

2019 25th International Workshop on Thermal Investigations of ICs and Systems (THERMINIC 2019)

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SESSION 1

Advances in Thermal Modeling and Simulation 1

🕒 9:45am - 11:05am

→ Chair: John Parry | Mentor Graphics

1 **Algorithm for Establishing the Dependence of Structure Functions on Spatial Distributions of Thermal Properties**

Lorenzo Codecasa¹, Vincenzo d'Alessandro², Dario D'Amore¹

¹Polytechnic University of Milan, Milan, Italy; ²University of Naples Federico II, Naples, Italy

7 **Three-Steps Approach to Uncertainty Quantification for Electronic Components and Packages**

Lorenzo Codecasa¹, Vincenzo d'Alessandro²

¹Polytechnic University of Milan, Milan, Italy; ²University of Naples Federico II, Naples, Italy

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Jan Kleiner, Lidiya Komsiyyska, Gordon Elger, Christian Endisch

Technische Hochschule Ingolstadt, Ingolstadt, Germany

19 **Novel Compact-Thermal-Model Approach to Estimate the Heat Spreading Effects of Flip-Chips on PCB regarding Laminar Flow Regimes**

Torsten Nowak, Sebastian Merbold, Christoph Egbers, Ralph Schacht

Brandenburg University of Technology Cottbus-Senftenberg, Germany

SESSION 2

Cooling Approaches for Devices and Packages 1

🕒 11:30am - 12:50am

→ Chair: Vadim Tsoi | Huawei Technologies Sweden AB

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Enhanced Two-Phase Heat Transfer by Direct-Contact Condensation Using Directional Acoustic Actuation

Thomas R. Boziuk, Marc K. Smith, Ari Glezer

Georgia Institute of Technology, Atlanta, United States of America

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Jaakko McEvoy, Tim Persoons

Trinity College Dublin, Dublin, Ireland

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Joseph Edward Lee Glass^{1,2,3}, Yvan Avenas¹, Didier Bouvard³, Sebastien Ferrouillet²

¹G2Elab, Grenoble, France; ²LEGI, Grenoble, France; ³SIMAP, Grenoble, France

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Hybrid-Cooled Server Optimization for Air-Side Waste Heat Recovery Using Passive and Active Flow Control

Sara Battaglioli, Tim Persoons

Trinity College Dublin, Dublin, Ireland

POSTER SESSION A

🕒 2:50pm - 4:10pm

→ Chairs:

Joan Yu | Signify

Ari Glezer | Georgia Institute of Technology

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Effects of Doping on the Morphology and Infrared Radiative Properties of Black Silicon

Sreyash Sarkar¹, Ahmed A. Elsayed^{1,2}, Frédéric Marty¹, Jérémie Drévillon³, Yasser M. Sabry², Jiancun Zhao⁴, Yiting Yu⁴, Elodie Richalot¹, Philippe Basset¹, Tarik Bourouina¹, Elyes Nefzaoui¹

¹Université Paris-Est, ESYCOM (FRE2028), CNAM, CNRS, ESIEE Paris, Université Paris-Est Marne-la-Vallée, F-77454 Marne-la-Vallée, France;

²Electronics and Electrical Com. Depart., Faculty of Eng., Ain Shams University, Cairo, Egypt; ³Institut Pprime, CNRS, Université de Poitiers, ISAE-ENSMA, Futuroscope Chasseneuil, France; ⁴Northwestern Polytechnical University, Xi'an, China

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Thermal Management and Processing Optimization for 3D Multi-Layer Stacked ICs

Melina Lofrano, Vladimir Cherman, Carine Gerets, Pieter Bex, Eric Beyne
imec, Belgium

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Thermal Modeling of a Power Ball Grid Array in System-In-Package Configuration

Alberto Bocca¹, Giovanni Graziosi², Alberto Macii¹

¹Polytechnic University of Turin, Turin, Italy; ²STMicroelectronics, Italy

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László Pohl, Mahmoud Darwish, János Mizsei

Budapest University of Technology and Economics, Budapest, Hungary

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Extraction of Equivalent Mechanical Properties for Power ICs Metallization

