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THE INFLUENCE OF NON-UNIFORM HEATING FROM BELOW ON THE DYNAMICS OF FLOATING DROPLETS

Abstract

The dynamics of isothermal droplets has been extensively studied at the past few decades because of it's importance in microgravity engineering. Droplets on a liquid substrate ("liquid lenses") play an important role in various branches of engineering, including microfluidics chemical engineering, environment protection, etc. The dynamics and instabilities of non-isothermal floating droplets are of a special interest. We consider a droplet of liquid 2 that floats on the layer of liquid 1, and it is in contact with the gas phase 3. To avoid the difficulties in the description of the temporal evolution of the triple line surrounding the droplet, we apply the precursor model. The interface between fluids 1 and 3 outside the droplet is replaced by an ultrathin precursor layer of fluid 2. We consider a slender droplet, i.e., the slopes of both droplet's interfaces are small. Also, we assume that the characteristic horizontal scale of the interface deformations is large as compared to the characteristic vertical size of the droplet and the substrate. That assumption allows applying the mathematical model governing the longwave dynamics of non-isothermal liquid layers that has been derived using the lubrication approximation. The evolution equations were discretized by central differences for spatial derivatives and solved using an explicit scheme. Periodic boundary conditions have been applied on the boundaries of the computational region. We perform computations for the system of fluorinert FC70 (liquid 1) and silicon oil 10 (liquid 2). This system of liquids was used in microgravity experiments. 1. We consider the evolution of the steady round droplet under the action of onedimensional temperature modulation. The non-homogeneous cooling creates a disbalance of thermocapillary stresses that leads to the redistribution of the liquids in the droplet and in the substrate: the substrate becomes thicker in the colder region and thinner in 1 the hotter region. The nonlinear growth of the deformation of the liquid substrate can lead to the rupture of the bottom layer. The rupture can be prevented with an increase of the Bond number. 2. The influence of two-dimensional temperature modulation on initially round droplet has been studied. The steady drop keeps the symmetry with respect to the axis $Y = X$ with the maximum, shifted to the region $X > L/2$. Like in the case of one-dimensional temperature modulation, the rupture can be prevented with an increase of the Bond number.