NANOMECHANICS AT WORK : BIOSENSING, MOLECULAR MOTORS AND LIFE SCIENCE APPLICATIONS

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The ability to understand and control mechanical structures has been instrumental for the introduction of e.g. mechanical motors, which in turn laid the basis for the industrial revolution to take place paving the way for our modern society. Now we are facing the nano-era and the mechanics at the nanoscale is becoming increasingly important. In this talk I will highlight a number of nanomechanical issues. Firstly, I will discuss about extremely efficient nanomotors based on molecular motors derived from muscle tissue. Here we have explored various nanostructures (topographical as well as chemical) in order to guide, rectify, and direct nanomechanical movement with uttermost precison and high effeciency. Then I will discuss about friction at the few nm scale. We have studied in our work the friction between InAs nanowires pushed laterally across surfaces by the AFM tip and different substrates and chemically modified surfaces. I will show examples of static and dynamic friction and the transition to stick-slip motion (**Fig 1**). Although detailed studies of friction has been around for long time, few studies of friction at the nanoscale has to date been performed. Then nanomechanical structures having the ablity to detect few molecular reactions on its surfaces by monitoring the resonance frequencies will be introduced. The structure of the nanomechanical device is a laterally deformable double-finger interdigitated cantilevers array (**Fig 2**), which are made on SiO_2/Si surface and evaporated with a metal layer. When a bias is applied, the cantilevers of the device will bend to each other due to electrostatic force. After deposition of a silane layer, the resonance frequency shows 25 kHz shift corresponding to a weight of 6 fg indicating that the device could be applied as a mass sensor with a 0,2 ag/Hz sensitivity. As a further extension of these nanogratings we have employed nanowires defined by Nanoimprint lithography and epitaxial growth. Surfaces containing nanowires have been employed to study neuronal outgrowth, cellular response and cellular survival (**Fig 3**. We show that peripheral nerve cells can survive and grow on gallium phosphide (GaP) nanowire surfaces and that cells are activated by the nanotopography. Then as a concluding remark I will discuss about the nanomechanical aspects of nanoimprint lithography (NIL). And, finally, I will give an outlook and discuss about NIL´s role as a very versatile alternative for future nanoscience based production.

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Figures:

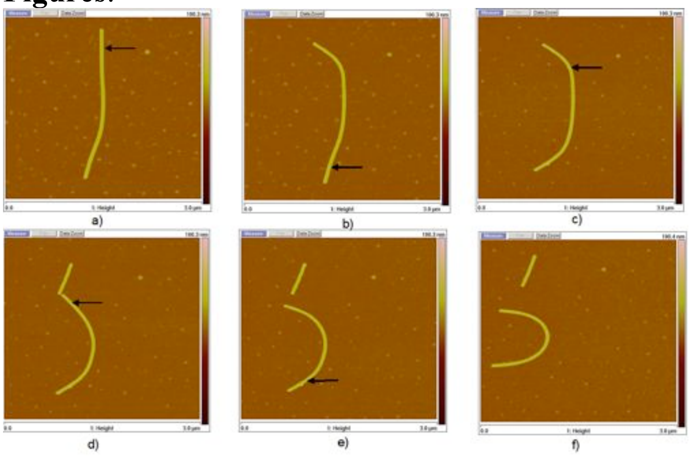

Figure 1. A typical nanowire manipulation experiment. The arrows show the position and direction of the push applied by the AFM tip before taking the subsequent image.

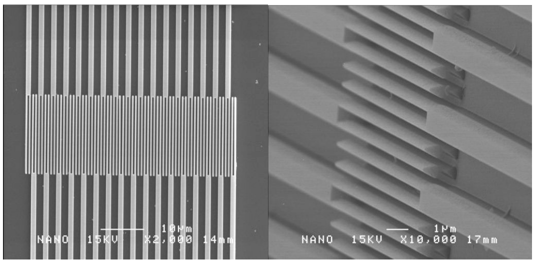

Fig. 2 SEM images of the NEMS device: top view (left) and side view (right).

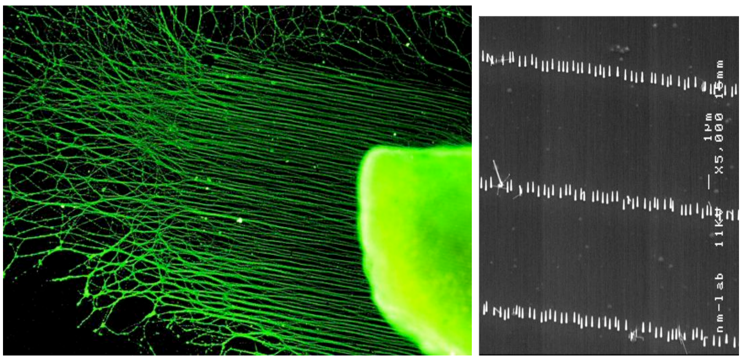

Fig. 3 a) Fluorescence microscopy image of the axons from superior cervical ganglia on a 1 by 1 mm nanowire-patterned surface (parallel rows of nanowires) b) SEM of the surface showing the aligned parallel rows of nanowires.