



# ASME® 2020 InterPACK®

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

CONFERENCE  
Oct 27–29, 2020

Virtual, Online

# Program

<https://event.asme.org/InterPACK>



## Handbook Collection in Packaging Materials & Thermal Packaging

In 4 Volumes

Set 1  
Interconnect and Wafer Bonding Technology



In 3 Volumes

Set 3:  
Thermal Packaging Applications

Edited by  
Avram Bar-Cohen  
(University of Maryland, USA)



Editors-in-Chief

Avram Bar-Cohen (University of Maryland, USA)  
Jeffrey C. Suhling (Auburn University, USA)  
Andrew A. O. Tay (Singapore University of Technology and Design, Singapore)

Packaging materials, assembly processes, and the detailed understanding of multilayer mechanics have enabled much of the progress in miniaturization, reliability, and functional density achieved by modern electronic, microelectronic, and nanoelectronic products. The design and manufacture of miniaturized packages, providing low-loss electrical and/or optical communication, while protecting the semiconductor chips from environmental stresses and internal power cycling, require a carefully balanced selection of packaging materials and processes.

Due to the relative fragility of these semiconductor chips, as well as the underlying laminated substrates and the bridging interconnect, selection of the packaging materials and processes is inextricably bound with the mechanical behavior of the intimately packaged multilayer structures, in all phases of development for traditional, as well as emerging, electronic product categories.

The *Encyclopedia of Packaging Materials, Processes, and Mechanics*, compiled in 8, multi-volume sets, provides comprehensive coverage of the configurations and techniques, assembly materials and processes, modeling and simulation tools, and experimental characterization and validation techniques for electronic packaging.

**Readership:** It will be most beneficial to undergraduate and graduate students studying materials, mechanical, electrical, and electronic engineering, with a strong interest in electronic packaging applications.

1060pp Aug 2019  
978-981-120-111-0 (SET) US\$1,350 £1,190  
978-981-120-963-5 (SET) US\$2,025 £1,780  
(ebook-Institutions)

The third set in the Encyclopedia includes two volumes in the planned focus on *Thermal Packaging Applications* and a single volume on the use of Phase Change Materials (PCM), a most important *Thermal Management Technique*, not previously addressed in the Encyclopedia. Set 3 opens with *Heat Transfer in Avionic Equipment*, authored by Dr Boris Abramzon, offering a comprehensive, in-depth treatment of compact heat exchangers and cold plates for avionics cooling, as well as discussion on recent developments in these heat transfer units that are widely used in the thermal control of military and civilian airborne electronics. Along with a detailed presentation of the relevant thermofluid physics and governing equations, and the supporting mathematical design and optimization techniques, the book offers a practical guide for thermal engineers designing avionics cooling equipment, based on the author's 20+ years of experience as a thermal analyst and a practical design engineer for Avionics and related systems.

**Readership:** Packaging engineers, electronic product development engineers, and product managers, as well as to researchers in thermal management of electronic and photonic components and systems, and most beneficial to undergraduate and graduate students studying mechanical, electrical, and electronic engineering.

904pp Oct 2018  
978-981-3239-66-1 (SET) US\$1,200 £1,055  
978-981-3239-67-8 (SET) US\$1,800 £1,585  
(ebook-Institutions)

For more information, visit:  
<https://doi.org/10.1142/11303>



For more information, visit:  
<https://doi.org/10.1142/10975>



For more information visit: <https://www.worldscientific.com>



## Table of Contents

<b>Welcome Letter.....</b>	<b>Page 3</b>
<b>Program-at-a-Glance.....</b>	<b>Page 5</b>
<b>Sponsors.....</b>	<b>Page 9</b>
<b>Keynotes.....</b>	<b>Page 16</b>
<b>Workshops.....</b>	<b>Page 19</b>
<b>Tutorials.....</b>	<b>Page 38</b>
<b>Panels.....</b>	<b>Page 41</b>
<b>Student Poster Presentations.....</b>	<b>Page 77</b>
<b>Awards.....</b>	<b>Page 79</b>
<b>In Memoriam.....</b>	<b>Page 81</b>
<b>Sponsor ADs.....</b>	<b>Page 82</b>



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>

## WELCOME!

On behalf of the ASME Electronic and Photonic Packaging Division (EPPD), welcome to the 2020 International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems (InterPACK) being held virtually, from October 27-29, 2020.

The InterPACK Conference is a premier event organized by ASME EPPD and carries a rich history of being a platform of exchanging information on cutting-edge research in the areas of electronic and photonic packaging, thermal management and reliability of electronic devices, components and systems for researchers from Academia, Government, and Industry. The 2020 meeting will continue to hold this tradition even under the unusual current COVID-19 situation. At these unprecedented times, the organizers have developed a comprehensive technical program comprising nearly 160 technical papers and presentations, close to 60 posters, as well as tutorials, panels, workshops, and keynotes aligned with the areas of heterogeneous integration, servers of the future, edge and cloud computing, internet of things, flexible and wearable devices, photonics and optics, power electronics, energy conversion and storage, and autonomous, hybrid and electric vehicles. Similar to the past events, the conference program is set up to promote networking between attendees, offering opportunities to foster collaboration in a virtual environment this time.

We are pleased to announce that we will have three keynote presentations from distinguished experts in the area of electronic and photonic packaging, including 'Advanced electronic packaging and integration' by Dr. Suresh Ramalingam from Xilinx, 'Challenges and opportunities for future servers and cloud computing' by Ritesh Jain from Intel, 'Flexible electronics' by Dr. Scott Miller from the NextFlex. It is noteworthy that emerging areas in electronics & photonics and flexible electronics have recently demonstrated immense development, and we will continue to encourage development in such emerging technologies aligned with the agenda and goals of the ASME EPPD through the conference. Accordingly, we formed new tracks of Photonics and Optics, and Flexible Electronics and these tracks have attracted even more interest from participants this year. Furthermore, we are pleased to offer new workshops, namely the Artificial Intelligence Workshop (special thanks to the volunteers from Intel Corporation) and comprehensive Professional Development Workshops, comprising multiple sessions focusing on aspects such as mentoring, OCP collaboration, Women in Engineering, and Heterogenous Integration Roadmap (HIR). Last but not least, we sincerely thank the ASME Design, Materials, and Manufacturing (DMM) Segment Leadership Team for supporting the workshops with the TEC Development Funds.

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 thank them as well as the ASME Staff for their great effort to make this conference a premier event and look forward to enjoying the outcome of this hard work. We also thank all our sponsors across the globe for their generous support as well as their participation.



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>

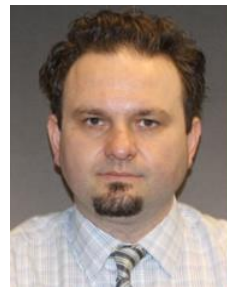
We all look forward to seeing you at InterPACK 2020!



Dr. Jin Yang  
General Conference Chair



Prof. Ankur Jain  
General Conference  
Vice-Chair



Dr. M. Baris Dogruoz  
Conference Program Chair



Dr. Gromala Przemyslaw Jakub  
Conference Program Co-Chair



Dr. Lauren M Boteler  
Conference Program Co-Chair



**PLEASE NOTE ALL CONFERENCE TIMES ARE IN PACIFIC DAYLIGHT SAVINGS TIME**

<b>INTERPACK 2020 PROGRAM-AT-A-GLANCE</b>					
<b>Pacific Time</b>		<b>Type</b>	<b>Moderators &amp; Speakers</b>	<b>Title</b>	<b>Company</b>
<b>Day 0 - Monday, 26th October 2020</b>					
<b>Workshop Session Chaired by Anna Prakash (Intel Corporation)</b>					
4:00 PM	6:00 PM	Workshop	Priyanka Dobriyal Abigail Agwai Oliver Chen Elaina Ashton	(AI in AD) Introduction to Robotics, Self-Driving Cars and AI with Drones	Intel Corporation & Arizona State University
6:00 PM	6:15 PM	Q&A			
<b>Day 1 - Tuesday, 27th October 2020</b>					
7:45 AM	8:00 AM	Welcome	Thomas Costabile (ASME Executive Director/CEO)	Welcome to ASME InterPACK 2020 Virtual Event	ASME
<b>Room 1: Keynote Session Chaired by Thomas Costabile and Baris Dogruoz</b>					
8:00 AM	8:50 AM	Keynote	Suresh Ramalingam	Challenges and Opportunities in Next Generation of Advanced Packaging	Xilinx
8:50 AM	9:00 AM	Q&A			
9:00 AM	9:10 AM	Break	<b>Exhibitor Corner - Presentation by Invensense/TDK</b>		
<b>Panel Sessions</b>					
<b>Room 1: Chaired by Gamal Refai-Ahmed (Xilinx) and Leila Choobineh (SUNY Polytechnic Institute)</b>					
9:10 AM	10:30 AM	Panel	Gamal Refai-Ahmed Leila Choobineh Amr Helmy Bahgat Sammakia Ravi Mahajan Suresh Ramalingam	HIR Challenges and Opportunity	Xilinx SUNY Polytechnic Institute University of Toronto Binghamton University Intel Corporation Xilinx
10:30 AM	10:40 AM	Q&A			
<b>Room 2: Chaired by Dan Hines (University of Maryland)</b>					
9:10 AM	10:30 AM	Panel	Dan Hines Brett Walker Ethan Secor Yuri Didenko Dave Pope Jeffrey Dee	Materials for Additive Manufacturing	University of Maryland Electroninks Iowa State University UTDots NovaCentrix DuPont
10:30 AM	10:40 AM	Q&A			
<b>Room 3: Industry, National Laboratory, and Academia Posters - Session 1 Chaired by Cheng Chen (Facebook)</b>					
9:10 AM	10:10 AM	Presentations	Poster Presentations and Q&A		
10:10 AM	10:40 AM	Q&A			
10:40 AM	10:50 AM	Break	<b>Coffee Break / Exhibitor Corner</b>		
<b>Panel Sessions</b>					
<b>Room 1: Chaired by Victor Chiriac (Global Cooling Technology Group)</b>					
10:50 AM	12:10 PM	Panel	Victor Chiriac Kinzy Jones, Jr. YC Lee Matthew Dalton Amy Marconnet Luca Amalfi	Advances in Wearable/Wireless Flexible Electronics: Thermal and Mechanical	Global Cooling Technology Group Magic Leap Kelvin Tech WP-AFRL Purdue University Nokia/Bell Labs
12:10 PM	12:20 PM	Q&A			



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>

Room 2: Chaired by Leila Choobineh (SUNY Polytechnic Institute)					
10:50 AM	12:40 PM	Panel	Leila Choobineh Tannaz Harirchian Jelena Srebric Nesrin Ozalp Elham Maghsoudi Anna M Prakash Shelby Nelson	Women in Engineering	SUNY Polytechnic Institute Intel Corporation University of Maryland Purdue University Northwest NASA Jet Propulsion Laboratory Intel Corporation Mosaic Microsystems, LLC
12:40 PM	12:50 PM	Q&A			
Room 3: Industry, National Laboratory, and Academia Posters - Session 2 Chaired by Cheng Chen (Facebook)					
10:50 AM	11:50 AM	Presentations	Poster Presentations and Q&A		
11:50 AM	12:20 PM	Q&A			
12:50 PM	1:50 PM	Tribute	Room 1: Tribute to Professor Avram (Avi) Bar-Cohen Organized by Madhu Iyengar (Google) and Dereje Agonafer (UTA)		
Room 1: Tutorial Chaired by David Huitink (University of Arkansas)					
1:50 PM	3:40 PM	Tutorial	Ephraim Suhir	Probabilistic DfR in Electronics & Photonics & Its Role in Making a Viable IC Package into a Reliable Product	Portland State University
3:40 PM	3:50 PM	Q&A			
InterPACK Organization Zoom Meetings					
4:00 PM	5:00 PM	ASME EPPD Executive Committee Meeting (By Invitation Only)			
5:00 PM	6:00 PM	InterPACK	Ricky Lee	JEP Meeting	Hong Kong University of Science and Technology
Day 2 - Wednesday, 28th October 2020					
7:45 AM	8:00 AM	ASME EPPD	Amy Spencer Fleischer	ASME EPPD Introduction	California Polytechnic University
Room 1: Keynote Session Chaired by Amy Spencer Fleischer (California Polytechnic University) and Jin Yang (Intel)					
8:00 AM	8:50 AM	Keynote	Bongtae Han	Quantitative Prediction of Warpage after Molding Processes: Is It a Myth?	CALCE - 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 Pradeep Lall (Auburn University)					
9:10 AM	10:30 AM	Panel	Pradeep Lall Bryan Germann Mike Newton Don Veri Doug Schardt	Printing Technologies for Additive Electronics	Auburn University Optomec nScript SUSS Komori America
10:30 AM	10:40 AM	Q&A			
Room 2: Chaired by: Victor Chiriac (Global Cooling Technology Group)					
9:10 AM	10:30 AM	Panel	Victor Chiriac Ravi Mahajan Hiroyuki Ryoson John Thome Mark Earnshaw Amy Marconnet Don Le	Mobile, IoT and Compute Device Applications: Thermal and Mechanical Challenge	Global Cooling Technology Group Intel Corporation Dexerials ex-EPFL Nokia Bell Labs Purdue University Qualcomm
10:30 AM	10:40 AM	Q&Q			



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>

10:40 AM	10:50 AM	Break	Coffee Break / Exhibitor Corner			
<b>Panel Sessions</b>						
<b>Room 1: Chaired by Fang Luo (Stonybrook)</b>						
10:50 AM	12:10 PM	Panel	Fang Luo Michael Fish Charles Lents Peter DeBock Guo-Quan (GQ) Lu	Potential of Additive Manufacturing for Power Electronics	Stonybrook Army Research Laboratory RTX DOE Virginia Tech	
12:10 PM	12:20 PM	Q&A				
<b>Room 2: Chaired by Jimil Shah (3M) and Saket Karajikar (Facebook)</b>						
10:50 AM	12:10 PM	Workshop	Dharmesh Jani Archana Haylock Rob Coyle Caleb Lusk Bapi Vinnakota	Open Compute Project Workshop	Facebook OCP PCX Rittal Broadcom	
12:10 PM	12:20 PM	Q&A				
<b>Room 1: InterPACK Achievement Award Presentation Chaired by Jin Yang (Intel)</b>						
12:20 PM	1:20 PM	Presentation				
		Presenter and Award Winner	Cristina H. Amon	Thermal Management of EVs with an Overview of Engineering Challenges and Our Work on Batteries and Chargers	University of Toronto	
1:20 PM	1:50 PM	Q&A				
<b>Room 1: Tutorial Chaired by Doug DeVoto (NREL)</b>						
1:50 PM	3:40 PM	Tutorial	Doug DeVoto Gilberto Moreno Sukwon Choi	Thermal and Reliability Aspects of Automotive Power Electronics: Current Status and Future Trends	National Renewable Energy Laboratory & Pennsylvania State University	
3:40 PM	3:50 PM	Q&A				
<b>InterPACK Organization Zoom Meetings</b>						
4:00 PM	5:00 PM	K-16 Committee Meeting				
5:00 PM	6:00 PM	InterPACK	InterPACK Advisory Committee	InterPACK Advisory Committee Meeting	By Invitation Only	
<b>Day 3 - Thursday, 29th October 2020</b>						
7:45 AM	8:00 AM	ASME EPPD	Amy Spencer Fleischer	ASME EPPD Introduction	California Polytechnic University	
<b>Room 1: Keynote Session Chaired by Amy Spencer Fleischer (California Polytechnic University) and Przemek Gromala (Bosch)</b>						
8:00 AM	8:50 AM	Keynote	Scott Miller	Flexible Hybrid Electronics Manufacturing for Integrated Systems	NextFlex	
8:50 AM	9:00 AM	Q&A				
9:00 AM	9:10 AM	Break	Coffee Break / Exhibitor Corner			





