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The 34th Annual Thermal Measurement, Modeling and Management Symposium
March 19th - 23rd, 2018
Thermal Innovations that Make the World's Technology Cool

34

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Consumer Electronics
Data Center Cooling
Liquid Cooling
Measurement Technologies
Thermal Interface Materials
Two Phase Cooling

NEW TO SEMI-THERM 34
Panel Discussion: "Challenges in Consumer Electronics Cooling"
Thursday Afternoon, March 22

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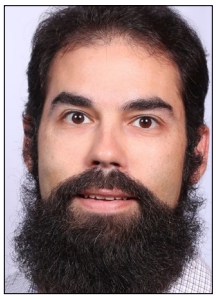
SEMI-THERM 34

Short Courses Monday, March 19, 2018

Short Course 1 Morning **8:00 a.m. – 12:00 p.m.**
Thermal Challenges for Power Electronics
Instructor: Brian Zahnstecher, PowerRox

Careful thermal architecting, design, and qualification are integral to the success of electronic systems, and power electronics are no exception. As the trend to increase power density will only continue in the positive direction, solutions to the thermal challenges become increasingly enabling. From dense enterprise systems to very low power consumer electronics, one cannot depend on increases in power supply conversion efficiency to address all these challenges though the desire for adiabatic or conduction-cooled implementations is driving improvement in this area. As usual, it comes down to an acceptable tradeoff of key project requirements such as cost, size, efficiency, application derating, and development resources/timeline.

This entry- to intermediate-level Short Course will provide an overview of the key thermal factors that must be considered at all aspects of implementing power electronics from inception to field use. Such factors will be evaluated against project requirements and objectives to help attendees internalize and prepare an appropriate methodology that aligns with project priorities, while still ensuring the technical success of the application. Some time will also be spent reviewing real-world examples and case studies to understand past successes and failures, with an emphasis on harsh environment applications.



Brian Zahnstecher is a Sr. Member of the IEEE, Chair of the IEEE SF Bay Area Power Electronics Society (PELS), and the Principal of PowerRox, where he focuses on power design, integration, system applications, OEM market penetration, and private seminars for power electronics. He has successfully handled assignments in system design/architecting, AC/DC front-end power, EMC/EMI design/debug, embedded solutions, processor power, and digital power solutions for a variety of clients. He previously held positions in power electronics with industry leaders Emerson Network Power, Cisco, and Hewlett-Packard, where he advised on best practices, oversaw product development, managed international teams, created/enhanced optimal workflows and test procedures, and designed and optimized voltage regulators. He has been a regular contributor to the industry as an invited speaker, author, workshop participant, session host, roundtable moderator, and volunteer. He has over 13 years of industry experience and holds Master of Engineering and Bachelor of Science degrees from Worcester Polytechnic Institute.

Short Course 2 Morning **8:00 a.m. – 12:00 p.m.**
Managing Cooling Fan Noise and Power Consumption
Instructor: David Nelson, Nelson Acoustics

Excessive cooling fan noise often disrupts progress late in a product's design, and last-minute fixes are usually fruitless. The reasons this occurs remain mysterious to most of the engineering community, which continues to hunt for the largely mythical "quiet fan". In practice, noise emission is determined very early in the design process by non-acoustical factors including cooling requirements, thermal design practices, flow path resistance, form factor and dimensional constraints, upstream turbulence, and of course fan selection.

This short course gives a practical overview of the connection between fan performance, noise emission, and power consumption, and uses fan similarity laws, vendor data, and empirical models to provide estimates of each along with the impact of various design choices. The goal is actionable insight that supports making, justifying, and defending wise design decisions before it's "too late". Examples will be drawn from the instructor's broad consulting experience. Audio demonstrations are used to illustrate key points. Each participant will receive a bound copy of the course slides. Instruction involves math no more advanced than logarithms.

David A. Nelson has over 35 years experience in acoustics and noise control, and is Board Certified by the Institute of Noise Control Engineering. Nelson Acoustics is in its 20th year providing acoustical consulting services to a wide variety of corporate clients on subjects including product noise control. Mr. Nelson promotes "quiet by design" principles with a particular emphasis on fan noise control.

