課題番号　　:F-19-KT-0083
利用形態　　:機器利用
利用課題名（日本語）　　:圧電ミラーデバイスの開発
Program Title(English)　　:Development of vibration-powered generators
利用者名（日本語）　　:尤清揚、平井義和
Username(English)　　:Q. You, Y. Hirai
所属名（日本語）　　:京都大学大学院工学研究科
Affiliation(English)　　:Graduate School of Eng., Kyoto Univ
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1. 概要（Summary）

MEMS torsional micro mirror device is a scanning device that scans a laser beam by reflecting it. Its reliability under the condition of high frequency and large scanning angle can be improved by dimensional downscaling. The decrease in optical surface can be compansated by array design. Using the method of silicon nanowire (SiNW) fabrication [1], we are developing piezoelectric mirror arrays of extremely small mirror size (200 μm in sides, 24 μm in thickness and 4 μm in the beam's width) and verfing the size effect.

2. 実験（Experimental）

【利用した主な装置】

[B08]　Reactive Ion Deep Silicon Etcher (DRIE)
[B12]　Vapor HF Release Etcher
[C16]　Micro System Analyzer

【実験方法】

Several 7mm square SOI chips with cavities beneath SiO_2 layer are used for mirror device fabrication. The patterns of the mirrors have already been made through photolithography, and the 20nm AlN layer are then removed (in Murata).

Apply the AlN upon the mirror plate as the mask, the Si layer are etched using B08. Anisotropic etching using bosch process followed by isotropic etching are conducted to create SiNW. Finally, SiO_2 film beneath the device Si layer are removed using B10, fully releasing the mirror device.

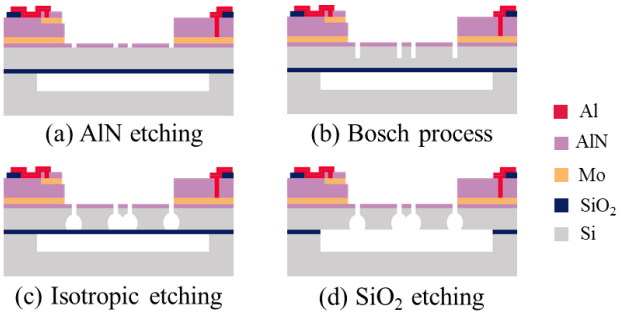
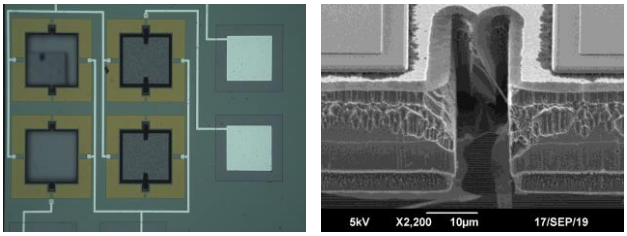


Fig. 1 Fabrication flow of piezoelectric mirror device.

After fabrication, apply excitation signal to the device and measure the out-of-plane vibration using C16.

3. 結果と考察（Results and Discussion）

The fabrication results are shown in Fig. 2. After DRIE, unwanted side etching and undercut below AlN film occurred. Most of the mirror beams are severely damaged and some mirrors are broken. But for the mirror samples that only went through Bosch process, no obvious undercut are observed. It turns out that AlN is not suitable for use as the mask in isotropic Si etching.



(a)　(b)

Fig. 2 (a) Fabrication result of a 2×2 mirror array and (b) SEM image at the fractured beam.

Using a mirror chip that is released through only Bosch process, piezoelectrical actuating experiments have been carried out. The mirrors showed twisting movement, proving the feasibility of the actuating method. However, the magnitude of the vibration is too small (less than 25 nm), and the natural frequency of each mirrors varies. Improvements in fabrication are needed in the future research.

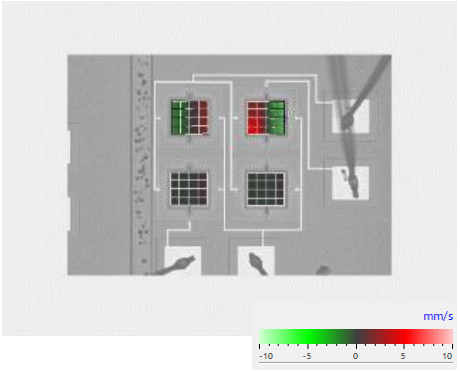


Fig. 3 out-of-plane movement of a 2×2 mirror array.

4. その他・特記事項(Others)

・参考文献

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