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A dynamic smoothed finite element method for large deformation and instability analyses of dielectric elastomer

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A novel method is proposed to analyze the static and dynamic responses of the dielectric elastomer under large deformations, using the smoothed finite element method. A novel semi-explicit algorithm is presented for solving the coupled mechanical and electrical governing equations of the dielectric elastomer, in conjunction with the Gent model of the nearly-incompressible hyperelastic constitutive solids. Using the dynamic relaxation scheme, the static solutions can be achieved. The method is verified by comparing the static and dynamic numerical solutions with the theoretical solutions of various benchmark problems, by which the accuracy, stability and performance of the method are examined as well. Various modes of inhomogeneous deformation can be captured and analyzed, which demonstrates the proposed method provides an effective numerical simulation tool to analyze the electromechanical instability and behaviors of the dielectric elastomer.

Keywords: Dielectric elastomer, Smoothed Finite Element, electromechanical instability, snap through