



Nano tools for 3-dimensional handling of nano-objects

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Smart materials with shape memory effect

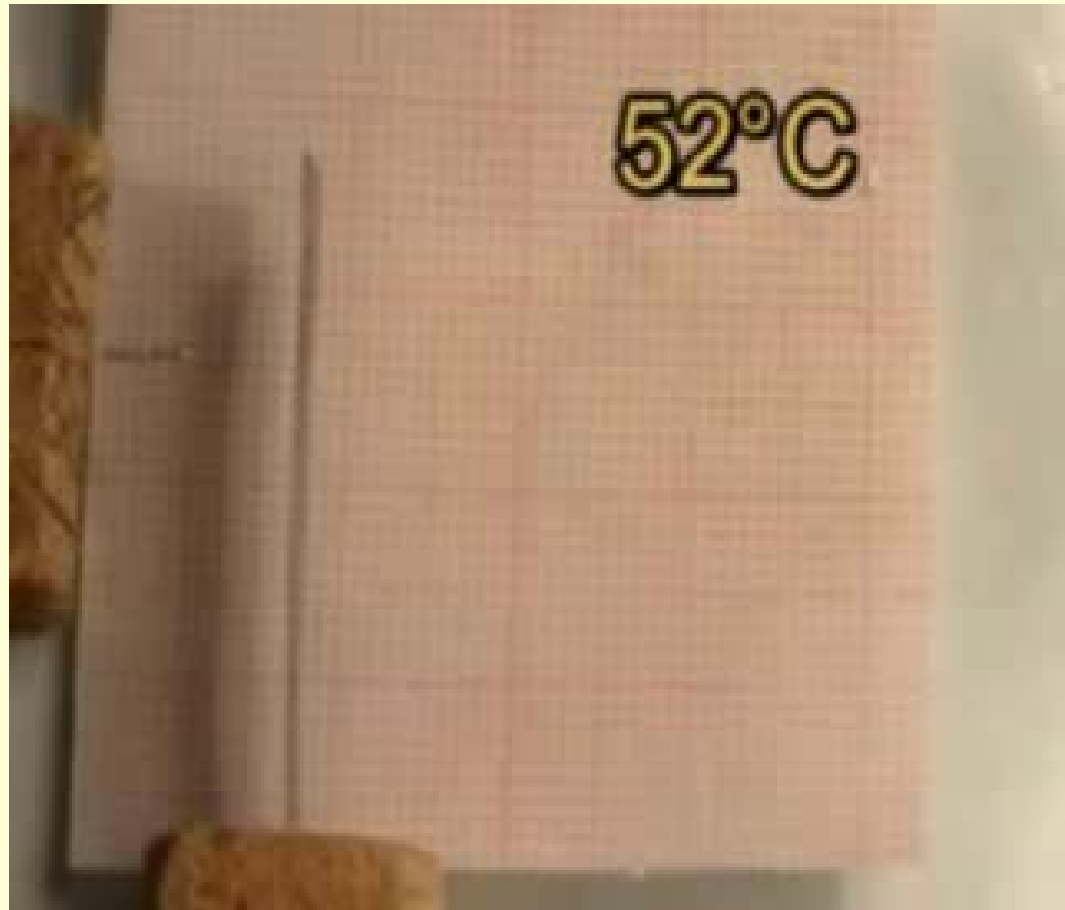
Shape memory alloys can change their form at heating.

Such alloy, as thin as a human hair, has enough natural energy to move weight about 15 kg and more.



Smart materials with shape memory effect

In comparison with usual bimetallic plate or other devices the shape memory composite has 1 000 times stronger deformation.



Smart materials with shape memory effect

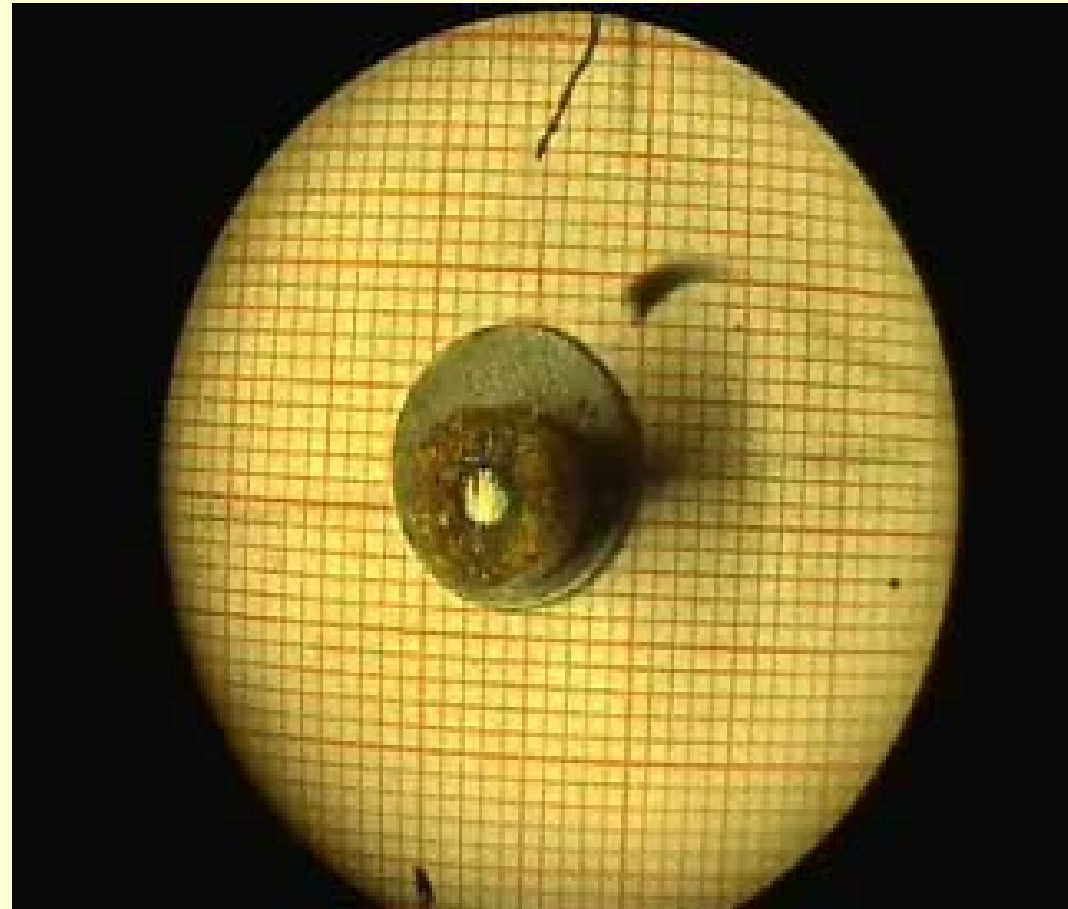
Nanostructured shape memory alloys are prototypes of the Material from the movie “Terminator 2”.



Smart materials with shape memory effect

Shape memory devices are easy to miniaturize.

They are particularly attractive for the development the new trends in Microsystems Technology.



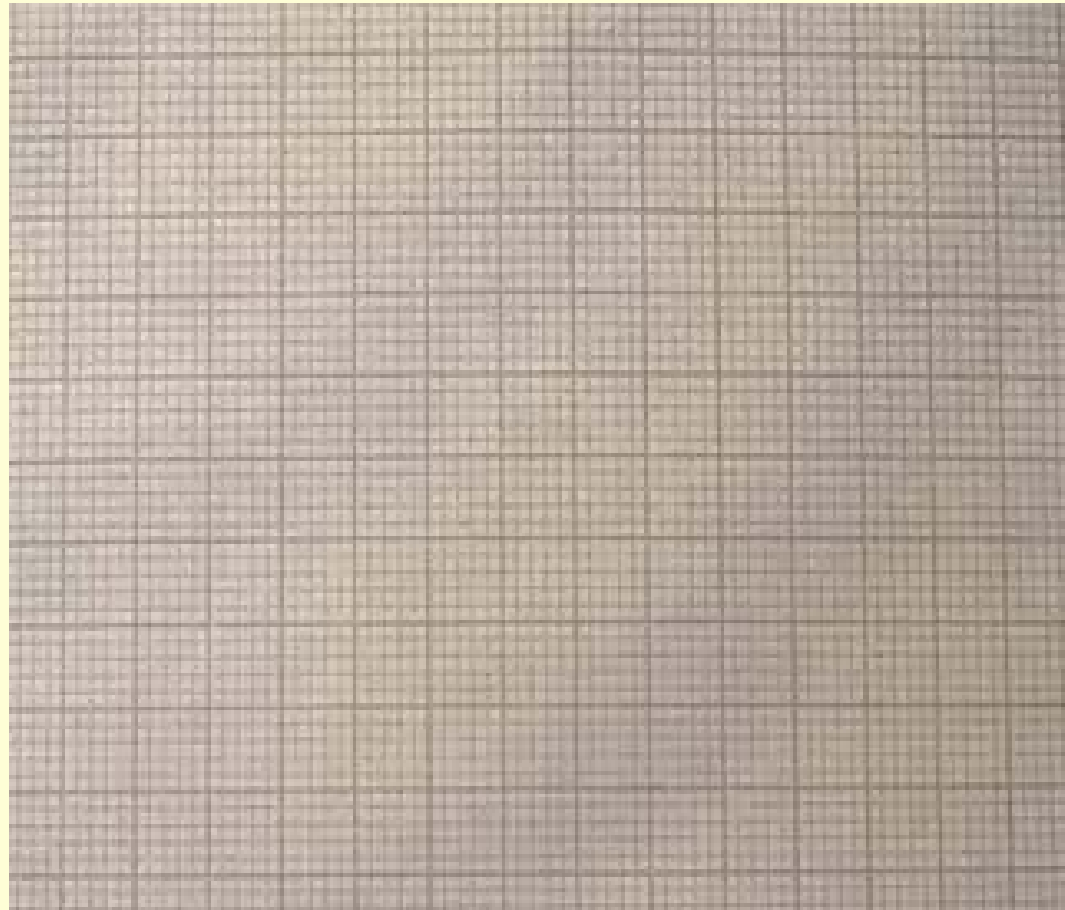
Smart materials with shape memory effect

The main problems were:

- need for training before use,
- fatigue effects,
- long response times

We have solved all these 3 problems.

