

Temperature Dependency of Electrostatic Breakdown in LDPE and PEEK

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Abstract

Electrostatic breakdown is a leading cause of many of the anomalies and failures attributed to spacecraft interactions with the space environment. It is therefore critical to understand how the electrostatic field strength varies due to changing environmental conditions, including temperature and radiation dose. Standard step-up to electrostatic discharge (ESD) tests were performed on two polymers, low density polyethylene (LDPE) and polyetheretherketone (PEEK). Tests were done at room temperature and at other temperatures ranging from ~130 K to ~350 K. Preliminary analysis found that samples tested at a higher temperature had lower average breakdown field strength and a narrower distribution of breakdown field values. These results are considered with respect to a proposed dual-defect theory for electrostatic breakdown, which incorporates both lower energy recoverable defect modes that can be generated and annihilated through thermal annealing and higher energy irrecoverable defect modes such as those created by radiation damage. The model predicts that at lower electric field strengths, an annealing process occurs due to the higher temperature which limits the density of low energy defects in the material. This means that while the overall breakdown field strength decreases, the minimum field strength required to breakdown the material would increase, thereby narrowing the breakdown distribution. This work was supported by a NASA Space Technology Research Fellowship.