ASME InterPACK® 2021

International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems

CONFERENCE
Oct 26–28, 2021

Virtual, Online

Program

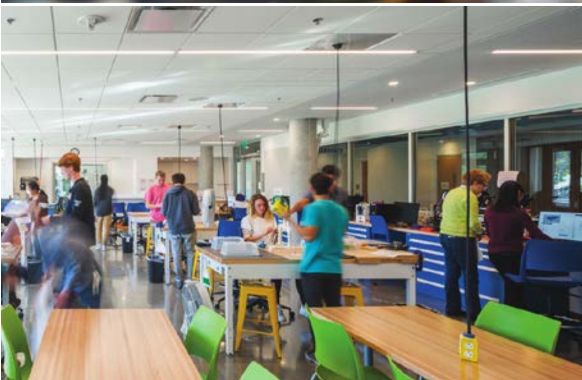
https://event.asme.org/InterPACK

The American Society of Mechanical Engineers®
ASME®

ASME
SETTING THE STANDARD

InterPACK® 2021

Washington University in St. Louis



Materials Science & Engineering at Washington University:

The Institute of Materials Science and Engineering (IMSE) and the McKelvey School of Engineering bring together more than 50 faculty and student researchers from engineering, the physical and natural sciences, and the medical school to discover new materials, understand how they behave, and envision innovative applications. IMSE supports extensive shared user facilities for micro/nanofabrication and materials characterization, and is home to an interdisciplinary, cross-school PhD program.

McKelvey Engineering just opened a new academic building, Jubel Hall, that is home to the Department of Mechanical Engineering & Materials Science (MEMS). Jubel Hall features a state-of-the-art makerspace in addition to laboratories that foster collaboration. Research in MEMS focuses on fundamental mechanical engineering and materials science at the interfaces between disciplines such as biology, nantotechnology, aerospace engineering and energy.

IMSE Research Areas:

- 2D and 3D Functional Nanomaterials
- Biomedical, Bioderived, and Bioinspired Materials and Applications
- Interfacial Nanoscale Thermal Transport
- Materials for Energy Generation, Harvesting and Storage
- Materials for Environmental Technologies and Sustainability
- Materials for Sensors and Imaging
- Nanomaterials and Glasses
- Wearable Technologies

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WELCOME LETTER

On behalf of the ASME Electronic and Photonic Packaging Division (EPPD), welcome to the 2021 International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems (InterPACK) being held virtually, from October 26 to 28, 2021.

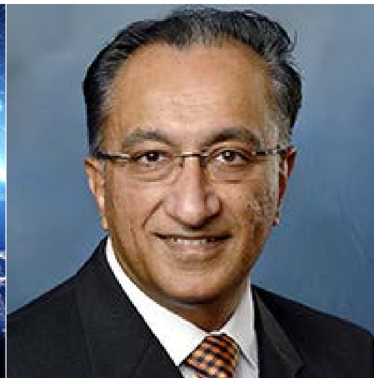
The InterPACK Conference is a premier event organized by the ASME EPPD and holds a rich history of serving as a platform for exchanging information on cross-cutting research in the areas of electronic and photonic packaging, thermal management and reliability of electronic devices, components, and systems for numerous researchers and technical professionals from Academia, Government, and Industry. While the ongoing pandemic situation does not allow large in-person events, the 2021 meeting still continues to embrace this convention and will be held in a virtual format for the second time. In these unprecedented times, the organizers have developed a comprehensive technical program comprising nearly 140 technical papers and presentations, close to 80 original full technical publications, as well as tutorials, panels, workshops, and keynotes aligned with the areas of heterogeneous integration; data centers; edge and cloud computing; flexible and wearable electronics; power electronics; multiscale heat transfer in optics and energy systems; autonomous, hybrid, and electric vehicles; reliability in electronics; and nano-scale heat transfer in electronic systems. Similar to the previous meetings, the conference program is set up to promote networking between attendees, offering opportunities to foster collaboration again in a virtual environment.

We are pleased to announce that we will have three keynote presentations from distinguished professionals in the area of electronic and photonic packaging, including “Developing wide bandgap electronics for future power and RF applications” by Professor Samuel Graham of University of Maryland, “Avoiding inelastic strains in solder joint interconnections of IC packages” by Professor Ephraim Suhir of University of Portland, and “Liquid cooling of IT equipment” by Dr. Jessica Gulbrand of Intel. It is remarkable that emerging areas in electronics and photonics have recently demonstrated significant development, and we will continue to highly encourage research and development in such emerging areas and technologies in line with the direction and goals of the ASME EPPD through the conference. Accordingly, this year, we have added two new tracks titled, “Reliability of Electronic Packages and Systems” and “Nano-Scale Thermal Transport and Materials,” and these tracks have attracted high levels of interest from researchers both from academia and industry. Furthermore, we are pleased to have a panel on Artificial Intelligence in Reliability and tutorials in the emerging areas, such as nano materials in electronic packaging and additive manufacturing for thermal management of electronics. Last but not least, we will hold the Artificial Intelligence workshop organized by Intel Corporation, in addition to the other comprehensive professional development workshops focusing on mentoring and career development in thermal management and the Heterogeneous Integration Roadmap (HIR).

We hope that you will enjoy the program that has been organized by numerous volunteers contributing as track chairs, session chairs, workshop and tutorial organizers, panel moderators, and technical paper reviewers. We are indebted to our volunteers as well as to the ASME Staff for their vigorous efforts to make this conference a premier event. We also thank all of our sponsors across the globe for their generous sponsorship funds as well as their participation in the technical sessions.

Thank you and we all look forward to seeing you at InterPACK 2021!

General Chair
Dr. Baris Dogruoz



Vice Chair
Dr. Pradeep Lall

Technical Program Chair
Dr. Przemyslaw Gromala

Technical Program Co-Chair
Dr. Sukwon Choi

Technical Program Co-Chair
Damena Agonafer, Ph.D.

GENERAL INFORMATION

The International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems (InterPACK) is the flagship conference of the Electronics and Photonics Packaging Division (EPPD).

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME strategy is designed to meet our commitment to serving societal needs; ASME positively impacts the safety, public welfare, and overall quality of life globally. We strive to deliver innovative products and services to our members, the engineering community, and society.

Mission: Advancing engineering for the benefit of humanity
Vision: The premier resource for the engineering community globally.

CONFERENCE TRACKS:

- Track 1: Heterogeneous Integration of Electronic Packages
- Track 2: Data Centers, Servers of the Future, Edge and Cloud Computing
- Track 3: Flexible and Wearable Electronics
- Track 4: Power Electronics
- Track 5: Multiscale Heat Transfer in Optics and Energy Systems
- Track 6: Autonomous, Hybrid, and Electric Vehicles
- Track 7: Reliability of Electronic Packages and Systems
- Track 8: Nanocale Thermal Transport and Materials

Registration Fees: All conference participants must register and pay the advertised fee, including authors, presenters, chairs, co-chairs, session, discussion chairs, sponsors, and general attendees**. At least one author needs to register at the full conference rate, for every 2 submissions, not at the student rate.**

Payment Method: Individuals with incomplete registrations will not be able to attend the conference until payment has been made and registration is completed. ASME accepts VISA, MasterCard, American Express, and Discover as well as wire transfers. Non-member fees include a one-year complimentary membership to ASME.

Registration Includes: OnDemand access to the virtual platform for 90 days after the conference, online access to all technical presentations, pre-recorded technical presentations, all the live sessions, which include the Keynotes, Workshops, Women in Engineering Panel, Tutorials, Poster Sessions, and digital access to all the online papers as well as the official conference proceedings.

Content Presented at ASME Conferences: Unless otherwise agreed to in a separate document, all copyright to abstracts/papers and live or recorded presentations made at the virtual conference will be the property of ASME, including translations, transcriptions, and third-party distribution rights worldwide without restriction in all current and future media. Participants are reminded to present information associated with approved papers and abstracts and not to present any information that may be considered proprietary, confidential, or restricted in any way.

Presenter Substitution: Each abstract/paper has a primary author identified who is responsible to present the abstract/paper at the conference. Should the primary author not be available to provide a pre-recorded presentation, a co-author may be nominated to present as a substitution. Any proposed substitution must be approved one week in advance by ASME Publications, and the Event Management staff must be notified one week in advance of the presentation.

Refunds/Cancellation Fee: There will be no refunds for ASME Virtual Conference Registration.

Registration Substitutions: Registrations may not be transferred or substituted at any time.

CONFERENCE PROCEEDINGS

Each attendee receives an email with a unique code to access the papers online. Check your spam folder if you have not received an email shortly before the conference. The official conference archival proceedings will be published after the conference and will not include accepted papers that were not presented at the conference. The official conference proceedings are registered with the Library of Congress and are submitted for abstracting and indexing. The proceedings are published on the ASME Digital Library. You will be provided with an individual link to the online papers via email. In the event you do not receive the email, send a request to conferencepubs@asme.org.

PRESENTER ATTENDANCE POLICY

According to ASME's Presenter Attendance Policy, if a paper is not presented during the conference, the paper will not be published in the official Archival Proceedings, which are registered with the Library of Congress and are abstracted and indexed. The paper also will not be published in the ASME Digital Collection and may not be cited as a published paper.

Photographs/Video/Audio Recordings: Unless otherwise agreed to in a separate document, participants are reminded that material presented at ASME conferences is under copyright of ASME. As a result, "Any recording of the presentations is prohibited."

Limitation of Liability: You agree to release and hold harmless ASME from any and all claims, demands, and causes of action arising out of or relating to your participation in this event.

TAX DEDUCTIBILITY

The expense of attending a professional meeting, such as registration fees and costs of technical publications, are tax deductible as ordinary and necessary business expenses for U.S. citizens. However, recent changes in the tax code have affected the level of deductibility.

MEMBERSHIP

It is easy to apply, and the benefits include the fellowship and recognition from being associated with one of the largest engineering societies in the world. ASME members and student members, and members from select countries can receive a discount on their conference registration. You can apply for ASME membership by registering online. Alternatively, you can call 1-800-THE-ASME (800-843-2763) or outside North America 973-882-1170 and ASME will mail you an application, or you can follow this link: https://www.asme.org/membership/membership-benefits to obtain an application.

PUBLICATION SALES

All InterPACK Technical Papers are available electronically to registered attendees only. Attendees will receive electronic access via their email on record. Additional copies of the proceedings can be ordered from: **ASME Order Department, 150 Clove Road, 6th Fl, Little Falls, NJ 07424-2139**

HAVE QUESTIONS ABOUT THE MEETING?

If you have any questions or need assistance, please contact Mary Jakubowski, Manager, Events Management at jakubowskim@asme.org.

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SCHEDULE-AT-A-GLANCE

PLEASE NOTE ALL CONFERENCE TIMES ARE IN PACIFIC DAYLIGHT SAVINGS TIME

INTERPACK 2021 SCHEDULE-AT-A-GLANCE					
Pacific Time		Type	Moderators & Speakers	Title	Company
Day 1 - Tuesday, 26th October 2021					
7:45 AM	8:00 AM	Welcome	Thomas Costabile (ASME Executive Director/CEO)	Welcome to ASME InterPACK 2021 Virtual Event	ASME
Room 1: Keynote Session Chaired by Kaushik Mysore, AMD (Introduction and Q&A)					
8:00 AM	8:50 AM	Keynote	Ephraim Suhir	Avoiding Inelastic Strains in Solder Joint Interconnections of IC Packages	Portland State University
8:50 AM	9:00 AM	Q&A			
9:00 AM	9:10 AM	Break	Coffee Break / Exhibitor Corner		
Panel Sessions					
Room 1: Chaired by Gamal Refai-Ahmed (Xilinx)					
9:10 AM	10:30 AM	Panel	Gamal Refai-Ahmed	Thermo-Mechanical Challenges from Package to System to Maximize Silicon Performance	Xilinx
10:30 AM	10:40 AM	Q&A			
Room 2: Chaired by Fang Luo (State University of New York, Stony Brook)					
9:10 AM	10:30 AM	Panel	Fang Luo	Potential of Additive Manufacturing for Power Electronics	State University of New York, Stony Brook
10:30 AM	10:40 AM	Q&A			
Room 3: Chaired by: Yoonjin Won (University of California, Irvine)					
9:10 AM	10:10 AM	Panel	Yoonjin Won	Issues, Challenges, and Future Opportunities about Nanomaterials Integration into Large Systems	University of California, Irvine
10:10 AM	10:40 AM	Q&A			
10:40 AM	10:50 AM	Break	Coffee Break / Exhibitor Corner		
Panel Sessions					
Room 1: Chaired by Dereje Agonafer (University of Texas at Arlington)					
10:50 AM	12:10 PM	Panel	Dereje Agonafer	Industrial Considerations for Data Center Thermal Management	University of Texas at Arlington
12:10 PM	12:20 PM	Q&A			
Room 2: Chaired by Victor Chiriac (Global Cooling Technology Group)					
10:50 AM	12:10 PM	Panel	Victor Chiriac	Thermal Challenges of Advanced Mobile/Telecom/Wireless and Computing Devices	Global Cooling Technology Group
12:10 PM	12:20 PM	Q&A			
Room 3: Chaired by Nenad Miljkovic (University of Illinois Urbana-Champaign)					
10:50 AM	12:10 PM	Panel	Nenad Miljkovic	Additive Manufacturing for Cooling and Thermal Storage in Electronics Thermal Management	University of Illinois Urbana-Champaign
12:10 PM	12:20 PM	Q&A			
12:20 PM	1:50 PM	Break	Lunch Break / Exhibitor Corner		
Room 1: Tutorial Chaired by Jin Yang (Intel)					
1:50 PM	3:40 PM	Tutorial	Abhijit Dasgupta, SB Park	Reliability of Heterogeneous Integration (HI) Systems	University of Maryland, State University of New York, Binghamton
3:40 PM	3:50 PM	Q&A			
Room 2: Tutorial Chaired by Jimil Shah (TMGCORE)					
1:50 PM	3:40 PM	Tutorial	Ryan J. Lewis, Y. C. Lee	Thermal Designs Using Vapor Chambers for Smartphones, Laptops, HPC and Power Electronics	Kelvin Thermal
3:40 PM	3:50 PM	Q&A			
3:50 PM	4:00 PM	Break	Coffee Break / Exhibitor Corner		
Room 1: Industry, National Laboratory, and Academia Posters - Chaired by Solomon Adera (University of Michigan)					
4:00 PM	6:00 PM	GatherTown	Poster Presentations and Q&A		
InterPACK Organization Zoom Meeting					
4:00 PM	5:00 PM	ASME EPPD Executive Committee Meeting (By Invitation Only)			

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Day 2 - Wednesday, 27th October 2021					
7:45 AM	8:00 AM	ASME EPPD	Kaushik Mysore	ASME EPPD Introduction	AMD
Room 1: Keynote Session Chaired by Kaushik Mysore (AMD)					
8:00 AM	8:50 AM	Keynote	Samuel Graham	Developing Wide Bandgap Electronics for Future Power and RF Applications	University of Maryland
8:50 AM	9:00 AM	Q&A			
9:00 AM	9:10 AM	Break	Coffee Break / Exhibitor Corner		
Panel Sessions					
Room 1: Chaired by Michael Fish (Army Research Laboratory)					
9:10 AM	10:30 AM	Panel	Michael Fish	Cryogenic Cooling of Solid State Devices	Army Research Laboratory
10:30 AM	10:40 AM	Q&A			
Room 2: Chaired by John Thome (JJ Cooling)					
9:10 AM	10:30 AM	Panel	John Thome	Two-Phase Cooling Systems for High Power Electronics/Data Centers	JJ Cooling
10:30 AM	10:40 AM	Q&A			
10:40 AM	10:50 AM	Break	Coffee Break / Exhibitor Corner		
Room 1: Tutorial Chaired by Adam Wilson (Army Research Laboratory)					
9:10 AM	11:00 AM	Tutorial	Casper Andreasen, Joe Alexandersen	Additive Manufacturing and Topology Optimization Methods for Thermal Management	Technical University of Denmark, University of Southern Denmark
11:00 AM	11:10 AM	Q&A			
Room 2: Chaired by: Michael H. Azarian (CALCE, University of Maryland College Park)					
10:50 AM	12:10 PM	Panel	Michael H. Azarian	Artificial Intelligence and Reliability: Future Opportunities	CALCE, University of Maryland College Park
12:10 PM	12:20 PM	Q&A			
Room 3: Chaired by Anna Prakash (Intel Corporation)					
10:50 AM	12:10 PM	Panel	Anna Prakash	Women in Engeering	Intel Corporation
12:10 PM	12:20 PM	Q&A			
12:20 PM	1:20 PM	Presenter and Award Winner	**Room 1: Avram Bar Cohen Memorial Award Presentation by Ricky Lee Chaired by Baris Dogruoz (Maxar Technologies)**		
1:20 PM	1:40 PM	Q&A			
1:40 PM	1:50 PM	Break	Coffee Break / Exhibitor Corner		
Room 1: Tutorial Chaired by Michael H. Azarian (CALCE, University of Maryland College Park)					
1:50 PM	3:40 PM	Tutorial	Ephraim Suhir	Thermal Stress Failures in Electronic Packaging: Prediction and Prevention	Portland State University
3:40 PM	3:50 PM	Q&A			
Room 2: Tutorial Chaired by Gilberto Moreno (NREL)					
1:50 PM	3:40 PM	Tutorial	Paul Paret	Boned Interface Materials for High Temperature, Wide-bandgap Power Electronic Devices	National Renewable Energy Laboratory
3:40 PM	3:50 PM	Q&A			
3:50 PM	4:00 PM	Break	Coffee Break / Exhibitor Corner		
Workshop Session Chaired by Anna Prakash (Intel Corporation)					
4:00 PM	6:00 PM	Workshop	Anna Prakash	Introduction to Robotics, AI and Intel's OpenVINO toolkit ™	Intel Corporation
6:00 PM	6:15 PM	Q&A			
InterPACK Organization Zoom Meeting					
6:00 PM	7:00 PM	K-16 Committee Meeting			

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Day 3 - Thursday, 28h October 2021					
6:30 AM	7:30 AM	InterPACK		JEP Meeting	Hong Kong University of Science and Technology
7:45 AM	8:00 AM	ASME EPPD	Kaushik Mysore	ASME EPPD Introduction	AMD
Room 1: Keynote Session Chaired by Kaushik Mysore (AMD)					
8:00 AM	8:50 AM	Keynote	Jessica Gullbrand	Liquid Cooling of IT Equipment	Intel
8:50 AM	9:00 AM	Q&A			
9:00 AM	9:10 AM	Break		Coffee Break / Exhibitor Corner	
Workshop Sessions					
Room 1: Chaired by Saket Karajgikar (Facebook)					
9:10 AM	10:30 AM	Workshop	Saket Karajgikar, Jimil M. Shah	Career Development Workshop	Facebook, TMGcore
10:30 AM	10:40 AM	Q&A			
Room 2: Moderated by Kaushik Mysore (AMD), SB Park (University of New York, Binghamton)					
9:10 AM	10:30 AM	Workshop	(1) Bahgat Sammakia, Ganesh Subbarayan, Kamal Sikka (2) Bryan Black	HIR Workshop - Part 1 (1) Federal Incentives & partnership with Academia & Industry to strengthen US Semiconductor Technology Leadership (2) Future Vision of Electronics Packaging	(1) Binghamton University, Purdue University, IBM (2) AMD
10:30 AM	10:40 AM	Q&A			
10:40 AM	10:50 AM	Break		Coffee Break / Exhibitor Corner	
Workshop Sessions					
Room 1: Chaired by Ronald Warzoha (K-16 Committee)					
10:50 AM	12:10 PM	Workshop	Luca Amalfi, Ashutosh Giri	K-16 Mentoring Workshop	Nokia/Bell Labs, University of Virginia
12:10 PM	12:20 PM	Q&A			
Room 2: Moderated by Kaushik Mysore (AMD), SB Park (University of New York, Binghamton)					
10:50 AM	12:10 PM	Workshop	William Chen William Bottoms	HIR Workshop - Part 2 Heterogeneous Integration Roadmap: Drivers & Ramifications of Strengthening US Semiconductor R&D, Manufacturing Ecosystem & Industrial Base	ASEUS, 3MTS
12:10 PM	12:20 PM	Q&A			
12:20 PM	12:50 PM	**Room 1: Award Ceremony**	Chaired by Dereje Agonafer	Allan Kraus Thermal Management Medalist	University of Texas at Arlington
12:50 PM	1:50 PM		Chaired by Baris Dogruoz	Other Awards Ceremony: Intel Best Paper Award	Maxar Technologies
Room 1: Tutorial Chaired by Jungwan Cho (Sungkyunkwan University)					
1:50 PM	3:40 PM	Tutorial	Ashutosh Giri, Ronald Warzoha, Ankur Jain	Nanoscale Thermal Metrology for Solid Materials in Electronics Packaging	University of Rhode Island, US Naval Academy, University of Texas at Arlington
3:40 PM	3:50 PM	Q&A			
Day 4 - Monday, 1st November 2021					
InterPACK Organization Zoom Meetings					
11:00 AM	12:00 PM	InterPACK Summary and Planning Meeting			
12:00 PM	1:00 PM	InterPACK Advisory Committee (By Invitation Only)			

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Our People are our Strength: As former Intel Chairman Andy Bryant said, "The ingredient we start with is sand. Everything else is value added by people." Our world-class talent is at the heart of everything we do. We are harnessing the breadth and scale of our reach—through people and partners—to have a positive effect on business, society, and the planet. Our people build our technology, unlock new business opportunities, and work with our partners and customers to create global impact.

Tech as a Force for Good (Intel Responsible Inclusive Sustainable Enabling – Intel RISE): Leading in the future means living up to our purpose, which is much bigger than the products we create. Intel's long-standing commitment to corporate responsibility and sustainability—built on a strong foundation of transparency, governance, and ethics—is deeply integrated throughout all aspects of our business.

Our commitments to positive global impact include:

- **Responsible:** Lead in advancing safety, wellness, and responsible business practices across our global manufacturing operations, our value chain, and beyond
- **Inclusive:** Advance inclusion across our global workforce and industry, and expand opportunities for others through technology, inclusion, and digital readiness initiatives
- **Sustainable:** Be a global leader in sustainability and enable our customers and others to reduce their environmental impact through our actions and technology
- **Enabling:** Through innovation technology and the expertise and passion of our employees, we enable positive change within Intel, across our industry, and beyond

At a time in history where the world is becoming more digitized than ever, there has never been a better or more important time to be a technologist.

- We can't afford to think of tech as someone else's problem.
- We must ALL play a role in helping to ensure tech innovation gets harnessed as a force for good to transform the turmoil of this challenging time into a recovery that creates world-changing technology that improves the life of every human on the planet. History may guide us, but the future is ours to make.
- Customers must be able to rely on Intel for their products and strategies for the future. Those of us who dream of impossible things realize just how far we can go. Visit us at: www.intel.com

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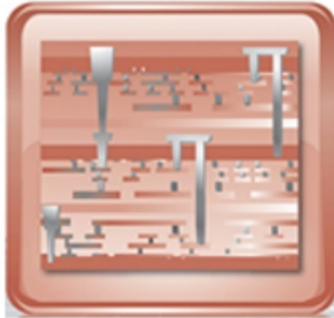

The ***Journal of Electronic Packaging*** publishes papers that use experimental and theoretical (analytical and computer-aided) methods, approaches, and techniques to address and solve various mechanical, materials, and reliability problems encountered in the analysis, design, manufacturing, testing, and operation of electronic and photonics components, devices, and systems.

The journal publishes papers that address 1) thermal management, applied mechanics, and technologies for microsystems packaging; 2) critical issues in systems integration; 3) emerging packaging technologies and materials with micro-/nanostructures; and 4) general small-scale systems.

The journal serves researchers and engineers working in academic and industrial settings. In addition, leaders in the field are invited to publish review articles on hot, emerging, and fundamental topics.

Scope: Electronic packaging; Thermal management; Applied mechanics; Microsystems's packaging; Systems integration; Small-scale systems in general.

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National Renewable Energy Laboratory (NREL) researchers within the Advanced Power Electronics & Electric Machines (APEEM) Group have expertise in thermal, electrothermal, mechanical, and reliability of power electronics and electric machines for energy efficiency and renewable energy applications, such as electric-drive vehicles. In collaboration with research and industry partners, NREL's APEEM Group is developing novel thermal management technologies to improve the performance, cost, reliability, and volume of power electronics and electric machines. NREL has five facilities dedicated to APEEM research, featuring a range of equipment to investigate primary research areas of 1) electronic and power electronic devices and sensors, 2) power electronics thermal management, 3) power electronics packaging reliability and prognostics, 4) electric motor thermal management, 5) integrated electric drive thermal management.

Learn more about the capabilities and facilities at NREL on our website: https://www.nrel.gov/transportation/peem.html

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Washington University in St. Louis

JAMES MCKELVEY SCHOOL OF ENGINEERING

WASHINGTON UNIVERSITY IN ST. LOUIS

Founded in 1854, the James McKelvey School of Engineering at Washington University in St. Louis is a research institution with emphasis on cross-disciplinary technologies in the areas of alternative energy, environmental engineering & sustainable technology, biotechnology, information technology, and nanotechnology/materials science. The mission of the McKelvey School is to promote independent inquiry in engineering research and education with an emphasis on scientific excellence, innovation and collaboration without boundaries.

WashU Engineers produce new knowledge that changes the world, and our faculty are educating students to explore and create in a world we cannot yet imagine. Through research and education, we are making a positive impact on the local community, the country and the world.

The IMSE was established in 2013 with the overarching mission of creating and sustaining a culture of interdisciplinary materials science research and education at Washington University. The IMSE brings together more than 50 faculty and student researchers from engineering, the physical and natural sciences, and the medical school to discover new materials, understand how they behave, and envision innovative applications. The IMSE conducts research in Nanomaterials and glasses, thin film and 2D materials, biomedical and bio-inspired materials and applications, materials for sensors and imaging and other areas of research. The IMSE supports extensive shared user facilities for micro/nanofabrication and materials characterization, and is home to an interdisciplinary, cross-school PhD program in Materials Science and Engineering.

For more information, please visit our website at:

https://imse.wustl.edu/about-us

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SUSS MicroTec is a leading supplier of equipment and process solutions for microstructuring in the semiconductor industry and related markets.

Our portfolio covers a comprehensive range of products and solutions for backend lithography, wafer bonding and photomask processing, complemented by micro-optical components. In close cooperation with research institutes and industry partners SUSS MicroTec contributes to the advancement of next-generation technologies such as 3D Integration and Imprint Lithography as well as key processes for Wafer-Level Packaging, MEMS and LED manufacturing. With its global infrastructure for applications and service, SUSS MicroTec supports more than 8,000 installed systems worldwide. **SUSS URL:** www.suss.com

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Novark Technologies, Inc. spans three factories and leverages close to two decades of experience and expertise in thermal management solutions of electronics. Its product lines include various heat pipe, vapor chamber, heat column, heat sink, liquid cooling and other advanced thermal solutions used in a variety of electronics cooling applications ranging from CPU to LED to industrial power systems to telecommunications to EV thermal management solutions and more. Routine support of academic research at various institutions in the US, Europe and China combines with constant exploration of new thermal management solutions to push the company's capabilities forward continuously.

