Thermocapillary effects in wavy faling liquid films.

Evgeny N. Shatskiy

Institute of Thermophysics SB RAS
Lavrentyev Ave. 1, Novosibirsk, 630090, Russia
shatskiy.itp@ngs.ru

Keywords: hydrodinamic instability, thrmocapillary structures.

ABSTRACT

Processes in liquid films are widely used in various technological systems, as well as provide a high intensity of heat and mass transfer, and a large surface of contact between the phases at low unit costs of the liquid. The study of flow instability of a liquid film, the transformation of three-dimensional waves in thermocapillary-wave structure and development of rivulet streams is of interest both from a practical point for understanding the mechanism of heat transfer, and in theoretical terms, as a basis for the construction of more accurate mathematical models of the phenomena.

As is known, two-dimensional (2D) waves in isothermal films are unstable with respect to 3D perturbations. It was established that the critical wavelength of instability with respect to transverse 3D perturbations decreases with increasing Reynolds number (Re) of the flow [1].

In the present study, an experimental study of the evolution of hydrodynamic disturbances in the thermocapillary-wave heated vertically falling water film is performed using a high-speed infrared photography and fluorescence techniques of thikness measurement. It is shown that due to the occurrence of temperature inhomogeneities on the wave front, there are additional thermocapillary forces. That forces leads to the deformation of the liquid film and formation of rivulets. We measured the distance between the three-dimensional waves and rivulets, depending on the density of heat flow. Artificial disturbances at sufficiently high heat fluxes ware found to have a significant influence on the structures and the wave flow of a liquid film. It is shown that, depending on the parameters of impinging waves to the heater, there may be different scenarios of changes in the rivulets [2].

References

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