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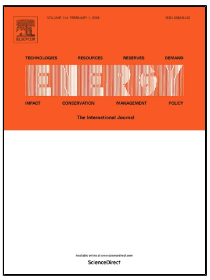

Energy gathering performance of micro/nanoscale circular energy harvesters based on flexoelectric effect

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Energy gathering performance of micro/nanoscale circular energy harvesters based on flexoelectric effect

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Abstract: At micro/nanoscale, flexoelectric energy harvesters (FEHs) are more effective than piezoelectric energy harvesters (PEHs). Calculating the voltage and efficiency of such small-scale FEHs is a challenge for their applications. Because of huge number of atoms, molecular dynamics simulation and first-principle theory are difficult to be used. It is essential to develop an analytical model that can provide a direct calculation of the voltage and the efficiency of FEHs. This paper develops an analytical model for micro/nanoscale circular FEHs which are a composite structure having a flexoelectric layer attached to an elastic substrate. Mechanical and electrical governing equations are derived based on the Hamiltonian principle and with consideration of the flexoelectric effect. Approximate closed-form solutions for voltage output, power output and optimal load resistance are obtained. The optimal values of the inner and outer radii of the flexoelectric layer for maximum voltage and power outputs are identified. The power output and the energy conversion efficiency of the present model are much larger than those of classical model which only includes piezoelectric effect. This research is helpful for materials scientists and mechanical engineers for designing high-performance micro/nanoscale energy harvesters.

Keywords: energy harvesting; circular nanoplate; flexoelectric effect; piezoelectricity; voltage output.

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