

# FUJITA LAB.

## [Micro/Nano Mechatronics]

Centre for International Research on MicroNano Mechatronics

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

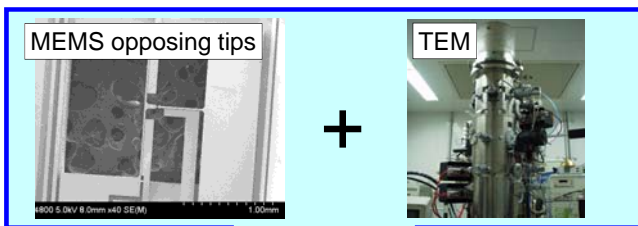
Research field: Nanotechnology, Biotechnology

Department of Electric Engineering

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, nano-scaled deformation was in-situ observed, while unique properties of nano structures were measured.



**MEMS-in-TEM**

- Si super plasticity:** SEM images (a-d) showing deformation of silicon nanowires under various currents (0 mA, 2 mA, 3 mA).
- Au quantized conductance:** Graph of conductance vs. gate voltage showing plateaus, with corresponding TEM images of nanowires.
- Nano scale heat transfer:** TEM images showing silicon nanodroplets under current.
- Silver nano friction:** TEM images showing silver nanowires with frictional deformation.
- Degradation of Au electrical contact:** Grid of TEM images (a-i) showing contact degradation.
- DLC nano bearing:** TEM images (a-f) showing a nanoball on a DLC surface with 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
- Four probe measurement
- Monitoring of Reaction between trapped DLA bundle and enzyme
- Cargo in 330 nm diameter

#### Transport of Nano-objects

Monorail at nanoscale

Cargo can be transported due to Kinesin motion along microtubules assembled by silicon nanotweezers

Cargo in 330 nm diameter

Kinesin motor protein

#### High Sensitive Bio Sensor

Oscillating cantilever at the interface between aer and liquid to detect bio material

#### Droplet Manipulation

pL Droplet formation by Liquid-Dielectrophoresis in open environment