

SEMI-THERM[®] TMPES

Thermal Management for Power Electronics and Storage (TMPES) 2020 Virtual Workshop

July 28-30, 2020

SIP

A New York State Center of Excellence

BINGHAMTON UNIVERSITY

Sponsored by



PROGRAM COMMITTEE

Dave Saums

General Chair, ST TMPES 2020

Principal, DS&A LLC (Amesbury, MA USA)

Steve Czarnecki, PhD

Program Committee Chair, ST TMPES 2020

Associate Director, S3IP Center of Excellence,
Binghamton University (Binghamton, NY USA)

Dave DeWire

Vice President Business Development, Hermetic
Solutions Group (Denver, CO USA)

Klaus Olesen

Senior Research Specialist, Danfoss Silicon Power
(Flensburg, Germany)

Alfonso Ortega, PhD

James R. Birlle Professor of Energy Technology;
Associate Director, NSF Center for Energy Smart
Electronic Systems; Director, Laboratory for
Advanced Thermal and Fluid Systems; Department
of Mechanical Engineering, Villanova University
(Radnor, PA USA)

Alexander Roth

Head of Department, Materials Innovations,
Infineon Technologies (Regensburg, Germany)

Ross Wilcoxon, PhD

Associate Director, Mechanical Engineering, Mission
Systems, Collins Aerospace (Cedar Rapids, IA USA)

CONTENTS

WELCOME MESSAGE	2
AGENDA	3
SPEAKERS	5
SPONSOR ADS	13
SAVE THE DATE 2021	16
THANK YOU SPONSORS	17

WELCOME MESSAGE



Dave Saums
TMPES Workshop
General Chair

TMPES 2020 Attendees:

On behalf of SEMI-THERM Educational Foundation and the S3IP Center of Excellence, we welcome you to this workshop. Power electronics and energy storage are transforming our world, and their importance rivals that of traditional microelectronics in the coming decade. As with microelectronics, thermal management is a critical issue; both of our organizations have decades of experience in thermal management for electronics, be it in research, partnership with industry, or in educating students and the community of practice. It becomes a natural step to place focus on the adjacent topic of thermal management for power electronics and storage.



Steve Czarnecki
TMPES Program
Committee Chair

This virtual workshop is an experiment; originally, a conventional in-person event was planned but the worldwide response to the pandemic necessitated different plans. We have developed an agenda featuring thought leaders from across industry, government, and academia that we hope you will find informative and thought provoking.

Our hope is to offer the workshop again in July 2021 with live attendance. As powerful as electronic conferencing tools may be, we look forward to the in-person interactions and the fostering of relationships so necessary for a robust, knowledge-based ecosystem.

In the meantime, thank you for joining us, and may you find this workshop productive. Stay safe and well so that you may join us next year as well at Binghamton University.

Dave Saums
TMPES Workshop General Chair

Steve Czarnecki
TMPES Program Committee Chair

AGENDA

DAY ONE Tuesday, July 28	
10 - 10:10 a.m.	Workshop Opens/Meeting Logistics, Dave Saums , TMPES General Chair
10:10 - 10:15 a.m.	Welcome Remarks, Bahgat Sammakia , Vice President for Research, Binghamton University
10:15 - 10:25 a.m.	Acknowledgments/Agenda Review, Dave Saums , TMPES General Chair
10:25 - 11:10 a.m.	Keynote Presentation M. Stanley Whittingham, Nobel Laureate, Binghamton University, “Lithium-Ion Batteries, from an Idea to Domination of Energy Storage: Future Challenges and Opportunities”
11:10 - 11:40 a.m.	Invited Speaker, Dave Saums, DS&A LLC “Opportunities across the Power and Energy Storage Landscape”
11:40 a.m. - 12:25 p.m.	Invited Speaker, Claus Petersen, Danfoss Silicon Power “E-mobility Will Shape Future Power Electronics Development”
12:25 - 12:40 p.m.	BREAK
12:40 - 1:15 p.m.	Invited Speaker, Edmund Riedl, Infineon “Semiconductor Packaging for High Reliability Advanced Automotive Electronics”
1:15 - 1:20 p.m.	Day 1 Wrap Up, Dave Saums , TMPES General Chair
1:20 p.m.	ADJOURN

