Piezoelectric Compliant Mechanism Energy Harvesters Under Large Base Excitations

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A piezoelectric compliant mechanism (PCM) energy harvester is designed, modeled, and analyzed that consists of a polyvinylidene diflouoride, PVDF unimorph clamped at its base and attached to a compliant mechanism at its tip. The compliant hinge stiffness is carefully tuned to approach a low frequency first mode with an efficient (nearly quadratic) shape that provides a uniform strain distribution. A nonlinear model of the PCM energy harvester under large base excitation is derived to determine the maximum power that can be generated by the device. Experiments with a fabricated PCM energy harvester prototype show that the compliant mechanism introduces a stiffening effect and a much wider bandwidth than a benchmark proof mass cantilever design. The PCM bridge structure self-limits the displacement and maximum strain at large excitations compared with the proof mass cantilever, improving the device robustness. The PCM outperforms the cantilever in both average power and power-strain sensitivity at high accelerations due to the PCM axial stretching effect and its more uniform strain distribution.