For more information, please visit our website:

https://www.novarktechnologies.com/

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Founded in 1970, Ansys is the original and gold standard simulation provider with high-fidelity results and best-in-class technical support. We offer a best-of-breed portfolio across all physics. Ansys simulation gives engineers the ability to explore and predict how products will work in the real world. It's like being able to see the future, enabling engineers to innovate as never before. Our simulation improves operational efficiency, streamlines regulatory approvals, supports fewer physical prototypes being developed, reduces warranty reserves, and increases engineering productivity. Our 4,900 global associates (750 PhDs) are singularly focused on giving engineers the clarity and confidence to simulate their way towards transformational innovation. Ansys empowers our customers to design and deliver transformational products. Visit us at www.ansys.com

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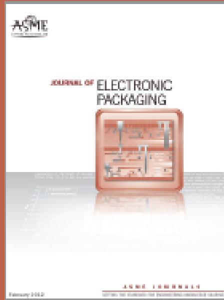

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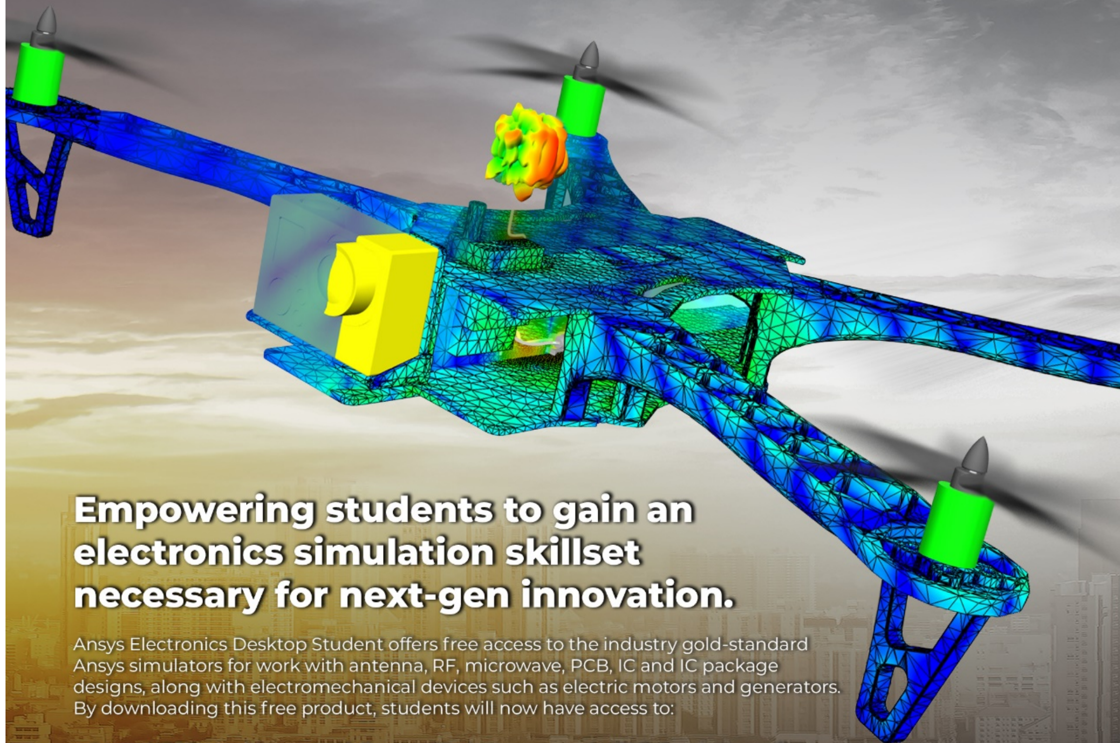

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KEYNOTE SPEAKERS

Keynote Title: Avoiding Inelastic Strains in Solder Joint Interconnections of IC Packages

Tuesday, October 26
8:00AM–9:00AM PDT

Ephraim Suhir, Portland State University

Ephraim Suhir is on the faculty of the Portland State University, Portland, OR, USA; Technical University, Vienna, Austria; and James Cook University, Queensland, Australia. He is CEO of a SBIR ERS Co. in Los Altos, CA, USA; Foreign Full Member of the National Academy of Engineering, Ukraine (he was born in that country); Life Fellow of the ASME, IEEE, SPIE, and the IMAPS; Fellow of the American Physical Society (APS), the Institute of Physics (IoP), UK, and the Society of Plastics Engineers (SPE); and Associate Fellow of the AIAA. Ephraim has authored and co-authored about 500 publications, presented numerous keynotes and invited talks worldwide, and received many professional awards, including 1992 ASME Clock Award, 1996 Bell Labs Dist. Member of Technical Staff Award, 1997 ASME InterPACK'97 General Chair Award, 1999 ASME Charles Russ Richards Memorial Award, and 2004 ASME Worcester Read Warner Medal. He is the third "Russian American," after S. Timoshenko and I. Sikorsky, who received this prestigious award. His most recent awards are 2019 IEEE EPS Field Award and 2019 IMAPS Lifetime Achievement award.

Abstract: The following three practically important questions associated with predicting and improving the reliability of solder joint interconnections of IC packages are addressed: *I. Could inelastic strains in the solder material be avoided* by a rational physical design, and if not, could the sizes of the inelastic strain areas be predicted and, if possible, minimized? II. Considering that the difference between a highly reliable and an insufficiently reliable product is "merely" in the level of their *never-zero probability of failure*, and that SJIs are usually the most vulnerable structural elements in an IC package design, could this probability be assessed at the design stage and, if possible, made adequate for the given application? *III. Should temperature cycling accelerated testing for SJIs be replaced* with a more physically meaningful, less costly, less time- and labor-consuming and, most importantly, less misleading accelerated test vehicle?

Keynote Title: Developing Wide Bandgap Electronics for Future Power and RF Applications
Wednesday, October 27
8:00AM–9:00AM PDT

Samuel Graham, University of Maryland

Samuel Graham is the Nariman Farvardin Dean of the A. James Clark School of Engineering at the University of Maryland. His research is focused on the electrical and thermal characterizeation, packaging, and reliability of wide bandgap semiconductors, solar cells, and flexible electronics. He also holds a joint appointment with the National Renewable Energy Laboratory and is a Distinguished Visiting Professor at Nagoya University in Nagoya, Japan. He is a Fellow of ASME, a member of the Engineering Sciences Research Foundation Advisory Board of Sandia National Laboratories, and a member of the Emerging Technologies Technical Advisory Committee of the U.S. Department of Commerce.

Abstract: Wide bandgap electronics are currently under development due to their potential to create future power and RF electronics. The growth of materials based on gallium nitride and more recently gallium oxide is expected to help create technological advancements that may yield a range of devices that operate with more efficiency, higher operational frequency, and smaller form factors. As these nitride and oxide semiconductors are being developed, there are a number of new materials, manufacturing techniques, and thermal and mechanical metrology methods that must be concurrently created to help ensure the transition from the laboratory to actual applications. Key concerns are scalable methods for growing and packaging the devices, materials and architectures needed to ensure efficient thermal management, and the control of stresses to prevent device failure.

In this talk, we will discuss a range of materials and device architectures that are being developed to enable efficient heat dissipation from both GaN and Ga2O3 devices starting at the device level. We will also cover a range of thermal and stress metrology methods that we have developed to enable the measurement of temperature and stresses in the devices both under steady state and transient operation. Finally, an actively cooled power substrate that is being developed for packaging power devices will be presented. At each step, we will show how considerations for materials development, metrology techniques, and methods for scalable manufacturing are necessary to help transition these advancements to applications.

Keynote Title: Liquid Cooling of IT Equipment
Thursday, October 28
8:00AM–9:00AM PDT

Jessica Gullbrand, Intel Corporation

Jessica is a Principal Engineer at Intel in the Data Platforms Engineering and Architecture Group. Currently, her focus is on developing advanced cooling solutions for IT equipment using liquid cooling. Jessica joined Intel 2006 and has managed projects relating to the development of new and innovative technology solutions for IT equipment in fluids, acoustics, and thermals. She joined Intel from academia, where she worked as an Assistant Professor in Mechanical Engineering. She taught a variety of fluid mechanic and thermal curriculum. She has 20+ years of experience in modeling, experiments, and project management. Jessica co-chaired the Grace Hopper Poster sessions by invitation from the Anita Borg Institute, and she is a recipient of the 2013 SWE Emerging Leader Award. Jessica has 10 patents and 25+ peer-reviewed publications in journals and conferences.

Abstract: There is a continued demand for increasing compute performance, which results in an increasing system power and power density of many computers. Traditionally, the cooling technology of choice has been air cooling using fans and heat sinks. However, as the power and power density are increasing, it is no longer feasible or cost effective to use air cooling to meet the thermal cooling requirements. Liquid cooling is more efficient than air cooling in removing heat and can be used to meet the increasing cooling demand. Traditionally, liquid cooling has been used to cool high power solutions (e.g., super computers) in large data center deployments, but liquid cooling is now becoming more mainstream. Depending on the installation and system solution, liquid cooling can be used selectively to cool the high-power components or cool the whole compute system. This presentation covers liquid cooling trends, components needed for liquid cooling, liquid cooling work performed at Intel, and information about liquid cooling collaborations performed in different industry organizations.

PANELS

TUESDAY, OCTOBER 26

Thermo-Mechanical Challenges from Package to System to Maximize Silicon Performance

9:10AM–10:40AM PDT
Room 1

Moderator: Gamal Refai-Ahmed, Xilinx fellow

Dr. Gamal Refai-Ahmed, Life Fellow ASME, Fellow IEEE, Fellow Canadian Academy of Engineering, is Xilinx Fellow and Chief Thermo-Mechanical Architect. He obtained the Ph.D. degree in Mechanical Engineering from the University of Waterloo. He has been recognized as one of the global technical leaders of thermal management through his numerous publications (more than 120 publications) and patents and patents pending U.S. (more than 60) and International (more than 120). His contributions are clearly seen in several generations of both GPU and FPGA products. Gamal is the recipient of the 2008 excellent thermal management award, 2010 Calvin Lecture and 2013 K16- Clock award in recognition for his scientific contributions and leadership of promoting best electronics packaging engineering practice. In 2014, Gamal received the IEEE Canada R. H. Tanner Industry Leadership for sustained leadership in product development and industrial innovation. In 2016, ASME awarded Gamal the ASME Service Award. State University of New York, Binghamton University awarded him the Innovation Partner Award for his industrial role with Binghamton University. In continuation to Dr. Refai's contributions to the best engineering practice, State University of New York at Binghamton awarded him the Presidential University medal in 2019, which is the highest recognition honor by the university. In 2021, Gamal was elected to IEEE Fellow and EIC Fellow.

Summary: This panel will be conducted in an interview format with executive technical and academic level panelists. They will be sharing their views on the associated challenges on how to maximize the Silicon performance from thermo-mechanical, reliability, assembly, infrastructure of a fabless point of view. The objective of this panel is to identify the gaps that need to be addressed by academic institutes, components providers, and system level providers to enable the next generation of Silicon performance.

Panelists
Professor Bahgat Sammakia, SUNY Binghamton
Dr. Suresh Ramalingam, Xilinx, Fellow
Dr. Ravi Mahajan, Intel Fellow
Dr. Krishna Darbha, Microsoft, Senior Director of Reliability

Professor Bahgat Sammakia, SUNY Binghamton

Professor Bahgat Sammakia is the vice president for research at Binghamton University and director of the NSF-IUCRC on Energy Smart Electronic Systems (ES2) and Binghamton University's Small-Scale Systems Integration and Packaging Center (S^3IP), a New York State Center of Excellence. He is a professor of mechanical engineering in the Thomas J. Watson School of Engineering and Applied Science. Dr. Sammakia has spent much of his research career working to improve thermal management strategies in electronic packaging systems at multiple scales ranging from devices to entire Data Centers. Dr. Sammakia joined the faculty of the Watson School in 1998 following a fourteen-year career at IBM, where he worked in the area of research and development of organic electronic systems. He has contributed to several books on natural convection heat transfer and is also the principal investigator or co-principal investigator on several cross-disciplinary research projects.

Dr. Sammakia earned his bachelor's degree in mechanical engineering from the University of Alexandria, Egypt, and his master's and doctorate in mechanical engineering from the State University of New York at Buffalo. He was a post-doctoral fellow at the University of Pennsylvania. He has over 200 published papers in refereed journals and conference proceedings, has contributed to several books in the areas of heat transfer and electronics packaging. He also holds 18 U.S. patents and 12 IBM technical disclosures in the area of electronics packaging. Dr. Sammakia was the General Chair for ITherm 2006 conference and InterPACK 2012 Conference. He is a Fellow of both the IEEE and the ASME and is the editor of the *Journal of Electronic Packaging*, Transactions of the ASME, and an associate editor of the *CPMT Transactions* of the IEEE.

Dr. Suresh Ramalingam, Xilinx

Dr. Suresh Ramalingam graduated in 1994 with a Ph.D. in Chemical Engineering from Massachusetts Institute of Technology, Cambridge. He holds 32 U.S. Patents, 2013 SEMI Award, Ross Freeman Award for Technical Innovation, ECTC 2011 Conference Best Paper Award, IMAPS 2013 and 2014 Conference Best Paper Awards for 2.5D/3D, and a book chapter on 3D Integration in VLSI Circuits. He started his career at Intel developing Organic Flip Chip Technology for Micro-processors which was implemented on Pentium II (Intel's first flip chip product) in 1997. As one of the co-founders and Director of Packaging Materials at Scion Photonics, he helped develop DWDM modules used by major communication companies. JDS Uniphase acquired Scion Photonics in 2002. As a Xilinx Fellow, he currently manages Advanced Packaging Interconnect Technology Development including TSV/3D for Xilinx FPGA products. Thermal Enablement and Board/-System Level is a key focus area to push the power/performance envelope under the leadership of Dr. Gamal Refai-Ahmed and happy to be a partner in crime supporting the necessary technology pieces. Suresh has more than 40 Patents, 35+ publications, and a VLSI Circuits Book Chapter on 3D Integration

Dr. Ravi Mahajan, Intel Fellow

Dr. Ravi Mahajan is an Intel Fellow and the Director of Pathfinding for Assembly and Packaging technologies for 7-nanometer (7nm) silicon and beyond in the Technology and Manufacturing Group at Intel Corporation. He is responsible for planning and carrying out multi-chip package pathfinding programs for the latest Intel process technologies. Ravi also represents Intel in academia through research advisory boards, conference leadership, and participation in various student initiatives. Ravi joined Intel in 1992 after earning a bachelor's degree from Bombay University, a master's degree from the University of Houston, and a Ph.D. from Lehigh University, all in mechanical engineering. His contributions during his Intel career have earned him numerous industry honors, including the SRC's 2015 Mahboob Khan Outstanding Industry Liaison Award, the 2016 THERMI Award from SEMITHERM, the 2016 Allan Kraus Thermal Management Medal & the 2018 InterPACK Achievement award from ASME, and IEEE 2019 "Outstanding Service and Leadership to the IEEE" Award for both the Phoenix Section & IEEE Region 6. He is an IEEE EPS Distinguished Lecturer. He is one of the founding editors for the *Intel Assembly and Test Technology Journal* (IATTJ) and currently VP of Publications & Managing Editor-in-Chief of the IEEE Transactions of the CPMT. Additionally, he has been long associated with ASME's InterPACK conference and was Conference Co-Chair of the 2017 Conference. Ravi is a Fellow of two leading societies, ASME and IEEE. He was named an Intel Fellow in 2017.

Dr. Krishna Darbha, Microsoft, Senior Director

Dr. Krishna Darbha is GM of Reliability at the Microsoft Devices Business Group (MDG) at Microsoft. He has been with Microsoft for the past 20 years and is currently responsible for Reliability of Surface. He has managed Reliability of many complex multi-physics consumer electronic products and worked on products like Xbox, PCHW peripherals, Zune, and Surface Tabletop. Prior to Microsoft he was with IBM in the Microelectronics Division responsible for multi-physics analysis of cutting-edge microelectronic modules. He obtained his Ph.D. in Mechanical Engineering from the University of Maryland (College Park) in 1999. He covers Reliability through the entire product life cycle starting from up-front product development relying on quantification of user scenarios, efficient virtual qualification techniques, qualification of supply-chain, development of acceleration models for new failure modes, demonstration of reliability goals, and quality assurance via ORT and other CTQ monitors in mainstream production. He is a member of ASME and IEEE and contributed through publishing and reviewing papers in conferences and journals for over 20 years. He currently holds more than 15 patents and patents pending.

Potential of Additive Manufacturing for Power Electronics

9:10AM -10:40AM PDT
Room 2

Moderator: Fang Luo, State University of New York, Stony Brook

Dr. Fang Luo is the Director of the Spellman High Voltage Power Electronics Laboratory, Empire Innovation Associate Professor, Department of Electrical and Computer Engineering, Stony Brook University.

Summary: Increasing power density and efficiency requirements in power electronics system have imposed strong challenges in existing module and system packaging technologies, as well as thermal management solutions. Additive manufacturing provides more possibility and extended design space compared to the traditional approaches. This panel invites experts from academia and industry to share their visions of current trends in how additive manufacturing can help to address the issues in power conversion systems, and it may change the future of power electronics.

Panelists:
Dr. Jeffrey Ewanchuk, Raytheon Technologies Research Center, Principal Engineer
Dr. Mike M. Mekhiche, Spellman High Voltage Electronics, Global Vice President of Engineering Technology)
Dr. Scott N. Schiffres, Binghamton University, Assistant Professor, Department of Mechanical Engineering
Dr. Ryan O'Hara, nTopology, Technical Director Aerospace and Defense

Dr. Jeffrey Ewanchuk, Raytheon Technologies Research Center, Principal Engineer

Jeffrey Ewanchuk, PhD received the B.Sc. degree (with distinction) in electrical engineering, M.Sc. degree with a specialization in power electronics, and a PhD degree in Energy Systems from the University of Alberta, Canada, in 2006, 2008, and 2012, respectively. From 2008 to 2009, he was a Design Engineer with RMS Welding Systems, Nisku, Canada. In 2012, he joined Mitsubishi Electric Research Centre Europe (MERCE) in Rennes, France as a Research Engineer in power electronics, afterwards taking position as a Senior Staff Research Engineer in 2015. In 2017, he took over the role of Research Manager at MERCE, where he led a team investigating reliable power packaging technology. Since 2019, he has been a Principal Engineer in Power Electronics Packaging with the Research Center at Raytheon Technologies, in East Hartford, Connecticut, USA. His current research interests include highly integrated power converters, additive manufacturing, high density packaging concepts, and the design consequences on the power converter lifetime and robustness.

"Opportunities in High Voltage Power Module Packaging with Additive Manufacturing"

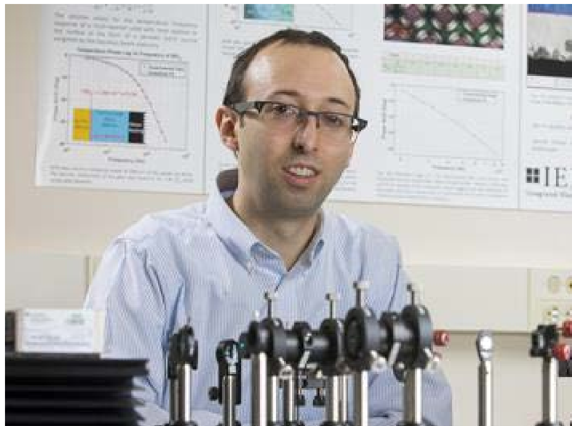
Abstract: Electrification is an ongoing trend to mitigate the contribution of the aviation industry to the global carbon emissions. As a result, the onboard power systems are increasing in terms of the total power, and the specific power densities of the various power distribution and power electronic components must also increase to make this trend economically viable. One solution to increase the onboard power system specific power density is to increase the distribution voltage. However, operation at high voltages at high altitude poses significant packaging issues for the various power electronic components. In this talk, the role of the power module package for highly integrated power converters is established, and the challenges at >1 kV operation are highlighted for modern power module packages. Elements of the power module package suitable for additive manufacturing are addressed from the state of the art to establish the various areas of opportunity motivated by these application challenges. Lastly, a mixed material additive manufacturing technique is presented to achieve a thin power substrate with high thermal performance with low electric field stress at the triple points within the power module.

Dr. Mike M. Mekhiche, Spellman High Voltage Electronics, Global Vice President of Engineering Technology

Dr. Mike M. Mekhiche, Spellman High Voltage Electronics, is the Global Vice President of Engineering Technology at Spellman High Voltage Electronics. Mike brings over 25 years of technology and product development, qualification and commercialization in the defense, aerospace, and commercial markets. He was the Deputy Director at Rolls-Royce Electrical (RRE) before joining Spellman High Voltage, where he led the specific mission to enable Rolls-Royce to be a major leader in the "third era of aviation" by developing the required business capability, technologies, products, and infrastructure to industrialize and commercialize electric and hybrid electric power generation and propulsion systems for aerospace applications and other market sectors. Prior to RRE, he was the Executive Vice President, Engineering and Operations for Ocean Power Technologies where he led the development, validation, commercialization, and production of innovative ocean based electric power generation systems for the oil and gas, defense and communications markets. He also held positions with increasing responsibilities at BAE Systems where he was Director of Programs, Technology and Products. At BAE Systems, Mike started as a Chief Engineer for Power Systems defense and commercial markets, and subsequently earned his full Global Engineering Fellowship and progressed to a business executive and leadership role. He also held a variety of other leadership positions in large organizations such as DRS Technologies where he was the Technical Director and Chief Engineer for the U.S. Navy's future combatant ship propulsion system program where he led the development, testing, and qualification of naval combat ship electric propulsion systems. Mike combines a breadth of demonstrated business acumen, program management, market development, new product introduction strategies, and a strong technical and technology expertise background. He holds a Master's and PhD in Electrical Engineering.

"How Can 3D Printing Enhance Power Electronics Design and Performance?"

Abstract: Manufacturing complexity and limitations have in many ways hindered power electronics designers from harvesting advancements in semi-conductor technology to their fullest. While wideband gap technology offers tremendous potential related to increased power density, efficiency, and overall system performance, the 2D approach to building power conversion subsystems does not address the competing EMI/EMC, dielectric isolation, thermal and volumetric packaging in a "force multiplier" fashion. This is where great opportunities lay for additive layer manufacturing (ALM/3D printing). They have the potential to enable the creation of intricate 3D volumes with possibly embedded cooling lattices, materials with differing properties (thermal, dielectric, EMI shielding) judiciously embedded in the 3D structure, and possibly passive electrical components as well, to ensure considerable power density is achieved while key performance characteristics are safeguarded. The subject of this presentation is to provide a high-level overview of ALN/3D printing potential in the context of maximization power converter design performance currently unachievable in standard 2D production processes.



Dr. Scott N. Schiffres, Binghamton University
Assistant Professor, Department of Mechanical Engineering

At Binghamton University, Scott's research is at the intersection of heat transfer, energy, and additive manufacturing. Scott has received support from the NSF, SRC, NYSERDA, and IEEC. He is a 2019 NSF CAREER Recipient in the Thermal Transport Processes program. Prior to joining the faculty at Binghamton University in January 2016, Scott was a postdoctoral associate at Massachusetts Institute of Technology, where he worked on energy-efficient adsorption refrigeration with Prof. Evelyn Wang, and heat transfer applications of nanomaterials and additive manufacturing with Prof. Anastasios John Hart. In 2014, Scott received his PhD in mechanical engineering from Carnegie Mellon University, working in the area of experimental nanoscale heat transfer with Prof. Jonathan A. Malen. In 2010, Scott was awarded a Steinbrenner Institute Research Fellowship.

Scott spent the summer of 2012 as a visiting researcher at Profs. Junichiro Shiomi and Shigeo Maruyama's laboratory at the University of Tokyo through a joint U.S.-Japan East Asia Pacific Summer Institute Fellowship. Before returning to academia in the fall of 2009, he worked as a flight and controls engineer at Boeing's Satellite Development Center in Los Angeles. Scott graduated from Princeton University in 2006 with a BSE in mechanical and aerospace engineering and a certificate in robotics and intelligent systems, and from Cornell University with a MEng in mechanical engineering in 2007.

"Saving Energy, Weight and Volume Thru Direct Printing of Cooling Devices"

Abstract: By cooling our electronics devices better, we can improve efficiency and reduce system weight and volume. This talk will explore potential strategies to build cooling devices directly onto chip substrates through additive manufacturing and evaluate their possible energy, weight, and volume savings.

Dr. Ryan O'Hara, nTopology, Technical Director Aerospace and Defense

Dr. Ryan P. O'Hara is currently serving as the Technical Director for Aerospace and Defense at nTopology. Dr. O'Hara joined nTopology in April 2019 after 20 years of military service in the United States Air Force as a Developmental Engineer. His technical focus is on the application of Mechanical Structures and Structural Dynamics to Aerospace Systems. Areas of interest include turbine engines, laminate composites, meta-materials, and additive manufacturing. Prior to starting at nTopology, he was in academia as an Assistant Professor in the Department of Aeronautics and Astronautics at the US Air Force Institute of Technology.

“Leveraging Implicit Geometry and Iterative Design Techniques to Maximize Heat Transfer”

Abstract: In the aerospace industry, the transport of heat is critical to meeting the system’s performance requirements. In many applications, the current generation of thermal management systems is insufficient to meet future applications due to the increased thermal output of advanced avionic systems and the high weight and lower heat rejection capabilities of these decades-old thermal management systems. A new approach to heat exchanger design using implicit geometry allows a user to encapsulate shape, physics, and manufacturing processes in a single unified environment. Engineers can now overlay CAD geometry, simulated and empirical engineering data, and manufacturing process knowledge to design advanced, knowledge-driven, thermal solutions that scale from the lab to production.

Implicit modeling technology enables a step-change improvement in speed and complexity utilizing an advanced platform that gives thermal design engineers control over their data and integrations so that they can deliver high-performance products over short timelines to meet the demands of these advanced aerospace systems. Utilizing implicit modeling and advanced manufacturing it is now possible to generate geometry with incredibly high surface areas for a given volume and large increases in thermal performance. Further, by coupling implicit modeling with advanced design exploration tools, like machine learning and artificial intelligence, it is possible to design optimal thermal solutions in timelines and configurations that were previously unimaginable.

This presentation will demonstrate how this new approach to heat exchanger design has been currently demonstrated on an advanced heat exchanger with application to the aerospace, oil and gas, and chemical industries.

Issues, Challenges, and Future Opportunities About Nanomaterials Integration into Large Systems

9:10AM–10:40AM PDT
Room 3

Moderator: Yoonjin Won, University of California, Irvine

Yoonjin Won, University of California, Irvine, Associate Professor of Mechanical and Aerospace Engineering, Associate Professor (Joint Appointment) in Chemical and Biomolecular Engineering

Summary: In recent decades, there have been significant efforts to develop new libraries of nanomaterials that can promise performance breakthroughs in a variety of innovative thermal technologies from thermal solar to advanced interfacial materials and two-phase cooling systems. In many cases, nanomaterials realize a unique combination of properties that are a very unusual combination of two properties neither of which is an extreme value when considered alone. With the recent observation, now the time is ripe for our panel to come together with expertise in nanostructure-integration to system level. Herein, we will discuss issues, challenges, and future opportunities about nanomaterials implementation to system-level integration as well as the limitations of moving this technology into the future.