DAY TWO Wednesday, July 29	
10 - 10:15 a.m.	Workshop Opens/Meeting Logistics/Acknowledgments/Agenda Review Dave Saums , TMPES General Chair
10:15 - 10:45 a.m.	Invited Speaker, Matt Watson, Empire State Development Division of Science, Technology and Innovation (NYSTAR) “New York State’s Innovation Ecosystem”
10:45 - 11:05 a.m.	Sponsor Presentation, Ole Mühlfeld, Danfoss Silicon Power “New Packaging Technologies Increase Power Density and Efficiency of Drive Trains for Future Electric Vehicles”
11:05 - 11:15 a.m.	Sponsor Presentation, Tim Jensen, Indium Corporation “High Performance Metal TIMs”
11:15 - 11:50 a.m.	Invited Speaker, Burak Ozpineci, Oak Ridge National Laboratory (ORNL) “Highly Integrated Power Module Needs for Electric Vehicle Drives”
11:50 a.m. - 12:05 p.m.	BREAK
12:05 - 12:40 p.m.	Invited Speaker, Lauren Boteler, Army Research Laboratory (ARL) “Exploring the Future of Power Module Design”
12:40 - 1 p.m.	Sponsor Presentation, Dave DeWire, Hermetic Solutions Group “Hermetic Solutions - High Reliability Packaging”
1 - 1:35 p.m.	Invited Speaker, Ahmad Pesaran, National Renewable Energy Laboratory (NREL) “Lithium Ion Battery Thermal Management and Safety”
1:35 - 1:40 p.m.	Day 2 Wrap Up, Dave Saums , TMPES General Chair
1:40 p.m.	ADJOURN

DAY THREE Thursday, July 30	
10 - 10:15 a.m.	Workshop Opens/Meeting Logistics/Acknowledgments/Agenda Review Dave Saums , TMPES General Chair
10:15 - 10:45 a.m.	Invited Speaker, Ben Alexander, ThermAvant Technologies, LLC “Oscillating Heat Pipes for Thermal Management of Li-ion Batteries”
10:50 - 11:30 a.m.	Invited Speakers Bahgat Sammakia, Binghamton University/Alfonso Ortega, Villanova University “Liquid Cooling as an Enabling Technology for High Performance Electronic Systems”
11:30 a.m. - 12:05 p.m.	Invited Speaker, Frede Blaabjerg, Aalborg University “Power Electronics – the Key Technology for Grid Integration”
12:05 - 12:20 p.m.	BREAK
12:20 - 12:55 p.m.	Invited Speaker, Zachary Edel, ThermoAnalytics “The Role of Modeling in the Development of Battery Thermal Management Solutions for Power Electronics and Storage”
12:55 - 1:30 p.m.	Invited Speaker, Ercan Dede, Toyota “Packaging and Thermal Challenges for Integrated Power Electronics”,
1:30 - 1:35 p.m.	Day 3 Wrap Up, Dave Saums , TMPES General Chair
1:35 p.m.	ADJOURN

SPEAKERS



Ben Alexander

Ben Alexander is a lead engineer with ThermAvant Technologies, where he has been involved with modeling, design and R&D of structurally embedded oscillating heat pipes for a variety of applications, with a focus on applications related to Li-ion battery cooling and waste heat acquisition and rejection from motors, generators and power electronics. In addition to work related to electric powertrains, Alexander has also led a number of large-format OHP programs related to space radiators and thermal management of cryocooling systems.