# ASME® 2020 InterPACK®

Panel and Workshop Sessions					
<b>Room 1: Chaired by Ben Leever (Air Force Research Laboratory)</b>					
9:10 AM	10:30 AM	Panel	Ben Leever Mary Herndon John Rogers Stephen Gonya David Shaddock	Aerospace Electronics	Air Force Research Laboratory Raytheon Lockheed Martin Boeing GE
10:30 AM	10:40 AM	Q&A			
<b>Room 2: Chaired by Bill Bottoms (3MTS) and Ravi Mahajan (Intel)</b> <b>Facilitators: Gamal Refai-Ahmed, Amr Helmy, Bill Chen, Madhusudan Iyengar, Weihua Tang. Abhijit Dasgupta</b>					
9:10 AM	10:30 AM	Workshop	John Shalf Antai Xu Ali Heydari John Bowers	HIR Workshop - Part 1	Lawrence Berkeley National Laboratory Xilinx Corporation Nvidia Institute for Energy Efficiency - UC-Santa Barbara
10:30 AM	10:40 AM	Q&A			
10:40 AM	10:50 AM	Break	Coffee Break / Exhibitor Corner		
<b>Workshop Sessions and Awards Ceremony</b>					
<b>Room 1: Chaired by Darshan Pahinkar (FIT) and Jimil Shah (3M)</b>					
10:50 AM	12:10 PM	Workshop	Darshan Pahinkar Ronald Warzoha Ankur Jain Lauren Boteler	K-16 Mentoring Workshop	K-16 Committee
12:10 PM	12:20 PM	Q&A			
<b>Room 2: Chaired by Bill Bottoms (3MTS) and Ravi Mahajan (Intel)</b> <b>Facilitators: Gamal Refai-Ahmed, Amr Helmy, Bill Chen, Madhusudan Iyengar, Weihua Tang. Abhijit Dasgupta</b>					
10:50 AM	12:10 PM	Workshop	John Shalf Antai Xu Ali Heydari John Bowers	HIR Workshop - Part 2	Lawrence Berkeley National Laboratory Xilinx Corporation Nvidia Institute for Energy Efficiency - UC-Santa Barbara
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 Jin Yang	Other Awards Ceremony	Intel Corporation
<b>Room 1: Workshop Chaired by Jimil Shah (3M) and Saket Karajgikar (Facebook)</b>					
1:50 PM	3:40 PM	Workshop	Saket Karajgikar Dereje Agonafer Amy Spencer Fleischer	Career Development Workshop	Facebook University of Texas at Arlington California Polytechnic University
3:40 PM	3:50 PM	Q&A			
<b>InterPACK Organization Zoom Meeting</b>					
4:00 PM	5:00 PM	InterPACK Summary and Planning Meeting			



## SPONSORS



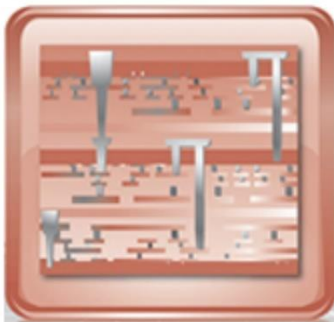
### Gold Sponsor

Intel is an industry leader, creating world-changing technology that enables global progress and enriches lives. Inspired by Moore's Law, we continuously work to advance the design and manufacturing of semiconductors to help address our customers' greatest challenges. By embedding intelligence in the cloud, network, edge, and every kind of computing device, we unleash the potential of data to transform business and society for the better.

**Contact:**

Ravi Mahajan

[ravi.v.mahajan@intel.com](mailto:ravi.v.mahajan@intel.com)



### Silver Sponsor

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/nano structures; 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.



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>

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

**Contact:**

Shi-Wei Ricky Lee, PhD

The Hong Kong University of Science and Technology, Hong Kong

[rickylee@ust.hk](mailto:rickylee@ust.hk)



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):

<https://www.nrel.gov/transportation/peem.html>

Contact:

Sreekant Narumanchi

[Sreekant.Narumanchi@nrel.gov](mailto:Sreekant.Narumanchi@nrel.gov)



## Silver Sponsor

### **Penn State's College of Engineering**

As a global leader in engineering education and research, the Penn State College of Engineering engages around the world to help solve humanity's greatest challenges. We are working to build a more inclusive academic community and a more diverse engineering workforce. We are partnering in new ways across Penn State and with government and industry. We are modernizing our facilities and reshaping the University Park campus. Today—125 years since our founding—we have grown into the largest college at Penn State and one of the largest engineering colleges in the nation. With a community of more than 12,000 undergraduate and graduate students, more than 400 faculty, and more than 100,000 alumni, we are committed to inspiring change and impacting tomorrow. Join us as we engineer solutions and build a better future. For more information, follow us here: <https://www.engr.psu.edu/>



### **Penn State's Materials Research Institute**

The Materials Research Institute is one of the preeminent interdisciplinary research organizations in the United States, with roots back to the 1960's. Materials Science research at Penn State is ranked #1 and Materials Engineering ranked #2 across R1 Universities in the US based on research expenditures by the National Science Foundation. The home of the Materials Research Institute is the Millennium Science Complex, a state-of-the-art facility that was completed in the Fall of 2011 with nearly 300K square feet of research space including 15 large vibration isolated labs for sensitive analytical work, and a 10K square foot clean room nanofabrication facility. The institute provides the facilities and framework to tackle the world's largest and most complex materials challenges in areas like 2D Materials and Coatings, Bio-inspired Materials, Thermally Functional Materials, Polymers, Electro-ceramics, Electronics, Materials Simulation, Materials Characterization and many more. Over 300 PSU faculty are affiliated with the institute from 25 academic departments across Penn State's vast campus network. Join the Materials Research Institute on November 10<sup>th</sup> and 11<sup>th</sup> for Materials Day, presented in a free virtual format this year. For more information, follow us here: <https://www.mri.psu.edu/>



## Silver Sponsor

InvenSense, Inc., a TDK Group company, is a world leading provider of MEMS sensor platforms. InvenSense's vision of Sensing Everything<sup>®</sup> targets the consumer electronics and industrial areas with integrated Motion, Sound, and Ultrasonic solutions. InvenSense's solutions combine MEMS (micro electrical mechanical systems) sensors, such as accelerometers, gyroscopes, compasses, microphones, and ultrasonic 3D-sensing with proprietary algorithms and firmware that intelligently process, synthesize, and calibrate the output of sensors, maximizing performance and accuracy. InvenSense's motion tracking, ultrasonic, audio, fingerprint, location platforms and services can be found in Mobile, Wearables, Smart Home, Industrial, Automotive, and IoT products. InvenSense is headquartered in San Jose, California and has offices worldwide. For more information, go to [www.invensense.tdk.com](http://www.invensense.tdk.com)

### **Contact:**

David Almoslino

[DAlmoslino@invensense.com](mailto:DAlmoslino@invensense.com)



## Silver Sponsor

To find out more about Stanford University, please visit:  
<https://nanoheat.stanford.edu/>



## **Silver Sponsor**

Novark Technologies, Inc. spans three factories and leverages over a decade of experience and expertise in thermal management solutions. Its product lines include various heat pipe, heat sink, and cold plate configurations used in a variety of industries ranging from automotive to LED to CPU cooling to industrial power systems and more. Routine support of academic research at various institutions combines with constant exploration of new thermal management solutions to push the company's capabilities forward every year.

For more information, please visit our website:

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



## **Bronze and Student Sponsor**

The University of Texas at Arlington is a Carnegie Research Institution (High Research Activity) whose mission is the advancement of knowledge and the pursuit of excellence in research, teaching, and service to the community. The mission statement affirms UT Arlington's commitment to expanding academic research; to attracting and retaining high quality faculty scholars who actively engage students; to providing a well-rounded academic experience that promotes student involvement, service learning, and free discourse; to employing alternative access venues to meet students' needs; and to developing public and private partnerships.



College of Engineering.

The University of Texas at Arlington's College of Engineering has emerged as one of the most comprehensive engineering programs in North Texas and the nation. It offers 11 baccalaureate, 14 master's, and nine doctoral degree programs, and its programs are ranked by U.S. News and World Report as among the best in the nation. With more than 7,500 students and more than 34,000 alumni, the College of Engineering is the fourth largest in Texas, providing the local, regional, and national workforce with motivated and highly skilled graduates. The College boasts seven buildings, including the Science and Engineering Innovation and Research (SEIR) Building, which opened in Fall 2018. UTA is classified as a Research 1 University.

Electronics, MEMS and Nanoelectronics Systems Packaging Center National Academy of Engineering, the Electronics, MEMS and Nanotechnology Systems Packaging Center is a first class research center that will meet the needs of industry, and in particular, the state of Texas and the North Texas region's "Electronic, MEMS and Nanoelectronics Packaging Industry". This includes research, education, and training. EMNSPC will target the needs of the Microelectronics, MEMS and Nanoelectronics (with a special emphasis on thermo-mechanical issues) as a fundamental research area as these technologies have and will continue to overlap. The EMNSPC is a partner in the NSF I/UCRC Center for Energy-Smart Electronic Systems, working with government, industry, and academia to develop systematic methodologies for efficiently operating electronic systems.

More information at:

<https://blog.uta.edu/emnspc/>



## Program Cover Advertisement

World Scientific Publishing is a leading international independent publisher of books and journals for the scholarly, research and professional communities. World Scientific

collaborates with prestigious organisations like the Nobel Foundation and US National

Academies Press to bring high quality academic and professional content to researchers and academics worldwide. The company publishes about 600 books and over 140 journals in various fields annually. To find out more about World Scientific, visit us at : [www.worldscientific.com](http://www.worldscientific.com).

### **Contact:**

Jason Lim Chongjin  
[cjlim@wspc.com](mailto:cjlim@wspc.com)

**We thank all our sponsors and exhibitors for their generous and continued support. Please be sure to visit the Exhibit Hall and their virtual booths during the breaks over the next 3 days and for up to 3 months after the conference. Their contributions help make this conference sustainable.**





## KEYNOTE SPEAKERS

**Tuesday, October 27, 2020**

**8:00 AM to 9:00 AM**

**Dr. Suresh Ramalingam, *Xilinx Fellow (VP)***

### **Challenges and Opportunities in Next Generation of Advanced Packaging**



**Dr. Suresh Ramalingam** graduated in 1994 with a Ph.D. in Chemical Engineering from Massachusetts Institute of Technology, Cambridge. He holds 32 US 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 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.

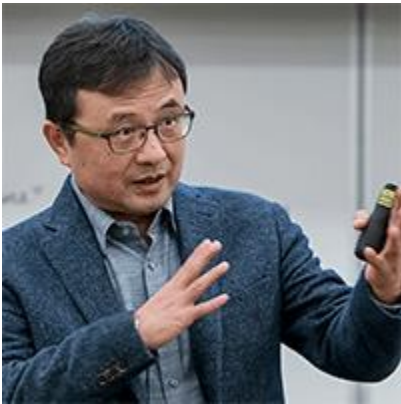


Wednesday, October 28, 2020

8:00 AM to 9:00 AM

Dr. Bongtae Han, Keystone Professor

**Quantitative Prediction of Warpage after Molding Processes: Is It a Myth?**



**Dr. Bongtae Han** is Keystone Professor of Engineering, and APT Chair of the Mechanical Engineering Department of the University of Maryland. Dr. Han has co-authored a textbook entitled "High Sensitivity Moiré: Experimental Analysis for Mechanics and Materials", Springer-Verlag (1997) and edited two books. He has published 12 book chapters and over 300 journal and conference papers in the field of microelectronics, photonics, and experimental mechanics. Dr. Han received the IBM Excellence Award for Outstanding Technical Achievements in 1994. He was a recipient of the 2002 Society for Experimental Mechanics (SEM) Brewer Award for his contributions to development of photomechanics tools used in semiconductor packaging. Most recently, he was named the 2016 American Society of Mechanical

Engineering (ASME) Mechanics Award winner in Electronic and Photonic Packaging Division for his contributions to structural mechanics of electronic systems. He has received several publication awards, including Year 2004 Best Paper Award of the IEEE Transactions on Components and Packaging Technologies. He served as an Associate Technical Editor for *Experimental Mechanics*, from 1999 to 2001, and *Journal of Electronic Packaging*, Transaction of the ASME from 2003 to 2012. He is currently serving as an Associate Editor for Microelectronics Reliability. He was elected a Fellow of the SEM and the ASME in 2006 and 2007, respectively.

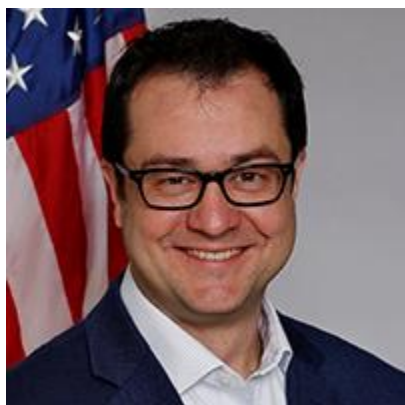


Thursday, October 29, 2020

8:00 AM to 9:00 AM

**Dr. Scott Miller, Director of Technology, NextFlex**

## Flexible Electronics



**Dr. Scott Miller** is the Director of Technology at NextFlex, America's Flexible Hybrid Electronics (FHE) Manufacturing Institute. Scott is responsible for the portfolio of technical projects funded by NextFlex, runs its Technical Council and Technical Working Groups, leads the development of FHE industry road mapping, oversees initiatives within the Institute, and builds and maintains relationships with government and industry partners.

Scott earned his Ph.D. in Chemical Engineering from Princeton University, where he did research on large area electronics manufacturing based on printing processes. Prior to joining NextFlex, Scott led materials R&D groups at GE Global Research supporting a diverse range of businesses. He has worked in areas including printed, flexible, and hybrid electronics; wearable devices; additive manufacturing; and bioprinting and bio fabrication.



