Piezoelectric Vibration Energy Harvester Based on Thickness-Tapered Cantilever

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Abstract

The paper presents simulations of uniform thickness and tapered thickness types of piezoelectric vibration energy harvesters using COMSOL Multiphysics software. The simulated vibration energy harvesters have bimorph cantilever structure with end mass. The results show that the thickness tapered geometry produces more power than the uniform thickness geometry.

INTRODUCTION: The power output of a vibration energy harvester (VEH) plays an important role in its designing steps, and finite element (FE) analysis can be used to design and estimate harvested power [1] [2] [3]. In this paper, bimorph piezoelectric VEHs consisting of brass substrate sandwiched between PZT-5H layers as shown in Figure 1 are simulated using COMSOL Multiphysics. The top and bottom surfaces of the bimorph are metalized to form electrodes for connection.

USE OF COMSOL MULTIPHYSICS®: COMSOL Multiphysics is used to simulate uniform thickness and tapered thickness types of piezoelectric VEHs and to obtain displacement of the end mass and generated power, as function of the excitation frequency and load resistance. Displacement and stress profiles are obtained using COMSOL Multiphysics. Eigen frequency analysis is used to find the resonance frequency of the VEHs under short circuit and open circuit condition.

RESULTS: Figure 3 and 4 show the power generated from the uniform and tapered VEHs respectively. Displacement and stress profiles are obtained. Variation of generated power with load resistance is plotted and optimal value of load resistance is found.

CONCLUSION: Bimorph piezoelectric VEHs of uniform and tapered thickness consisting of brass substrate sandwiched between two PZT-5H layers are simulated using COMSOL Multiphysics. The VEH with tapered thickness generates more power compared to the VEH of uniform thickness.

Reference

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Figures used in the abstract

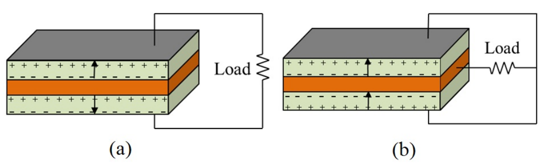

Figure 1: Piezoelectric bimorphs in (a) series and (b) parallel configuration.

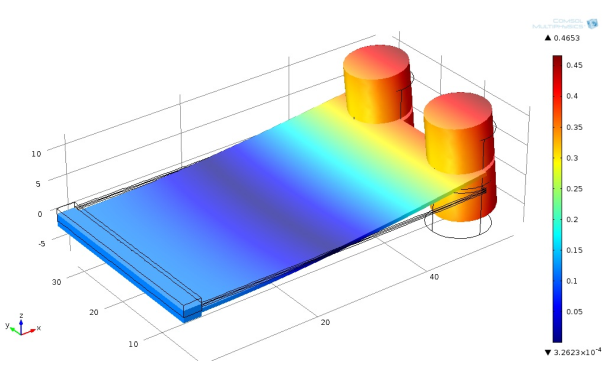

Figure 2: Displacement profile of the simulated VEH.

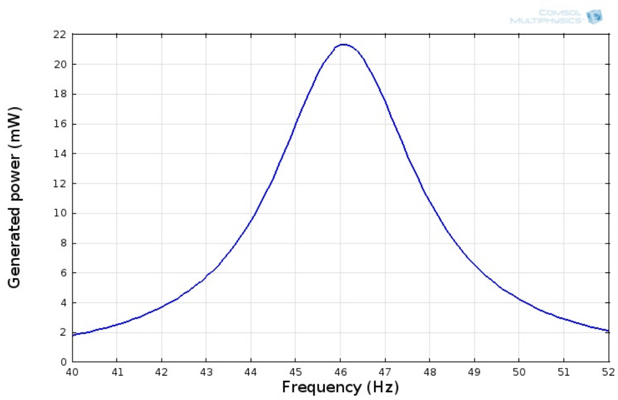

Figure 3: Generated power from VEH of uniform thickness.

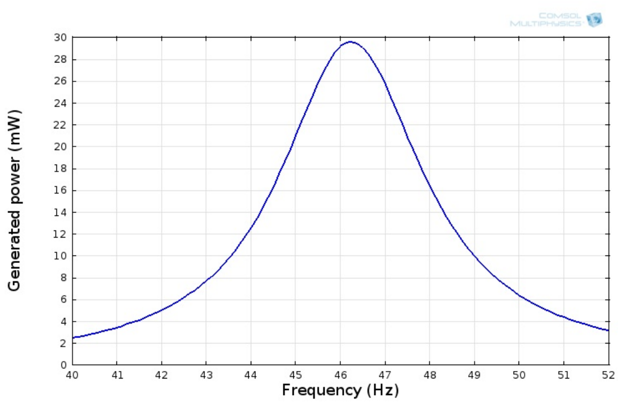

Figure 4: Generated power from VEH of tapered thickness.