9. Additive Flexible Hybrid Electronics – Manufacturing and Reliability

Course Leader: Pradeep Lall – Auburn University

Course Description:
Technology progression in the field of electronics has been marked with “Dennard Scaling,” which defined that smaller transistors offered less power consumption, higher frequencies and higher density. Given that current gate lengths have approached 3nm, it is widely realized that future performance needs to be realized through packaging innovations and heterogeneous integration. Heterogeneous integrated modules may require a unique mix of components and custom design specific to a particular application. This course covers additive manufacturing methods for the realization of circuits and packaging for high-mix low-volume heterogeneous integration. This course will cover manufacturing, design, assembly, and accelerated testing of additively printed electronics for applications in some emerging areas.

Manufacturing processes for additive fabrication of rigid and flexible electronics will be discussed. The manufacture of thin additively packaged electronic architectures requires the integration of thin chips, flexible encapsulation, compliant interconnects, and nano-particle inks for metallization traces. Several additive-printed electronics processes for fabricating and assembling electronics have become tractable. Pick-and-place of thin-silicon and compliant interposers through interconnection processes such as reflow requires an understanding of the deformation and warpage processes. Several product areas for applying additive electronics are tractable, including Internet-of-Things (IoT), medical wearable electronics, communications, and automotive electronics.

Course Outline:

1. Heterogeneous Integration
2. Need for High-Mix Low-Volume
3. Additive Technologies - Aerosol-Jet Printing, Ink-Jet Printing, Screen-Printing and Gravure Printing
4. Structure Integrated Packaging - Laser-Direct Sintering, In-Mold Labeling
5. Ultra-Thin Chips
6. Die-Attach Materials for Additive Semiconductor Packaging
7. Flexible Encapsulation Materials
8. Dielectric Materials for Large-Area Electronics
9. Substrates for Flexible and Rigid Additive Applications
10. Power Sources Integration and Reliability
11. Accelerated Testing Protocols for Complex Integrated Systems
12. Additive Complex Integrated Package Assembly

Who Should Attend:
The targeted audience includes scientists, engineers, and managers considering the use of heterogeneous integration, as well as reliability, product, or applications engineers who need a deeper understanding of additively-print processes to enable high-mix low-volume applications and understand the advantages, limitations; and, failure mechanisms

Bio: Pradeep Lall is the MacFarlane Endowed Distinguished Professor and Alumni Professor with the Department of Mechanical Engineering and Director of the NSF-CAVE3 Electronics Research Center at Auburn University. He holds Joint Courtesy Appointments in the Department of Electrical and Computer Engineering and the Department of Finance. He is a member of the technical council and academic co-lead of automotive and asset monitoring TWGs of NextFlex Manufacturing Institute. He is the author and co-author of 2-books, 15 book chapters, and over 900 journal and conference papers in the field of electronics. Dr. Lall is a

fellow of the ASME, fellow of the IEEE, a Fellow of NextFlex Manufacturing Institute, and a Fellow of the Alabama Academy of Science. He is recipient of SEMI's FLEXI R&D Achievements Award for landmark contributions to Additive Printed Electronics, ASME Avram Bar-Cohen Memorial Medal, IEEE Biedenbach Outstanding Engineering Educator Award, IEEE Sustained Outstanding Technical Contributions Award, NSF Alex Schwarzkopf Award, Alabama Academy of Science Wright A, Gardner Award, IEEE Exceptional Technical Achievement Award, ASME-EPPD Applied Mechanics Award, Three-Motorola Outstanding Innovation Awards, Five-Motorola Engineering Awards, and over Fifty Best-Paper Awards.