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Defect-Driven Dynamic Model of Electrostatic Discharge and Endurance Time Measurements of Polymeric Spacecraft Materials

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Defect-Driven Dynamic Model of Electrostatic Discharge and Endurance Time Measurements of Polymeric Spacecraft Materials

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Abstract

Electrostatic discharge tests for two prototypical materials with different types of trap state densities—low density polyethylene (LDPE) and polyethylene (PE or Kapton HN)—were conducted by applying a high voltage across the material in parallel plate geometry using a modified ASTM D149-99 method. One set of experiments used Kapton Kapton HN film, applied film face to a grounded copper plate, and the other set used PE film, with a grounded copper plate as the bottom electrode and 100 µm resistors used to measure the electrostatic field, rate of field changes, and history of exposure to high fields. This research STUDY emphasizes experimental and theoretical investigations of the characteristics and the operation of the new measurement technique, applied field, and pure PE film to investigate the behavior of the material. The present work examines the influence of the applied field, rate of field changes, and history of exposure to high fields. This research STUDY emphasizes experimental and theoretical investigations of the characteristics and the operation of the new measurement technique, applied field, and pure PE film to investigate the behavior of the material.

Analysis of Breakdown Results

Breakdown Analysis

In the 250 to 284 V/cm range the breakdown is dominated by the irrecoverable pre-breakdown process. Breakdown times observed here were on the order of 1 to 10 ms. Breakdown in the 2900 V/cm range demonstrate a transition region, in which the irrecoverable breakdown process occurs. The breakdown process as the electric field is increased. Breakdown times observed here were on the order of 1 to 10 ms.

Endurance Time Analysis

Figure 8. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 9. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 10. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 11. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 12. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 13. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 14. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 15. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 16. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 17. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 18. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 19. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 20. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.

Figure 21. A statistical analysis conducted of the many observed short arc events during 65 breakdown I-V runs. The fitting parameters of the exponential distribution function were used to calculate the lifetime probability of a short arc event. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level. The probability of an arc event of any specific voltage level is given by the probability density function. The probability density function is used to calculate the probability of an arc event of any specific voltage level.