9. INTEGRATED THERMAL PACKAGING AND RELIABILITY OF POWER ELECTRONICS

Course Leader: Patrick McCuskey – University of Maryland

Course Objective:
Power electronics are becoming ubiquitous in engineered systems as they replace traditional ways to control the generation, distribution, and use of energy. They are used in products as diverse as home appliances, cell phone towers, aircraft, wind turbines, radar systems, smart grids, and data centers. This widespread incorporation has resulted in significant improvements in efficiency over previous technologies, but it also has made it essential that the reliability of power electronics be characterized and enhanced. Recently, increased power levels, made possible by new compound semiconductor materials, combined with increased packaging density have led to higher heat densities in power electronic systems, especially inside the switching module, making thermal management more critical to performance and reliability of power electronics. Following a quick review of active heat transfer techniques, along with prognostic health management approaches to assess and ensure reliability, this short course will present the latest developments in the materials (e.g. organic, flexible), packaging, assembly, and thermal management of power electronic modules, MEMS, and systems along with modeling and testing techniques. This course will emphasize thermal packaging techniques capable of addressing performance limits and reliability concerns associated with increased power levels and power density in power electronic components.

Course Outline:

1. Introduction to Integrated Thermal Packaging for Reliable Power Electronic Systems
2. Simulation and Assessment of Active Thermal Management Techniques: Air, Single Phase Liquid, Two Phase, Phase Change Materials, and Thermal Interface Materials
3. Application of Thermal Management Techniques to Commercial Power Systems/Data Centers
4. Durability Assessment: Failure Modeling, Simulation, Testing, Prognostics and Health Monitoring
5. Reliability and Thermal Packaging of Active Devices: Si, SiC, and GaN and Interconnects
6. Reliability and Thermal Packaging of Switching Modules, including Organic Encapsulates
7. Reliability in Rigid Assembly Packaging: PCB, Solders, and Glass Interposers
8. Flexible Materials, Packaging, and Thermal Management: Flex Circuit, OLED, Wearables
9. Reliability of Additively Manufactured and Embedded Power Electronics

Who Should Attend:
This course is intended for practicing engineers, designers, and technical managers who work with high heat flux electronics or power electronics and want to learn more about the design, manufacturing, thermal management and reliability of these power electronic systems.

Bio:
Dr. Patrick McCluskey (Ph.D. 1991, Materials Science and Engineering, Lehigh University, Bethlehem, PA) is a Professor of Mechanical Engineering at the University of Maryland, College Park, where he conducts research in the areas of thermal management, reliability, and packaging of electronic microsystems for use in extreme temperature environments and high power applications. Dr. McCluskey has published more than 100 refereed technical articles on these subjects, and has edited three books. He has also served as technical chairman for

multiple international conferences and workshops, and is an associate editor of the IEEE Transactions on Components, Packaging, and Manufacturing Technology. Dr. McCluskey has provided short courses on extreme temperature electronics and power electronics for companies in the aerospace, automotive, motor drives, energy exploration and generation, and defense industries. He is a fellow of the International Microelectronics and Packaging Society (IMAPS), a senior member of IEEE, and is a member of ASME, TMS, and SAE.