The size-dependent behavior of a broadband magnetic energy nanoharvester array with consideration of surface and nonlocal effects

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Abstract

Nanoharvester, which can convert various forms of energy into electric energy in nanoscale, is now a high-profile issue. To better improve the performances and further fulfill the potential applications, it is essential to analyze the physical and mechanical properties of nanoharvester as well as evaluating the size effect qualitatively and quantitatively. In the current work, a nonlinear magnetoelectric (ME) coupling model of the magnetic energy nanoharvester array with the consideration of the surface and nonlocal effects is developed and used to investigate the extensional vibration of a magnetic energy nanoharvester, which is composed of a magneto-electro-elastic (MEE) laminated cylindrical nanoshell array when the circuit is connected either in series or in parallel. The analytical results indicate that the performance of nanoharvester exhibits obvious size-dependent phenomenon, including the resonant frequency, output electrical power density, efficiency and so forth, which is only attributed to the surface effect. Based on this, a critical thickness, related to material parameters of surface layer, is proposed, below which the size-dependent effect is obvious and the surface effect must be considered. On the other hand, the output electrical power and operating frequency band of the nanoharvester can be better tuned by applying a matched magnetic field and pre-stress, which provides us opportunity to improve its work performance. The current work is essential and crucial for the physical phenomenon explanations and experimental design of the MEE nanodevices, especially in the extremely complex magnetic and pre-stress field environments.

Keywords: **Mgnetic energy nanoharvester array, Surface and nonlocal effects, Size-dependent behavior**

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