

# **Pan Pacific Microelectronics Symposium 2015**

## **(PAN PAC 2015)**

**Kauai, Hawaii, USA  
2 – 5 February 2015**

**ISBN: 978-1-63439-931-9**

**Printed from e-media with permission by:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571



**Some format issues inherent in the e-media version may also appear in this print version.**

Copyright© (2015) by Surface Mount Technology Association (SMTA)  
All rights reserved.

Printed by Curran Associates, Inc. (2015)

For permission requests, please contact Surface Mount Technology Association (SMTA)  
at the address below.

Surface Mount Technology Association (SMTA)  
5200 Wilson Road  
Suite 215  
Edina, MN 55424

Phone: (952) 920-4682  
Fax: (952) 926-1819

[www.smta.org](http://www.smta.org)

**Additional copies of this publication are available from:**

Curran Associates, Inc.  
57 Morehouse Lane  
Red Hook, NY 12571 USA  
Phone: 845-758-0400  
Fax: 845-758-2634  
Email: [curran@proceedings.com](mailto:curran@proceedings.com)  
Web: [www.proceedings.com](http://www.proceedings.com)

# TABLE OF CONTENTS

## 2015 Pan Pacific Symposium Technical Papers

### Plenary Keynote Session

Chair: Charles Bauer, Ph.D., TechLead Corporation

- Memory Markets and Applications: Future Outlook** 1  
Il Ung Kim, Ph.D., SK C&C/ESSENCORE Ltd.

- Patient Connected Health: The Digital Domain** 6  
Matthew K. Hudes, Deloitte Consulting LLP

- Perspective on Required Packaging Technologies for Cognitive Computing Devices** 13  
Yasumitsu Orii, Ph.D., IBM Research Tokyo

### TA1– Power Electronics

Chair: Matthew Kelly, P.Eng., M.B.A., IBM Corporation

- COOL Substrate for Power and Performance** 19  
Charles Lin, Ph.D., Nick Wang and Jerry Tan, Bridge Semiconductor Corporation

- DC Power: Rebellion or Revolution?** 23  
Herbert J. Neuhaus, Ph.D. and Charles E. Bauer, Ph.D., TechLead Corporation

- Modeling and Fabrication of a SiC-Based Power Module with Double Sided Cooling** 30  
Klas Brinkfeldt, Ph.D., Michael Edwards and Dag Andersson, Swerea IVF AB; Klaus Neumaier and Olaf Zschieschang, Fairchild Semiconductor GmbH; Florian Hilpert, Fraunhofer IISB; Alexander Otto, Fraunhofer ENAS; Eberhard Kaulfeich, Berliner Nanotest and Design GmbH

- Piezoelectric Thin Film of Sodium Niobate for Energy Harvesting Devices** 38  
Young-Ku Jin, Subrata Sarker, Ki-Seong Lee, Hyun Woo Seo and Dong Min Kim, Hongik University

- Power Conversion Trends That Will Impact System Packaging and Assembly** 42  
Carl Blake, PSMA, CBK Consulting LLC and Transphorm

### TA2 – Industry Challenges and Directions

Chair: Markus Wimplinger, EV Group E. Thallner GmbH

- 3D Integration – Status, Challenges & Requirements** 52  
M. Juergen Wolf and Klaus-Dieter Lang, Fraunhofer IZM

- The Impact of Recent Counterfeit Mitigation Standards and US DFAR's on the Supply Chain** 57  
Kevin Sink, TTI, Inc.

- Astute Use of Commercial Off the Shelf Components** 68  
Dock Brown, CRE, Dfr Solutions

- Rare Earth Recovery from Electronic Materials** 72  
Alan Rae, Ph.D., ReNew Rare Earth Inc.

