Thermodynamics and instability of dielectric elastomer

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ABSTRACT

Dielectric elastomer is a kind of typical soft active material. It can deform obviously when subjected to an external voltage [1, 2]. When a dielectric elastomer with randomly oriented dipoles is subject to an electric field, the dipoles will rotate to and align with the electric field. The polarization of the dielectric elastomer may be saturated when the voltage is high enough. When subjected to a mechanical force, the end-to-end distance of each polymer chain, which has a finite contour length, will approach the finite value, reaching a limiting stretch. On approaching the limiting stretch, the elastomer stiffens steeply.

Here, we develop a thermodynamic constitutive model of dielectric elastomers undergoing polarization saturation and strain-stiffening, and then investigate the stability (electromechanical stability, snap-through stability) and voltage induced deformation of dielectric elastomers. Analytical solution has been obtained and it reveals the marked influence of the extension limit and polarization saturation limit on its instability. The developed thermodynamic constitutive model and simulation results would be helpful in future to the research of dielectric elastomer based high-performance transducers.

REFERENCES
