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Dielectric Performance of Polymer Nanocomposites: Matrix Free, Hairy Nanoparticle Assemblies and Amorphous Polymer-Nanoparticle Blends CHRISTOPHER GRABOWSKI, ELIZABETH OPSITNICK, HILMAR KOERNER, Air Force Research Laboratory, WPAFB, JEFFREY METH, E.I. DuPont Nemours & Co, MICHAEL BOCKSTALLER, Carnegie Mellon University, MICHAEL DURSTOCK, RICHARD VAIA, Air Force Research Laboratory, WPAFB — Over the past decade, polymer nanocomposites (PNCs) have been developed for electrical insulation and capacitor films to achieve extreme energy-power storage. The quality of nanoparticle dispersion has been shown to greatly affect dielectric performance. Nanoparticle aggregates function as defect sites and dramatically reduce dielectric strength. It is unclear, however, to what extent enhanced nanoparticle order (or perfect dispersion) can improve energy storage properties. Uniform dispersions of silica colloids (15 and 29 nm diam.) in polystyrene (PS) and polymethyl methacrylate (PMMA) have been achieved by two methods: (1) solvent-annealed, two-component, polymer-nanoparticle blends and (2) single-component matrix free, hairy nanoparticle assemblies. The dielectric strength, permittivity, and energy storage over a wide range of silica loadings (0-50% v/v) will be discussed. Our findings indicate PS NCs have comparable breakdown strength for blend and hairy nanoparticle assemblies, while at intermediate silica loadings ($\sim$ 15% v/v) PMMA grafted silica assemblies show enhanced breakdown strength compared to simple blends. Dielectric permittivity follows the Bruggeman effective medium model for all materials.

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