Modeling, Simulation and Optimization of Piezoelectric Bimorph Transducer For Broadband Vibration Energy Harvesting

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Introduction: The objective of this research is to design a millimeter scale broadband energy harvester device through the use of a polycrystalline piezoelectric single bimorph beam. In this research, we use COMSOL finite element analysis software to design, simulate and analyze the voltage and power characteristics under mechanical vibrations of a piezoelectric cantilever beam.

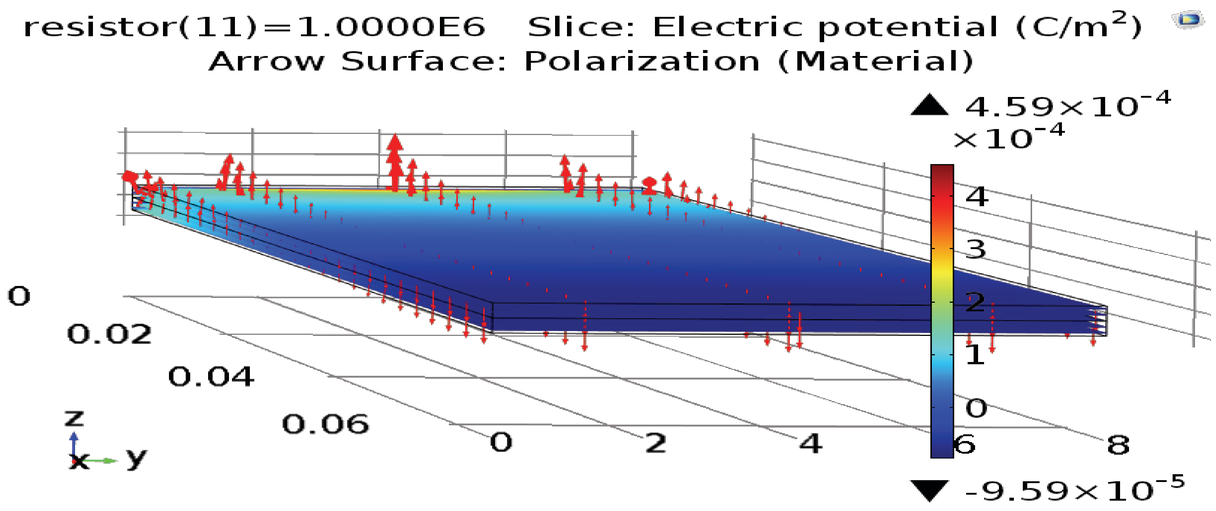

Fig. 1. Polarization vector of bimorph cantilever bending downward simulation (3-1 mode)

Modeling idea: Our main contributions in this research are using newly developed PZT-PZN material and converting its piezoelectric material properties to the "language" which COMSOL can understand in multi-physics simulation. Optimization idea is expressed in a flow chart shown in Fig. 2.

Fig. 3. PZT-PZN Samples

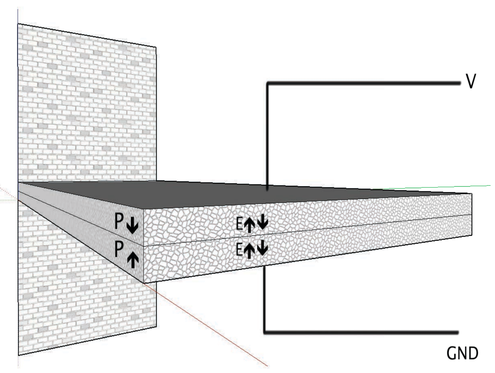

Fig. 4. Bimorph connected in series

Name	Power(mW)	Optimal resistance(MΩ)	Voltage (v)
Sample 1	0.404	4.9	44.5
Sample 2	0.394	5.4	46.2
PZT5A	0.206	3.5	26.9
PZT5H	0.144	1.8	16.1