Panelists:
Terry Hendricks, Retired - Previously, NASA-JPL
Jihwan An, Seoul Tech
Nenad Miljkovic,
Jorge Padilla, Google

Terry Hendricks, Retired - Previously, NASA-JPL

Dr. Hendricks is currently an ASME Fellow, IEEE Senior Member, and retired from NASA–Jet Propulsion Laboratory (JPL) / California Institute of Technology. While at JPL, he was responsible for designing spacecraft thermal and propulsion systems, solar power systems, radioisotope power systems, thermal management and thermal energy storage systems critical to NASA missions. Among his numerous awards, he was recently inducted into the University of Texas at Austin Mechanical Engineering Academy of Distinguished Alumni. He also has been nominated for the Eni 2020 Energy Frontiers Award in Rome/Milan, Italy, for his innovative work in terrestrial energy recovery. He has over 40 years of professional expertise in thermal and fluid systems, nanoscale and micro-scale heat transfer, energy recovery, energy conversion and storage systems, terrestrial and spacecraft power systems, micro electro-mechanical systems, and project management. His extensive expertise is embodied in three book chapters published by Taylor and Francis and Elsevier; and over 100 reports, conference papers, and journal articles in the *Journals of Electronic Materials*; *Energy*; *Materials Research*; *Heat Transfer*; *Thermophysics and Heat Transfer*; and *International Heat and Mass Transfer*. Dr. Hendricks holds nine patents and is a Registered Professional Engineer in California and Texas.

“Transitioning Nanotechnology to the Space & Terrestrial Power - Thermal Nexus for 2021 and Beyond – Nanotechnology to Astronomical Systems”

Abstract: Project Manager leading and managing complex, multi-disciplinary projects to: 1) Develop next-generation aircraft energy recovery technologies using advanced heat exchangers, integrated with advanced thermoacoustic generators, and heat pipe technologies; 2) Develop Solar Array Dust Mitigation technologies; 3) Develop a thermoelectric power system design for unmanned aircraft (UAV) engine energy recovery applicable to different UAV platforms; and 4) Characterize and quantify pyroshock-driven dynamic effects on Radioisotope Thermoelectric Generator power output, thereby reducing risk on Mars 2020 spacecraft.

Dr. Jihwan An, SeoulTech

Jihwan An is an Associate Professor in the Department of Manufacturing Systems and Design Engineering at Seoul National University of Science and Technology (SeoulTech), Korea since 2014. Before SeoulTech, he worked as a research associate and lecturer in the Department of Mechanical Engineering at Stanford University. He received his MS and PhD degrees in Mechanical Engineering from Stanford University in 2009 and 2013, respectively, and BS degree in Mechanical and Aerospace Engineering from Seoul National University in 2007. Current research interests: nanoscale phenomena in solid oxide fuel cells and thin film processes with current focus on atomic layer deposition (ALD) process.

"Atomic Layer Deposited Nanomaterials for Energy Conversion and Storage Devices"

Abstract: Upon the shrinkage of characteristic sizes of modern electronic and energy devices, the need for precise control of associated components, preferentially in sub-nm or in atomic scale, has been continuously growing. In this regard, atomic layer deposition (ALD), a variant of chemical vapor deposition (CVD), has recently drawn much attention from researchers in various fields. Due to the intrinsic nature of ALD process based on surface-saturated atomic layer-by-layer growth mechanism, one can precisely control the thickness and composition of films with extremely high conformality. In this talk, the strategies on the application of atomic layer deposited nanomaterials, which are fabricated in forms of nanoparticles, porous layer, and complete films, to thin film energy devices are discussed with case studies on thin film solid oxide fuel cells. Issues, challenges, and future opportunities of the application of ALD to energy devices will be also presented.

Professor Nenad Miljkovic, UIUC

Dr. Nenad Miljkovic is an Associate Professor of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign (UIUC). He has courtesy appointments in Electrical and Computer Engineering, and the Materials Research Laboratory. He is the Associate Director of the Air Conditioning and Refrigeration Center (ACRC), which is supported by 30 industrial partners. His group's research intersects the multidisciplinary fields of thermo-fluid science, interfacial phenomena, scalable nanomanufacturing, and renewable energy. He is a recipient of the NSF CAREER Award, the ACS PRF DNI Award, the ONR YIP Award, a Distinguished Visiting Fellowship from the UK Royal Academy of Engineering, a U.S. NAS Arab-American Frontiers Fellowship, the ASME ICNMM Young Faculty Award, the ASME Pi Tau Sigma Gold Medal, the CERL R&D Technical Achievement Award, the UIUC Dean's Award for Excellence in Research, the U.S. Army Corps of Engineers ERDC R&D Achievement Award, the SME Young Faculty Award, the Bergles-Rohsenow Young Investigator Award in Heat Transfer, and is a Kritzer Faculty Scholar at the University of Illinois.

"Fundamental Challenges to Structured Surface Implementation with Real Thermal Systems"

Abstract: Almost a century ago, the concept of "dropwise condensation" was proposed, which states that steam condensation on hydrophobic surfaces can enhance heat transfer by up to 10 times compared to traditional "film wise condensation." The potential of dropwise condensation has driven researchers to design thin (≈100 nm-thick) hydrophobic coating materials. However, the lack of long-term (>5 year) durability has been the main hindrance to coating utilization over the past century. In this talk, I will present our most recent progress in designing thin and durable hydrophobic coating materials for stable dropwise condensation. I will then cover design guidelines and challenges of creating durable and scalable surface structures for stable pool and flow boiling. Next, I will briefly discuss how micro-/nanoengineered materials can be scaled up and applied to real life meter-scale industrial equipment through rational nanomanufacturing considerations. For anti-icing heat exchanger applications, we show that nano structuring of the aluminum surface can delay frosting by 3x and increase overall heat pump system efficiency by 50%. Finally, I end my talk by briefly discussing novel approaches and use cases for structured surfaces, including high temperature braze flow control in manufacturing, low and high temperature fouling, and advanced thermal management of power electronics.

Dr. Jorge Padilla, Google

Jorge Padilla is a Staff Mechanical Engineer at Google where, since 2014, he has developed and delivered end-to-end, chip-to-chiller thermal technologies at scale for thermal management of data center IT equipment. He has co-chaired technical sessions at the ASME InterPACK and Itherm conferences since 2017. He has published in ASME conference proceedings, peer-reviewed journals, and is a co-inventor on nine issued U.S. patents. Prior to joining Google, he earned a PhD in mechanical engineering from the University of California, Berkeley where he focused on water droplet vaporization from nanostructured surfaces in the Energy and Multiphase Transport Laboratory led by Prof. Van Carey. Jorge holds a Bachelor of Science degree in mechanical engineering from MIT.

"Scaling Nanomaterials Technology Beyond the Lab for Adoption in Data Center Applications"

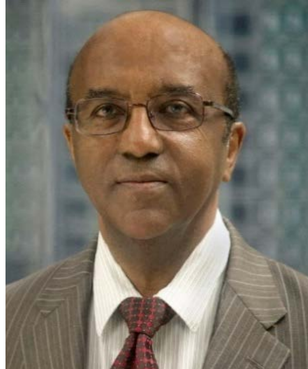
Abstract: The talk will focus on the criteria for adoption of nano research technologies in the hyperscale DC industry, i.e., demonstrating repeatable performance, reliability, quality, and scaling the technology beyond the lab environment with industrial partners.

InterPACK® 2021

Industrial Considerations for Data Center Thermal Management

10:50AM–12:20PM PDT
Room 1

Moderators: **Professor Dereje Agonafer, University of Texas at Arlington, and Peter de Bock, Advanced Research Projects Agency-Energy (ARPA-E)**



Prof. Dereje Agonafer, University of Texas at Arlington

Dereje Agonafer is a Presidential Distinguished Professor in MAE at The University of Texas at Arlington where he heads two centers: Site Director of an NSF IUCRC - Center for Energy-Smart Electronic Systems (ES2) and Director of EMNSPC (an electronic packaging center). Since joining UTA in 1999, he has graduated 245 graduate students including 28 PhDs and is currently advising 15 PhDs and 7 MS students. He has received several awards including the 2008 Thermi Award, the 2009 InterPACK Excellence Award, the 2014 ITHERM Achievement Award, and the 2019 ASME Heat Transfer Memorial Award. He is a fellow of the National Academy of Inventors, AAAS, and ASME. In 2019, he was elected to the National Academy of Engineering.

Dr. Peter de Bock, ARPA-E

Dr. Peter de Bock currently serves as Program Director at the Advanced Research Projects Agency-Energy (ARPA-E). His focus at ARPA-E includes electronics thermal management and electrified aviation propulsion systems. Prior to joining ARPA-E, Dr. de Bock worked at GE Research as Principal Engineer Thermosciences. Dr. de Bock is the former chair of ASME K-16 committee on Heat Transfer in Electronics equipment and holds 50+ patents and publications. Dr. de Bock received his Ph.D. in Mechanical Engineering from the University of Cincinnati and holds MSc degrees from University of Twente in the Netherlands, and University of Warwick in the UK.

Panelists

Dr. Husam Alissa, Microsoft
Dr. Ashish Gupta, Intel
Dr. Ali Heydari , Nvidia
Dr. Saket Karajgika, Facebook
Dr. Jorge Padilla, Google)

Dr. Husam Alissa, Microsoft

Dr. Husam Alissa is a principal engineer and technical lead in Microsoft's Data Center Advanced Development Team. His focus areas include systems (chip-server-data center), cooling (air, direct to chip, immersion, and cryogenics), performance, architecture, reliability, efficiency, sustainability, and TCO, with more than 50 publications in these fields. Husam's work has received many recognitions including New York State assembly early career achievement, ASME InterPACK Outstanding paper award, IEEE TCPMT Electronics Packaging Society Best Paper Award, and S3IP distinguished doctorate dissertation award. Husam is a member of IEEE, ASHRAE TC9.9, ASME, OpenCompute, and iMasons.

"Liquid Cooling Ecosystem for the Cloud"

Abstract: The chip industry is running into limits of all scaling laws (Moore's and Dennard's). A new generation of chips and architectures with superior performance and monetization per VM is required. Those new architectures will include higher densities systems that will have higher power and cooling demand. Liquid cooling technology is one of the pillars for unlocking next generation HW.

Dr. Ashish Gupta, Intel Corporation

Dr. Ashish Gupta is the Senior Director of the Thermal Mechanical Solution group at Intel Corporation. His group is responsible for developing thermal and mechanical engineering in support of the Data Center and Artificial Intelligence product roadmap. In his career, Ashish has managed numerous engineering teams across various U.S., Latin America, and Asia sites. Ashish has nine patents and has published more than 80 papers at Intel and outside. Ashish holds a Ph.D. in Mechanical Engineering from Purdue University, USA and was awarded with the Outstanding Mechanical Engineer award by Purdue University in 2020.

"Benefits and Challenges of Deploying Different Liquid Cooling Technologies in Data Centers"

Abstract: With the advancement of Moore's law, server CPUs have been able to utilize more and more every process generation. With increasing core count, demand for power increases to deliver higher overall performance and higher performance/core. Increasing power trend of server CPUs is pushing air cooling to its limits. As fan power approaches about 15% of total server power budget, it is no longer energy efficient to cool servers with air and alternate liquid cooling options must be considered. As part of this panel discussion, the speaker will discuss both benefits and challenges of deploying different liquid cooling technologies in datacenters. Both cold plate based liquid cooling and immersion based liquid cooling will be covered. Various standardization efforts to accelerate development and deployment of liquid cooling technologies will be covered.

Dr. Ali Heydari, Nvidia

Dr. Ali Heydari is Distinguished engineer and Data Center Technologist at Nvidia in charge of all data center technology development at Nvidia. In this role, he is developing direct to chip cooling technologies using cold plates, cooling distribution units, and manifolds for cooling of Nvidia's high heat density using single and two phase refrigeration cooling systems. Prior to Nvidia, he worked as senior director in charge of Rigetti's Quantum Computers using the most futuristic technology in today's data center compute. Accomplishments include setting up the first Quantum Cloud Services enabling over the cloud access of the Quantum Computers. Prior to that he served as Senior Technical Director and Chief Data Center Architect at Baidu, the largest search engine and AI company in China. In this role, he was server and data center architect in charge of hardware and data center design, development, and deployment in China's largest data center search and AI company. He was responsible for development of cutting-edge data center and server hardware technology such as IDEC and free air-cooled data center design, high power density server rack design, liquid cooling of GPU/CPU servers and liquid cooled heat exchanger rack and data center solutions for achieving extremely low data center PUE/WUE at Baidu's data centers in China. Formerly, he was Senior Hardware Engineer at Twitter where he was responsible for grounds up development of Twitter's data center ODM server development. Earlier, he was Senior Hardware Engineer at Facebook where he helped in developing Facebook's original OCP server and data center products. Prior to that he worked at Sun Microsystems and spent about 10 years as Associate Professor of Mechanical Engineering at Sharif University of Technology in Iran. He received his B.S. in mechanical engineering from University of Illinois, Urbana, M.S., Ph.D. in mechanical engineering and M.A. in applied mathematics from University of California, Berkeley. He has over 25 issued patents in data center cooling technologies.

"High Heat Density Liquid Cooling of Data Centers"

Abstract: Artificial intelligence and machine learning applications are about to permanently change design of data centers where liquid will be coming closer than ever as the common medium to cool the core of computational servers from GPU, CPU, Switch, and other components. Hybrid air and liquid cooling with direct to chip cooling design is going to be the low hanging fruit of choice for designers where liquid will be used to directly cool high heat density components while air will continue to cool other components. Design of Liquid plumbing, selection of cooling distribution unit, selection of compatible wetted materials list, and reliability/serviceability issues are some of the challenges that industry is striving to resolve as we see more data centers preparing to embrace liquid for cooling servers and other IT equipment.

Dr. Saket Karajgikar, Facebook

Dr. Saket Karajgikar is a lead R&D Engineer at Facebook with a focus on emerging technologies to address short- and long-term data center needs. Leveraging his experience in developing thermal solutions at both data center and at HW level, he is responsible for developing and adopting technologies which are both efficient and environmentally less disruptive.

"Liquid Cooling – Easier Said Than Done"

Abstract: Industry had witnessed a rapid development in areas such as AI/ML which has raised cooling challenges compared to other storage/network platforms. This requires data centers to be more flexible than ever which may house several different technologies under one roof. This talk will briefly discuss how requirements are changing and thus raising the complexity of building and operating a large-scale infrastructure that can include hybrid cooling.

Dr. Jorge Padilla, Google

Dr. Jorge Padilla is a Staff Mechanical Engineer at Google where, since 2014, he has developed and delivered end-to-end, chip-to-chiller thermal technologies at scale for thermal management of data center IT equipment. He has co-chaired technical sessions at the ASME InterPACK and Itherm conferences since 2017. He has published in ASME conference proceedings, peer-reviewed journals and is a co-inventor on nine issued U.S. patents. Prior to joining Google, he earned a PhD in mechanical engineering from the University of California, Berkeley, where he focused on water droplet vaporization from nanostructured surfaces in the Energy and Multiphase Transport Laboratory led by Prof. Van Carey. He holds a Bachelor of Science degree in mechanical engineering from MIT.

"Enabling Liquid Cooling at Scale"

Abstract: The talk will focus on the end-to-end challenges of liquid cooling at scale to include demonstration of repeatable thermal-hydraulic performance, reliability, quality, and scaling with suppliers/vendors in a still nascent industry.

Thermal Challenges of Advanced Mobile/Telecom/Wireless Computing Devices

10:50AM–12:20PM PDT
Room 2

Moderator: **Dr. Victor Chiriac, Managing Director of Global Cooling Technology Group, ASME Fellow**

Dr. Victor Chiriac, GCTG LLC

A fellow of the American Society of Mechanical Engineers (ASME) since 2014, Dr. Victor Adrian Chiriac is a co-founder and managing partner with the Global Cooling Technology Group since 2019. He previously held technology/engineering executive/leadership roles with Motorola (1999–2010), Qualcomm (2010–2018) and Huawei R&D USA (2018–2019). Dr. Chiriac was elected Chair of the ASME K-16 Electronics Cooling Committee (2013–2017), also elected the Arizona and New Mexico IMAPS Chapter President in 2010. He is a leading member of the organizing committees of ASME/InterPack, ASME/IMECE, and IEEE/CPMT ITherm Conferences, also a co-editor of the popular *Electronics Cooling* magazine. He holds 19 U.S. issued patents, 2 U.S. Trade Secrets, and 1 Defensive Publication, and has published over 107 papers in scientific journals and at conferences.

Summary: The emergence of 5G will help power a significant rise in wearable/mobile/wireless communication, providing the infrastructure needed to carry large amounts of data, allowing for a smarter connected world. A panel of experts from diverse industrial sectors and academia will share their vision on the future of small to large wearable/wireless electronics thermal management and other advanced system-level thermo-mechanical challenges and solutions of the future.

Panelists: “Thermal Challenges of Advanced Mobile/Telecom/Wireless and Computing Devices”
Dr. Todd Salamon, Nokia Bell Labs, Member of Technical Staff
Dr. YC Lee, Kelvin Thermal, President and CEO
Prof. Yogendra Joshi, Georgia Institute of Technology
Dr. Ravi Mahajan, Intel Fellow
Prof. John R. Thome, GCTG, Technical Director
Ryoson Hiroyuki, Dexerials/ex Sony Chemicals, Chief Executive Engineer

Dr. Todd Salamon, Nokia Bell Labs

Todd R. Salamon received the Ph.D. degree in chemical engineering from the Massachusetts Institute of Technology (MIT), Cambridge, MA, USA. He is currently a Member of Technical Staff in the Hybrid Integration Research Group, Nokia Bell Labs, Murray Hill, NJ, USA, where he has worked on thermal management, microfluidics, transport phenomena in optical fiber manufacturing, design of photonic crystal fibers, and Raman and erbium amplifier dynamics and control in transparent optical networks. He has authored over 60 publications and conference presentations and holds 36 issued or pending patents. He was the Principal Investigator on a U.S. Department of Energy project titled, "Advanced Refrigerant-based Cooling Technologies for the Information and Communications infrastructure," to develop and commercialize refrigerant-based cooling technology targeting the Information and Communications Technology (ICT) sector, and a Team Member of the MIT-lead DARPA ICECool Fundamentals Program.

"Impact of 5G on Thermal Management of Telecommunications Networks"

Abstract: Network operators are beginning the buildout of 5G wireless networks, with the enhanced bandwidth and extremely low latency of 5G networks anticipated to enable a range of applications, including self-driving cars, industrial automation, and digital health, to name a few. The demands that 5G applications will place on network infrastructure require continued innovations in wireless and wireline technologies. As one example, the low latency requirements of 5G-enabled applications is resulting in the emergence of so-called "edge" computing, where compute and data resources are located in small-scale data centers that are near the end user or application, with high-speed radio access networks (RANs) providing the needed application bandwidth. In this talk, he will discuss telecom industry trends brought on by 5G, how such trends are impacting the design of networks and devices, and the associated implications for thermal management in telecommunications networks.

Dr. Y.C. Lee, Kelvin Thermal

Dr. Y.C. Lee is the President and CEO of Kelvin Thermal. He retired from the University of Colorado Boulder in August 2021. Dr. Lee received the ASME InterPACK Achievement Award in 2013. He was the Editor of *ASME Journal of Electronic Packaging* from 2015 to 2020.

“Foldable Thermal Ground Planes”

Abstract: Foldable thermal ground planes (TGPs) are enabling components for more powerful foldable smartphones, laptop PCs, ARs/VRs, and other systems with varying configurations in real time. We will present testing results on our foldable TGPs with a bending radius of 3mm and 150,000 folding cycles. More importantly, we will illustrate how to improve foldable system’s power dissipation by at least 3X with the use of the foldable TGPs.

Prof. Yogendra Joshi, Georgia Tech

Yogendra Joshi is Professor and John M. McKenney and Warren D. Shiver Distinguished Chair at the G.W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology. His research interests are in multi-scale thermal management. He is the author or co-author of over four hundred publications in this area, including over two hundred journal articles. He is an elected Fellow of the ASME, the American Association for the Advancement of Science, and IEEE.

“Microfluidic Thermal Management for Heterogeneously Integrated Microsystems”

Abstract: Heterogeneous integration is bringing in several thermal challenges. Two examples will be presented to illustrate these and some potential solutions. Power delivery to high performance computing hardware requires internal voltage regulators (IVR), which employ package embedded passive elements such as inductors. Close proximity of the passives and IVR requires independent thermal management of the passives. The passives are embedded within the packaging structure and do not have direct access to thermal management. The second example considers glass interposer-based packaging of 5G and beyond mm wave wireless modules. Embedding of components within the interposer is a promising technology for compact heterogeneous integration. Thermal management of components such as power amplifiers for glass interposer-based packaging presents significant challenges. As discussed, microfluidics presents promising solutions for both applications.

Dr. Ravi Mahajan, Fellow

Ravi Mahajan is an Intel Fellow responsible for Assembly and Packaging Technology Pathfinding for future silicon nodes. Ravi also represents Intel in academia through research advisory boards, conference leadership, and participation in various student initiatives. He has led Pathfinding efforts to define Package Architectures, Technologies, and Assembly Processes for multiple Intel silicon nodes including 90nm, 65nm, 45nm, 32nm, 22nm, and 7nm silicon. Ravi joined Intel in 1992 after earning Ph.D. in Mechanical Engineering from Lehigh University. He holds the original patents for silicon bridges that became the foundation for Intel's EMIB technology. His early insights have led to high-performance, cost-effective cooling solutions for high-end microprocessors and the proliferation of photo-mechanics techniques for thermo-mechanical stress model validation. His contributions during his Intel career have earned him numerous industry honors, including the SRC's 2015 Mahboob Khan Outstanding Industry Liaison Award, the 2016 THERMI Award from SEMITHERM, the 2016 Allan Kraus Thermal Management Medal and the 2018 InterPACK Achievement award from ASME, the 2019 "Outstanding Service and Leadership to the IEEE" Awards from IEEE Phoenix Section and Region 6, and most recently the 2020 Richard Chu ITherm Award For Excellence and the 2020 ASME EPPD Excellence in Mechanics Award. He is one of the founding editors for the *Intel Assembly and Test Technology Journal* (IATTJ) and currently VP of Publications & Managing Editor-in-Chief of the IEEE Transactions of the CPMT. He has long been associated with ASME's InterPACK conference and was Conference Co-Chair of the 2017 Conference. Ravi is a Fellow of two leading societies, ASME and IEEE.

"Thermal Management in Devices in Thermally Demanding Environments"

Abstract: The context for the thermal problem for some of the devices and applications addressed by this panel is provided. A call for action on developing thermal solutions is made and opportunities for collaboration are identified.

Professor John R. Thome, GCTG LLC

John R. Thome is Co-Founder and Technical Director of Global Cooling Technology Group in Phoenix, AZ, developing pulsating heat pipe technologies for the mobile electronics market as well as JJ Cooling Innovation in Lausanne, Switzerland, a micro-two-phase cooling technology development company for numerous other industries. Has 20+ years of experience with development of micro-two-phase cooling systems for electronics (pumped systems, thermosyphons, pulsating heat pipes and high-fidelity simulators for them). He is the author of five books and is editor-in-chief of the *Encyclopedia of Two-Phase Heat Transfer and Flow* (16 volumes). He received the 2017 Nusselt-Reynolds Prize, the 2019 IEEE ITHERM Award and the 2019 ASME InterPACK Medal, the ASME Heat Transfer Division's *Journal of Heat Transfer* Best Paper Award in 1998, the United Kingdom's Institute of Refrigeration J.E. Hall Gold Medal in 2008, the 2010 ASME Heat Transfer Memorial Award, among others.

"Pulsating Heat Pipe for Cooling of Mobile Electronics"

Abstract: Pulsating heat pipes (PHPs) are a new high performance cooling solution for mobile electronics: tablets, phones, portable PCs, etc. Presently, a newly developed planar PHP has been developed with a very thin form factor (<1.0mm thickness) that handles one or multiple distributed thermal cooling loads up to and beyond 30W. Some test results and IR thermal images will be presented to illustrate the thermal performance in various cooling orientations (vertical and horizontal) and in steady state/transient operation.

Hiroyuki Ryoson, Dexerials (ex-Sony Chemicals)

Hiroyuki Ryoson is the Dexerials Executive Chief Engineer responsible for thermal management technology and thermal management materials. Ryoson is also a researcher of Tokyo Institute of Technology responsible 3D stacking technology development. He was also a member of Sony corporation responsible for thermal management technology development.

"Low Thermal Resistance 3D Stacked IC Using WOW Technology"

Abstract: Recently stacked DRAM is commercialized in response to the demand for increasing DRAM capacity, and it uses microbump technologies for stacking. When using the microbump method, the thermal resistance in interlayer and in BEOL are large, so that total thermal resistance is larger. As the result total the temperature rise between top layer and bottom layer of stacked dies is large. At this point, Tokyo Institute of Technology reports the bumpless stacking technologies. When this method is used via last technology and the total thermal resistance is small, the temperature rise is also small. The total thermal resistance in the microbump method is 1.54 K/W, and the temperature rise at 22.6 W input power is 19.9 C. On the other hand, the total thermal resistance method in bumpless method is only 0.46 K/W and the temperature rise at 22.6 W input power is only 5.8 C.

Additive Manufacturing for Cooling and Thermal Storage in Electronics Thermal Management

10:50AM–12:20PM PDT
Room 3

Moderator: Nenad Miljkovic, University of Illinois at Urbana-Champaign

Dr. Nenad Miljkovic, University of Ilinois at Urbana-Champaign

Dr. Nenad Miljkovic is Associate Professor, Department of Mechanical Science and Engineering, and Associate Director - Air Conditioning and Refrigeration Center (ACRC), at the University of Illinois at Urbana-Champaign.

Summary: Additive manufacturing (AM) is beginning to have a profound impact on the design of thermal management systems. In this panel, a series of experts will discuss current trends in the design of cooling and thermal energy storage systems as well as future directions in AM for thermal management. This panel brings together leading experts who are at the forefront of AM in the development of thermal technologies.

Panelists:
Professor Bill King, UIUC, Full Professor
Dr. David Huitink, University of Arkansas, Assistant Professor
Darin Sharar, Army Research Laboratory

Professor William P. King, University of Illinois at Urbana-Champaign

William P. King, Ph.D. is Professor and Ralph A. Andersen Endowed Chair in the University of Illinois Urbana-Champaign Grainger College of Engineering, Department of Mechanical Science and Engineering. He holds courtesy appointments in the Departments of Electrical and Computer Engineering and Materials Science and Engineering, as well as in the Department of Biomedical and Translational Biosciences in the Carle Illinois College of Medicine. Dr. King is the Chief Scientist at Fast Radius, a company that sells software-driven manufacturing. In 2018, the World Economic Forum named Fast Radius as a Lighthouse Factory, one of the world's best digital factories. Dr. King was the founding Chief Technology Officer at the Digital Manufacturing and Design Innovation Institute (DMDII) at UI LABS in Chicago, IL, now known as MxD. DMDII was one of the first institutes in the U.S. National Network for Manufacturing Innovation. Dr. King's awards include the PECASE award from the White House and the ASME Gustus-Larson Award for accomplishment in Mechanical Engineering. Dr. King has published 250 journal articles and 19 patents. He is a Fellow of the American Society of Mechanical Engineers, American Association for the Advancement of Science, and the American Physical Society.

"Ultra-Power Dense Heat Exchanger Enabled by Shape Optimization and Additive Manufacturing"

Abstract: This talk describes the development of power dense heat exchangers using shape optimization and additive manufacturing. Using generative design and a genetic algorithm, we demonstrate the design of a dual tube device with separate liquid streams flowing through either side of the device. The device was additively manufactured in aluminum silica (AlSi10Mg) and then tested under both laminar and turbulent flow conditions. The shape optimized device shows significant increase in heat transfer rate and power density when compared to devices having either no fins or conventional straight fins.

