Abstract Submitted
for the MAR09 Meeting of
The American Physical Society

Theory of Ferroelectric Nanoparticles in Nematic Liquid Crystals[1] LENA LOPATINA, JONATHAN SELINGER, Liquid Crystal Institute, Kent State University — Many recent experiments have reported that ferroelectric nanoparticles have drastic effects on nematic liquid crystals. Low concentrations of such particles increase the isotropic-nematic transition temperature by over 10 C, and greatly increase the sensitivity of the nematic phase to applied electric fields. To understand these effects, we develop a theory for the statistical mechanics of ferroelectric nanoparticles in liquid crystals. In this theory, the key issue is the distribution of orientations for the electrostatic dipole moments of the nanoparticles. This distribution is characterized by an orientational order parameter, which interacts with the orientational order of the liquid crystals and stabilizes the nematic phase. We estimate the coupling strength and calculate the resulting enhancement in the transition temperature, in good agreement with experiments. We also predict the response to applied electric fields, showing that the Kerr effect is enhanced above the isotropic-nematic transition. These predictions apply even when the electrostatic interactions are partially screened by moderate concentrations of ions.

[1]This work was supported by NSF Grant DMR-0605889.

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Date submitted: 20 Nov 2008 Electronic form version 1.4