Frede Blaabjerg

Frede Blaabjerg's research interests include power electronics and its applications such as in wind turbines, PV systems, reliability, harmonics and adjustable speed drives. He has published more than 600 journal papers in the fields of power electronics and its applications. He is the co-author of four monographs and editor of 10 books in power electronics and its applications. Blaabjerg serves as president of IEEE Power Electronics Society and vice-president of the Danish Academy of Technical Sciences. He was nominated in 2014-2019 by Thomson Reuters to be among the most 250 cited researchers in Engineering in the world. Blaabjerg was with ABB-Scandia, Randers, Denmark, from 1987 to 1988. He earned a doctorate in electrical engineering from Aalborg University. He became an assistant professor in 1992, an associate professor in 1996 and a full professor of power electronics and drives in 1998. From 2017, he became a Villum Investigator. Blaabjerg has received 32 IEEE Prize Paper Awards, the IEEE PELS Distinguished Service Award in 2009, the EPE-PEMC Council Award in 2010, the IEEE William E. Newell Power Electronics Award 2014, the Villum Kann Rasmussen Research Award 2014, the Global Energy Prize in 2019 and the 2020 IEEE Edison Medal. He was the editor-in-chief of the IEEE Transactions on Power Electronics from 2006 to 2012. He has been a distinguished lecturer for the IEEE Power Electronics Society from 2005 to 2007 and for the IEEE Industry Applications Society from 2010 to 2011 as well as 2017 to 2018.



Lauren Boteler

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 doctoral degree in mechanical engineering from the University of Maryland. Her work at ARL, beginning in 2005, has included electronics packaging and thermal management solutions for a wide range of Army applications. Her research programs focus on design tool development and package integrated thermal solutions, including 3D chip stacking, power electronics, laser diodes, double side cooling and phase change materials. She initiated a research portfolio in advanced power electronics packaging and thermal management, which defines the four main challenges of power electronics packaging: co-engineering/co-design, transient thermal mitigation, additive manufacturing and high-voltage packaging. She recently completed a developmental assignment as the technical assistant to the director of the U.S. Army Research Laboratory. Boteler, an adjunct professor at Johns Hopkins University, received the 2018 ASME EPPD Woman Engineer of the Year award for her contributions to the electronics packaging community.



Ercan M. Dede

Ercan M. Dede received his bachelor's degree and doctorate in mechanical engineering from the University of Michigan and a master's degree in mechanical engineering from Stanford University. He is the group manager of the Electronics Research Department at the Toyota Research Institute of North America. His team focuses on vehicle systems involving advanced sensors, power semiconductors, power electronics and photonics packaging, and thermal management technology. He has over 110 issued patents and has published more than 85 articles in archival journals and conference proceedings on topics related to design and structural optimization of thermal, mechanical and electromagnetic systems. He is an author of a book titled "Multiphysics Simulation: Electromechanical System Applications and Optimization." His team has received two R&D 100 Awards for the development of technologies related to next-generation power electronics for electrified vehicles.



Dave DeWire

Dave DeWire, vice president of business development for Hermetic Solutions Group, has a strong background in thermal management in device packaging for high frequency and high power applications. He has broad industry experience across multiple packaging architectures, which include the use of metals, metal matrix composites, multilayer ceramics, plastics, direct bond copper and other CTE matched technologies. His role in business development with HSG is focused on high reliability technologies for harsh environment applications, which includes packages, lids, connectors and feedthrus, getters and absorbers, solder preforms and sealing of ceramic and high-rel packaging. He holds degrees in international business and marketing and is the co-holder of four patents on modular low stress packaging technologies.



Zachary J. Edel

Zachary J. Edel is a senior research engineer at ThermoAnalytics Inc. and the chief engineer of the TAItherm battery extension. He is involved in thermal/electric and thermal/CFD simulation, advanced physics modeling, algorithm development and multi-physics coupling. Edel has over 13 years of research experience developing advanced physics models, performing numerical modeling and performing experimentation and data analysis. In 2013, he received his doctorate in mechanical engineering-engineering mechanics from Michigan Technological University.



Tim Jensen

Tim Jensen is the senior product manager for Indium Corp.'s engineered solder materials, the company's most diverse product group. His product group encompasses solder preforms, wire, ribbon and thermal interface materials. He is responsible for ensuring the product line is poised for long-term success by developing technologies that best meet the current and future needs of customers. Jensen joined Indium Corp. in 1997 and has held a number of positions, including senior technical support engineer, Pb-free programs manager and global product manager for PCB Assembly Materials. He holds a degree in chemical engineering from Clarkson University and an MBA from Syracuse University.