The new shape memory composites can be treated by the standard technologies.

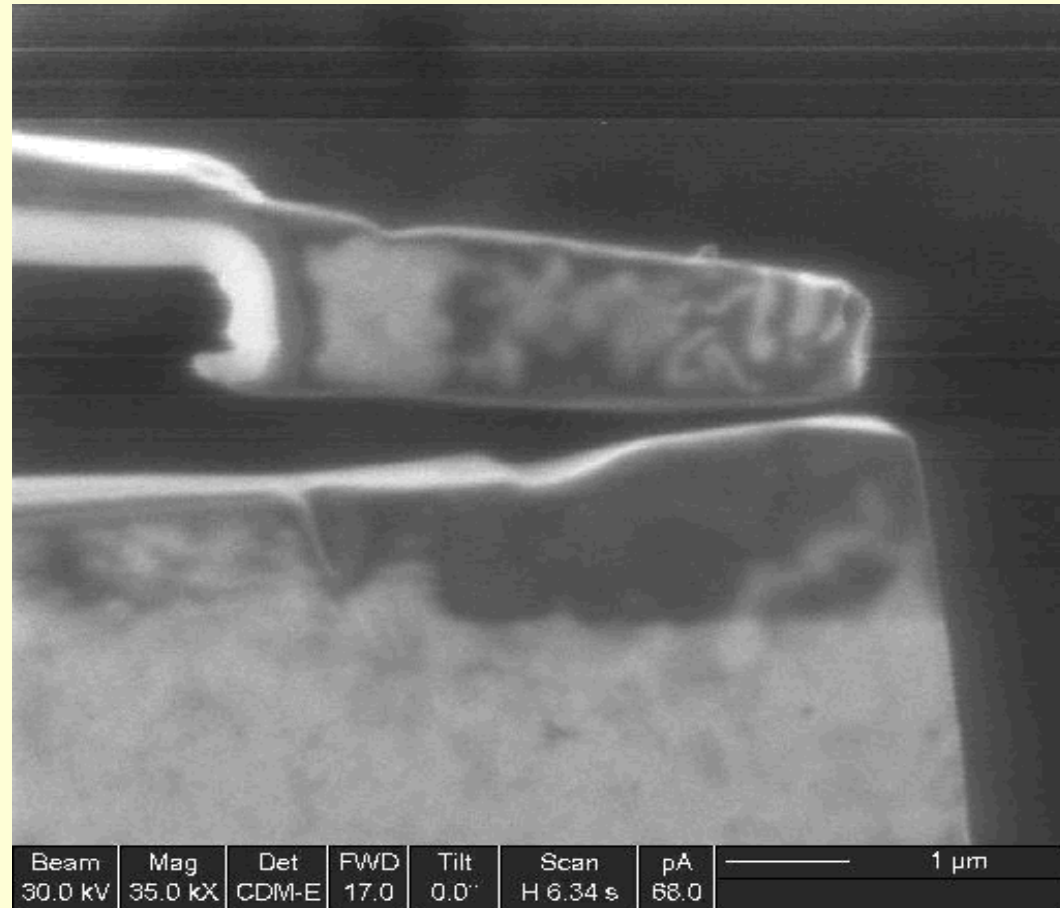


The Smallest Nanotool in the World

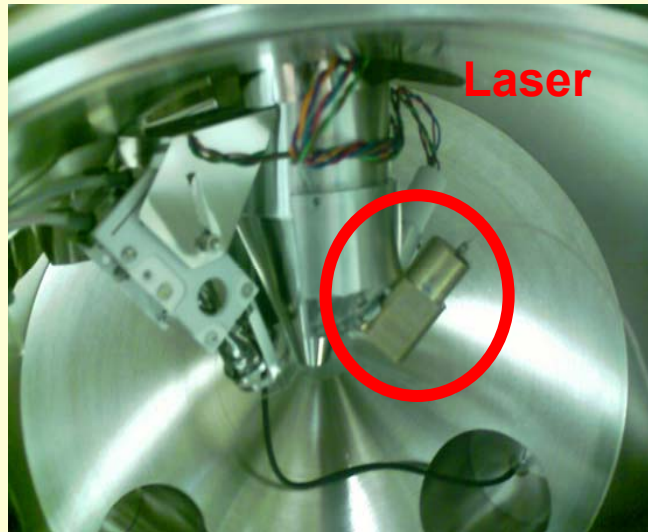
We have constructed the shape memory composite nano-grippers. It can

- pick up and place,
- cut,
- pull,
- bend,
- turn

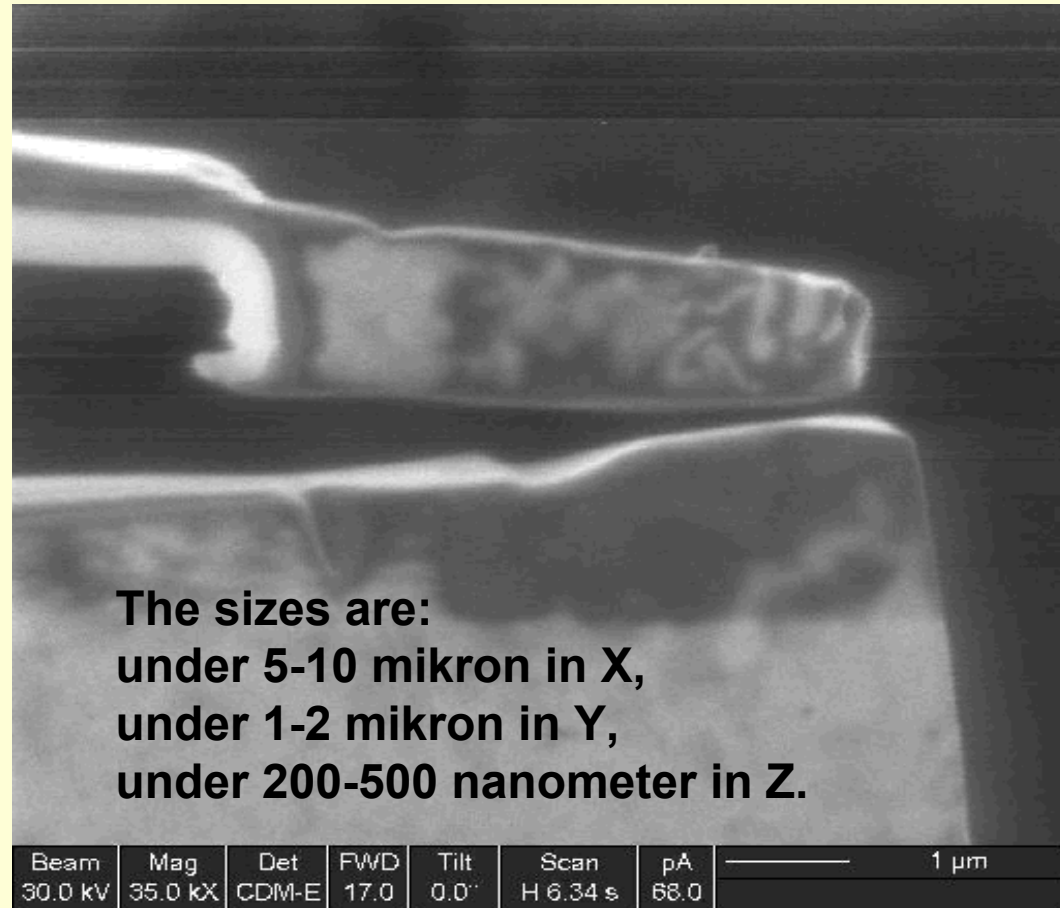
the objects with the sizes from nanometers to 1micron.



Nanogripper under laser-control



The control of nanogripper by the radiation of semiconductor laser within the vacuum chamber of scanning ion microscope.



The sizes are:
under 5-10 mikron in X,
under 1-2 mikron in Y,
under 200-500 nanometer in Z.

Nanogripper inside Focus Ion Beam Microscope

For the shape memory
nano-tools
no engine,
no transmission
are needed.

