Droplet Scanning Microscopy

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Abstract

Sliding drops on solid surfaces experience lateral adhesion owing to capillary forces. Local capillary forces of drops are of interest for fundamental wetting science and industrial applications such as self-cleaning surfaces or paint spraying. In particular, functional coatings can be stained on purpose or unintentionally as a defect during a coating deposition process. Therefore, techniques are required to map capillary forces over large areas. Attempts have been made by measuring locally the vertical adhesion forces [1] or the roll-off angles. However, both techniques are time-consuming and cannot examine a relatively large area at once.

In order to overcome these limitations, we have built a setup that allows us to measure the sliding force of drops over area of 5x2 cm^2, with different hydrophobicities, within 1-5 minutes. The drop of 15 µL volume is immobilized by a metal ring, which is attached to a glass capillary. While the drop is sliding over the surface, the lateral deflection of the glass capillary, which is proportional to the sliding force [2], has been recorded in form of a video. The obtained deflection of the glass capillary is multiplied with its spring constant which results in the lateral sliding force. Subsequently, we plot the force values for the respective positions in form of 2D-Heat map. With this technique, we mapped heterogeneous hydrophobic surfaces made from PFOTS and OTS (Figure 1(a)). This scanning technique allows studying the lateral distribution of different hydrophobicities. As our contribution, we will discuss the setup and the origin of forces while water drops are drawn over different hydrophobically stained areas. Our initial experiments reveal that we can detect stained areas smaller than $1/4^{th}$ fraction of the drop diameter.

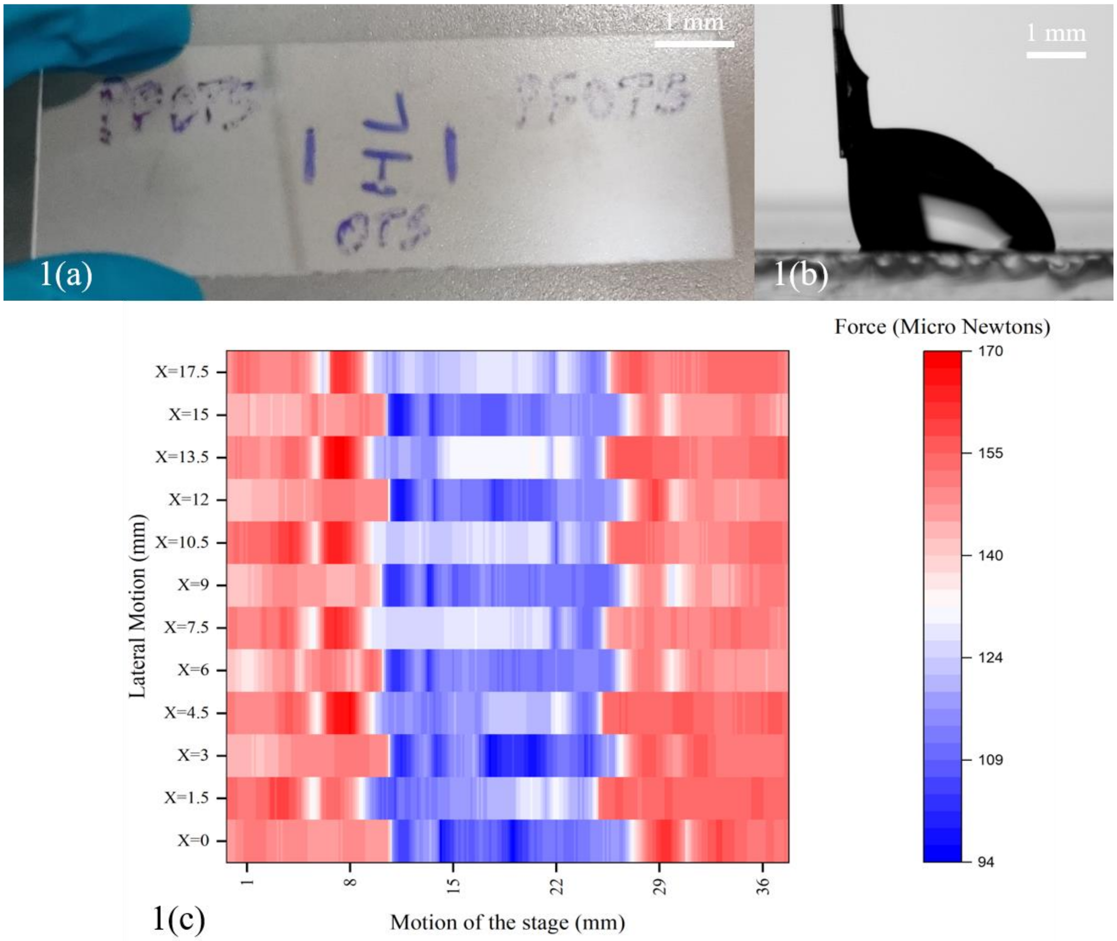

Fig. 1(a) Model inhomogeneous surface, 1(b) Photographic visual of a sliding drop, 1(c) 2D force map for the sample as shown in 1(a).

References

[1] V. Liimatainen *et al.*, "Mapping microscale wetting variations on biological and synthetic water-repellent surfaces," *Nat Commun*, vol. 8, no. 1, p. 1798, Nov 27 2017, doi: 10.1038/s41467-017-01510-7.

[2] N. Gao *et al.*, "How drops start sliding over solid surfaces," (in English), *Nat Phys*, vol. 14, no. 2, pp. 191-+, Feb 2018, doi: 10.1038/Nphys4305.