課題番号　　:F-15-KT-0101
利用形態　　:技術補助
利用課題名(日本語)　　:へき開破壊によるナノギャップ創製 MEMS デバイス
Program Title (English)　　:MEMS device for controlled fracture fabricated nanogap
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1. 概要(Summary)

Controllable nanogaps are extremely important for fabricating futuristic cold field emission devices. However, there are attempts made in the past to fabricate nanogap electrodes using various methods, like focused ion beam, batch processing them and to be able to maneuver the gap distance with ease is often very difficult. We wish to fabricate a MEMS device that can produce controllable nanogaps by fracturing a Si microbeam through an inbuilt thermo-mechanical actuator.

2. 実験(Experimental)

Laser lithography tool (A3, A10, A11)
Deep reactive ion etching (B8-2)
HF vapor etching of sacrificial (oxide) layer (B12)

3. 結果と考察(Results and Discussion)

a. Fabrication scheme.

The MEMS device is fabricated from Silicon On Insulator wafer, which consists of a 400 µm handle layer, and a 5 µm device layer, separated by a 2 µm box layer of SiO_2. Photolithography and thin film metal deposition is used to define metal pads on the device layer (lift off). Then, the device layer is patterned by photolithography with the device mask. The masks are fabricated by the laser lithography tool. This is followed by the deep reactive ion etching process to selectively etch out Si from the device layer. Then, the resist mask is removed and the wafer is diced into individual chips. After that the box (SiO_2) layer is etched out by the HF vapor etching system to release the devices.

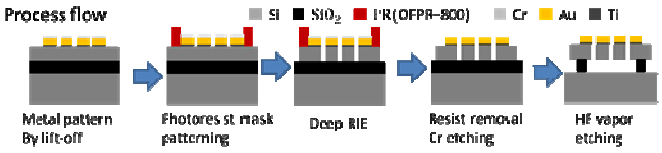

Fig. 1　schematic diagram of the fabrication process.

b. Fabricated device

The MEMS device is successfully fabricated, utilizing aforementioned facilities (Fig.2). The device is currently being studied. The thermal actuator is activated by application of electric current, which expands the actuator arms by means of Joule heating, resulting in an axial tensile stress on the overhanding silicon microbeam. The controlled fracture was successfully achieved in some of the devices.

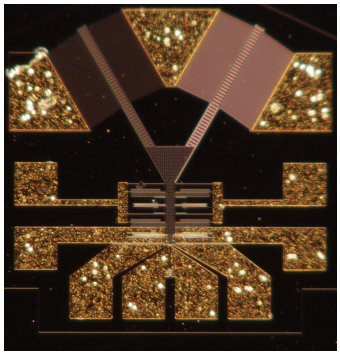

Fig. 2 Fabricated device.

4. その他・特記事項(Others)

参考論文; A. Banerjee, Y. Hirai, T. Tsuchiya, O. Tabata, Electromechanical Fabrication of Conformal Nanogap Electrodes for Thermotunnelling Cooling, IEEE-NEMS2016, Matsushima bay and Sendai city, Japan (17 – 20 Apr. 2016).

5. 論文・学会発表（Publication/Presentation）

なし。

6. 関連特許（Patent）

なし.