

Electromechanical properties of 2-degree-of-freedom piezoelectric vibration energy harvester for impulsive force

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[Introduction] In order to expand the application of piezoelectric vibration energy harvester (pVEH), it is important to effectively harvest vibration energy in ambient vibrations, which has random, time-varying and low-frequency properties. Instead of broadening the bandwidth of the harvester, which the decreasing of mechanical Q factor leads to lower output power, we focus on harvesting energy from the impulsive force. In our previous work, electromechanical properties of conventional pVEHs with one-degree-of-freedom system (1DOF) were characterized under impulsive force.¹ Moreover, the significant improvement of output energy from the impulsive force was observed experimentally by using dynamic magnifier under the pVEH, which is known as a 2DOF system.² In this work, the electromechanical response of 2DOF-pVEHs under the impulsive force is discussed by theoretical calculation.

[Simulation and Results] The theoretical calculation based on the lumped parameter model of pVEH with 2DOF was used.³ The parameters of pVEH and dynamics magnifier are shown in Table I. Figure. 1 shows the dependences of the output energy on Q factor of the dynamic magnifier (Q_{dm}) and impulse duration. When the resonance frequency of dynamic magnifier f_{dm} is the same as that of pVEH (Fig. 1(a)), the high output energy is obtained because of the amplification by the resonance of the dynamic magnifier. When f_{dm} is 400 Hz (Fig. 1(b)), the output energy decreases drastically. In the both cases, broad dependence on Q_{dm} was observed, which is different in the case of sinusoidal vibration. The further analysis of electromechanical of 2DOF-pVEH and the energy conversion efficiency will be presented.

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[References]

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Table I. Parameters of pVEHs

	m (mg)	f (Hz)		Q	K^2 (%)
pVEH	4.19	236		400	0.7
DM	370	a.236	b.400	50-1000	

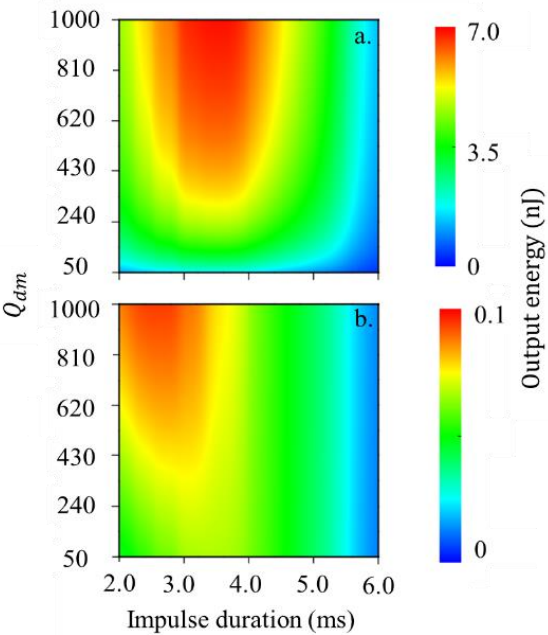


Fig.1: The dependences of output energy on dynamic magnifier’s Q factor and duration of impulsive force.
a. $f_0 = f_{dm} = 236$ Hz ;
b. $f_0 = 236$ Hz, $f_{dm} = 400$ Hz.