6. Wafer-to-Wafer and Die-to-Wafer Hybrid Bonding for Advanced Interconnects

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Course Description:

This course is addressing fundamental and practical aspects of low temperature fusion and hybrid bonding with the aim to provide a good understanding of the current status and the potential of this technology to provide manufacturing solutions for current and future applications. The course starts with a short overview of all wafer bonding processes currently in use. A detailed explanation of the working principles of low temperature fusion and hybrid bonding is presented. Aspects related to materials specifications and surface preparation are reviewed. Wafer-to-wafer alignment concepts are further introduced, with emphasis on face-to-face alignment. An overlay model is introduced and the benefits of its use are illustrated with experimental results. Aspects regarding the implementation of advanced process control methods are discussed, with an example on bond wave monitoring and control.

The concept of die-to-wafer bonding is presented as a heterogenous integration technology for chiplets-based applications. The different process flows available are reviewed. Some important aspects specific to die-to-wafer bonding are discussed, with emphasis on dies preparation and specific requirements of the various process flows. Experimental results are used for illustration of this technology capabilities. A short overview of the current and future challenges of wafer bonding concludes this course.

Course Outline:

1. Introduction: Wafer Bonding Processes Short Overview (Principles, Basic Conditions)
2. Short Overview of the Wafer Bonding Process Variables
3. Low Temperature Fusion Bonding: Description, Specifications, Surface Preparation and Activation, Bonding Process
4. Low Temperature Hybrid Bonding: Description, Specifications, Surface Preparation, Bonding Process
5. Wafer-to-wafer Alignment: General Principles (Methods, Errors), SmartView Alignment Introduction, Overlay and Distortion
6. Advanced Process Control: Using Numerical Simulation and Data Analysis
7. Advanced Bond Wave Monitoring and Control
8. Short Overview of Wafer Bonding - Specific Metrology: Defects, Bond Strength
9. Die-to-wafer Bonding: Introduction of the Concept and Process Flows
10. Die-to-wafer: Specific Process Features Compared to Wafer-to-wafer Bonding (Dies Preparation, Alignment, and Metrology)
11. Summary: Short Overview of Wafer Bonding Current and Future Challenges

Who Should Attend:

The course is addressed to engineers involved in heterogenous integration technology development who are willing to understand the status of wafer bonding technology and its applications potential. Principles and concepts are presented and explained together with more advanced topics. No prior experience in wafer-to-wafer or die-to-wafer bonding is required.

Bio: The author graduated the Faculty of Physics at University of Bucharest in 1995 and received his PhD from the Institute of Atomic Physics Bucharest, Romania, in 2000, with a thesis on low temperature wafer bonding. He was working in National Institute of Materials

Physics, Bucharest first as process technician and later on as junior scientist. In 1998 he joined Max Planck of Microstructure Physics, starting his work on wafer bonding in the group of Professor Ulrich GÖSELE. In 2001, after receiving his PhD, he joined EV Group as a wafer bonding technology process engineer and product manager for fusion wafer bonding equipment. His activities were focusing since then on process development based on wafer bonding with applications in MEMS and 3D integration. He is currently Chief Scientist for permanent wafer bonding and the manager of the Process Technology Development team at EV Group headquarters in Austria. He is author and co-author of over 150 papers published in scientific journals, proceedings volumes, magazines and book chapter contributions.