Short Courses Monday, March 19, 2018

Short Course 3 Morning **8:00 a.m. – 12:00 p.m.**
Efficient Flow and Thermal Modeling of Large Scale Electronic Systems
Instructors: Jan Visser, Boyd Corp. and Suhkvinder Kang, Aavid

This short course will teach thermal designers how to use different solution techniques in thermal design software to simplify and optimize the thermal design of large scale systems like server systems, heat exchangers, liquid cooling networks etc. In the hybrid solution approach, the solution domain is divided into different types of regions where flow and heat transfer equations are solved using different techniques. The approach recognizes that air and/or liquid flow within some regions or subsystems is well defined (e.g. channels formed between shrouded card arrays, packaged power supplies, heat exchanger fin arrays, pipes, valves etc.) while in other regions it is poorly defined (e.g. air or liquid flow plenums, manifolds, large electronics boards.) Using the hybrid approach, designers can efficiently and accurately model the flow and heat transfer within the entire geometry of large scale systems.

Dr. Jan Visser (pictured) is the VP of Boyd Corporation and responsible for the development of all CFD software and compact models used in the Boyd CFD software. He has 30 years of experience in CFD. Over the last 15 years he specialized in the development of sub models for electronic applications and methods to speed up solution time without sacrificing accuracy. This include the optimization of thermal designs. He is the author of many related publications in journals and technical conferences.

Dr. Sukhvinder Kang is the CTO at Aavid and responsible for advanced thermal technology development programs. He has over 30 years of industry experience in electronics cooling, space, defense, nuclear, and oil exploration applications. He has authored over thirty patents and technical papers on fluid flow and heat transfer and lectured a number of courses and seminars in electronics cooling.

Short Course 4 Morning **8:00 a.m. – 12:00 p.m.**
Design of LED-based Applications
Instructors: Genevieve Martin, Philips Lighting and András Poppe, Mentor Graphics

This course provides insights into the key parameters, strategies and methodologies for the thermal-optical-electrical-mechanical design of LED-based applications. The course presents limitations at the various phases of the product design and provides a view of future perspectives. Practical examples and illustrations are presented for the analysis, concept choice, characterisation. This course has no bias towards a special application field.
A brief course outline:

- Overview of Standards for Product Development & Characterization
- LED System Design Approach
- Modeling of LEDs for the Design Purposes, Multi-Domain Modeling
- Basics of LEDs and Future Trends
- Application Overview and Implication for the LED Choices
- Application Constraints and Consequences of Design Choices

Genevieve Martin is principal engineer and Thermal & Mechanics Competence Leader at Philips Lighting in the Netherlands. In the past, she worked for different application fields mainly dealing with electronics cooling and thermal management in consumer applications, professional and consumer healtcare products. She started working with LED application in 2007 by delivering the first thermal technology roadmap for the department of Lighting at Philips. In 2014, she joined the lighting division and now focuses most of her time in LED based application. As Thermal & Mechanics Competence Leader, her role is to lead the roadmap, propose yearly programs and setup collaboration for research projects. Since 2016, she coordinates the European project Delphi4LED (a 3 year project) dealing with multi-domain compact model of LEDs. An active reviewer in several conferences, she served as General Chair of Semi-Therm 31 and is now a member of the Technical Committee.

András Poppe obtained his MSc degree in electrical engineering in 1986 from the Technical University of Budapest (BME), Faculty of Electrical Engineering. In 1996 he obtained a cand.Sci. degree from the Hungarian Academy of Sciences and his PhD from BME. In 1986-1989 he was a researcher at BME Department of Electron Devices with scholarship of the Hungarian Academy of Sciences; he has been head of the Department of Electron Engineering (BME) since 2013. His research field was circuit simulation and semiconductor device modeling. Later in the 1980's he was a guest researcher at IMEC (Leuven, Belgium). Since 1990 he has been with BME as a lecturer, and since 1996 he has been an associate professor. Co-founding MicReD in 1997 (now part of Mentor – a Siemens business), he is actively involved in the JEDEC JC15 committee and is chairing the CIE TC2-84 technical committee.

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Short Courses Monday, March 19, 2018

Short Course 5 Afternoon **1:30 p.m. – 5:30 p.m.**
Experimental Measurements in Electronics Cooling Systems
Instructors: Dr. Alfonso Ortega, Santa Clara University and Dr. Marcelo Del Valle, Intel

The experimental characterization of temperature, airflow, and velocity, among others, is one of the most common needs in the evaluation of thermal performance and reliability of electronic systems. Because of the apparent simplicity of building and using thermocouple sensors, the errors that commonly occur in the measurement of both air and solid component temperatures are not well appreciated. Similarly, the errors that may occur in the measurement of flow and velocity are often not well understood and often ignored. If ignored, these errors will propagate throughout the measurement chain and lead to high uncertainty in the measurements to be interpreted. Because experimental verification has become an essential part of computational simulation using CFD tools, lack of certainty in the "real" data will also lead to an inability to validate the computational simulations.