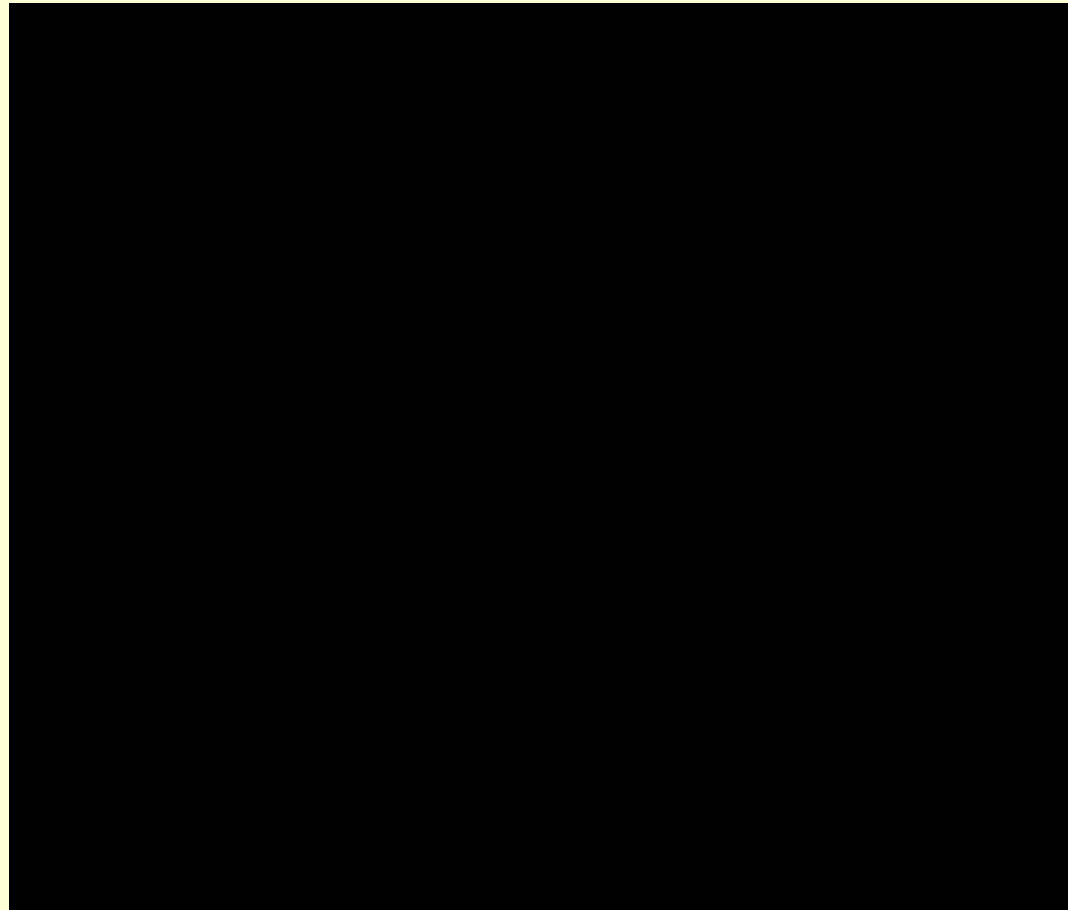
Thus the design and
production are simple
and cheap.

The operation is
simple and intuitive.

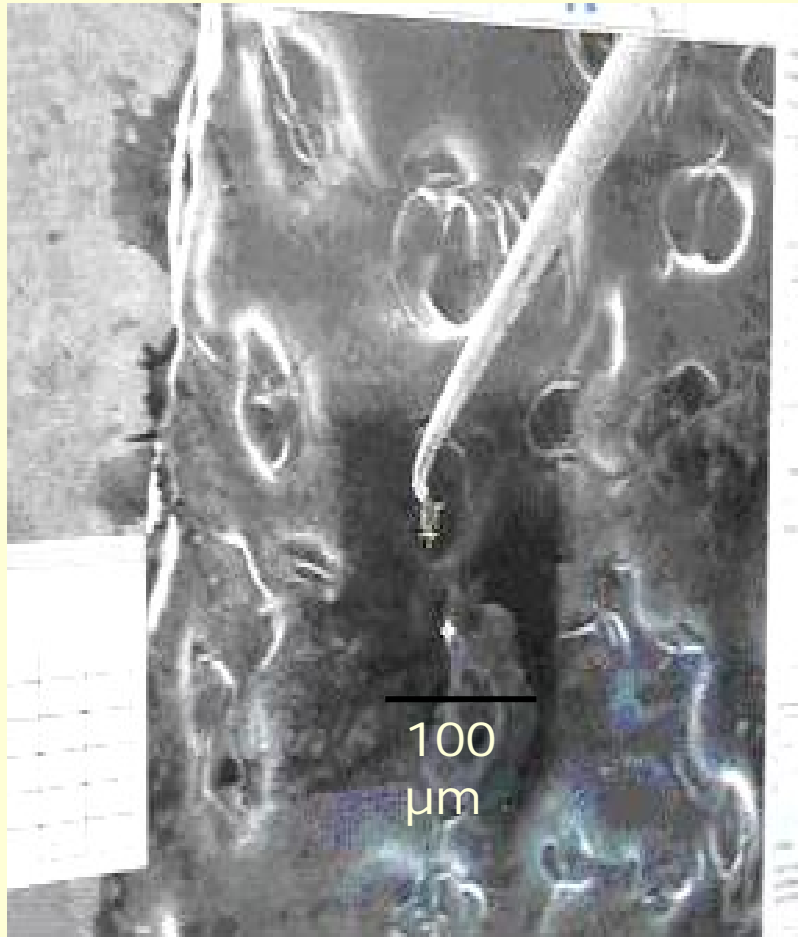


Nanogripper inside Focus Ion Beam Microscope

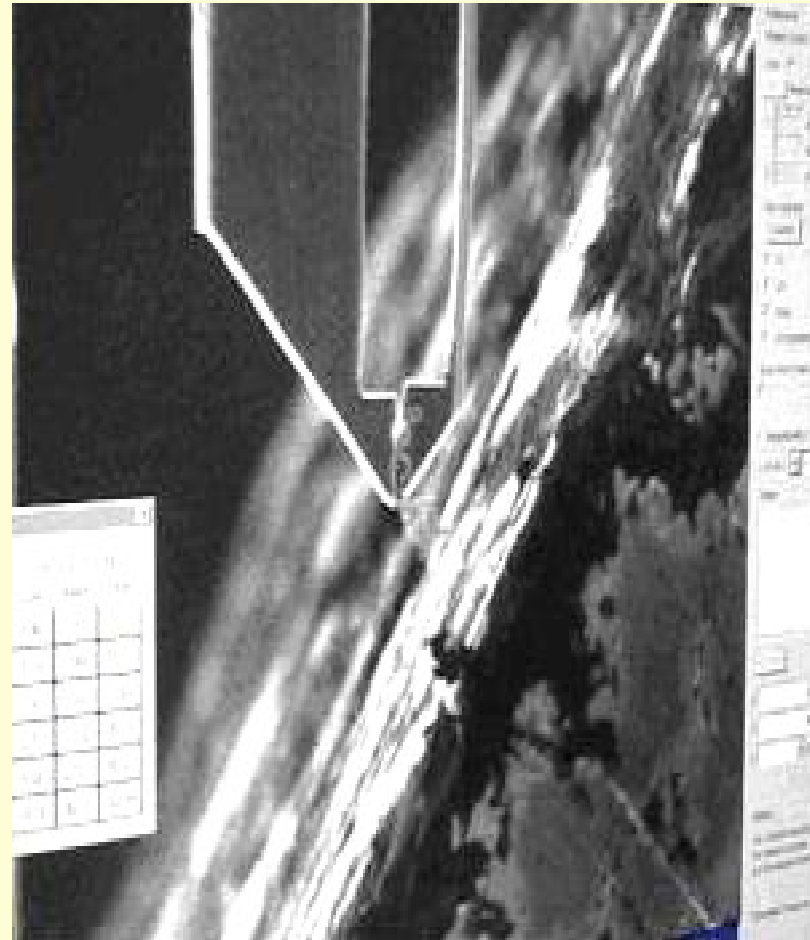
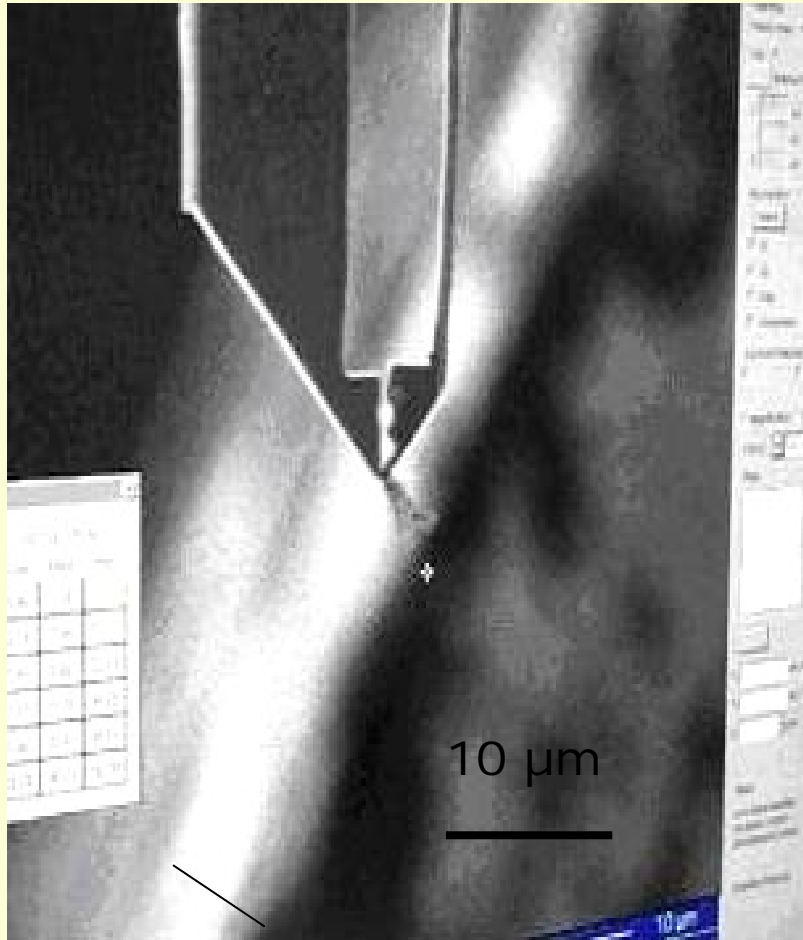
For the first time nanogripper gives the possibility to operate in closed volume of several cubic microns. The size of the nanogripper and the objects are of the same order.



