Modeling, Simulation, and Optimization of Piezoelectric Bimorph Transducer for Broadband Vibration Energy Harvesting in Two-piece Trapezoidal Approach

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Abstract

The objective of the research is to design a broadband energy harvester device through the two-piece non-linear trapezoidal geometry approach. The performance of two piezoelectric PZT-PZN polycrystalline ceramic composition samples are simulated in COMSOL Multiphysics, and results are compared using series configuration of a bimorph energy harvester which vibrates near the its respective fundamental frequency. Designing and simulating a trapezoidal piezoelectric bimorph cantilever has its own challenges: simulating a trapezoidal piezoelectric beam requires a good engineering judgement to reject unrealistic voltage and power performance measures based on the specific trapezoidal geometry design. The weakest structural location is around the joint area or narrowest area of the trapezoidal beam. Applying mechanical vibration on the trapezoidal beam at its natural frequency in some cases cause collapse of the beam structure as the high strain and stress appears on the narrowest area of the trapezoidal beam. Therefore, a good engineering balance needs to be kept between reaching the broadband frequency response of a trapezoidal piezoelectric beam and maintaining the structural stability of a trapezoidal piezoelectric beam. Authors believe that the two-piece trapezoidal beam design leads to broader band frequency response.