

## Course Description

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| <b>Course name</b> | <b>#035 - Introduction to Semiconductor Packaging Technology</b> |
| <b>Duration</b>    | <b>3 days</b>  |
| <b>Format</b>      | <b>Public Classroom, Inhouse Event and Online</b>                |

### Overview

Dr. Jeffrey Gambino, ON Semiconductor, United States, is teaching this advanced 3-day course, which will provide a high-level overview of the packaging options for semiconductor devices. This course covers design considerations, packaging materials, assembly processes, yield, and reliability. The course is addressed to a broad audience and is not intended as a research review, although it will be taught at a high level and in many areas will require familiarity with the subject matter.

### Technical Focus

The rapid growth of the microelectronics industry has historically focused on semiconductor technology, with packaging being a secondary consideration. However, with the challenges of device fabrication at advanced nodes and the need for integrating diverse devices, such as sensors, MEMS, and compound semiconductors, packaging has become a primary focus for new product development. This course will provide basic information on packaging technology and provide guidance on how to choose the best packaging options in order to meet system performance and cost requirements.

### Course Content

This course covers design considerations, packaging materials, assembly processes, yield, and reliability.

### Who should attend?

The course is addressed to a broad audience and is not intended as a research review, although it will be taught at a high level and in many areas will require familiarity with the subject matter

## Course Daily Schedule

### Day 1

#### 1. Introduction;

- a. Basic package requirements.
  - i. Cost, Size, Thermal, System Performance, Yield, Reliability
- b. Basic assembly flow
  - i. Wire bond
  - ii. Flip-chip
- c. Device types
  - i. microprocessors
  - ii. memory
  - iii. power semiconductors.
  - iv. sensors/MEMS
- d. Wafer fabrication
  - i. process flow
  - ii. bond pads
  - iii. die seal

#### 2. First level packaging

- a. Wafer thinning
- b. Wafer saw
  - i. Si
  - ii. SiC, GaAs, GaN
- c. Substrate,
  - i. Lead Frame
  - ii. Organic
  - iii. Flexible
  - iv. Laminate
  - v. Ceramic
- d. Die attach
  - i. Epoxy adhesives
  - ii. Eutectic solders
  - iii. Underfill
- e. Interconnect
  - i. Wire bond; Au, Cu, Al, wedge bond
  - ii. Tape-automated bonding (TAB)
  - iii. Solder bumps
  - iv. Cu pillars

f. Mold compound

## **Day 2**

### **3. Advanced Packaging.**

- a. Quad Flat Packs (QFP)
- b. Quad flat No lead (QFN)
- c. Ball Grid Array (BGA)
- d. Wafer-level packaging (WLP)
  - i. Fan-in
  - ii. Fan-out (FO-WLP)
  - iii. Redistribution Layers (RDLs)
- e. System in Package (SiP)
- f. Multi chip modules (MCMs)
- g. Stacked packages.
  - i. Package on package (PoP)
  - ii. Package in Package (PiP)
- h. Interposers
  - i. 3D chip stacking
  - i. Wafer bonding
  - ii. Through-Silicon Vias (TSVs)
  - iii. Assembly

### **4. Specialized packages**

- a. RF
- b. MEMS
- c. Sensors
- d. Photonics
- d. Hermetic

## **Day 3**

### **5. Second level packaging.**

- a. Design
- b. Connections
  - i. Pins
  - ii. Solder
  - iii. Interposer

- c. Component placement
- d. Routing
- e. Solder Masks

## **6. Mechanical Design**

- a. Vibration analysis
- b. Fatigue and creep

## **7. Thermal Design**

- a. Heat transfer,
- b. Thermal Resistance,
- c. Thermal Interface Materials,
- d. Heat spreaders and Heat sinks

## **8. Reliability**

- a. Failure Mechanisms
  - i. Die Fracture
  - ii. Metal corrosion
  - iii. Wire sweep
  - iv. Bond pad damage
  - v. Wire bond / solder bump fatigue
  - vi. Mold compound cracking
  - vii. Electrostatic discharge (ESD)
  - viii. Electrical Overstress (EOS)
- b. Reliability stresses.
  - i. Pre-conditioning
  - ii. High Temperature Storage
  - iii. Thermal cycle
  - iv. Humidity
  - v. Consumer vs Automotive applications
- c. Accelerated Degradation Modeling
  - i. Reliability statistics
  - ii. Diffusion-related failure models
  - iii. Fracture-related failure models
- d. Test coverage
- e. Failure analysis

## **9. Future Trends.**

## Instructor Biography

**Dr. Jeffrey Gambino.** PhD, ON Semiconductor, Oregon, USA.

Dr. Gambino received the B.S. degree in materials science from Cornell University, Ithaca, NY, in 1979, and the PhD degree in materials science from the Massachusetts Institute of Technology, Cambridge, MA, in 1984.

He joined IBM, Hopewell Junction, NY, in 1984, where he worked on silicide processes for Bipolar and CMOS devices. In 1992, he joined the DRAM development alliance at IBM's Advanced Semiconductor Technology Center, Hopewell Junction, NY. While there, he developed contact and interconnect processes for 0.25-, 0.175-, and 0.15-um DRAM products. In 1999, he joined IBM's manufacturing organization in Essex Junction, VT, where he worked on copper interconnect processes for CMOS logic technology.

Since 2015 Dr. Gambino has held a position as Senior Process Integration Engineer at ON Semiconductor in Oregon, USA.

He has published over 90 technical papers and holds over 100 patents.

Dr. Gambino has been a member of the Continuing Education Institute-Europe faculty since 2007.