課題番号　：F-18-UT-0090
利用形態　：機器利用
利用課題名（日本語）　：
Program Title (English)　：Push-button kinetic energy harvester
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キーワード／Keyword　：リソグラフィ・露光・描画装置, Flexible Piezoelectret, Energy Harvester

1. 概要（Summary）

A push-button energy harvester based on soft-X-ray charged folded multilayer piezoelectret is proposed. The folded structure with CYTOP-coated parylene-C membranes yields an extremely low effective Young's modulus of 14 kPa. With the early prototype, 15.5 μJ/push has been obtained with max force of only 1 N, which corresponds to a record-high piezoelectric coefficient d_{33} of 30000 pC/N. In addition, LED light-up is also demonstrated upon finger press.

2. 実験（Experimental）

【利用した主な装置】

高速大面積電子線描画装置, マスク・ウエーハ自動現像装置群, ブレードダイサー

【実験方法】

The fabrication process starts with the growth of 200 nm SiO_2 layer by thermal oxidization on a 4-inch Si wafer. By using standard photolithography, SiO_2 etch mask is patterned. Next, Si wafer is etched in 25% TMAH to obtain "protrusion" and "trench" structures. After removing SiO_2, 18 μm Parylene-C is deposited, followed by sputtering Cr/Au/Cr electrode and a second 18 μm parylene-C deposition. The wafer is then diced and the membranes are peeled off. Dip coating is used to coat 10 μm CYTOP electret. Finally, the piezoelectret is fabricated by assembling two folded sheets and charged using soft-X-ray (Fig. 1).

3. 結果と考察（Results and Discussion）

A capacitance change of 156 pF was achieved by pushing the piezoelectret at maximum force 1 N (Fig. 1). Output voltage around 200 V was obtained across a 500 MΩ load, which corresponded to 15.5 μJ electric energy. The piezoelectret is quite soft with effective Young's modulus of only 14 kPa and piezoelectric coefficient d_{33} as high as 30000 pC/N, one order of magnitude higher than that of previous piezoelectrets. In Fig. 2, we fix the piezoelectret inside a 3D-printed push-button case and demonstrate light-up of a LED. The electric circuit consists of the push-button, a full-bridge diode rectifier, a storage capacitor, a DC/DC converter and a LED.

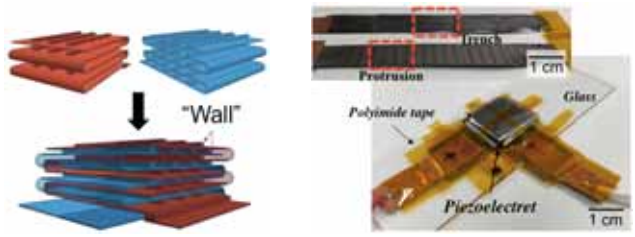

Figure 1. Design and as-fabricated prototype.

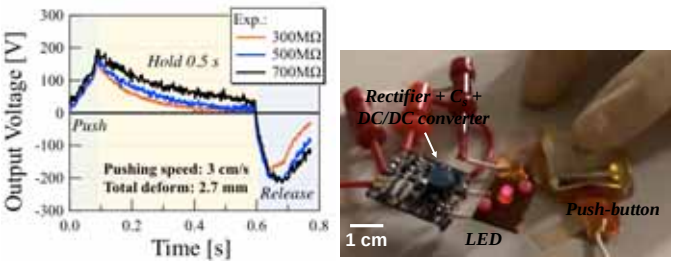

Figure 2. Output performance and LED light-up demo.

4. その他・特記事項（Others）

なし

5. 論文・学会発表（Publication/Presentation）

(1) J. Lu & Y. Suzuki, 18th Int. Conf. on Micro and Nanotechnology for Power Generation and Energy Conversion Applications (PowerMEMS 2018), Daytona Beach, W3B-01 (2018) (Best Paper Award Finalist).

6. 関連特許（Patent）

なし