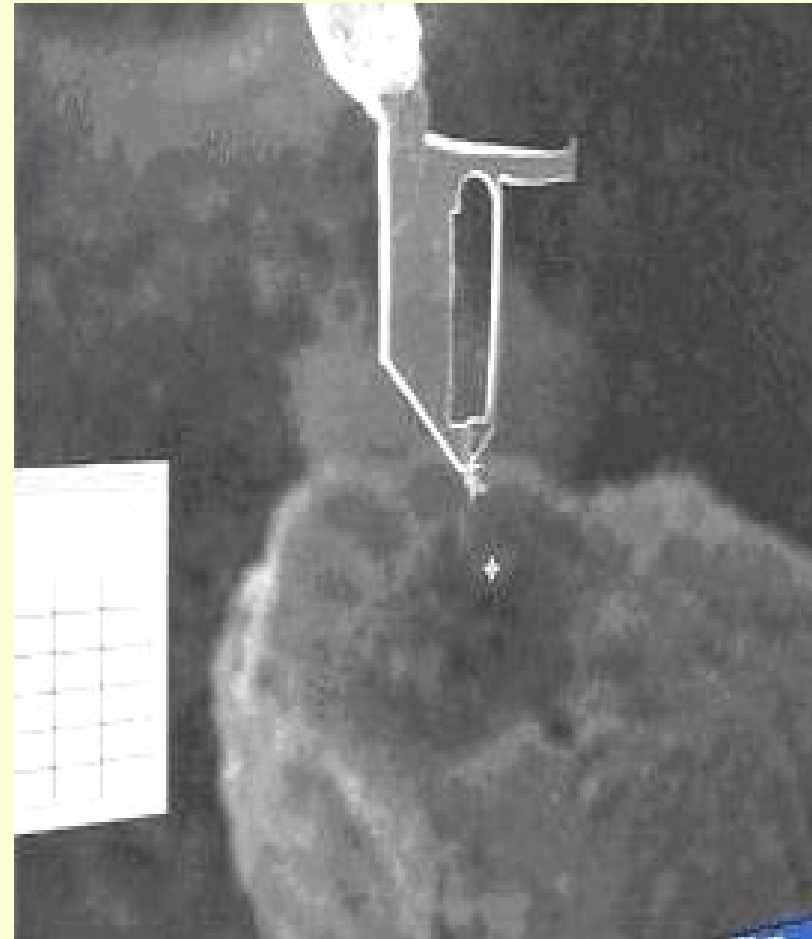
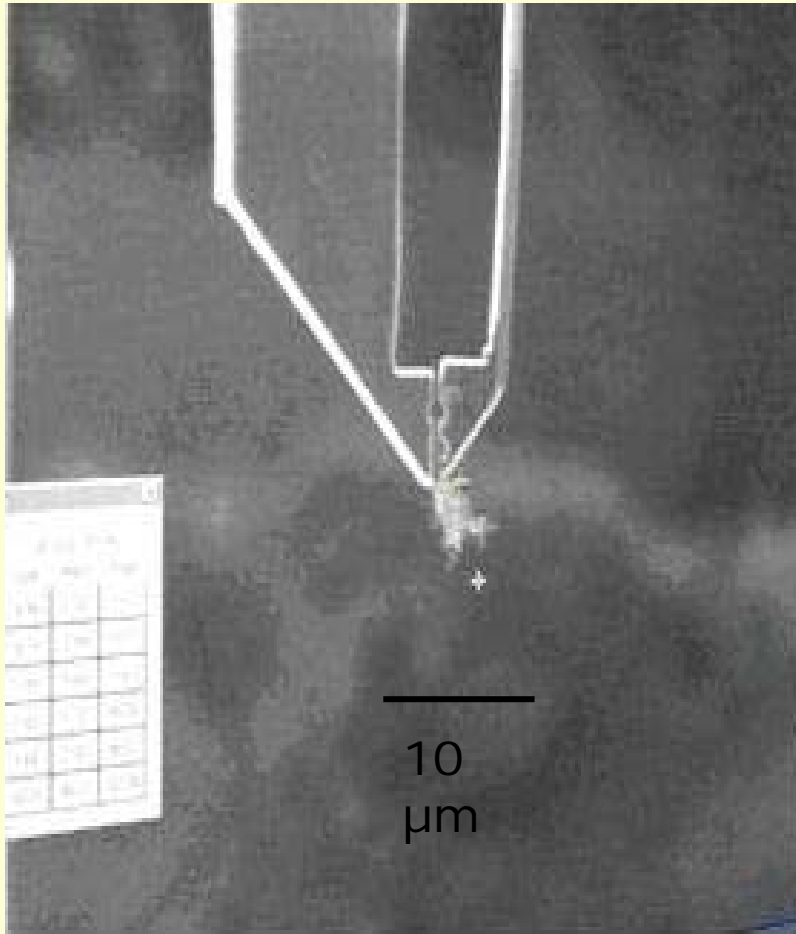
Handling of Carbon Nanotubes



Handling of Carbon Nanotubes



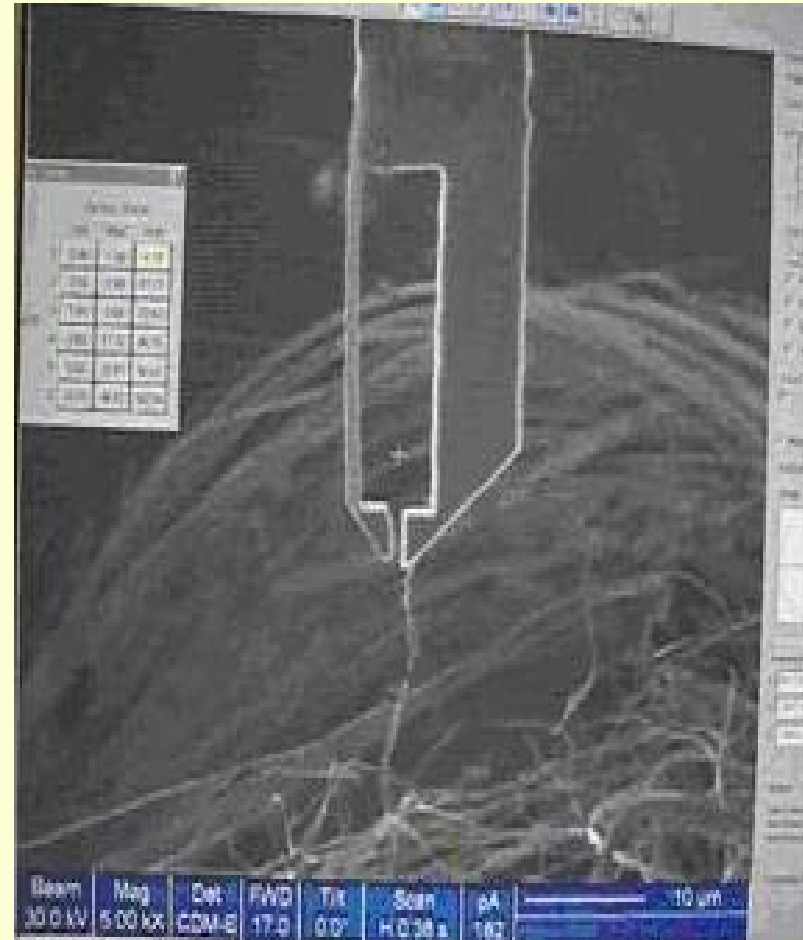
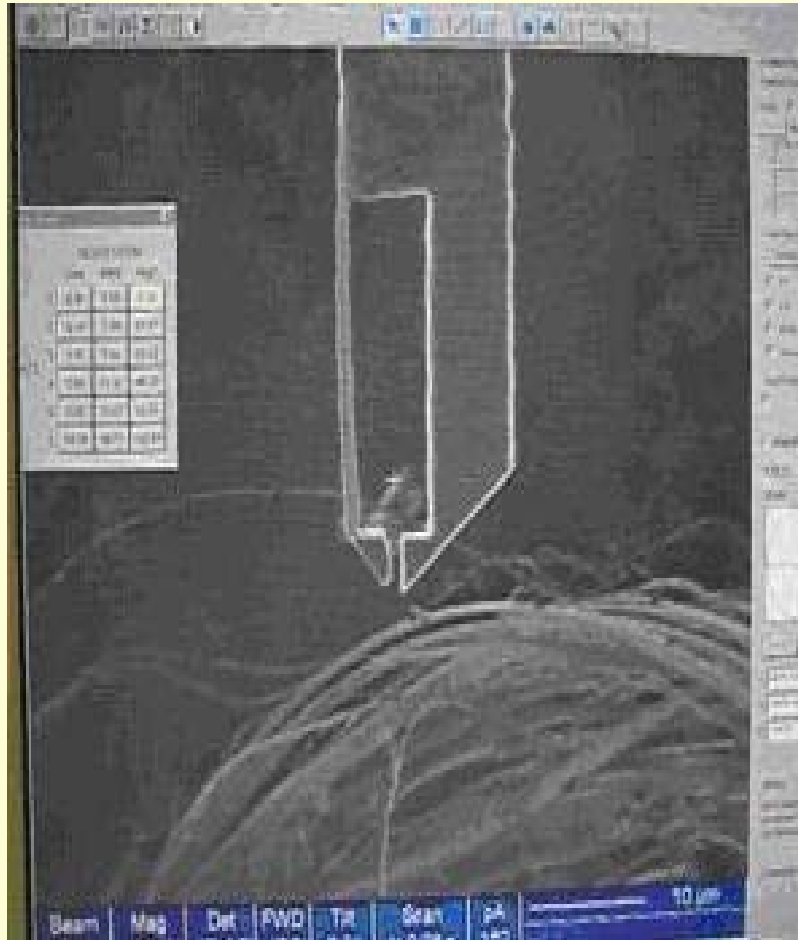
Handling of Carbon Nanotubes



