TUNING FORK BASED NANO-TOOLBOX FOR MOLECULAR AND ORGANIC ELECTRONIC

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The development of a new electronics based on nanoscale building blocks in the bottom up approach needs new techniques for visualising, probing and connecting the building blocks at the nanometre scale. This is especially true for organic and molecular materials which are, most of time, incompatible with standard lithography and deposition techniques. In this purpose, scanning probe microscopies already allow characterizing at the atomic scale the topological arrangement of these building blocks, and thus, open the way for probing and controlling the assembling process of the future architectures. In addition, the spectroscopic capabilities associated with both STM or AFM allow probing the electronic or mechanical properties at the atomic scale. Single molecules properties can be investigated without any wiring technology, to reveal the intrinsic behaviour of these molecular building blocs.

However, an important problem which remains to be resolved is the electrical connectivity between individual electro-active molecules and the macro-world. Without solving it, no further progress in the molecular electronics can be achieved and the great integration potentiality of the molecular materials can be lost. This step is then considered as a crucial milestone towards operational molecular devices. In return, solving it will allow fundamental studies. This is especially important for understanding the connexion behaviour at this length scale where the contact interface plays a dominant role in the whole device characteristic. In this purpose, one can expect to develop a nanometric toolbox for the manipulation and connection of functional molecules.

In this presentation, the developments of such a toolbox based on quartz tuning forks will be presented. We will first demonstrate that frequency-modulated atomic force microscopy with these rigid cantilever can be used to image the microphase separation of soft materials, i.e., a polystyrene/poly(methylmethacrylate) block copolymer [1]. Two-dimensional force spectroscopy images revealing a clear contrast originating from local variations in the mechanical properties of the two microsegregated phases will be presented. The force versus tip-sample distance dependence extracted from the frequency shift data will be discussed in the frame of the contact forces theories.

These results illustrate the possibility to use quartz tuning forks for imaging and probe soft material. Then we will discuss how it can be used for "driving" dynamic nanostencils with integrated AFM tip for both the imaging and wiring single organic nano-objects. Some preliminary results on the dynamic nanostencils realisation by conventional microelectronic routes will be shown. They are based on the standard Si_3N_4 suspended membrane with an integrated AFM tip and nanostencil holes realized by focused ion beam deposition and milling. The possibility to drive this functionalised chip in close proximity of the nano-objects with tuning forks will be discussed.

References:

[1] M. Brun, S. Decossas, F. Triozon, P. Rannou, and B. Grévin , Applied Physics Letters, **87** (2005) 133101.

Figures:

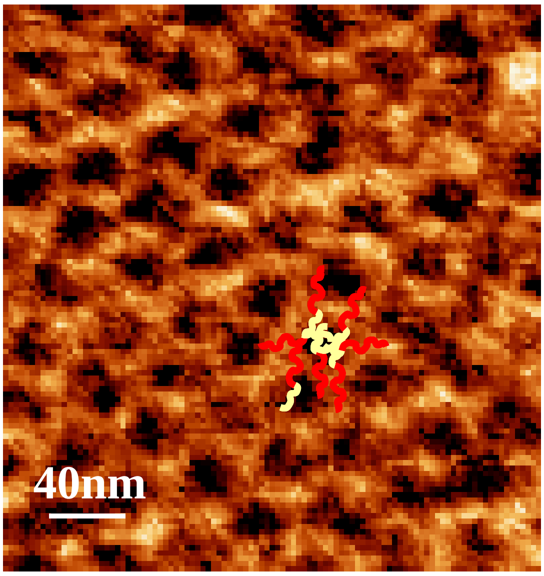

Fig 1. TF-AFM dissipation image (HV, 300K) of a PS:PMMA copolymer. The red and yellow sketch illustrates copolymer chain segregation.

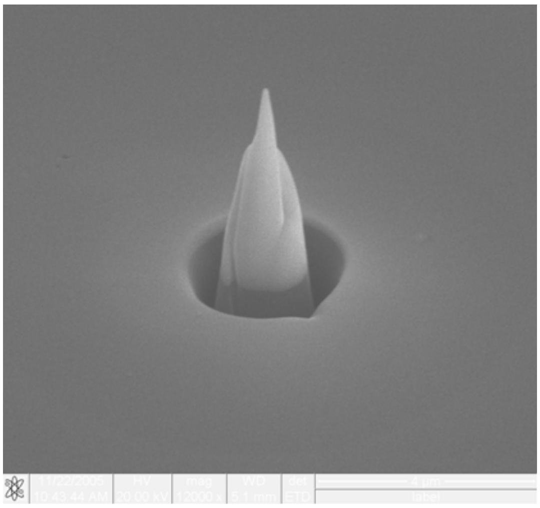

Fig 2. AFM tip grown on Si_3N_4/Si substrate and subsequently shaped by focused ion beam.