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NANO-OPTOMECHAFLUIDICS: PROBING NANOFLUIDICS IN EXTREME CONDITIONS

Nano-optomechanical systems have recently emerged as ultra-sensitive and versatile transducers. These systems consist of nanometer-sized mechanical resonators whose position is measured using a coherent nano-optical probe, with a very high sensitivity. However, to date, nano-optomechanical systems have remained weakly considered in the context of fluidics applications: The massive dissipation of the mechanical energy in dense media result in the suppression of the resonant behavior of the mechanical device, which compromises the sensing potential.

Recently, we have developed an original approach, where the liquid medium of interest is inserted *within* the optomechanical transducer, thereby fully preserving the resonant sensing capabilities. The purpose of the present internship is to integrate this “nano-optomechafluidics” measurement apparatus to an experimental environment enabling the exploration of fluidics phenomena in unprecedented conditions (humidity, temperature and spatial confinement). The established experimental setup will serve for a) demonstrating ultra-sensitive viscometry (notably using rare solutions e.g. ion liquids), b) explore the viscosity properties of supercooled liquids and c) measure the dynamics of evaporation of nanodroplets.

This work can be extended in the frame of a PhD jointly supervised by Pr. Frédéric Caupin and Dr. P. Verlot, notably with the perspective of controlling nanomechanical motion by addressing the internal state of active molecules being confined in the nanomechanical channel and extending the capabilities of the system e.g. using magnetic fluids for magnetic imaging applications.

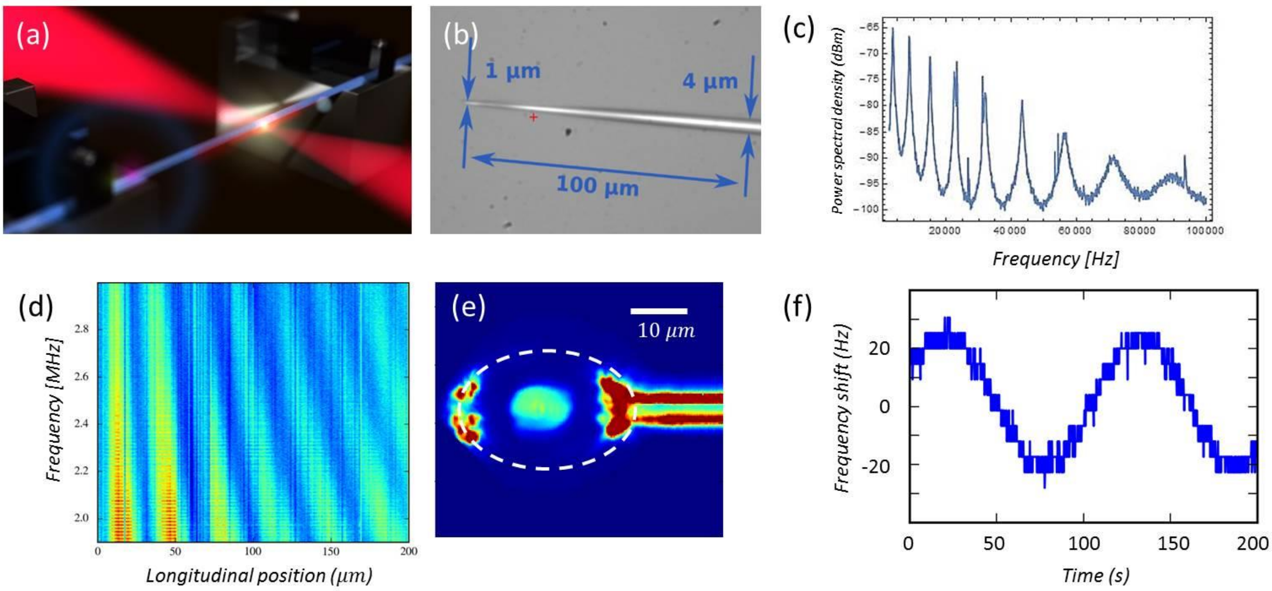

Figure 1 Nano-optomécafluidique avec des capillaires vibrants. (a) Nano-optomechafluidics concept. A focused laser beam is used to probe the nanomechanical motion of a suspended nano-capillary resonator. (b) Optical micrograph showing a single-ended nano-optomechanical capillary. (c) Brownian motion spectrum. (d) Diagram representing the optomechanical spectrum as a function of the probe beam longitudinal position. The high spatial periodicity enables very accurate sampling of the species circulating inside the channel. (e) Micrograph showing a micro-droplet obtained using coherent backscattering imaging. (f) Real-time evolution of the mechanical resonance frequency of the nanochannel as a micro-droplet being migrating along the external walls of the capillary.