Wearable Inertial Energy Harvester with Sputtered Bimorph Lead Zirconate Titanate (PZT)

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Energy harvesting from human motion addresses the growing need for self-powered wearable health monitoring systems which require 24/7 operation. Human motion is characterized by low and irregular frequencies, large amplitudes, and multi-axial motion, all of which limit the performance of conventional translational energy harvesters. An eccentric rotor-based rotational approach originally used in self-winding watches has been adopted to address the challenge. This paper presents a three-dimensional generalized rotational harvester model that considers both linear and rotational excitations. A hypothetical power upper bound for such architectures derived using this generalized model demonstrated the possibility for harvesting significantly more energy compared to existing devices. A wrist-worn piezoelectric rotational energy harvester was designed and fabricated attempting to narrow this gap between existing devices and the theoretical upper bound. The harvester utilizes sputtered bimorph PZT/nickel/PZT thin-film beams to accommodate the need for both flexibility and high piezoelectric figure of merit in order to realize a multi-beam wearable harvester. The prototype was characterized using a bench-top swing arm set-up to validate the system-level model, which provides many degrees of freedom for optimization.

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