In this course, we will discuss and perform hands-on demonstrations of practical temperature and velocity measurements that are common in the characterization of electronic equipment. We will point out difficulties in the use of point-sensors such as thermocouples and thermistors in the measurement and interpretation of temperature, flow, and velocity of flowing fluids in air and liquid cooled systems, and in the measurement of the temperature of solid materials. We will discuss the errors that commonly occur in alternative methods such as Infrared measurements. With understanding of the source of errors, we will discuss the use of uncertainty analysis in order to understand and control the propagation of error in the measurement chain.

Dr. Alfonso Ortega is the Sobrato Professor of Engineering and the Dean of the School of Engineering at Santa Clara University, a position that he occupied in August 2017.
Prior to his current position, he was at Villanova University for eleven years where he was the James R. Birle Professor of Energy Technology and the Director of the Laboratory for Advanced Thermal and Fluid Systems, which he founded in 2005. From 2011 to 2017 he was the founding Director of the NSF Center for Energy Smart Electronic Systems (ES2) at Villanova University. The NSF ES2 Center, which includes partner universities Binghamton University, University of Texas-Arlington, and Georgia Tech, is an industry-university research partnership that seeks to address critical issues of energy utilization in data centers through directed research in areas such as thermal management, controls, workload optimization, and sustainability. Most recently, Dr. Ortega has directed research in the areas of passive and active two phase cooling of servers, dynamic air cooling strategies that couple with real time load scheduling, the use of second law principles to identify energy inefficiencies in air-cooled data centers, and waste energy recovery using organic Rankine cycles and thermoelectrics technology.
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, where he directed the Experimental and Computational Heat Transfer Laboratory. From 2004 to 2006, Dr. Ortega was the Program Director for Thermal Transport and Thermal Processing in the Chemical and Transport Systems Division of The National Science Foundation in Arlington, Virginia, where he managed the NSF's primary program funding heat transfer and thermal technology research in U.S. universities. From 2006 to 2017 he was on the faculty of Mechanical Engineering at Villanova University. He served as Associate Dean of the College of Engineering for Graduate Programs and Research from 2007-2012. From 2012-2016 he served as the inaugural Associate Vice President for Research and Graduate Programs at Villanova.

Dr. Marcelo del Valle is a Thermal/Mechanical engineer at INTEL Corporation. He received his B.S.M.E from Universidad de Santiago, Chile, M.S.M.E. from University of Nevada, Reno and his Ph.D. in Mechanical Engineering from Villanova University. Dr. del Valle has worked extensively in experimental measurements in the thermal sciences for more than 7 years. His doctoral research involved detailed experimental characterization and modeling of air to liquid heat exchangers in data center applications. 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 liquid cooling, and thermal management in energy systems. He is part of the program committee of the IEEE Semitherm Symposium.

Short Courses Monday, March 19, 2018

Short Course 6 Afternoon **1:30 p.m. – 5:30 p.m.**

Computational and Experimental Thermal Characterization for the Future of the Microelectronics Industry: A Philosophy and Promising Directions

Instructor: Peter Raad, Southern Methodist University

Transistor scaling has led to rapid and profound developments in both commercial and consumer electronics, which have had a transformative impact on society at large. As is the nature of human appetite, there seems to be only a desire for more, with ever-wider capabilities and possibilities. Unfortunately, the same cannot be said about transistor scaling, which appears to have reached hard stops, leading the microelectronics industry to switch from scaling to novel architectures that use three-dimensional device manufacturing and integration of chips. Whenever such foundational change occurs, engineering perspectives and approaches must follow. This calls for a thorough evaluation of needs, strategies, and opportunities.

In this short course, we will (i) review the fundamental promises of both numerical and experimental approaches to the characterization of the thermal behavior of microscale, three-dimensional, transient devices, (ii) outline a general philosophy guided by the anticipated directions that the industry is taking, and (iii) propose experimental and computational directions that hold promise in addressing current design trends as well as anticipated directions.

