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Investigation on electromechanical harvesting schemes to improve the performance of viscoelastic dielectric elastomer generators

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As a category of electroactive polymers, dielectric elastomers (DEs) exhibit physical response to electrical stimuli and transduce electrical energy to mechanical energy. On the other hand, when acting in a generator mode, they can also convert mechanical energy from different sources, such as winds, ocean waves and human movement into electrical energy. Due to their flexibility and high energy density, dielectric elastomer generators (DEGs) have recently attracted much attention from the research community. It has been demonstrated in experiments that DEGs can achieve energy densities more than 10 times higher than those of piezoelectric and electromagnetic generators. Although some DEGs have shown very promising results, their performance is in fact affected by multiple failure modes and the material viscoelasticity. Particularly, the material viscoelasticity of the DE membrane embedded in a DEG could cause high energy dissipation of the generator and exert a strong influence on the design of its harvesting scheme. To uncover possible approaches to improve the performance of DEGs, this work presents a framework to comprehensively evaluate the harvested energy and conversion efficiency of DEGs with the consideration of the finite-deformation viscoelasticity of the material. Also, different possible energy harvesting schemes are explored in this work. From our simulation results, it is found that choosing a suitable voltage level of the power supply (or a suitable bias voltage) could markedly raise both the harvested energy and conversion efficiency of DEGs. The general framework and results in this work are expected to provide insight into optimizing the design of dielectric elastomer generators.

Biography

Liying Jiang is an Associate Professor at the Department of Mechanical and Materials Engineering, University of Western Ontario, Canada. She has received her PhD from the University of Alberta in 2005. Her research interests and activities cover a wide range of applied mechanics. Her expertise is theoretical and numerical simulation to develop mechanics and physics models for challenging problems related to material's behavior ranging from traditional composites to smart materials and to nanostructured materials.

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