

FUJITA LAB.

[Micro/Nano Mechatronics]

Centre for International Research on MicroNano Mechatronics

<http://www.fujita3.iis.u-tokyo.ac.jp/>

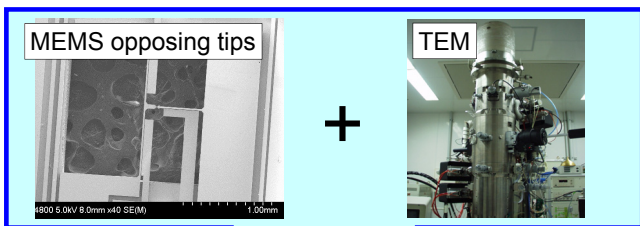
Research field: Nanotechnology, Biotechnology

Department of Electrical Engineering and Information Systems

From the beginning of MEMS (Micro Electro Mechanical Systems), our group has investigated the fabrication technology and applications of MEMS in the forefront of the field. Currently we focus on MEMS application to two major research fields, "nanotechnology" and "biotechnology". In nanotechnology, the combination between MEMS and TEM (Transmission Electron Microscope) enabled us to study nano physics under in-situ observation. In biotechnology, the combination between molecule and MEMS opened a new scientific field, which cannot be realized by bulk experiment.

Physics in Nanoworld

We combined "MEMS opposing tips" and "TEM" with atomic resolution and real time imaging". With this setup, called MEMS-in-TEM, the formation and deformation of nano-scaled junction were in-situ observed, while unique properties of nano structures were measured.



MEMS-in-TEM

- Si super plasticity:** SEM images showing silicon nanowires under stress.
- Au quantized conductance:** Plot of conductance vs. gate voltage showing discrete steps.
- Nano scale heat transfer:** SEM images of silicon nanodroplets at different current densities (0 mA, 2 mA, 3 mA).
- Silver nano friction:** SEM image of a silver nanowire with a red arrow indicating friction.
- Degradation of Au electrical contact:** Grid of SEM images showing contact degradation.
- DLC nano bearing:** SEM images of a nanoball on a DLC surface showing rotation and slip.

Biological applications

Transportation and reaction measurement of ultra small bio materials, especially single molecular level, were achieved using MEMS devices.

Handling and Characterization of Fiberlike Molecules by MEMS Tweezers

"Pick and place" of fiberlike protein

- Microtubule
- Nano-dots on trapped DNA bundle
- Monitoring of Reaction between trapped DNA bundle and enzyme
- Bare Tweezers: Monitoring by resonance frequency. Comparison of enzyme reaction with and without DNA.

Transport of Nano-objects

Monorail at nanoscale

Cargo can be transported due to Kinesin motion along Microtubules (MTs) assembled by silicon nanotweezers

- Cargo: 330 nm in diameter
- Kinesin motor protein
- Assembled microtubules

Generation with vibration

Put ionic liquid between electrodes. Obtain power output due to change of the contact area.

Initial state vs. squeezed state

Diagnostic test

Detection of Tau protein (biomarker of AD, vital for MTs stability) detection by Kinesin motility assay

Suspended MT → similar condition to organism

- Normal motion
- Slightly hindered
- Hindered

Micro object