Ciprian Ionuț Florea^{1,2}, Cazimir Gabriel Bostan², Dan Ionuț Simon², Vasile Țopa¹, Marius Purcar¹

¹Technical University of Cluj-Napoca, Cluj-Napoca, Romania; ²Infineon Technologies Romania & Co. SCS, Bucharest, Romania

Wednesday, September 25, 2019

🕒 2:50pm– 4:50pm

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Pierluigi Guerriero, Santolo Daliento
Dept. Electrical Engineering and Information Technology, University of Naples Federico II, Naples, Italy
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Krzysztof Górecki, Kalina Detka, Krzysztof Górski
Gdynia Maritime University, Gdynia, Poland
- 78 **Efficient Computational Model Mesh of Thermo-Mechanical Phenomena in the Metal System of Power ICs**
Ioan-Adrian Bojita¹, Marius Purcar¹, Cristian Boianceanu², Vasile Topa¹
¹*Technical University of Cluj-Napoca, Cluj-Napoca, Romania;* ²*Infineon Technologies Romania & Co. SCS, Bucharest, Romania*
- 82 **Application of Infrared Thermography to Thermal Transient Measurements**
Nils J. Ziegeler¹, Peter W. Nolte², Stefan Schweizer^{1,2}
¹*South Westphalia University of Applied Sciences, Iserlohn, Germany;*
²*Fraunhofer Application Center for Inorganic Phosphors, Fraunhofer IMWS, Halle, Germany*
- 86 **An In-Line Failure Analysis System Based on IR Thermography Ready for Production Line Integration**
Dan Ralf Wargulski¹, Daniel May^{1,2}, Florian Löffler¹, Torsten Nowak¹, Jan Petrick¹, Bernhard Wunderle², Eef Boschman³, Mohamad Abo Ras¹
¹*Berliner Nanotest und Design GmbH, Berlin, Germany;* ²*Chemnitz University of Technology, Chemnitz, Germany;* ³*Advanced Packaging Center, The Netherlands*
- 90 **Quantitative SThM Characterization for Heat Dissipation through Thin Layers**
Verena Leitgeb, Katrin Fladischer, Lisa Mitterhuber, Stefan Defregger, Jürgen Spitaler
Materials Center Leoben Forschung GmbH, Leoben, Austria

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George Floros, Chrysostomos Chatzigeorgiou, Nestor Evmorfopoulos, George Stamoulis
University of Thessaly, Greece
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Gdynia Maritime University, Gdynia, Poland
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Festo AG & Co. KG, Germany
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Luca Maresca, Michele Riccio, Giovanni Breglio, Andrea Irace
University of Naples Federico II, Naples, Italy
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Michele Riccio, Alessandro Borghese, Luca Maresca, Giovanni Breglio, Andrea Irace
University of Naples Federico II, Naples, Italy

Coffee break and Poster Viewing

🕒 4:10pm - 4:50pm

SESSION 3

Advanced Thermal Measurement Strategies 1

🕒 4:50pm - 6:10pm

→ Chair: Gabor Farkas | Mentor Graphics MAD MicReD Division

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Latest Advancements towards Delamination Detection in a FC0B Assembly Using Thermal Pixel (Thixel) Array

Akhil Kumar¹, Marcus Schulz¹, Volker Bader², Markus Wöhrmann², Jörg Bauer², Daniel May^{3,4}, Mohamad Abo Ras^{1,4}, Bernhard Wunderle³

¹AMIC GmbH, Berlin, Germany; ²Fraunhofer IZM, Berlin, Germany; ³Chemnitz University of Technology, Chemnitz, Germany; ⁴Berliner Nanotest und Design GmbH, Berlin, Germany

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Button Shear Fatigue Test: Fracture-Mechanical Interface Characterisation under Periodic Subcritical Mechanical Loading

Mehrdad Shaygi¹, Bernhard Wunderle¹, Jörg Arnold¹, Nadine Pflügler², Reinhard Pufall²