Ole Mühlfeld

Ole Mühlfeld is head of application engineering at Danfoss Silicon Power. He holds a doctorate in electrical engineering and a diploma in physics from the University of Kiel, Germany. He and his team develop product concepts for customized power modules, using advanced technologies to satisfy requirements of automotive, industrial and renewable applications. Mühlfeld has filed a number of patent applications related to packaging of power electronics.



Alfonso Ortega

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 is associate director of the NSF ES2 Center. Ortega received his bachelor's degree from the University of Texas-El Paso and his master's and doctoral degrees 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. Ortega, a teacher of thermal sciences and experimental methods, is an internationally recognized expert in the areas of thermal management in electronic systems. He has supervised over 40 master's and doctoral candidates to degree completion, five 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 on thermal management and experimental measurements. Ortega is a fellow of the ASME and received the 2003 SEMITHERM Thermie Award and the 2017 IOTHERM Achievement Award in recognition of his contributions to the field of electronics thermal measurements.



Burak Ozpineci

Burak Ozpineci received a bachelor's degree in electrical engineering from Orta Dogu Technical University in Ankara, Turkey, in 1994, and master's and doctoral degrees in electrical engineering from the University of Tennessee in 1998 and 2002, respectively. He joined the Post-Master's Program with Power Electronics and Electric Machinery (PEEM) Group, Oak Ridge National Laboratory (ORNL), Knoxville, in 2001, and was a full-time research and development staff member and later the group leader of the Power and Energy Systems Group. Today he leads the Power Electronics and Electric Machinery Group and manages the Electric Drive Technologies Program at ORNL. Ozpineci, a Fellow of IEEE, also serves as a joint faculty member with the Bredesen Center at the University of Tennessee.



Ahmad Pesaran

Ahmad Pesaran, chief energy storage engineer at the National Renewable Energy Laboratory, received his doctorate from UCLA in 1983. Since then, he has been working at NREL on various energy-efficiency technologies, including electrified vehicles and their batteries, ocean-thermal energy conversion and advanced air conditioning. Until 2017, he was the manager of the Energy Storage Group researching science and engineering of high energy anodes and cathodes, battery thermal management, 3D electrochemical-thermal modeling, safety and thermal runaway modeling, battery second use, techno-economic analysis of batteries for EVs. He led the Computer-Aided Engineering for Electric Drive Vehicle Batteries for Department of Energy (DOE). Pesaran has co-authored more than 150 papers and conference presentations on energy storage and electric drive vehicles. He is an active member of United States Advanced Battery Consortium. He has won many NREL and external awards, including three R&D100 Awards and EERE Assistance Secretary's 2017 Outstanding Impact. Pesaran was elected to Fellow of the Society Automotive Engineers in 2018 for his contribution to electric mobility. Between 2016 and 2018, he was detailed at the DOE's Vehicle Technologies Office (VTO) as technical advisor to the battery program supporting battery processing, extreme fast charging and recycling. He was the administrator for the Phase I of the DOE Battery Recycling Prize. Pesaran is the chief energy storage engineer at the Center for Integrated Mobility Sciences supporting VTO on battery processing, manufacturing, solid electrolyte and low-cobalt projects.



Claus A. Petersen

Claus A. Petersen is vice president and general manager of Danfoss Silicon Power. After completing his business studies in Denmark, Petersen joined Danfoss in 1984 and has been responsible for Silicon Power since 1998, growing the business to be a top power module supplier, to a turnover of ~150m€ and approximately 450 employees. Besides his responsibilities as general manager, Petersen is part of the Danfoss Drives Segment leadership team. A former president of CEMEP (2017 - 2019, European Committee of Manufacturers of Electrical Machines and Power Electronics) and member of the board for ZVEI (Central Association of Electrical Engineering and Electrical Industry), Petersen sits on the boards of Fraunhofer ISIT (Institute for Silicon Technology) and the Danish Electric Vehicle Alliance.