Peter E. Raad is a professor of mechanical engineering at Southern Methodist University (SMU) in Dallas, Texas. He first joined SMU in 1986 and has previously served as the associate dean of its School of Engineering. From 2000 to 2012, he founded and directed the Hart eCenter at SMU, a university-wide center to address the impact of the interactive networked technologies on society, and The Guildhall at SMU, a first of its kind graduate program in digital game development.

Raad has received over $2.5 million in funding support for his research in tsunami mitigation and in metrology of submicron electronics. In 2006 he founded TMX Scientific, a company to innovate and commercialize deep submicron thermal measurement systems and ultrafast thermal computational engines. Raad's work in the thermal management field includes the development of innovative deep-submicron thermal metrology techniques and systems, as well as novel coupling of computations and measurements to provide transient, three-dimensional temperature fields in electronic structures with inaccessible internal features.

His honors include the Allan Kraus Thermal Management Medal (2014); the Harvey Rosten Award for Excellence in the Physical Design of Electronics (2006); the ASME North Texas Section Engineer of the Year (1999-2000); the Next-Gen's Top 25 People of 2007 (most influential in the video gaming industry); and Outstanding Graduate (four times) and Undergraduate (three times) Faculty Awards at SMU.

He has published over 50 journal articles, and given more than 100 conference and invited talks. He holds U.S. and international patents in thermal metrology and computational characterization of multiscale integrated circuits. He is a Fellow of ASME and a Senior Member of IEEE. He received his BSME (with honors, 1980), MS (1981), and PhD (1986) in mechanical engineering from the University of Tennessee - Knoxville.

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Short Courses Monday, March 19, 2018

Short Course 7 Afternoon **1:30 p.m. – 5:30 p.m.**
Fundamentals of Vibration and Shock for Electronics Applications
Instructor: Nicholus Clinkinbeard, Rockwell Collins

Vibration and shock can be extremely detrimental to products fielded in rugged environments. This is particularly true for electronic systems designed to meet multiple functional requirements while also surviving extreme thermal, moisture, erosion, and electromagnetic conditions. This course is designed to guide engineers and other professionals to consider shock and vibration during the entire product design lifecycle, not just detailed design or qualification. Specifically, the following will be discussed:
The topics will include some theory, but will focus on application to product development.

- Introduction to response spectra
- Vibration and shock testing
- Design for vibration and shock
- Concepts in shock and vibration
- Vibration and shock requirements for rugged applications
- Reliability and production vibration requirements

Nick Clinkinbeard is a Principal Mechanical Engineer for Rockwell Collins in Cedar Rapids, Iowa, where he has functioned as both a general design engineer and a vibration and shock specialist. For the past eleven years, he has worked in the Environmental Effects Engineering department, where his duties have focused primarily on shock and vibration—specifically including requirements capture and design support, classical and finite element analysis, test lab development and support, and training. Nick is also a Vice President of Education for the Institute of Environmental Sciences and Technology, and has taught courses on vibration and shock testing for the organization. Nick has BS and MS degrees in mechanical engineering from Iowa State University, where he is currently pursuing a PhD in the field.

KEYNOTE Tuesday March 20, 2018
Thermal Challenges and Industry Trends of Consumer Electronic Devices.
There are many thermal design challenges in consumer electronic devices including wearables, portable computing platforms and IOT communication devices. This talk covers industry trends in the consumer electronics hardware business and the role that thermal management and design plays, as well as how to cope with the trends to overcome power and thermal challenges.

Dr. Andre Ali currently heads thermal engineering for Google HW. He is a former chief thermal architect at Apple where he is credited for leading and innovating thermal technologies and design architectures for Apple's MacBook, MacBook Pro, MacBook Air, iPhone and iPad. He is a former thermal technologist at Intel's mobile product group. His interests and research focus are in electronics thermal management and control, energy efficiency, renewable energy. Dr. Ali invented and published numerous patents and papers in the field of thermal management, CFD and two-phase heat transfer. He also served as keynote speaker, panelist and chair at various conferences and forums worldwide. He has a PhD in Mechanical Engineering from University of Maryland.

Luncheon Speaker Tuesday, March 20, 2018
ASHRAE Activities in Data Center Standards
Dustin Demetriou, Senior Engineer at IBM
This presentation will provide an overview of ASHRAE TC 9.9 standards setting (who is involved, organization structure, etc.). The majority of the presentation will discuss 3 topics: Thermal Guidelines, IT Equipment Design and Standard 90.4 - Energy Standard for Data Center. Also included will be the newest items published by TC 9.9.