Table 1. Output Power comparison between samples

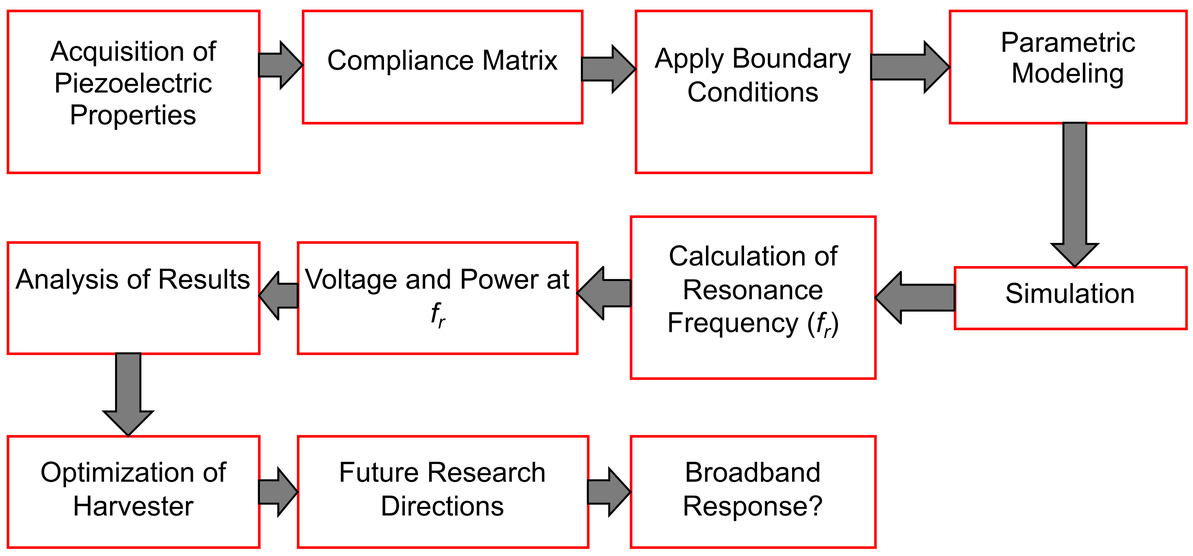

Fig. 2. Optimization flow chart

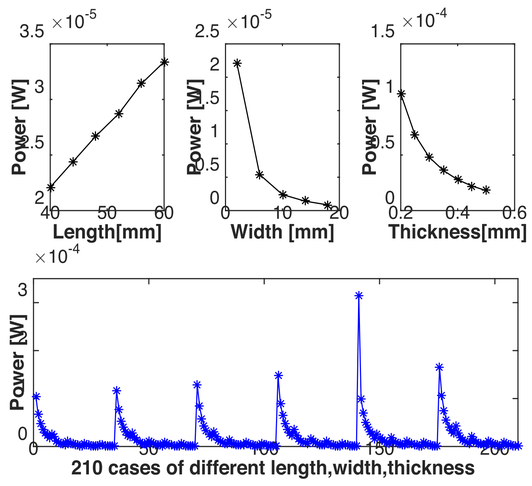

Fig. 5. Power vs. geometry

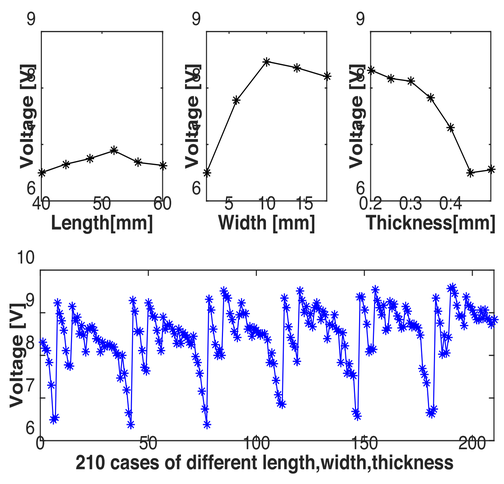

Fig. 6. Voltage vs. geometry

Conclusions: It is seen that power and voltage results in TABLE 1, are results of simulations showing a promising method to design energy harvesters to provide power for small-scale sensors of piezoelectric materials. Voltage and power of piezoelectric cantilever beams using composition of two samples is better than traditional PZT5A and PZT5H.

References:

1. Priya, Shashank. et al. ,Energy Harvesting Technologies. Springer,2006 p93
2. Moheimani, S.O. Reza. et al. ,Piezoelectric Transducers for Vibration Control and Damping. London: Springer,2006, p16,p21