Professor David Huitink, University of Arkansas

Professor Huitink's research portfolio spans the intersection of materials and thermal sciences, where fundamental thermophysical material behaviors can be leveraged for engineered applications. Herein, the interplay between atomic bonding, polymorphism, and nanoscale interactions with thermal transport, generation, and storage have important implications in energy sciences, thermally active and functional materials, and materials processing. In particular, the Huitink lab works closely with Electrical Engineering collaborators in developing next generation, high density power electronics for electrified transportation and power conversion systems, and leverages advances in materials and thermal technologies for enabling High-Reliability electronics packaging. Recent efforts include use of additive manufacturing for hot-spot thermal management and transient temperature abatement, as well as interconnect fabrication technology development for enhanced lifetimes of electronic packaging through thermal cycling events. Moreover, the reliability efforts include developing novel methods for observing and isolating the physical mechanisms behind material degradation and failure in materials used in high power, high voltage electronic assemblies. Prior to joining Academia, Professor Huitink spent more than 5 years in industry, working in microelectronics technology development and manufacturing at Intel Corporation, where he served as Quality & Reliability Engineering Program Manager for Intel's Custom Foundry Division. There he pioneered the development of advanced methods of predicting reliability of silicon-based flip chip microelectronic packages, as well as developed testing protocols and FEA methods for governing Design for Reliability (DfR) guidance. Additionally, he has patent applications filed in Low Z-height Electronic System design and thermal optimization of space limited electronic systems. Recently, Professor Huitink also served as an Associate Editor of *Microelectronics Reliability* Journal. Prior to his industry experience, Dr. Huitink received his PhD in Mechanical Engineering from Texas A&M University as a NSF Graduate Research Fellow, working on complex nano-scale interactions at material interfaces under chemical and mechanical influence.

"Additive Manufacturing for Electronics Thermal Management"

Abstract: With the increase of electronic device power density, thermal management and reliability are increasingly critical in the design of power electronic systems. First, increased density challenges the capability of conventional heat sinks and cold plates to adequately dissipate heat. Secondly, higher frequency switching in high voltage, high current, wide bandgap power modules is creating intensified electromagnetic interference challenges, in which metallic heat removal systems will couple and create damaging current ringing.

Furthermore, mobile power systems (such as in electrified aircraft) require lightweight heat removal methods that satisfy the heat loads dissipated during operation. In this effort we introduce an additive manufacturing pathway to produce custom heat removal systems using non-metallic materials, which take advantage of impinging fluid heat transfer to enable efficient thermal management. Herein, we leverage the precision of additive manufacturing techniques in the development of 3D optimized flow channels for achieving enhanced effective convective heat transfer coefficients. The experimental performance of convective heat removal due to liquid impingement is compared with conventional heat sinks, with the requirement of simulating the heat transfer needed by a high voltage inverter. Thermal and hydraulic performances will be discussed, along with the demonstration of this cooling approach in a high frequency T-type inverter intended for electrically driven aircraft propellers. The implementation of non-metallic materials manufacturing is aimed to reduce electromagnetic interference in a low weight and reduced cost package, which are presented using modeling and experimental validation of common mode noise induced by high voltage switching characteristics.

Darin Sharar, PhD, U.S. Army Research Laboratory (ARL)

Dr. Sharar is a Research Scientist and Team Lead in the Energy and Power Branch within the U.S. Army Research Laboratory (ARL). Research efforts reside at the intersection of materials science, additive manufacturing, numerical modeling, thermal metrologies, and active/passive heat transfer to enable future high-power electronic/photonic capabilities. He is principal investigator and sponsor for several tri-service, industry, and academic efforts aimed towards accelerating adoption of emerging additive manufacturing-enabled cooling and thermal storage approaches. He received his Ph.D. from the University of Maryland, College Park in Mechanical Engineering in 2016 under the guidance of the late Dr. Avram Bar-Cohen. He has authored/co-authored over 55 journal papers, refereed proceedings papers, and book chapters with nearly 400 peer citations; has delivered 20 research and invited lectures at major technical conferences and institutions; and has authored 5 U.S. patents.

"Recent Developments in Active Cooling and Passive Thermal Energy Storage Systems"

Abstract: This discussion covers ongoing efforts at the Army Research Lab, and academic/-industry partners, to develop state-of-the-art active cooling and passive thermal energy storage systems. The discussion begins with a description of emerging electronic/opto-electronic steady-state and transient load scenarios, followed by limitations of traditional thermal management approaches, and progresses to recent advances in high centrifugal force flow boiling and high-capacity high-power thermal storage owing to unique implementations of additive manufacturing and metallic solid-solid phase change materials. Focus is placed on emerging cooling technologies and anticipated future needs for improved materials, modeling tools, and manufacturing approaches.

WEDNESDAY, OCTOBER 27

Cryogenic Cooling of Solid-State Devices

9:10AM–10:40AM PDT
Room 1

Moderator: Michael Fish, Army Research Laboratory

Michael Fish is a research scientist at the Advanced Power Packaging group at the U.S. Army Research Laboratory, where he serves as Principal Investigator for the Thermally Enabling Architectures for Pulsed Power Systems (TEAPPS) tri-service program. His current interest is in the packaging and management of highly transient electronic systems, with particular focus on directed energy systems, vehicle electrification, and power conversion. He is one of three primary developers of ARL's open-source thermal-mechanical co-design and simulation tool, ARL ParaPower.

Panelists:
Dr. Matthew Harrison, The Aerospace Corporation
Dr. Joshua Gess, Oregon State University
Mr. Howard Tseng, NASA Goddard Space Flight Center

Dr. Matthew Harrison, The Aerospace Corporation

Dr. Matt Harrison attended Oklahoma State University where he received his Bachelor of Mechanical Engineering in 2015. He then attended Oregon State University and graduated in 2020 with his Master's and Ph.D. also in Mechanical Engineering. While at Oregon State his research was primarily focused on high heat flux electronics cooling. This led to the creation of a collegiate overclocking group where LN2 was the primary coolant used for high performance computing competitions. For his dissertation he experimentally measured and analytically modeled the net coolant flow rate of a boiling fluid to a high heat flux surface. In August of 2020 he joined The Aerospace Corporation as a Thermal Controls Engineer and member of the technical staff. Since he joined The Aerospace Corporation he has worked on active and passive cooling solutions for spacecraft. He also has been actively researching ways to mitigate vibrations from external disturbances induced from multiple cryocoolers in a single payload.

"Early Career Lessons on Cryocooler Landscape and Cryogenic Thermal Margins"

Abstract: Modern spacecraft utilize sensitive sensors with tight thermal margins. As programs continue to optimize spacecraft design the use of cryocoolers continues to change. Increasingly important characteristics include size and cost, which are leading many programs to integrate multiple smaller cryocoolers to meet the thermal demands. This presentation will cover early career lessons on cryogenic thermal margins, integration challenges, and current cryocooler landscape.

Dr. Joshua Gess, Oregon State University

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.

"Pitfalls and Challenges in Cryogenic Overclocking"

Abstract: Electronics like to run cold, but how cold is too cold? Cryogenics can keep electronics at temperatures where leakage currents are near minimum, and the inherent phase change these coolants undergo ensures that the underlying components are certainly energy-dense. However, issues from thermal expansions are exacerbated and system complexity (most importantly size) increases as well. There are trades to be made in this space, which means there is valuable research to be conducted and discoveries to be made. This presentation will cover advances made in cryogenic cooling with a focus on computer overclocking and extremely low temperature compatible packaging.

Howard Tseng, NASA Goddard Space Flight Center

Howard Tseng attained his Bachelor of Science in Civil Engineering from the University of California, Berkeley in May of 2000. After working overseas for a year and half developing gas turbine engines for power generation, he returned to the U.S. to start graduate school in September 2002 at the University of California, Los Angeles. Howard's research project was studying the effect of flowing a colloidal gas aphrons (CGA) solution on heat transfer in mini-channels. After completing his Masters of Science in Mechanical Engineering in June of 2004, he joined the Jet Propulsion Laboratory (JPL) as a full-time employee in the Cryogenic Systems Engineering group. While working at JPL Howard also completed his MBA degree in May of 2013 from UC Berkeley Haas School of Business. During his time at JPL, Howard's duties have included thermal conductivity testing of materials and components from 3 K to 300 K, thermal design and modeling of spacecraft and instruments, and new technology development and maturation for space application. Some of Howard's past projects have been Moon Mineralogy Mission (M3), Orbital Carbon Observatory (OCO), Ultra Compact Imaging Spectrometer (UCIS), and flexible graphene thermal strap development and qualification. Currently, Howard is working in the Cryogenics and Fluids Branch at the Goddard Space Flight Center. Howard's technical interests include developing unique and new cooling architecture for instruments and spacecraft as well as creating tools to help engineers be more efficient.

"Closed Loop Cryogenic Cooling in Spaceborne Applications"

Abstract: In the not so distant past, getting down to cryogenic temperatures meant using a stored cryogenic fluid. Even though this was effective, it also meant there was a finite amount of time associated with operating at that temperature. In the last few decades, there have been rapid and major developments of technologies that helped our field to move away from using stored cryogens as the working medium. We will look at the lessons learned through those advances, as well as the new challenges to tackle in the future

Two-Phase Cooling Systems for High Power Electronics/Data Centers

9:10AM–10:40AM PDT
Room 1

Moderator: **Prof. John R. Thome, Technical Director, JJ Cooling Innovation Sarl, Lausanne**

John R. Thome is Co-Founder and Technical Director of JJ Cooling Innovation in Lausanne, Switzerland, a micro-two-phase cooling technology development company for numerous industries, also for Global Cooling Technology Group in Phoenix, AZ, developing pulsating heat pipe technologies for the mobile and commercial electronics markets. He has 20+ years of experience with development of micro-two-phase cooling systems for electronics (pumped systems, thermo-syphons, pulsating heat pipes and high-fidelity simulators for them). He is the author of five books and is editor-in-chief of the *Encyclopedia of Two-Phase Heat Transfer and Flow* (16 volumes). He received the 2017 Nusselt-Reynolds Prize, the 2019 IEEE ITHERM Award and the 2019 ASME InterPack Medal, the ASME Heat Transfer Division's *Journal of Heat Transfer* Best Paper Award in 1998, the United Kingdom's Institute of Refrigeration J.E. Hall Gold Medal in 2008, the 2010 ASME Heat Transfer Memorial Award, among others.

Panel Summary: Two-phase cooling is gaining traction in the cooling of high-power electronics (large heat loads, high density equipment, and high heat fluxes) in a broadening of industries: data centers, Edge computing, power electronics, automotive, etc. Two-phase cooling is also seen as the way forward to energy-efficient cooling, using less energy (pumped or compressor driven cooling systems) or no energy (loop thermosyphon systems). The panelists will address both fundamental (research) issues and engineering (application) issues.

Panelists:
Dr. Jackson B. Marcinichen, JJ Cooling Innovation, CEO, Switzerland
Prof. Tassos Karayiannis, Brunel University, London, UK
Fred Buining, HIRO-MicroDataCenters, CEO, Netherlands
Dr. Victor Chiriac, GCTG LLC, CEO, USA

Dr. Jackson B. Marcinichen, JJ Cooling Innovation

J.B. Marcinichen is founder and CEO of JJ Cooling Innovation and has over 30 years of experience in HVAC & R systems. He received his PhD in Mechanical Engineering from the Federal University of Santa Catarina, Brazil in 2006. He has authored over 60 scientific and technical papers in indexed journals and international peer-reviewed conferences, book chapters, and patents. He is mainly engaged in the development of novel hybrid cooling systems (passive and active) to cool high heat flux electronics using on-chip cooling. He received the IEEE Best Paper Award at the ITHERM 2020 conference (USA, 2020).

"The Real Impact of Loop Thermosyphon Cooling Systems in the Next Generation of Electronics"

Abstract: In the last decade several passive cooling systems were developed, experimentally tested, and proved to be an excellent and reliable choice for applications where high heat flux must be dissipated from electronics. Nowadays, the main challenge seems to be more related to the acceptability of the electronic industry for this new disruptive cooling technology, which means investment in a new production strategy considering the passive system integrated and the measurement of the cost-benefit at the end of the selling process.

Professor Tassos Karayiannis, Brunel University

Tassos Karayiannis leads the Two-Phase Flow and Heat Transfer Group and is Director of the Energy Efficient and Sustainable Technologies Research Centre at Brunel University, London. He carried out extensive experimental work in pool boiling heat transfer, including heat transfer enhancement and flow boiling in small to micro tubes and micro-multi-channels for over 35 years and published more than 250 book chapters, papers, and industrial reports. He is the Chairman of the UK Nat. Heat Transfer Committee.

"Flow Boiling in Microchannels for Cooling Small-Scale High Heat Flux Devices"

Abstract: Spatially non-uniform and unsteady dissipative heat generation in high heat flux devices used in a number of applications is detrimental to their performance and lifetime constituting, at the same time, a bottleneck for further development. Flow boiling in microchannels constitutes one of the best options for cooling such devices, promising to meet requirements >1 MW/m2 since it can (i) yield very high heat transfer coefficients due to the dissipation of latent heat; (ii) maintain a uniform surface temperature, vital for the correct operation of components; and (iii) respond passively to alleviate localised "hot-spots," as the heat transfer coefficient increases with heat flux. The presentation will include latest research findings in this area, highlighting both fundamental and practical aspects of the use of microchannels.

Fred Buining, HIRO-MicroDataCenters

Fred has 30 years of experience in Industrial Innovation across various industries and ICT related technologies including robotics, autonomous driving, vision technology, and embedded computing. He is the founder of HIRO-MicroDataCenters, a start-up developing Edge services supporting Big Data processing and AI in factories, cities, hospitals, etc. HIRO-microdatacenters are mobile, with unprecedented high density 1.5kW shoebox size–150kW rack size, composable with any mix and quantity (CPU, FPGA, GPU, NVMe) and come with a complete stack for Edge services (storage, compute, acceleration, networking) and virtualization (Containers and VM's). The hardware based on Industry standards is completely solid state, no moving parts, including the cooling, thereby saving up to 40% in IT energy consumption.

"The Multidimensional Challenge of Achieving Cost Efficiency, Reliability, High Density, and Cooling Hardware at the Edge"

Abstract: GDPR, latency, privacy, security, fault tolerance requirements draw Big Data and AI processing back from the Cloud to the Edge. Edge IT infrastructure however spreads out over factories, cities, buildings and is exposed to conditions very different from the managed data center space. To create cost efficient yet reliable high performance in these conditions is a multidimensional challenge to HIRO-MicroDataCenters. Innovating in cooling technology is one of the key success factors in achieving this.

Dr. Victor Chiriac, GCTG LLC

A fellow of the American Society of Mechanical Engineers (ASME) since 2014, Dr. Victor Adrian Chiriac is a co-founder and a managing partner with the Global Cooling Technology Group since 2019. He previously held technology/engineering leadership roles with Motorola (1999–2010), Qualcomm (2010–2018), and Huawei R&D USA (2018–2019). Dr. Chiriac was elected Chair of the ASME K-16 Electronics Cooling Committee (2013–2017) and was elected the Arizona and New Mexico IMAPS Chapter President in 2010. He is a leading member of the organizing committees of ASME/InterPack, ASME/ IMECE, and IEEE/CPMT ITherm Conferences, also a co-editor of the highly popular *Electronics Cooling* magazine. He holds 19 U.S. issued patents, 2 U.S. Trade Secrets, and 1 Defensive Publication (with Motorola) and has published over 107 papers in scientific journals and at conferences.

“Heterogeneous Integration for 5G High Performance Computing – Cooling Challenges and Opportunities”

Abstract: There is a critical need for heterogeneous system integration for systems-in-a-package (SiPs) for the 5G High Performance Computing (HPC) and to identify potential solutions for short to long term challenges to design these SiPs. Aside from the processor-memory performance gap that remains a key driver for the overall system architecture, new factors that drive the need for heterogeneous integration in the HPC and data center markets have been emerging. These include cooling technology limitations, new and emerging applications, and scaling needs for power delivery and dissipation, also package level IO constraints. Some of these challenges and opportunities will be discussed.

Artificial Intelligence and Reliability: Future Opportunities

10:50AM–12:20PM PDT
Room 2

Moderator: Dr. Michael H. Azarian, Research Scientist, CALCE, University of Maryland College Park

Dr. Michael H. Azarian is a Research Scientist at the Center for Advanced Life Cycle Engineering (CALCE) at the University of Maryland. He holds a Master's and Ph.D. in Materials Science from Carnegie Mellon University, and a Bachelor's degree in Chemical Engineering from Princeton University. His research is focused on the analysis, detection, prediction, and prevention of failures in electronic and electromechanical products. He has over 150 publications and 6 U.S. patents on electronic packaging, component reliability, prognostics and health management, and tribology. He chairs the SAE G-19A committee on laboratory standards for counterfeit part detection, and the IEEE 1624 working group on organizational reliability capability. Prior to joining CALCE he spent over a dozen years in the disk drive and fiber optics industries.

Panel Summary: Progress in machine learning (ML) and deep learning (DL), increased access to powerful computers and data storage, and the Internet of Things, have all contributed to greater opportunities for the application of Artificial Intelligence (AI) across a wide range of fields. This panel will offer insights into how AI can benefit reliability engineering. Some of the questions that fall within the scope of the panel include the possible use of AI for: creating component-specific reliability models, possibly replacing analytic stress-and-damage models; predicting application conditions for improved estimation of remaining useful life; aggregating data on materials or components from a variety of sources for model development; and product design and selection based on multi-variate analysis.

Panelists:
Dr. Abhinav Saxena, General Electric Research
Prof. Mark Fuge, University of Maryland College Park
Prof. Payman Dehghanian, George Washington University
Dr. N. Jordan Jameson, Johns Hopkins Applied Physics Laboratory

Abhinav Saxena, PhD, GE Research

Dr. Abhinav Saxena is a Principal Scientist in AI & Learning Systems at GE Research. Abhinav has been developing ML/AI-based PHM solutions for various industrial systems (aviation, nuclear, power, and healthcare) at GE and has been driving integration of AI-based PHM analytics in GE's industrial systems. Abhinav is also an adjunct professor in the Division of Operation and Maintenance Engineering at Luleå University of Technology, Sweden. Prior to GE, Abhinav was a Research Scientist with SGT Inc. at NASA Ames Research Center for over seven years. Abhinav's interests lie in developing PHM methods and algorithms with special emphasis on deep learning and data-driven methods in general for practical prognostics. Abhinav has published over 100 peer-reviewed technical papers and has co-authored a seminal book on prognostics. He actively participates in several SAE standards committees, IEEE prognostics standards committee, and various PHM Society educational activities, and is a Fellow of the PHM Society. He is also the chief editor of *International Journal of Prognostics and Health Management* since 2011 and actively participates in organization of PHM Society conferences.

"Use of AI and ML in Industrial Reliability Engineering"

Abstract: This talk will discuss application and use cases for ML and AI to improving reliability for industrial applications. Some successful AIML examples in industrial domain will be presented that may have direct applicability to electronics systems. Current research directions and challenges from industrial perspective will be shared.

Professor Mark Fuge, University of Maryland College Park

Dr. Mark Fuge is an Associate Professor of Mechanical Engineering at the University of Maryland, College Park, where he is also an affiliate faculty in the Institute for Systems Research and a member of the Maryland Robotics Center and Human-Computer Interaction Lab. His staff and students study fundamental scientific and mathematical questions behind how humans and computers can work together to design better complex engineered systems, from the molecular scale all the way to systems as large as aircraft and ships using tools from Computer Science (such as machine learning, artificial intelligence, and submodular optimization) and Applied Mathematics. He received his Ph.D. from UC Berkeley and has received an NSF CAREER Award, a DARPA Young Faculty Award, and a National Defense Science and Engineering Graduate (NDSEG) Fellowship. He gratefully acknowledges prior and current support from NSF, DARPA, ARPA-E, NIH, ONR, and Lockheed Martin, as well as the tireless efforts of his current and former graduate students and postdocs, upon whose coattails he has been graciously riding since 2015. You can learn more about his research at his lab's website: http://ideal.umd.edu.

"Machine Learning Generative Models for Power Electronics Design and Reliability"

Abstract: Deep Generative Graph Models—to accelerate the design and evaluation of Power Converter circuits as part of the ARPA-E DIFFERENTIATE program. In particular, I will focus on one key idea that underlies the success of generative models more broadly: the embedding of high-dimensional design spaces into low-dimensional manifolds. I'll describe how this applies to power electronics design, but also the broader relevance of this to other engineering design challenges, with potential examples from aerospace engineering, material science, and medical devices. I will also discuss some of the practical challenges with deploying these techniques in industrial settings where available data size and quality are limited, as well as potential research and development opportunities that result from these challenges.

Professor Payman Dehghanian, George Washington University

Dr. Payman Dehghanian is currently an Assistant Professor at the Department of Electrical and Computer Engineering at George Washington University, Washington DC, USA. He received his Ph.D. degree from the Department of Electrical and Computer Engineering at Texas A&M University in 2017. He received a B.Sc. and M.Sc. degrees both in Electrical Engineering, respectively, from the University of Tehran, Tehran, Iran in 2009 and the Sharif University of Technology, Tehran, Iran, in 2011. His research interests include power system resilience and reliability assessments, synchrophasor technology, and smart electricity grid applications. Dr. Dehghanian is the recipient of the 2016 Best Engineering Graduate Student in the State of Texas, the 2015 IEEE-HKN Outstanding Young Electrical Engineer Award, the 2014 and 2015 IEEE Region 5 Outstanding Professional Achievement Awards, and the 2021 Washington Academy of Sciences Early Career Award. In 2015 and 2016, he was also selected among the World's Top 20 Young Scholars for Next Generation of Research in Electric Power Systems.

"Distributed Intelligence for Online Situational Awareness and Resilience in Electric Power Grids"

Abstract: The electricity grid is constantly exposed and vulnerable to fast- and slow-dynamic threats ranging from unpredictable faults, weather-driven natural disasters, malicious cybersecurity attacks, and other random disruptions. With the growing demand to ensure higher quality electricity to end customers and mission critical systems and services, there is an urgent need to enrich the power delivery infrastructure resilience against disruptive events while reducing and mitigating such threatening risks. This calls for derivation and fundamental advancements of new, fast, and efficient analytical frameworks embedded in modular and localized solutions for online situational awareness and real-time decision making. This presentation seeks to provide analytical foundations to design, develop, and test next-generation smart sensors embedded with artificial intelligence and signal processing algorithms for online situational awareness in cyber-physical smart grids. Going beyond the traditional centralized monitoring paradigms, which are vulnerable to communication failures, delays, and cyber-attacks, the proposed solution for system monitoring and control paradigms enables fusing the online measurements in a distributed manner, translating the data to valuable information closer to where it is generated, i.e., distributed intelligence. Enabling a paradigm shift from sensing-only to sensing-and-actuating apparatus at the grid edge, the proposed solution would prepare the smart grids for a wide range of slow and fast-dynamic events while minimizing the disastrous consequences of such threats and maximizing its resilience to emergencies.

Dr. N. Jordan Jameson, Johns Hopkins University

Dr. N. Jordan Jameson is a data scientist working at Johns Hopkins University Applied Physics Laboratory in Cyber Systems Warfare group within Asymmetric Operations Sector. He has also worked as a data scientist at the National Geospatial-Intelligence Agency (NGA) and a manufacturing systems prognostics and health management (PHM) engineer at the National Institute for Standards and Technology (NIST). He holds a PhD in mechanical engineering from the University of Maryland, College Park, where he studied prognostics and health management methods within the Center for Advanced Life Cycle Engineering (CALCE).

“Don’t Forget About ‘Good, Old-Fashioned’ Statistics”

Abstract: As computing power becomes ubiquitous and incorporating machine learning (ML) and artificial intelligence methods becomes more convenient, it is easy to forget about statistical methods. However, these methods are powerful. Markov chains can enable efficient modeling of system operational regimes and application conditions; Monte Carlo methods can help us model and reproduce parametric and non-parametric data distributions, leading to, e.g., better estimation of component/system parameters; and hypothesis testing is invaluable to generating useful features for application in AI/ML modeling. While it is blissful to believe that we can throw data at a deep neural network and let it sort out the modeling, this is ultimately naïve. Success demands that we use all tools at our disposal, and traditional statistical tools often have the edge when it comes to computational efficiency and interpretability.

Women in Engineering
“Developing Wide Bandgap Electronics for Future Power and RF Applications”
10:50AM–12:20PM PDT
Room 3

Moderator: Anna Prakash, Intel Corporation

Anna Prakash began her engineering career working on LCDs, HDTVs, and handheld communication devices. She joined Intel in 2004 as a Packaging R&D Engineer, focusing on automotive components and super computers. Anna has several patents and papers covering sensors and semiconductor packaging materials and process. Outside of work, Anna is passionate about promoting STEM education for local children. Along with her daughter Elaina, she co-founded Education Empowers Inc., a non-profit, to promote STEM education. Anna is the recipient of the 2019 Intel Hero award, Society of Women Engineers "Prism Award" and the IEEE STEM outreach award for her contribution to technology and the community.

Panelists:
Jennifer Cordero (Maxar Space)
Jennifer R. Lukes (University of Pennsylvania)
Sylvie Lorente (Villanova University)
Taravat Khadivi (Facebook)

The Panel on “Women in Engineering” will be composed of exemplary female educators and industry/lab leaders who will discuss their career paths and challenges as well as their advice to younger females. Thriving while preserving through STEM journey can be hard. These extraordinary women will share their journey, career paths, constantly evolving with different challenges, uncertainties, frustrations, and setbacks but to emerge as leaders in their fields of Engineering, Science, and Technology. The goal of this session is to share reflections, challenges, and practical actions to empower you through your STEM journey. The panel will have representation from a wide range of educators from university level and leaders from related industries and government labs.

Jennifer Cordero, Maxar Space

Jennifer Cordero currently serves as the Thermal Subsystem Director at Maxar Space in Palo Alto, California. She has been with Maxar for over fourteen years, and in that time has filled many roles, such as thermal analyst, thermal hardware engineer, thermal products engineer, thermal responsible engineer, systems engineering lead, thermal technical partner, and now director. The Thermal Subsystem is responsible for the thermal design, analysis, manufacturing, and testing of spacecraft used for broadcast communications, Earth intelligence, deep space science, and many other missions. Currently, it is comprised of almost 70 engineers and technicians who, like Ms. Cordero, all have a passion for space. Prior to working at Maxar, Ms. Cordero worked at BAE Systems, Teledyne Energy Systems, MidAmerican Energy, the National Hispanic University, and Iowa State University. Ms. Cordero has a Bachelor's degree in Mechanical Engineering from Princeton University and a Master's degree in Mechanical Engineering from Iowa State University of Science and Technology. She is originally from southern New Mexico and is the first in her family to graduate from college. She has been married for 23 years and has twin boys in college studying engineering. In her spare time, she volunteers on the Maxar Space Women's Network Leadership team and enjoys hiking, reading, and traveling.

Jennifer R. Lukes, University of Pennsylvania

Jennifer R. Lukes is currently Professor of Mechanical Engineering and Applied Mechanics at the University of Pennsylvania. Her research activities are directed toward understanding the unusual thermal, fluid, and mass transport phenomena that emerge as the characteristic dimensions of devices and materials approach the nanometer scale. Her primary focus has been the development and application of computational methods to investigate the thermal transport characteristics of nanostructures such as carbon nanotubes, superlattices, nanowires, and ultrathin solid films. Professor Lukes received her B.S. in Mechanical Engineering magna cum laude from Rice University in 1994. Following her undergraduate studies, she worked in industry as a facility engineer at Amoco Production Company. A National Science Foundation Fellow, she returned to academia and earned her M.S. and Ph.D. degrees in Mechanical Engineering at the University of California, Berkeley in 1998 and 2001. She joined the Department of Mechanical Engineering and Applied Mechanics at the University of Pennsylvania in September 2002 as William K. Gemmill Assistant Professor. Professor Lukes received the National Science Foundation CAREER Award in 2006. In 2007 she was selected to participate in the National Academy of Engineering's U.S. Frontiers of Engineering Symposium, and in 2011 she was invited to the National Academy of Sciences' Indonesian-American Kavli Frontiers of Science Symposium. A member of the American Society of Mechanical Engineers and the Materials Research Society, she has organized technical sessions, symposia, and a conference in the area of nanoscale thermal transport.

