FM14S_11996

XXI International Congress of Theoretical and Applied Mechanics
Warsaw, Poland, August 15–21, 2004

Hydrodynamics of Particle-Stabilized Thin Liquid Film

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Thermodynamic and hydrodynamic properties of thin liquid films stabilized by colloidal particles are investigated theoretically and numerically. A thermodynamic description of the film is formulated, in which the system is treated as an effective two-dimensional medium. Equilibrium equations of state were evaluated via a Monte-Carlo method for a film stabilized by a suspension of hard spheres. Our results provide basis for quantitative description of stepwise structure of films with coexisting regions of different thickness. We also evaluated the effective viscosity coefficients for two-dimensional compressional and shear flows of a film and the self and collective mobility coefficients of the stabilizing particles. The hydrodynamic calculations were performed using a multiple-reflection representation of Stokes flow between two free surfaces. In this approach, the particle-laden film is equivalent to a periodic system of spheres with a unit cell that is much smaller in the transverse direction than in the lateral direction.

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