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Speech subject: Industrial Testing of 3D Heterogeneous

Chip-Package-PCB-Antenna Modules via Advanced Electromagnetic-Thermal Analysis

Speech leader: Andrew Tay Adjunct Professor National University of Singapore

Speech Description/Objective:

For 5G telecommunications, the antenna is usually integrated in a Chip-Package-PCB-Antenna module. Currently, the testing of such modules is carried out in an anechoic chamber with sensors placed in the space around the antenna which is slow and expensive. This presentation describes an innovative, rapid and cost-effective method of testing 3D Heterogeneous Chip-Package-PCB-Antenna modules in a unified sub-10GHz and mm Wave platform. Fast multi-channel RF-correlators are combined with advanced transient multi-beam thermal-imaging leading to time-resolutions from millisecond to microsecond scales in synchronized pulsed modes enabling ultra-fast testing solutions compliant with industry mass-production requirements. The basis of the test is the use of a quantum spin crossover (SCO) material which converts the intensity of the electromagnetic (EM) radiation at a point to temperature. Hence, by placing a very thin layer of this SCO material at various distances from an antenna or array of antennas, one can generate a temperature field which correlates with the EM field. This temperature field is measured using advanced thermoreflectance imaging technologies which can provide sub-micron spatial resolution (beyond diffraction limit) and temporal resolution in the picosecond range. The proposed industrial-testing solutions have been validated through several practical applications using front-end-modules (FEMs) manufactured in advanced heterogeneous GaN and FDSOI technologies co-integrated with antenna-in-package (AiP) modules in various packaging assembly platforms including WLCSP fan-in/fan-out and 3D heterogeneously-integrated packages. These would be described in this presentation. Finally, some comments will be made on the importance of chip-package-PCB-antenna co-design for optimum performance and how the above-mentioned system can be used for verification of multi-physics simulations of chip-package-PCB-antenna modules.

Speech Outline:

1. Introduction: current method of testing antennas.
2. Correlation between electromagnetic intensity and temperature using quantum spin crossover materials.
3. Advanced thermal imaging system using thermoreflectance.
4. Description of an innovative, rapid and cost-effective method of testing Antenna-in Package.
5. Practical applications using front-end-modules (FEMs) in heterogeneously integrated packages.
6. Optimization of chip-package-PCB-antenna modules through co-design and simulations.

Who Should Attend:

This presentation should be attended by engineers and researchers involved in the design and testing of antenna systems and thermal analysis of advanced microelectronics packages.

Introduction of Speaker:

Prof Andrew Tay is currently an Adjunct Professor at the Singapore Hybrid-Integrated Next-Generation μ -Electronics Centre (SHINE), National University of Singapore, and a Visiting Professor and Advisor at the School of Mechanical Engineering, Eastern International University (EIU), Binh Duong, Vietnam. Before this, he was a Professor of Mechanical Engineering at the National University of Singapore from 1975 to 2015, and a Senior Research Fellow at the Singapore University of Technology and Design from 2016 to 2018. He was a Visiting Professor at Guilin University of Electronic Technology, and at Central South University, Changsha, China. He obtained his B.E. (Hons I and University Medal) and PhD in Mechanical Engineering from the University of New South Wales, Australia. His research interests include electronics packaging (thermo-mechanical failures, delamination, effects of moisture, solder joint reliability); thermal management of electronic systems and EV batteries; infrared and thermo-reflectance thermography; solar photovoltaics reliability, and fracture mechanics. He is an ASME Fellow, an IEEE Fellow, and a Distinguished Lecturer of the IEEE Electronics Packaging Society (EPS). He has also been engaged as a consultant by more the 40 companies.

He is currently the IEEE Electronics Packaging Society (EPS) Program Director for the Asia-Pacific Region, a member of the Board of Governors of EPS, and a member of the Executive Committee of the IEEE Singapore RS/EPS/EDS Chapter. He was the inaugural General Chair of the 1st Electronics Packaging Technology Conference (EPTC) in 1997 which is now the flagship conference of the IEEE Electronics Packaging Society in the Asia Pacific region. He is currently the Chairman of the EPTC Board and is serving or has served in the International Advisory Boards and Organising committees of several regular international electronics packaging conferences such as DTIP, ECTC, EMAP, EPTC, EuroSime, HDP, ICEPT, IEMT, IMPACT, InterPack, IOTHERM and THERMINIC.

For his exceptional technical achievements and contributions, he was awarded the 2019 IEEE EPS David Feldman Outstanding Contribution Award, the 2012 IEEE CPMT Exceptional Technical Achievement Award, and the 2012 IEEE CPMT Regional Contributions Award. For his outstanding contributions in the application of engineering mechanics to electronics and/or photonics packaging, he was awarded the ASME EPPD Engineering Mechanics Award in 2004. He was also awarded an IEEE Third Millennium Medal in 2000.