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P25

水平基板上を濡れ拡がる液膜と微小円柱上構造物との相互作用による局所的加速現象に関する数値解析

Numerical Analysis on local Acceleration of Liquid Film Spreading on Smooth Substrate Induced by Interaction with a Single Short Pillar

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Control of the dynamic wetting and delivery of the liquid are indispensable technology under not only terrestrial but also microgravity environments for a range of industrial applications and for environmental control of on-orbit facilities. The phenomenon that liquid erodes in the gap of innumerable tiny structures (hemiwicking) has attracted researchers for such applications[1-3]. Experimental[4] and numerical[5] investigations have indicated that the interaction between a liquid film spreading on a horizontal substrate and multiple structures accelerates the fluid near the contact interface (contact line: CL) of the liquid film. In this study we focus on the effect of the height of the tiny structure on the acceleration phenomenon.

Target system is a liquid film spreading on the horizontal substrate on which a single short pillar is installed (Fig. 1).

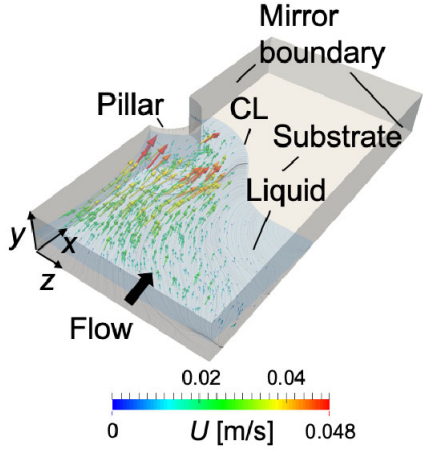

Fig. 1 Typical example of local acceleration of liquid near front edge of liquid film (contact line) spreading on smooth substrate after interaction with a cylindrical pillar.

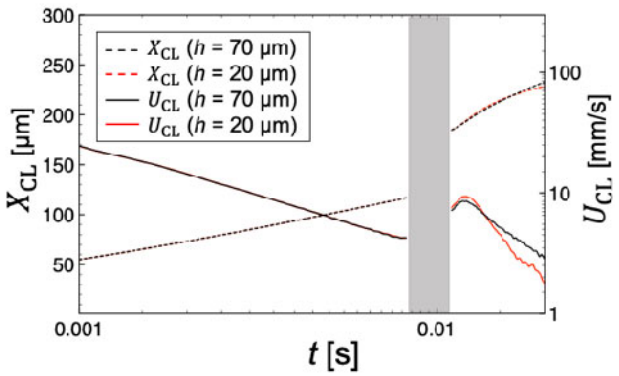

Fig. 2 Temporal variations of position (X_{CL}) and velocity (U_{CL}) of CL.

The analysis is conducted by varying the height of the pillar (outer diameter D = 50 μm) to 40, 30, 20, and 10 μm. The temporal variations of the position and the velocity of the CL on the substrate are compared in systems with different pillar heights (Fig. 2). It is indicated, in the case of short pillars, that the liquid near the CL is hardly driven, and that the damping of the velocity becomes more significant. We find that a meniscus with a small curvature radius[5] cannot be formed for a sufficiently long time to induce the acceleration of the liquid near CL when the pillar is short. We will discuss the correlation between the flow field inside the film and the CL mobility.

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