12. FLEXIBLE HYBRID ELECTRONICS

Course Leader: Pradeep Lall – Auburn University

Course Description:

In this course, manufacture, design, assembly, and accelerated testing of flexible hybrid electronics for applications in some of the emerging areas will be covered. Flexible hybrid electronics opens the possibilities for the development of stretchable, bendable, foldable form-factors in electronics applications which have not been possible with the use of rigid electronics technologies. Flexible electronics may be subjected to strain magnitudes in the neighborhood of 50-150 percent during normal operation. The integration processes and semiconductor packaging architectures for flexible hybrid electronics may differ immensely in comparison with those used for rigid electronics. The manufacture of thin electronic architectures requires the integration of thin-chips, flexible encapsulation, compliant interconnects, and stretchable inks for metallization traces. A number of additive manufacturing processes for the fabrication and assembly of flexible hybrid electronics have become tractable. Processes for handling, pick-and-place operations of thin silicon and compliant interposers through interconnection processes such as reflow requires an understanding of the deformation and warpage processes for development of robust process parameters which will allow for acceptable levels of yields in high-volume manufacture. Modeling of operational stresses in flexible electronics requires the material behavior under loads including constant exposure to human body temperature, saliva, sweat, ambient temperature, humidity, dust, wear and abrasion. The strains imposed on flexible stretchable electronics may far exceed those experienced in rigid electronics requiring the consideration of finite-strain formulation in development of predictive models. The failure mechanisms, failure modes, acceleration factors in flexible electronics under operational loads of stretch, bend, fold and loads resulting from human body proximity are significantly different than rigid electronics. The testing, qualification and quality assurance protocols to meaningfully inform manufacturing processes and ensure reliability and survivability under exposure to sustained harsh environmental operating conditions, may differ in flexible electronics as well. A number of product areas for the application of flexible electronics are tractable in the near-term including Internet-of-Things (IoT), medical wearable electronics, textile woven electronics, robotics, communications, asset monitoring and automotive electronics.

Course Outline:

1. Ultra-Thin Chips
2. Die-Attach Materials for Flexible Semiconductor Packaging
3. Compliant Interconnects
4. Flexible Encapsulation Materials
5. Inkjet and Aerosol-Jet Printing Processes
6. Dielectric Materials for Large-Area Flexible Electronics
7. Flexible Substrates
8. Stretchable Inks for Printed Traces
9. Pick-and-Place and Material Handling Processes
10. Additive Technologies in Flexible Electronics
11. Reflow and Printing Processes
12. Accelerated Testing Protocols

Who Should Attend:

The targeted audience includes scientists, engineers and managers currently using flip chip technology (w/solder or Cu Pillar) or considering moving from wire bonding to flip chip, as well as reliability, product or applications engineers who need a deeper understanding of flip chip technologies: the advantages, limitations and failure mechanisms.

Bio:

Pradeep Lall is the John and Anne MacFarlane Endowed Professor in the Department of Mechanical Engineering. He is Director of the Harsh Environment Node of NextFlex, and Director of the NSF Center for Advanced Vehicle and Extreme Environment Electronics at Auburn University. He is author and co-author of 2-books, 14 book chapters, and over 500 journal and conference papers in the field of electronics reliability, safety, energy efficiency, and survivability. Dr. Lall, a fellow of the ASME, fellow of the IEEE, fellow of the Alabama Academy of Science, is recipient of the NSF-IUCRC Association's Alex Schwarzkopf Award, Alabama Academy of Science Wright A, Gardner Award, IEEE Exceptional Technical Achievement Award, ASME-EPPD Applied Mechanics Award, SMTA's Member of Technical Distinction Award, Auburn University's Creative Research and Scholarship Award, SEC Faculty Achievement Award, Samuel Ginn College of Engineering Senior Faculty Research Award, Three-Motorola Outstanding Innovation Awards, Five-Motorola Engineering Awards, and Twenty Best-Paper Awards at national and international conferences. Dr. Lall has served in several distinguished roles at national and international level including serving as member of National Academies Committee on Electronic Vehicle Controls, Member of the IEEE Reliability Society AdCom, IEEE Reliability Society Representative on the IEEE-USA Government Relations Council for R&D Policy, Chair of Congress Steering Committee for the ASME Congress, Member of the technical committee of the European Simulation Conference EuroSIME, Associate Editor for the IEEE Access Journal, and Associate Editor for the IEEE Transactions on Components and Packaging Technologies. Dr. Lall is the founding faculty advisor for the SMTA student chapter at Auburn University and member of the editorial advisory board for SMTA Journal. He received the M.S. and Ph.D. degrees in Mechanical Engineering from the University of Maryland and the M.B.A. from the Kellogg School of Management at Northwestern University.