Electro-Thermal and -Mechanical Model of Thermal Breakdown in Multilayered Dielectric Elastomers

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Abstract

Multiple breakdown phenomena may take place when operating dielectric elastomers. Thermal breakdown, which occurs due to Joule heating, becomes of special importance when using multilayered stacks of dielectric elastomers, due to the large volume-to-surface-area-ratio. In this article, a 2D axisymmetric finite-element model of a multilayered stack of dielectric elastomers is set up in \comsol. Both the electro-thermal and electro-mechanical couplings are considered, allowing for determination of the onset of thermal breakdown. Simulation results show that an entrapped particle in the dielectric elastomer drastically reduces the possible number of layers in the stack. Furthermore, the possible number of layers is greatly affected by the ambient temperature and the applied voltage. The performance of three hyperelastic material models for modelling the elastomer deformation are compared, and it is established that the Gent model yields the most restrictive prediction of breakdown point, while the Ogden model yields the least restrictive estimation.

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