## WORKSHOPS

### AI Workshop

Introduction to Robotics, Self-Driving Cars and AI with Drones

Monday, October 26

4:00 PM– 6:00 PM

Cost: \$25

### Presenters:

Anna Prakash, Dobriyal Priyanka, Abigail Agwai, Oliver Chen, *Intel Corp., AZ*

Elaina Ashton, *Arizona State University, Tempe, AZ*

**Abstract:** Have fun as you learn about virtual robotics, AI, and program self-driving cars with this introductory course. From understanding sensors to programming robots for missions, this course will equip you with virtual coding experience in programming 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 virtual robotics 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.

### Biographies:



**Elaina Ashton** is an engineering student at Arizona State University, Tempe Arizona. 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.



**Oliver Chen** is a Technical Marketing Engineer supporting AI in the Sales and Marketing Group at Intel Corporation. He is passionate about the intersection of leading-edge technology and new business opportunities. He thrives in expanding the STEAM pipeline by making AI and Maker content easier to consume.



**Priyanka Dobriyal** is a Product Engineer in Datacenter group at Intel Corporation. She has a Ph. D in Chemistry from University of Massachusetts, Amherst, and MS from Indian Institute of Technology, Roorkee, India. She is passionate about leading STEM outreach related activities.



**Abigail Agwai** received her BS, MS, and Ph. D in Mechanical Engineering for the University of Arizona. She is a Packaging Engineer at Intel. Abigail is passionate about introducing the next generation to the exciting world of STEM.



**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 & super computers. Anna has several patents & papers covering sensors and semiconductor packaging materials & 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.



## **Open Compute Project Workshop**

**Wednesday, October 28**

**10:50 AM to 12:20 PM**

**Organizers:** Jimil M. Shah and Saket Karajgikar

**Details:** The Open Compute Project Foundation is a rapidly growing, global community whose mission is to design, use, and enable mainstream delivery of the most efficient designs for scalable computing. The members of the community believe that openly sharing ideas, specifications, and other intellectual property is the key to maximizing innovation and reducing complexity in tech components. The Open Compute Project Foundation provides a structure in which individuals and organizations can share their intellectual property, research, ideas etc. with others and encourage the industry to evolve. At heart OCP promotes open collaboration for the industry/academia to share their insights and evolve as a community.

The organizers of the workshop would like to invite you all to learn more about OCP and their initiatives. During the workshop, our esteemed speakers will talk about inception of OCP, mechanics of OCP and some of the key project initiatives such as Data Center Facilities, Rack and Power, Advance Cooling Solutions and Open Domain-Specific Architecture (ODSA).

## **Program**

10.50 AM – 10.55 AM – Welcome and Introduction, Dr. Jimil M. Shah

10:55 AM – 11:10 AM – Inception and Background of OCP, Mr. Dharmesh Jani

11:10 AM – 11:25 AM – Mechanics and key projects, Mrs. Archana Haylock

11:25 AM – 11:40 AM – Data Center Facilities, Mr. Rob Coyle

11:40 AM – 11:55 AM – Rack and Power and Advance Cooling Solutions, Mr. Caleb Lusk

11:55 AM – 12:10 PM – Open Domain-Specific Architecture (ODSA), Dr. Bapi Vinnakota

12:10 PM – 12:20 PM – Collaboration opportunities and Concluding remarks, Dr. Saket Karajgikar



## Biographies:



**Jimil M. Shah** is an Application Development Engineer for server liquid cooling of data centers at 3M Company. His research is in the area of advanced cooling solutions for data center thermal management with a focus on single- and two-phase direct-to-chip and immersion cooling. Prior to joining 3M, Dr. Shah was the Post-Doctoral Research Associate at the University of Texas at Arlington. Dr. Shah received his PhD 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 Electronics and Photonics Packaging Division (EPPD) Student Engineer of The Year Award”. He is the recipient of the 2018 UTA College of Engineering Summer Dean’s Dissertation Fellowship

and spring 2018 UTA I-Engage Mentoring Program Scholarship. He has also received the “Best Student Abstract Award” at IMAPS 2015, Los Gatos, CA. He has published 24 journal and conference papers with two additional journal papers under review.



**Saket Karajgikar** has experience in developing thermal solutions at both data center level and at HW level. When he was working with Future Facilities, he assessed numerous data centers and provided recommendation to operate those efficiently. Later at Hyve Solutions, he managed team of thermal engineers while providing design inputs for compute and storage platforms. At Facebook, he is a lead engineer bridging the gap between HW design team and Data Center Solutions to ensure efficient and reliable operations of Facebook’s fleet of servers. Before joining industry, he graduated from University of Texas at Arlington under supervision of Prof. Agonafer.





**Dharmesh Jani ('DJ')** has been an active member of OCP since 2012. DJ has over 20+ years of experience in various roles spanning engineering, product management, and business strategy. He started his career at Rockwell Science Center designing ultra-high-speed circuits in CMOS, subsequently as a system designer he designed first terrestrial FEC based optical transmission system at Corvis Systems. As a product manager at Semtech, he introduced the world's first coherent 100G MUX for ultra-long-haul transport systems. Prior to joining Facebook, DJ led the cloud transformation for the biggest business unit at Flex. He was instrumental in bringing Flex into OCP and via founding of CloudLabs team, building core competencies within Flex to launch a cloud business unit. In his current role at Facebook, he is responsible for leading

OCP and other open technologies, working with stakeholders inside and outside Facebook. Earlier in his career, he held roles at Infinera and Intel among others listed above. DJ is based out of Menlo Park, CA and is looking forward to working with the OCP Community and leadership team to continue the drive towards more open infrastructure.



**Archna Haylock** has over 25 years of account executive experience delivering over-quota sales performance, leading team revenue growth, and discovering new markets. She is passionate about people, relationships and making connections. Being results oriented and strongly adept at creating cross-brand solutions, Archna has been assisting customers scale to global presence and helping them expand to new markets. She has been involved in creative solution design for "Internet of Things" applications and service-related solutions for Enterprise, Medical and Consumer industries. With over 15 years at IBM, she was a strong proponent that our customers' success is predicated on stellar sales service, their brand depends on it and they depend on our team. This personal philosophy led her to the Open Compute

Project (OCP) Foundation. At OCP, scalability, growth, impact, and efficiency are the key tenets which OCP solutions follow. Scalable designs across geographies and open source collaboration provide faster results for challenges faced by multiple industries. These open source hardware and software solutions will have a tremendous impact on the way we design, develop, create, and address these challenges.



**Rob Coyle** — PCX Corporation's Director of Sales and Marketing — oversees the customer's journey at PCX and works to remove friction from the client's problem-solving process. Coyle's sales experience includes electrical switchgear and emergency backup power systems for the data center market. He has several years of experience as an application engineer, where he sold and managed the implementation of emergency power systems akin to UPS Systems, electrical switchgear, automatic transfer switches and generators. Coyle holds Bachelors' degrees in Applied Science in Aeronautics, Aviation and Aerospace Science Technologies from Southern Illinois University. He is also a certified commercial multi-engine pilot, as well as a certified maintenance technician for airframe and powerplant systems.



**Caleb Lusk, PMP** is an Engineering Systems Consultant with Rittal, the world's leading manufacturer of industrial and IT enclosures. He has over 19 years of experience in design, enclosure manufacturing and project management with the company. Caleb holds a Mechanical Engineering degree and is a certified Project Management Professional (PMP). He is also an active member of the Open Compute Project serving as a Project Lead for the Rack and Power group. With his direct involvement, across global Rittal engineering teams, Caleb has helped to produced innovative designs for rack enclosures and liquid cooling solutions for both data center and industrial environments. He has a strong customer focus with an entrepreneurial spirit and is helping define next generation data centers.



**Bapi Vinnakota** is a System Architect with Broadcom. After a Ph.D. at Princeton, he taught at the University of Minnesota, where he received an NSF CAREER and IBM Faculty Development Awards. He joined Intel through an acquisition and was an architect of a VoIP flow processor, worked in networking technology and incubated a networking SaaS product. At Netronome, he created and ran open-nfp.org, a service for research in networking. He leads the Open Domain-Specific Architecture sub-project, in the Open Compute Project. The ODSA has active volunteers from over 30 companies and aims to define an open chiplet marketplace.



## **Heterogeneous Integration Roadmap Workshop - Part 1**

**Thursday, October 29**

**9:10 AM – 10:40 AM**

## **Heterogeneous Integration Roadmap Workshop - Part 2**

**Thursday, October 29**

**10:50 AM – 12:20 PM**

**Moderators:** Bill Bottoms, Ravi Mahajan

**Facilitators:** Gamal Refai-Ahmed, Amr Helmy, Bill Chen, Madhusudan Iyengar, Weihua Tang, Abhijit Dasgupta

The Workshop will be held on Thursday October 29th (9:10 AM –12:20 PM PST). The Workshop topics are tailored to the InterPACK audience and include a focus on Photonics, Thermals, Interconnects and Reliability. The workshop has a panel format and we are excited to welcome a highly distinguished panel in this workshop.

### **Panel Format**

- Each panelist gets 5 mins to make an opening statement on their strategic vision for Heterogeneous Integration
- Moderators will then open the panel for questions and an open debate
  - Attendees are encouraged to send questions by email to Bill Bottoms (bill\_bottoms@3mts.com) or Ravi Mahajan (ravi.v.mahajan@intel.com) beforehand.
    - Questions will also be solicited live in the chat window
  - End panel with a closing statement by Bill Bottoms and Bill Chen on HIR status/plans



## Panelists Biographies:



**John Shalf** is Department Head for Computer Science Lawrence Berkeley National Laboratory, and recently was deputy director of Hardware Technology for the DOE Exascale Computing Project. Shalf is a coauthor of over 80 publications in the field of parallel computing software and HPC technology, including three best papers and the widely cited report "The Landscape of Parallel Computing Research: A View from Berkeley" (with David Patterson and others). He also coauthored the 2008 "ExaScale Software Study: Software Challenges in Extreme Scale Systems," which set the Defense Advanced Research Project Agency's (DARPA's) information technology research investment strategy. Prior to coming to Berkeley Laboratory, John worked at the National Center for Supercomputing Applications and the Max

Planck Institute for Gravitation Physics/Albert Einstein Institute (AEI) where he was co-creator of the Cactus Computational Toolkit.



**Dr. Antai Xu** has been the Senior Director of Reliability Engineering at Xilinx Corporation since 2015. He has led all new product qualifications of 16nm and 7nm technologies, overcoming many challenges in 2.5D & 3D Si integration. Prior to joining Xilinx, he served as the Division Head of Backend Quality and Reliability in TSMC, where he led the reliability testing and qualifications of the two breakthrough technologies, CoWOS & InFO. Both technologies were successfully delivered to production with phenomenal impact to the semiconductor product development in the final stage of Moore's Law. Dr. Xu's broader experiences also include 28 years of R&D, Materials Processing, Reliability as well as Executive Management in the industry of Aerospace Electronics, HDD Storage, O/MEMS, and Bio/DNA

testing systems. Dr Xu received his PHD from Purdue University in Materials Science, and MS from Georgetown University in Physics.



**Dr. Ali Heydari** is Data Center Technologist at Nvidia in charge of all data center technology development at Nvidia. In this role, he is developing direct to chip liquid cooling technologies using cold plates, cooling distribution units and manifolds for cooling of Nvidia's high heat density. 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 CPU/GPU servers and liquid cooled heat exchanger rack and data center solutions for achieving extremely low data center PUE/WUR 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 BS in Mechanical Engineering from University of Illinois, Urbana, MS, PhD in Mechanical Engineering and MA in Applied Mathematics from University of California, Berkeley. He has over 25 issued patents in data center cooling technologies.



**Professor John Bowers** is Director of the Institute for Energy Efficiency and a Distinguished Professor in the Departments of Electrical and Computer Engineering and Materials at the University of California, Santa Barbara. His research interests are primarily concerned with silicon photonics, optoelectronic devices, optical switching and transparent optical networks and quantum dot lasers. Bowers received the M.S. and Ph.D. degrees from Stanford University and then worked for AT&T Bell Laboratories before joining UCSB. Bowers is a fellow of the IEEE, OSA and the American Physical Society, and a recipient of the IEEE Photonics Award, OSA/IEEE Tyndall Award, the IEEE LEOS William Streifer Award and the South Coast Business and Technology Entrepreneur of the Year Award. He is a member of the National

Academy of Engineering and the National Academy of Inventors.



## **Mentorship Workshop**

**Thursday, October 29**

**11:00 AM to 12:30 PM**

**Organizers:** Darshan G. Pahinkar and Ronald Warzoha

**Details:** This workshop, sponsored by the ASME K-16 committee, focuses on providing a common platform for those seeking advice regarding their careers such as growth, change of careers, networking and any other pertinent concerns outside their everyday contact circle without any obligation. Senior experts in the academics, industries and national labs shall be providing their contact details on a common LinkedIn platform, which shall be accessible to the interested mentees, who can contact them at seek guidance on as-needed basis. This mentoring activity not only gives mentees exposure to a wider network of successful peers, but also gives them a perspective of their progress from an outsider's standpoint.

In this workshop, three senior experts will share their life stories with attendees detailing how timely and constructive advice from mentors and peers helped them 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. A pilot scale mentoring program was introduced in ASME InterPACK 2019 and a mentor-mentee pair will share their experiences on how this mentoring program helped them. The workshop will conclude with the question and answer session.

## **Program**

11:00 AM – 11.05 PM – Welcome and Introduction, Dr. Ron Warzoha

11:05 AM – 11.45 AM – Panel Presentations

1. Dr. Ron Warzoha, US Naval Academy
2. Dr. Ankur Jain. University of Texas, Arlington

11:45 AM – 12.00 PM – Mentoring activity details, instructions, and next steps, Dr. Darshan Pahinkar

12:00 PM – 12.10 PM – Experience of a mentor-mentee pair

12:10 PM – 12.25 PM – Question and answer session

12:25 PM – 12.30 PM – Concluding remarks



## Speaker Biographies:



**Darshan G. Pahinkar** joined Florida Tech as an assistant professor of Mechanical Engineering in the Department of Mechanical and Civil Engineering in Spring 2020. He is developing the [Energy Systems Laboratory at Florida Tech](#) and his research currently focuses on developing scalable and sustainable energy conversion and storage systems, and thermal management of electronic components. Prior to this appointment, Darshan received his B.E. in Mechanical Engineering from the 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. For next two years, he worked as a Manager (Development) in Tata Motors Engineering Research Center, Pune, and his work involved thermal management of automobiles.

Darshan graduated with a PhD in Mechanical Engineering from Georgia Tech in fall 2016. He was a post-doctoral fellow at Georgia Tech Electronics Manufacturing and Reliability Laboratory before joining Florida Tech. He is the author of 16 peer reviewed journal papers related to energy systems, their thermal management and interface materials for electronic packaging, and holds one patent.



