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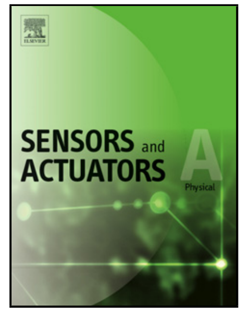

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Micron Scale Energy Harvesters Using Multiple Piezoelectric Polymer Layers

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Highlights

- **CMOS compatible multilayer piezoelectric energy harvesters were fabricated.**
- **Resonant frequencies of 1.8 mm-long microfabricated cantilevers were below 200 Hz.**
- **Power output density under 1.0 g peak acceleration was measured as 27.8 nW/mm2.**
- **Experimental data indicates that substrate clamping can increase power output.**
- **Proposed devices are suitable for operation under high strain levels.**

Abstract. This paper presents the design, fabrication, and experimental results of micron scale energy harvesters that utilize piezoelectric polymer polyvinylidene fluoride-trifluoroethylene (PVDF-TrFE). Proposed devices are free-standing thin film cantilevers with multiple PVDF-TrFE and electrode layers. During the design phase, optimal piezoelectric layer thickness for the chosen substrate was calculated as 7.4 µm. In order to alleviate the potential fabrication problems, a multilayer approach was adopted instead of coating a single layer. Device dimensions were selected to yield resonance frequencies below 1 kHz. Cantilever type piezoelectric energy harvesters with 3 parallel-connected PVDF-TrFE layers were created using standard microfabrication techniques. Energy harvesting performances of the fabricated devices were evaluated using an electrodynamic shaker and an accelerometer to create and observe input vibrations at different amplitudes and frequencies. Measurement results were compared with theoretical calculations and the effect of substrate clamping was discussed. The power output of an (1800 µm x 2000 µm) prototype was measured as 0.1 µW when driven with a peak input acceleration of 1.0g at its resonance frequency of 192.5 Hz. Half power bandwidth of the same prototype was measured as 2.9 Hz. Proposed energy harvesters have relatively low resonance frequencies for their sizes and have the potential to be easily integrated with other microfabricated devices.

1 Introduction

The remarkable improvements in CMOS and MEMS technologies keep driving the advent of high performance electronic sensors and transducers at smaller scales. Shrinking dimensions reduce the unit costs and power requirements of the microfabricated sensor cores; however, the necessity of a power source, typically a battery in current technology, limits the overall size and cost of these devices. Energy

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