BITS-Pilani, Hyderabad Campus

FIRST SEMESTER 2022-2023

Course Handout Part II

Date: August 02nd, 2022

In addition to Part-I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

CourseNo.	: MELG611
CourseTitle	: IC FabricationTechnology
Units	: 5 (3 2 5)
Instructor-in-charge	: Dr. Parikshit Sahatiya
Instructor	:Dr. Parikshit Sahatiya
Lab Teaching Assistants	: Mr. Venkatarao Selamneni and Mr. Gowtham Polumati

Description: Material properties; crystal growth and doping; diffusion; oxidation; epitaxy; ion implantation; deposition of films using CVD, LPCVD and sputtering techniques; wet and dry etching and cleaning; lithographic process; device and circuit fabrication; process modeling and simulation

1. COURSE DESCRIPTION:

The course describes both theoretical and practical aspects of Integrated Circuit (IC) fabrication technology. Conversion of a single crystal of silicon into an IC requires several fabrication steps such as epitaxy, oxidation, chemical vapor deposition, metallization, ion implantation, diffusion, etching, lithography etc. All these process steps will be discussed. Further, modelling of each processing step would be discussed in details.

2. SCOPE ANDOBJECTIVE:

The objective of the course is not only to introduce the basic principles involved in IC fabricationbutalsotodiscussthe processingtechnology.Fabricationofintegratedcircuits is a joint venture by electrical engineers, chemical engineers, materials scientists and physicists. This interdisciplinary course builds bridges across variousdisciplines.

3. TEXTBOOK:

T1: Plummer, James D. Silicon VLSI technology: Fundamentals, Practice and Modeling. Pearson Education India, 2009.

4. REFERENCEBOOKS:

R1: Sze S. M., VLSI Technology, McGraw-Hill, 2nd ed., 1980.

R2:CampbellSA,ThescienceandEngineeringofmicroelectronicfabrication,Oxford 2001.

R3: Gandhi, Sorab K. VLSI fabrication principles: silicon and gallium arsenide. John Wiley, 1994.

5. Schedule:

Lecture:	Mon, Wed, Fri,	9 am – 9:50 am.
Labs:	Tue, Thurs	11 am – 12:50 pm.

6. COURSE PLAN

Section	Lecture #	Topic	Brief	Reference
I	1 - 2	Introduction to IC Fabrication Technology	A brief overview of the course and basic fabrication steps.	Lect notes/slides
II	3-5	CMOS Technology	CMOS Process flow	Lecture Notes/Slides/Ch .2 Plummer
III	6- 8	Crystal structures, defects, directions, planes	Basic Solid State Physics for understanding of Silicon fundamentals	Lect notes/ slides/Ch. 3, Plummer
IV	9-11	Single crystal growth to Waferpreparation, dopantdistribution	To learn the art of wafer preparation and some of the basic properties of these wafers.	Lect Notes/Slides/Ch .3, Plummer
V	12	Semiconductor Manufacturing	Introduction to Clean room and wafer cleaning process (RCA)	Lect Notes/Slides/Ch .4, Plummer
VI	13-18	Oxidation and Si/SiO_2 interface	Focus primarily on the thermal oxidation process and the properties at the Si/SiO_2interface.	Lect Notes/Slides /Ch. 6, Plummer
VII	19-24	Lithography	Learn how to print the patterns on the wafer using optical exposure systems. Basics of Optical systems	Lect Notes/Slides /Ch. 5, Plummer's
VIII	25-29	Dopant Diffusion (Doping process)	Understand the doping concept by diffusion method.	Lect Notes/Slides /Ch. 7, Plummer
IX	30-34	Ion Implantation (Doping process)	Understand the doping concept by Ion Implantation method	Lect Notes/Slides /Ch. 8, Plummer
X	35	Annealing of damages and masking during implantation	How annealing helps to recover damages and how the thickness of themasking layer improves the maskingefficiency.	Ch. 8, Plummer's book
XI	36-38	Thin Film Deposition	Understand different techniques to deposit thin films (Chemical/Physical Vapor Deposition systems)	Lect Notes/Slides /Ch. 9, Plummer
XII	39-40	Etching	Introducing various etching mechanism involved in CMOS device fabrication	Lect Notes/Slides /Ch. 10, Plummer
XIII	41-42	Metallization and conclude the course	How devices are connected to the outside world.	Ch. 11 Plummer

7. EVALUATIONSCHEME:

Component	Duration (min)	Weightage		Date &Time	Remarks
		%	Marks		
Mid Semester	90	20	60	31/10 3.30 - 5.00PM	CB
Research Project	-	20	60	Comment 1*	OB
Assignment	-	5	15	To be announced	OB
Lab	-	15	45	Comment 2^{+}	OB
Quizzes	-	10	30	To be announced	OB
Comprehensive Exam	180	30	90	19/12 AN	CB
Total		**100**	**300**		

- *Comment 1: Details regarding the Project evaluation will be announced separately.
- $^{+}$Comment 2: Regular labs will be as per schedule and details regarding the lab reports will be announced separately.
- OB →Open Book
- CB → Closed Book

8. LIST OF EXPERIMENTS

i. To study/observe clean room formation, various components, reliability.
ii. Study the poly-di-methyl-siloxane (PDMS) based fabrication and its testing
iii. To study the 3D printing based device fabrication and its testing
iv. Characterization Lab -1 (XRD and XPS)
    a. Study the crystal structure using XRD
    b. Study the chemical composition and oxidation state using XPS
v. Characterization Lab – 2 (UV-vis and FESEM)
    a. Study the UV-visible spectroscopy and calculating the optical bandgap
    b. Study the Surface Morphology using Scanning Electron Microscopy
vi. Demonstration of the Thermal Oxidation Process
vii. Demonstration of the Positive/NegativePhotolithography process and wet-etching
viii. Demonstration of the Chemical Vapour Deposition (CVD Technique)
ix. Demonstration of the Metallization Process using E-Beam Evaporator/Thermal Evaporator
x. Demonstration of the IV Characterization using Semiconductor Parameter Analyzer

9. CHAMBER CONSULTATION HOUR: To be announced in theclass.

10. Makeup Policy: Make-up only to those who apply before start of an evaluation component (medical reason only).

11. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and any mode of academic dishonesty will not be acceptable

Instructor-in-charge