Physically Based DC Lifetime Model for Lead Zirconate Titanate Films

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Accurate lifetime predictions for $Pb(Zr_{0.52}Ti_{0.48})O_{-3}$ thin films are critical for a number of applications, but current reliability models are not consistent with the resistance degradation mechanisms in lead zirconate titanate. In this work, the reliability and lifetime of chemical solution deposited (CSD) and sputtered $Pb(Zr_{0.52}Ti_{0.48})O_{-3}$ thin films are characterized using highly accelerated lifetime testing (HALT) and leakage current-voltage (I-V) measurements. Temperature dependent HALT results and impedance spectroscopy show activation energies of approximately 1.2 eV for the CSD films and 0.6 eV for the sputtered films. The voltage dependent HALT results are consistent with previous reports, but do not clearly indicate what causes device failure. To understand more about the underlying physical mechanisms leading to degradation, the I-V data are fit to known conduction mechanisms, with Schottky emission having the best-fit and realistic extracted material parameters. Using the Schottky emission equation as a base, a unique model is developed to predict the lifetime under highly accelerated testing conditions based on the physical mechanisms of degradation. Published by AIP Publishing.