

Numerical techniques for modeling nonlinear oscillation of dissipative dielectric elastomers

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Abstract: Dielectric elastomer (DE) has emerged as one of promising electro-active polymers for diverse applications, ranging from soft actuators, sensors, resonators, and energy generators. The most commonly used DE material is the acrylic elastomer, which is known to be dissipative when subject to either mechanical or electrical loadings. We focus on the nonlinear behaviors of DE when oscillatory loading is applied. We firstly revisit the nonlinear oscillation of a dissipative DE balloon. We show that accounting for dissipation can obtain periodic vibration, while a balloon without damping can mostly exhibit quasi-periodic vibration. We then adopt a shooting technique in together with an arc-length continuation scheme to trace the whole branch of frequency curve. The bifurcation point and the jump phenomena can be captured by collective use of the above strategies. Finally, we program a user-material (UMAT) subroutine in ABAQUS, which can model the dynamic viscoelastic response of DE actuators. Several numerical examples are presented to demonstrate the capability of UMAT code.

Key words: dielectric elastomer, dissipative, shooting technique, numerical continuation

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