Lecture “Nanotechnology”

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Contents:

Introduction:

1. Why Nanotechnology?
    a. Basic physics
    b. Quantum effects
    c. Applications
2. Applications and materials
    a. Semiconductors
    b. Magnetism
    c. Plasmonics
    d. Metamaterials

Fabrication methods:

3. Top-down approach
    a. General approaches
    b. Positive/negative techniques; lift-off; wet and dry etching
4. Top-down-approach
    a. Optical lithography
    b. Electron beam lithography
    c. Focused ion beam
    d. Nanoimprint
5. Bottom-up approach
    a. Nanoparticles
    b. Fullerenes
    c. Graphene

6. Bottom-up approach
    a. Basic principles of self-organization
    b. Nanosphere lithography
    c. Micelles
    d. Ion erosion
    e. Alumina templates

Characterization techniques:

7. Forces at the nanoscale
    a. Comparison macroscale - nanoscale
    b. Van der Waals interaction
    c. Casimir force
    d. Dipolar forces (magnetic stray fields)
8. Scanning probe microscopy (SPM)
    a. Scanning tunnteling microscope (STM)
    b. Atomic force micsoscope (AFM) and related techniques (MFM, SCM)
    c. Manipulation of surfaces using SPM
    d. Scanning nearfield microscopy (SNOM)
9. Local characterization of topography and elementary composition
    a. Scanning electron microscopy
    b. Transmission electron microscopy, incl. EDX and EELS
    c. Secondary ion mass spectroscopy
10. Local characterization of magnetic properties
    a. Kerr microscopy
    b. Lorentz- microscopy
    c. X-ray magnetic circular dichroism (XMCD)
    d. Photo-emission electron mikroscopy (PEEM)
    e. Transmission x-ray microskopy (TXM)
    f. Holography

Special applications:

11. Molecular machines

12. Lab-on-a-chip

13. Photonic crystals

14. Magneto resistance and spin transfer torque

15. Plasmonics, metamaterials