**Prof. Ronald Warzoha** is an Associate Professor of Mechanical Engineering at the United States Naval Academy, which is an undergraduate-only institution, and is a first-generation college student. He teaches undergraduate courses in Heat Transfer, Thermal-fluid Sciences, Thermodynamics, and Fluid Mechanics. Prof. Warzoha also runs the Nanoscale Electronic and Thermal Transport (NEaTT) Laboratory at USNA with 4-5 undergraduate students annually and focuses on the development of novel optical pump-probe thermoreflectance techniques for interrogating nanoscale thermal physics in electronic material systems. He is the recipient of the USNA Apgar Award for Excellence in Teaching, which is given every two years to a junior faculty member who has had a demonstrable impact on

their students and has made a significant contribution to the art of teaching and counseling students, and is a nominee for the current Class of 1951 Faculty Research Award. He was also the recipient of the 2016 ITherm "Best Paper" award in the Emerging Technologies track and has had several featured papers selected by the Editors of *Applied Physics Letters*. He is a graduate of Villanova University (PhD '14, MS '09, and BS '08), where he was awarded the College of Engineering's Most Outstanding Ph.D. Student Award and was given the Outstanding Graduate Student Award as an M.S. student. He is the author of 34 peer-reviewed publications, has been awarded nearly \$2M in funding from ONR, JTO, and the DoD, and holds one patent. He has three young daughters, one of which was born during his Ph.D. work.



**Ankur Jain** is an Associate Professor in the Mechanical and Aerospace Engineering Department at the University of Texas, Arlington, USA. He directs the [Microscale Thermophysics Laboratory](#), which carries out experimental and theoretical research on heat transfer and energy conversion in Li-ion batteries, advanced manufacturing, bioheat transfer, as well as theoretical heat transfer. He received the Lockheed Martin Excellence in Teaching Award (2018), UTA 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, where he received the Stanford Graduate Fellowship (SGF) and his B.Tech. (2001) in Mechanical

Engineering from the Indian Institute of Technology (IIT), Delhi with the highest GPA among the class of Mechanical Engineering. He has published 77 high quality journal articles on topics related to energy conversion and heat transfer in batteries, microelectronics as well as theoretical heat transfer.



**Dr. Lauren Boteler** leads the thermal and packaging research programs as part of the Advanced Power Electronics group at the U.S. Army Research Laboratory (ARL). She received her PhD degree in mechanical engineering from the University of Maryland. Her work at ARL, beginning in 2005, has included electronics packaging and thermal management solutions for a wide range of Army applications. Her research programs focus on design tool development and package integrated thermal solutions including 3D chip stacking, power electronics, laser diodes, double side cooling, and phase change materials. She initiated a research portfolio in Advanced Power Electronics Packaging and Thermal Management which defines the four main challenges of power electronics packaging: co-engineering/co-design,

transient thermal mitigation, additive manufacturing, and high-voltage packaging. She recently completed a broadening assignment as the Technical Assistant to the Director as part of the senior technical staff of the U.S. Army Research Laboratory and is currently on a detail assignment at the Combat Capabilities Development Command focused on building an S&T Integration Strategy. Dr. Boteler is also an adjunct professor at Johns Hopkins University and was awarded the 2018 ASME EPPD Woman Engineer of the Year award for her contributions to the electronics packaging community.





## **Career Development Workshop**

**Thursday, October 29**

**1:50 PM to 3:30 PM**

**Organizers:** Jimil M. Shah and Saket Karajgikar

**Details:** Effective job search with skilled networking is extremely important for engineers and researchers especially in current situation. This workshop will focus on the career development and job hunting. Three presenters – two from academia and one from industry will discuss key do's and don'ts of networking and job search. They will share their experiences and offer advice about designing effective job-hunting tools. Professors from different institutions will also provide their expertise and market current graduating students through a video.

## **Program**

1:50 AM – 2:00 PM – Welcome and Introduction, Dr. Jimil M. Shah

2:00 PM – 2:15 PM – Prof. Dereje Agonafer

2:15 PM – 2:30 PM – Dr. Saket Karajgikar

2:30 PM – 2:45 PM – Prof. Amy S. Fleischer

2:45 PM – 3:15 PM – Video

3:15 PM – 3:30 PM – Q&A and Concluding remarks, Dr. Jimil M. Shah



## Speaker Biographies:



**Dereje Agonafer** is a Presidential Distinguished Professor in MAE at University of Texas at Arlington (UTA) where he heads two centers: Site Director of NSF I/UCRC in Energy Efficient Systems and Director of Electronic Packaging. After receiving his PhD at Howard University, he worked for 15 years at IBM. In 1991, his work was recognized by being awarded the "IBM Outstanding Technical Achievement Award in Appreciation for Computer Aided Thermal Modeling." Since joining UTA in 1999, he has graduated 230 graduate students (a record for the University) including 25 PhDs and currently advising 16 PhDs and 13 MS students. His former students are making significant contributions in many technology companies such as Facebook, Intel, 3M, Microsoft, and Amazon. His new initiative is to start a new center called

RAMPES (Center for Reliability Assessment in Micro and Power Electronic Systems) for which he has received significant funding including \$1.3M for new equipment, 3000 sq ft of new lab space, Assistant and Associate Professor openings to work with him, and research engineer among others. For his contributions, he has received numerous awards including the 2008 Thermi Award, the 2009 InterPACK Excellence Award, the 2014 IThERM Achievement Award, the 2014 NSBE Golden Torch Award and the 2019 ASME Heat Transfer Memorial Award. In 2020, he was the recipient of Howard University Charter Day Award for Distinguished Postgraduate Achievement: research engineer. He is a fellow of the National Academy of Inventors, the American Association for the Advancement of Science, and the American Society of Mechanical Engineers. In 2019, he was elected to the National Academy of Engineering. According to Dean Crouch, "the first current faculty member elected to the Academy." Professor Agonafer is married to his wife Carolyn and they have two children; a son, Dr. Damena Agonafer who is Professor of Mechanical Engineering & Materials Science at Washington University in St. Louis, and a daughter, Dr. Senayet Agonafer, a Radiologist, who works at Lennox Hill Radiology in New York City.



**Saket Karajgikar** has experience in developing thermal solutions at both data center level and at HW level. When he was working with Future Facilities, he assessed numerous data centers and provided recommendation to operate those efficiently. Later at Hyve Solutions, he managed team of thermal engineers while providing design inputs for compute and storage platforms. At Facebook, he is a lead engineer bridging the gap between HW design team and Data Center Solutions to ensure efficient and reliable operations of Facebook's fleet of servers. Before joining industry, he graduated from University of Texas at Arlington under supervision of Prof. Agonafer.



**Dr. Amy S. Fleischer** is in her third year of leadership as Dean of Engineering at Cal Poly. In this role she sets strategic direction for the college and oversees the operations of the eight departments, 14-degree programs, 220 FTE faculty, 55 staff, 6000 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.



## TUTORIALS

### **Probabilistic Design for Reliability in Electronics and Photonics and Its Role in Making a Viable IC Package into a Reliable Product**

**Tuesday, October 27**

**1:50 PM – 3:50 PM**

**Presenter:** Ephraim Suhir

This tutorial addresses an evolving philosophy of accelerated testing in electronic and photonic packaging. The suggested methodology could be viewed as a possible extension and modification of Highly Accelerated Life Testing (HALT) for applications where a high level of operational reliability is critical, such as aerospace, military, long-haul communications, automatically driving vehicles, or medical devices. The highly focused and highly cost-effective Failure Oriented Accelerated Testing (FOAT) approach is suggested as a suitable experimental basis for the Probabilistic Design for Reliability (PdFR) concept. The PdFR concept is used to assess a product's lifetime and the corresponding never-zero probability of failure in the field, and to make this probability adequate for the given product and application. The general concepts are illustrated by numerical examples.



**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 also CEO of a Small Business Innovative Research (SBIR) ERS Co. in Los Altos, CA, USA, is Foreign Full Member (Academician) of the National Academy of Engineering, Ukraine (he was born in that country); Life Fellow of the Institute of Electrical and Electronics Engineers (IEEE), the American Society of Mechanical Engineers (ASME), the Society of Optical Engineers (SPIE), and the International Microelectronics and Packaging Society (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 American Institute of Aeronautics and Astronautics (AIAA).

Ephraim has authored about 450 publications (patents, technical papers, book chapters, books), presented numerous keynote and invited talks worldwide, and received many professional awards, including 1996 Bell Laboratories Distinguished Member of Technical Staff (DMTS) Award (for developing effective methods for predicting the reliability of complex structures used in AT&T and Lucent Technologies products), and 2004 ASME Worcester Read Warner Medal (for outstanding contributions to the permanent literature of engineering and laying the foundation of a new discipline “Structural Analysis of Electronic Systems”). Ephraim is the third “Russian American”, after S. Timoshenko and I. Sikorsky, who received this prestigious award. Last year he received the 2019 IEEE Electronic Packaging Society (EPS) Field award for seminal contributions to mechanical reliability engineering and modeling of electronic and photonic packages and systems and Int. Microelectronic Packaging Society’s (IMAPS) Lifetime Achievement award for making exceptional, visible, and sustained impact on the microelectronics packaging industry and technology.



## Thermal and Reliability Aspects of Automotive Power Electronics: Current Status and Future Trends

Wednesday, October 28

1:50 PM – 3:50 PM

**Presenters: Sukwon Choi, Gilberto Moreno, Douglas DeVoto**

This tutorial will first provide an overview of existing automotive power electronics thermal management systems. This includes descriptions of current packaging configurations and heat exchanger designs. The thermal performance of various automotive systems is quantified, and thermal bottlenecks are identified. Common failure locations (e.g., wire bonds, solder interface) and mechanisms within traditional package designs are then discussed. The second part of the tutorial will discuss future trends in automotive power electronics thermal management systems. This includes the vision towards efficient, high temperature, higher voltage wide bandgap (WBG) devices (e.g., silicon carbide, gallium nitride). Device-scale thermal modeling work will be presented to highlight the challenges associated with WBG devices based on gallium oxide. Concerns associated with packaging the higher temperature and high heat flux devices will be described. Finally, examples of alternative packaging solutions and cooling concepts (i.e., heat exchanger) that enable high temperature devices operation and increased power density will be presented.

### Speaker Biographies:



**Gilberto Moreno** leads research projects related to the development of advanced thermal management solutions for automotive power electronics components within NREL's APEEM Group. He has over 10 years of experience in the design and evaluation of thermal management systems.



**Douglas DeVoto** leads reliability evaluation and prognostics research for automotive power electronics within NREL's Advanced Power Electronics and Electric Machines (APEEM) Group, with a focus on bonded interfaces and electrical interconnects. He has 10 years of experience in accelerated testing, thermal, and thermomechanical FEA modeling for electric-drive vehicles and other applications.



**Sukwon Choi** is an Assistant Professor of Mechanical Engineering at the Pennsylvania State University. His group focuses on the thermal characterization and electro-thermal co-design of ultra-wide bandgap power electronics and thin film piezoelectric micro-electro-mechanical systems (MEMS).



## PANELS

### **HIR Challenges and Opportunities**

**Tuesday, October 27**

**9:10 AM – 10:40 AM**

**Chair: Dr Gamal Refai-Ahmed, Xilinx Fellow**

**Co-Chair: Professor Leila Choobineh, SUNY Polytechnic Institute**

#### **Panelists:**

- Prof Bahgat Sammakia, Vice President Binghamton University
- Prof Amr Helmy, Professor University of Toronto
- Dr. Ravi Mahajan, Intel Fellow
- Dr. Suresh Ramalingam, Xilinx Fellow

This panel will be addressing the challenges of the current and future HIR challenges. This is a complete dynamic panel. Panelists will be in a complete dialog with each other in the following areas:

- Can academia produce a valuable proposition to the industry?
  - Each academic panelist will give 1-2 examples
- Can Foundry provide a meaning information (i.e. manufacturing process, materials, assemble, analysis) to enable holistic Heterogenous Integration from Si supplier/OSAT/
  - Each industrial panelist will give 1-2 examples
- Do we need to have a new definition of Life time in Heterogenous Integration era? h (i.e. Fit Budget should be done based on the end customer applications, Co-planarity should be revised in JEDEC, how can we connect TC (C/B/G..), Electro migration.... Component to system)
  - Each Panelist will give its view
- What are the gaps from Panelists point view on the current offering road maps from HIR?



**Dr Gamal Refai-Ahmed**, Life Fellow ASME, Fellow Canadian Academy of Engineering, is a Distinguished Engineer and Adjunct Professor in Watson School of Engineering and Applied Science SUNY Binghamton. He obtained the M. A. SC. and PhD degrees in Mechanical Engineering from the University of Waterloo. He is the author of more than 90 technical papers and more than 100 US patents/International Patents/ Pending patents. He is an Associate Editor of Journal Components and Packaging, IEEE and Journal of thermal Sciences and Engineering and Applications, Transactions of the ASME.



**Dr. Leila Choobineh** is an assistant professor of Mechanical Engineering at SUNY Polytechnic institute. She received the Ph.D. degree (2014) in mechanical engineering from the University of Texas at Arlington. Her research interests include the development of micro- and nano-scale sensors, thermal management of 3D integrated circuits, microelectronics, flexible electronics, and microelectronics cooling. She recently received funding from Silicon Research Corporation and Research Foundation of State University of New York to work on nano porous metal applications for thermal capacitor and immersion cooling of microelectronics. She published her work at IEEE TCPMT, ASME Journal of electronics packaging, Applied Physics Letters, Applied Thermal Engineering, International Journal of Thermal Sciences and presented her work at ASME IMECE, ASME InterPACK, IEEE Itherm conferences. She is an Associate Editor of the IEEE Transactions on Components, Packaging and Manufacturing Technology journal. In addition, she had served as session chair, topic chair and track chair at IMECE, IEEE ITherm and ASME InterPACK conferences.





**Bahgat Sammakia**, a SUNY distinguished professor of mechanical engineering, is the vice president for research at Binghamton University.

He is the founding director of S3IP, a New York State Center of Excellence, and is the director of the Energy-Efficient Electronic Systems Center (ES2) and the Center for Heterogeneous Integration Research in Packaging (CHIRP). Sammakia served as the interim president of SUNY Polytechnic Institute from December 2016 to June 2018.

Sammakia, who holds 21 U.S. patents and has published more than 250 peer-reviewed technical papers, is a fellow of the American Society of Mechanical Engineers, the National Academy of Inventors, and the IEEE. He 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, Sammakia joined Binghamton University's faculty in 1998.



**Amr S. Helmy** joined the department of Electrical and Computer engineering of the University of Toronto with a mixed experience in academic as well as industrial settings. He received both his M.Sc. (1995) and Ph.D. (1999) degrees from the University of Glasgow, Scotland, in the field of photonics. Between 2000 and 2004 he joined Agilent Technologies, where he was involved in developing different photonic devices ranging from high reliability submarine-class lasers, to un-cooled single mode lasers, to integrated photonic circuits. Dr. Helmy's research interests include quantum/non-linear integrated photonic devices/circuits and nano-photonic devices/circuits using hybrid metallic architectures. The application domains, where his group contributes, include optical signal processing, communications, and sensing.

