Technical Elective: Micromachining and Integration Technology

Fall, 2025

INSTRUCTOR: Min GONG

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LECTURES: Tue.: 1:50 – 3:30 PM, S104, Fri.:10:15-11:55AM

TEXTBOOK: C. Y. Chang, S. M. Sze, ULSI Technology, McGraw-Hill, ISBN: 0-07-114105-7. S. A. Campbell, The Science and Engineering of Microelectronic Fabrication, Publishing House of Electronics Industry, ISBN: 7-5053-8626-3.

PREREQUISITE: Physics for Science and Engineering; Electromagnetics; Analytical Methods; Semiconductor Device Theory.

DESCRIPTION:

"Micromachining and Integration Technology" is a professional course related to micro/nanomachining and manufacturing technology of electronic devices. This course consists of the scientific principles and methods of the individual processes for micro/nano-devices, including epitaxy, film-growth, lithography, etching, coating, oxidation/diffusion, ion implantation, device isolation and interconnection (metallization), and several representative integrated machining technologies, including submicron CMOS processes etc.

Through the course study, students have a systematic understanding of the scientific principle, process method, integrated technology and application of micro/nano-processing technology. At the same time, through the study of relevant scientific principles, students can understand and master the use and specific application methods of basic principles in practical engineering and technology, laying the foundation for future engineering technology and scientific research. The characteristics of the course are embodied in highlighting the coherence and logical context of the knowledge system, emphasizing the physical image of knowledge elements and theoretical principles, considering both technicality and cutting-edge, introducing the trends of cutting-edge science and technology in combination with knowledge points, expanding students' scope of knowledge, and improving students' ability to analyze and solve problems. Cultivate students' scientific thinking ability, scientific thinking method, exploration spirit and innovation consciousness. Aiming at the problems of the integrated circuit manufacturing industry in the country, train relevant technical personnel. The basic purpose of this course is to achieve:

(1) Firmly grasp the individual processes and integration technologies required for the manufacture of silicon-based electronic devices and master the integrated manufacturing process of silicon-based electronic devices.

(2) Generally, master the basic concepts, physical principles, process flow and equipment composition of various micro-machining processes, and lay a good knowledge foundation for engaging in the integrated circuit industry.

(3) Generally, understand the cutting-edge knowledge and industry status of silicon-based electronic device micromachining technology, understand the country's needs and expectations for the integrated circuit industry, understand the close relationship between the industry and the country, and cultivate a scientific research attitude towards electronic science research issues.

(4) Cultivate students' ability to apply theory and practice in combination with semiconductor micromachining experiment course.

COURSE OBJECTIVES:

1. Enable students to accurately understand the concept of process flow for micro/nano devices and write the process flow for manufacturing the device based on its structure.
2. Have a preliminary understanding of the basic principles and characteristics of each individual process, the advantages and disadvantages of different technical methods, the key points of process quality control, and detection methods.
3. Preliminarily grasp the main characteristics of integration technology and the basic requirements of process configuration; Be able to preliminarily select technical solutions for each process step based on the characteristics of the device, provide process flow, and describe its basic process requirements.
4. Have a good understanding of the importance of yield in micro/nano device manufacturing and the basic factors that affect yield in manufacturing processes.

LEARNING OUTCOMES FOR THIS COURSE:

1. Knowledge objective: Master the basic methods and principles of micro/nano device manufacturing processes.

2. Ability goal: Able to independently select micro/nano device process technologies and judge process quality based on test results.

3. Quality and emotional value goals: To lay a solid theoretical foundation for subsequent professional course learning, scientific research, and engineering practice.

4. Able to apply principles of engineering, science, and mathematics to identify, analyze, and solve complex engineering problems.

5. Able to apply engineering design methods, comprehensively consider public health, safety and well-being, as well as global, cultural, social, environmental and economic factors, and propose solutions that meet specific needs.

6. An ability to communicate effectively with a range of audiences.

7. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

8. An ability to function effectively on a team whose members together provide leadership, create a collaborative environment, establish goals, plan tasks, and meet objectives.

9. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

10. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

GRADE DETERMINATION:

Usual Performance and Homework 40%

Midterm Exam 30%

Final Exam 30%

Letter grades will be determined from accumulated point totals and assigned according to the scale below.

A: 90 – 100; A-: 85 – 90; B+: 80 – 85; B: 76 – 80; B-: 73 – 76; C+: 70 – 73; C: 66 – 70; C-: 63 –

66; D: 60 – 63; F: < 60.

Note: Usual performance and homework up to 20% points could be granted to the final grade based on the overall course performance (lecture attendance, homework submission punctuality, course engagement such as in-class question answering and discussion, etc.).

EXAMS: There will be one midterm exam and one final exam. Exact exam dates will be announced at least two weeks ahead of time.

QUIZZES: In-class quizzes will be arranged generally prior to the exams. Each quiz will have up to a few questions or problems related to the learned content and help the preparation for exams. The lowest one quiz grade will be dropped when calculating final grades. Each student must complete the quizzes individually.

GRADE REBUTTAL: For any exam, you have one week to request correction if you feel your answer might be mis-graded. No correction will be made a week after the exam grade is posted.

HOMEWORK: Homework problems will be assigned throughout the semester. All finished homework needs to be submitted by the specified due date. While discussion between students is allowed for solving homework problems, each student must write and submit the homework individually.

ATTENDANCE: Less than 60% attendance might be failed for this course. Students will be given excused absences only in cases of a certified medical excuse, or a family emergency. Students missing homework because of an excused absence must submit the completed assignments after they return. Students missing an exam because of an excused absence will take the exam at another time arranged by the instructor.

MATERIAL COVERED: The sequence of the sections covered in this class is:

Chapter 1: Overview of Micro/Nano Device Manufacturing and Integration Technology, (2 credit hours)

Chapter 2: Purification Plant and Wafer Cleaning Technology, (4 credit hours)

Chapter 3: Epitaxial Technology, (2 credit hours)

Chapter 4: Dielectric and Polycrystalline Silicon Thin Film Growth, (8 credit hours)

Chapter 5: Doping and Ion Implantation Technology, (6 credit hours)

Chapter 6: Annealing and Rapid Thermal Treatment, (2 credit hours)

Chapter 7: Photolithography Technology, (4 credit hours)

Chapter 8: Etching Technology, (2 credit hours)

Chapter 9: Metalization Technology, (2 credit hours)

Chapter 10: Integrated Process Flow, (6 credit hours)

Chapter 11: Overview of Advanced Packaging, (3 credit hours)

Chapter 12: Overview of Yield and Reliability, (2 credit hours)