Sylvie Lorente, Villanova University, PA

Sylvie Lorente is the new College of Engineering Associate Dean for Research & Innovation at Villanova University, PA. She is the College of Engineering Chair Professor in Mechanical Engineering at Villanova, and Professor (Exceptional Class) at the National Institute of Applied Sciences (INSA), University of Toulouse, France. She is also Hung Hing-Ying Distinguished Visiting Professorship in Science and Technology at Hong Kong University (Hong Kong), Extraordinary Professor at the University of Pretoria (South Africa), and Adjunct Professor at Duke University (USA). She is a member of the Academy of Europe. Sylvie has a passion for flow architectures, and works on thermal design, energy storage, vascularized structures, porous media, biological flow networks, urban design and organizations, among other things. She is the author of 7 books, 10 book chapters, and 200+ peer-reviewed international journal papers. She is listed among the 2% most cited scientists worldwide.

Taravat Khadivi, Facebook

Taravat Khadivi is a Thermal Design Lead at Facebook Reality Labs focusing on thermal architecture and design of Facebook Portal. She holds a Ph.D. in mechanical & materials engineering and a master's in aerospace engineering. Prior to joining Facebook, she held various technical and managerial roles at Qualcomm, Samsung Electronics, and Emirates Airlines. Taravat has a passion for empowering young Women in STEM. She participated in TechWomen program as a mentor twice, was a board member and VP of Qwomen Bay Area, and served a member of the organization committee of Girl Geek X at Qualcomm.

TUTORIALS

TUESDAY, OCTOBER 26

Reliability of Heterogeneous Integration (HI) Systems

1:50PM–3:50PM PDT
Room 1

Moderator and Organizer: Jin Yang, Intel Corporation

Dr. Jin Yang is currently senior staff R&D engineer/architect with Intel Corporation located in Oregon USA. He serves on the ASME EPPD Executive Committee and IEEE EPS BoG. He is an Associate Editor for the *ASME Journal of Electronic Packaging* (JEP). He once served as General Chair of ASME InterPACK2020 and Program Co-Chair of InterPACK2019. He received his PhD Degree from Georgia Tech. He has published over 30 peer-reviewed papers and has over 25 patents.

Presenters:
Abhijit Dasgupta, University of Maryland, State University of New York,
SB Park, State University of New York, (SUNY) Binghamton

Abstract: The Heterogeneous Integration Roadmap (HIR) is a roadmap to the future of electronics identifying technology requirements and potential solutions, in a post-Moore world. The primary objective is to stimulate pre-competitive global collaboration between industry, academia, and government to accelerate progress. The roadmap offers professionals, industry, academia, and research institutes a comprehensive, strategic forecast of technology over the next 15 years. The HIR also delivers a 25-year projection for heterogeneous integration of Emerging Research Devices and Emerging Research Materials with longer research-and-development timelines. The HIR is sponsored by three IEEE Societies (Electronics Packaging Society, Electron Devices Society, and Photonics Society) together with SEMI and ASME EPPD.

Abhijit Dasgupta. **University of Maryland**

Abhijit Dasgupta is Jeong H. Kim Professor of Mechanical Engineering at the University of Maryland (UMD), with research experience in the microscale and nanoscale mechanics and reliability physics of engineered materials used in conventional and additively manufactured 3D flexible electronic packaging and intelligent microsystems. He holds a Ph.D. in Theoretical and Applied Mechanics from the University of Illinois at Urbana-Champaign (UIUC) and has been a principal investigator at the Center for Advanced Life Cycle Engineering (CALCE) at UMD for over 30 years, conducting research in reliability physics, design for reliability, accelerated stress testing, and real-time health management. He has published over 300 articles and conference papers, served on editorial boards of three international archival journals, presented over 45 workshops and short courses, and helped form research and educational roadmaps for the electronics industry and provided consulting services to numerous industry leaders. He has presented numerous keynote talks at international conferences, received 6 best-paper awards and received 8 major awards in recognition of his research and educational contributions. He is an ASME Fellow; past Chair of the ASME Electronic and Photonic Packaging Division (EPPD); past member of the ASME Design, Manufacturing and Materials Segment Leadership Team (DMM-SLT); and Current Chair of Reliability Technology Working Group in the Heterogeneous Integration Roadmap (HIR) Team sponsored by IEEE/ASME/SEMI/IEPS/EDS.

SB Park, The State University of New York (SUNY) at Binghamton

Prof. Seungbae (SB) Park is a Professor of Mechanical engineering of the State University of New York at Binghamton. He is also the director of Integrated Electronics Engineering Center (IEEC), a New York State Center for Advanced Technology (CAT). He received his Ph.D. at Purdue University in 1994. Upon graduation, Dr. Park began his professional career at IBM. He was responsible for the reliability of IBM's corporate flip chip technology in both leaded and lead-free solders and high-performance packaging. Dr. SB Park started his academic career as a professor of mechanical engineering at the State University of New York at Binghamton in 2002. Professor Park is an expert in Modeling and Simulation for electronics components and systems integration. His contributions have been recognized many international awards and citations. He has contributed in various 2.5D/3D package development, MEMS packaging, reliability assessment of assemblies and systems, and smart electronics manufacturing. He has more than 200 technical publications and holds 4 US patents. Dr. Park served for several technical committees including a member of JEDEC 14-1 Reliability Committee, co-chair of iNEMI Modeling and Simulation TWG, chair of "Electronics Packaging" council in Society of Experimental Mechanics, and an associate editor for ASME Journal of Electronic Packaging. Professor Park has been helping consumer electronics and packaging companies such as Microsoft, Samsung, ASE, Xilinx, and Qualcomm, as a consultant.

Thermal Designs Using Vapor Chambers for Smartphones, Laptops, HPC, and Power Electronics

1:50PM–3:50PM PDT
Room 2

Moderator and Organizer: Y.C. Lee, Kelvin Thermal
Presenter Ryan J. Lewis, Kelvin Thermal

Abstract: This tutorial will teach engineers how to design thermal systems using vapor chambers. A vapor chamber is also known as a 2D heat pipe; it is becoming a common component used to enhance thermal management. The annual shipments of vapor chambers for smartphones and laptops will reach over 100M units per year soon. Driven by such an application, vapor chambers become thin, light and low-cost alternatives to heat pipes and graphite and metal heat spreaders. However, most of thermal engineers do not know how to design their thermal systems using vapor chambers. For example, a vapor chamber's performance can drop from 6,000 W/mK to 1,000 W/mK if its next cooling level is not arranged properly. In another case, a vapor chamber's mass can increase from 30 to 90 grams if the specifications are not defined correctly. This tutorial will review different features offered by current and future vapor chambers with our thermal ground planes (TGPs) as examples. These features are temperature uniformity, maximum power, thickness, size, flexibility, bendability, foldability, RF transparency, heat flux, and cost. In addition, we will illustrate several cases to gain an insight into a thermal design using vapor chambers for smartphones, laptops, high performance computing (HPC), power electronics, and other applications.

Y. C. Lee, **Kelvin Thermal**

Y. C. Lee is the President and CEO of Kelvin Thermal. Dr. Lee is recognized as a world leader in thermal management, packaging and interconnect technologies for microsystems integrating microelectronic, optoelectronic, microwave, microelectro-mechanical and nanoelectromechanical devices. He is an Emeritus Professor of Mechanical Engineering at the University of Colorado (CU) Boulder. At CU, he was the S. J. Archuleta Professor from 2011 to 2020 and the Director of DARPA Center on Nanoscale Science and Technology for Integrated Micro/Nano-Electromechanical Transducers (iMINT) from 2006 to 2012. Dr. Lee received the ASME InterPACK Achievement Award in 2013. He was the Editor of *ASME Journal of Electronic Packaging* from 2015 to 2020.

Ryan J. Lewis, Kelvin Thermal

Ryan J. Lewis is the Director of R&D in Kelvin Thermal. He is the lead inventor of major patents awarded to Kelvin Thermal for flexible thermal ground planes (TGPs). One of his notable accomplishments is the demonstration of the world's thinnest vapor chamber with a thickness of only 0.15mm in 2018. In addition, he demonstrated a feasible polymer TGP in 2015, which was further enhanced in 2020. In 2021, Dr. Lewis' team developed a high power TGP good for over 1,000 Watts and another novel foldable TGP proven reliable over 150,000 folding cycles with a bending radius of 3mm. Dr. Lewis has designed over 20 different TGPs for customers.

WEDNESDAY, OCTOBER 27

Additive Manufacturing and Topology Optimization Methods for Thermal Management

9:10AM–11:10AM PDT
Room 1

Moderator & Organizer: Adam Wilson, Army Research Laboratory
Organizer: Ron Warzoha, U.S. Naval Academy

Presenters:
Casper Andreasen (Technical University of Denmark)
Joe Alexandersen (Technical University of Denmark)

Abstract: This tutorial session will feature case studies that highlight the utility of topology optimization techniques in additively manufactured (AM) cooling solutions. The speakers will share basic optimization algorithms for passively and actively cooled heat sinks fabricated with AM. Finally, recent case studies will be used to highlight current progress and future trends in topology optimization. A corresponding discussion on the particular benefits of additive manufacturing for electronics cooling will take place at the end of the tutorial session.

Dr. Adam Willson, Army Research Laboratory

Dr. Adam A. Wilson is a research physicist in the Thermal Sciences and Engineering team at the U.S. Combat Capabilities Development Command Army Research Laboratory (ARL). His research focuses on exploring the extent to which thermal properties may be tailored and dynamically tuned in various material systems, such as shape memory alloys, intercalated transition metal dichalcogenides, doped polymers, nanostructured thermoelectric materials, and MEMS microstructures. During his postdoc at ARL, Adam served as the chair of the Postdoc Association and founded a working group for early career researchers at ARL, and is currently participating in an entrepreneurial leadership development program, co-leading a team that aims to improve cohesive career development in early to mid-career employees at ARL.

Ron Warzoha, United States Naval Academy

Ron Warzoha received his Ph.D. in Mechanical Engineering at Villanova University under the guidance of Dr. Amy Fleischer and is currently an Associate Professor at the United States Naval Academy. His technical areas of expertise are in nanoscale thermal transport, thermal metrology, electronics thermal management, microscopic energy carrier interactions and caloric refrigeration. He is the recipient of the U.S. Naval Academy Apgar Award for Excellence in Teaching (2019), has over 50 published papers, owns one patent, and has recently won a major DURIP award to develop advanced nanoscale thermal characterization systems in order to better understand energy carrier interactions in electronic materials exposed to extreme environments. He is also an Associate Editor for the *ASME Journal of Electronic Packaging*.

Casper Andreasen, Technical University of Denmark

Casper Schousboe Andreasen is an Associate Professor at the Technical University of Denmark, Department of Mechanical Engineering. He obtained his MSc (2008) and PhD (2011) from the same University with Professor Ole Sigmund as supervisor. His research interests are diverse covering both simulation of fluid flows, conjugate heat transfer, particle transport processes and tribology as well as the integration of the multiple physics in order to conduct topology and shape optimization. Currently he is scientific lead on a project named "Easy-E - Easy Energy Efficiency made Industry Available via Thermal Topology Optimisation" with industrial partners in the Danish industry.

Joe Alexandersen, University of Southern Denmark

Joe Alexandersen is an Assistant Professor at the University of Southern Denmark, Department of Mechanical and Electrical Engineering. He received his M.Sc. (2013) and Ph.D. (2016) degrees from the Technical University of Denmark. His research area is multiphysics simulation and optimisation, focused mainly on flow-based and heat transfer problems. His work has been internationally recognised by being awarded the 2015 ISSMO/Springer Prize for Young Scientists and the 2017 DTU Young Researcher Award.

Thermal Stress Failures in Electronic Packaging: Prediction and Prevention

1:50PM–3:50PM PDT
Room 1

Organizer & Presenter: Ephraim Suhir, Portland State University

Abstract: The tutorial addresses the causes of thermal stress failures an electronic and photonic packaging and the ways they could be predicted and possibly prevented. The emphasis is on the physics of failure, the roles of the predictive modeling (both analytical and FEA), and accelerated testing.

Here are the main topics addressed: Physics of Thermal Stress; Thermal Stress Types in Adhesively Bonded or Soldered Assemblies; Typical Thermal Stress Failures and What Could Be Done to Reduce the Thermal Stress; Soldered Assemblies with Low Yield Stress Bonding Layer; Global and Local Thermal Stresses and Their Interaction; Tri-Material Assemblies; Flip-Chip Solder Joint Assemblies and the Role of the Underfill; Assemblies with Low Modulus Bonding Material at the Assembly Ends; Accelerated Testing of Assemblies Experiencing Thermal Loading; Failure Oriented Accelerated Testing (FOAT) vs. Highly Accelerated Life Testing (HALT); Elevated Stand-Off Heights Could Relieve Thermal Stress in Solder Joints: Column-Grid-Array (CGA) vs. Ball-Grid-Array (BGA) Design; Thermal Stress in Thin Films; Thermal and Lattice Mismatch Stresses; Thermal Stress Induced Bow (Warpage) and Bow-Free Assemblies; In-homogeneously Bonded Assemblies: Could Inelastic Strain in Them be Avoided?; Thermal Stress in Optical Fibers; and Some Other Thermal Stress Related Problems in Electronic and Photonic Packaging.

Ephraim Suhir, **Portland State University**

Ephraim Suhir is on the faculty of the Portland State University, Portland, OR, USA, Technical University, Vienna, Austria, and James Cook University, Queensland, Australia. He is CEO of a SBIR ERS Co. in Los Altos, CA, USA; Foreign Full Member of the National Academy of Engineering, Ukraine (he was born in that country); Life Fellow of the ASME, IEEE, SPIE, and the IMAPS; Fellow of the American Physical Society (APS), the Institute of Physics (IoP), UK, and the Society of Plastics Engineers (SPE); and Associate Fellow of the AIAA. Ephraim has authored and co-authored about 500 publications, presented numerous keynotes and invited talks worldwide, and received many professional awards, including 1992 ASME Clock Award, 1996

Bell Labs Dist. Member of Technical Staff Award, 1997 ASME InterPACK'97 General Chair Award, 1999 ASME Charles Russ Richards Memorial Award, and 2004 ASME Worcester Read Warner Medal. He is the third "Russian American," after S. Timoshenko and I. Sikorsky, who received this prestigious award. His most recent awards are 2019 IEEE EPS Field Award and 2019 IMAPS Lifetime Achievement award.

Boned Interface Materials for High Temperature, Wide-Bandgap Power Electronic Devices

1:50PM–3:50PM PDT
Room 2

Organizer and Presenter: Paul Paret, National Renewable Energy Laboratory

Abstract: Wide-bandgap devices have pushed the operational limit of semiconductor devices in automotive power electronics packages to higher temperatures (>200°C). While a higher efficiency can be achieved through the use of wide-bandgap devices, the entire package must be re-designed with components that can withstand the higher temperature limits. Sintered silver and transient liquid phase bonds are potential candidates as bonded materials for use in higher temperatures however, the underlying mechanics of deformation under thermal loads and the resulting failure mechanisms in these materials are not well understood. Accelerated experiments conducted at NREL reveal that high-lead solder joints have better reliability than sintered silver under extreme thermal cycling conditions. Furthermore, efforts to develop a crack propagation model for the high-temperature materials are described.

Paul Paret, National Renewable Energy Laboratory

Paul Paret is a researcher in the Center for Integrated Mobility Sciences at the National Renewable Energy Laboratory. In this role, Paul leads the computational modeling efforts to simulate the thermal and thermomechanical behavior and develop lifetime prediction models of various bonded materials in power electronics packages used in electric-drive vehicles and aviation systems. He conducts design optimization studies to identify the optimal component layers and geometry within power electronics package topologies to improve their power density, efficiency, and reliability. Additionally, he performs mechanical characterization and reliability evaluation experiments to identify the fundamental failure mechanisms of materials under harsh operating conditions. Paul has published several articles including journals, conference papers, technical reports, and a book chapter on the thermomechanical performance and lifetime prediction models of power electronics materials. Paul has a master's degree in Aerospace Engineering Sciences from the University of Colorado, Boulder and a bachelor's degree in Mechanical Engineering from College of Engineering, Trivandrum, India.

THURSDAY, OCTOBER 28

Nanoscale Thermal Metrology for Solid Materials in Electronics Packaging

1:50PM–3:50PM PDT
Room 1

Moderator & Organizer: Jungwan Cho, **Sungkyunkwan University**

Organizer & Presenter: Ronald Warzoha, U.S. Naval Academy, University of Texas at Arlington

Presenters:
Ashutosh Girl, University of Rhode Island
Ankur Jain University of Texas at Arlington

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Jungwan Cho, **Sungkyunkwan University**

Jungwan Cho is an Assistant Professor of Mechanical Engineering at Sungkyunkwan University (SKKU), South Korea. He directs the Multi-Scale Heat Transfer Laboratory (mheat.skku.edu), which carries out experimental and theoretical research on electronics cooling, novel energy conversion, and thermal metrology development. A particular focus is on nanoscale heat transfer in advanced semiconductor thin films and at interfaces using cutting-edge thermal characterization methods, including an ultrafast photothermal method. He received his Ph.D. (2014) and M.S. (2010) in Mechanical Engineering from Stanford University, where he received the Samsung Scholarship.

Abstract: This tutorial will provide guidance on building and developing three state-of-the-art thermal characterization techniques in their most basic forms. These systems include time-domain thermoreflectance (TDTR), frequency-domain thermoreflectance (FDTR), and 3-ω. In addition to providing basic system details and subsequent analysis, presenters will also discuss best practices for optimizing measurements and briefly discuss modifications to each system that can extend their utility. These tutorials are intended to serve as resources for early-career graduate students, new laboratories, and scientists who wish to expand their current capabilities. The latter part of each talk will be useful to scientists already familiar with these techniques and who wish to discuss new developments in metrology.

Ron Warzoha, **United States Naval Academy**

Ron Warzoha received his Ph.D. in Mechanical Engineering at Villanova University under the guidance of Dr. Amy Fleischer and is currently an Associate Professor at the United States Naval Academy. His technical areas of expertise are in nanoscale thermal transport, thermal metrology, electronics thermal management, microscopic energy carrier interactions and caloric refrigeration. He is the recipient of the U.S. Naval Academy Apgar Award for Excellence in Teaching (2019), has over 50 published papers, owns one patent, and has recently won a major DURIP award to develop advanced nanoscale thermal characterization systems in order to better understand energy carrier interactions in electronic materials exposed to extreme environments. He is also an Associate Editor for the *ASME Journal of Electronic Packaging*.

Ashutosh Giri, **University of Rhode Island**

Ash Giri received his M.S. degree in Mechanical Engineering from University of Pittsburgh in 2012 and his Ph.D. from University of Virginia in 2016. Prior to joining URI as an Assistant Professor, he worked as a senior scientist at University of Virginia in the Mechanical and Aerospace Engineering Department focusing on developing a microscopic understanding of thermal transport at the nanoscale. His research interests are at the intersection of engineering, materials science, and physics where he specializes in understanding energy conversion, charge flow and photonic interactions with condensed matter, soft materials, liquids, and their interfaces. He has published over 70 peer-reviewed journal articles and has recently won the ONR Young Investigator Program award.

Ankur Jain, University of Texas at Arlington

Ankur Jain is an Associate Professor in the Mechanical and Aerospace Engineering Department at the University of Texas, Arlington. His research interests include heat transfer in Li-ion batteries, microscale thermal transport, additive manufacturing and applied mathematics. He has published 90 journal papers, and given 51 invited talks, seminars, and tutorials. He received the UT Arlington College of Engineering Lockheed Martin Excellence in Teaching Award (2018), UT Arlington College of Engineering Outstanding Early Career Award (2017), NSF CAREER Award (2016), and the ASME EPP Division Young Engineer of the Year Award (2013). He received his Ph.D. (2007) and M.S. (2003) in Mechanical Engineering from Stanford University, and B.Tech. (2001) in Mechanical Engineering from Indian Institute of Technology, Delhi with top honors.

WORKSHOPS

WEDNESDAY, OCTOBER 27

InterPACK 2021 Workshop: Introduction to Robotics, AI, and Intel's OpenVINO™ Toolkit
4:00PM–6:00PM PDT

Abstract: Have fun as you learn about virtual robotics using Coderz platform, AI using Jupyter notebooks & Intel's OpenVINO™ toolkit, with this introductory course. From understanding sensors to programming missions, this course will equip you with virtual coding experience in programing robots or drones and understanding AI. No robot required. No prior experience required. A laptop with internet access and Chrome browser will do. This course will also enable you to set up after-school robotics /AI clubs for your local community children. These lessons are taught by award winning teams from Education Empowers Inc. (501 (c) non-profit) as well as Intel Industry professionals.

Be the first 30 to register and receive an Intel Movidius Neural Compute Stick (NCS2, $70 value) and access to CoderZ for a year, from Education Empowers Inc. www.educationempowers.org

Presenters:
Stewart Christie (Intel Corporation)
Anna Prakash (Intel Corporation & Education Empowers Inc.)
Elaina Ashton (Arizona State University, Tempe, AZ, and Education Empowers Inc.)

Stewart Christie, Intel Corporation

Stewart Christie is an AI/IoT Evangelist in the Developer Enabling Team at Intel. His day job includes developing demos and teaching classes on AI Enhanced Computer Vision, primarily for use in the Retail and Hospitality industries, including remote management and digital signage use cases. Stewart is focused on the software side of the ecosystem, guiding developers building Inference at the Edge Applications in C/C++ and Python. He is an expert in the deployment of the Intel Distribution of OpenVINO™ Toolkit, and the vPRO/AMT software solutions. While not working at Intel, Stewart plays with cameras, and robots, and builds robots with cameras. For his dedication and community outreach, Stewart has received the prestigious Presidential Service Awards. You can follow Stewart on twitter @intel_stewart, and follow the robots on twitter@dalekleo

Anna Prakash, Intel Corporation & Education Empowers Inc.

Anna Prakash began her engineering career working on LCDs, HDTVs, and handheld communication devices. She joined Intel in 2004 as a Packaging R&D Engineer, focusing on automotive components, microLEDs, and Aurora super computers. Anna has several patents and papers covering sensors and semiconductor packaging materials and process. Outside of work, Anna is passionate about promoting STEM education for local children. Along with her daughter Elaina, she co-founded Education Empowers Inc., a non-profit, to promote STEM education. Anna is the recipient of the 2019 Intel Hero award, Society of Women Engineers "Prism Award," and the IEEE STEM outreach award for her contribution to technology and the community. You can follow Anna on Twitter @AnnaPrakashAZ.

Elaina Ashton, Arizona State University, Tempe, AZ, and Education Empowers Inc.

Elaina Ashton is an Electrical Engineering student at Arizona State University, Tempe, Arizona. Through Education Empowers Inc., she spends her weekends promoting robotics for girls and underserved children living in the Arizona community. For her dedication to STEM outreach, she received the Cox connect2STEM award, 18 under 18 award, and the Chandler Mayor's Youth of the Year award.

THURSDAY, OCTOBER 28

Career Development Workshop

9:10AM–10:40AM PDT
Room 1

Moderators & Organizers: Saket Karajgikar, Facebook, and Jimil M. Shah, TMGcore

Presenters:
Prof. Pradeep Lall, Auburn University
Prof. Amy Spencer Fleischer, California Polytechnic State University
Prof. Ankur Jain, The University of Texas at Arlington
Prof. Damena Agonafer, Washington University in St. Louis

Summary: Most of the time when a student embarks on his/her college journey, he or she has little guidance about how to navigate successfully through it. "Success" to students largely means achieving good grades in their curriculum, however, that is only a small aspect of a long tireless journey. It is journey that should start by understanding their interests, strengths, and ambitions—a journey where the student gains skills to contribute towards the greater good, towards his/her community. While gaining all the necessary skills, students also must learn how to make sound financial decisions which can have a significant impact on him/her years after he/she completes his/her education.

Our esteem panels will provide insight into some of the aspects mentioned before that will help students to make an educated decision on the available options. Panelists will shed some light on available resources at the university and most importantly how to learn from experience. This would help students to prepare themselves for their next step into the world commonly referred to as "Career." Panelists will cover the following questions, but are not limited to them, along with their own experiences:

1. Should I pursue a career in the field of my interest or an area that pays more? (It is a very tough question, and most of the time students do not have the maturity to answer it.)

2. How do students supplement their studies by adding courses or certificates to help strengthen their potential for employment in hot areas like AI?

3. Is it a good idea to work part-time while studying? If so, should you work for $10/hour in a lab or $15/hour in a fast-food restaurant?

4. Should I continue for Graduate school?

5. When do I start preparing for GRE?

6. How important is undergraduate research? Does it take away from studying or does it help maybe by bringing “senior design” type of experience early?

7. Post M.S. degree; job or Ph.D.?

8. Managing student loans? What is too much?

9. Brutality of taxes when you start earning (full time)

10. Should students request to have short training in investment? It could be in the graduate seminar series?

11. Pros and cons of an internship?

12. How important is it to attend conferences?

13. How important is it to publish as a graduate student? Suppose the sponsoring company prohibits the publication or slows it down to a trickle?

Saket Karajgikar, Facebook

Saket has experience in developing thermal solutions at both data center and at HW level. His early career at Future Facilities focused on assessing numerous data centers and providing recommendations to improve efficiency and reduce stranded capacity. Later at Hyve Solutions, he managed a team of thermal engineers while providing design inputs for compute and storage platforms. At Facebook, he is part of Strategic Engineering & Development team exploring advance technologies which are efficient and environmentally less disruptive. Before joining industry, he graduated from University of Texas at Arlington.

Jimil M. Shah, TMGcore

Dr. Jimil M. Shah is a Senior Director of Thermal Sciences at TMGcore. Before joining TMGcore, he was an Application Development Engineer for server liquid cooling of data centers at 3M Company. His research is in advanced cooling solutions for data center thermal management, focusing on single- and two-phase direct-to-chip and immersion cooling using dielectric fluids. Before joining 3M, Dr. Shah worked as a Post-Doctoral Research Associate at the University of Texas at Arlington. Dr. Shah received his Ph.D. in Mechanical Engineering from the University of Texas at Arlington in 2018 and is a professional member of IEEE, ASHRAE TC9.9, ASME, and OpenCompute. In InterPACK 2018, he received the “ASME Electronic and Photonic Packaging Division (EPPD) Student Engineer of The Year Award.” He has published 26 journal and conference papers with two additional journal papers under review.

