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A new framework for large strain electro-mechanics based on convex multi-variable strain energies: new relaxation techniques and application to composite materials

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Dielectric Elastomers (DE) are a class of Electro Active Polymers with outstanding actuation properties [1]. Voltage induced area expansions of 1980% on a DE membrane have been recently reported. In this case, the electromechanical instability is harnessed as a means for obtaining these electrically induced massive deformations with potential applications in soft robots. The authors postulated in [2] a Convex Multi-Variable (CMV) definition of the electromechanical internal energy of *single-phase* dielectric elastomers. Crucially, this definition guarantees material stability or, equivalently, the ellipticity condition for the entire range of deformations and electric fields.

This paper focuses on the extension of CMV constitutive models to *composite multi-layered* dielectric elastomers [3]. The performance of dielectric elastomers can be dramatically improved when they are arranged in this configuration. However, even when CMV constitutive models are considered for each of its constituents, the homogenised response of the composite can violate material stability. Specifically, new relaxation/convexification techniques yielding ellipticity compliant constitutive models are presented in this paper, tailor-made for these type of composite materials. A comparison of non-relaxed and relaxed homogenised constitutive models will also be presented.

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