computer performance and reliability evaluation, stochastic model checking, as well as data science. He is a Fellow of the IEEE since 2007, and has published around 200 papers about his scientific work in the above fields, and has chaired a large number of international conferences. Since 2016 he is chairman of the Dutch national research program on big data and applications.

Maurits de Graaf is an experienced Innovation Program and Project manager with a thorough scientific background. He has guided many research projects from first concepts to final implementation. He received his PhD in 1994 at the University of Amsterdam for the thesis 'Graphs and Curves on Surfaces'. After a period with the telecommunications research institute KPN Research, he started working with Thales Netherlands B.V. in 1999, mainly in the innovation department. Since 2010 he combines this with a part-time position at the University of Twente as associate professor at the department Mathematics of Operations Research (MOR). He co-authored over 30 publications.

Marco E. T. Gerards received the M.Sc. degrees in computer science and in applied mathematics from the University of Twente, Enschede, the Netherlands, in 2008 and 2011 respectively. He finished his Ph.D. thesis titled "Algorithmic power management: energy minimisation under real-time constraints" in 2014. Then he worked as a postdoc, until 2016 when he became an assistant professor. His research interests are energy management for smart grids and sustainable computing.

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:

- The work represents an advance in thermal analysis or thermal modeling of electronics equipment or components, including experiments aimed specifically at validating numerical models.
- The work demonstrates clear application to practical electronics design.
- The work demonstrates insight into the physical processes affecting the thermal behavior of electronics components, parts and systems.
- The work is innovative in embodying this understanding in either thermal analysis or thermal modeling.
- A pragmatic approach is taken in the application of the work.

The winner of the 2020 Harvey Rosten Award has been identified and will be announced at SEMI-THERM 38

Schedule of Events

Schedule of Events Thursday, March 25, 2021
All times PDT

10:40 a.m. – 11:00 a.m.
Actively Cooled Two-phase Cold Plate for High Heat Flux Electronics *
Michael C. Ellis, Advanced Cooling Technologies, Inc.

11:00 a.m. – 11:20 a.m.
Break

11:20 a.m. – 12:30 p.m.
SEMI-THERM Hall of Fame Award Presentation: Dereje Agonafer, University of Texas at Arlington
Dynamic Liquid Cooling at Device and Server Level for High and Non-Uniform Powered Data Center Servers

Awarding of Thermal Hall of Fame Lifetime Achievement Award is Alfonso Ortega, Villanova University

Schedule of Events Friday, March 26, 2021
All times PDT

8:30 a.m. – 12:00 p.m.
JEDEC JC 15 Meeting
Members Only

EXHIBITOR LISTINGS

AR Brown Co. Ltd.
ADVANTAGE OF CSC ALN POWDER AS THERMAL CONDUCTIVITY FILLER
(D50=5um/10um/20um/30um/50um/70um/80um/100um/120um)
We are worldwide authorized distributor of AlN powder as thermal conductivity filler manufactured by CSC (Japan).
CSC AlN powder materializes High thermal conductivity with low viscosity and reasonable cost, and is made in Japan.
• CSC AlN powder is very new irregular AlN.
• There is no trade-off problem between thermal conductivity and viscosity mixing resin.
• Price is cheaper than competitors.
Considering from filling rate and viscosity, currently, customers are using spherical AlN. But there are essential problems of spherical AlN as below;
1)High price due to production process.
2)Lower thermal conductivity than customer expected due to structure of particle came from production process.
But customer has no choice except for using spherical AlN because current other AlN has lower filling rate and higher viscosity mixing resin than those of spherical type even if thermal conductivity is better. So, customer scratch the head how to solve this trade-off problem.
CSC overcome this trade-off problem. CSC AlN is irregular type, but materialize higher thermal conductivity and higher filling rate and lower viscosity with reasonable cost.

Blueshift Materials, Inc.
Blueshift Materials, Inc. developed and manufactures in a roll-to-roll format a 125-micron high performance polymer aerogel film called AeroZero®. AeroZero was developed for thermal management applications that require an extremely thin and lightweight material with a low rate of heat transfer, that can also withstand extreme environmental conditions. AeroZero is 85% air, and the company has branded it "Structured Air." The film thus has low density, high porosity, and extremely low dielectric properties and thermal conductivity. AeroZero retains most of the key properties of a polyimide: wide operating temperature range (-200 C to +260 C), inherent flame retardancy, etc. www.blueshiftmaterials.com

Continued

*This presentation has no formal paper.

EXHIBITOR LISTINGS

Boyd Corporation
Boyd Corporation has over 90 years of customer-focused performance success and is a global leader in advanced sealing, thermal management and protection solutions. Aavid, Thermal Division of Boyd Corporation has a long history of developing, designing, testing, optimizing, and fabricating reliable high-performance cooling systems across all industries. By choosing, integrating, or developing the right technology, Boyd delivers solutions that can increase power, improve functionality and reliability, and reduce the cost and size of our customers' applications.

