



ID de Contribution: 201

Type: Contribution orale

Ultra-high frequency rheology of liquids at the micron scale

mercredi 5 juillet 2023 15:45 (15 minutes)

We employ optomechanical transduction techniques with silicon disk resonators to measure the rheological properties of liquids in the ultra-high frequency range. Backed by analytical and numerical models, our measurements give access to the liquid's viscosity, density, and compressibility, measured locally within a micron scale volume. Thanks to careful approximations of Navier-Stokes equations permitted by the disk geometry, we notably derive closed-formed expressions for the mechanical frequency shift and quality factor of a disk immersed in liquid [1], transforming it into a calibrated rheometer. As this rheometer covers the frequency range from 200 MHz to 3 GHz, the measured fluid-structure interactions show pronounced compressibility effects in water, and confirm that this liquid remains Newtonian in this range. In contrast, 1-decanol (a monohydric alcohol) exhibits a non-Newtonian behavior, with a frequency-dependent viscosity associated with relaxation times that we reveal experimentally. Our work demonstrates the potential of immersed miniature disk resonators to probe the ultra-high frequency rheological properties of a liquid at the micron scale.

References

[1] H. Neshasteh, M. Ravaro, I. Favero, "Fluid-structure model for disks vibrating at ultra-high frequency in a compressible viscous fluid", To appear in Phys. Fluids, (2023).

Affiliation de l'auteur principal

Matériaux et Phénomènes Quantiques, Université Paris Cité, CNRS-UMR 7162, 75013 Paris, France

Auteurs principaux: M. NESHASTEHE, Hamidreza (Matériaux et Phénomènes Quantiques, Université Paris Cité, CNRS-UMR 7162, 75013 Paris, France); Dr RAVARO, Marco (Matériaux et Phénomènes Quantiques, Université Paris Cité, CNRS-UMR 7162, 75013 Paris, France); Dr HENTZ, Sébastien (Université Grenoble Alpes, CEA, LETI, 38000, Grenoble, France); Dr JOURDAN, Guillaume (Université Grenoble Alpes, CEA, LETI, 38000, Grenoble, France); FAVERO, Ivan (CNRS, Université Paris Cité); FAVERO, Ivan

Orateur: FAVERO, Ivan (CNRS, Université Paris Cité)

Classification de Session: Mini-colloques: MC24 Bicentenaire des équations de Navier-Stokes

Classification de thématique: MC24 Bicentenaire des équations de Navier-Stokes