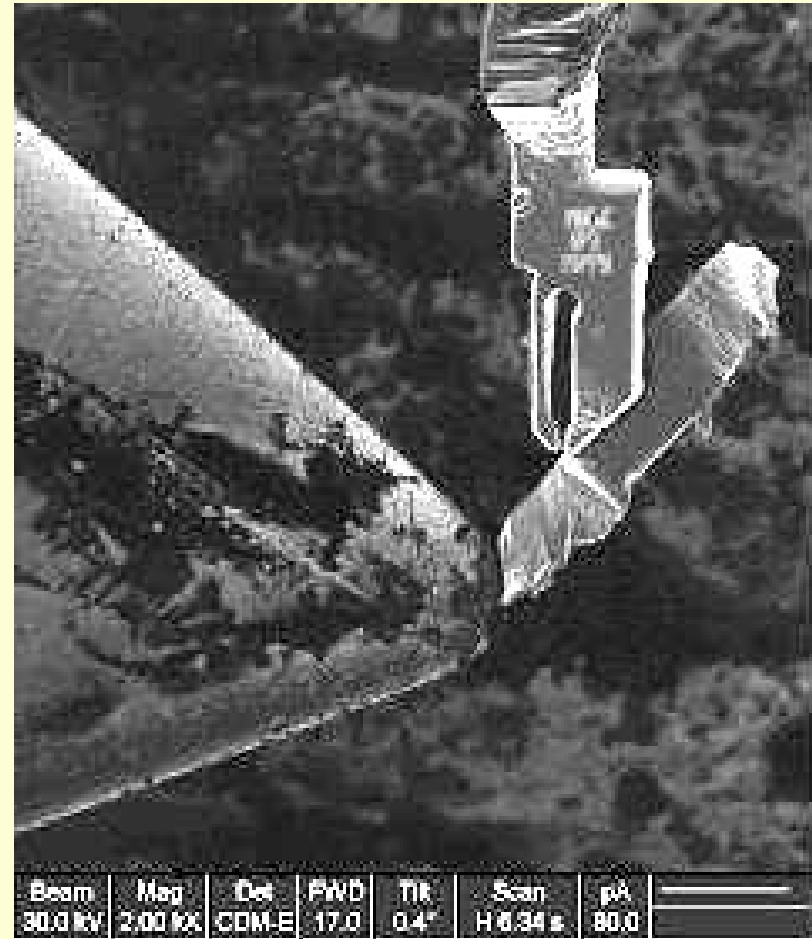
Handling of Single Carbon Nanotubes



Handling of Viskers



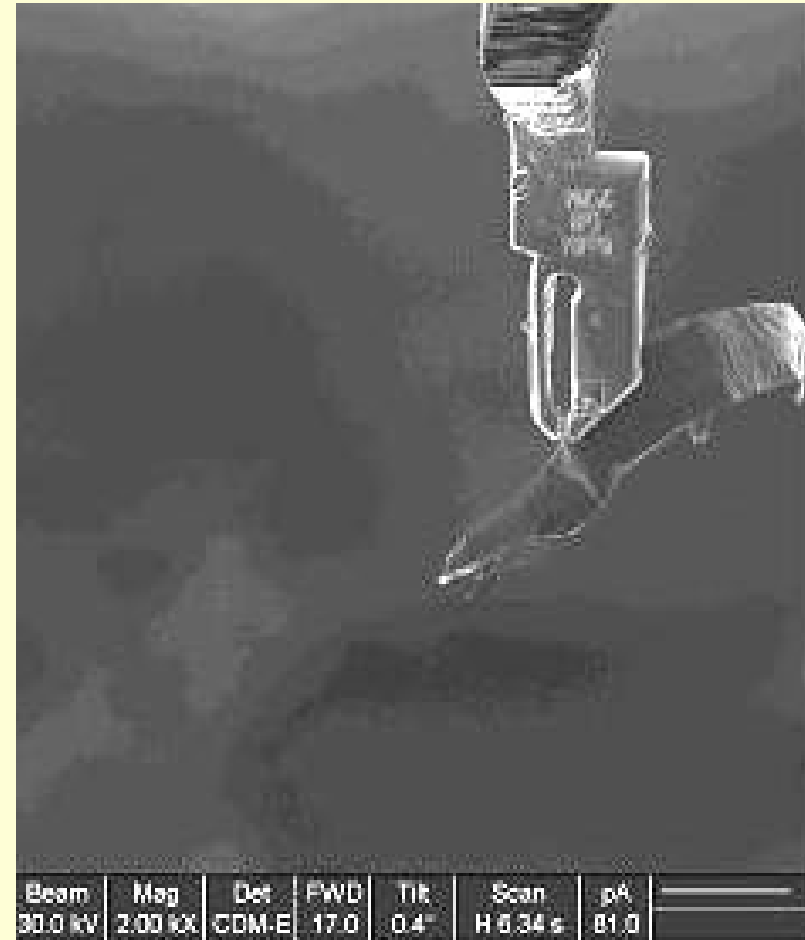
Handling of Grafene



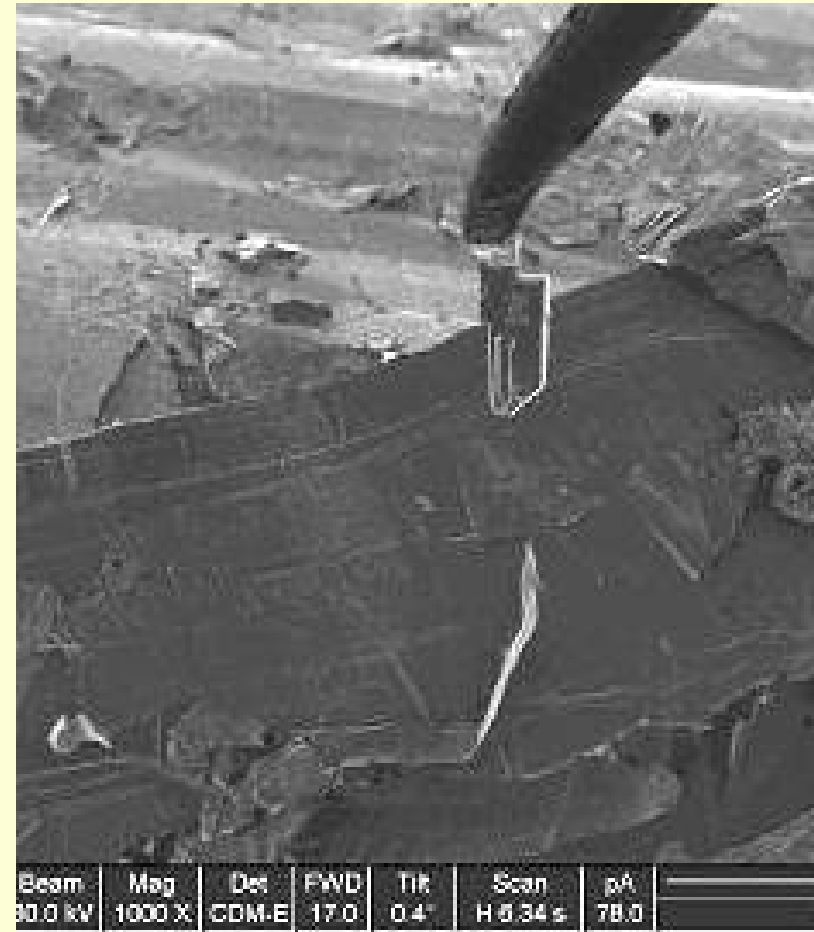
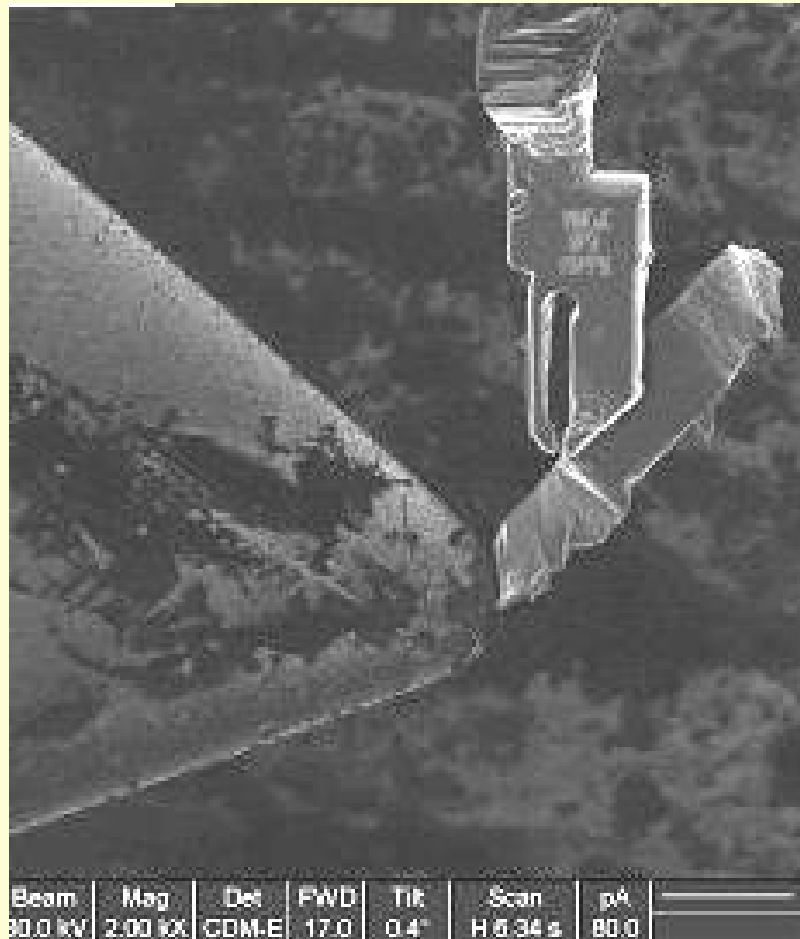
Hannover Messe 2011