CPC
CPC is an undisputed leader in liquid cooling connections offering couplings designed to protect valuable electronics with unmatched design, quality, and reliability. They withstand long periods of connection yet disconnect reliably without drips. For more information, visit www.cpcworldwide.com/liquidcooling

Cadence
Cadence has expanded its presence in the system analysis and design market with the introduction of the Celsius Thermal Solver, the industry's first complete electrical-thermal co-simulation solution for the full hierarchy of electronic systems from ICs to physical enclosures. The Celsius Thermal Solver seamlessly integrates with Cadence IC, package, and PCB implementation platforms, enabling new system analysis and design insights and empowering design teams to detect and mitigate thermal issues early in the design process. Learn more at www. cadence.com.

Element Six
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 the diamond synthesis process to unlock innovative applications, including thermal management, optics, wastewater management and sensing.

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.

We don't work for you, we work with you.

Celsia
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.

Future Facilities
We set Future Facilities up to deliver the power of engineering simulation into the hands of an emerging data center industry. We created a tool optimized for data centers, designed to be used by the DC professional, and made it powerful, intelligent, automated and connected. Five years later, we tuned our technology to deliver the same benefits to the thermal management of electronics and provide an integrated toolset for these two converging industries. We develop engineering simulation software that allows our customers to quantify and qualify business decisions balancing risk against cost. Our offering covers the full spectrum starting from electronics design to data center design and operations. Our software provides a safe, offline environment in which to create virtual prototypes, troubleshoot existing designs and run what-if scenarios for future configurations.

EXHIBITOR LISTINGS

Indium Corporation
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.

Klinger IGI
Klinger IGI is an AS9100 / ISO 9001-2015 / ITAR registered manufacturer, specializing in precision cut thermal interface and gap pads, EMI/RFI shields, acoustic and vibration dampers, washers and spacers, filters, and custom gaskets and seals for OEMs and Tier 1s in the highly regulated aerospace, electronics, medical, and energy industries. Klinger IGI delivers total solutions with a large selection of material options, proven manufacturing technologies and simple integration of manufactured production parts with tight tolerances. We offer expertise in selecting the most cost-effective material solutions while supporting the design of your parts with effective manufacturing and assembly operations.

InfraTec
The Dresden-based company InfraTec GmbH Infrarotsensorik und Messtechnik has been a specialist for products and services in the field of infrared technology for 30 years. Now about 230 staff are employed. In the business division of sensor systems, custom-made components are produced on more than 1.500 m^2 of clean room space – especially pyroelectrical infrared detectors – for clients worldwide. With its business division of infrared measurement InfraTec ranks among the large suppliers of thermography and non-military thermal imaging. InfraTec has been supplying thermal imaging technology like its high-end camera series ImageIR® to demanding customers. Specific solutions tailored to electronic and microelectronic testing have been developed which today suit the needs of customers in the value chain of LED development and manufacturing.

MSC Software
MSC Software develops simulation software technology that enables engineers to validate and optimize their designs using virtual prototypes. Our CFD solutions are characterized by their user-friendly interfaces, high accuracy, and high efficiency. Customers in almost every part of manufacturing use our software to complement, and in some cases even replace the physical prototype "build and test" process that has traditionally been used in product design.

JETCOOL
JETCOOL's microconvective cooling technology empowers high performance data centers to compute faster and more sustainably. Delivering the most effective cooling for today's CPUs, GPUs, and ASICs, engineers use JETCOOL to increase compute speed by 40% and achieve up to 8% energy savings by maximizing efficiency with coolant temperatures up to 55°C. JETCOOL's next-generation cooling solutions are a perfect match for data center processors pushing the limits of performance.

Nanoramic
Nanoramic Thermexit™ is a line of high-end thermal interface gap filler pads. Nanoramic's® gap fillers are a non-reactive, non-silicon, no cure system featuring high thermal conductivity and high thermal stability. Nanoramic® produces 2 novel product lines, a High Performance TIM Gap Filler and an Electrically Insulating TIM Gap Filler.

EXHIBITOR LISTINGS

Novark Technologies, Inc.
Novark Technologies, Inc. was founded in 2004 in Shenzhen, China, and quickly became a recognized name in the thermal management industry. Novark first established itself as a qualified supplier of heat pipes to support the development of tier-one high-tech companies such as Microsoft, AMD, Sony, and Toshiba, then branched out into heat sinks and cold plates. Novark became known for their cost-effective and high-quality manufacturing processes and their agility in response to customer needs.
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.

Siemens
Siemens PLM Simcenter portfolio includes a range of simulation software and test equipment solutions to aid development of a virtual digital twin of a product for improved design and lifecycle management. This portfolio now includes 30+ year industry leading Simcenter Flotherm electronics cooling software product family and Simcenter T3STER thermal test hardware solutions from Mentor, A Siemens Business.
Find out about the latest in enhancements to Simcenter Flotherm and Simcenter Flotherm XT at SEMI-THERM, and seek more information on other simulation tools in the portfolio incl. multi-physics simulation software (Simcenter STAR-CCM+), CFD for designers (Simcenter FLOEFD).
In semiconductor thermal measurement, characterization and thermal reliability, find out the latest on Simcenter T3STER test solution family. This includes latest developments in thermal measurement to support automatic thermal simulation model calibration and LED multi-domain models, TIM material testing, and power semiconductor thermal reliability testing (SIMCENTER POWERTESTER range).

Thermal Engineering Associates
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.