**Module Description, available in: EN**

# *Advanced thin film technology*

## General Information

**Number of ECTS Credits**

3

**Module code**

TSM_ThinFilm

**Valid for academic year**

2024-25

**Last modification**

2021-12-23

**Coordinator of the module**

Martin Krejci (FHNW, martin.krejci@fhnw.ch)

**Explanations regarding the language definitions for each location:**

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

| | Lausanne | | | Lugano | Zurich | | |
|---|---|---|---|---|---|---|---|
| **Instruction** | | | | | **X** E 100% | | |
| **Documentation** | | | | | **X** E 100% | | |
| **Examination** | | | | | **X** E 100% | | |

**Module Category**

TSM Technical scientific module

**Lessons**

2 lecture periods and 1 tutorial period per week

## Entry level competences

**Prerequisites, previous knowledge**

- Optics: Basics of wave and geometrical optics;
- Physics basics for engineers
- Analysis and linear algebra on FH bachelor level recommended

The students are required to fill possible gaps by self-study. Students without basic knowledge in optics are requested to complete the EVA module "Fundamentals of Light" prior to the "Advanced Thin Film Technology" TSM module.

## Brief course description of module objectives and content

The Technology of thin films is a core element in the design and fabrication of photonic components. The objective of the module "Advanced Thin Film Technology" is the introduction to this important technology and to the applications of thin films in the field of photonics with the focus on optical coatings. This includes the design and fabrication of thin films as well as the characterization of their physical properties.

## Aims, content, methods

### Learning objectives and competencies to be acquired

The students

- are familiar with the main deposition and structuring methods used in thin film technology. They know the advantages and drawbacks of the different methods and are able to select a suitable method for a given thin film design
- know important microstructural, chemical, mechanical, optical, electrical and thermal properties of thin films and are familiar with the relevant methods used in industry to characterize these properties
- understand the main physical concepts related to the application of thin films in photonics and are able to solve simple problems involving thin layers. They are able to perform calculations and evaluations of optical coating designs.
- know the most important applications of thin layers in passive and active devices

### Module content with weighting of different components

There will be several thematic blocks. Although several different types of thin layers will be discussed, the focus will be set on optical coatings:

- Fabrication methods (~3 weeks)
  - A detailed discussion of deposition methods, with the focus on the following deposition method categories: Physical evaporation, Plasma enhanced physical and chemical deposition, liquid phase deposition
  - A rough introduction to structuring methods such as photo-, e-beam and imprint lithography, plasma assisted physical – and chemical dry etching, wet etching, lift-off
- Properties and characterization methods of thin films (~3 weeks)
  - Properties such as morphology, microstructure, optical and electric properties, chemical and mechanical properties
  - Methods such as atomic force microscopy and profilometry, optical an electron microscopy, focused ion beam, x-ray analytical methods, ion beam based methods (SIMS, RBS) as well ellipsometric and spectroscopic methods
- Physics of thin films (~3 weeks)
  - Optical properties:
    - Behavior of radiation in thin layers and at layer interfaces
    - Reflection, transmission and absorption properties of thin layers and and multilayer stacks
  - Material diffusion in thin layers
  - Mechanical behavior and adhesion of thin films
- Simulations of thin films (2 weeks)
  - Numerical simulation of optical properties
- Applications (~3 weeks)
  - Coatings designs for optical components such as lenses, mirrors and filters
  - Planar wave guide structures, gratings or plasmonic structures
  - Thin films in photonic devices

### Teaching and learning methods

Will be defined by the lecturers

### Literature

Used in lecture:

- Materials Science of Thin Films, 2nd edition, Milton Ohring, Academic Press
- Introduction to Optics, Frank Pedrotti, Pearson

Additional Literature:

- Optical Thin Films and Coatings, Editors: Angela Piegari, François Flory, Elsevier

## Assessment

### Certification requirements

Module does not use certification requirements

### Basic principle for exams

**As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.**

**Standard final exam for a module and written resit exam**

**Kind of exam**

Written exam

**Duration of exam**

120 minutes

**Permissible aids**

*Aids permitted as specified below:*

**Permissible electronic aids**

- Calculator

**Other permissible aids**

- Summary and personal formula collection without solved problems (number of pages to be defined by lecturers)

**Special case: Resit exam as oral exam**

**Kind of exam**

Oral exam

**Duration of exam**

30 minutes

**Permissible aids**

No aids permitted