MEMS/NEMS for Nano and Bio Technology

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Abstract :

Silicon micromachining technology has made a remarkable progress in terms of structural complexity, miniaturization and material variety. Micromachined MEMS tools are useful to perform scientific analysis of physical phenomena at nano-scale and bio molecules.

A pair of probes with 10-50 nm tip radius were micromachined with integrated microactuators. They were brought into contact to form a nano-contact. The contact was pulled away mechanically. This procedure was performed in a ultra-high-vacuum TEM that visualized dynamic structural change during the tensile testing of the nano-contact. Silicon contacts exhibited larger plastic deformation than gold contacts.

The similar twin-probe device was applied to obtain nano tweezers that handle DNA molecules. Micromachined fluidic channels for isolation of DNA with sharp electrodes were fabricated and operated successfully. They isolated and captured a DNA molecule for further observation.

For bio assay of enzymes, microchips with fL-chambers and micro heaters were fabricated in which the enzymatic product was evaluated in a single molecular level. Rotational bio molecular motors, F1-ATPase, are immobilized on a chip equipped with a micro heater. The rotational speed increased at elevated temperatures. By encapsulating a single molecule in a extremely small chamber, its chemical activity, i.e. consumption and synthesis of ATP molecules, was associated with its mechanical rotation in a single molecular level.

It is also possible to utilize various functions of bio molecules by integrating them in MEMS. A conveyance device driven by bio motor molecules (microtubules and kinesin) is reconstructed in MEMS fluidic devices. Linear bio molecular motors, microtubules and kinesin, were integrated with MEMS structures. Conveyance of micro objects by the bio motor was demonstrated. Selective binding and transportation of two kinds of target molecules were demonstrated.