Phase separation of block copolymers driven by oscillating particles

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The phase separation in a binary immiscible mixture has been studied extensively theoretically and experimentally. When the system is suddenly quenched below the spinodal line, the domain morphology may be an interconnected bicontinuous phase or isolated droplets, depending on the relative fraction of the two phases, and changes continuously in space and time. In order to obtain new and useful ordering structures due to its potential importance in the material engineering, some previous studies have considered the application of external perturbations (e.g., shear flows, electric field, temperature inhomogeneity, and surface) to control the domain curvature and orientaion. For example, depending on the frequency and amplitude of the oscillatory shear flow, the domain morphologies of the block copolymer system could be the lamellar structures either parallel or perpendicular to the flow direction.

In this paper, we numerically study the formation of two-dimensional order structures of phase-separating systems by introducing mobile particles in a periodically oscillating field. The oscillatory direction, and the particles in turn influence the phase-separating process due to an affinity for one of the components, resulting in the development of anisotropic structures. We find that the competition between the phase segregation and the deformation of the favored phase induced by mobile particles, can lead to continuous structures along the oscillation forcing direction and the lamellar structures perpendicular to the osillatory direction. Depending on the strength of the oscillatory fileds, we can observe highly ordered structures. To discuss how to realize highly ordered lamellar structures, we have also investigated the dependence of the morphology and the domain size on the relative concentration between two phases, the diffusion coefficient, and quench depth. Details will be discussed on the conference.