Edmund Riedl

Edmund Riedl started his academic career as a graduated chemical engineer from University of Applied Sciences Nuremberg in 1996 and worked in the area of synthesis and scale up of pharmaceutical drugs from 1986-1997. After moving to solid-state chemistry in 1997 at University of Bayreuth/Germany department of crystallography, he joined Infineon in 1999. There he worked on innovative materials and surface design for semiconductor products. He holds a doctorate on adhesion promoter technologies and corrosion prevention coatings since 2014. The focus of his work was the development of highly reliably packages for automotive products covering materials, processes and respective manufacturing tools. He also established a holistic approach covering aspects from wafer technology to package technology.



Bahgat Sammakia

Bahgat Sammakia, a SUNY distinguished professor of mechanical engineering, is the vice president for research at Binghamton University. He is the current and founding director of S3IP, a New York State Center of Excellence. He is the director of the Center for Energy-Smart Electronic Systems (ES2), an NSF IUCRC founded in 2011 with a focus on reducing the energy consumed by data centers around the world. He is also the Binghamton University director of the Center for Heterogeneous Integration Research in Packaging (CHIRP), established in 2018 by the Semiconductor Research Corporation (SRC) and led by Binghamton University and Purdue University. Sammakia served as the interim president of SUNY Polytechnic Institute from December 2016 to June 2018. He is a fellow of the American Society of Mechanical Engineers, the National Academy of Inventors and the IEEE. Sammakia has contributed to several books on heat transfer, holds 21 U.S. patents and has published more than 250 peer-reviewed technical papers. Sammakia, who received the SUNY Chancellor's Award for Excellence in Scholarship and Creative Activities in 2010, was honored with the 2010 ITherm Achievement Award for his contributions to the field of semiconductor thermal management. Sammakia earned his bachelor's degree from the University of Alexandria in Egypt and his master's and doctoral degrees from the University at Buffalo. A former IBM senior technical staff member focused on research and development of organic electronic systems, Sammakia joined Binghamton's faculty in 1998.



Dave Saums

Dave Saums has 42 years of technical marketing, product development and business development experience in electronics thermal management, across a wide range of electronic systems market segments. In 2003, he founded DS&A LLC, a full-time consulting firm focused on assisting client companies in the EU, North America and Japan with development of new concepts and new business in thermal materials, CTE-matched composites, advanced thermal components and two-phase pumped liquid cooling systems. Saums' industry experience includes managing a core product development group, corporate strategy and product development, authoring a textbook chapter on thermal interface materials for LED design and presentations at industry technical conferences in the EU, Asia and North America. He has also served as general chair for more than two dozen thermal management conferences and workshops in North America, Germany and The Netherlands.



Matthew C. Watson

Matthew Watson has extensive experience in organizational management, program development, policy and advocacy. His career includes senior and executive roles in the public and private sectors. He serves as the senior vice president of Empire State Development's Division of Science, Technology & Innovation (ESD/NYSTAR), the state economic development division responsible for advancing science, technology and innovation in support of industry growth and competitiveness. NYSTAR's \$55 million annual portfolio includes innovation-led economic development programs such as the Centers for Advanced Technology, Centers of Excellence, High Performance Computing Consortium, Innovation Hot Spots, Certified Business Incubators, the New York Manufacturing Extension Partnership and others. In his leadership of ESD/NYSTAR, Watson has created multiple initiatives to accelerate the commercialization of research and to improve the pathway by which early-stage New York State companies address growth hurdles and innovation needs. He instituted a new framework for the division's programs that has resulted in higher volumes of companies drawn into the pipeline of assistance and a more successful method of matching companies to appropriate resources and tracking them to their resolution. Watson previously held a management role with a leading global strategic communications firm, FleishmanHillard, where he advised corporate clients.