- 2015 iNEMI Technology Roadmap Overview** 76  
Bill Bader and Chuck Richardson, iNEMI

## **Keynote Presentation I**

Chair: Soeren Noerlyng, MICRONSLT

### **Advanced Integration Technologies – Challenges and Solutions Concerning Cyber-Physical Systems 86**

Klaus-Dieter Lang, Harald Pötter, Ivan Ndip, Michael Töpper, Karl-Friedrich Becker, Tanja Braun, Jan Hefer, Carsten Brokmann, Jürgen Wolf, Andreas Ostmann and Maik Hampicke, Fraunhofer Institute for Reliability and Microintegration (IZM)

## **TP3 – Wearable Electronics**

Chair: Raiyo Aspandiar, Ph.D., Intel Corporation

### **3D Packaging for Mobile and Wearable Electronics 94**

Shen Li Fu, Ph.D. and Jia-Jung Wang, I-Shou University; Wei-Chung Lo, Industrial Technology Research Institute

### **ACFs Interconnection Technology for Wearable Electronics Packaging 98**

Kyung W. Paik, Ph.D., Tae-Hwan Kim, Ji-Hye Kim, and Young R. Kim, Korea Advanced Institute of Science and Technology (KAIST)

### **Interconnection of Electrically Conductive Textile Fibers for Application in Smart Textiles 102**

Dag Andersson, Erik Nilsson and Göran Wetter, Swerea IVF AB

### **Hybrid Packaging of Circuits and Devices onto Flexible Screen Printed Electrical Interconnects 110**

Meriem Akin, Marc Wurz and Lutz Rissing, Leibniz Universitaet Hannover; Joe Corea, Simon Scott and Ana Claudia Arias, University of California Berkeley

### **Self-Powered Flexible Large Scale Integration (F-LSI) 119**

Keon Jae Lee, Ph.D., Korea Advanced Institute of Science and Technology (KAIST)

## **TP4 – Process Control**

Chair: Debbie Carboni, Kyzen Corporation

### **The Reliability of 1 mil Au Wire Bonds to Different Pad Opening Shapes, Sizes and Locations 122**

Salvatore T. Napoli, Daryl Santos, Ph.D., Ross Havens and Krishnaswami Srihari, Ph.D., State University of New York at Binghamton

### **Effect of Pad Design, Solder Paste Type, and Stencil Printer on Fine Pitch Printing 132**

Ganesh Pandiarajan and Satyanarayan Iyer, SMART Modular Technologies Inc.; Ajinkya P. Ranade, Ross Havens and Krishnaswami Srihari, Ph.D., Binghamton University

### **Dynamic Mechanical Analysis of PCB Laminates 139**

Jing Zhang, Jason T. Wertz, Joseph P. Kuczynski and Dylan J. Boday, IBM Corporation

### **A Novel Die Sawed Trench Structure for Warpage Reduction in WLP Process 145**

Cunsheng Zhu, Gaowen Xu and Le Luo, Shanghai Institute of Microsystems and Information Technology

## **Keynote Presentation II**

Chair: Shen-Li Fu, I-Shou University

### **Innovation in Entrepreneurship Education 150**

Robin Anderson, Ed.D. and Tae-In Eom, Ph.D., University of Portland

## **WA1 – Interposers and Their Assembly**

Chair: Hélène Frémont, University of Bordeaux

### **Interposers, Interconnections and Assembly Technologies 153**

Rao Tummala, Ph.D., Qiao Chen, Fuhan Liu, Venky Sundaram, and Vanessa Smet, Georgia Institute of Technology

### **Paving the Way to 3D: From Passive to Active Interposers 160**

Yann Lamy, Ph.D., University of Grenoble Alps

### **Interposer Packaging Technologies for Optical Interconnects 169**

Terry Bowen, Sandeep Razdan and Jibin Sun, TE Connectivity

### **Intermetallics Issues and Challenges in 2.5/3D Assembly Microjoints 175**

F. Batieha, F. Feyissa, S. Hamasha, S. Shirazi, L. Wentlent, P. Ongutu, N. Dimitrov, E. Fey and P. Borgesen, Binghamton University

## **WA2 – Reliability and Simulation & Analysis**

Chair: Dag Andersson, SWEREA

### **Harsh Marine Environment - Toward Corrosion Simulation 182**

K. Weide-Zaage, Ph.D., A. Moujbani, Leibniz Universität Hannover; H. Frémont and A. Guedon-Gracia, Université Bordeaux

### **Simulations and Measurements to Predict EMC Characteristics in Electronic Assemblies: Obsolescence Management 189**

Geneviève Duchamp, Tristan Dubois and Hélène Frémont, University of Bordeaux

### **Field Returns of Electronic Hardware – No Trouble Found (NTF) Returns Why? 197**

Terry Munson, Foresite Inc.