¹Chemnitz University of Technology, Chemnitz, Germany; ²Infineon Technologies, Germany

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Rick Cressall, Kenneth Christensen, Tim Persoons
Trinity College Dublin, Dublin, Ireland

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Maxime Cozzi, Jean-Marc Gallière, Philippe Maurine
LIRMM, University of Montpellier, Montpellier Cedex, France

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Thermal Management in Power Electronics

🕒 9:30am - 11:10am

→ Chair: Vincenzo d'Alessandro | University Federico II

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Justin Dongmin Broughton, Yogendra Joshi
Georgia Institute of Technology, Atlanta, United States of America
- 151 **Electro-Thermal Modeling Method of Protection Power Diodes Using TCAD 3D/ 2D Approach**
Achraf Kaïd¹, Fabrice Roqueta¹, Jean-Baptiste Kammerer², Luc Hébrard²
¹STMicroelectronics, Tours, France; ²ICUBE, Strasbourg, France
- 157 **Optimum Thermal Design of High-Voltage Double-Sided Cooled Multi-Chip SiC Power Module**
Antonio Pio Catalano¹, Ciro Scognamillo², Alberto Castellazzi², Vincenzo d'Alessandro¹
¹Department of Electrical Engineering and Information Technology, University of Naples Federico II, Naples, Italy; ²Power Electronics, Machines and Control Group, University of Nottingham, Nottingham, United Kingdom
- 161 **Analytical Modeling of Through-PCB Thermal Vias and Heat-Sinks for Integrated Power Electronics**
Antonio Pio Catalano¹, Roberto Trani², Alberto Castellazzi², Vincenzo d'Alessandro¹
¹Department of Electrical Engineering and Information Technology, University of Naples Federico II, Naples, Italy; ²Power Electronics, Machines and Control Group, University of Nottingham, Nottingham, United Kingdom

Thursday, September 26, 2019

🕒 9:30am – 11:30am

Thermal Management of LEDs

🕒 9:30am – 11:10am

→ Chair: Marta Rencz | Budapest University of Technology & Economics

- 167 **Investigation of Thermomechanical Local Stress Induced in Assembled GaN LEDs**
Enrico Brugnotto¹, Sri Krishna Bhogaraju², E Liu², Fosca Conti^{1,2}, Danilo Pedron¹, Raffaella Signorini¹, Gordon Elger²
¹Department of Chemical Sciences, University of Padua, Padua, Italy; ²Institute of Innovative Mobility, Technische Hochschule Ingolstadt, Ingolstadt, Germany
- 173 **Comparison of Model Order Reduction and Thermal Network Approaches in the Extraction of Dynamic Compact Thermal Models of LEDs**
Robin Bornoff¹, Lajos Gaal²
¹Mentor Graphics, United Kingdom; ²Mentor – A Siemens Business, Hungary
- 180 **Multi-Domain Modelling and Simulation of White CoB LEDs**
László Pohl, Márton Németh, János Hegedűs, Gusztáv Hantos, Zsolt Kohári, András Poppe
Budapest University of Technology and Economics, Budapest, Hungary
- 187 **Luminaire Digital Design Flow with Delphi4LED Multi-Domain LEDs Compact Model**
Joan Yu, Patrick Zuidema, Grigory Onushkin, Genevieve Martin
Signify, The Netherlands
- 192 **Novel Methods for Checking the Validity of Models of Single Packaged Light Emitting Devices and Complex LED Modules in a Broad Current and Temperature Range**
Gabor Farkas¹, Andras Poppe^{1,2}, L. Gaal¹, Robin Bornoff¹, Marta Rencz^{1,2}
¹Mentor, a Siemens Business, Hungary/UK; ²Budapest University of Technology and Economics, Hungary

Coffee break

🕒 11:10am – 11:30am

SESSION 5

Cooling Approaches for Devices and Packages 2

🕒 11:30am - 12:50am

→ Chair: Yogendra Joshi | Georgia Institute of Technology

200 **Design of Additively Manufactured Heatsinks for Power Electronics Thermal Management Using Adjoint Level Set Topology Optimisation**

