

Hysteresis and Dynamics of the Contact Line

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Many recent experiments on wetting dynamics on solid substrates have been analysed in the framework of the so-called molecular-kinetic model first proposed by Blake about forty years ago [1]. In this MK approach, the dynamics of the contact line is controlled by thermally activated jumps. The main parameters are (i) the size λ of the jumps, of the order of the mean distance between adsorption sites on the substrate (ii) the activation energy E^* .

If E^* is large compared to the thermal energy $k_B T$, the hopping frequency is small, which means that the contact line is trapped as long as it is not submitted to a force per unit length of the order of E^*/λ^2 . In other words, *the contact line show some hysteresis*. The fact that the wetting hysteresis can be of kinetic nature has been recognized by Blake himself, but, strangely enough, no attempts have been done to correlate hysteresis and dynamics.

In order to clarify this point, we have performed systematic experiments on a simple and well controlled system [2]. We use liquid hydrogen on cesium substrate. This unusual system has the great advantage of being free from contamination, which allows us to perform repeated experiments for very low velocities of the contact line. We have measured the dynamics of the contact line on several cesium substrates at low capillary number ($Ca < 10^{-5}$). We find that the dynamics is thermally activated. The order of magnitude of both λ and E^* show that the activated jumps are likely to be related to the roughness of the substrate. Finally, for all substrates, we find that the activation energy is of the order of the hysteresis (fig. 1).

Thus, in this simple system, a single physical mechanism – the pinning of the contact line on mesoscopic heterogeneities – is likely to control *both* the hysteresis and the dynamics of the contact line at low velocity. We believe that such an interpretation can be relevant also for simple room-temperature systems.

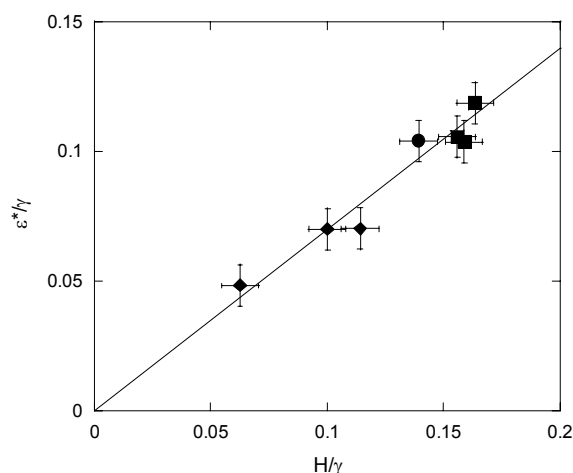


Fig. 1 : normalized activation energy vs normalized hysteresis for H_2/Cs systems

References

- [1] T.D. Blake, J. Colloid Interface Sci. **299**, 1, 2006 and ref. therein.
- [2] E. Rolley and C. Guthmann, to be published in Phys. Rev. Lett. 2007.