

16. Power Electronics for Automotive Applications

Course Leader: Mervi Paulasto-Kröckel – Aalto University

Course Objective:

The amount of electronics in vehicles has increased dramatically over the last years and will increase further in the future. Power electronics plays a major role in controlling automotive electronics and with the transition to energy-efficient forms of mobility its importance is even greater. E-mobility also strongly increases power levels of related converters, such as HEV/EV main inverters and other high voltage systems requiring new type of high-power module packages. The new package concepts and technologies have to be qualified for the reliability and safety of automotive standards with simultaneously increasing life time requirements.

This course provides an overview of what kind of power technologies, packaging concepts and materials are currently being used in different products from power semiconductors to power modules. What are the prevailing trends and challenges that power electronic packaging engineers face in automotive applications? This course will start by reviewing application areas for different power semiconductor technologies. Then different power packages and interconnect technologies used in these automotive applications will be introduced. Power module packaging concepts will be explained, and the requirements and possible concepts for e-mobility are presented. The lecture will then proceed to reliability issues of the power packages and modules. In this context, robustness validation and design for reliability is covered. Finally, new developments in terms of materials and their implications on performance, thermal management and reliability will be discussed.

Course Outline:

1. Power Electronics for Automotive – What and Where?
2. Background Power Semiconductors and Power Conversion
3. Power Electronics Packaging
 - Requirements and Challenges
 - Interconnects for Power Devices: Die Attach and Pb-rich Solder Interconnects; and, Wire Bonding and low RDSon Interconnects
 - Thermal Management in Power Packaging
 - Chip Embedding in Laminate Packaging
 - Power Modules structure and Interconnects
 - WBG Semiconductors – What is Changing?
4. Typical Failure Mechanisms in Power Packages
5. Robustness Validation and Design for Reliability
6. Summary

Who Should Attend:

This PDC is dedicated to engineers and managers already involved in the field of reliability of electronics packaging especially for automotive electronics and for those who need fundamental understanding on robustness validation and design for reliability.

Bio:

Mervi Paulasto-Kröckel is an Associate Professor, Department of Electrical Engineering and Automation, at Aalto University in Finland. Mervi completed her studies at the Helsinki University of Technology in 1995. Prior to joining Aalto University at the end of 2008, Mervi worked over 12 years in the automotive semiconductor industry in various R&D and management positions. Her group Electronics Integration and Reliability focuses on advanced materials and interconnect technologies for MEMS/NEMS and power electronics, as well as multi-material assemblies' behavior under

different loads and their characteristic failure mechanisms. Prof. Paulasto-Kröckel has over 110 international publications covering microelectronics packaging and the compatibility of dissimilar materials. She is Distinguished Lecturer of IEEE EPS.