

課題番号 : F-14-UT-0051  
 利用形態 : 機器利用  
 利用課題名(日本語) : 櫛歯電極を持つ MEMS エレクトレット発電器の開発  
 Program Title (English) : Development of MEMS Vibration Electret Energy Harvester with comb drives  
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### 1. 概要(Summary)

A novel in-plane MEMS electret energy harvester with combined electrodes of overlapping-area-change and gap-closing types is proposed for large output power both at low and high vibration accelerations. An early prototype has been successfully micro-fabricated with the single layer silicon-on-insulator process. Soft-X-ray charging is employed to establish uniform surface potential around 60 V on vertical electrets on the sidewall of the comb fingers. Up to 1.19  $\mu$ W output power has been obtained at 552 Hz and 2.15 g acceleration oscillations, which corresponds to the effectiveness as high as 27.2 %.

### 2. 実験(Experimental)

#### ・利用した主な装置

高速大面積電子線描画装置(F5112 + VD01)、ステルスダイニング装置、ワイヤボンダー

#### ・実験方法

The device was fabricated through the silicon-on-insulator (SOI) MEMS technology. The process starts with a standard lithography on 4 inch SOI wafer using photo-resist. 70  $\mu$ m-thick device layer is etched with DRIE to form springs, electrodes and etched holes. Then, the buried oxide layer is etched with vapor HF for releasing the structure through the etched holes on the seismic mass. This is followed by a 1.5  $\mu$ m-thick Parylene-C deposition as the electret material. Finally, soft X-ray charging using 9.5 keV acceleration voltages is applied with the bias voltage of 130 V for 150 seconds.

### 3. 結果と考察(Results and Discussion)

The prototyped device is shown in Fig. 1. As shown in Fig. 2, up to 1.19  $\mu$ W output power has been obtained at 552 Hz and 2.15 g acceleration oscillations, which corresponds to the effectiveness as high as 27.2 %.

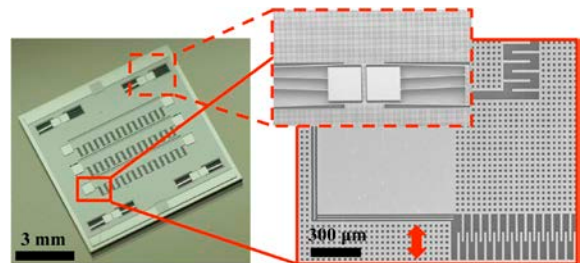


Fig. 1 Fabricated device.

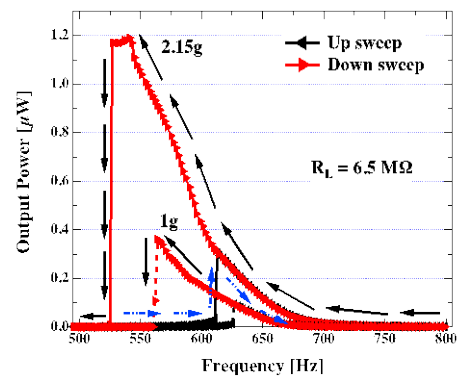


Fig. 2 Measurement results of output power.

### 4. その他・特記事項(Others)

This work is partially supported by NEXCO Group Companies' Support. SK was supported through the Leading Graduates Schools Program by MEXT.

### 5. 論文・学会発表(Publication/Presentation)

- (1) Kim, S., Fu, Q., Hagiwara, K., and Suzuki, Y., Proc. 14th PowerMEMS, Awaji, (2014). Also, J. Phys.: Conf. Ser., Vol. 557, No. 012063 (2014).
- (2) 付 乾炎, 東京大学博士論文, 2014.

### 6. 関連特許(Patent)

なし