Dr. Dustin Demetriou is an Advisory Engineer in the IBM System's Advanced Thermal Energy Efficiency Lab focusing on advanced cooling technologies, cross brand thermal development and state-of-the-art data center designs. He received a Ph.D. in Mechanical and Aerospace Engineering from Syracuse University. His research is focused on the analysis, application and optimization of energy conversion systems, particularly in the area of high-density data centers and high-performance buildings and the development of advanced cooling technologies.

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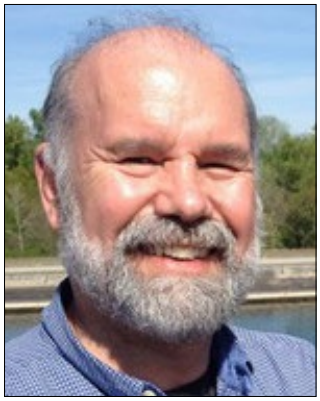
Evening Tutorial
Tuesday March 20, 2018

The Internet of Things — A Personal Perspective
Dr. Bruce Guenin



It is commonly acknowledged that the term Internet of Things (IoT) was created in reference to the introduction of RFID tags in 1999. They represented the first wave of autonomous sensors that enabled computers to observe, identify and understand the world—without the limitations of human-entered data. Since then, the types and numbers of sensors providing this function have increased exponentially. Also, through the use of big data analyses and machine learning, computers are able to analyze inputs of large numbers of sensors and can make rapid decisions based on the input data. We are seeing increasing use of this capability in manufacturing, farming, traffic control, healthcare, and the list goes on and on. We have also witnessed computer networks being hacked and huge amounts of data stolen and misused.

Where is all this heading? This presentation will describe current technical approaches for managing inputs from a large number of sensors and possible options for the future as the number of sensors is expected to increase by many orders of magnitude. It will discuss possible business opportunities for electronics cooling vendors in this new technology landscape. It will also address the bigger picture and speculate on what the future may hold for us, in terms of both benefits and risks.

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. He is on the Editorial Board of Electronics Cooling Magazine and is a past chairman of the JEDEC JC-15 Thermal Standards Committee and the SEMI-THERM Conference. His contributions to the thermal sciences have been recognized by receiving the Harvey Rosten Award in 2004 and the Significant Contributor Award by the Semi-Therm Conference in 2010.
He received a B.S. degree in Physics from Loyola University, New Orleans, and the Ph.D. in Physics from the University of Virginia. He has authored and co-authored over 80 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 awarded 18 patents in these areas. As an editor of Electronics Cooling he has contributed, to date, 35 installments of the tutorial column, Calculation Corner.

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Panel Discussion
"Challenges in Consumer Electronics Cooling"
Thursday, March 22 2:00p.m. - 4:00p.m.

"Challenges in Consumer Electronics Cooling" will address how current challenges are being met and will emphasize future challenges, how they are framed, and what approaches and technologies might be applied to overcome them. Each panelist will give a 10 minute presentation from their perspective, with 30 minutes for audience questions.

Moderator: Mark Carbone, Intel
Co-Topic Champions: Consumer Electronics
William Maltz, President, Electronic Cooling Solutions, wmaltz@ecooling.com
and Mark Carbone, Senior Thermal Engineer, Intel, mark.carbone@intel.com

PANELISTS:
Andy Delano, Microsoft, andel@microsoft.com
Jie Yang, Huawei, yangjie67@huawei.com
Emil Rahim, Google, emilrahim@google.com
Guy Wagner, ECS, gwagner@ecooling.com
Gabriel Khouri, Intel, gabriel.g.khouri@intel.com

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K. Mulay Memorial Scholarship ($1,500); Celsia Inc. Scholarship ($1,000);
Thermal Engineering Associates, Inc. Scholarship ($1,000);
Center for Energy-Smart Electronic Systems Scholarship ($1,000)

SEMI-THERM 33 Scholarship Winners

K. Mulay Memorial Scholarship ($1,500)
Award for Best Student Paper at ST33:
Experimental Study on Flow Boiling in a Hierarchial Manifold Microchannel Heat Sink Array
Kevin P Drummond, Purdue University

