GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2024-2025

Thin Films: Physics and Analysis (C004511)

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

Credits 6.0 **Study time 180 h**

Course offerings in academic year 2024-2025

A (semester 1) English Gent

Lecturers in academic year 2024-2025

Dendooven, Jolien	WE04	lecturer-in-charge
Depla, Diederik	WE04	co-lecturer

Offered in the following programmes in 2024-2025	**crdts**	**offering**
Master of Science in Physics and Astronomy	6	A
Exchange Programme in Physics and Astronomy (Master's Level)	6	A

Teaching languages

English

Keywords

Thin films, deposition methods, characterization

Position of the course

In this course, the student will gain an understanding of thin film technology based on the physical principles on which deposition techniques rely. Through a detailed description of the growth mechanisms of thin films, the student will gain insight into the process of selecting a technique for a particular application. The various characterization techniques characteristic of thin films are taught both theoretically and practically. A number of concrete examples are used to demonstrate the importance of thin films for applications.

Certain parts of the content of course C004511 are covered in the course Fysica van oppervlakken en dunne lagen (C004449). Students who already took this course (C004449) in the Bachelor's program and would like to take the other parts of the content of course C004511 can take the course Thin Films: Atomic Scale Processing and Analysis (C004512).

The content of course C004511 has considerable overlap with the course Thin Films: Physics and Technology (E006700). Therefore, including both courses in the curriculum is not possible.

Contents

• Part 1. An introduction on thin film technology with attention for the different types of deposition techniques and different application fields.
• Part 2. Growth mechanisms. Nucleation theory is discussed in detail. Both the thermodynamic and the kinetic approach are discussed. The gradual transition from the initial nucleation to a continuous thin film is treated.
• Part 3. Stress in thin films : origin and characterization.
• Part 4a. Deposition techniques : Physical Vapour Deposition with as examples: thermal evaporation, sputtering and pulsed laser deposition.
• Part 4b. Deposition techniques : Chemical Vapour Deposition with focus on atomic layer deposition.
• Part 5. Characterization : atomic structure and texture analysis of thin films via diffraction methods (XRD, pole figures, EBSD, RHEED), structure information on the nanoscale via grazing incidence small angle X-ray scattering (GISAXS), different

methods to determine thin film thickness, both ex-situ and in-situ (ellipsometry, XRR, XRF, QCM).
Finally, the accumulated knowledge from the different parts of the course is used to understand some important practical applications of thin films.

Initial competences

Materials Physics, Solid State Physics, Atomic and Molecular Physics, Quantum Mechanics

Final competences

1 Describe in a transparent way the physical working principles of the deposition techniques that have been addressed in depth.
2 Understand the growth of thin films, and identify the most important underlying physical processes.
3 Understand the origin of stress in thin films.
4 Select deposition techniques for a given application based on their working principles.
5 Design a strategy to study thin film properties based on the acquired knowledge on thin film characterization techniques, their principle of operation, capabilities and limitations.
6 Recognize for a number of selected applications the function of the thin film(s).

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

Seminar, Lecture, Practical, Independent work

Extra information on the teaching methods

- The seminars give more insight in the topics discussed in the lectures, and permit to apply the theoretical concepts to practical examples.
- The tasks foreseen in the independent work allow the student to individually practice the subjects.
- The practical courses (lab sessions) offer the possibility to get practical insight in theoretical concepts and to get hands-on experience with certain deposition and characterization techniques discussed in the lectures.
- Selected applications of thin films may be addressed via a seminar by a guest lecturer from the work field.

Study material

Type: Syllabus

Name: Course Thin Films: Physics and Analysis
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

Type: Slides

Name: Slides
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

Type: Software

Name: SRIM/SIMTRA/NASCAM
Indicative price: Free or paid by faculty
Optional: no
Online Available : Yes
Usability and Lifetime within the Course Unit : not applicable
Usability and Lifetime within the Study Programme : one-time
Usability and Lifetime after the Study Programme : occasionally
Additional information: These software packages are free to use. The copyright regulation was negotiated by the lectures with the authors.

Type: Other

Name: Scientific articles and book chapters
Indicative price: Free or paid by faculty
Optional: no
Language : English
Available on Ufora : Yes

References

• Thin-Film Deposition: Principles and Practice (D. Smith, ISBN: 978-0070585027)
• Materials Science of Thin Films (M. Ohring, ISBN: 9780125249751)
• Handbook of Deposition Technologies for Films and Coatings (P. Martin, ISBN: 9780815520313)
• Glow Discharge Processes: Sputtering and Plasma Etching (B. Chapman ISBN: 978-0-471-07828-9)

Course content-related study coaching

Individual explanations by instructors, by appointment.

Assessment moments

end-of-term and continuous assessment

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

Written assessment open-book

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

Written assessment open-book

Examination methods in case of permanent assessment

Presentation, Assignment

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

Periodic evaluation:
• First examination period: Open book examination
• Second examination period: Open book examination
Non-periodic evaluation
• Solve an excerise regarding sputter deposition by simulations.
• Give a presentation on a modern deposition- or characterization method or thin film application.

Calculation of the examination mark

Average score calculated based on the outcome per question of the open book exam (13/20).
Results on the non-periodic evaluation (7/20)