Efficient Energy Harvesting Using Piezoelectric Compliant Mechanisms: Theory and Experiment

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Piezoelectric energy harvesters typically perform poorly in the low frequency, low amplitude, and intermittent excitation environment of human movement. In this paper, a piezoelectric compliant mechanism (PCM) energy harvester is designed that consists of a polyvinylidene diflouoride (PVDF) unimorph clamped at the base and attached to a compliant mechanism at the tip. The compliant mechanism has two flexures that amplify the tip displacement to produce large motion of a proof mass and a low frequency first mode with an efficient (nearly quadratic) shape. The compliant mechanism is fabricated as a separate, relatively rigid frame with flexure hinges, simplifying the fabrication process, and surrounding and protecting the piezoelectric unimorph. The bridge structure of the PCM also self-limits the response to large amplitude impacts, improving the device robustness. Experiments show that the compliant hinge stiffness can be carefully tuned to approach the theoretical high power output and mode shape efficiency.