Department of Materials Science and Engineering
Norwegian University of Science and Technology

TMT4320 Nanomaterials, fall 2015

EXERCISE 8

Guidance: Wednesday 21st October, 18:15-20:00, H3
Due date: Friday 23rd October, 14:00, boxes outside R7

PROBLEM 1

a) Explain how nanowires can be made by the vapor-liquid-solid (VLS) process.

b) What types of materials can be made using the VLS process?

c) What types of materials cannot be made using the VLS process? Explain why.

d) How can you make 1D nanostructures of materials that cannot be made using the VLS process? Explain one method that can be used for almost all materials.

PROBLEM 2

Electrodeposition can be used in combination with a template with one-dimensional porous channels to obtain metal nanorods. A metal film is evaporated onto one side of the template (see figure 2). The metal film is used as one of the electrodes (the cathode) during the growth of the metal nanorods. The growth occurs when the structure is immersed in a solution containing metal ions and an electrical potential is supplied. (NB! Electrodeposition has not been covered in detail during lecture. A good source to use here is: A. Huczko, Template-based synthesis of nanomaterials, Appl. Phys. A- Mater. Sci. Proc., 2000, **70**, 365)

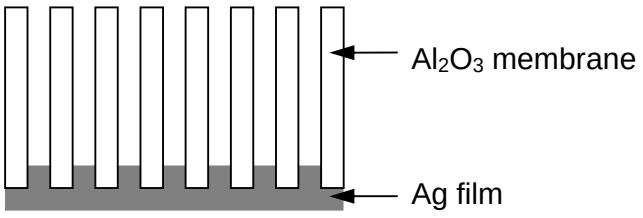

Figure 1: Structure of an alumina membrane template with an evaporated Ag film on the bottom side (cross section).

a) Explain how the growth of metal nanorods occurs by the electrodeposition method and how free-standing nanorods can be obtained after the electrodeposition.

b) How can we use this method to grow nanorods with segments along the nanorod length containing different metals (bar-coded nanorods), for instance alternating between silver and gold?

PROBLEM 3
(Parts of this problem was covered in the first quarter of the semester)

In atomic force microscopy, a tip is brought into proximity of a sample surface. The forces between the tip and the sample lead to a deflection of the cantilever. The AFM tip shape may influence the observations because of the convolution effect. The convolution effect increases as the radius of curvature of the tip increases and as the slopes of the facets increase. If the shape of the tip is known the images can be partly corrected.

a) Describe by drawing how a line scan across a material surface with either a stepped surface (figure 2A) or a rough surface (figure 2B) will look if you use a tip with a pyramid shape (figure 2C) or a parabola shape (figure 2D) (in total 4 line scans). Draw both the surface structure and the line scan.

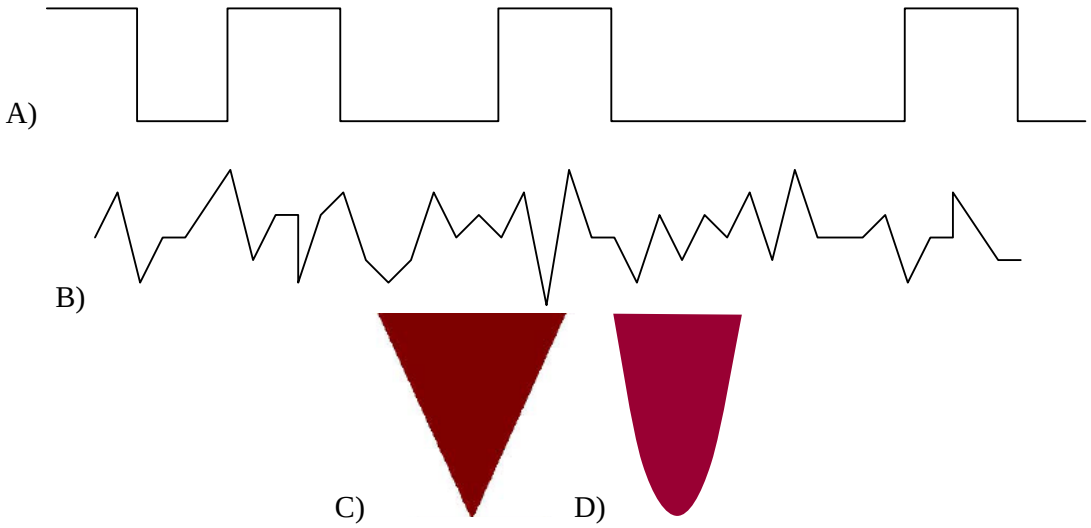

Figure 2: A) Stepped surface of a material. B) Rough surface of a material. C) Pyramid-shaped tip used for imaging. D) Parabola-shaped tip used for imaging.

b) Is it possible to correct the line scan if you know the exact shape of the tip? Explain.

c) How can the convolution effect be minimized by using carbon nanomaterials?