Nano III: Tfy-125.4003/ S-129.4003/HY

Exam May 17 2011, hall K216, 9-12 o'clock

Instructions and advice:

There are 6 questions, and you choose 5 to answer.

All questions are worth 6 points.

Start each answer from top of a page.

Make drawings and graphs were appropriate.

You can have A4 "cheat sheet", written on both sides, with you at the exam. It has to be handwritten, and it must be returned with the exam papers.

1. Imagine that you would be studying the following systems using x-rays.
Which method would you use? Give the main reasons for your selection. 1 point each.

a) Crystal structure in a thin film with a thickness of 1 nm
b) Crystallinity of nanocellulose powder
c) Size of aerosol particles in gas sample
d) Short range order of palladium atoms in a polymer supported catalyst
e) Shape of proteins in solution
f) For which of the following tasks synchrotron radiation or free electron laser would be needed ?

2. Explain how these techniques are suited for fabrication of 100 nm periodicity grating. 1 point each.

a) electron beam lithography
b) focussed ion beam milling
c) micro contact printing
d) optical projection lithography
e) nanoimprint lithography (NIL)
f) which one would you use in an university laboratory setting, and which in industrial mass production and why?

3. Forces on the micro- and nano-scale range from 10 nN required to break a covalent bond, and down to < 1pN required to significantly stretch a DNA molecule. Describe nanotechniques for measuring these forces. Discuss e.g.: the physical principle of the technique, an application of the technique, the experimental setup, the calibration procedure, the force range and resolution of the technique, the limitations and advantages of the technique.

4. What is Langmuir-Blodgett deposition? Describe the complete Langmuir-Blodgett process for deposition of multilayers on a glass substrate. Make a schematic drawing. Discuss strengths and limitations and give some application ideas.

5. How does the DNA origami technique work and what are its potential applications? Other nano-objects can be attached on DNA origami; what has been already experimentally demonstrated in this respect?

6. Describe the physical phenomena behind SPR and QCM techniques as well as their working principle. What kind of information do the SPR and QCM techniques provide? Give one application of both techniques, and describe what is the main information that was extracted from the measurements !