Mani sekaran Santhanakrishnan², Tim Tilford¹, Chris Bailey¹, Pushparajah Rajaguru¹

¹Computational Mechanics and Reliability Group, University of Greenwich, London, United Kingdom; ²Cranfield University, Cranfield, United Kingdom

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Pedro Rodrigues¹, Arnaud Meyer¹, Nicolas Zerounian²

¹Thales DMS France, Elancourt Cedex, France; ²Centre for Nanoscience and Nanotechnology, Université Paris-Sud, Palaiseau, France

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Wessel W. Wits¹, Yannick Jeggels², Norbert Engelberts²

¹Thales Nederland B.V., Hengelo, The Netherlands; ²Optimal Thermal Solutions B.V., Bussum, The Netherlands

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Lee Gibbons¹, Tim Persoons², Bryan Coyne², Eleanor Denny², David Kennedy¹, Sajad Alimohammadi¹

¹Technological University Dublin, Dublin, Ireland; ²Trinity College Dublin, Dublin, Ireland

POSTER SESSION B

🕒 2:00pm - 2:55pm

→ Chairs:

Wendy Luiten | WLC

John Janssen | NXP Semiconductors

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Highly Thermal Conductivity h-BN Composite Films for Electronic Packaging

Ya Liu^{1,3}, Nan Wang², Lilei Ye², Johan Liu^{1,2,4}

¹Electronics Materials and Systems Laboratory, Department of Microtechnology and Nanoscience, Chalmers University of Technology, Gothenburg, Sweden;

²SHT Smart High Technology AB, Gothenburg, Sweden; ³State Key Laboratory of Molecular Engineering of Polymers, Department of Macromolecular Science, Collaborative Innovation Center of Polymers and Polymer Composites, Fudan University, Shanghai, China; ⁴SMIT Center, School of Mechanical Engineering and Automation, Shanghai University, Shanghai, China

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Quasi-3D Thermal Model of Stacked IC-TSV-BGA Package

Konstantin Orestovich Petrosyants, Nikita Ivanovich Ryabov

HSE Tikhonov Moscow Institute of Electronics and Mathematics, Moscow, Russian Federation

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Thermal Characterization and Reliability Assessment of Chip Scale Packaged Light-Emitting Diodes with High Color Rendering Index

Ju Ho Lee¹, Byongjin Ma¹, Soo Geun Jeon², Seung Ho Baek², Kwan-hun Lee¹

¹Korea Electronics Technology Institute, Gyeonggi-do, South Korea; ²Semicon Light, South Korea

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Influence of the Use of a Thermal Pad on Electric, Optical and Thermal Parameters of Selected Power LEDs

Krzysztof Górecki¹, Przemysław Ptak¹, Tomasz Torzewicz², Marcin Janicki²

¹Gdynia Maritime University, Gdynia, Poland; ²Technical University of Łódź, Łódź, Poland

Thursday, September 26, 2019

🕒 2:00pm – 3:35pm

- 242 **Modeling of Temperature Distribution Induced by Thermo-Mechanical Deformation of High-Power InGaN Arrays**
Anton Chernyakov¹, Andrey Aaladov¹, Alexander Zakgeim¹, Anton Ivanov¹, Ilia Belov², Vladimir Belov³
¹Submicron Heterostructures for Microelectronics Research and Engineering Center of RAS, Saint-Petersburg, Russian Federation; ²School of Engineering, Jönköping University, Jönköping, Sweden; ³Mordovian State University, Saransk, Russian Federation
- 246 **A Review: New Designs of Heat Sinks for Flow Boiling Cooling**
Ali Yahyaei Nujukambari, Amir Sajjad Bahman, Jakob Hærvig, Henrik Sørensen
Aalborg University, Aalborg, Denmark
- 252 **Thermal Investigation of GaN Multilayer Structures**
Lisa Mitterhuber, René Hammer, Katrin Fladischer, Verena Leitgeb, Stefan Defregger, Jürgen Spitaler
Materials Center Leoben Forschung GmbH, Leoben, Austria
- 258 **Temperature Control of IGBTs by Thermoelectric Cooler**
Alireza Rezaniakolaei
Faculty of Engineering and Science, Aalborg University, Aalborg, Denmark
- 261 **Developments in the Use of Amorphous Carbon Based Coating Materials as Electrically Insulating, Thermal Interfaces for Heat Spreaders in Ruggedized Electronics Applications**
Chris H Walker
Diamond Hard Surfaces Ltd., Towcester, United Kingdom
- 265 **TIMiTIC: A C++ Based Compact Thermal Simulator for 3D ICs with Microchannel Cooling**
Piotr Zajac
Łódź University of Technology, Łódź, Poland
- 271 **Component Model Calibration Using Transient Thermal Test Methods and Multiple Measurement Setups**
Zoltán Kórádi, Szilárd Szóke
Robert Bosch Kft., Budapest, Hungary