### **Memberships/Awards**

Vice President for the IEEE Photonics Society

Editor for several IEEE and OSA journals

Chaired flagship conferences for IEEE and OSA; namely CLEO and IEEE IPC



**Ravi Mahajan** is an Intel Fellow responsible for Assembly and Packaging Technology Pathfinding for future silicon nodes. 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 also led to high-performance, cost-effective cooling solutions for high-end microprocessors and the proliferation of photo-mechanics techniques used 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 & the 2018

InterPACK Achievement award from ASME, the 2019 "Outstanding Service and Leadership to the IEEE" Awards from IEEE Phoenix Section & Region 6 and most recently the 2020 Richard Chu ITherm Award For Excellence. 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 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.



**Dr. Suresh Ramalingam** graduated in 1994 with a Ph.D. in Chemical Engineering from Massachusetts Institute of Technology, Cambridge. He holds 32 US 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 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.



## Materials for Additive Manufacturing

Tuesday, October 27

9:10 AM – 10:40 AM

**Chair:** Daniel Hines, Laboratory for Physical Sciences, College Park, MD

**Summary:** Materials for Additive/Printed Electronics are one of the ‘hard problems’ related to achieving robust manufacturing capabilities in this area. High quality and fully characterized solutions are needed in at least 3 main categories of inks: (1) conducting inks, (2) dielectric inks and (3) structural inks (e.g., for substrates). Panelists will discuss the state of the art in materials for additive/printed electronics and will also address questions including how to set requirements/standards for these materials and how to create a robust supply chain that can service the manufacturing needs of the industry.

### Panelists:

Brett Walker, Electroninks

Ethan Secor, Iowa State University

Yuri Didenko, UTDots

Dave Pope, NovaCentrix

Jeffrey Dee, DuPont

**Daniel Hines, Ph.D.** obtained an MS in Physics from Michigan State University and a Ph.D. from the University of Maryland. Prior to coming to the Laboratory for Physical Sciences (LPS), he worked at Schumberger's research center in Ridgefield, CT and at the NEC Research Institute (NECI) in Princeton, NJ.

**S Brett Walker** is the CEO of Electroninks Incorporated which was founded in 2013 based on his PhD research at the University of Illinois. Electroninks Incorporated is an advanced materials company based on high performance metal precursor inks based in Austin TX where there are 30 employees and a 30,000 sq ft lab space.



**Ethan B. Secor** is an assistant professor in mechanical engineering at Iowa State University, where his research addresses materials and processing challenges in printed electronics. He received a Ph.D. in Materials Science and Engineering from Northwestern University for research on graphene-based inks. During postdoctoral research at Sandia National Laboratories, he established a process science framework and real-time monitoring tools to better understand aerosol jet printing, including factors of ink formulation, printer design, and process

optimization.



**Dr. Yuri Didenko** is the President and CTO of UT Dots, Inc. He oversees company's manufacturing process and sales, manages budget and resources, research, and development of new products, and develops strategic plans to promote revenue and profitability of the company.

Yuri obtained his PhD in Physical Chemistry from Moscow State University, Russia. The subject of his research was sonochemistry and, sonoluminescence. Then he moved to the United States, where he continued his research at the University of Illinois, and then developed chemical aerosol-flow synthesis of nanoparticles and quantum dots. He founded UT Dots in 2006. The company manufactures and sells conductive and dielectric inks for printed electronics. UT Dots continues working on developing new products for specific applications and collaborates with research organizations, printing companies and universities to achieve these goals.



**Dr. Pope** is currently Director of Printing Technologies at NovaCentrix in Austin, Texas where he has led the development and implementation of new conductive and other functional inks since 2008. Previous to his time at NovaCentrix, he held various research and engineering positions with Cabot, Sasol, and Schlumberger working on projects ranging from producing modified inkjet pigments to optimizing production of aluminum alkyls to oil well stimulation. He received his PhD in Chemical Engineering from The University of Texas at Austin and has a number of patents and publications.

**Jeffrey Dee** is the printed electronics application development leader for DuPont Silicon Valley Technology Center, focused on establishing DuPont as the materials partner of choice for consumer electronics and emerging electronics OEMs and fabricators. Jeffrey received his M.S. in Mechanical Engineering and B.S. in Chemical Engineering, both from the University of Washington. He joined DuPont in 2011, with prior process engineering experience in semiconductor and solar materials industries. Currently, Jeffrey and the DuPont team are working closely with OEMs and fabricators to develop optimized materials, characterization, and process solutions for the most challenging technical problems that the electronics industry faces today.



## Advances in Wearable/Wireless Flexible Electronics: Thermal and Mechanical Challenges and Opportunities- Wearable/Wireless Flexible Electronics

Tuesday, October 27

10:50 AM – 12:20 PM

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

**Summary:** The emergence of 5G will help power a significant rise in wearable/mobile/wireless communication, providing the infrastructure needed to carry huge amounts of data, allowing for a smarter and more 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 flexible electronics thermal management and other advanced system-level thermo-mechanical challenges and solutions of the future.

### Panelists:

- Dr. Kinzy Jones, Jr. (Magic Leap, VP Engineering)
- Professor YC Lee (UC Boulder, CEO of Kelvin Tech)
- Matthew Dalton (WP-AFRL, Engineering Lead)
- Prof Amy Marconnet, (Purdue)
- Dr. Luca Amalfi (Nokia/Bell Labs, Sr Engineer)



**Victor Chiriac** is 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. He previously held technology/engineering leadership roles, led corporate thermal technology teams and roadmaps, working on leading-edge mobile/wireless technologies with Motorola (1999-2010), Qualcomm (2010-2018) and Futurewei /Huawei R&D USA (2018-2019). Dr. Chiriac was elected Chair of the ASME K-16 Electronics Cooling Committee and was elected the Arizona and New Mexico IMAPS (International Microelectronics and Packaging Society) Chapter President in 2010. He is a co-editor of Electronics Cooling Magazine since 2016 and a leading member of the organizing committees of ASME/InterPack,

ASME/ IMECE and IEEE/CPMT ITherm Conferences. He holds 19 U.S. issued patents, 1 US Trade Secret, 1 US Defensive Publication and has published over 109 papers in scientific journals and at international conferences. PhD (1999) in Aerospace and Mechanical Engineering, University of Arizona, Tucson, USA



## User-Centric Modeling in Spatial Computing



**Dr. Jones'** background is mathematical modeling including materials, fluids, and structures. His work, and that of his team, strives to use simulation, material analysis, and high fidelity testing to predict product failures and identify design improvements, thus reducing cost from unnecessary prototype builds and field failures, reducing time to market, and improving KPIs. He has been at Magic Leap for six years creating and managing the Advanced Mechanics and Materials group and serving as a Magic Leap Fellow. Previously, he was a Distinguished Member of the Technical Staff at Motorola and Vice President of Consulting Services at Amoeba Technologies. He received his Ph.D. from the University of California, Berkeley in Materials Science and Engineering in 1999.

**Abstract:** Spatial computing facilitates mixed reality experiences and is poised to become the world's next computing platform. This will enable innovative forms of entertainment, productivity, education, communication, and commerce. This new platform will radically change human interaction with technology by blurring the lines between the physical and virtual worlds – making computer interaction richer, faster, and more enjoyable. The addition of 5G will further this merging, enabling virtual objects to 'live' in our physical environments just as physical objects do today. Achieving this grand vision requires overcoming many challenges. This talk focuses on moving from device- to human-centric metrics and results. Traditional device-centric key performance indicators (KPI) like temperature, stress, and displacement, are difficult to resolve in terms of user experience, potentially focusing engineering effort on parameters with limited impact. This talk presents two examples showing a user-based, rather than device-based, approach to spatial computing product development: human thermal comfort modeling, and the use of Multiphysics to determine sensor performance.



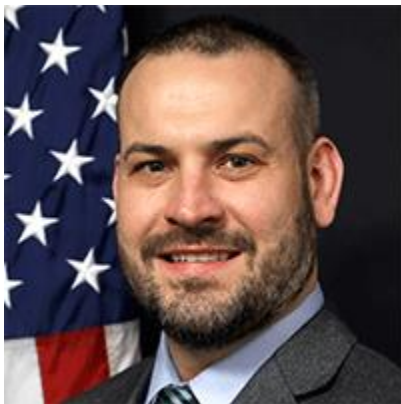
## Flexible Thermal Ground Planes for Smartphones, Computers and Power Electronics



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

**Abstract:** Flexible thermal ground planes (TGP) are vapor chambers designed and manufactured using flexible circuit board technologies. The first TGP product is to be mass produced by 4Q in 2020. Our TGP is known for its outstanding features: thinnest configuration, large size, flexible, conformable, deformable, foldable, super isothermal, high heat flux and low cost. Kelvin Thermal is well positioned to provide leading thermal management solutions for smartphones, tablets, laptop computers, ARs/VRs, displays, electric vehicles with autonomous features, GaN-based power electronics, and edge and cloud computing. This brief presentation will illustrate some of the TGP products to be introduced in the near future: 0.150mm TGP, polymer TGP, folding TGP and high power TGP.

## SmartMedTech Prototype Wearable Devices for the USAF Aeromedical Mission

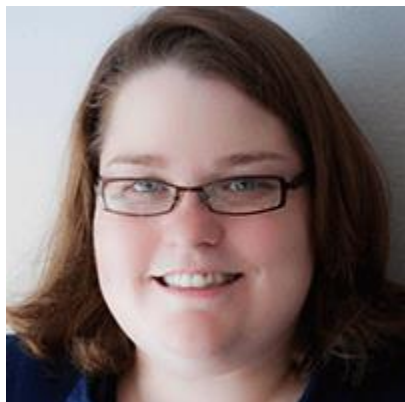


**Matthew J. Dalton** is a Research Chemist and Program Manager within the Soft Matter Materials Branch of the Materials and Manufacturing Directorate at the Air Force Research Laboratory. Executes the branch's applied technology development portfolio developing and demonstrating advanced materials solutions for aerospace wearable technology for both the high-performance flight environment and the aeromedical mission. Manages the Materials for Aeromedical Technology and Care Program developing low-cost physiological sensors for the En Route Care mission. Mr. Dalton obtained his BS in Chemistry from Wright State University and his MS in Materials Chemistry from the University of Illinois at Urbana-Champaign.

**Abstract:** The En Route Care (ERC) Aeromedical Evacuation (AE) system provides for the strategic military medical evacuation of patients and wounded warfighters. Vital to this mission is the pursuit of new methods for transporting patients with increased effectiveness and efficiency while dealing with the unique challenges of the aerospace transport environment: reduced barometric pressure and oxygen availability, increased accelerational and vibrational forces, ambient thermal instability, and a dry environment that may negatively impact patient health or device performance during transport. Reliable, wireless, wearable physiological monitoring technology can help the AE medical provider optimize patient care en-route through increased situational awareness, alerting, and decision support. Most commercial off-the-shelf (COTS) technology does not meet USAF or military requirements (JECETS, MIL-STD-810H) for operational use. Flexible electronic prototypes in development and challenges and opportunities will be discussed.



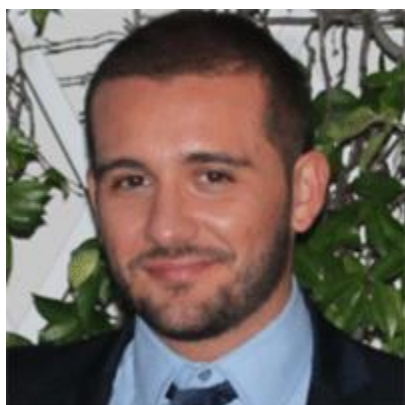
## Flexible, High Thermal Conductivity Materials



**Professor Amy Marconnet** is an associate professor of Mechanical Engineering at Purdue University. Research in the Marconnet Thermal and Energy Conversion (MTEC) Lab intersects heat transfer, energy conversion, and materials science to enable advances in technologies where energy conversion and thermal transport are key factors in performance. Prof. Marconnet has developed an interdisciplinary research program to evaluate, understand, and control the physical mechanisms governing the multifunctional properties of materials, machines, and systems. Recently, Dr. Marconnet won the 2020 Bergles-Rohsenow Young Investigator Award in Heat Transfer from ASME.

**Abstract:** The emergence of wearable and flexible electronics necessitates the development of flexible materials with tailored thermal/mechanical properties not naturally occurring. A particular challenge for wearable electronics is optimizing and tuning the thermal transport to dissipate heat to the environment without exceeding safety limits for human contact and while maintaining the mechanical flexibility for user comfort. Woven materials consisting of high thermal conductivity fibers have shown significant promise in meeting these multi-functional needs. From a filament to fabric perspective, we have developed new metrology tools to evaluate these systems and provide feedback as we engineer high thermal conductivity, flexible materials for wearable and flexible electronics.

## Mini-Pulsating Heat Pipes for Wearable and Flexible Electronics



**Dr. Raffaele Luca Amalfi** is a Member of Technical Staff and Lead Researcher at Nokia Bell Labs New Jersey, where he performs cutting-edge research in the field of thermal management of high-performance telecommunications and computing systems across multiple scales. He is the Principal Investigator on behalf of Nokia of America Corporation and Bell Labs for the Eurostars Project PCOOLDATA focused on the development of innovative cooling solutions for datacenters. His research activities include macro-to-micro-scale heat and mass transfer, thermal-mechanical design of advanced heat exchangers, integrated opto-electronics thermal management; active and passive thermal solutions for electronics, power-electronics- and datacenter-cooling. He has received a Ph.D. in Energy Engineering from EPFL and he has authored more than 30 scientific publications.





**Abstract:** The world is entering the Fourth Industrial Revolution that is bringing together digital, physical, and biological systems, which will deeply transform economy and society. Demand for processing, transporting, and storing digital data is growing exponentially, and this will have profound implications on system design with the associated trend toward achieving greater device functionality per unit volume. Sensing and diagnostic wearable devices, as well as flexible electronics are seen as emerging products, allowing greater connectivity between humans and machines. However, these devices present many thermal and mechanical challenges. Embedded passive two-phase cooling represents a viable and attractive solution, as it provides high heat dissipations and uniform heat spreading coupled with small form factors. In this talk, I will discuss the benefits and opportunities of implementing mini-pulsating heat pipes to keep scaling and developing advanced wearable and flexible devices.



## Women in Engineering

Tuesday, October 27

10:50 AM-12:50 PM

Chair: Dr. Leila Choobineh

- 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.
- The panel will have representation from a wide range of educators from university level and leaders from related industries and government labs.

