GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2015-2016

Physics of Semiconductor Technologies and Devices (E031521)

Course size (nominal values; actual values may depend on programme)

Credits 4.0 Study time 120 h Contact hrs 36.0 h

Course offerings and teaching methods in academic year 2017-2018

A (semester 2)	English	project	5.0 h
		lecture	30.0 h
		practicum	5.0 h
B (semester 2)	Dutch	project	5.0 h
		guided self-study	30.0 h
		practicum	5.0 h

Lecturers in academic year 2017-2018

Van Steenberge, Geert	TW06	lecturer-in-charge
Missinne, Jeroen	TW06	co-lecturer
Vounckx, Roger	VUB	co-lecturer

Offered in the following programmes in 2017-2018	crdts	offering
Bridging Programme European Master of Science in Photonics	4	A
Bridging Programme Master of Science in Photonics Engineering	4	A
Master of Science in Electrical Engineering (main subject Communication and Information Technology)	4	A
Master of Science in Electromechanical Engineering (main subject Control Engineering and Automation)	4	A
Master of Science in Electromechanical Engineering (main subject Electrical Power Engineering)	4	A
Master of Science in Electrical Engineering (main subject Electronic Circuits and Systems)	4	A
Master of Science in Electromechanical Engineering (main subject Maritime Engineering)	4	A
Master of Science in Electromechanical Engineering (main subject Mechanical Construction)	4	A
Master of Science in Electromechanical Engineering (main subject Mechanical Energy Engineering)	4	A
European Master of Science in Photonics	4	A
Master of Science in Photonics Engineering	4	B

Teaching languages

Dutch, English

Keywords

technology, crystal growth, oxidation, photolithography, etching, diffusion, ion implantation, film deposition, photodetector, LED

Position of the course

This course describes the different processes involved in the fabrication of modern semiconductor components. The course is divided into two parts. The first part describes the physics of the different processing steps, while the second part describes the fabrication of the most important optical and optoelectronic components.

Contents

Crystal Growth

- Silicon Crystal Growth from the Melt: Starting Material, The Czochralski Technique,

Distribution of Dopant, Effective Segregation Coefficient
- Silicon Float-Zone Process
- GaAs Crystal Growth Techniques: Starting Materials, Crystal Growth Techniques
- Material Characterization: Wafer Shaping, Crystal Characterization

Silicon Oxidation
- Thermal Oxidation Process: Kinetics of Growth, Thin Oxide Growth
- Impurity Redistribution During Oxidation
- Masking Properties of Silicon Dioxide
- Oxide Quality
- Oxide Thickness Characterization

Photolithography
- Optical Lithography: The Clean Room, Exposure Tools, Masks, Photoresist, Pattern Transfer, Resolution Enhancement Techniques
- Next-Generation Lithographic Methods: Electron Beam Lithography, Extreme Ultraviolet Lithography, X-Ray Lithography, Ion Beam Lithography, Comparison of Various Lithographic Methods

Etching
- Wet Chemical Etching: Silicon Etching, Silicon Dioxide Etching, Silicon Nitride and Polysilicon Etching, Aluminum Etching, Gallium Arsenide Etching
- Dry Etching: Plasma Fundamentals, Etch Mechanism, Plasma Diagnostics, and End-Point Control, Reactive Plasma Etching Techniques and Equipment, Reactive Plasma Etching Applications

Diffusion
- Basic Diffusion Process: Diffusion Equation, Diffusion Profiles, Evaluation of Diffused Layers
- Extrinsic Diffusion: Concentration-Dependent Diffusivity, Diffusion Profiles
- Lateral Diffusion

Ion Implantation
- Range of Implanted Ions: Ion Distribution, Ion Stopping, Ion Channeling
- Implant Damage and Annealing
- Implantation-Related Processes: Multiple Implantation and Masking, Tilt-Angle Ion Implantation, High-Energy and High-Current Implantation

Film Deposition
- Epitaxial Growth Techniques: Chemical Vapor Deposition, Molecular Beam Epitaxy
- Structures and Defects in Epitaxial Layers: Lattice-Matched and Strained-Layer Epitaxy, Defects in Epitaxial Layers
- Dielectric Deposition: Silicon Dioxide, Silicon Nitride, Low-Dielectric-Constant Materials, High-Dielectric-Constant Materials
- Polysilicon Deposition
- Metallization: Physical Vapor Deposition, Chemical Vapor Deposition, Aluminum Metallization, Copper Metallization, Silicide

Semiconductor Components
- Silicon Photodetectors
- Compound Semiconductor Photosensors
- Light Emitting Diodes

Initial competences

basic knowledge of physics and solid-state physics

Final competences

KNOWLEDGE and INSIGHTS:
- Understanding of different process steps like crystal growth, oxidation, photolithography, etching, diffusion, ion implantation, and film deposition;
- Understanding of the basic operation and the fabrication of the most important optical and optoelectronic components.

SKILLS:
- Basic use of TCAD tools for process modelling;
- Critical reading and understanding of a scientific article;
- Hands-on experience with a number of process steps in a clean room environment.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Guided self-study, lecture, practicum, project

Extra information on the teaching methods

lectures; practicum, project.

Learning materials and price

Syllabus (in English)

References

- G.S. May and S.M. Sze. Fundamentals of Semiconductor Fabrication, John Wiley and Sons, 2004.
- H. Zimmermann. Silicon Optoelectronic Integrated Circuits, Springer, 2004.
- C.Y. Chang and S.M. Sze. ULSI Technology, McGraw-Hill, 1996.
- C.Y. Chang and S.M. Sze. ULSI Devices, John Wiley and Sons, 2000.

Course content-related study coaching

4 researchers

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Oral examination

Examination methods in case of periodic evaluation during the second examination period

Oral examination

Examination methods in case of permanent evaluation

Report

Possibilities of retake in case of permanent evaluation

not applicable

Extra information on the examination methods

During examination period: written closed-book exam complemented with oral examination;
During semester: graded project reports.

Calculation of the examination mark

Reports: 30%. examination: 70%