### **Package Level Reliability Study of a Module in Package (MiP) Assembly 203**

Ajinkya P. Ranade, Ross Havens and Krishnaswami Srihari, Ph.D., Binghamton University; Ganesh Pandiarajan and Satyanarayan Iyer, Ph.D., SMART Modular Technologies

## **WA3 – Interconnect Materials**

Chair: Jing Zhang, IBM Corporation

### **A Nano-Copper Based Alternative to High Temp Solder 210**

S. Hamasha, A. Sharma, B. Schnabl, L. Cheng, L. Desir, K. Bretz, L. Wentlent and P. Borgesen, Binghamton University; A. A. Zinn and J. Beddow, Lockheed Martin Space Systems Company, Advanced Technology Center; K. Schnabl, E. Hauptfleisch and D. Blass, Lockheed Martin Mission Systems & Training

### **Influence of Microalloying Elements on Reliability of SnAgCu Solder Joints 217**

Babak Arfaei, Ph.D., Universal Instruments Corporation; Francis Mutuku and Eric Cotts, Ph.D., Binghamton University; Richard Coyle, Ph.D., Alcatel-Lucent

### **The Effects of Bath Conditions on Electroless Nickel-Iron Alloy Plating for UBM Applications 225**

Ja-Kyung Koo and Jae-Ho Lee, Hongik University

## **WA4 – Design Solutions**

Chair: Jeff Kennedy, Celestica Inc.

**System I/O Optimization with SoC, SiP, PCB Co-Design 230**  
Humair Mandavia and Kazunari Koga, Zuken Inc.

**The Benefits of Small Package Size for RF Applications 235**  
Roy Starks, Libra Industries, Inc.

## **Keynote Presentation III**

Chair: Dock Brown, CRE, DfR Solutions

**The Coming of Big Data in Health and Biomedical Research 240**  
John Quackenbush, Ph.D., Dana-Farber Cancer Institute, Harvard School of Public Health, and  
GenoSpace, LLC

## **WP5a – Embedded Assemblies**

Chair: Kirsten Weide-Zaage, Leibniz Universität Hannover

**Device Embedded Substrate with Embedding Multi Passive Components for Camera Module 242**  
Hyunho Kim, Ph.D., KAIST, Center for Integrated Smart Sensors; Jongtae Lee, Minjoon Kim, Se-Meyung Hwang  
and Sangsuk Cha, Simmtech

**Smart System Integration: Moulding of Magnetic Field Sensors into AlSi9Cu3 (FE)-Alloys 248**  
D. Klaas, Dipl.-Ing., A. Wienecke, P. Freytag, M.C. Wurz, H. J. Maier and L. Rissing, Leibniz Universität  
Hannover

## **WP5b – Ultra Fine Geometry Fabrication**

Chair: Kirsten Weide-Zaage, Leibniz Universität Hannover

**Three Micron Lines and Spaces on Printed Circuit Boards 256**  
Hajime Tomokage, Fukuoka University

**Fabrication of Micro-Pattern on Flexible Substrate Using Pulsed Electroplating Techniques 259**  
Yu-Jung Huang, Wei-Han Huang and Shen-Li Fu, I-Shou University

## **WP6 – Failure Analysis Tools and Techniques**

Chair: Martin Anselm, Ph.D., Rochester Institute of Technology

### **Enhanced Analysis and Imaging Methods for High Resolution Acoustic Micro Imaging of Flip Chip Devices 265**

Janet Semmens, Sonoscan, Inc.

