The study of the behaviour of liquids at nanometer scale is an emerging area of science. Many questions remain unanswered due to the lack of physical models coupling macroscopic hydrodynamics to molecular processes. In particular, the structure and dynamics of the contact line (the edge of a droplet) are poorly understood while they condition the physics of wetting. Experimentally, it is necessary to overcome the lack of experimental techniques allowing to probe liquids at nanometer scale.

We showed recently that atomic force microscopy (AFM), used in non conventional conditions, allow to address these issues and to give quantitative information on the shape of the liquid interface and on the dissipation processes in the vicinity of the contact line.

The aim of this thesis is the experimental and theoretical study of nanohydrodynamics of viscous liquids. The PhD student will in particular investigate wetting processes at nanometer scale using an AFM. Two approaches will be used:

- Direct imaging of droplets by AFM coupled with numerical modelling of tip – liquid interaction (fig. 1).
- Measurement of the mechanical properties of nanomeniscus obtained by immersion in a liquid interface of an AFM tip terminated by a nanoneedle or nanotube (fig. 2).

These original experiments will allow a systematic study of the elementary mechanisms of spreading of droplets at molecular scale.

This experimental work will benefit from the development of multiscale physical modelling of wetting.
This multidisciplinary thesis will take place in two labs (CEMES and IMFT) which have state-of-the-art equipment in scanning probe microscopy as well as a recognized expertise in numerical modeling.

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Recent publications:

“Nanoscale Deformation of a Liquid Surface”
“Contact angle hysteresis at the nanometer scale”
“Multiscale deformation of a liquid surface in interaction with a nanoprobe”
“Numerical simulation of spreading drops”
“Writing with liquid using a nanodispenser: spreading dynamics at the sub-micron scale”
   L. Fabié, T. Ondarçuhu, Soft Matter 8 (2012) 4995-5001
“Capillary forces during liquid nanodispensing”

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