

Wetting at the nanometer scale: molecular desorption induced by a moving contact line

Sylvain Franiatte, Philippe Tordjeman, Thierry Ondarçuhu

Institut de Mécanique des Fluides de Toulouse, IMFT, 2 allée du Professeur Camille Soula, 31400 Toulouse
 thierry.ondarcuhu@imft.fr

It is well established that the wetting properties of a surface by a liquid largely depend on the topographic and chemical nature of the substrate. In particular, the contact line motion is extremely sensitive to the presence of surface defects down to the nanometer scale. Here, we address the fundamental question of a possible action of the contact line on the surface at molecular scale.

We have shown recently that Atomic force microscopy (AFM) is a unique tool to study the dynamics of contact line or nanomeniscus down to the nanometer scale. The measurement of the capillary force exerted by the liquid on a nanoneedle carved at the apex of the AFM tip allows the monitoring of minute changes of surface wettability of the tip. In the present study, we continuously dip and withdraw the tip from the liquid a large number of times. We demonstrate that this leads to a change of the wettability of the surface chemistry while keeping the topography intact (see figure). Since the initial surface can be recovered when the tip is left in air, we interpret this behavior as a desorption of airborne contaminants by the liquid. Interestingly, using specific experiments, we unambiguously demonstrate that the desorption of physically sorbed molecules is induced at the contact line. The mechanism of molecules desorption is directly determined by the capillary force exerted at the contact line on the molecules. We also emphasize the potential of AFM to clearly decorelate the effects of topographical and chemical defects and monitor, with a subsecond time resolution, the dynamics of molecules adsorption on a surface.

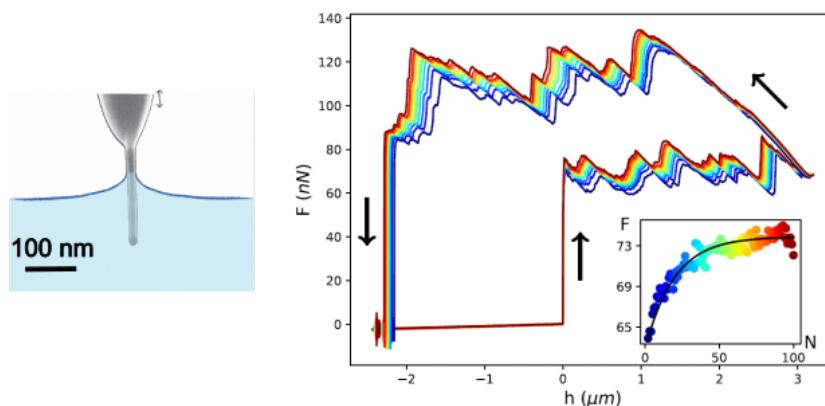


Figure 1. Left: sketch of the experiment; right: capillary force F measured as a function of the immersion depth h for a nanoneedle dipped in (increasing h) and withdrawn from (decreasing h) a liquid bath, for successive dipping cycles (from blue to red); inset: evolution of the force associated with a given peak of the force curve as a function of the number N of cycles.

References

1. S. FRANIATTE, P. TORDJEMAN, T. ONDARÇUHU, *Phys. Rev. Lett.*, **127**, 065501 (2021).
2. S. FRANIATTE, P. TORDJEMAN, T. ONDARÇUHU, *Langmuir*, **38**, 2614-2625 (2022).