### Panelists:

- Tannaz Harirchian, Intel Corporation
- Jelena Srebric, Professor, Acting Associate Dean of Research, A. James Clark School of Engineering, University of Maryland
- Nesrin Ozalp, Professor of Mechanical Engineering and Department Chair, Purdue University Northwest
- Elham Maghsoudi, NASA Jet Propulsion Laboratory
- Anna M Prakash, Intel Corporation
- Shelby Nelson, Mosaic Microsystems
- 



**Dr. Leila Choobineh** is an assistant professor of Mechanical Engineering at SUNY Polytechnic institute. She received the Ph.D. degree (2014) in mechanical engineering from the University of Texas at Arlington. Her research interests include the development of micro- and nano-scale sensors, thermal management of 3D integrated circuits, microelectronics, flexible electronics, and microelectronics cooling. She recently received funding from Silicon Research Corporation and Research Foundation of State University of New York to work on nano porous metal applications for thermal capacitor and immersion cooling of microelectronics. She published her work at IEEE TCPMT, ASME Journal of electronics packaging, Applied Physics Letters, Applied Thermal Engineering, International Journal of Thermal Sciences and presented her work at ASME IMECE, ASME InterPACK, IEEE Itherm conferences. She is an Associate Editor of the IEEE Transactions on Components, Packaging and Manufacturing Technology journal. In addition, she had served as session chair, topic chair and track chair at IMECE, IEEE ITherm and ASME InterPACK conferences.



**Dr. Tannaz Harirchian** is an engineering manager at Intel Corporation in Assembly & Test Technology Development organization. She leads a team of thermal mechanical engineers who are responsible for developing test capabilities and new technologies to enable testing of Intel products. Prior to her current role, she was a Packaging R&D Engineer where she led innovation and development of Intel CPU and SoC products with a focus on thermal-mechanical solutions for Mobile applications. She received her PhD in Mechanical Engineering from Purdue University in 2010. She has authored 1 book and more than 20 refereed journal articles and conference proceedings.”



**Dr. Jelena Srebric** is Acting Associate Dean of Research, A. James Clark School of Engineering and Professor, Director of CITY@UMD, Mechanical Engineering at Maryland Energy Innovation Institute. She received her Ph.D., in Building Technology at Massachusetts Institute for Technology in 2000, her Bachelor of Science, B.Sc. in 1994 and her Master of Science, M.Sc., in Mechanical Engineering at the University of Belgrade in 1997.

- Elected Fellow of the International Building Performance and Simulation Association (IBPSA) by the IBPSA Board, 2019
- Elected Fellow of the International Society of Indoor Air Quality and Climate (ISIAQ) by the Academy of Fellows of ISIAQ, 2018
- Inaugural Particle and Fibre Toxicology Prize Paper Award, 2016
- Serbian National Academy of Engineering, Elected International Member, 2013
- Outstanding Research Award, Penn State Engineering Alumni Society (PSEAS), 2012



**Dr. Nesrin Ozalp** is a Professor and Chair of Mechanical and Civil Engineering at Purdue University Northwest, and a Full Professor by Courtesy at the School of Mechanical Engineering of Purdue University West Lafayette. She received her Ph.D. from the University of Washington’s Mechanical Engineering Department and her MSc in Mechanical Engineering from Stanford University. Dr. Ozalp specializes in the areas of designing novel solar reactors for emission-free generation of fuels. She is the Lead Principal Investigator of research projects totaling \$5M+, the corresponding author of 110+ peer reviewed journal, book chapter, and conference papers, Co-PI of completed Phase I of Solar Carbon Black commercialization with Fraunhofer, supervised 25 graduate students’ theses.



**Dr. Elham Maghsoudi** is a Thermal Engineer at NASA Jet Propulsion Laboratory (JPL) in the Propulsion, Thermal and Material Engineering section. She received her PhD in Thermo-fluid Science from Louisiana State University in 2013. She currently splits her time between thermal system engineering and management for Europa Clipper Magnetometer/Magboom and developing new thermal technologies for future JPL missions. Since joining JPL she has been completed the thermal design for the Psyche Magnetometer, performed Europa Lander exhaust plume analysis, developed novel 3D printed heat exchangers to support a variety of applications from an active thermally controlled CubeSat to actuators on a future icy moon robotic sampling arm.



**Dr. 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 & super computers. Anna has several patents & papers covering sensors and semiconductor packaging materials & 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.



**Dr. Shelby F. Nelson** is a semiconductor device physicist with broad industrial research experience. Her work has included ferroelectric materials at AT&T Bell Labs, silicon/germanium heterostructures at IBM's Thomas J. Watson Research Center, and a mixed-signal CMOS process for ink-jet ejector heads at Xerox Corporation. In addition, Dr. Nelson spent 16 years as a Senior Research Scientist in the area of thin-film and printed electronics at the Kodak Research Labs.



## Printing Technologies for Additive Electronics

Wednesday, October 28

9:10 Am - 10:40 AM

**Moderator: Pradeep Lall, MacFarlane Endowed Distinguished Professor and Director, Auburn University**

Traditionally, electronics manufacturing has involved the use of subtractive processes requiring the use of plating, wet-etching, and masks. Additive processes hold the promise of a shorter time to first-prototype through the use of digitally driven design and in some cases the added ability to migrate to non-planar structures. A number of processes have emerged for high volume production of electronics including aerosol-jet printing, ink-jet printing, direct-write and stencil printing. Each of the processes offers advantages with a balance of trade-offs in comparison with traditional methods. In this session, the panelists will provide an overview of each of the technologies and engage in discussion on the opportunities and the technology gaps related to each of the additive technologies.

### Panelists:

- Bryan Germann, Optomec
- Mike Newton, nScript
- Don Veri, SUSS
- Doug Schardt, Komori America
- 



**Professor Pradeep Lall** is the MacFarlane Endowed Distinguished Professor with the Department of Mechanical Engineering and Director of the NSF-CAVE3 Electronics Research Center at Auburn University. He holds Joint Courtesy Appointments in the Department of Electrical and Computer Engineering and the Department of Finance. He is a member of the technical-council, academic co-lead of the asset-monitoring TWG, and past-member of governing council of NextFlex Manufacturing Institute. He is the author and co-author of 2-books, 14 book chapters, and over 650 journal and conference papers in the field of electronics reliability, safety, energy efficiency, and survivability. Dr. Lall is a fellow of the ASME, fellow of the IEEE, a Fellow of NextFlex Manufacturing Institute, and a Fellow of the Alabama Academy of Science. He is recipient of the Auburn Research and Economic Development

Advisory Board Award for Advancement of Research and Scholarship Achievement, IEEE Sustained Outstanding Technical Contributions Award, National Science Foundation's Alex Schwarzkopf Prize for Technology Innovation, Alabama Academy of Science's 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 Thirty Best-Paper Awards at national and international conferences.



## High Performance & Reliable Aerosol Jet Printed 3D Interconnects for Bare Die & Components



**Mr. Germann** is product manager of the Aerosol Jet Product line, including machine platforms, print engine products, as well as digital and software products. He is also managing strategic customer projects centered around volume production applications for Aerosol Jet technology. Bryan joined Optomec in mid-2017, previously he worked for GE Power he successfully integrated Optomec's Aerosol Jet technology into production work cells for printing high temperature ceramic sensors on heavy-duty gas turbine

blades. His background in materials, process and Optomec's core technology enable him to Optomec's customer base working on high volume, production applications for Aerosol Jet. Bryan currently holds 13 published patents. He also holds a B.S. and M.S. in Mechanical Engineering from University of South Carolina (USC).

**Abstract:** Flexible and wearable electronics have a wide range of applicability. Achieving flexibility on substrates like PET OR Polyimide sheet is straightforward and can be accomplished with many different printing techniques for high volume manufacturing processes. However, once unpackaged die or components are introduced to minimize size/weight of final devices and maintain flexibility things become more difficult. Traditional means for interconnecting die & components such as wire bonding are not able to be used as these de-packaged components have extremely small bond pads and bonding to printed metal on. As a result, a new method of interconnecting is required to create robust signal and power connections for the die to the circuitry around it. Aerosol Jet is a unique printed electronics technology which is able to create conductive printed 3D interconnects. These conformal electronic traces transfer signal and power into and out of the die similar to wire bonds but with lower profiles and the ability to interconnect to another printed circuitry. Several real-world examples are to be showcased along with reliability and signal performance, especially when signal frequencies climb over 40 GHz along with production-oriented equipment to deliver the solution to market.



## Direct Digital Manufacturing – The Integration of Multi-material and Multi-processing



**Mike Newton** has 30+ years' experience in the areas of advanced microelectronics and Microsystems technologies. He has built and managed a number of fabrication and research labs serving both commercial and government markets. Currently as nScript's Director of Electronic Packaging developing total solutions in micro-dispensing and direct digital manufacturing for the electronic packaging market. Mr. Newton also serves as Strategic Technology and Transition Director with Sciperio, nScript's parent company, leading strategic technology pursuits into the DoD, National Labs and DARPA. He currently has over 50 patents in advanced electronic packaging technologies. Mr. Newton's interest

includes serving as the Charter Organization Rep for Troop 37 and various K-12 educational and vocational outreach opportunities focused on STEAM.

**Abstract:** Direct Digital Manufacturing (DDM) has the potential to fabricate electrically functional complex shapes. Today electronics and electronic packaging is done using planar geometries. Extending to the 3<sup>rd</sup> dimension is done using wires, cables, connectors, bolts, and glue; this can be simply thought of as placing a square peg in a round hole. Making printed circuit boards into printed circuit cylinders or cones or other doubly curved shapes is not feasible using traditional PCB manufacturing methods. DDM is direct printing, milling, polishing, placing, curing, sintering, and monitoring on a single platform which provides the advantage of in situ processing and packaging capabilities for all stages of the manufacturing process. Next generation electronics will not be boards that are attached to objects, instead they will be objects with electronics permeating throughout the structure. The advantage of this is a reduction in wires, cables and connectors and the electronics can be more strategically placed therefore reducing the lengths of power lines. The net effect will be more efficient circuitry and ultimately more electronic functions per volume. A summary of DDM and working device demonstrations that are planar and non-planar will be presented. Additionally, questions of reliability, yield and throughput will also be addressed.



**Mr. Don Veri** has an extensive international business development and sales background and has been active in the Semiconductor, Printed Electronics, Renewable Energy/Solar, and Technology/Process Automation market sectors for 30 years. He has held executive management and business/commercial development positions within industry leading companies including SUSS MicroTec and formerly with MBT System's (a wholly owned subsidiary of Meyer Burger AG of Thun, Switzerland, Toolex USA/Toolex International, Smit Thermal Solutions and Metatec Corporation. Currently Mr. Veri is the Key Account/Business Development Manager for SUSS MicroTec's, North American division. Mr. Veri has played an integral role in developing SUSS MicroTec's Industrial Ink Jet Printing product lines for the Semiconductor, PCB, Printed Electronics and Photovoltaics markets. Mr.

Veri has received his graduate (MBA) and undergraduate degrees (BS Natural Resources) from The Ohio State University.

**Abstract:** With the work of Gutenberg, printing technology enabled the mass manufacturing of books and other printed media. Today, printing technology spread beyond the graphical industry and plays a role in the manufacturing of many products, e.g. in electronics applications. In this presentation an update will be given of the role of inkjet printing in this landscape. We will show how the unique capabilities of inkjet printing qualify it for new ways of manufacturing. The benefits can be diverse and range from enabling things that were not easily possible before, to more basic effects such as decreasing cost through floor space, labour or waste management. Specific examples will be given for the manufacturing of solar cells, printed circuit boards and semiconductors.



**Doug Schardt** is Director of Product Management for Komori America including oversight of North American demonstration facility and national training. Technical knowledge includes sheetfed offset, web offset, digital, gravure, gravure offset, intaglio screen, flexo and various specialties. Application knowledge ranges through packaging, commercial, currency (banknote), pharma, and other unique markets.

**Overview:** The Komori corporation leverages their broad base of experience and expertise gained from those diverse industries to bring to market an extraordinary lineup of equipment that takes printed electronics, both rigid and flexible to the next level. I am proud to be part of that advancement.





## Mobile, IoT and Compute Device Applications: Thermal and Mechanical Challenge

Wednesday, October 28

9:10 AM – 10:40 AM

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

**Summary:** The emergence of 5G will help power a significant rise in mobile communication, IoT technology, providing the infrastructure needed to carry huge amounts of data, allowing for a smarter and more connected world – enabling Smart Cities, connected roads, advanced transportation (Self-driving cars), AR/VR, AI robotics, Digital healthcare, smart Sports and many other. Everything requires higher performance, more data, faster processors! Heterogeneous Computing involves the central processing units (CPUs), the graphics processing units (GPUs), high speed interconnects and other elements that push forward the computing industry. A panel of experts will share their vision on the future of small to large electronics thermal management and other advanced system level thermo-mechanical challenges and solutions of the future.

### Panelists:

- Dr. Ravi Mahajan (Intel Corporation, Engineering Fellow)
- Mr. Hiroyuki Ryoson (Dexerials, Executive Chief Engineer)
- Professor John Thome (ex-EPFL, CTO of GCTG)
- Dr. Mark Earnshaw (Nokia Bell Labs, Group Lead/Director)
- Professor Amy Marconnet (Purdue)
- Don Le (Qualcomm, Principal Manager)



**Victor Chiriac** is 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. He previously held technology/engineering leadership roles, led corporate thermal technology teams and roadmaps, working on leading-edge mobile/wireless technologies with Motorola (1999-2010), Qualcomm (2010-2018) and Futurewei /Huawei R&D USA (2018-2019). Dr. Chiriac was elected Chair of the ASME K-16 Electronics Cooling Committee and was elected the Arizona and New Mexico IMAPS (International Microelectronics and Packaging Society) Chapter President in 2010. He is a co-editor of Electronics Cooling Magazine since 2016 and a leading member of the organizing committees of ASME/InterPack, ASME/ IMECE and IEEE/CPMT ITherm Conferences. He holds 19 U.S. issued patents, 1 US Trade Secret, 1 US Defensive Publication and has published over 109 papers in scientific journals and at international conferences. PhD (1999) in Aerospace and Mechanical Engineering, University of Arizona, Tucson, USA.



## Packaging Architectures for Heterogeneous Integration: Thermal/Thermo-Mechanical Implications



**Ravi Mahajan** is an Intel Fellow responsible for Assembly and Packaging Technology Pathfinding for future silicon nodes. 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 also led to high-performance, cost-effective cooling solutions for high-end microprocessors and the proliferation of photo-mechanics techniques used 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 & the 2018

InterPACK Achievement award from ASME, the 2019 "Outstanding Service and Leadership to the IEEE" Awards from IEEE Phoenix Section & Region 6 and most recently the 2020 Richard Chu ITherm Award For Excellence. 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 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.

**Abstract:** In this presentation, I will set the context for why Heterogeneous Integration using advanced packaging matters and briefly describe the various advanced packaging architectures in development. These architectures open up many challenges in thermal management and in ensuring robustness under thermo-mechanical stresses experienced during manufacturing and application conditions. I will describe how these challenges also offer opportunities for the packaging engineers in the fields of thermal management, reliability and thermo-mechanical analysis and experimentation.

