Modeling, Simulation and Optimization of Piezoelectric Bimorph Transducer For Broadband Vibration Energy Harvesting in two-piece trapezoidal approach

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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 trapezoidal beam approach with a non-linear geometry. In this research, we use COMSOL finite element analysis software to design, simulate and analyze the voltage and power characteristics under applied mechanical vibrations of a piezoelectric cantilever beam.

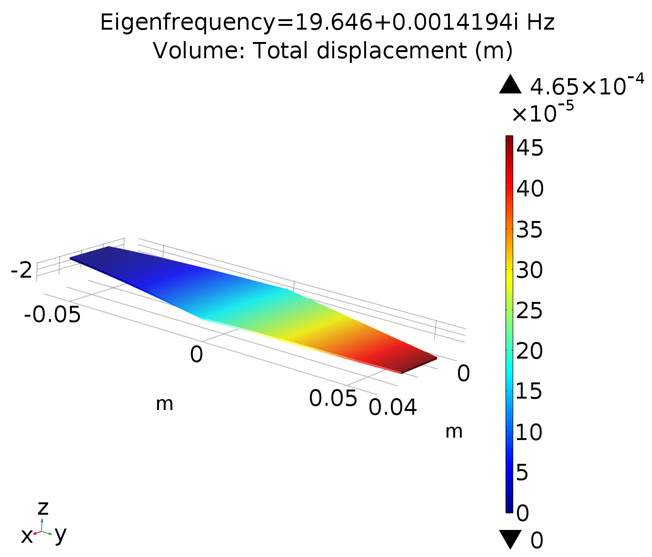

Figure 1. Displacement of the 2-piece trapezoidal design with fixed edge

Modeling idea: the piezoelectric ceramic composition samples have $^{332mW/cm^3}$ series combinations of a bimorph energy harvester design ,vibrating at the frequency near the natural frequency of the beam. We propose a new design of an optimized geometry for bimorph harvesters to capture energy at multiple frequencies. We aims to reach boarder vibration frequency response of the piezoelectric beam as well as its optimized output voltage power of the energy harvesting device by investigating fundamental frequencies ,dimensions of the beam design as well as external factors : such as optimal external resistance.

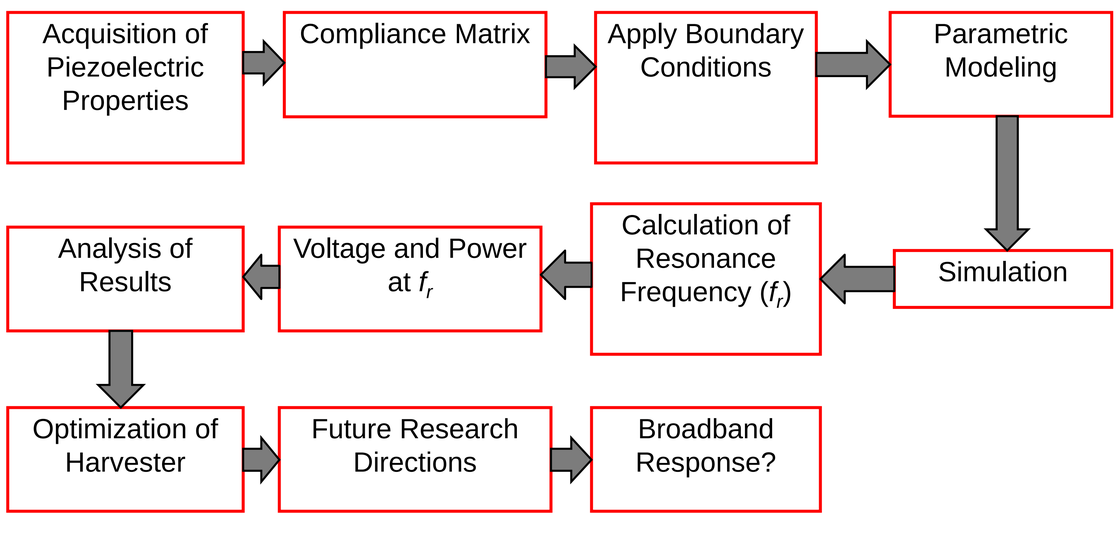

Figure 2. Optimization flow chart

Results: The vibration frequency bandwidth of the trapezoidal beam is about 42Hz. Comparing with the previous bandwidth results an improvement of broader band is seen.

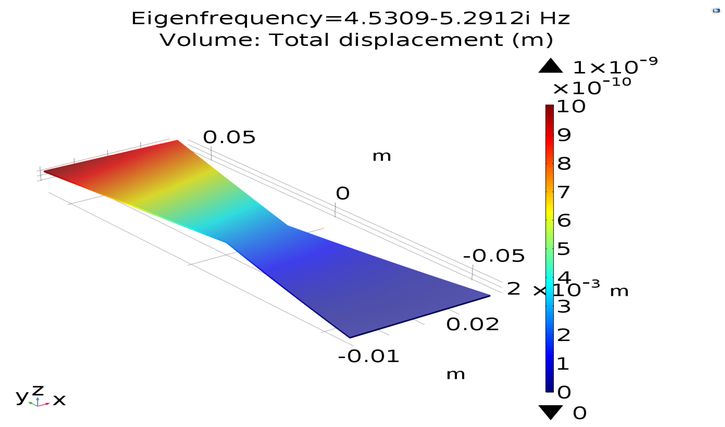

Figure 3. Displacement of a 2-piece reserve trapezoidal beam

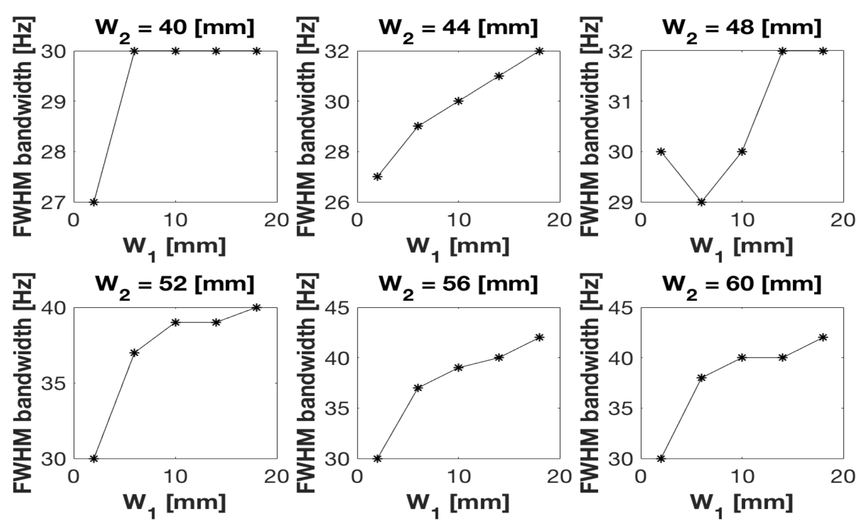

Figure 4. Rev. Trap. bandwidth of real power density vs. widths

Conclusions: The full width at half maximum power density bandwidth of the reverse 2-piece trapezoidal energy harvester is up to 42 Hz with maximum power density 7.27 μW/cm^3. The FWHM power density bandwidth of the 1-piece trapezoidal energy harvester designs are much narrower (6-7Hz) than those of 2-piece trapezoidal designs.