Nanostructured surfaces

Nanosize clusters formation at condensation from gaseous phase in overdamped stochastic reaction-Cattaneo systems

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We study statistical properties of a generalized reaction-diffusion system of reaction-Cattaneo kind allowing to describe nanosize pattern formation on a surface at condensation from gaseous phase. Our generalization takes into account physical properties of disturbance of atomic configuration related to nonzero relaxation time for the diffusion flux and fluctuation source responsible for dissipation processes. We consider this system in overdamped limit where above relaxation and stochastic mechanism are taken into account. Statistical properties of arranged islands of adsorbate and vacancies are studied by distribution functions over island sizes analysis and dependence of a characteristic size *versus* control parameters reduced to adsorption/desorption rate, interaction energy of adsorbate, nonequilibrium chemical reactions rate, diffusion flux relaxation time-scale and an intensity of corresponding fluctuations.

Pattern formation processes are studied numerically. We compare dynamics and statistical properties of islands in system with zero and nonzero relaxation time for the diffusion flux. It was found that in the last case dynamics of pattern formation is delayed and number of islands and their sizes decrease at elevated values of this time scale. Varying values of the interaction energy of adsorbate it was shown that at low temperatures the size of islands decreases down to 10% of the diffusion length depending on other system parameters. Controlling the nonequilibrium reactions rate one can manage processes of vacancy or adsorbate islands formation having sizes from one diffusion length to 10% of it. Analogous picture is observed at variation in the adsorption rate. A transition from configuration of vacancy islands toward configuration of adsorbate islands is accompanied by emergence of a microstructure relevant to spinodal decomposition. Stochastic contribution representing weak nonlinear multiplicative noise at elevated intensities is able to change a morphology of islands when spherical islands interact stochastically forming stripes. At large noise intensities one has chaotic spatial structure of the coverage.