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A numerical framework for modeling flexoelectricity and Maxwell stress in soft dielectrics at finite strains

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Abstract

In the present work, a numerical finite element framework is introduced to model and solve the response of nonlinear soft dielectrics, including the effects of Maxwell stress and flexoelectricity at finite strains. Weak forms, finite element discretizations and constistent linearizations, able to handle strain gradient in the context of flexoelectricity are introduced. Numerical algorithms for the treatment of a soft dielectric in a surrounding medium are presented, more specifically to handle the effects of discontinuities of the Maxwell stress at the interfaces. Finally, several benchmarks are proposed to assess the present formulations and numerical schemes, through applications of special cases of interest: induced piezoelectricity in non-piezoelectric materials due to coupling of Maxwell stress and electrets, flexoelectricity, or stretching of electroactive soft dielectrics subjected to an external electric field.

Key words: Flexoelectricity, Dielectrics, Finite Elements, Nonlinear dielectrics, Maxwell stress, Finite strains

1 Introduction

Soft dielectrics have recently attracted a growing attention due their ability to generate large deformations when they are subjected to an electric voltage.

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