【Grant-in-Aid for Specially Promoted Research】
Science and Engineering (Engineering)

Title of Project : Nano Mechanical Characterization Method by MEMS Devices and *In-situ* TEM Observation and its Applications

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Research Area : Micro/Nano Science, Microdevices/Nanodevices

Keywords : MEMS/NEMS, Micromechanics

【Purpose and Background of the Research】

Scanning probe microscopy (SPM) is one of the most powerful tools for observing and manipulating nano structures in the atomic/molecular level. However, SPM could not observe the manipulation process by itself in real time. In order to tackle the issue, it is crucial to develop tools for handling an individual nano object or molecule as well as to establish an advanced characterization method with single molecular sensitivity and with simultaneous imaging capability.

The proposal aims at the development of a characterization system that is capable of simultaneous TEM visualization and electro-mechanical measurement of a nano object manipulated by a MEMS device. First we want to investigate the dependence of electrical and mechanical parameters on the nano structural shape under mechanical stress and to understand its basic mechanism by comparing experimental results to ab-initio calculation based on theoretical models. In the second stage, more practical targets will be pursued such as mechanical testing of polymer fibers, electro-migration phenomena, wearing properties of electrical contacts, thermal conductance in nano structures, nano tribology, and bonding for wafer-level packaging.

【Research Methods】

We will develop the characterization system that allows simultaneous TEM visualization and electro-mechanical measurement of a nano object manipulated by a MEMS device.

The basic device has opposing sharp tips; one tip is fixed and another is actuated toward it. By bringing them together, a nano contact is formed. The contact is stretched and pulled apart by retracting the movable tip (Fig. 1). Silicon tips can be covered with metals or attached with nano fibers to be tested. During the tensile testing, TEM visualization and electrical conductivity measurement are conducted. Thermal characterization devices will have a heater and a thermal sensor on each tip to measure the heat transfer over the nano contact. Two-DOF (degree-of-freedom) devices will have another actuator to apply share stress to the contact for tribology measurement. Diffusion characterization devices will have tips coated with different materials.

【Expected Research Achievements and Scientific Significance】

- To provide a versatile characterization method for simultaneous and real-time measurement of the shape and various electromechanical parameters in nano scale. This has strong impact on nano science.
- To provide deep insight in the cause of practical engineering issues from the nano scale and guiding principles to solve them. Development of new polymer materials, improved reliability of contacts and wiring in electronic parts, and novel wafer level packaging processes will be realized.

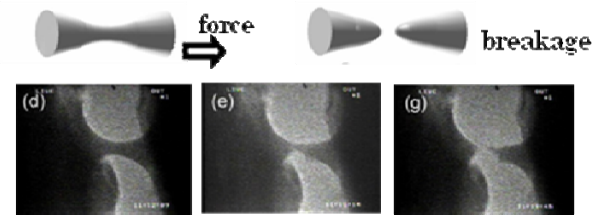

Fig. 1 Tensile testing of nano contact

【Publications Relevant to the Project】

[1] H. Fujita (Ed.) Micromachines as Tools for Nanotechnology, Springer (2003)
[2] G. Hashiguchi, H. Fujita, et al., Analytical Chemistry, vol.75, pp.4347-4350, 2003.

【Term of Project】 FY2009-2013

【Budget Allocation】 251,100 Thousand Yen

【 Homepage Address and Other Contact Information】

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