Celsia Inc. Scholarship ($1,000)
Best Student Paper in the area of Two-Phase Thermal Management at ST33:
Experimental Study on Flow Boiling in a Hierarchial Manifold Microchannel Heat Sink Array
Kevin P Drummond, Purdue University

Thermal Engineering Associates, Inc. Scholarship ($1,000)
Best Student Paper in the area of Thermal Measurement Technology at ST33:
Experiments on the Thermal Resistance of Deformable Thermal Interface Materials under Mechanical Loading
Richard Kenney, Villanova University

Center for Energy-Smart Electronic Systems Scholarship ($1,000)
Best Student Paper in the area of Energy-Smart Electronic Systems Technology at ST33
Impact of Elevated Temperature on Data center Operation based on Internal and External Instrumentation
Mohammad I. Tradat, Binghamton University

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SEMI-THERM 34

Embedded Tutorial
Wednesday March 21, 2018

Selecting Adhesives and Thermally-Conductive Adhesives for Electronics Systems

Presented by:

Tom Rogers
Technical Director, Polyonics Inc.,
Westmoreland NH USA

Dave Saums
Principal and Founder, DS&A LLC,
Amesbury MA USA

Part I – Thermal Interface Material Categories
Dave Saums (20 minutes)

I. Terminology for Thermal Interface Materials

II. TIM categories
- Why Does Understanding Different Tim Categories Matter?
- Fourteen Tim Category Definitions
- Table: Category Definitions, Basic Relative Differences
- Thermally-Conductive Adhesive Tims
- Adhesives And Mechanical Clamping: Differences In Packaging And Uses Of Each

III. Thermal performance testing of TIMs
- Thermal Resistance And Bulk Thermal Conductivity: Which Matters For Selecting A TIM For An Application?
- Understanding TIM Data Sheet Performance Values And Sources Of Data
- Sources Of TIM Data Sheet Performance Values
- Standard Test Methodologies For TIM Performance

Part II – Adhesives and Thermally-Conductive Adhesives
Tom Rogers (40 minutes)

I. Adhesive categories
- Principal Chemistries
- Common Applications By Principal Category
- Important Distinctions

II. Thermally-Conductive Adhesives
- Principal Types
- Common Applications

III. Selection Process for Thermally-Conductive Adhesives

IV. High-Temperature Thermally-Conductive Adhesives

Part III – Q&A

Tom Rogers is the Technical Director at Polyonics, Inc., where he leads the company's product and technology development efforts with an emphasis on specialty films, tapes, and interface materials for electronics applications.

Tom has a BS and MS in Chemical Engineering from the New Jersey Institute of Technology and University of Idaho, respectively. He also has an MBA from Xavier University.

Dave L. Saums has thirty-nine years of technical marketing, product development, and business development experience with advanced thermal materials, thermal components, and two-phase liquid cooling systems.

Dave has operated a consulting firm focused on thermal materials and components for fourteen years, in addition to twenty-five years' experience with thermal component and materials manufacturers.

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Presented To

Bernie Siegal

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

Bernie Siegal's first involvement in semiconductor thermal matters came in 1966 while working at the microwave semiconductor group within Hewlett-Packard Associates (HPA). Bernie and an associate developed an automated system for making thermal resistance measurements on microwave diodes and authored a feature article describing the method, which appeared in the October 1967 issue of the HP Journal. From that beginning to today, Bernie has been an active participant in the semiconductor measurement, modeling and management field. In 1974, Bernie founded SAGE Enterprises, Inc. and began offering test equipment for measurement of thermal resistance for many different types of semiconductor devices. The thermal testing techniques Bernie developed eventually became incorporated into many of the industry (SEMI and EIA/JEDEC) and US military measurement (Mil Std 750) standards. Besides being actively involved in many of the various standards-creating committees, Bernie is co-founder and primary force behind the start of SEMI-THERM, the premier technical symposium in the field. He has authored over 40 technical papers, presented seminars to world-wide audiences, and conducted several short courses for the UC Berkeley Extension program. His current company, THERMAL ENGINEERING ASSOCIATES, INC. (TEA), maintains his involvement in the field. Bernie holds M.B.A. (Santa Clara University), M.S.E.E. (San Jose State University), and B.S.E.E. (Cornell University) degrees. He was elected a Fellow of the IEEE and received the IEEE Significant Contributor Award for his work in the semiconductor thermal field. He currently serves as the Chairman of the IEEE CPMT Silicon Valley Chapter.