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A Dual-defect Model for Predicting Lifetimes for Polymeric Discharges from Accelerated Testing[1] ALLEN ANDERSEN, JR DENNISON, Utah State University — Electrostatic discharge (ESD) can cause catastrophic failures in electronic devices. Estimating the lifetime of dielectrics under prolonged high field exposure is a major design concern for applications including spacecraft, high voltage DC power transmission, and semiconductor electronics. Dielectric strengths listed in engineering handbooks are primarily based on cursory measurements with poor repeatability and tend to overestimate ESD fields in real applications. Standard measurements subject test samples to ≈500 V/s ramp rates until breakdown. We present the results of ESD studies in two prototypical polymer dielectrics using a ramp rate of ≈20 V/4s until breakdown, together with tests applying a static voltage and directly observing time-to-breakdown. Prior to ESD, transient current spikes, termed pre-arcs, were also observed. The results of these tests are explained in terms of a physics-based model of defect creation within the material from bond stress due to applied electric fields. A first order approximation is presented to develop an extended temperature- and ramp rate-dependent ESD model with both repairable and irreparable defect mechanisms. Repairable defects such as bond bending have energies on the order of thermal energies so that they can be readily repaired through thermal annealing; irreparable defects such as bond breaking have higher energies. We discuss how defect energies and densities, extracted from the results of accelerated laboratory tests, can be used to estimate fields with a satisfactory probability of material lifetimes of many years.

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