M. Stanley Whittingham

M. Stanley Whittingham is a SUNY distinguished professor of chemistry and materials science and engineering at Binghamton University and the 2019 Chemistry Nobel Laureate. He received his BA and D Phil degrees in chemistry from Oxford University, where he is an honorary Fellow of New College. He has been active in Li-batteries since 1971, when he won the Young Author Award of the Electrochemical Society for his work on the solid electrolyte beta-alumina. In 1972, he joined Exxon's Corporate Research Laboratory and discovered the role of intercalation in battery reactions, which resulted in the first commercial lithium rechargeable batteries that were built by Exxon Enterprises. In 1988 he returned to academia at Binghamton to initiate a program in materials chemistry. He was awarded a JSPS Fellowship in the Physics Department of the University of Tokyo in 1993. From 1993-1999 he was vice provost for research. In 2004 he received the Battery Division Research Award. He is director of the NorthEast Center for Chemical Energy Storage (NECCES), an Energy Frontier Research Center based at Binghamton. Whittingham received the Yeager Award of the International Battery Association in 2012 for his lifetime contributions to battery research. In 2015, he received the Lifetime Contributions to Battery Technology award from NAATBaaT; in 2017, he received the Senior Research Award from Solid State Ionics; in 2018, he was elected a member of the National Academy of Engineering and received the Turnbull Award from MRS. He is a fellow of the Electrochemical Society and the Materials Research Society. He is vice-chair, Board of Directors of the New York Battery and Energy Storage Technology Consortium (NYBEST).

Maximize the potential of Si and SiC



DCM™1000 – Enabling the electrification of the drive train

With silicon (Si) and silicon carbide (SiC) being the main cost-drivers in power modules, our **DCM™1000 platform** aims at reducing the semiconductor surface.

At the same time, it also increases power density, reliability, robustness and lifetime of the inverter. By selecting the best fitting chips from a competitive supplier base and by carefully selecting the power module components, package and electrical configuration, we are able to use the semiconductors to their full potential. In this way, we can drive down the overall cost of the half-bridge module.

www.siliconpower.danfoss.com

ENGINEERING
TOMORROW

Danfoss

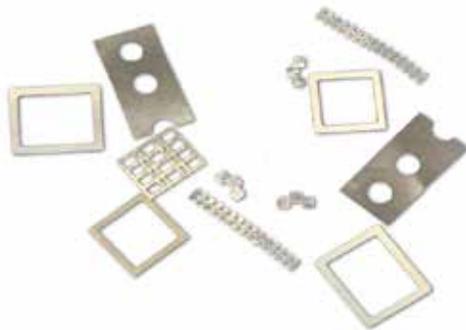
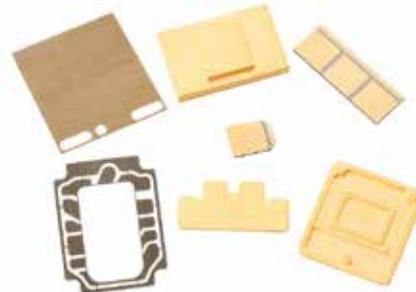
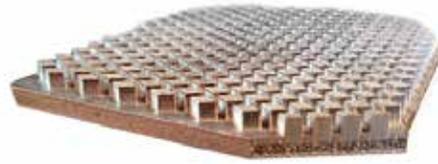
Your Source for Engineered Materials and Services

About HSG

At Hermetic Solutions Group, we solve problems. We were formed in 2016 specifically to provide a comprehensive offering that houses and protects microelectronics in the world's most extreme environments to maximize performance and life. With a common focus of putting our customers at the center of everything we do, our four companies employ proprietary technologies, best practices engineering and specialized manufacturing to get it right for you the first time, every time and on-time.

Extensive Thermal Solutions

- **Thermal Tabs**
Offering heat sinks, thermal carriers, and thermal tabs, the Hermetic Solutions Group delivers both high quality standard shapes, as well as complex geometries and materials.
- **Thermal Base Plates**
The Hermetic Solutions Group manufactures base plates made from advanced thermal management materials that efficiently draw heat away from sensitive electronics within a electronic package, ensuring performance and longevity.
- **DiaCool™**
DiaCool™ delivers a device-friendly coefficient of thermal expansion (CTE) and very high thermal conductivity that can satisfy the most demanding high power density applications. Our DiaCool materials exhibit excellent surface quality for all your die attach and soldering needs.
- **Speciality Alloys**
Hermetic Solutions Group offers Standard and Custom Alloy formulations built and tested in our Factory in Niagara Falls Ontario. We offer a comprehensive line of materials from the traditional precious metals to Lead Free options such as SAC305 in custom form factors and thicknesses.