Poster Viewing 2 and Coffee Break

🕒 2:55pm – 3:35pm

SESSION 6

Reliability

🕒 3:35pm - 4:55pm

→ Chair: Bernhard Wunderle, TU Chemnitz

- 276 **Influence of Power Cycle Turn-On Duration on the Lifetime of Power Module Die-Attach Layers**
Javier Acuña
University of Stuttgart, Stuttgart, Germany
- 282 **Experimental Assessment of Malfunction Events in Photovoltaic Modules from IR Thermal Maps**
Pierluigi Guerriero¹, Antonio Pio Catalano¹, Ilaria Maticena¹, Lorenzo Codecasa², Vincenzo d'Alessandro¹, Santolo Daliento¹
¹Dept. Electrical Engineering and IT, University of Naples Federico II, Naples, Italy; ²Dept. Electronics, Information, and Bioengineering, Polytechnic University of Milan, Milan, Italy
- 288 **Temperature Sensitive Electrical Parameter Sensing Unit for Early Failure Detection**
Julien Magnien, Lisa Mitterhuber, Elke Kraker
Materials Center Leoben Forschung GmbH, Leoben, Austria
- 293 **Reliability Issues of Mid-Power LEDs**
János Hegedűs, Gusztáv Hantos, András Poppe
BME Department of Electron Devices, Budapest, Hungary

SESSION 7

Advanced Thermal Measurement Strategies 2

🕒 9:30am - 11:10am

→ Chair: Robin Bornoff | Mentor Graphics

N/A

Thermal Characterization of Solid Materials by Means of Scanning Thermal Microscopy: Impact of Sample Surface Properties

Eloise Guen¹, Jan Kaur², Petr Klapetek², P. Olivier Chapuis¹, Séverine Gomès¹
¹Univ Lyon, CNRS, INSA-Lyon, Université Claude Bernard Lyon 1, CETHIL UMR5008, F-69621, Villeurbanne, France; ²Czech Metrology Institute, Brno, Czech Republic

N/A

Nanothermometry by Means of Scanning Thermal Microscopy: Investigation of Electro-Thermal Devices with Embedded Metallic Lines

Georges Hamaoui¹, Axel Pic^{1,2}, Wenyu Zhao⁴, Ali Alkurdi¹, Jun Yin³, Stéphane Gallois-Garreignot², Matthieu Bugnet⁴, Jean-François Robillard³, Séverine Gomès¹, P. Olivier Chapuis¹
¹Univ Lyon, CNRS, INSA-Lyon, Université Claude Bernard Lyon 1, CETHIL UMR5008, France; ²STMicroelectronics, Crolles, France; ³Univ. Lille, CNRS, Centrale Lille, ISEN, Univ. Valenciennes, UMR 8520-IEMN, Lille, France; ⁴Univ Lyon, MATEIS, CNRS, INSA de Lyon, Villeurbanne, France

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Thermo-Physical Properties of 500 nm Thin, CVD Grown Tungsten Layers Investigated with Time Domain Thermoreflectance and Scanning Thermal Microscopy

Katrin Fladischer, Verena Leitgeb, Lisa Mitterhuber, Stefan Defregger
Materials Center Leoben Forschung GmbH, Leoben, Austria

