課題番号	:	F-12-TT-0004
支援課題名（日本語）	:	マイクロマシン材料の破壊・疲労機構解明に関する研究
Program Title（in English）	:	Mechanical Fracture and Fatigue Mechanism of MEMS materials
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概要（Summary）：

This paper proposes in situ transmission electron microscope (TEM) fatigue test to observe continuously nanoscopic process of fatigue behavior. For this purpose, a material testing device in small chip size of 4.5 × 4.5 mm² was fabricated by SOI-MEMS technologies. This device was designed for working on a TEM sample holder, at a high resonance frequency by parallel-plate electrostatic actuator, performing tensile-compressive fatigue test with the controlled stress ratio, while observing defect accumulation and its interactions with environmental gas species in a reaction science high-voltage electron microscopy (RSHVEM) newly established in Nagoya University.

実験（Experimental）：

The test structure designed was fabricated by silicon micromachining. Silicon on insulator (SOI) with 2 μm thick silicon (100) device layer, 1 μm thick buried oxide layer, and 200 μm thick silicon handle layer were prepared. The microfabrication process of test structure consisted of standard photolithography steps, including positive photoresist spin coating, exposure, and development, followed by deep reactive ion etching (DRIE). Photoresist was spun on and patterned to form the feature of Ti layer (154 nm). Ti layer was deposited on the silicon handle layer for electrostatic chuck. After the Ti layer was deposited by sputtering process, photoresist was removed by acetone. The pattern of specimen is formed by the next photoresist process. The device layer was etched by the first DRIE to the buried oxide layer.

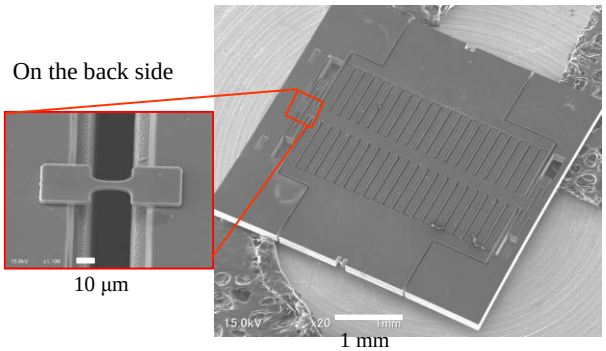

Figure 1. SEM images of resonating device fabricated by SOI-MEMS process.

Afterward, other lithography and DRIE steps were used in sequence to pattern the handle layer. Finally, the buried oxide layer was etched by HF solution.

結果と考察（Results and Discussion）：

SEM images of resonating device and specimen were shown in Figure 1. The electric resonance device consists of 42 parallel-plate electrodes and a laterally-resonating mass supported by elasticity spring. The specimen integrated on the device has dimensions of 2 μm thick, 10 μm wide and 20 μm long. Fabricated device and developed mechanical loading apparatus are assembled into the TEM sample holder.

その他・特記事項（Others）：なし

論文・学会発表（Publication/Presentation）：

Development of a MEMS Resonator for In Situ TEM Fatigue Test, Proc. JSME 2012 Conference , Kanazawa, Sep.9-12, J032014 (2012).