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Publication date:
2018

Document Version
Peer reviewed version

Citation (APA):
Vaicekauskaite, J., Mazurek, P., Yu, L., & Skov, A. L. (2018). *Deeper Insight into the Dielectric Breakdown of Elastomers*. Abstract from MRS Spring meeting 2018, Phoenix, United States.

Deeper Insight into the Dielectric Breakdown of Elastomers

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Dielectric elastomers find more and more uses but nevertheless the fundamentals behind the electrical breakdown of these thin and elastic films are still not fully understood and elucidated. Dielectric breakdown strength measurement is one of the most common methods to evaluate stability of polymers in an electric field. This breakdown test has been extensively used over many years and is still gaining on importance, due to an increasing demand on novel polymeric materials applied in high electric fields, such as: dielectric or transport layers, modern devices or flexible electronics[1].

There are only few theoretical models that assess the physical processes occurring during a breakdown phenomenon, for example: the hole-induced breakdown model, the electron-trapping breakdown model, the resonant-tunneling-induced breakdown model and the filamentary model [2]. All these theories consider movements of electrons from electrodes to polymer film samples. Other theory is the so-called electro-mechanical model [3]. It implies, that polymer films are not always smooth, and when an electric field is applied, the force gets bigger at the thinnest spot of the film. For that reason the film sample starts to deform and when electric strength is reached at the thinnest spot, breakdown occurs [3]. This is also referred to as electro-mechanical instability (EMI) and has been extensively studied by modelling [4]–[6].

In this work a high-speed camera is used in order to capture macroscopic processes taking place during the dielectric breakdown to verify if the time-scale and behavior of the electrical breakdown can elucidate the underlying behavior.

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