S-104.3610 Nanotechnology (5 cr) **Exam 13.5.2008**

You can answer either in English or Finnish. Numerical values of calculations are not needed (calculators not necessary).

1. Explain briefly (max. 2 pages altogether, draw schematics if needed):
   a) dip pen lithography
   b) atomic layer deposition
   c) role of chirality in carbon nanotubes
   d) break-junction technique in molecular electronics
   e) photonic bandgap
   f) two examples of biomimetic nanostructures
   (each 1 p)

2. a) Self-assembled monolayers (SAMs) in "bottom-up" nanotechnology. (3 p)
   b) Fabrication, structure and properties of fullerene C_{60}. (3 p)

3. a) Operation principle of STM. (2 p)
   b) An electron in STM tip has an energy of E = 2 eV as it tunnels through a V = 5 eV barrier with thickness d = 1.0 nm to conductive surface. Estimate the change in the sample-tip distance d if the current increases by a factor of 10000. (4 p)

4. a) Contact angle on superhydrophobic surfaces (3 p)
   b) Growth process of atomic layer deposition (ALD). (3 p)

5. a) Operation modes of atomic force microscope (AFM). (3 p)
   b) An electron in a tip of a scanning tunneling microscope (STM) has an energy of E = 3,5 eV as it tunnels through a V = 7 eV barrier with thickness d to conductive surface. Estimate the change in current if the sample-tip distance is increased from d = 3 Å to 9 Å. Numerical values are not necessary. (3 p)