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Electric-field-induced pattern formation in colloidal suspensions
JAE SUNG PARK, DAVID SAINTILLAN, University of Illinois at Urbana-Champaign — We use numerical simulations to investigate the long-time dynamics and pattern formation in semi-dilute suspensions of colloidal spheres in a viscous electrolyte under a uniform electric field. Dielectrophoretic interactions between particles occur as a result of Maxwell stresses in the fluid, and the dynamics under these interactions are analyzed in the thin Debye layer limit. Simulations in large-scale suspensions in a thin gap are performed with periodic boundary conditions in the directions perpendicular to the electric field. Results show the rapid formation of finite chains in the field direction, followed by a slow coarsening process by which chains coalesce into hexagonal sheets and eventually rearrange to form mesoscale cellular structures, in agreement with recent experimental observations. The effects of suspension volume fraction, electrode spacing and field strength on this phase transition are described, and a simple explanation for the observed wave number selection is proposed based on the analysis of interactions between two identical finite-length chains.

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