## Packaging High Thermal Conductive EMI Shielding TIM



**Hiroyuki Ryoson** finished the master's degree in mechanical engineering at Kyoto University in 1990, and he joined Sony Corporation in 1990 and researched mainly in mechanical field. He is now an executive chief engineer in Dexerials Corporation (former Sony Chemical) and managing every theme in technology side in this company.



**Abstract:** In order to support 5G communication technology, it is necessary to perform large-scale information processing instantly, and it is expected that the heat density of LSIs will increase. At this time, heat dissipation from ICs such as CPU or GPU is a huge problem. Generally, the method of releasing heat from the IC to the heat sink is often used. However, since the heat sink is generally made of metal, the heat sink itself acts as an antenna and there is a risk that it emits an electromagnetic field due to electromagnetic coupling between the heatsink and the IC. In order to suppress such a phenomenon, a new type TIM in which carbon fibers are oriented in thickness direction is developed which has two performances in one material, which performances are EMI shielding performance and high thermal conductivity. And this material can achieve a high thermal conductivity of 20 W/mK.

## Cooling of Mobile and Portable Electronics with Pulsating Heat Pipes



**Professor John R. Thome** is 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 and pulsating heat pipes and high-fidelity simulators for them). 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 UK's Institute of Refrigeration J.E. Hall Gold Medal in 2008, the 2010 ASME Heat Transfer Memorial Award, among others.

**Abstract:** Pulsating heat pipes (PHPs) are an emerging two-phase cooling technology for cooling of mobile and portable electronics. A PHP consists of a serpentine channel that runs back-and-forth from the hot end (cooling electronics) to the cold end within a thin plate. The two-phase flow inside the serpentine is designed to be inherently unstable, with bubbles growing in the evaporator zone and condensing in the cold zone, and by transporting latent and sensible heat from the hot end to the cold end is able to cool devices with moderate up to high heat loads with a very thin shape factor. PHPs are particularly effective as they can operate in any orientation and can transport heat to large cooling surface areas. Innovative PHP studies of Global Cooling Technology Group and related thermal performance results will be presented together with prospects for future applications.



## Thermal Challenges in the New 5G End-End Network Era



**Dr. Mark Earnshaw** and optical transceivers. His recent work has focused on developing a hybrid photonics integration platform for extremely efficient optical communications and sensing applications. Mark Earnshaw has received the Bell Labs President's award and Bell Labs & CTO award and the 2018 Nokia US Top Inventor Recognition Award.

**Abstract:** The new 5G era will impact all aspects of communication networks including not just radio antennas but the access network and edge data centers which will create seamless connectivity to enable the new era of industrial automation. The new services will drive capacity growth both directly but also indirectly in order to achieve the new ultra-low latency and ultra-high reliability demands. Massive MIMO antenna arrays have clear need for advances in efficient, lightweight cooling solutions. Optical transceivers interconnecting antennas to remote radio access network equipment and edge cloud data centers are reaching extremely high-power densities. The harsh operating environments in which networking equipment is often deployed require novel device and system level reliability solutions for mission critical end-to-end connected services to be viable.

## Engineering Materials for Thermal Challenges



**Professor Amy Marconnet** is an associate professor of Mechanical Engineering at Purdue. Research in the Marconnet Thermal and Energy Conversion (MTEC) Lab intersects heat transfer, energy conversion, and materials science to enable advances in technologies where energy conversion and thermal transport are key factors in performance. Prof. Marconnet has developed an interdisciplinary research program to evaluate, understand, and control the physical mechanisms governing the multi-functional properties of materials, machines, and systems. Recently, Dr. Marconnet won the 2020 Bergles-Rohsenow Young Investigator Award in Heat Transfer from ASME.

**Abstract:** Mobile platforms, IoT, and compute devices with limited heat dissipation pathways are becoming ubiquitous while requiring integration of dissimilar materials and components with a high density of interfaces and placing additional constraints on device performance. Open challenges exist in optimizing and tuning the thermal transport within the multi-scale materials in these heterogeneous systems, while meeting constraints on mechanical properties and device performance. Ultimately, efficient, thermally informed engineering is needed to translate research into technology and requires integrated modeling, experiments, and materials development.



## Thermal Design Challenges & Possible Solutions in 5G Mobile/Wireless Devices



**Don Le** is a 25-year veteran of the semiconductor/computer product development industry. His work included thermal solution development for CPU, GPU, and mobile SOC from silicon/package to system levels at IBM, Intel, Nvidia, and Qualcomm.

**Abstract:** As 5G technology becomes more prevalent on various mobile wireless devices along with increasing demand for higher performance, the author will outline some of the challenges and thermal solution techniques that can be employed to optimize the performance of the products.



## Potential of Additive Manufacturing for Power Electronics

Wednesday, October 28

10:50 AM - 12:20 PM

Chair: Fang Luo, Stonybrook

### Panelists:

Michael Fish, Army Research Laboratory

Charles Lents, RTX

Peter DeBock, DOE

G.Q. Lu, Virginia Tech

### Rethinking Power Electronic Packaging: Multifunctional Components and Transient Mitigation



**Dr. Michael Fish** is a research scientist at the Advanced Power Packaging group at the U.S. Army Research Laboratory, where he serves as Principle 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.

**Abstract:** Incredible improvements in power electronic devices have been accompanied by only incremental advances in the packaging technologies that support them. The capabilities of wide bandgap materials are not fully realized because they are held back by traditional module architectures that ultimately limit the power density of power conversion systems. I will discuss recent efforts at ARL and at Academic and Industry partners that explore novel components, materials, and approaches to electrical-thermal co-design. Areas where additive manufacturing can enable the realization of these approaches will be highlighted, and gaps where further development is necessary will be discussed.



## Opportunities and Challenges for Additive Manufacturing of Power Electronics Magnetics



**Dr. Guo-Quan (GQ) Lu** is a professor jointly appointed between the Department of MSE and the Bradley Department of ECE at Virginia Tech. He has a double-major BS degree in Physics and MSE from Carnegie-Mellon University and a PhD degree in Applied Physics/Materials Science from Harvard University. He worked briefly at Alcoa Technical Center before joining Virginia Tech. For over 25 years of his professional career, Dr. Lu has researched on: packaging and integration of power electronics; three-dimensional, double-side cooled power modules; silver sintering for bonding power semiconductor devices; and recently magnetic materials for additive manufacturing of power magnetics. Dr. Lu has a Virginia Tech teaching award and a National Science Foundation CAREER award. His development of a die-attach nanoscale silver paste was recognized by an R&D 100 award. He has

published over 170 peer-reviewed journal articles. Dr. Lu is an IEEE fellow.

**Abstract:** Inductors and transformers are necessary components for converting electric and magnetic energy in switch-mode power electronics (PE) systems. The process of designing and selecting a magnetic component, namely its core material and winding structure, is a critical task faced by a PE engineer for achieving higher conversion efficiency and power density. Today, a PE designer relies on standard sets of commercial magnetic cores with limited selections of core materials, shapes, and form factors. This limitation has prevented the engineers from implementing innovative designs of the components that would lead to improved performance metrics. Given its advantages of rapid prototyping and flexibility in making complex structures, additive manufacturing could be an ideal tool to make custom-designed magnetic components. However, the fact that an inductor or transformer is made of at least two types of materials, magnetic for the core and metal for the winding, presents significant challenges to 3D-printing the components. Of the many challenges, the most difficult one has to do with material feedstock. In this presentation, I will share our work on processing and demonstration of magnetic paste materials as feedstock to a multi-extruder 3D printer for making custom inductors. Barriers to further advance the manufacturing technology in the PE field will be discussed.



## Aerospace Electronics

Thursday, October 29

9:10 AM - 10:40 AM

**Moderator: Dr. Ben Leever, US AFRL**

**Summary:** Flexible and printed electronics are providing new opportunities for aerospace electronics in terms of both innovative packaging solutions as well as unique form factors. Panelists will discuss packaging strategies to enable the integration of thin die as well as higher density electronic packages. They will also describe how flexible & conformal electronics (such as photovoltaics, antennas, and interconnects) deliver reduced weight and/or new capabilities for applications such as UAVs, satellites, and wearable sensors.

### Panelists:

- Mary Herndon, Raytheon
- Steve Gonya, Lockheed Martin
- John Rogers, Boeing
- David Shaddock, GE



**Benjamin Leever** is currently the Technical Director in the Air Force Research Laboratory (AFRL) Manufacturing & Industrial Technology Division. As Tech Director, Dr. Leever is the principal advisor on internal & external technical programs for the division, and he functions as senior leader for the division addressing strategic planning & execution, definition of organizational & program policy, support for transition of technology, & establishment of appropriate partnerships with industrial customers.

Prior to assuming his current duties, Dr. Leever served as Government Chief Technology Officer of NextFlex, a \$250M public-private partnership established to create a domestic manufacturing ecosystem in flexible hybrid electronics. He also previously served as the Advanced Development Leader for AFRL's Soft Materials Branch, leading an external portfolio focused on flexible electronics and biomaterials. Prior to that role, he led a research team focused on the development and modeling of multifunctional materials for structural power applications. Dr. Leever earned a B.S. in Chemical Engineering from the University of Cincinnati and a Ph.D. in Materials Science & Engineering from Northwestern University.





## Printed and Flexible Electronics at Raytheon Technologies



**Mary K. Herndon** is an Engineering Fellow on the Materials Engineering Technical Staff at Raytheon Missiles and Defense (RMD). Mary has a background in semiconductor physics, including processing and characterization of electronic materials.

Dr. Herndon joined Raytheon in January 2006 and was named Technology Area Lead for Mechanical, Materials and Structures in June 2014. In this role, she is responsible for technology planning and development for advanced materials and structures at RMD. Herndon works closely with universities and technology companies to implement next generation mechanical and materials technologies in Raytheon products. Mary is co-director of the

Raytheon-UMass Lowell Research Institute (RURI), coordinating research on printed electronics and additive manufacturing for RF applications.

In 2017, Dr. Herndon was named Corporate Technology Champion for Mechanical, Materials and Structures. Reporting to the Corporate Vice President for Research and Innovation, the Technology Champions are responsible for providing long term shaping of corporate technology strategy across all business units within Raytheon Technologies.

During her tenure at Raytheon, Mary has implemented novel optical techniques for material characterization and served as a Materials Engineering lead for Zumwalt, Patriot and other programs. Mary has led multiple Advanced Materials and Innovation projects for Raytheon including sensor design for chemical and explosive detection, RF metamaterial research and development of printed electronics materials and processes.

Before joining Raytheon, she spent six years working at a start-up company, where she managed a silicon MEMS fabrication lab and specialized in transitioning electronic packaging processes to volume manufacturing. Mary received her Ph.D. in Applied Physics with an Emphasis in Materials Science from the Colorado School of Mines in December 1999, working within the Center for Solar and Electronic Materials and collaboratively with partners at the National Renewable Energy Lab.



## Recent Advances in Additive Manufacturing for Electronic Packaging



**John Rogers** is a Senior Electrical Engineer at Boeing's Research and Technology Division, Huntsville, AL. Prior to joining Boeing in 2017, he was an Electrical Engineer at Harris Corporation's Microelectronics Division, Melbourne, FL, from 2007 to 2013. He has a Ph.D. in electrical engineering from the University of Florida and was a corecipient of Boeing's Engineering Excellence Team of the Year in 2019.

**Abstract:** Today, we are living in a fourth industrial revolution where the things we interact with are becoming more autonomous. The Internet of Things (IoT) promises to improve the quality of life by bridging networks of sensors and devices. At the core of these sensors and devices are packaged electronics on printed circuit boards, which have not changed much in the past century. Additive manufacturing can fundamentally revolutionize the way circuit boards are manufactured. Recently, Boeing has been working towards maturing the manufacturability of multilayer flexible circuit boards including demonstrating an integrated printed antenna array operating in the X-band.

## Direct-Write Additively Printed Electronics for 3D RF Applications



**Stephen Gonya** is responsible for new product designs, R&D, advanced manufacturing, quality assurance, failure analysis, reliability testing and materials consulting. Chartered to develop new and emerging technology for RMS next generation electronic platforms.

### Current Research Activities:

- 3D conformal multi-layer circuitry over complex surfaces
- Direct-write printed electronics using additive manufacturing methods
- Printed 3D RF microwave circuit elements and antennas
- Flexible Hybrid Electronic (FHE) technology for UAV and EW platforms
- 3D-IC & 2.5D-IC chip stacking for system-in-package (SIP) applications
- Anti-Tamper volume protection and sensors for electronic hardware



**Abstract:** This topic focuses on leveraging industry/academia/government developed tools, materials, equipment and processes for direct-write (DW) printing and additive manufacturing (AM) to create electromagnetic (EM) circuit elements for radio frequency (RF) devices used in wireless communication, electronic warfare and radar systems. Our goal is to advanced fabrication technology for 3D-RF circuit elements using DW and AM methods. Direct-Write technologies enable the selective deposition and patterning of both dielectric and conductive material in a multi-layer fashion to create high-resolution 3D circuit elements on both flat and conformal surfaces. A hybrid circuit fabrication approach was chosen using conventional RF substrate materials and copper foil circuitry with Si and GaAs active die. Printed RF elements are placed in the circuit where there is a realizable advantage in terms of better performance, size reduction, lower cost, or faster build cycle. This new DW-AM technology for RF electronics is particularly relevant for millimeter-wave (mmW) and micro-wave ( $\mu$ W) systems. Aerosol Jet, inkjet, and extrusion DW methods are considered immediately relevant for hybridization with AM because they use digitally driven data from CAD files and afford multi-axis control of the deposition tool and multi-material delivery systems. Examples of printed RF elements being used for tech insertions include CPWG transmission lines, bare die direct attach, coupling transformers, broadband bias inductors, limiter PIN diodes, MIS capacitor connections and various 3D or conformal antenna configurations.

## Additive Manufacturing for High Temperature Electronics Applications



**David Shaddock** is a Senior Electronics Packaging Engineer at the General Electric Global Research. He received a B.S.M.E. degree from Carnegie-Mellon University and M.S.Eng. Sci. in Microelectronics Manufacturing from Rensselaer Polytechnic Institute. His research interests are in harsh environment electronics, thermal management, electronics manufacturing, and reliability. He has over 30 years of experience in electronics manufacturing and packaging at GE, Rockwell, and Motorola. He has over fifty-two (52) publications including thirty-three (33) in the field of high temperature electronics packaging and materials. Twenty-three (23) patents including nineteen (19) in the field of high temperature electronics, packaging, and sensors. He was a member of the Board of Advisors

Association of Electronic Manufacturing, Society of Manufacturing Engineers 1999-2002, its chairman in 2002-2004, and was chairman of ASME E&PP High Temperature and Harsh Environment Electronics Committee in 2015.