Pradeep Lall, Auburn University

Pradeep Lall is the MacFarlane Endowed Distinguished Professor in the Department of Mechanical Engineering with a Courtesy Joint Appointment in the Department of Electrical and Computer Engineering and a Courtesy Joint Appointment in the Department of Finance. He serves on the Technical Council and is the Academic Co-Lead of the Asset Monitoring TWG of NextFlex Manufacturing Institute, and is Director of the NSF Center for Advanced Vehicle and Extreme Environment Electronics at Auburn University. He is author and co-author of 2-books, 14 book chapters, and over 700 journal and conference papers in the field of semiconductor packaging, electronics design, reliability, safety, energy efficiency, and survivability. Dr. Lall is a fellow of the ASME, a fellow of the IEEE, a fellow of the NextFlex National Manufacturing Institute, and a fellow of the Alabama Academy of Science. He is recipient of the IEEE Biedenbach Outstanding Engineering Educator Award, Auburn University Research Advisory Board's Advancement of Research and Scholarship Achievement Award, IEEE Sustained Outstanding Technical Contributions Award, NSF-IUCRC Association's Alex Schwarzkopf Award, Alabama Academy of Science Wright A Gardner Award, IEEE Exceptional Technical Achievement Award, ASME-EPPD Applied Mechanics Award, SMTA's Member of Technical Distinction Award, Auburn University's Creative Research and Scholarship Award, SEC Faculty Achievement Award, Samuel Ginn

College of Engineering Senior Faculty Research Award, Three-Motorola Outstanding Innovation Awards, Five-Motorola Engineering Awards, and over Forty Best-Paper Awards at national and international conferences. Dr. Lall has served in several distinguished roles at national and international level including serving as member of National Academies Committee on Electronic Vehicle Controls, Member of the IEEE Reliability Society AdCom, IEEE Reliability Society Representative on the IEEE-USA Government Relations Council for R&D Policy, Chair of Congress Steering Committee for the ASME Congress, Member of the technical committee of the European Simulation Conference EuroSIME, Associate Editor for the *IEEE Access Journal*, and Associate Editor for the *IEEE Transactions on Components and Packaging Technologies*. Dr. Lall is the founding faculty advisor for the SMTA student chapter at Auburn University and member of the editorial advisory board for *SMTA Journal*. He received the M.S. and Ph.D. degrees in Mechanical Engineering from the University of Maryland and the M.B.A. from the Kellogg School of Management at Northwestern University.

Amy Spencer Fleischer, California Polytechnic State University

Dr. Amy S. Fleischer is the Dean of Engineering at the California Polytechnic State University (Cal Poly) in San Luis Obispo, CA, a role she has held for three years. In this role she sets strategic direction for the college and oversees the operations of the nine departments, 14-degree programs, 220 FTE faculty, 55 staff, 6,000 students, and a $40M budget. She is a passionate advocate for Cal Poly's Learn by Doing approach to engineering education.

Before arriving in San Luis Obispo, Dean Fleischer was a Professor and Chair of the Mechanical Engineering Department and director of the National Science Foundation Research Center for Energy-Smart Electronic Systems at Villanova University. She was on the faculty at Villanova for 18 years. As an internationally recognized research expert in thermal management of electronics systems, she has led work on 42 research grants funded for a total of $7.4M and has published more than 90 peer-reviewed publications and two books.

Dean Fleischer is also active in leadership in the broader engineering community, and currently serves as the chair of ASME's Electronics and Photonics Packaging Division and on the Diversity and Inclusion Committee of ASEE's Engineering Dean's Council. She also co-chairs the CSU Engineering Dean's council. She is a fellow of ASME and has won numerous teaching and research awards.

Ankur Jain, The University of Texas at Arlington

Ankur Jain is an Associate Professor in the Mechanical and Aerospace Engineering Department at the University of Texas, Arlington. His research interests include heat transfer in Li-ion batteries, microscale thermal transport, additive manufacturing, and applied mathematics. He has published 90 journal papers, and given 51 invited talks, seminars, and tutorials. He received the UT Arlington College of Engineering Lockheed Martin Excellence in Teaching Award (2018), UT Arlington College of Engineering Outstanding Early Career Award (2017), NSF CAREER Award (2016), and the ASME EPP Division Young Engineer of the Year Award (2013). He received his Ph.D. (2007) and M.S. (2003) in Mechanical Engineering from Stanford University, and B.Tech. (2001) in Mechanical Engineering from Indian Institute of Technology, Delhi with top honors.

Damena Agonafer, Washington University in St. Louis

Damena Agonafer is an Assistant Professor in the Mechanical Engineering and Materials Science Department at Washington University. He is a faculty adviser at the Institute of Materials Science and Engineering and an advisor to the National Science of Black Engineers local WashU chapter. As a PhD candidate at the University of Illinois, Professor Agonafer was the recipient of the Alfred P. Sloan fellowship award. After his PhD, Damena joined Professor Ken Goodson's Nanoheat lab as a Postdoctoral Scholar in the Mechanical Engineering Department at Stanford University. Professor Agonafer's research interest is at the intersection of thermal-fluid sciences, electrokinetics and interfacial transport phenomena, and renewable energy. He is recipient of the Google Research Award, Sloan Research Fellowship Award, Cisco Research Award, NSF CAREER Award, and American Society of Mechanical Engineer's Early Career award. Most recently, he was awarded an STTR grant from the Office of Naval Research (ONR). He was one of 85 early-career engineers selected to attend the 2021 National Academy of Engineering's 26th annual U.S. Frontiers of Engineering symposium.

HIR Workshop – Part 1

9:10AM–10:40AM PDT
Room 2

Moderators: SB Park, State University of New York, Binghamton, Kaushik Mysore, AMD, Ravi Majahan, Intel Fellow

Organizer: **Darshan G. Pahinkar, Florida Institute of Technology (FIT)**

"Federal Incentives & Partnership with Academia & Industry to Strengthen U.S. Semiconductor Technology Leadership"

Presenters:
Bahgat Sammakia, Binghamton University
Ganesh Subbarayan, Purdue University
Kamal Sikka, IBM

Abstract: The supply chains need of US semiconductor manufacturing and advanced packaging is highlighted in President's Executive Order on strengthening America's Supply Chains in semiconductor manufacturing and advanced packaging (February 24, 2021). The recognition of supply chain challenges has resulted in the US Senate passing the USICA/CHIPS Act appropriating $52B for research and development in microelectronics and advanced packaging. Of the $52B, $2.5B has been allocated to NIST to create a National Advanced Packaging Manufacturing Program, including a Manufacturing USA Institute. This talk will briefly outline the opportunity for an academia-industry partnership to create a Manufacturing USA Institute dedicated to Advanced Packaging.

SB Park, The State University of New York (SUNY) at Binghamton

Prof. Seungbae (SB) Park is a Professor of Mechanical engineering of the State University of New York at Binghamton. He is also the director of Integrated Electronics Engineering Center (IEEC), a New York State Center for Advanced Technology (CAT). He received his Ph.D. at Purdue University in 1994. Upon graduation, Dr. Park began his professional career at IBM. He was responsible for the reliability of IBM's corporate flip chip technology in both leaded and lead-free solders and high-performance packaging. Dr. SB Park started his academic career as a professor of mechanical engineering at the State University of New York at Binghamton in 2002. Professor Park is an expert in Modeling and Simulation for electronics components and systems integration. His contributions have been recognized many international awards and citations. He has contributed in various 2.5D/3D package development, MEMS packaging, reliability assessment of assemblies and systems, and smart electronics manufacturing. He has more than 200 technical publications and holds 4 US patents. Dr. Park served for several technical committees including a member of JEDEC 14-1 Reliability Committee, co-chair of iNEMI Modeling and Simulation TWG, chair of "Electronics Packaging" council in Society of Experimental Mechanics, and an associate editor for ASME Journal of Electronic Packaging. Professor Park has been helping consumer electronics and packaging companies such as Microsoft, Samsung, ASE, Xilinx, and Qualcomm, as a consultant.

Kaushik Mysore, AMD

Kaushik Mysore is a Senior Member of Technical Staff at AMD where he supports promising packaging and thermal technologies to meet AMD's computing and graphics business needs. His responsibilities include qualifying AMD's products across Client, Enterprise, Server, Automotive & Semi-Custom Business Units. Some of his best works have been leading cross-functional teams to drive timely, cost-effective and innovative solutions to manufacturing challenges. Notably, he is the founding architect of AMD's cross-functional initiative Test-Package Interactions (TPI) to address quality, reliability and manufacturability of AMD's packaging and back-end test solutions. Kaushik holds a PhD from Purdue University where his research was at the intersection of CAD, Mechanics and Reliability.

Dr. Ravi Mahajan, Intel Fellow

Dr. Ravi Mahajan is an Intel Fellow and the Director of Pathfinding for Assembly and Packaging technologies for 7-nanometer (7nm) silicon and beyond in the Technology and Manufacturing Group at Intel Corporation. He is responsible for planning and carrying out multi-chip package pathfinding programs for the latest Intel process technologies. Ravi also represents Intel in academia through research advisory boards, conference leadership, and participation in various student initiatives. Ravi joined Intel in 1992 after earning a bachelor's degree from Bombay University, a master's degree from the University of Houston, and a Ph.D. from Lehigh University, all in mechanical engineering. His contributions during his Intel career have earned him numerous industry honors, including the SRC's 2015 Mahboob Khan Outstanding Industry Liaison Award, the 2016 THERMI Award from SEMITHERM, the 2016 Allan Kraus Thermal Management Medal & the 2018 InterPACK Achievement award from ASME, and IEEE 2019 "Outstanding Service and Leadership to the IEEE" Award for both the Phoenix Section & IEEE Region 6. He is an IEEE EPS Distinguished Lecturer. He is one of the founding editors for the *Intel Assembly and Test Technology Journal* (IATTJ) and currently VP of Publications & Managing Editor-in-Chief of the IEEE Transactions of the CPMT. Additionally, he has been long associated with ASME's InterPACK conference and was Conference Co-Chair of the 2017 Conference. Ravi is a Fellow of two leading societies, ASME and IEEE. He was named an Intel Fellow in 2017.

Darshan G. Pahinkar, Florida Institute of Technology (FIT)

Darshan is the principal investigator of AETL and an Assistant Professor in Mechanical and Civil Engineering Department at Florida Tech. Prior to joining Florida Tech, he was a post-doctoral fellow in Mechanical Engineering at Georgia Institute of Technology and led research in the area of interface materials for electronic packaging and materials of neuromorphic computing. He received his PhD from Georgia Tech in Fall 2016 specializing in gas separation systems. He received his B.E. in Mechanical Engineering, from Government College of Engineering, Pune India in 2006 and his M.E. in Mechanical Engineering from the Indian Institute of Science, Bangalore, India in 2009 with focus on Thermal and Fluids. He was a manager (Development) in Tata Motors Engineering Research Center, Pune between 2009 and 2011.

Bahgat Sammakia, SUNY Binghamton

Bahgat Sammakia, a SUNY distinguished professor of mechanical engineering, is the vice president for research at Binghamton University, the State University of New York. He is the founding director of S3IP, a New York State Center of Excellence at Binghamton University, the center director of the Energy Efficient Electronic Systems Center, an NSF IUCRC founded in 2011 with a focus on reducing the energy consumed by data centers around the world and the director of the Center for Heterogeneous Integration Research in Packaging (CHIRP) at Binghamton 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 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/project manager and lab director at Endicott location, Sammakia joined Binghamton’s faculty in 1998.

Ganesh Subbarayan, Purdue University

Ganesh Subbarayan is a Professor of Mechanical Engineering at Purdue University and the Co-Director of the Purdue-Binghamton SRC Center for Heterogeneous Integration Research in Packaging (CHIRP). He began his professional career at IBM Corporation (1990-1993). He holds a B.Tech degree in Mechanical Engineering (1985) from the Indian Institute of Technology, Madras and a Direct Ph. D. (1991) in Mechanical Engineering from Cornell University. Dr. Subbarayan's research is broadly concerned with modeling and experimentally characterizing failure in microelectronic devices and assemblies. He was a pioneer in using geometric models directly for analysis, popularly referred to as Isogeometric Analysis. As an independent consultant, he contributed to ensuring reliable designs of Microsoft Kinect and Surface line of products. Among others, Dr. Subbarayan is a recipient of the 2005 Mechanics Award from the ASME EPP Division and the NSF CAREER award. He is a Fellow of ASME as well as IEEE, and he served as the Editor-in-Chief of IEEE Transactions on Advanced Packaging during 2002-2010.

Dr. Kamal Sikka, IBM

Dr Kamal Sikka is a Senior Technical Staff Member at IBM. He joined IBM after obtaining a PhD degree from Cornell University. His initial work at IBM Systems focused on thermal solution development and modeling and simulation for IBM servers. Kamal then transitioned from IBM Systems to IBM Research initiating the Heterogeneous Integration (HI) effort and defining the HI research strategy. He has led the establishment of the HI Lab at Albany NY. He is also the technical leader for the IBM Direct Bonded Heterogeneous Integration (DBHi) Si-bridge and stacked Si-microcooler technologies.

"Future Vision of Electronic Packaging"

Abstract: A discussion outlining a possible future of electronics packaging with a specific interest in the design challenges of these devices.

Bryan Black, AMD

Bryan Black received his Ph.D. in Electrical and Computer Engineering from Carnegie Mellon. With more than 30 years of experience, Black has had the honor of working at Motorola, Intel, and AMD. He has done a little of everything from devices to circuits to microarchitecture to DRAM to packaging, test, and manufacturing. Currently Black is a Senior AMD Fellow responsible for AMD advanced graphics memory systems and packaging solutions. In 2015 AMD introduced its first die stacked products integrating High Bandwidth Memory (HBM) on an interposer, the AMD Radeon™ R9 Fury family of graphics products, making Black the creator of HBM and a leader in Die Stacking in the industry. This work laid the technology foundation of the AI industry as we know it today.

K-16 Mentoring Workshop

10:50AM–12:20PM PDT
Room 1

Moderators: Dr. Luca Amalfi, Dr. Ash Giri
Organizers: **Ron Warzoha, Darshan G. Pahinkar, Luca Amalfi, and Ashutosh Giri**

Presenters:
Dr. Lucas Lindsay, Oak Ridge National Laboratory
Dr. Naveenan Thiagarajan, GE Global Research
Dr. Adam Wilson, U.S. Army Research Laboratory
Dr. Yoonjin Won, University of California, Irvine

Summary: This workshop, sponsored by the ASME K-16 committee, focuses on providing a common platform for those seeking career advice, including issues related to promotion, career changes, networking, and any other pertinent concerns outside their everyday contact circle without any obligation. A new Slack channel will be used for communication between junior and senior scientists for career advice and an informal mentor-mentee network once the workshop has ended. This mentoring activity is designed to provide mentees with a perspective of their progress from an outsider's view.

In this workshop, four mid-career scientists and faculty will share their own mentorship experiences with attendees, detailing how timely and constructive advice from mentors and peers helped them to succeed in their short-term and long-term career goals, reiterating the necessity and availability of a mentoring platform for everyone that can benefit the wider community of engineers. This will be followed by the agenda and roadmap description for this mentoring exercise. The workshop will conclude with the question-and-answer session.

Lucas Lindsay, Oak Ridge National Laboratory

Dr. Lucas Lindsay received a BS degree in physics from the College of Charleston in 2004. He did his PhD work on theoretical thermal transport in carbon nanostructures at Boston College and received his PhD in 2010. Following this he taught physics for two years at Christopher Newport University, then spent three years as a National Research Council Postdoctoral Fellow at the U.S. Naval Research Laboratory in Washington, D.C. He has been a research scientist in the Materials Science and Technology Division at Oak Ridge National Laboratory since 2014. He received the Department of Energy Early Career Award in 2019. His general research area is the theoretical description of vibrational and transport properties of condensed matter.

Naveenan Thiagarajan, GE Global Research

Dr. Naveenan Thiagarajan is a lead research engineer at GE Research in Niskayuna, New York. Before starting this role at GE Research in 2013, he received his MS and PhD in Mechanical Engineering at Auburn University, Alabama, where he focused on the development of phase change liquid cooling techniques for high power electronics in terrestrial and micro-gravity environments, supported by grants from NASA and NSF. In his current role at GE, he has led multiple internal programs developing novel thermal management technologies to enable next generation of electrical/electronic systems used in aviation, healthcare, and recently, renewable energy systems such as wind turbines and energy storage. Dr. Thiagarajan holds more than 20 granted and pending patent applications along with more than 20 peer-reviewed publications in the field of electronics and electric machines thermal management. He is the recipient of GE Whitney awards in ’15 and ’18 awarded for outstanding technical achievement.

Adam Wilson, U.S. Army Research Laboratory

Dr. Adam A. Wilson is a research physicist in the Thermal Sciences and Engineering team at the U.S. Combat Capabilities Development Command Army Research Laboratory (ARL). His research focuses on exploring the extent to which thermal properties may be tailored and dynamically tuned in various material systems, such as shape memory alloys, intercalated transition metal dichalcogenides, doped polymers, nanostructured thermoelectric materials, and MEMS microstructures. During his postdoc at ARL, Adam served as the chair of the Postdoc Association and founded a working group for early career researchers at ARL and is currently participating in an entrepreneurial leadership development program, co-leading a team that aims to improve cohesive career development in early to mid-career employees at ARL.

Yoonjin Won, University of California, Irvine

Dr. Won's overarching research goal is to gain fundamental insights into nanoscale phase change and interfacial principles, centering on keywords—machine vision, machine learning models, data-driven analysis, and materials design approach. The research efforts aim to bring transformational efficiency enhancements in energy, water, manufacturing processes, and electronics cooling by fundamentally manipulating liquid-solid-vapor interactions and transport phenomena across multiple length and time scales. Dr. Won is recognized with an NSF CAREER in 2018 and has also received several awards including the ASME EPPD Early Career Award 2018, The Emerging Innovation/Early Career Innovator of the Year 2020 from UCI Beall Innovation Center, ASME EPPD Women Engineer Award 2020, ASME ICNMM Outstanding Leadership Award 2019, UCI Samueli Career Development Fellowship, and numerous best paper and poster awards. The key papers are published in high impact journals including *Small*, *Proceedings of National Academy of Science (PNAS)*, *Advanced Functional Materials*, and American Chemical Society (ACS). Additional details for Dr. Won’s qualifications and research group are available online (won.eng.uci.edu).

HIR Workshop - Part 2

10:50AM–12:20PM PDT
Room 2

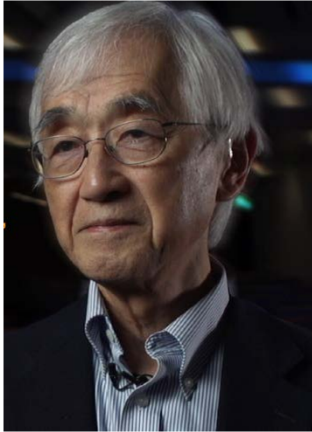
Moderators: SB Park, State University of New York, Binghamton, Kaushik Mysore, AMD, Ravi Mahajan, Intel Fellow

Organizers: William Chen, ASEUS, William Bottoms, 3MTS

Presenters:
William Chen, ASEUS
William Bottoms, 3MTS
Timothy Lee, Boeing
E. Jan Vardaman, TechSearch International, Inc.
Thomas Kazior, DARPA
Richard Otte, PROMEX Industries, Inc.
Tom Salmon, SEMI
Tim Green, Semiconductor Research Corporation
Jason G. Milne, Raytheon Technologies

"Heterogeneous Integration Roadmap: Drivers & Ramifications of Strengthening US Semiconductor R&D, Manufacturing Ecosystem & Industrial Base"

Abstract: This is a broad-based panel discussion bringing to focus US National Policy to build resilient Supply Chains and strengthening US Semiconductor Research & Manufacturing Ecosystem. The discussions will underscore strategic impact of such policy changes to the Heterogeneous Integration Roadmap, and will also cover how this might possibly shape opportunities for pre-competitive collaborations with industry, academia and government.



William Chen, ASEUS

William Chen (Bill) holds the position of ASE Fellow & Senior Technical Advisor at ASE Group. Prior to joining the ASE, he was Director at the Institute of Materials Research & Engineering (IMRE) in Singapore, following a distinguished career at IBM Corporation. Bill is a past President of the IEEE Electronics Packaging Society. He has been elected a Life Fellow of IEEE and a Fellow of ASME. In 2018, he received the IEEE Electronics Packaging Field Award, recognizing his contribution to electronic packaging, from research & development through industrialization.

Bill chairs the Heterogeneous Integration Roadmap initiative, Co-sponsored by three IEEE Societies (EPS, EDS & Photonics) together with SEMI & ASME EPPD.

William Bottoms, 3MTS

Dr. W. R. “Bill” Bottoms, the holder of a Ph.D. from Tulane University, has an extensive background in academia, venture funding, and in the commercial semiconductor equipment sector. Since founding 3MTS in 1999, Bill Bottoms has provided strategic leadership and vision in keeping with the promise of the 3MTS business model. Dr. Bottoms has also served on a number of important government and industry committees and advisory positions. Key posts include chairmanship of the subcommittee of the Technical Advisory Committee of the United States Commerce Department’s Export Control Commission for Semiconductor Equipment and Materials. Shortly after receiving his doctorate in physics, Dr. Bottoms joined the electrical engineering faculty of Princeton University, where he remained until 1976. He then joined Varian Associates in Palo Alto, as manager of research and development, and he was later named president of Varian’s newly formed semiconductor equipment group. After leaving Varian, he was senior vice president and general partner at Patricof & Co. Ventures, Inc., an international venture capital firm. He founded Third Millennium Test Solutions in March 1999.

Timothy Lee, Boeing

Timothy Lee is a Subject Matter Export in the field of Advanced Communication Networks in the area of wireless communications and technologies. He is currently a Boeing Technical Fellow, based on Huntington Beach, CA and leading R&D of advanced microelectronics for compute, communications, and sensing applications including airborne, ground, and space platforms. He has over 35 years of experience in the area of microwave device technology, microwave circuit design, and hardware development for aerospace applications. He is active in the IEEE activities that promote the use of technology that benefits humanity, and he have served in multiple roles. He is currently on the IEEE Board of Directors, serving as the Director for Region 6 (Western US). He is a recognized technical leader in technology roadmap development for the IEEE. In the IEEE Electronics Packaging Society, he serves as the Co-Chair of the IEEE Heterogenous Integration Roadmap (HIR)[1] Technical Working Group on 5G and on Aerospace/Defense and for millimeter-waves. He is currently serving as the Co-Chair of the IEEE Future Networks Initiative[2] (FNI), which is fostering the development of a technical community of interest for next generation wireless networks including 5G and beyond. A significant product that FNI has delivered to the technical community is the International Networks Generation Roadmap (INGR), which covers the entire communication stack from devices, circuits, modules, sub-systems, connectivity, cyber-security, deployment, and standards. The INGR covers 5G and 6G technologies, challenges, and projects needed solutions for 3-, 5-, and 10-year horizons. In the INGR, Tim leads the Technical Working Group (TWG) for Millimeter-waves and Signal Processing for technology assessment, challenges, and solutions for hardware, semiconductors, packaging, and integration methods that would support a rapid transition from research labs into high volume manufacturing. He was the General Chair of the IEEE 2020 International Microwave Symposium (https://ims-ieee.org), which is the flagship Conference/Exhibition for the microwave industry. In 2015, he served as the President of the IEEE Microwave Theory and Techniques Society (MTT-S), which is the technical home for all microwave engineer students and professionals.

[1]IEEE Heterogenous Integration Roadmap, online at https://eps.ieee.org/technology/heterogeneous-integration-roadmap/2020-edition.html

[2]IEEE Future Networks Initiative, online at https://futurenetworks.ieee.org/roadmap

E. Jan Vardaman, TechSearch International, Inc.

E. Jan Vardaman is president and founder of TechSearch International, Inc., which has provided market research and technology trend analysis in semiconductor packaging since 1987. She is the author of numerous publications on emerging trends in semiconductor packaging and assembly. She is a senior member of IEEE EPS and an IEEE EPS Distinguished Lecturer. She received the IMAPS GBC Partnership award in 2012, the Daniel C. Hughes, Jr. Memorial Award in 2018, the Sidney J. Stein International Award in 2019, and she is an IMAPS Fellow. She is a member of MEPTEC, SMTA, and SEMI. Before founding TechSearch International, she served on the corporate staff of Microelectronics and Computer Technology Corporation (MCC), the electronics industry's first pre-competitive research consortium.

Thomas Kazior, DARPA

Dr. Thomas E. Kazior joined DARPA in July 2020 as a program manager in the Microsystems Technology Office (MTO). His research interests include semiconductor material and device design, fabrication, and integration processes including 3D heterogeneous integration (HI) of silicon and compound semiconductor and other non-silicon devices for RF arrays, and microwave/millimeter-wave/sub-millimeter-wave devices for sensors and communications. Kazior received his Doctor of Philosophy degree in material science and engineering, specializing in electronic materials, from the Massachusetts Institute of Technology. Prior to joining DARPA, he was a senior principal fellow at Raytheon Company's Integrated Defense Systems. Kazior has co-authored more than 100 publications, contributed and invited conference papers, and a book chapter on compound semiconductor and heterogeneous integration technology. He also has more than 20 patents in semiconductor fabrication technology. Kazior participated in the International Technology Roadmap for Semiconductors (ITRS), co-authoring the analog mixed signal chapter. He is an IEEE fellow.

Richard Otte, Promex Industries, Inc.

Richard Otte has been President & CEO of PROMEX Industries, Inc., since 1995. PROMEX is an ISO 9001:2008, ISO 1348:2003, and ITAR registered manufacturing services provider specializing in onshore heterogeneous assembly of medical, biotech, and semiconductor products in its facilities in Santa Clara and Escondido, California. Prior to that he was the General Manager of AMP's Kaptron Passive Fiber Optic Products Subsidiary in Palo Alto. Prior to that he was President of Advanced Packaging Systems, a Raychem-Corning Joint Venture, and with other Raychem business units for 20+ years where he filled various positions, many related to product development for the electronics industry. Early in his career, Otte was an electronics engineer. He is a member of the IEEE, IPC, OSA, SMTA, and MEPTEC. He has a BSEE and an MSEE from MIT and an MBA from Harvard University.

Tom Salmon, Calloborative Technology Platforms

As Vice President of Collaborative Technology Platforms, Tom Salmon works with SEMI's staff to ensure that members, standards users, and volunteers worldwide receive maximum value from their association with SEMI. Additionally, he manages a number of SEMI's business and technology communities, including SEMI's Smart Manufacturing initiative, the Electronic Materials Group (EMG), Advanced Packaging, and Semiconductor Components, Instrumentation & Subsystems (SCIS), and Collaborative Alliance of Semiconductor Test (CAST) groups. Before joining SEMI, he held several management positions in manufacturing, logistics, customer relations, and sales. Salmon is a member of the Heterogeneous Integration Roadmap Committee, the IEEE, and the American Society of Association Executives, and holds a BA from the University of Minnesota and a Level One Proficiency Certificate from Japan's Ministry of Education.

Tim Green, Semiconductor Research Corporation

Tim Green is the Director of Innovative Research at SRC. Tim and his team are working to advance Information and Communications Technology through large-scale public/private academic research initiatives like JUMP (Joint University Microelectronics Program) and nCORE (Nanoelectronics Computing Research).

Previously, Tim led R&D teams for Cray and IBM. His groups delivered the first AI and Analytics platforms for Cray's exascale HPC systems. At IBM, his teams worked with customers and industry leaders to create SFF-8639 and NVMe, and pioneered high-performance, enterprise-level persistent storage and composable infrastructure for x86 servers and Storage. They also delivered the first IBM FlashSystems arrays, and helped to usher in the spectrum storage era.

