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Improving Dielectric Breakdown Strength: Physically Aging Amorphous Polymers and Nanocomposites RICHARD A. VAIA, CHRISTOPHER A. GRABOWSKI, HILMAR KOERNER, United States Air Force Research Laboratory — Processing conditions play a significant role in maximizing the available energy storage density of polymer dielectrics. Trapped solvents and voids act as defect sites that prematurely trigger breakdown and reduce dielectric strength. To address these issues, solvent-cast films are conventionally annealed above the glass transition and under vacuum; however these procedures can yield materials far from thermodynamic equilibrium with substantial free-volume. Here in, we demonstrate improvement in dielectric performance via controlled post-deposition annealing based on their structural relaxation characteristics. Using enthalpy relaxation studies, we quantify how local chain packing evolves in the glass during controlled cooling or physical aging; and how this impacts dielectric breakdown, complex permittivity, and energy storage density for polystyrene, poly(methyl methacrylate), and their related blended and single-component nanocomposites. These process-performance correlations, and their dependence on nanocomposite topography, provide a basis for the rational design of dielectrics for high performance capacitors.

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