**Abstract:** There is growing interest in applications for electronics in military and commercial aviation applications that can support mission needs to sense, actuate, and communicate at temperatures beyond the normal range of operations. Electronics for extreme temperature environments has been demonstrated with SiC electronics to operate at more than 300 °C. Capability of electronics packaging materials and reliability at extreme temperatures has also been demonstrated in the temperature range of 300 to 750 °C using ceramic hybrid multi-chip modules technology but this approach typically requires high NRE costs and lead time. 3D additive processes reduce time and NRE cost for this packaging with the added benefits of novel 3D structures



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>

and embedded features. Additive manufacturing processes of metals, ceramics, conductors, and dielectrics provides a digital transformation of hybrid circuit manufacturing technology. However, understanding of additive pack-aging material properties and reliability at extreme temperatures is not known. The interest and investment at GE in both additive manufacturing and high temperature electronics supports this effort to develop and characterize materials and processes for additive fabrication of high temperature electronic packaging. An overview of the approach and accomplishments will be presented.



## InterPACK 2020 PRE-RECORDED POSTER PRESENTATIONS SCHEDULE

### Poster Session 1 - Tuesday, October 27, 2020 - 9:10 am - 10:40 am (Pacific Time)

Submission Code	ASME Paper No.	Paper Type	Submitting Author Name	Presenting Author Name
55199	InterPack-2730	Student Poster Presentation	Matthew Clark	Matthew Clark
55224	InterPack-2751	Student Poster Presentation	David Huitink	Tumininu Olatunji
55225	InterPack-2752	Student Poster Presentation	David Huitink	Bakhtiyar Mohammad Nafis
55049	InterPack-2767	Student Poster Presentation	Gargi Kailkhura	Gargi Kailkhura
55210	InterPack-2740	Student Poster Presentation	Hayden Carlton	Hayden Carlton
55192	InterPack-2720	Student Poster Presentation	Siddhesh Khanvilkar	Siddhesh Khanvilkar
55179	InterPack-2721	Student Poster Presentation	Kaustubh Adsul	Kaustubh Adsul
55228	InterPack-2757	Student Poster Presentation	Qianying Wu	Qianying Wu
55207	InterPack-2736	Student Poster Presentation	Prajwal Murthy	Prajwal Murthy
55188	InterPack-2717	Student Poster Presentation	Ved Soni	Ved Soni
55155	InterPack-2703	Student Poster Presentation	Kartik Goyal	Kartik Goyal
55226	InterPack-2754	Student Poster Presentation	Mohammad Ashraful Haq	Mohammad Ashraful Haq
55211	InterPack-2743	Student Poster Presentation	Debabrata Mondal	Debabrata Mondal
55218	InterPack-2748	Student Poster Presentation	Jun Chen	Jun Chen
55197	InterPack-2728	Student Poster Presentation	Huabin Yu	Huabin Yu
55205	InterPack-2734	Student Poster Presentation	Serdar Ozguc	Serdar Ozguc
55204	InterPack-2738	Student Poster Presentation	Sebastien Sequeira	Sebastien Sequeira
55140	InterPack-2666	Student Poster Presentation	Sukwon Choi	Daniel Shoemaker
55141	InterPack-2667	Student Poster Presentation	Sukwon Choi	Yiwen Song
55206	InterPack-2735	Student Poster Presentation	Kalind Baraya	Kalind Baraya
55045	InterPack-2558	Student Poster Presentation	Alison Hoe	Alison Hoe
55200	InterPack-2731	Student Poster Presentation	Manohar Bongarala	Manohar Bongarala



<b>Poster Session 2 - Tuesday, October 27, 2020 - 10:50 am - 12:20 pm (Pacific Time)</b>				
<b>Submission Code</b>	<b>ASME Paper No.</b>	<b>Paper Type</b>	<b>Submitting Author Name</b>	<b>Presenting Author Name</b>
55227	InterPack-2755	Student Poster Presentation	Mohammad Al Ahsan	Mohammad Al Ahsan
55223	InterPack-2753	Student Poster Presentation	S M Kamrul Hasan	S M Kamrul Hasan
55222	InterPack-2750	Student Poster Presentation	Fahim Fahim	Abdullah Fahim
55182	InterPack-2712	Student Poster Presentation	Vikas Yadav	Vikas Yadav
55185	InterPack-2715	Student Poster Presentation	Mrinmoy Saha	Mrinmoy Saha
55178	InterPack-2709	Student Poster Presentation	Vishal Mehta	Vishal Mehta
55189	InterPack-2716	Student Poster Presentation	Yunli Zhang	Yunli Zhang
55212	InterPack-2742	Student Poster Presentation	Jing Wu	Jing Wu
55213	InterPack-2741	Student Poster Presentation	Km Rafidh Hassan	KM Rafidh Hassan
55187	InterPack-2714	Student Poster Presentation	Padmanava Choudhury	Padmanava Choudhury
55219	InterPack-2747	Student Poster Presentation	Mohd Aminul Hoque	Mohd Aminul Hoque
55036	InterPack-2628	Student Poster Presentation	Jihyun Kim	Jihyun Kim
55108	InterPack-2687	Student Poster Presentation	Changhwan Song	Changhwan Song
55176	InterPack-2727	Student Poster Presentation	Nhi Quach	Nhi Quach
55186	InterPack-2713	Student Poster Presentation	Hyesoo Jang	Hyesoo Jang
55180	InterPack-2707	Student Poster Presentation	Madhu Kasturi	Madhu Kasturi
55170	InterPack-2704	Student Poster Presentation	Sungmo Jung	Sungmo Jung
55181	InterPack-2708	Student Poster Presentation	Tony Thomas	Tony Thomas
55183	InterPack-2710	Student Poster Presentation	Aathi Raja Ram Pandurangan	Aathi Raja Ram Pandurangan
55184	InterPack-2711	Student Poster Presentation	Jinesh Narangaparambil	Jinesh Narangaparambil

**For a list of Technical Presentations which are available OnDemand starting on October 27 through January 24, 2021, go to:**

<https://event.asme.org/Events/media/library/resources/interpack/InterPACK-Technical-Presentations-On-Demand.pdf>



## INTERPACK ACHIEVEMENT AWARDS

Year	InterPACK Achievement Award	Affiliation
1999	Alan Kraus (Dedicated Conference)	Naval Postgraduate School
2001	Wataru Nakayama	ThermTech International & Tokyo Institute of Technology
2003	Richard Chu	IBM Corporation
2005	Not Awarded	
2007	Avram Bar-Cohen	University of Maryland
2009	William Chen and Dereje Agonafer	ASE and University of Texas at Arlington
2011	Yogendra Joshi	Georgia Institute of Technology
2013	Y.C. Lee	University of Colorado
2015	Bahgat G. Sammakia	Binghamton University
2017	Ken Goodson	Stanford University
2018	Ravi Mahajan	Intel
2019	Abhijit Dasgupta	University of Maryland
2020	Professor Cristina H. Amon	University of Toronto



## 2020 Allan Kraus Thermal Management Medalist – MICHAEL J. ELLSWORTH JR.



### **Michael Ellsworth**

Poughkeepsie, New York

1962 – 2020 (Age 57)

Michael had been employed as a Senior Technical Staff Member at IBM in Poughkeepsie, where he worked for over 30 years. Michael was a Master Inventor with over 300 patents and was the winner of the 2020 Alan Kraus Thermal Management Medal from the American Society of Mechanical Engineers for a lifetime of thermal innovation. Second only to his family, Mike loved skiing, good Scotch, and the NY Mets. Michael also had great taste in music and his iTunes playlist was legendary at get together with friends and family. His memory lives on in all the joy he gave to those who loved him.





## IN MEMORIAM



Avram Bar-Cohen, 1946-2020

Dear Heat Transfer Community Members,

It is with a heavy heart that the Heat Transfer Division Executive Committee has learned that **Professor Avram Bar-Cohen** passed away on October 10, 2020. Avi was an internationally recognized leader in thermal science and technology, Honorary Member of ASME, and Life Fellow of IEEE. His extensive research activity, lectures and short courses have enhanced the scientific foundation for thermal management of electronic components and systems. In his distinguished career, Avi authored/co-authored more than 400 technical publications and delivered some 100 keynotes, plenary and invited lectures at major technical conferences and institutions. He was the Editor-in-Chief of WSPC's *Encyclopedia of Thermal Packaging* and the co-editor of its *Advanced Integration and Packaging* book series. He co-authored *Dielectric Liquid Cooling of Immersed Components* (WSPC, 2013), *Design and Analysis of Heat Sinks* (Wiley, 1995), and *Thermal Analysis and Control of Electronic Equipment* (McGraw-Hill, 1983), and has edited/co-edited another 28 books in this field. He holds several patents and advised to completion 70 master's and PhD students at the University of Maryland, the University of Minnesota, and the Ben Gurion University (Beer Sheva, Israel), where he began his academic career in 1972. His many research and educational recognitions in Heat Transfer included the Luikov Medal from the International Center for Heat and Mass Transfer (2008), and ASME's Heat Transfer Memorial Award (1999), Edwin F. Church Medal (1994), and Worcester Reed Warner Medal (1990). For his activities with IEEE, he was honored with the prestigious CPMT Field Award (2014), CPMT Society's Outstanding Sustained Technical Contributions Award (2002), IThERM Achievement Award (1998) and the THERMI Award (1997). From 2001 to 2010 Professor Bar-Cohen served as the Chair of Mechanical Engineering and Distinguished University Professor at the University of Maryland and was on a leave-of-absence from that institution while serving as a Principal Engineering Fellow at Raytheon.

Professor Bar-Cohen has touched many lives both professionally and otherwise and imparted to us his knowledge and wisdom that the Heat Transfer Community greatly appreciates. We will truly feel the loss.  
ASME Heat Transfer Division Executive Committee



## SPONSOR ADS

**intel.**

Leading the way in advanced semiconductor packaging and test

The technology revolution has changed virtually every aspect of our lives. Within the semiconductor industry, advanced packaging architectures are enabling compact, power efficient platforms for heterogeneous integration.


Intel and its Assembly Test Technology Development (ATTD) group is leading the way. We invite you to come change the world with us.

[www.intel.com/jobs](http://www.intel.com/jobs)

Copyright © 2020 Intel Corporation. All rights reserved. Intel and the Intel logo are trademarks of Intel Corporation in the U.S. and other countries.



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>



## ADVANCED POWER ELECTRONICS AND ELECTRIC MACHINES

NREL's Advanced Power Electronics and Electric Machines (APEEM) team has expertise in thermal, electrothermal, mechanical, and reliability aspects of power electronics and electric machines for electric-drive vehicles as well as other energy efficiency and renewable energy applications.  
<https://www.nrel.gov/transportation/peem.html>

<b>EXPERTISE</b> 12 researchers	<b>INNOVATION</b> 6 patents
<b>PUBLICATIONS</b> Since 2004, the APEEM team has published over <b>140+</b> peer-reviewed journal articles, conference papers, and book chapters	<b>AWARDS</b> <b>10</b> industry, government, and academic awards, including an R&D 100 Awards for Wide-Bandgap research
<b>COLLABORATION</b> The APEEM team has over <b>40+</b> collaborators within industry, government, labs, and academia	

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

## Whatever your cooling needs, We Can Take The Heat.



Design | Production | Testing | Heat pipes | Heat Sinks | Cold Plates



[www.novarktechnologies.com](http://www.novarktechnologies.com) **We Can Take The Heat**



# ASME® 2020 InterPACK®



## NOW AVAILABLE Journal of Electronic Packaging

### EDITOR

Shi-Wei Ricky Lee, PhD  
The Hong Kong University of  
Science and Technology,  
Hong Kong

### ASSOCIATE EDITORS

Mehdi Asheghi, PhD  
Stanford University, USA

Satish Chaparala, PhD  
Applied Materials, USA

Ercan M. Dede, PhD  
Toyota Research Institute of  
North America, USA

M. Baris Dogruoz, PhD  
Cisco Systems, Inc., USA

Toru Ikeda, PhD  
Kagoshima University, Japan

Xiaobing Luo, PhD  
Huazhong University of Science  
and Technology, China

Amy Marconnet, PhD  
Purdue University, USA

Kaushik Mysore, PhD  
Advanced Micro Devices, Inc., USA

Sreekant V. J. Narumanchi, PhD  
National Renewable Energy  
Laboratory, USA

Jeffrey C. Suhling, PhD  
Auburn University, USA

Tse Eric Wong, PhD  
Raytheon Co., USA

Jin Yang, PhD  
Intel Corporation, USA

JUNE 2020

- TIMELY
- ACCESSIBLE
- HIGH IMPACT

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/nano structures; 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 Packaging
- Reliability Analysis
- Systems Integration
- Small Scale Systems in general

To submit a paper to this journal or for more information, visit:

[asmedigitalcollection.asme.org](https://asmedigitalcollection.asme.org) <<<<

(select *Journal of Electronic Packaging*)

The American Society of Mechanical Engineers®  
ASME®





# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>



**Leadership in  
MEMS Packaging &  
Multiphysics Integration**

[invensense.tdk.com](http://invensense.tdk.com)



# ASME<sup>®</sup> 2020 InterPACK<sup>®</sup>

20+ engineering disciplines

Multiple program types and formats

Assistantships, fellowships, and scholarships available



## Grow WITH PENN STATE

The Penn State College of Engineering is adding more graduate programs to our portfolio, more qualified students to our programs, and more top faculty across our disciplines. We invite you to join more than 1,700 residential and online graduate students who are part of our growing engineering community. Learn more at [engr.psu.edu](http://engr.psu.edu).



©2020 The Pennsylvania State University. All Rights Reserved. This publication is available in alternative media on request. Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to all qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national origin, disability or protected veteran status. U.S. EOE 10-7-13



### PennState Materials Research Institute

## A World Leader in Interdisciplinary Research and Education

Our integrated facilities & highly qualified technical staff enables your research success.



#### The Materials Characterization Lab

Our fully-staffed, open access analytical research facility is charged with enabling research and educating the next generation of highly qualified researchers.



#### The Nanofabrication Lab

Our staff scientists and engineers will enable users to transition fundamental research in nanomaterials to innovation-driven multicomponent integrated devices and systems.



#### The Materials Computation Center

Our primary goal is to support internal and external users working in computer-based simulations of materials across the various length and time scales.



#### 2D Crystal Consortium - MIP

The 2DCC-Materials Innovation Platform is focused on advancing the synthesis of 2D materials within the context of a national user facility.



Visit: [mri.psu.edu](http://mri.psu.edu)

**JOIN US**  
Nov. 10-11

[mri.psu.edu/MaterialsDay](http://mri.psu.edu/MaterialsDay)

**MATERIALSDAY2020**  
Convergence of  
**MATERIALS** and **LIFE**





**THANK YOU FOR JOINING  
US.**

**SEE YOU IN 2021!**