15. Design-On-Simulation for Advanced Packaging Reliability and Life Prediction

Course Leaders: Kuo-Ning Chiang – National Tsing Hua University and Xuejun Fan – Lamar University

Course Description:
The electronic packaging community has widely used Design-on-Simulation (DoS) methodology for designing new packaging structures. However, it has encountered many challenges in ensuring a trustable simulation result. Artificial intelligence (AI)/machine learning approaches can be combined with DoS to solve this uncertainty. This course aims to illustrate the solution methodology and procedure, including the fundamentals of physics associated with different failure mechanisms in electronic packaging, finite element analysis (FEA) and simulation, large database generation, and AI training performance of different machine learning algorithms. This course will also describe how to combine AI and finite element simulation to estimate the reliability life and obtain the best structure combination of each packaging component using wafer-level packages as demonstrations. The course will cover the following topics: 1) Introduction to advanced packaging; 2). Physics of failures due to thermal, mechanical, moisture/humidity and electromigration. 3). Finite element simulation, 4) Material constitutive equations, 5) AI-Assisted DoS, and 6) Solder joint reliability life cycle prediction empirical equations.

Course Outline:

1. Introduction to Advanced Packaging
2. Physics of Failures Under Thermal, Mechanical, Moisture/Humidity, and Electric Current Stresses
3. Finite Element Analysis and Simulation
4. Material Properties and Constitutive Equations
5. AI-Assisted Design-On-Simulation Methodology
6. AI Solvers
7. Case Study: Solder Joint Reliability Life Cycle Prediction Empirical Equations

Who Should Attend:
This course is intended for technical managers and staff members, reliability engineers, scientific researchers, and graduate students who are involved in thermal/mechanical modeling, package design, material selection, qualification, and reliability assessment of chip-package interaction, package, and package/board interaction.

Bio 1: Professor K.N. Chiang received his PhD from the Georgia Institute of Technology, USA. He is the Chair Professor at the National Tsing Hua University in Hsinchu, Taiwan. After graduating from Georgia Tech, he worked for four years as a senior researcher at MSC/NASTRAN, a world-famous finite element system. From 2010 to 2013, he served as General Director of the National High-Performance Computing Center, which is the National Strategic Research Center of Taiwan. He has received outstanding research awards from the Ministry of Science and Technology of Taiwan three times and has published more than 450 technical papers in international journals and conference proceedings. He has been granted more than 50 invention patents. Among the major awards Professor Chiang received are the Excellence in Mechanics Award from ASME (2022) and the Outstanding Sustained Technical Contribution Award (2020) from IEEE-EPS. Currently, he is Editor-in-Chief of the Journal of Mechanics (SCI), Academic Editor of Materials (SCI), and Associate Editor of the Journal of Electronic Packaging (SCI). He is an IEEE, ASME, STAM, and IMAPS Fellow, and an academician of the International Academy of Engineering (IAE). He has made significant achievements in simulation-based science and technology.

Bio 2: Xuejun Fan is a Regents' Professor of Texas State University System, a Mary Ann and Lawrence E. Faust endowed chair professor in the Department of Mechanical Engineering at Lamar University, Beaumont, Texas. He received his Ph.D. degree in solid mechanics from Tsinghua University, Beijing, China in 1989. His interests and research lie in the area of modeling, characterization and reliability in heterogeneous integration in microelectronics. Dr. Fan had extensive experience in industry, such as with Intel Cooperation, Philips Research, and the Institute of Microelectronics (IME), Singapore. Dr. Fan received the Outstanding Sustained Technical Contribution Award in 2017, and the Exceptional Technical Achievement Award in 2011 from IEEE Electronic Packaging Society (EPS). He is an Associate Editor of IEEE Transactions on Components, Packaging and Manufacturing Technology and Microelectronics Reliability. Dr. Fan is an IEEE Fellow and a Distinguished Lecturer. He serves as chair, co-chairs, and committee members of various conferences such as ECTC, EPTC, ESTC, EuroSimE, ICEPT, ESREF, and EMPT. He has published more than 300 papers, including 4 books, over 100 journal papers, many book chapters, and numerous conference papers. He is a co-chair of Modeling and Simulation in Heterogeneous Integration Roadmap (HIR).