Static and Dynamic Properties of Nanomenisci

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The study of fluid properties at the nanometer scale is an emerging field. Modern techniques of microscopy provide us now the opportunity to probe the physical properties of liquid interfaces at the nanometer scale and to answer fundamental questions raised for a long time [1]. An open issue concerns in particular the structure and the dynamic of meniscus near the contact line.

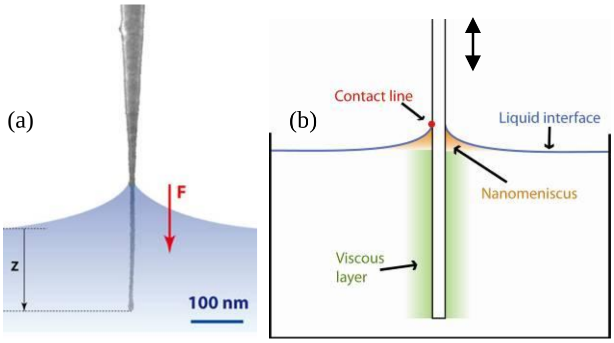

Figure 1: (a) Sketch of the experiment dipping nanosized carbon tip into a liquid interface.
(b) Different contributions of dissipation during oscillation into the liquid.

The method we used is to dip an unconventional tip (carbon nanotube, nanocylinder with diameter ranging from 15 nm to 55 nm) of an atomic force microscope at the free interface of a liquid bath or droplet (Fig. 1a) [2-3]. We access dynamic processes using the oscillating AFM frequency modulation mode (FM-AFM) implemented on a Bruker Picoforce microscope equipped with a phase lock loop module (EasyPLL – Nanosurf). Thus, we are able to uncouple conservative information about the effective stiffness of the meniscus and dissipative process in the nanomeniscus or at the contact line.

Systematic studies are performed for different fluids and tips in order to have a comprehensive picture of static and dynamic properties of nanomeniscus and fundamental mechanisms at the contact line, controlling spreading dynamics (Fig. 1b).

With silica nanocylinder tips we observe that the dynamic meniscus stiffness is systematically larger than the static one, which may result from a new characteristic size (thickness of the viscous layer $\delta \approx 20$ µm) (Fig. 1b). The dissipative signal gives informations on the viscous layer around the cylinder.

We also present preliminary results with carbon tips which allow us to investigate dissipation at the contact line and single defect pinning, mechanism which is largely unknown.

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References

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