Miami Dade College

Course Description

ETS2165C | Semiconductor Characterization and Packaging | 4.00 credits

This course covers photolithography in semiconductor fabrication, focusing on pattern generation, statistical process control, and process fundamentals. Students gain hands-on experience with photomasks, spin-coating, exposure systems, and chemical development, while exploring various lithography methods and evaluating key process variables for successful pattern transfer. Prerequisites: ETS2160C - Intro to Semiconductors and Vacuum Science and ETS2163C Cleanroom Safety and Introduction to Cleanroom processing

Course Competencies

Competency 1: The student will demonstrate working knowledge of key thin film measurement techniques by:

1. Operating a stylus profilometer to accurately obtain topographical information, including step heights and feature widths
2. Utilizing ellipsometry to precisely measure the thickness of transparent materials such as silicon dioxide and silicon nitride
3. Analyzing characterization data to identify and interpret the presence of defects

Competency 2: The student will develop a comprehensive understanding of key metrology equipment used in the semiconductor industry by:

1. Operating a scanning electron microscope (SEM) and demonstrating understanding of image optimization, and the limitations and strengths of SEM
2. Describing the theory and applications of an atomic force microscope (AFM), including the types of imaging precision required for various applications
3. Describing the fundamentals of crystal thickness monitoring and demonstrating techniques for monitoring real time thickness and deposition rate
4. Applying fundamentals of profilometry techniques including working knowledge of stylus profilometer and an optical profilometry
5. Engaging in practical exercises to describe the applications of ellipsometry equipment, operate the equipment, review the data outputs, and troubleshoot common issues encountered during ellipsometry measurements
6. Engaging in practical exercises to understand the principles of optical microscopy, operate the equipment, analyze the images, describe the applications of optical microscopy, and troubleshoot common issues

Competency 3: The student will operate a scanning electron microscope and understand key characterization processes by:

1. Performing SEM imaging and parameter optimization
2. Performing Energy Dispersive Spectroscopy by using both a point analysis and an elemental mapping analysis
3. Utilizing particle counting software for statistical analysis and process control
4. Employing low pressure modes for charge reduction imaging in SEM for non-conducting samples

Competency 4: The student will demonstrate an understanding of electrical wafer probing by:

1. Explaining the purpose of electrical wafer probing in semiconductor manufacturing
2. Describing the relationship between wafer probing and subsequent semiconductor processing stages, such as packaging and final testing
3. Identifying the components of a probe station, including wafer chuck, probe card, and testers
4. Describing various electrical tests performed during wafer probing, such as parametric tests and functional tests
5. Demonstrating proficiency in manual probing techniques
6. Evaluating test data to identify which dies are functional and which are defective

Competency 5: The student will demonstrate an understanding of packaging by:

1. Analyzing spin speed and spin curves to understand how the spin speed of the photoresist application influences the final material thickness
2. Explaining the fundamental principles of nanomanufacturing processes, with an emphasis on packaging
3. Explaining the importance of miniaturization in semiconductor packaging
4. Outlining the key steps in packaging processes such as wafer dicing, die attach, wire bonding, encapsulation, and package testing
5. Identifying and describing various types of single die packaging, including their structures, applications, and benefits for enhancing performance, reliability, and miniaturization in semiconductor devices
6. Operating and troubleshooting tools commonly used in packaging nanomanufacturing, such as deposition systems, lithography tools, and inspection equipment

Competency 6: The student will demonstrate an understanding of packaging safety practices and industry standards by:

1. Implementing safety practices for handling nanoscale materials and high-precision tools
2. Identifying common quality issues in semiconductor packaging and their root causes
3. Discussing current industry standards (e.g., JEDEC, IPC) in semiconductor packaging
4. Recognizing trends in the field, such as chiplet architectures, heterogeneous integration, and advanced packaging technologies

Learning Outcomes:

- Use quantitative analytical skills to evaluate and process numerical data
- Solve problems using critical and creative thinking and scientific reasoning
- Formulate strategies to locate, evaluate, and apply information