Motion of droplets on flat or structured solid surfaces: rolling or sliding?

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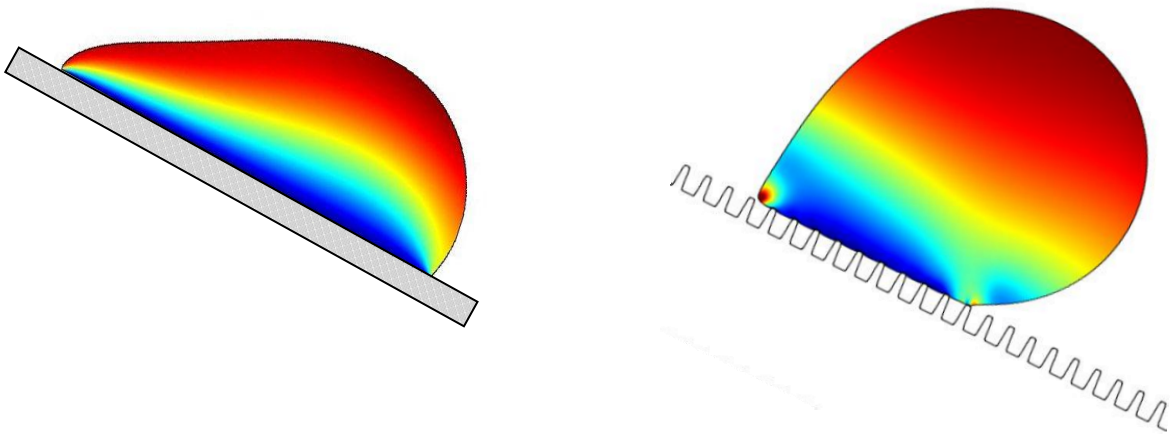
We investigate the motion of a two-dimensional droplet on an inclined surface, under the action of gravity using a sharp interface continuum-level model. The liquid/gas and the liquid/solid interfaces are treated in a unified context (one equation for both interfaces) by employing an interfacial stress balance augmented with a disjoining pressure term which accounts for the micro-scale liquid/solid interactions [1]. The main advantage of this method is that it avoids the implementation of any boundary condition at the contact line; the contact angle emerges implicitly as the result of the combined action of the disjoining and the capillary pressure; no predefinition of the cardinality and the position of moving contact lines is required, contrary to previous computational approaches. We perform a thorough parametric study and investigate the effect of geometrical characteristics of the solid surface, inclination angle, droplet size on the contact angle hysteresis as well as the critical conditions for rolling motion of the droplet.



(a) (b)

Figure: Droplet sliding on a inclined (a) flat and (b) structured surface

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References

[1] Chamakos N. T., Kavousanakis M. E., and Papathanasiou A. G., "Neither Lippmann nor Young: Enabling Electrowetting Modeling on Structured Dielectric Surfaces", Langmuir, 2014, 30 (16), 4662–4670