Properties of phase separation processes in binary stochastic systems with thermal diffusion and ballistic mixing

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We have considered dynamics of binary stochastic systems with thermal diffusion and ballistic mixing representing irradiation influence. Starting from the continuity equation for the concentration field we have obtained the Langevin equation describing behaviour of globally conserved quantity with thermal diffusion flux and ballistic mixing term describing fluctuating environment (atom relocation due to irradiation). Introducing fluctuations of thermal flux and a source representing regular and random atom relocations we have shown that there are two competing mechanisms of phase transitions: thermally assisted diffusion and irradiation induced atomic exchange. In our model ballistic mixing leads to atomic exchange to nearest, next and next-next neighbors of the fixed atom.

We have studied dynamics of the structure function at early stages of spinodal decomposition. It was shown that with an increase in the regular part of ballistic mixing describing nearest atomic neighbors a critical wave-vector values are decreased. An increase in the correlation radius of atomic jumps leads to decrease in the domain of the system parameters where unstable modes growth. In the framework of the mean field theory we have derived the effective Fokker-Planck equation to describe phase separation processes in systems with ballistic mixing and thermally activated diffusion. It was found that changing the composition in a binary alloy a domain of ordered phase decreases when ballistic mixing intensity and temperature increase. A reentrant behavior of the mean field order parameter was found versus the intensity of stochastic part of ballistic mixing term. Considering macroscopic approximation it was found that except ordinary phase separation processes a patterning is realized. With increase in the ballistic mixing strip patterns are realized. Phase separation processes and patterns formation are studied in details.