DESIGN OF A LOW-FREQUENCY ELECTROMAGNETIC ENERGY HARVESTER BY USING INDUCED MAGNETIC FORCE

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I. ABSTRACT

An electromagnetic energy harvester using magnetic force to improve the insufficient bandwidth and the non-matching resonant frequency with the environmental vibration is proposed [1][2]. For the fabrication, we used MEMS process to produce a cantilever structure with a proof mass. Then, conductive coils and magnetic nickel film were added on the cantilever beam. The magnetic force between the nickel epoxy and a magnet was used to adjust the resonant frequency. The characteristics of the energy harvester with respect to magnetic force were tested, including resonant frequency, bandwidth, and voltage. When the distance between the energy harvester and the magnet was set from 10 to 2 mm, the resonant frequency was dropped from 197 to 185 Hz, and the induced voltage was increased from 1 to 5.3 mV. In addition, adjusting the overlapping position of the magnet and the energy harvester will increase the bandwidth of the generator. The fabricated devices are shown in figure 1 and figure 2.

II. PROCESS

The fabrication process of the energy harvester is shown in figure 3. First, a silicon cantilever device (include mass) was fabricated by microelectromechanical systems (MEMS) process [3]. Then, the coil and the magnetic nickel film were deposited on the cantilever by using dispensing process. During the fabrication, the materials were controlled with appropriate speed and pressure to make the structure.

III. CONCLUSION

In this research, the coil and magnetic nickel film were successfully fabricated on the cantilever device, and magnetic force was used to improve the insufficient bandwidth and the non-matching resonant frequency. Distance between the energy harvester and the magnet of the experiment result is shown in table I. The energy harvester induction voltage increased and resonant frequency decreased when the energy harvester was put closer to the NdFeB magnet. In table II, by adjusting the overlapping position of the magnet and the energy harvester, the resonant frequency and the bandwidth showed apparent difference.

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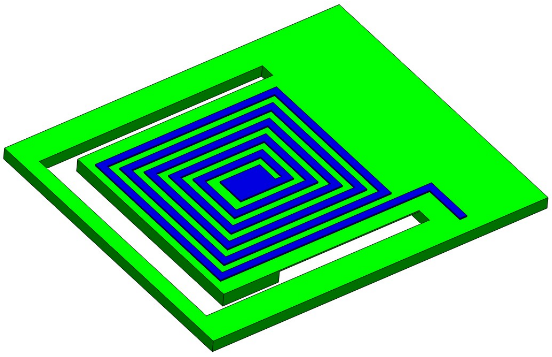

Fig. 1 Schematic of the energy harvester.

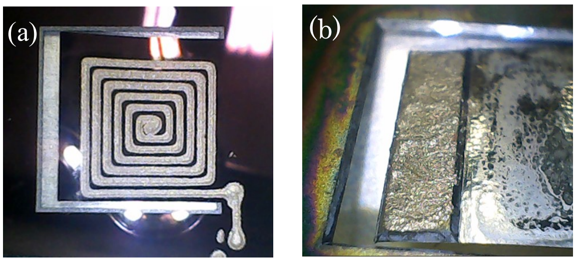

Fig. 2 Photo of the energy harvester device: (a) coil (b) magnetic nickel film.

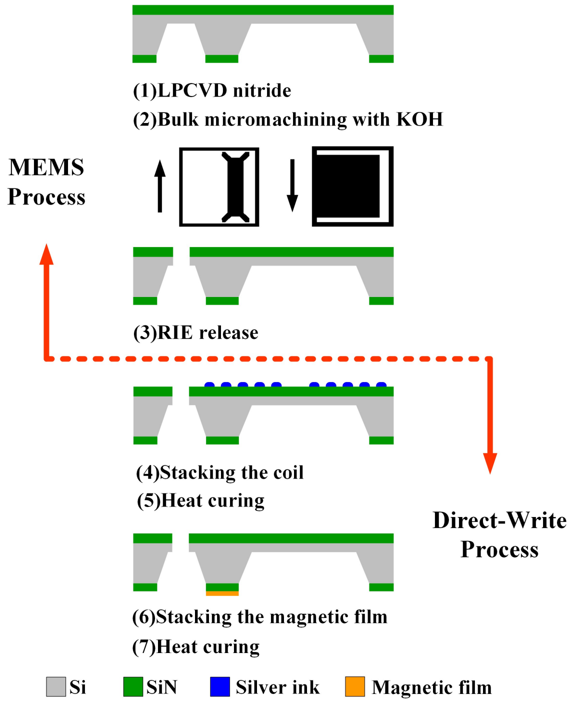

Fig. 3 The fabrication process of the device.

Table I System performance with respect to various vertical distances.

Displacement	Frequency	Voltage	Bandwidth
10 mm	197 Hz	48 mV	8.27 Hz
5 mm	188 Hz	102 mV	4.95 Hz
2 mm	185 Hz	264 mV	4.3 Hz

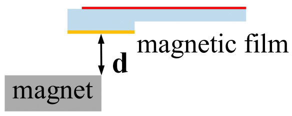

Table II System performance with respect to various overlapping lengths.

Type	Frequency	Voltage	Bandwidth
no magnetic film	195 Hz	198 mV	5.21 Hz
(a)	155 Hz	128 mV	24.94 Hz
(b)	185 Hz	264 mV	4.22 Hz