The Electrical Breakdown Strength of Pre-Stretched Elastomers, With and Without Sample Volume Conservation

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ABSTRACT

In practice, the electrical breakdown strength of dielectric electroactive polymers (DEAPs) determines the upper limit for transduction. During DEAP actuation, the thickness of the elastomer decreases, and thus the electrical field increases and the breakdown process is determined by a coupled electro-mechanical failure mechanism. A thorough understanding of the mechanisms behind the electro-mechanical breakdown process is required for developing reliable transducers. In this study, two experimental configurations were used to determine the stretch dependence of the electrical breakdown strength of polydimethylsiloxane (PDMS) elastomers. Breakdown strength was determined for samples with and without volume conservation and was found to depend strongly on the stretch ratio and the thickness of the samples. PDMS elastomers are shown to increase breakdown strength by a factor of ~3 when sample thickness decreases from 120 to 30 μm, while the biaxial pre-stretching ($\lambda = 2$) of samples leads similarly to an increase in breakdown strength by a factor of ~2.5.

KEYWORDS: dielectric elastomer, silicone, dielectric breakdown strength, volume dependent breakdown, pre-stretch

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