### **High Resolution Scanning Acoustic Microscopy for Inspection and Failure Analysis of 3D System Integration Technologies 272**

Peter Czurratis, Tatjana Djuric and Peter Hoffrogge, PVA TePla Analytical Systems GmbH; Sebastian Brand, Sebastian Tismer and Matthias Petzold, Fraunhofer Institute for Mechanics of Materials IWM

### **The X-Ray Metrology of TSVs and Wafer Bumps 275**

David Bernard, Ph.D., John Tingay, Philip Moyse, Simon White, Evstatin Krastev, Ph.D. and Will Heeley, Nordson DAGE

### **3D IC Stack Characterization Using Multi-Scale X-Ray Tomography 281**

Ehrenfried Zschech, Ph.D., Markus Gall and Sven Niese, Fraunhofer IKTS-MD; Markus Löffler, Technische Universität Dresden; M. Jürgen Wolf, Fraunhofer IZM-ASSID

## **THA1 – 3D Integration**

Chair: M. Juergen Wolf, Fraunhofer Insitute

### **Low Cost TSV (Through Silicon Via) Technologies 287**

Gu-Sung Kim, Kangnam University and ESIP EPWorks

### **Progress in 3D Memory IC & 3D Integration 290**

Wei Koh, Ph.D., PacRim Technology

### **Hybrid Bonding for 3D Integration 295**

Markus Wimplinger, Florian Kurz, Thomas Wagenleitner, Thomas Uhrmann, Bernhard Rebhan and Günther Weidlinger, EV Group E. Thallner GmbH; Thomas Plach, EV Group Korea Ltd.

### **Development of Micro Gold Bump Joints Technology for 3D IC Chip Stacking 301**

Masahiro Aoyagi, Ph.D., Fumito Imuna, Naoya Watanabe, Shunsuke Nemoto, Wei Feng, Katsuya Kikuchi, and Hiroshi Nakagawa, Nanoelectronics Research Institute, National Institute of Advanced Industrial Science and Technology (AIST)

### **Latest Topics of 2.1D/2.5D IC Integration and Challenges 307**

Henry H. Utsunomiya, Interconnection Technologies, Inc.

## **THA2 – Process Technologies**

Chair: Rod Howell, Libra Industries

### **Deposition of Solder Paste into High Density Cavity Assemblies 311**

Fernando Coma Martinez, Jeffrey Kennedy and Thilo Sack, Celestica Inc.

### **The Use of No-Clean Flux 325**

Phil Isaacs, Dave Braun and Jing Zhang, IBM Corporation; Eddie Kobeda, Lenovo

### **New Technology Waterless Cleaning Approach for High Density Assemblies and Power Electronics 332**

Thomas M. Forsythe, Mike Bixenman, DBA and Ram Wissel, Kyzen Corporation; Ryan Hulse, Ph.D., Honeywell Performance Solvents

### **Depaneling of Circuit Boards 343**

Ahne Oosterhof, Eastwood Consulting and Thomas Nether, LPKF Laser & Electronics AG

**Keynote Presentation IV**

Chair: Phil Isaacs, IBM Corporation

**Component Engineering and Correct Design of Electronic Devices 349**

Lev Shapiro, M.Sc. E.E., Component Master Ltd.

**THP3 – Nano-Tech**

Chair: Alan Rae, Ph.D., ReNew Rare Earth Inc.

**Decision Making Model for the Emerging Nanotechnologies 355**

Audré Dixon, DHA and Kewal K. Verma, Ph.D., University of Phoenix Online

**Application of Novel Polydopamine-Polypyrole Nanofibers for Electrically Conductive Adhesives 364**

Wei Zhang, Behnam Meschi Amoli, Jeffrey d'Eon and Boxin Zhao, University of Waterloo; Alex Chen, Celestica Inc.

**Design and Optimization of CMOS-Compatible Silicon Nanowires Based Biosensor 370**

Anran Gao, Na Lu, Pengfei Dai, Yuelin Wang and Tie Li, Shanghai Institute of Microsystem and Information Technology