10
µm 16

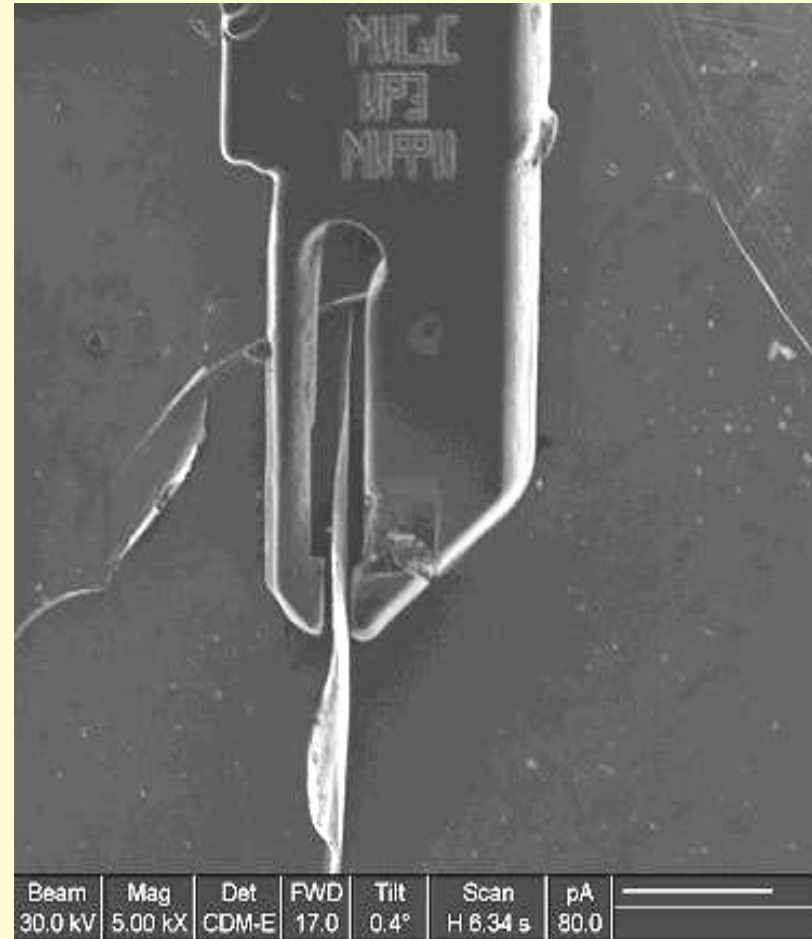
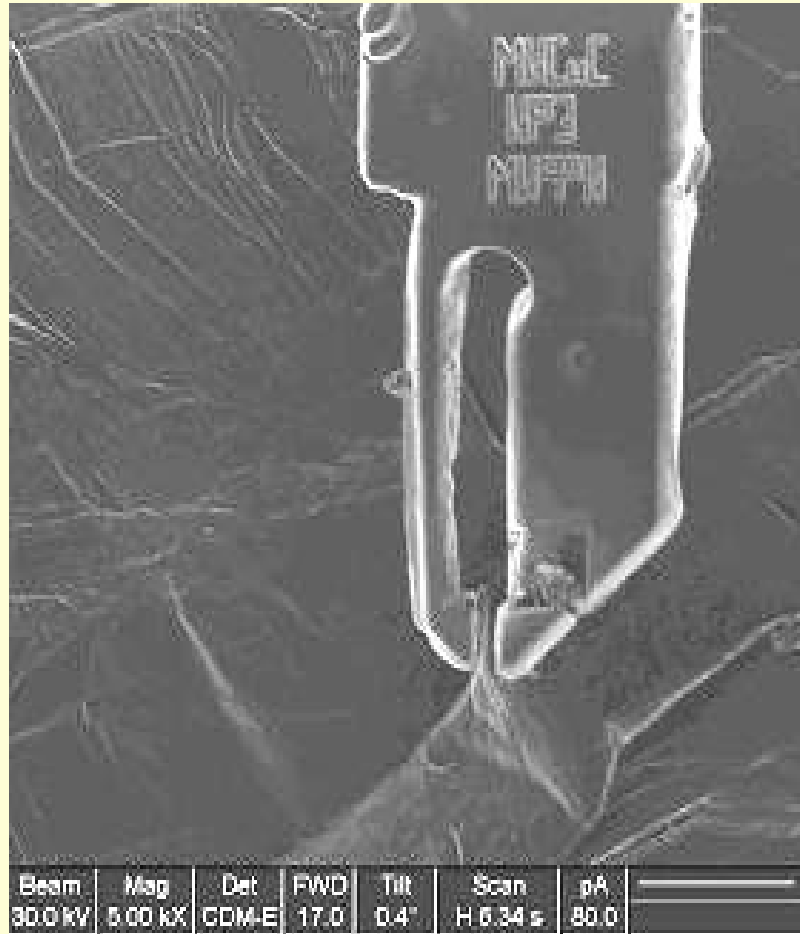
Handling of Grapfene



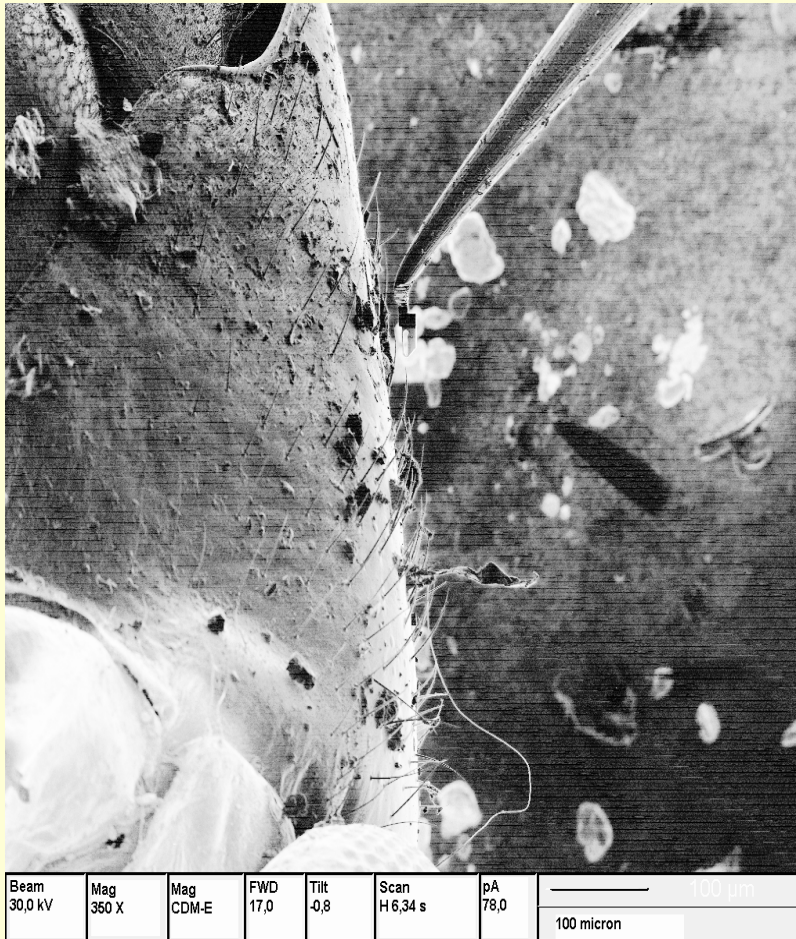
Handling of Graphene



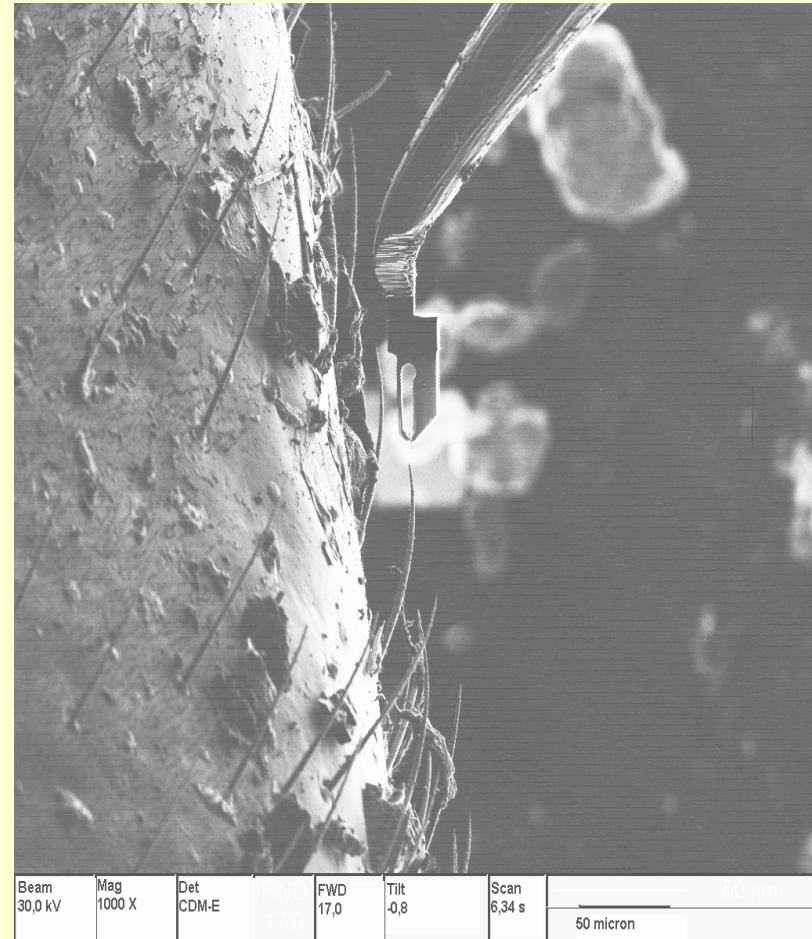
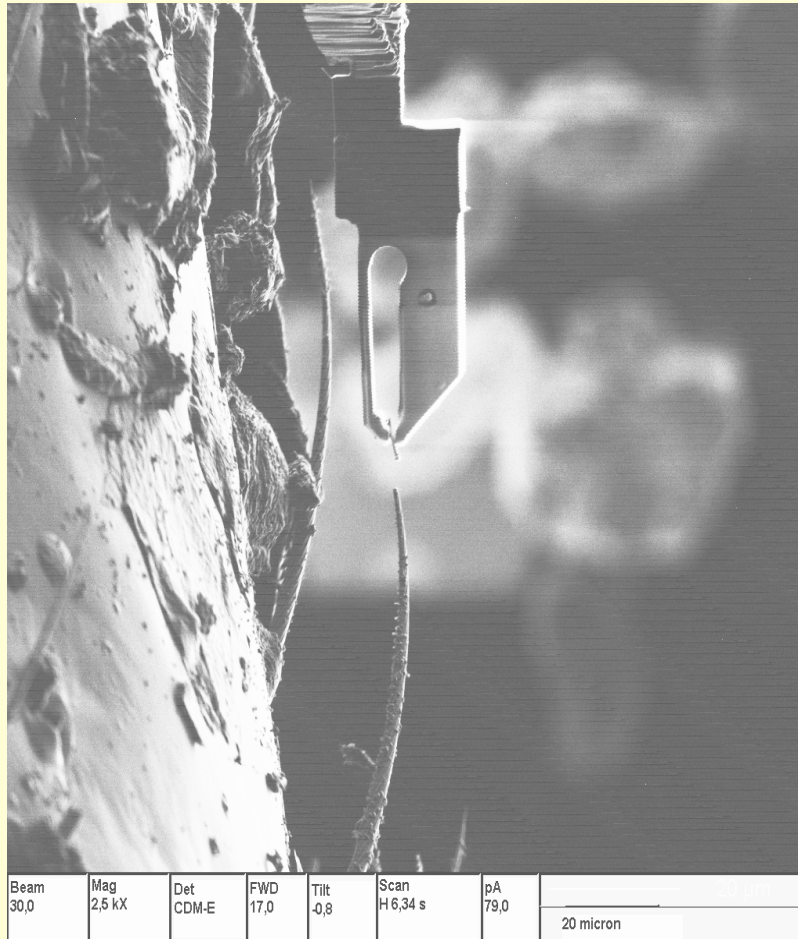
Handling of Graphene