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Experimental Investigation on Power Electronics Cooling by Convective Evaporation of R134a in High Aspect Ratio Copper Microchannels

Gennaro Criscuolo, Martin Ryhl Kærn, Wiebke Brix Markussen
Technical University of Denmark, Lyngby, Denmark

Friday, September 27, 2019

🕒 9:30am – 11:30am

311 Manufacturing and Characterization of Test Structures Dedicated for the Investigation of Heat Transfer Processes at Nanoscale

Jedrzej Topilko¹, Artur Sobczak¹, Piotr Pietrzak¹, Piotr Zajac¹, Marcin Janicki¹, Pawel Janus², Mariusz Zubert¹, Andrzej Napieralski¹

¹*Łódź University of Technology, Łódź, Poland;* ²*Institute of Electron Technology, Warsaw, Poland*

Coffee Break

🕒 11:10am - 11:30am

SESSION 8

Advances in Thermal Modeling and Simulation 2

🕒 11:30am - 1:10pm

→ Chair: András Poppe | Budapest University of Technology and Economics

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Thermal Resistance and Impedance Calculator (TRIC)

Lorenzo Codecasa¹, Francesca De Viti², Salvatore Race², Vincenzo d'Alessandro², Donata Gualandris³, Arianna Morelli³, Claudio Maria Villa³

¹Polytechnic University of Milan, Milan, Italy; ²University of Naples Federico II, Naples, Italy; ³ST Microelectronics, Agrate Brianza, Italy

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Time Saving Averaging Algorithm for Transient Thermal Analysis over Deterministic Pulse Superposition

Maximilian Schmid, Alexander Hanß, Sri Krishna Bhogaraju, Gordon Elger
Technische Hochschule Ingolstadt, Ingolstadt, Germany

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Closing the Loop between Circuit and Thermal Simulation: A System Level Co-Simulation for Loss Related Electro-Thermal Interactions

Thomas Langbauer¹, Christian Mentin¹, Michael Rindler¹, Franz Vollmaier¹, Alexander Connaughton¹, Klaus Krischan²

¹Silicon Austria Labs, Austria; ²Graz University of Technology, Graz, Austria

N/A

Thermo-Fluidic Characterizations of Multi-Port Compact Thermal Model of BGA Electronic Package

Valentin Bissuel¹, Eric Monier-Vinard¹, Frederic Joly², Olivier Daniel¹, Alain Neveu²

¹Thales Global Services, Vélizy-Villacoublay, France; ²Université Paris-Saclay, France

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Application of Simulation in Improving Vibration Reliability of Steering Control Units

Chalukya Nagappa Chincholi¹, Mahdi Sadeghinia², Ulrich Grau², Andreas Fischer²

¹Robert Bosch Engineering and Business Solutions Private Limited, India;

²Robert Bosch GmbH, Germany

SESSION 9

Thermal Management in Digital Circuits, Processors, and Nanoscale Devices

🕒 2:10pm - 3:30pm

→ Chair: Andrzej Krzysztof Tomasz Napieralski | Technical University of Lodz

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A Generic Processor Temperature Estimation Method

Baver Ozceylan¹, Boudewijn R. Haverkort², Maurits de Graaf³, Marco E. T. Gerards¹

¹University of Twente, Enschede, The Netherlands; ²Tilburg University, Tilburg, The Netherlands; ³Thales Nederland B.V., Hengelo, The Netherlands

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Alternating Current Electrothermal Flow for Energy Efficient Thermal Management of Microprocessor Hot Spots

Golak Kunti, Jayabrata Dhar, Anandaroop Bhattacharya, Suman Chakraborty
Indian Institute of Technology Kharagpur, Kharagpur, India

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Thermal Digital Innovation in the DfSS - DIDOV Framework

Wendy Luiten
WLC, The Netherlands

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Spring Constants and Damping Coefficient Temperature Dependency Analysis for Actuating and Sensing in Vibratory Microsensors

Jacek Nazdrowicz, Andrzej Napieralski
Lodz University of Technology, Lodz, Poland