Design Engineering

The Hermetic Solutions Group has proven design engineering expertise in merging science and technology to provide complex, often unique solutions for Hundreds of Defense, Power and Energy, Medical and Optoelectronics customers throughout the world.

Hermetic Solutions Group

www.hermeticsolutions.com

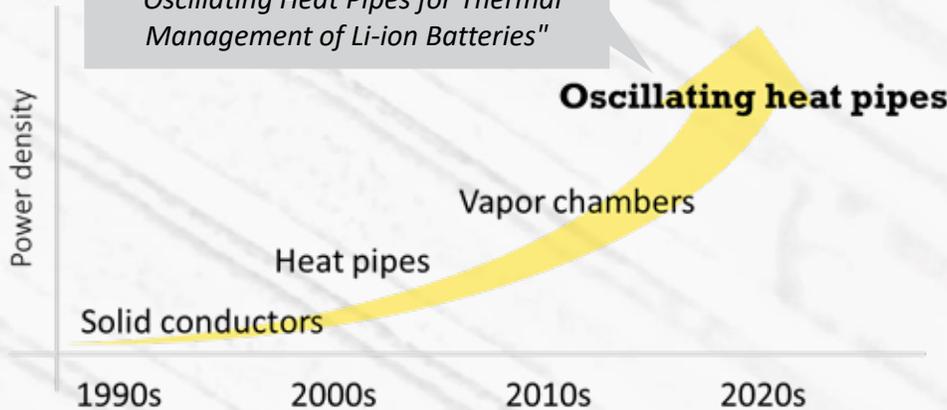
Tel: 215.645.9420 | Email: info@hermeticsolutions.com

Eight Neshaminy Interplex, Suite 221 | Trevoese, PA 19053



Leading designer, manufacturer of Oscillating Heat Pipe structures for aero-defense and opto-electronics industries

Attend 2020 TMPES presentation
"Oscillating Heat Pipes for Thermal Management of Li-ion Batteries"



- +** Conductance
 - +** Reliability
 - +** Thin, 3D shapes
 - +** Material options
- Resistance
 - Temperatures
 - Gravity effects
 - SWaP + Cost

WWW.THERMAVANT.COM TEL: 573-397-6912 2508 PARIS RD COLUMBIA, MO 65202
 ITAR REGISTERED AS9100D & ISO9001:2015 CERTIFIED

Producing polyimide in Pasadena, Texas for over 20 years and conceiving new materials at our Kaneka Innovation Center in Newark, California.

Continually reinventing.

7979 Gateway Blvd, Suite 220, Newark, CA 94560
 Tel 832.741.3858/info.thermal@kaneka.com
<http://www.elecdiv.kaneka.co.jp/english/index.html>



Thermal Solutions Provider

GRAPHINITY™

- High thermal conductivity pyrolytic graphite
- Thin, lightweight
- Different form factors available (multilayer, straps and plates)

THERMALLY CONDUCTIVE ELASTOMER

- Single phase
- Non-silicon, no outgasing
- Reworkable

APICAL™ POLYIMIDE

- Excellent mechanical, chemical and electrical properties from -269°C to 400°C

NEW PRODUCTS TO BE ANNOUNCED SOON



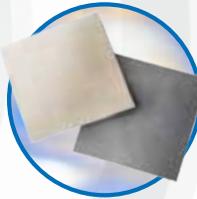
High-Performance

Metal Thermal Interface Materials



Heat-Spring®

- Patterned, compressible interface
- Optimizes performance between the heat source and a heat-sink
- No pump-out or bake-out over time



HSMF

Non-Silicone-Based Thermal Compounds

- Perform well in applications with large area thermal interface requirements
- Inherent adhesive property for easy placement and clean-up
- No pump-out or bake-out over time



m2TIM™ and Liquid Metals

- Very effective thermal interface materials
- High-thermal conductivity
- Low interfacial resistance against most surfaces

Learn more: www.indium.com/TMPES
askus@indium.com

From One Engineer To Another®

©2020 Indium Corporation



SAVE THE DATE

Next year's workshop is scheduled
for July 20-22, 2021.

It will be held at Binghamton University
in Binghamton, New York.

THANK YOU SPONSORS