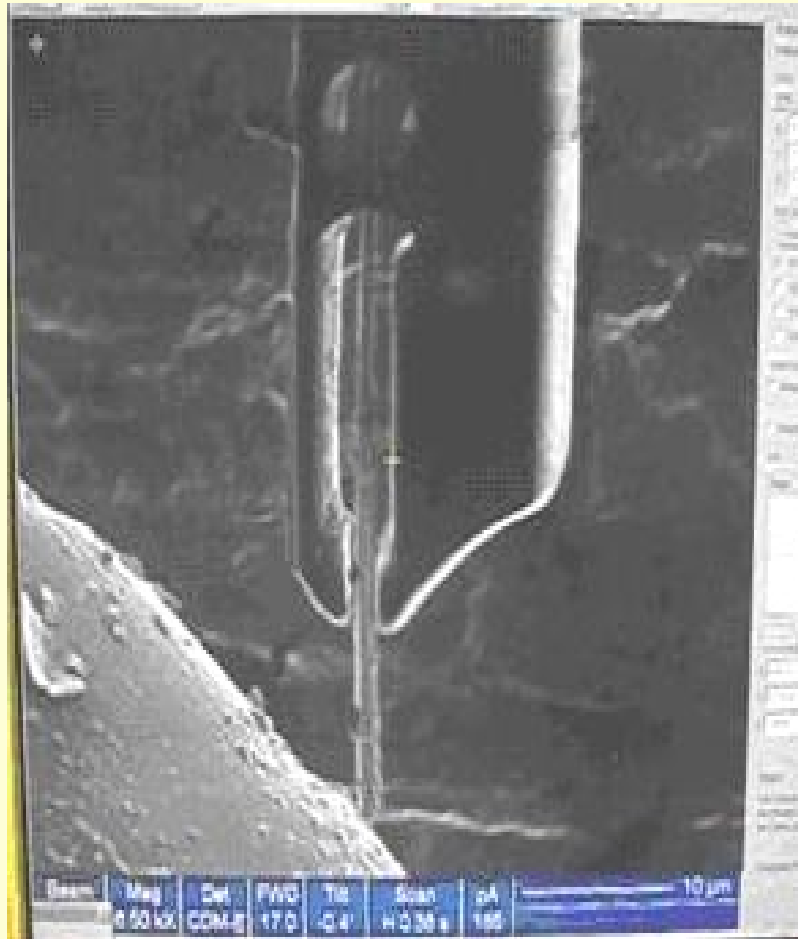
Handling of the tip of the hair on the leg of mosquito



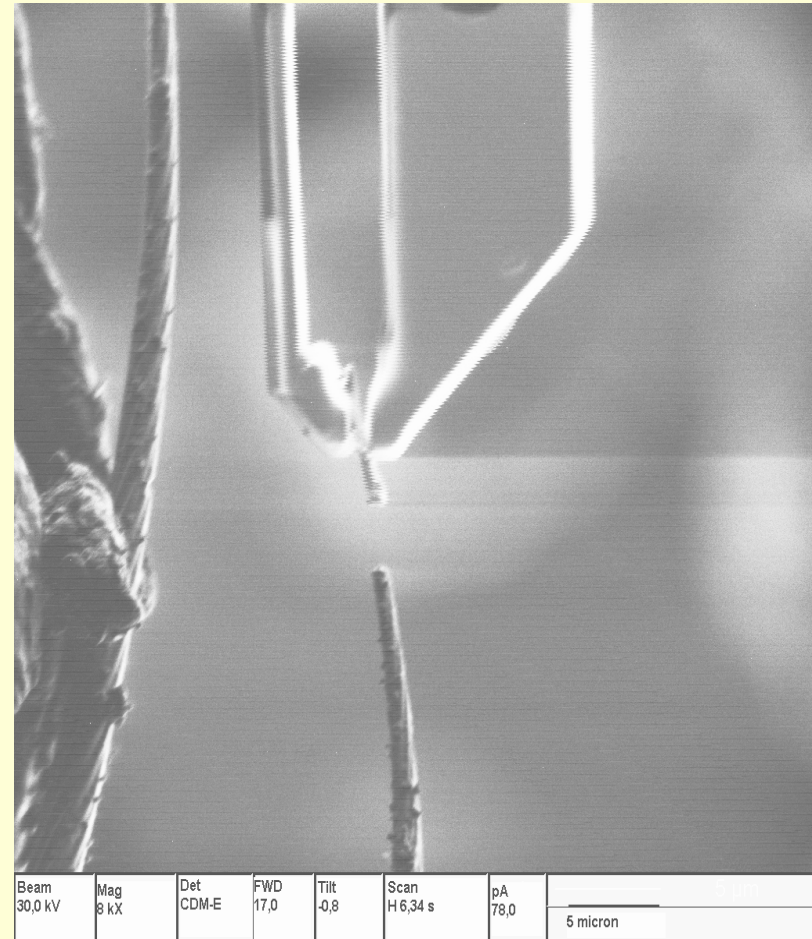
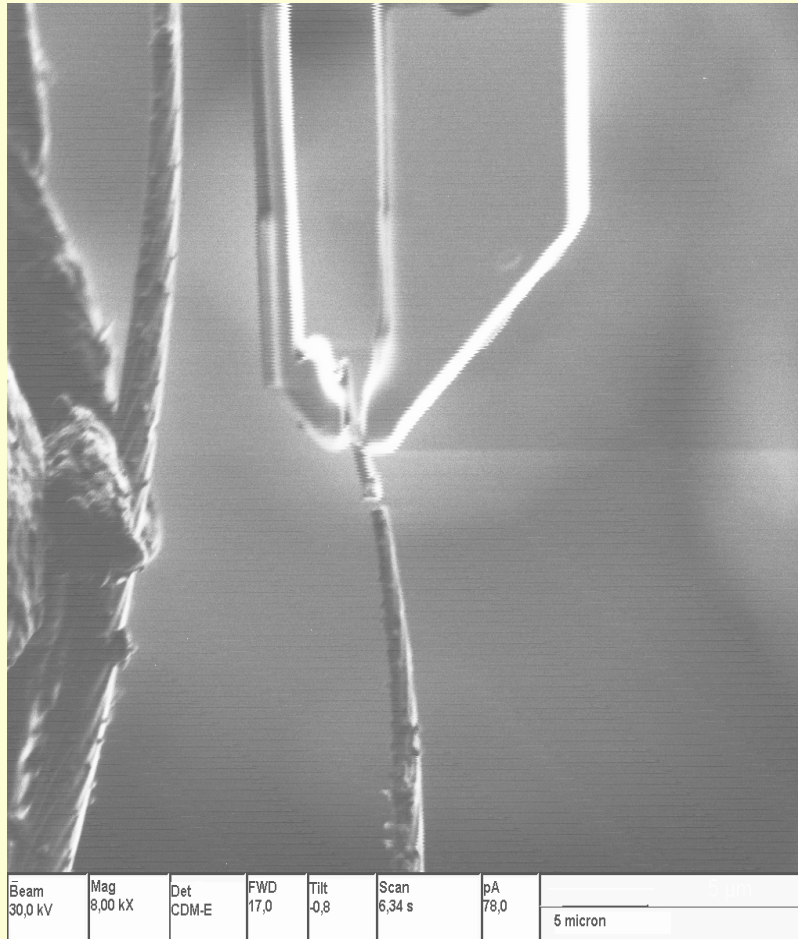
Haircut of the tip of the hair on the leg of mosquito