Currently, Tim and SRC are working to bring together Industry, Defense, and Academic thought leaders to lay the scientific groundwork for future research that supports the SRC Decadal Plan call to action, and addresses technology needs for 2030 and beyond

Jason G. Milne, Raytheon Technologies

Jason G. Milne is an Engineering Fellow and Program Manager at Raytheon Intelligence & Space in El Segundo, CA. He has 21 years of experience in microelectronics packaging and is a subject matter expert in Raytheon for 3DHI and thermal packaging technology. He is the Raytheon TA2 technical lead for DARPA MTO's MIDAS program and was a performer on several recent DARPA MTO efforts (T-MUSIC, ICE Cool). He is a graduate of Harvey Mudd College and holds 15 domestic and international patents in the area of RF electronics, advanced packaging, thermal solutions, and phased array design architectures.

AWARDS

Wednesday, October 27

Avram Bar Cohen Memorial Award Presentation by Ricky Lee

12:20PM–1:50PM PDT
Room 1

Chair: Baris Dogruoz, Maxar Technologies

The prestigious Avram Bar-Cohen Memorial Award (formerly InterPACK Achievement Award) has been given to

exceptional candidates who must have demonstrated scientific and technical leadership, excellence and international recognition in the areas of research and development related to electronic packaging and had a high level of service accomplishments to the technical community at large.

Thursday, October 28

Award Ceremony

12:20PM–1:50PM PDT

Allan Kraus Thermal Management Medalist

Chair: Dereje Agonafer, University of Texas at Arlington

Other Awards Ceremony: Intel Best Paper Award

Chair: Baris Dogruoz, Maxar Technologies

POSTER PRESENTATONS

Tuesday, October 26

4:00 PM – 6:00 PM PDT
Gather Town (Link can be found in the Poster Session of the Virtual Platform)

THERMAL MANAGEMENT (POSTERS 1–9)

No.	Submission Code	Submission Name	Author First Name	Author Last Name
1	74166	Cooling of High Powered GPUS Using Liquid Nitrogen Cold Plates Made With Additive Manufacturing	Alec	Nordlund
2	74103	The Effect of Heterogeneous Temperature on Lithium-Based Batteries	Yangying	Zhu
3	76964	Characterization of Linear Viscoelasticity Evolution of Epoxy Molding Compound Subjected to High Temperature Long Term Aging	Yunli	Zhang
4	76974	The Dynamics of Flow Through Porous Media for Application in Heat Pipe and Vapor Chamber	Binjian	Ma
5	77025	Pumping Power Saving for Rack Level Dynamic Direct to Chip Liquid Cooling Using Novel Flow Control Device and Control Strategy	Pardeep	Shahi
6	77027	Thermal Performance Studies of a Single-Phase Immersion Cooled 3rd Generation Open Compute Server Using Immersion Cooling Fluid/Alumina Nanofluid Through CFD Techniques	Prajwal	Murthy
7	77075	Thermal Design Analysis of Server Chassis Manifolds for Liquid Cooled Servers Using CFD	Kaustubh	Adsul
8	77722	Predicting Anisotropic Thermophysical Properties and Heat Generation Rates in Cylindrical Lithium-Ion Batteries	Camilo	Escobar
9	77727	Thermal Characterization Approach for In Situ Estimation of Thermophysical Properties of an Inductor-Transformer Assembly Within an Offboard Electric Vehicle Faster Charger	Omri	Tayyara

THERMAL MANAGEMENT (POSTERS 10–15)

No.	Submission Code	Submission Name	Author First Name	Author Last Name
10	77673	Design and Fabrication of a Bioinspired Evaporative Microcooler With an Array of Hollow Micropillar Structures	Quan	Chau
11	77743	Cooling Performance of a Combined Microporous Wick and 3D Manifold µ-Cooler Under Uniform and Locally Varying Heat Dissipation via Thermal-Fluidic Coupled Simulations	Qianying	Wu
12	77739	Numerical Modeling of Thin Film Evaporation in Wicking Structures	Yimin	Zhou
13	77771	Machine Learning for Enhanced Reliability in Thermal Energy Storage Using Phase Change Materials	Debjyoti	Banerjee
14	77737	Enhanced Data Center Efficiency Using a Novel Two-Phase Heat Sink	Suhas Rao	Tamvada
15	77676	Design and Optimization Guidelines for Micropillar Structures for Enhanced Evaporative Cooling	Kidus	Guye

MECHANICS AND RELIABILITY (POSTERS 21–29)

No.	Submission Code	Submission Name	Author First Name	Author Last Name
21	75887	High Strain Rate Mechanical Properties of SAC-Q Solder at Extreme Surrounding Temperatures for up to 180 Days of Isothermal Aging	Vishal	Mehta
22	76621	Interfacial Fracture of Epoxy-PCH Interface Under Four Point Bend Loading With Long Term High Temperature Storage	Aathi Raja Ram	Pandurangan
23	76622	High Strain Rate Material Characterization of Leadfree Sac Solder Alloys at Low Testing Temperatures After Prolonged Storage	Vikas	Yadav
24	76625	Evaluation of High and Low Temperature High Strain Rate Mechanical Properties for Doped Solder Sac-R After Exposure to Isothermal Aging of 50°C up to 240 Days	Mrinmoy	Saha
25	76626	Effect of Fold Diameter on State of Health Degradation of Li-Ion Batteries Subjected to U-Flex-to-Install and Dynamic U-Fold Testing	Ved	Soni
26	76627	Interaction of Process Parameter and Surface Preparation on the Interface Strength of Flexible Encapsulation in FHE Applications	Padmanava	Choudhury
27	76663	RUL Estimations of Sac305, Sac105, and SNPB Solders Under Combined Conditions of Temperature and Vibration Loads Using LSTM-Deep Learning Technique	Tony	Thomas
28	76965	Evolution of Prony Parameters for Underfills Subjected to High Temperature Long Term Aging	Yunli	Zhang
29	77026	Design, Development, and Characterization of a Flow Control Device for Dynamic Cooling Liquid-Cooled Servers	Pardeep	Shahi

MECHANICS AND RELIABILITY (POSTERS 30–35)

No.	Submission Code	Submission Name	Author First Name	Author Last Name
30	77796	Exploration of Multi-Physics Design Trade-Offs in a Multi-Chip Sic Mosfet Module With Integrated Cooling	Ahmet Mete	Muslu
31	76629	Surface-Mount Component Attachment Using Electrically Conductive Adhesive and Low-Temperature Solder Material for Multilayer Flexible Circuit Development	Jinesh	Narangaparambil
32	77732	The Impact of Various Test Conditions on Rth,jc Measurement	Jack	Knoll
33	76633	Studies on Reliability of Flexible Batteries Under Various Flexing Conditions	Hyesoo	Jang
34	74079	Process Property Relationships of Inkjet Printed Copper on Flexible Substrate	Kartik	Goyal
35	77013	Estimation of Solder Joint Fatigue Life For Photonic Package	Ojas	Tyagi

TRACK CHAIRS

Track	Track Name	Role	Name
1	Heterogeneous Integration:	Track Chair	Gamal Ahmad Refai
		Track Co-Chair	Amenie Abdelmessih
		Track Co-Chair	Jin Yang
		Track Co-Chair	Tim Chainer
2	Servers of the Future, and Edge to Cloud:	Track Chair	Saket Karjgikar
		Track Co-Chair	Chen Cheng
		Track Co-Chair	Pritish Parida
3	Flexible and Wearable Electronics:	Track Chair	Winston Zhang
		Track Co-Chair	Nazli Donmezer
		Track Co-Chair	Benjamin Leever
5	Power Electronics:	Track Chair	Gilbert Moreno
		Track Co-Chair	Michael Fish
		Track Co-Chair	Fang Luo
6	Multiscale Heat Transfer in Optics and Energy Systems	Track Chair	Ron Warzoha
		Track Co-Chair	Anil Yuksel
		Track Co-Chair	Jungwan Cho
		Track Co-Chair	Nenad Milkovic
7	Autonomous, Hybrid, and Electric Vehicles	Track Chair	Fabian Welschinger
		Track Co-Chair	David Huitink
		Track Co-Chair	Klas Brinkfeldt
8	Reliability of Electronic Packages and Systems:	Track Chair	Patrick McCluskey
		Track Co-Chair	Sven Rzepka
9	Nano-scale Thermal Transport and Materials:	Track Chair	Yoonjin Won
		Track Co-Chair	Jorge Padilla
		Track Co-Chair	Yegan Erdem
10	Poster	Track Chair	Solomon Adera
		Track Co-Chair	Leila Choobineh
		Track Co-Chair	Mahsa Ebrahim
11	Keynotes, Workshops, Panels	Track Chair	Jimil Shah
		Track Co-Chair	Victor Chiriac

TECHNICAL SESSIONS

Session 01-01 - Heterogeneous Integration of Electronic Packages

Epoxy Die Attach Combined With Face-Up Die Bonding for Improved XYZ Placement Accuracy
Technical Paper Publication: InterPack2021-69495
Tadeh Avanessian - Keysight Technologies, Inc.
Jim Clatterbaugh - Keysight Technologies, Inc.
Robin Zinsmaster - Keysight Technologies, Inc.
Leyla Hashemi - Keysight Technologies, Inc.

Efficient Thermal Analysis of Lab-Grown Diamond Heat Spreaders
Technical Paper Publication: InterPack2021-73017
Zihao Yuan - Boston University
Tao Zhang - Boston University
Jeroen Van Duren - Diamond Foundry
Ayse K. Coskun - Boston University

Ultra-High-Density Interconnect Enabled by Hybrid Bonding for Heterogeneous Integration: Interfacial Characteristics
Technical Paper Publication: InterPack2021-73314
Mei-Chien Lu - Monte Rosa Technology

Session 02-01 - Data Center II

Electrical Performances of Package Layout for High Speed Networking and Cloud Computing Application
Technical Paper Publication: InterPack2021-66660
Ming-Han Zhuang - Siliconware Precision Industries Co. Ltd.
Teny Shih - Siliconware Precision Industries Co. Ltd.
David Lai - Siliconware Precision Industries Co. Ltd.
Yu-Po Wang - Siliconware Precision Industries Co. Ltd.

Measuring the Thermal Contact Resistance Between Cu Foams and Substrates for Direct Contact Cooling Applications in Data Centers
Technical Paper Publication: InterPack2021-73015
Lucas Arrivo - Villanova University
Steven Schon - QuantaCool Corporation
Aaron P. Wemhoff - Villanova University

BER Illusion Methodology: A Novel, Open Sourced and Scalable Approach to Troubleshooting High Radix Photonics Interconnects in a Modern Hyperscale Datacenter
Technical Paper Publication: InterPack2021-73253
Shreyas Rao - Facebook Inc.
Dharmesh Jani - Facebook Inc.
Abhijit Chakravarty - Facebook Inc.

Next Generation Data Centers Two-Phase Cooler With 700 W/cm^2 Maximum Heat Flux
Technical Presentation Only: InterPack2021-77002
Suhas Rao Tamvada - University of Florida
Morteza Alipanah - University of Florida
Saeed Moghaddam - University of Florida
Suhas Tamvada - University of Illinois at Chicago

Machine Learning-Based Model for Optimal Operating Conditions of Thermosyphons for Electronic Cooling Applications
Technical Paper Publication: InterPack2021-72618
John Kim - Nokia Bell Labs
Raffaele L. Amalfi - Nokia Bell Labs

Session 02-02 Data Center I

Annular Liquid Film Development and Thermohydraulic Behavior in Microchannels,
Technical Presentation Only: InterPack2021-77048
Adam Kriz - University of Florida
Meisam Habibi Matin - University of Florida
Saeed Moghaddam - University of Florida

Experimental Characterization of Heat Pipe Recovery From a Power-Burst-Induced Dryout,
Technical Presentation Only: InterPack2021-76983
Justin Weibel - Purdue University
Suresh Garimella - Purdue University
Kalind Baraya - Purdue University

A Multiscale Evaporator for Enhancing the Thermal Performance of the Ultrathin Vapor Chamber
Technical Presentation Only: InterPack2021-74017
Yinchuang Yang - The Hong Kong University of Science and Technology
Jian Li - The Hong Kong University of Science and Technology
Dong Liao - The Hong Kong University of Science and Technology
Xin Ye - The Hong Kong University of Science and Technology
Huihe Qiu - The Hong Kong University of Science and Technology

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Session 02-03 - Microchannel and Two-Phase Cooling

Optimizing Closed-Loop Liquid Cooling Solution for Extreme High Power Multi-Packages
Technical Paper Publication: InterPack2021-73954
Arunima Panigrahy - Intel Corp.
Prabhakar Subrahmanyam - Intel Corp.
Ying-Feng Pang - Intel Corp.
Ridvan Sahan - Intel Corp.
Amy Xia - Intel Corp.

Thermal-Hydraulic Analytical Models of Split-Flow Microchannel Liquid-Cooled Cold Plates With Flow Impingement
Technical Paper Publication: InterPack2021-73283
Deogratius Kisitu - Villanova University
Alfonso Ortega - Villanova University

A Novel Concept for Air Removal in Two-Phase Immersion Cooling Systems
Technical Paper Publication: InterPack2021-72682
Eric Peterson - Microsoft Corp.
Seth Morris - D2H Advanced Technologies
Husam Alissa - Microsoft Corp.
Nicholas Keehn - Microsoft Corp.
Bharath Ramakrishnan - Microsoft Corp.
Vaidehi Oruganti - Microsoft Corp.
Ioannis Manousakis - Microsoft Corp.
Noah Mckay - D2H Advanced Technologies

An Assessment of Effects of Nanofluids on Heat Transfer Performance of Two-Phase Cooling Systems
Technical Paper Publication: InterPack2021-68121
Sana Fateh - Synano B.V.
Alexander Korobko - Synano B.V.

Session 02-04 - Thermosyphon Cooling II

Operational Maps and Thermal Performance Analysis of a Thermosyphon Cooling System for Compact Servers
Technical Paper Publication: InterPack2021-72612
Raffaele L. Amalfi - Nokia Bell Laboratories
Cong H. Hoang - Nokia Bell Laboratories
Ryan Enright - Nokia Bell Laboratories
Filippo Cataldo - Provides Metalmeccanica S.r.l.
Jackson B. Marcinichen - JJ Cooling Innovation Sàrl
John R. Thome - JJ Cooling Innovation Sàrl

Compact Thermosyphon Cooling System for High Heat Flux Servers: New Validation of Thermosyphon Simulation Code Considering New Test Data
Technical Paper Publication: InterPack2021-72620
Remy Haynau - JJ Cooling Innovation Sarl
Jackson Braz Marcinichen - JJ Cooling Innovation Sarl
Raffaele L. Amalfi - Nokia Bell Labs
Filippo Cataldo - Provides Metalmeccanica S.r.l.
John R. Thome - JJ Cooling Innovation Sàrl

Novel Air-Cooled Thermosyphon Cooling System for Desktop Computers
Technical Paper Publication: InterPack2021-72621
Filippo Cataldo - Provides Metalmeccanica S.r.l.
Raffaele L. Amalfi - Nokia Bell Labs
Jackson B. Marcinichen - JJ Cooling Innovation S.a.r.l.
John R. Thome - JJ Cooling Innovation S.a.r.l.

Session 02-05 - Thermosyphon Cooling I

Rack-Level Thermosyphon Cooling and Vapor-Compression Driven Heat Recovery: Evaporator Model
Technical Paper Publication: InterPack2021-73269
Rehan Khalid - Villanova University
Raffaele Luca Amalfi - Nokia Bell Laboratories
Aaron P. Wemhoff - Villanova University

Rack-Level Thermosyphon Cooling and Vapor-Compression Driven Heat Recovery: Condenser Model
Technical Paper Publication: InterPack2021-73270
Rehan Khalid - Villanova University
Raffaele Luca Amalfi - Nokia Bell Laboratories
Aaron P. Wemhoff - Villanova University

Rack-Level Thermosyphon Cooling and Vapor-Compression Driven Heat Recovery: Compressor Model
Technical Paper Publication: InterPack2021-73271
Rehan Khalid - Villanova University
Raffaele Luca Amalfi - Nokia Bell Laboratories
Aaron P. Wemhoff - Villanova University

Session 02-06 - Novel Cooling Techniques

Experimental Investigation of Boiling Heat Transfer in a Liquid Chamber With Partially Soluble Nanofluids
Technical Paper Publication: InterPack2021-67330
Noriyuki Unno - Sanyo-Onoda City University
Kazuhisa Yuki - Sanyo-Onoda City University
Risako Kibushi - Sanyo-Onoda City University
Rika Nogita - Ube Material Industries Ltd.
Atsuyuki Mitani - Ube Material Industries Ltd.

Thermal Performance of Modular Microconvective Heat Sinks for Multi-Die Processor Assemblies
Technical Paper Publication: InterPack2021-74016
Chris May - JETCOOL Technologies Inc.
Jordan Mizerak - JETCOOL Technologies Inc.
David Earley - JETCOOL Technologies Inc.
Bernard Malouin - JETCOOL Technologies Inc.

Design and Application of Innovative 3DVC in AI Server System
Technical Paper Publication: InterPack2021-69723
Xianguang Tan - Baidu
Yongzhan He - Baidu
Bin Liu - Baidu
Jiang Yu - Intel
Ahuja Nishi - Intel
Wenbin Tian - Intel

Cooling of High-Powered GPUs Using Liquid Nitrogen Cold Plates Made With Additive Manufacturing
Technical Paper Publication: InterPack2021-74108
Alec Nordlund - Oregon State University
Rachel McAfee - Oregon State University
Rebecca Ledsham - Oregon State University
Joshua Gess - Oregon State University

Session 03-01 - Reliability of Printed Electronics

Damage of Flexible Electronic Line Under Mechanical and Electrical Stress Loading
Technical Paper Publication: InterPack2021-68902
Ryota Horiuchi - Hirosaki University
Kazuhiko Sasagawa - Hirosaki University
Kazuhiro Fujisaki - Hirosaki University

Repeatability and Extended Time Stability Study of an Additively Printed Strain Gauge Under Different Load Conditions
Technical Paper Publication: InterPack2021-74570
Pradeep Lall - Auburn University
Jinesh Narangaparambil - Auburn University
Tony Thomas - Auburn University
Kyle Schulze - Auburn University

Performance Characteristics of Additively Printed Strain Gauges Under Different Conditions of Temperature and High Stress Loads
Technical Paper Publication: InterPack2021-74074
Pradeep Lall - Auburn University
Tony Thomas - Auburn University
Jinesh Narangaparambil - Auburn University

Interaction of Surface Preparation and Cure-Parameters on the Interface Reliability of Flexible Encapsulation in FHE Applications
Technical Paper Publication: InterPack2021-74060
Pradeep Lall - Auburn University
Padmanava Choudhury - Auburn University
Scott Miller - NextFlex Manufacturing Institute

Session 03-02 - Flexible Electronics Processing

Development of Multi-Layer Circuitry Using Electrically Conductive Adhesive and Low-Temperature Solder Material for Surface-Mount Component Attachment
Technical Paper Publication: InterPack2021-74086
Pradeep Lall - Auburn University
Jinesh Narangaparambil - Auburn University
Scott Miller - NextFlex Manufacturing Institute

Print-Consistency and Process-Interaction for Inkjet-Printed Copper on Flexible Substrate
Technical Paper Publication: InterPack2021-74063
Pradeep Lall - Auburn University
Kartik Goyal - Auburn University
Curtis Hill - NASA Marshall Space Flight Center
Kyle Schulze - Auburn University

Additively Printed Flexible Temperature Sensor for Wearable Applications
Technical Paper Publication: InterPack2021-74071
Pradeep Lall - Auburn University
Hyesoo Jang - Auburn University
Jinesh Narangaparambil - Auburn University
Curtis Hill - NASA Marshall Space Flight Center
Kartik Goyal - Auburn University

Printed Flexible LC Filter Using Additive Micro-Dispensing With Silver Conductive Paste and ECA for Component Attachment
Technical Paper Publication: InterPack2021-74073
Pradeep Lall - Auburn University
Jinesh Narangaparambil - Auburn University
Kyle Schulze - Auburn University
Scott Miller - NextFlex Manufacturing Institute

Session 03-03 - Reliability of Flexible Batteries

Reliability and SOH Degradation of Thin Li-ion Batteries Under Various Flexing Conditions
Technical Paper Publication: InterPack2021-74065
Pradeep Lall - Auburn University
Hyesoo Jang - Auburn University
Ved Soni - Auburn University
Scott Miller - NextFlex

Life-Assessment for Thin Flexible Batteries Under U-Flex-to-Install and Dynamic Folding
Technical Paper Publication: InterPack2021-74115
Pradeep Lall - Auburn University
Ved Soni - Auburn University
Scott Miller - NextFlex Manufacturing Institute

Effect of Lamination Parameters and Mechanical Folding on SOH Degradation of Li-ion Battery Subjected to Accelerated Life Testing
Technical Paper Publication: InterPack2021-74088
Pradeep Lall - Auburn University
Ved Soni - Auburn University
Jinesh Narangaparambil - Auburn University
Scott Miller - NextFlex National Manufacturing Institute

Session 05-01 - Advanced Cooling Technologies

Phase Change Materials (PCMs) Effectiveness Index for Rapid Assessment in Thermal Management of Transient Pulse Electronics
Technical Paper Publication: InterPack2021-69321
Adrian Olivera - University of Puerto Rico
Jhonathan Rosales - NASA Marshall Space Flight Center
Pedro O. Quintero - University of Puerto Rico

Transient Performance and Melt Front Characterization of Phase Change Materials
Technical Paper Publication: InterPack2021-73252
Tyler Stamps - University of Arkansas
David Huitink - University of Arkansas

Lightweight, Cost-Effective Power Modules Using Polymer Baseplates With Integrated Microconvective Cooling
Technical Paper Publication: InterPack2021-74015
David Earley - JETCOOL Technologies
Jordan Mizerak - JETCOOL Technologies
Chris May - JETCOOL Technologies
Bernard Malouin - JETCOOL Technologies

Thermal Performance of Field-Effect Transistors Based on Diamond and Other Ultra-Wide Bandgap Semiconductors
Technical Presentation Only: InterPack2021-77606
James Spencer Lundh - Pennsylvania State University
Daniel Shoemaker - Pennsylvania State University
Anthony Birdwell - Army Research Laboratory
James Weil - Army Research Laboratory
Leonard De La Cruz - Army Research Laboratory
Pankaj Shah - Army Research Laboratory
Kevin Crawford - Army Research Laboratory
Tony Ivanov - Army Research Laboratory
Hiu Yung Wong - San Jose State University
Sukwon Choi - Pennsylvania State University

Thermal Conductivity of Ga_2O_3 and $(Al_xGa_{1-x})_2O_3$ Heteroepitaxial Thin Films
Technical Presentation Only: InterPack2021-77769
Yiwen Song - Pennsylvania State University
Praneeth Ranga - University of Utah
Yingying Zhang - University of Minnesota
Zixuan Feng - Ohio State University
Hsien Lien Huang - Ohio State University
Marco Santia - Air Force Research Laboratory
Stefan Badescu - Air Force Research Laboratory
Ulises Gonzalez-Valle - Pennsylvania State University
Carlos Perez - Pennsylvania State University
Kevin Ferri - Pennsylvania State University
Robert Lavelle - Applied Research Laboratory
David Snyder - Applied Research Laboratory
Jon-Paul Maria - Pennsylvania State University
Bladimir Ramos-Alvarado - Pennsylvania State University
Jinwoo Hwang - Ohio State University
Hongping Zhao - Ohio State University
Xiaojia Wang - University of Minnesota
Sriram Krishnamoorthy - University of California, Santa Barbara
Brian Foley - Pennsylvania State University
Sukwon Choi - Pennsylvania State University

Session 05-02 - System Level Thermal Design

Thermal and Electrical Co-Optimization of a Multi-Chip Double-Sided Cooled Gan Module
Technical Paper Publication: InterPack2021-72726
Hayden Carlton - University of Arkansas
Md Maksudul Hossain - University of Arkansas
Arman Ur Rashid - University of Arkansas
Yuxiang Chen - University of Arkansas
Alan Mantooth - University of Arkansas
Asif Imran - Stony Brook University
Fang Luo - Stony Brook University
John Harris - University of Arkansas
Alexis Krone - University of Arkansas
David Huitink - University of Arkansas

Thermal Design of Variable Frequency Drives for Hybrid and Electric Transport Applications
Technical Paper Publication: InterPack2021-68870
NIkhil R. Lakhkar - Emerson Climate Technologies

Using Short Thermal Transient Tests to Assess the Quality of High Power Density Semiconductor Packages in Production
Technical Presentation Only: InterPack2021-68948
Voon Hon Wong - Siemens Digital Industry Software, Singapore
Diane Duvall - Siemens Digital Industry Software, USA
Andras Vass-Varnai - Mentor Graphics A Siemens Business
Antonio Caruso - Siemens Digital Industry Software, Italy

Session 05-03 - Power Electronics Packaging and Reliability

Cold Gas Spray of Copper on Aluminum Nitride as Substrate for Power Electronics
Technical Paper Publication: InterPack2021-69270
Margie Guerrero - University of Puerto Rico
Pedro Quintero - University of Puerto Rico
Ozan Ozdemir - Northeastern University
Tricia Schwartz - Northeastern University

Performance and Durability Validation of Voltage Blocking Technologies to Enable Direct Cooled High-Voltage, High-Power Modules
Technical Paper Publication: InterPack2021-73313
Ange-Christian Iradukunda - University of Arkansas
David Huitink - University of Arkansas
Tarek Gebrael - University of Illinois at Urbana-Champaign
Nenad Miljkovic - University of Illinois at Urbana-Champaign

Durability of Non-Metallic Nozzles for Use in High-Voltage Power Electronics Jet Impingement Cooling at Elevated Temperatures
Technical Presentation Only: InterPack2021-73421
Reece Whitt - University of Arkansas
Rafael Estrella - University of Arkansas
David Huitink - University of Arkansas

Coupling Effect of Manufacturing Process and Thermal Cycle Test on High-Power Module
Technical Presentation Only: InterPack2021-70157
Ji-Yuan Syu - National Tsing Hua University
Chi-Wei Wang - National Tsing Hua University
Kuo-Shu Kao - National Tsing Hua University
Sheng-Tsai Wu - Industrial Technology Research Institute
Tai-Kuang Lee - Industrial Technology Research Institute
Han-Lin Wu - Industrial Technology Research Institute
Tzu-Hsuan Ni - Industrial Technology Research Institute
Chun-Hua Tseng - Industrial Technology Research Institute
Tai-Jyun Yu - Industrial Technology Research Institute
Chang-Chun Lee - National Tsing Hua University

Session 05-04 - Two-Phase Cooling

Investigation on the Optimization of Arrays of Micropillar Structures for Enhancing Microscale Evaporative Cooling
Technical Presentation Only: InterPack2021-77675
Kidus Guye - Washington University in Saint Louis
Quan Chau - Washington University in Saint Louis
Erdong Song - Washington University in Saint Louis
Damena Agonafer - Washington University in Saint Louis

Investigation of Buoyancy-Driven Convection in Non-Axisymmetric Evaporating Droplets Confined on Hollow Micropillars
Technical Presentation Only: InterPack2021-77725
De Dong - Washington University in Saint Louis
Kidus Guye - Washington University in Saint Louis
Mun Mun Nahar - Washington University in Saint Louis
Zhikai Yang - Washington University in Saint Louis
Damena Agonafer - Washington University in St. Louis

Session 6-01- Multiscale Heat Transfer in Optics and Energy Systems

Microchannel Heat Sink for Thermal Management of Concentrated Photovoltaic Cells
Technical Paper Publication: InterPack2021-74010
Dinumol Varghese - Amrita Vishwa Vidyapeetham
Ahmed Sefelnasr - United Arab Emirates University
Mohsen Sherif - United Arab Emirates University
Fadi Alnaimat - United Arab Emirates University
Bobby Mathew - United Arab Emirates University

A Hybrid Microporous Copper Structure for High Performance Capillary-Driven Liquid Film BoilingTechnical Paper Publication: InterPack2021-73309
Farid Soroush - Stanford University
Tanya Liu - Stanford University
Qianying Wu - Stanford University
Chi Zhang - Stanford University
Mehdi Asheghi - Stanford University
Kenneth E. Goodson - Stanford University
Lorenz Marco - Robert Bosch GmbH
Christian Egger - Robert Bosch GmbH
Rittner Martin - Robert Bosch GmbH

Modeling and Optimization of Transient and Steady-State SMA-Based Elastocaloric Refrigeration Cycle

Technical Presentation Only: InterPack2021-66950
Sarah Nguyen - United States Naval Academy
Joshua Radice - United States Naval Academy
Andrew Smith - United States Naval Academy
Darin Sharar - United States Naval Academy
Brian Donovan - United States Naval Academy
Ronald Warzoha - United States Naval Academy

An Application-Centric Design Tutorial for Phase Change Material Composites
Technical Presentation Only: InterPack2021-73321
Alison Hoe - Texas A&M University
Michael Barako - Northrop Grumman Corp.
Achutha Tamraparni - Texas A&M University
Chen Zhang - Texas A&M University
Alaa Elwany - Texas A&M University
Jonathan Felts - Texas A&M University
Patrick Shamberger - Texas A&M University

Strategic Quality and Reliability Plan for Pic: Road to Reliable CPO Solution
Technical Presentation Only: InterPack2021-73038
Vincent Zeng - Facebook Inc.

