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A hydrodynamic mechanism for spontaneous formation of ordered drop arrays in confined shear flow[1] SAGNIK SINGHA, Texas Tech University, MAURICIO ZURITA-GOTOR, Universidad Loyola Andalucia, MICHAEL LOEWENBERG, Yale University, KALMAN MIGLER, NIST, JERZY BLAWZDZIEWICZ, Texas Tech University — It has been experimentally demonstrated [Phys. Rev. Lett. 86, 1023 (2001)] that a drop monolayer driven by a confined shear flow in a Couette device can spontaneously arrange into a flow-oriented parallel chain microstructure. However, the hydrodynamic mechanism of this puzzling self-assembly phenomenon has so far eluded explanation. In a recent publication [Soft Matter 8, 7495 (2012)] we suggested that the observed spontaneous drop ordering may arise from hydrodynamic interparticle interactions via a far-field quadrupolar HeleShaw flow associated with drop deformation. To verify this conjecture we have developed a simple numerical-simulation model that includes the far-field HeleShaw flow quadrupoles and a near-field short-range repulsion. Our simulations show that an initially disordered particle configuration self-organizes into a system of particle chains, similar to the experimentally observed drop-chain structures. The initial stage of chain formation is fast; subsequently, microstructural defects in a partially ordered system are removed by slow annealing, leading to an array of equally spaced parallel chains with a small number of defects. The microstructure evolution is analyzed using angular and spatial order parameters and correlation functions.

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