Haircut of the tip of the hair on the leg of mosquito



Haircut of the tip of the hair on the leg of mosquito



Applications of composite Nanotools

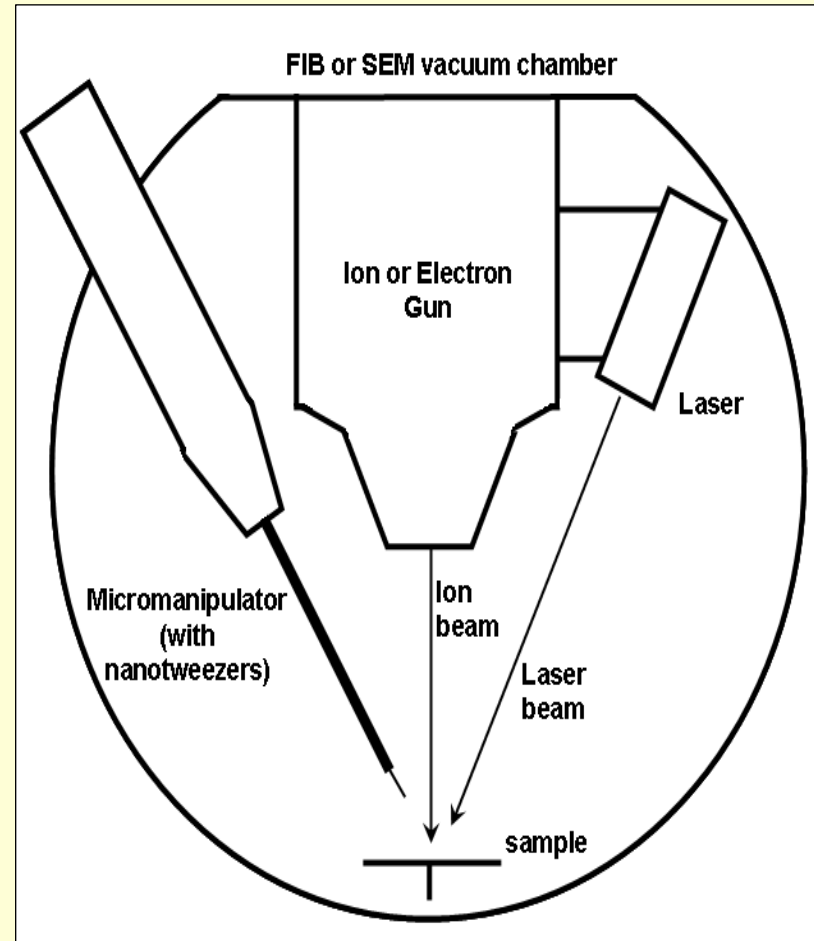
Microscopy accessories for:

- **Scanning Tunnel
Microscopes,**
- **Scanning Electron
Microscopes,**
- **Transmission
Electron microscopes,**
- **Focused Ion Beam
Microscope**



Applications of composite Nanotools

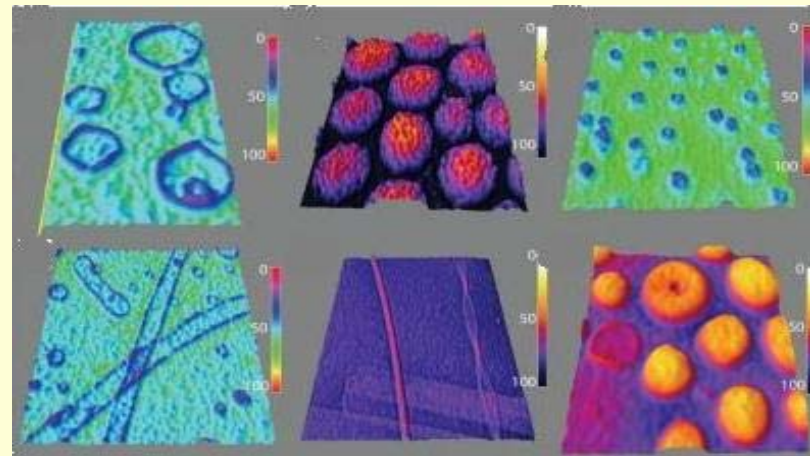
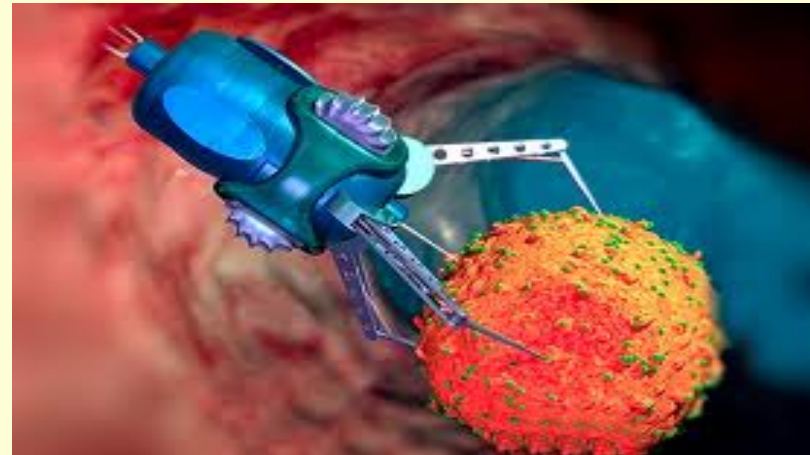
We offer cheap and easy in use micron-size end-effectors for nanomanipulators controlled by semiconductor laser radiation in vacuum chamber of a microscope.



Applications of composite Nanotools

Processes for nanotechnology:

- Assembler for devices from large molecules (CNT, DNA)
- Measurements of nano-objects,
- Nano/Micro-robotic,
- Nano/Mikroaktor,
- Nano/Mikroventil,
- Nano/Mikrosensor,
- Mikro-Nanofluidic,
- Lab-on-Chip

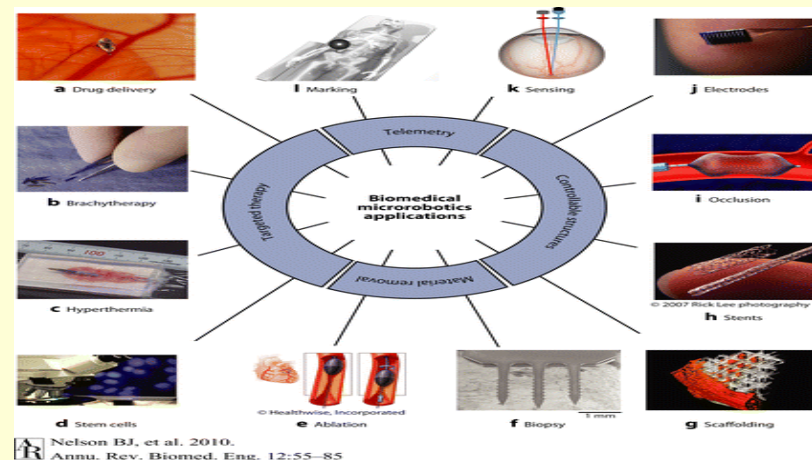


Sources:membrane.ru

Applications of composite Nanotools

Nano-bio MEMS – Micro-systems for biomedical applications:

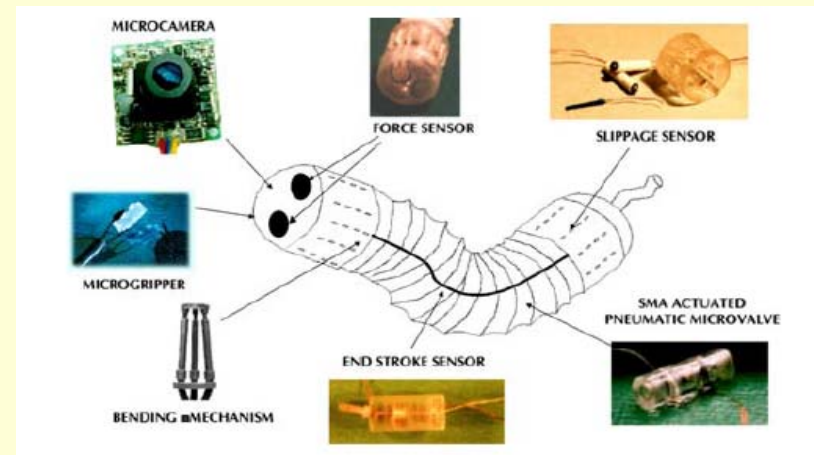
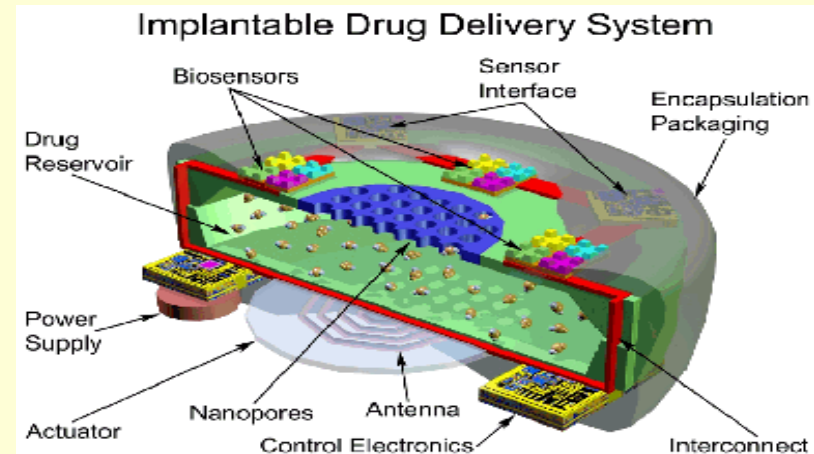
- nano-diagnostics (single cell diagnostics);
- minimal invasive drug delivery;
- neural prosthetics and tissue engineering;



Applications of composite Nanotools

- Minimally invasive surgery.

For the time nanogripper gives the possibility to operate in closed volume of several cubic microns.



P. Dario, M.C. Carrozza, A. Benvenuto, et al. J. Micromech. Microeng. 10 (2000) 235–244. B. J. Nelson, I. K. Kaliakatsos, et al. Annual Review of Biomedical Engineering 12: 55-85.2010

Conclusions

- **Our company proposed and tested the new composite scheme based on shape memory alloy which enlarge opportunities of MEMS and NEMS**
- **The prototype of the nanogrippers based on Ti-Ni-Cu alloy with shape memory effect were produced and have record small size: 12x3x1 micron, the size of the grabbed objects 10-1000 nm. The nanogripper are controlled by the laser beam.**
- **The nanogrippers are compatible with such nanomanipulators like “Omniprobe” and “Kliendiek” enhancing their opportunities.**
- **The new technology will solve the problem with nanomanipulation with micro and nano organic and inorganic nanoobjects.**

iⁿknowledgement

