Electric field interactions and aggregation dynamics of ferroelectric nanoparticles in isotropic fluid suspensions

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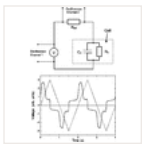
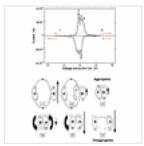
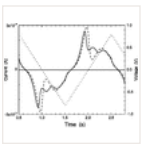
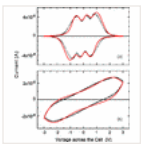
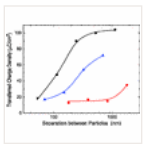
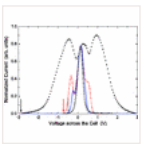
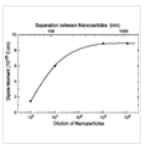
ABSTRACT

Stressed ferroelectric nanoparticles have been shown to yield unconventional properties that may open the doors to a variety of new fundamental studies and applications. For many of these new areas understanding particle-to-particle interactions will be a requirement. In this paper, the dynamics of aggregation of stressed ferroelectric nanoparticles as small as 9 nm in diameter are investigated in a nonpolar (isotropic) fluid, with the concentration of nanoparticles varying by four orders of magnitude. We also investigate the dependence on the separation distance between nanoparticles and how the field interactions between nanoparticles results in single species (i.e. dipoles) and higher-order aggregates. A theoretical model that accounts for three types of nanoparticles species, based on the Fokker–Planck equation, describes the experimental results. Prior published claims of increased aggregation with concentration and decreased aggregation with large ac fields are verified. Dipole moments for different sizes and concentrations of nanoparticles are determined; techniques to obtain an estimation of dipole moments, when the exact size and shape are unknown, are presented.

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