Microlayer Evaporation Enhancement During Pool Boiling on Structured Surfaces
Technical Presentation Only: InterPack2021-76949
Manohar Bongarala - Purdue University
Han Hu - University of Arkansas
Suresh Garimella - Purdue University

Decreased Undercooling in Gallium-Based Phase Change Materials via Epitaxial Nucleation Catalysts
Technical Presentation Only: InterPack2021-73394
Sourav Chakravarty - Texas A&M University
Darin Sharar - CCDC Army Research Laboratory, Sensors and Electron Devices Directorate
Patrick J. Shamberger - Texas A&M University

Prediction and Characterization of Dry-Out Heat Flux in Micropillar Wick Structures
Technical Presentation Only: InterPack2021-77731
Yimin Zhou - University of Michigan-AnnAarbor
Solomon Adera - University of Michigan-Ann Arbor

Session 07-01 - Autonomous, Hybrid, and Electric Vehicles

Thermal Conductivity Prediction Model for Composite Thermal Interface Materials Using Copper Metal Foam
Technical Paper Publication: InterPack2021-70410
Shinya Kawakita - Hitachi Astemo, Ltd.
Yuki Ishizaka - Tokyo Institute of Technology
Kazuyoshi Fushinobu - Tokyo Institute of Technology

Numerical Modeling of Continuous Dynamic Recrystallization in Sn-Based Solder Connection Under Cyclic Loading
Technical Paper Publication: InterPack2021-73319
Marta Kuczynska - Robert Bosch GmbH
Youssef Maniar - Robert Bosch GmbH
Ulrich Becker - Robert Bosch GmbH
Stefan Weihe - University of Stuttgart

Nonlocal Damage Modeling of Solder Joint Failure Under Thermomechanical Cyclic Loading
Technical Paper Publication: InterPack2021-73100
Youssef Maniar - Robert Bosch GmbH
Alexander Kabakchiev - Robert Bosch GmbH
Marta Kuczynska - Robert Bosch GmbH
Masoomeh Bazrafshan - Robert Bosch GmbH
Peter Binkele - University of Stuttgart
Sigfried Schmauder - University of Stuttgart

Numerical Investigation on the Load-Dependent Solder Joint Failure of Multilayer Ceramic Capacitors in Automotive Applications
Technical Paper Publication: InterPack2021-68535
Jonas Gleichauf - Robert Bosch GmbH
Youssef Maniar - Robert Bosch GmbH
Steffen Wiese - Saarland University

Session 08-01 - Reliability of Electronic Packages and Systems

Reliability of Electronic Drivers: An Industrial Approach
Technical Paper Publication: InterPack2021-72293
P. Watte - Signify
Ger Van Hees - Signify
Roy Engelen - Signify
Willem Van Driel - Signify

Solderability and Reliability of Sintered Nano-Ag Bond Pads of Printed Re-Distribution Layer (RDL)
Technical Paper Publication: InterPack2021-74199
S.W.R. Lee - Hong Kong University of Science & Technology
J.C.C. Lo - Hong Kong University of Science & Technology
X. Qiu - Hong Kong University of Science & Technology
N. Tu - Hong Kong University of Science & Technology

Reliability Evaluation of Cu-Al WB in High Temperature and High Current Applications
Technical Paper Publication: InterPack2021-75890
Pradeep Lall - NSF-CAVE3 Electronics Research Center Auburn University
Sungmo Jung - NSF-CAVE3 Electronics Research Center Auburn University

Fundamental Investigation of Effects of Surrounding Conditions on Measurement Uncertainty in Temperature of Surface-Mounted Components by Thermocouples
Technical Paper Publication: InterPack2021-69101
Takashi Fukue - Kanazawa Institute of Technology
Koichi Hirasawa - KOA Corporation

Session 08-02 - Reliability of Electronic Packages and Systems

Temperature Cycling Study of Aerosol-Jet Printed Conductive Silver Traces in Printed Electronics
Technical Paper Publication: InterPack2021-73197
Beihan Zhao - University of Maryland
Christopher Riso - University of Maryland
David Leslie - University of Maryland
Abhijit Dasgupta - University of Maryland
Siddhartha Das - University of Maryland
Jason Fleischer - Laboratory of Physical Science
Daniel Hines - Laboratory of Physical Science

Characterization of High-Density Aircraft Electronic and Thermal Management Systems
Technical Paper Publication: InterPack2021-73287
Joshua Kasitz - University of Arkansas
David Huitink - University of Arkansas

Contact Angle Tuning of Copper Microporous Structures
Technical Paper Publication: InterPack2021-73334
Farid Soroush - Stanford University
Tanya Liu - Stanford University
Qianying Wu - Stanford University
Marco Lorenz - Robert Bosch GmbH
Christian Egger - Robert Bosch GmbH
Martin Rittner - Robert Bosch GmbH
Mehdi Asheghi - Stanford University
Kenneth Goodson - Stanford University

Electromigration Analysis of Solder Joints for Power Modules Using an Electrical-Thermal-Stress-Atomic Coupled Model
Technical Paper Publication: InterPack2021-69882
Mitsuaki Kato - Toshiba Corporation
Takahiro Omori - Toshiba Corporation
Akihiro Goryu - Toshiba Corporation
Tomoya Fumikura - Toshiba Corporation
Kenji Hirohata - Toshiba Corporation

Session 08-03 - Reliability of Electronic Packages and Systems

Flow and Thermal Resistance Network Modeling of Finned Heat Sinks With Bypass Mounted in Rectangular Enclosure
Technical Paper Publication: InterPack2021-72975
Masaya Fukada - Kanazawa Institute of Technology
Takashi Fukue - Kanazawa Institute of Technology
Yasuhiro Sugimoto - Kanazawa Institute of Technology
Tomoyuki Hatakeyama - Toyama Prefectural University
Masaru Ishizuka - Toyama Prefectural University

CFD-Based Investigation of Effects of Obstruction in Front of Small Axial Cooling Fan and Deterioration of Supply Flow Rate
Technical Paper Publication: InterPack2021-72976
Tetsushi Fukuda - Kanazawa Instituite of Technology
Yukio Masuda - Nagano Prefecture General Industrial Technology Center
Takashi Fukue - Kanazawa Institute of Technology
Yasuhiro Sugimoto - Kanazawa Institute of Technology
Tomoyuki Hatakeyama - Toyama Prefectural University
Masaru Ishizuka - Toyama Prefectural University
Katsuhiro Koizumi - Denso Corp.

Effect of Mechanical Cycling at Elevated Temperatures on The Constitutive Properties and Microstructure of Lead-Free Solder Alloys
Technical Paper Publication: InterPack2021-73548
Mohd Aminul Hoque - Auburn University
Mohammad Ashraful Haq - Auburn University
Jeffrey C. Suhling - Auburn University
Pradeep Lall - Auburn University

Design for Reliability of Automotive Chip Scale Packages by Calibrated Virtual Prototyping
Technical Paper Publication: InterPack2021-73970
Ralf Döring - Fraunhofer ENAS
R. Dudek - Fraunhofer ENAS
S. Rzepka - Fraunhofer ENAS
L. Scheiter - Chemnitzer Werkstoffmechanik GmbH
E. Noack - Chemnitzer Werkstoffmechanik GmbH
B. Seiler - Chemnitzer Werkstoffmechanik GmbH

Session 08-04 - Reliability of Electronic Packages and Systems

Effects of Aging on the Properties of Intermetallic Layers in SAC+BI Solder Joints
Technical Paper Publication: InterPack2021-73348
Mohammad Ashraful Haq - Auburn University
Mohd Aminul Hoque - Auburn University
Jeffrey C. Suhling - Auburn University
Pradeep Lall - Auburn University

Enhanced Processability and Thermal Fatigue Reliability With Low Melting Point SnBi Solder Alloy LMPA-Q
Technical Paper Publication: InterPack2021-73456
Bart Vandevelde - IMEC
Chinmay Nawghane - IMEC
Riet Labie - IMEC
Ralph Lauwaert - Interflux Electronics
Daniel Werkhoven - Interflux Electronics

Mechanical Properties of Doped Solder SAC-Q for High Strain Rate Testing at Extreme Surrounding Temperatures for 6 Months of Isothermal Aging
Technical Paper Publication: InterPack2021-74067
Pradeep Lall - Auburn University
Vishal Mehta - Auburn University
Jeff Suhling - Auburn University
Ken Blecker - U.S. Army Combat Capabilities Development Command - Armament Center

Evolution of Mechanical Properties and Microstructure in SAC Bulk Solder and Solder Joints During Thermal Cycling Exposures
Technical Paper Publication: InterPack2021-74044
S.M. Kamrul Hasan - Auburn University
Abdullah Fahim - Auburn University
Mohammad Al Ahsan - Auburn University
Jeffrey Suhling - Auburn University
Sa'd Hamasha - Auburn University
Pradeep Lall - Auburn University

Session 08-05 - Reliability of Electronic Packages and Systems

Prognostics and RUL Estimations of SAC305, SAC105 and SnAg Solders Under Temperature and Vibration Using Long Short-Term Memory (LSTM) Deep Learning
Technical Paper Publication: InterPack2021-74066
Pradeep Lall - Auburn University
Tony Thomas - Auburn University
Ken Blecker – U.S. Army CCDC-AC

Evolution of Potting-PCB Interfacial Reliability After Long Term High Temperature Operation
Technical Paper Publication: InterPack2021-74062
Pradeep Lall - Auburn University
Ken Blecker - US Army CCDC-AC
Aathi Raja Ram Pandurangan - Auburn University

Module-Level TIM Degradation in HALT
Technical Paper Publication: InterPack2021-69511
Joshua Tompkins - University of Arkansas
David Huitink - University of Arkansas

Session 08-06 - Reliability of Electronic Packages and Systems

Low Temperature Material Characterization of Lead-Free SAC Solder Alloy at High Strain Rate After Prolonged High Temperature Storage
Technical Paper Publication: InterPack2021-74068
Pradeep Lall - Auburn University
Vikas Yadav - Auburn University
David Locker - U.S. Army Combat Capabilities Development Command - Armament Center
Jeff Suhling - Auburn University

Determination of High and Low Temperature High Strain Rate Mechanical Properties for SAC-R After Exposure to Isothermal Aging of 50°C up to 8 Months
Technical Paper Publication: InterPack2021-74069
Pradeep Lall - Auburn University
Mrinmoy Saha - Auburn University
Jeff Suhling - Auburn University
Ken Blecker – U.S. Army Combat Capabilities Development Command - Armament Center

Reliable Additive Manufacturing Using Transient Liquid Phase Sintering
Technical Paper Publication: InterPack2021-73367
F. Patrick McCluskey - University of Maryland, College Park
Clifton Buxbaum - University of Maryland, College Park
Gilad Nave - University of Maryland, College Park

Session 08-07 - Reliability of Electronic Packages and Systems

Characterization of Linear Viscoelasticity Evolution of Epoxy Molding Compound Subjected to High Temperature Long Term Aging
Technical Paper Publication: InterPack2021-74075
Pradeep Lall - Auburn University
Yunli Zhang - Auburn University
Jaimal Williamson - Texas Instruments
Jeff Suhling - Auburn University
Haotian Wu - Auburn University
Ed Davis - Auburn University

Evolution of Prony Parameters for Underfills Subjected to High Temperature Long Term Aging
Technical Paper Publication: InterPack2021-74076
Pradeep Lall - Auburn University
Yunli Zhang - Auburn University
Haotian Wu - Auburn University
Edward Davis - Auburn University
Jeff Suhling - Auburn University

Mechanical Behavior of Heat Activated Film Adhesives
Technical Paper Publication: InterPack2021-69719
Prabhat Janamanchi - University of Maryland
Abhijit Dasgupta - University of Maryland
Narendra Singh - Microsoft Corporation

Property Evolution and Reliability of Underfills Under Sustained High Temperature Storage
Technical Paper Publication: InterPack2021-74061
Pradeep Lall - Auburn University
Madhu Kasturi - Auburn University
Haotian Wu - Auburn University
Edward Davis - Auburn University
Jeff Suhling - Auburn University

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Session 09-01 - Nano-Scale Thermal Transport and Materials

Confined Transducer Geometries to Enhance Sensitivity to Thermal Boundary Conductance in Frequency-Domain Thermoreflectance Measurements
Technical Paper Publication: InterPack2021-66842
Ronald J. Warzoha - United States Naval Academy
Brian Donovan - United States Naval Academy
Adam Wilson - Army Research Laboratory
Andy Clark - Bryn Mawr College
Lu An - Villanova University
Ezra Lee - Villanova University
Xiaosong Liu - Villanova University
Xuemei Cheng - Bryn Mawr College
Gang Feng - Villanova University

Thermal Transport Across Al-($(Al_xGa_{1-x})_2O_3$ and Al-Ga_2O_3 Interfaces
Technical Paper Publication: InterPack2021-74116
Jingjing Shi - Georgia Institute of Technology
Anusha Krishnan - Georgia Institute of Technology
A.F.M. Anhar Uddin Bhuiyan - The Ohio State University
Yee Rui Koh - University of Virginia
Kenny Huynh - University of California, Los Angeles
Akhil Mauze - University of California, Santa Barbara
Sai Mu - University of California
Brian M. Foley - The Pennsylvania State University
Habib Ahmad - Georgia Institute of Technology
Takeki Itoh - University of California, Santa Barbara
Yuewei Zhang - University of California, Santa Barbara
Chao Yuan - Georgia Institute of Technology
Samuel Kim - Georgia Institute of Technology
W. Alan Doolittle - Georgia Institute of Technology
Chris Van De Walle - University of California, Santa Barbara
James S. Speck - University of California, Santa Barbara
Mark Goorsky - University of California, Los Angeles
Patrick Hopkins - University of Virginia
Hongping Zhao - The Ohio State University
Samuel Graham - Georgia Institute of Technology

Thermal Performance of Different Carbonaceous Nanoparticles as Additives to Thermal Paste as an Interface Material
Technical Paper Publication: InterPack2021-69254
Bharath R Bharadwaj - Virginia Tech
Prashant Singh - Mississippi State University
Roop L. Mahajan - Virginia Tech

Boiling Heat Flux Prediction Using a Convolutional Long Short-Term Memory (CONVLSTM) Model Trained on Image Sequences
Technical Presentation Only: InterPack2021-76880
Connor Heo - University of Arkansas
Manohar Bongarala - Purdue University
Christy Dunlap - University of Arkansas
Justin Weibel - Purdue University
Han Hu - University of Arkansas

Session 09-02 - Nano-scale Thermal Transport and Materials

Hotspot Cooling Performance for Submerged Confined Two-Phase Jet Impingement Cooling
Technical Paper Publication: InterPack2021-69317
Tanvir Ahmed Chowdhury - University of Central Florida
Shawn A. Putnam - University of Central Florida

Performance Analysis of Micro-Raman Spectroscopy Models for Thermal Conductivity Calculation
Technical Paper Publication: InterPack2021-73648
Taher Meydando - Boğaziçi University
Nazli Donmezer - Boğaziçi University

The Inertia Regime of Capillary Wicking During Enhanced Pool Boiling Heat Transfer on Ph-Modulated Copper Foams
Technical Presentation Only: InterPack2021-76894
Hari Pandey - University of Arkansas
Hamed Mehrabi - University of Arkansas
Robert Coridan - University of Arkansas
Han Hu - University of Arkansas

Droplet Dynamics and Heat Transfer on Micro/nano Doubly Reentrant Cavity Under Freezing Temperature
Technical Presentation Only: InterPack2021-73969
Dong Liao - The Hong Kong University of Science and Technology
Yinchuang Yang - The Hong Kong University of Science and Technology
Huihe Qiu - The Hong Kong University of Science and Technology

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Session 07-02 - Autonomous, Hybrid, and Electric Vehicles

A Review on the Current Industrial Uses and the Future Outlook of Battery Thermal Management Systems for Electric Vehicles
Technical Paper Publication: InterPack2021-69751
Nicholas Choi - University of California, Irvine
Nhi V. Quach - University of California, Irvine
Yoonjin Won - University of California, Irvine

Session 10-01 - Thermal Management Posters

Process-Property Relationships of Inkjet Printed Copper on Flexible Substrate
Student Poster Presentation: InterPack2021-74079
Kartik Goyal - Auburn University
Pradeep Lall - Auburn University
Kyle Schulze - Auburn University
Curtis Hill - NASA MSFC

The Effect of Heterogeneous Temperature on Lithium-Based Batteries
Student Poster Presentation: InterPack2021-74103
Yangying Zhu - UCSB

Cooling Performance of a Combined Microporous Wick and 3D Manifold μ-Cooler Under Uniform and Locally Varying Heat Dissipation via Thermal-Fluidic Coupled Simulations
Student Poster Presentation: InterPack2021-77743
Qianying Wu - Stanford University
Mehdi Asheghi - Stanford University
Kenneth Goodson - Stanford University

Numerical Modeling of Thin Film Evaporation in Wicking Structures
Student Poster Presentation: InterPack2021-77739
Yimin Zhou - University of Michigan-Ann Arbor
Solomon Adera - University of Michigan

Machine Learning for Enhanced Reliability in Thermal Energy Storage Using Phase Change Materials
Student Poster Presentation: InterPack2021-77771
Debjyoti Banerjee - Texas A&M University
Gangchen Ren - Texas A&M University
Aditya Chuttar - Texas A&M University
Ashok Thyagarajan - Texas A&M University

Enhanced Data Center Efficiency Using a Novel Two-Phase Heat Sink
Student Poster Presentation: InterPack2021-77737
Suhas Rao Tamvada - University of Florida
Morteza Alipanah - University of Florida
Saeed Moghaddam - University of Florida

Design and Optimization Guidelines for Micropillar Structures for Enhanced Evaporative Cooling
Student Poster Presentation: InterPack2021-77676
Kidus Guye - Washington University in Saint Louis
Zhikai Yang - Washington University in Saint Louis
Quan Chau - Washington University in Saint Louis
De Dong - Washington University in Saint Louis
Baris Dogruoz - Cisco Systems
Damena Agonafer - Washington University in Saint Louis

Cooling of High Powered GPUS Using Liquid Nitrogen Cold Plates Made With Additive Manufacturing
Student Poster Presentation: InterPack2021-74166
Alec Nordlund - Oregon State University
Rachel Mcafee - Oregon State University
Rebecca Ledsham - Oregon State University

Characterization of Linear Viscoelasticity Evolution of Epoxy Molding Compound Subjected to High Temperature Long Term Aging
Student Poster Presentation: InterPack2021-76964
Yunli Zhang - Auburn University

The Dynamics of Flow Through Porous Media for Application in Heat Pipe and Vapor Chamber
Student Poster Presentation: InterPack2021-76974
Binjian Ma - Harbin Institute of Technology (Shenzhen)
Huizhu Yang - Harbin Institute of Technology (Shenzhen)

Pumping Power Saving for Rack Level Dynamic Direct to Chip Liquid Cooling Using Novel Flow Control Device and Control Strategy
Student Poster Presentation: InterPack2021-77025
Pardeep Shahi - The University of Texas Arlington
Hardik Hurnekar - The University of Texas Arlington
Apurv Deshmukh - The University of Texas Arington
Satyam Saini - The University of Texas Arlington
Pratik Bansode - The University of Texas Arlington
Agonafer Dereje - The University of Texas Arlington

Thermal Performance Studies of a Single-Phase Immersion Cooled 3rd Generation Open Compute Server Using Immersion Cooling Fluid/Alumina Nanofluid Through CFD Techniques
Student Poster Presentation: InterPack2021-77027
Prajwal Murthy - The University of Texas at Arlington
Amirreza Niazmand - The University of Texas at Arlington
Pratik Bansode - The University of Texas at Arlington
Pardeep Shahi - The University of Texas at Arlington
Satyam Saini - The University of Texas at Arlington
Raufur Chowdhury - The University of Texas at Arlington
Dereje Agonafer - The University of Texas at Arlington

Thermal Design Analysis of Server Chassis Manifolds for Liquid Cooled Servers Using CFD
Student Poster Presentation: InterPack2021-77075
Kaustubh Adsul - University of Texas at Arlington
Satyam Saini - University of Texas at Arlington
Pratik Bansode - University of Texas at Arlington
Pardeep Shahi - University of Texas at Arlington
Amirreza Niazmand - University of Texas at Arlington
A S M Raufur Chowdhury - University of Texas at Arlington
Dereje Agonafer - University of Texas at Arlington

Predicting Anisotropic Thermophysical Properties and Heat Generation Rates in Cylindrical Lithium-Ion Batteries
Student Poster Presentation: InterPack2021-77722
Camilo Escobar - University of Toronto
Maan Al-Zareer - University of Toronto
Andrew Michalak - University of Toronto
Carlos Da Silva - University of Toronto
Cristina Amon - University of Toronto

Thermal Characterization Approach for In Situ Estimation of Thermophysical Properties of an Inductor-Transformer Assembly Within an Offboard Electric Vehicle Faster Charger
Student Poster Presentation: InterPack2021-77727
Omri Tayyara - University of Toronto
Maan Al-Zareer - University of Toronto
Carlos Da Silva - University of Toronto
Cristina Amon - University of Toronto

Design and Fabrication of a Bioinspired Evaporative Microcooler With an Array of Hollow Micropillar Structures

Student Poster Presentation: InterPack2021-77673
Quan H. Chau - Washington University in St. Louis
Kidus Guye - Washington University in St. Louis
Erdong Song - Washington University in St. Louis
Minju Lee - Washington University in St. Louis
Damena Agonafer - Washington University in St. Louis

Session 10-02 - Mechanics and Reliability Posters

High Strain Rate Mechanical Properties of SAC-Q Solder at Extreme Surrounding Temperatures for up to 180 Days of Isothermal Aging
Student Poster Presentation: InterPack2021-75887
Vishal Mehta - Auburn University
Pradeep Lall - Auburn University
Jeff Suhling - Auburn University
Ken Blecker – U.S. Army Combat Capabilities Development Command - Armament Center

Interfacial Fracture of Epoxy-PCB Interface Under Four Point Bend Loading With Long Term High Temperature Storage
Student Poster Presentation: InterPack2021-76621
Aathi Raja Ram Pandurangan - Auburn University
Pradeep Lall - Auburn University
Jeffrey Suhling - Auburn University
Ken Blecker - U.S. Army CCDC-AC

Surface-Mount Component Attachment Using Electrically Conductive Adhesive and Low-Temperature Solder Material for Multilayer Flexible Circuit Development
Student Poster Presentation: InterPack2021-76629
Jinesh Narangaparambil - Auburn University
Pradeep Lall - Auburn University
Kyle Schulze - Auburn.University
Scott Miller - NextFlex Manufacturing Institute

Estimation of Solder Joint Fatigue Life for Photonic Package
Student Poster Presentation: InterPack2021-77013
Ojas Tyagi - The University of Texas at Arlington
A.S.M. Raufur Chowdhury - The Universoty of Texas at Arlington
Krishna Bhavana Sivraju - The University of Texas at Arlington
Dereje Agonafer - The University of Texas at Arlington
Rabin Bhandari - The University of Texas at Arlington

The Impact of Various Test Conditions on Rth,jc Measurement
Student Poster Presentation: InterPack2021-77732
Jack Knoll - Virginia Tech
Christina Dimarino - Virginia Tech

Studies on Reliability of Flexible Batteries Under Various Flexing Conditions
Student Poster Presentation: InterPack2021-76633
Hyesoo Jang - Auburn University
Pradeep Lall - Auburn University
Ved Soni - Auburn University
Scott Miller - NextFlex Manufacturing Institute

High Strain Rate Material Characterization of Leadfree Sac Solder Alloys at Low Testing Temperatures After Prolonged Storage
Student Poster Presentation: InterPack2021-76622
Vikas Yadav - Auburn University
Pradeep Lall - Auburn University
Jeff Suhling - Auburn University

Evaluation of High and Low Temperature High Strain Rate Mechanical Properties for Doped Solder Sac-R After Exposure to Isothermal Aging of 50°C up to 240 Days
Student Poster Presentation: InterPack2021-76625
Mrinmoy Saha - Auburn University
Pradeep Lall - Auburn University
Jeff Suhling - Auburn University
Ken Blecker – U.S. Army Combat Capabilities Development Command - Armament Center

Effect of Fold Diameter on State of Health Degradation of Li-Ion Batteries Subjected to U-Flex-to-Install and Dynamic U-Fold Testing
Student Poster Presentation: InterPack2021-76626
Ved Soni - Auburn University
Pradeep Lall - Auburn University
Scott Miller - NextFlex Manufacturing Institute

Interaction of Process Parameter and Surface Preparation on the Interface Strength of Flexible Encapsulation in FHE Applications
Student Poster Presentation: InterPack2021-76627
Padmanava Choudhury - Auburn University
Pradeep Lall - Auburn University
Scott Miller - NextFlex Manufacturing Institute

RUL Estimations of Sac305, Sac10,5 and SNPB Solders Under Combined Conditions of Temperature and Vibration Loads Using LSTM-Deep Learning Technique
Student Poster Presentation: InterPack2021-76663
Tony Thomas - Auburn University
Pradeep Lall - Auburn University

Evolution of Prony Parameters for Underfills Subjected to High Temperature Long Term Aging
Student Poster Presentation: InterPack2021-76965
Yunli Zhang - Auburn University

Design, Development, and Characterization of a Flow Control Device for Dynamic Cooling Liquid-Cooled Servers
Student Poster Presentation: InterPack2021-77026
Pardeep Shahi - University of Texas Arlington
Hardik Hurnekar - The University of Texas at Arlington
Apurv Deshmukh - The University of Texas Arlington
Satyam Saini - The University of Texas Arlington
Pratik Bansode - The University of Texas at Arlington
Dereje Agonafer - The University of Texas at Arlington

Exploration of Multi-Physics Design Trade-Offs in a Multi-Chip Sic Mosfet Module With Integrated Cooling
Student Poster Presentation: InterPack2021-77796
Ahmet Mete Muslu - Georgia Institute of Technology
Vanessa Smet - Georgia Institute of Technology
Yogendra Joshi - Georgia Institute of Technology

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