Danish title: Mikro- og Nanofabrication / MICRO 2

English title: Micro- and Nanofabrication / MICRO 2

Credits: 10 ECTS

Prerequisites: INANO, NANOS, MICRO1

Aim:
Micro and nano systems are small systems built from a number of functional parts, for example: electronics, mechanics, optics, and/or microfluidics. All or most parts are fabricated partly or fully using micro and nanofabrication technology, and they form a single entity. A hearing aid, and a lab-on-a-chip are examples of such systems. In every modern car you will find a number of micro systems, for instance the air-bag accelerometer for the air bag control. The aim of this course, which builds on the competences obtained in MICRO1, is to make the students able to design, fabricate, and characterize micro and nano systems.

Competences:
At the end of the course, the student is expected to be able to

- choose fabrication methods suited for the fabrication of a given micro or nano system and specify how the various processes can be integrated in a process recipe
- select relevant process parameters based on underlying theory.
- explain the principles behind the specified lithographic techniques and their field of use and limitations.
- use finite element modelling and CAD software to aid in the design process.
- calculate the behaviour of simple mechanical structures, e.g. cantilevers and membranes and describe their potential applications.
- account for the basic components in micro- and nano-fluidics and the operational principles
- work independently in the cleanroom
- use standard electrical measurements techniques such as lock-in techniques

For course content, please see page 2:

Course content:

- Introduction to micro and nano systems
- Micro fabrication (recap from MICRO1)
- Nanolithography
    - Electron beam lithography
    - Nano-imprint lithography
- Lithography mask lay-out exercise (L-Edit)
- Process integration
- Back-end processing
    - Bonding
    - Packaging
- MEMS and NEMS
    - Structures
        - Cantilever beams
        - Doubly-clamped beams
        - Membranes
    - Modelling
        - Continuum mechanics
        - Finite element exercise (COMSOL)
    - Fabrication
        - Deep etching (KOH, ICP-RIE)
    - Applications
        - Sensors, actuators
- Micro and nano-fluidics
    - Structures
        - Pumps
        - Mixers
        - etc
    - Basics of modelling
    - Fabrication
        - Deep etching, wafer bonding, hot embossing
    - Applications
- Electronics measurement techniques
    - DC and AC measurements
        - Lock-in

List of exercises
Exercise 1: Process recipe development?
Exercise 2: Lithography mask lay-out
Exercise 3: Finite element simulation
Exercise 4: Processing exercise (including electron-beam lithography)
Exercise 5: Characterization exercise

All exercises must be approved before the exam
Exercises 4 and 5 must be documented in a report made in groups of 2-3 students.

Evaluation:
Oral exam: Danish 7 mark scale, internal examiner; exam protocol required
Lab work: Pass/fail, internal evaluation by teacher

Remarks regarding evaluation:
Examination is based on content of lectures and lab exercises

Withdrawal: 7 days

Teaching method:
Lectures, 64 hours
Laboratory exercises, 36 hours

The course takes place in the autumn semester

Teachers: Jens Ebbecke and Jakob Kjelstrup-Hansen

The course is compulsory in the following curricula: Mechatronics, specialisation nanotechnology
Valid from: September 2010.