Effect of Contact Line Pinning on Maximum Spreading of Liquid Drop Impacted onto Groove-Textured Surfaces

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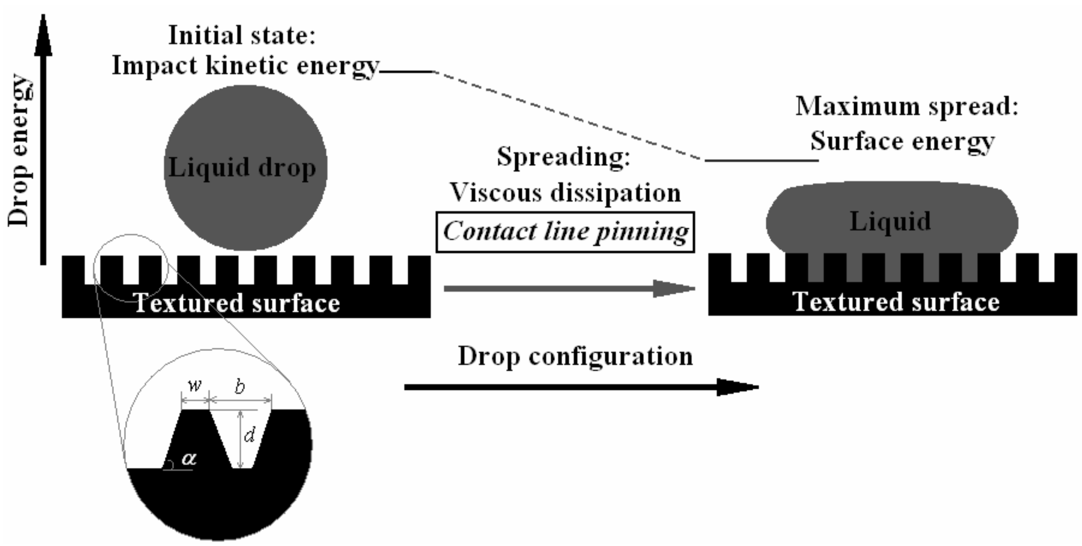
Abstract

The present work attempts to develop an understanding on the role of contact line pinning on roughness asperities of target surfaces in the maximum spreading diameter of an impacting liquid drop. Model rough (textured) surfaces of stainless steel material comprising unidirectional parallel grooves were used as the target surfaces. The impacted drop spreading in the direction perpendicular to the grooves experiences the pinning of its contact line as the drop liquid advances over the asperity posts. The highlight of the current study is the modeling of this contact line pinning as an energy loss parameter in terms of the contact angle hysteresis of liquid drop on the target surfaces, and its inclusion in the energy conservation based theoretical models of maximum spreading diameter. Experimental measurements of maximum spreading diameter of impacting drops of water and ethanol-water mixture with varying Weber number (~ 2 to 80) were collected on three groove-textured surfaces with different groove depths and pillar angles. The model predictions clearly capture the experimental observation of a reduction in maximum drop spreading in the direction perpendicular to the grooves compared to that on smooth surface and its trend with *We* for all the drop impact cases studied here. A comparison of the model predictions of maximum spreading diameter of impacting liquid drop perpendicular to the grooves with the experimental data yielded satisfactory quantitative agreement with a maximum error of ~14%. Further, in the limiting case of zero roughness, the model reduces to the one for maximum drop spreading during drop impact on smooth surfaces reported by Ukiwe and Kwok.



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