



**HAL**  
open science

# When liquids meet solids: An amazing microscale frontier that may govern the macroscopic rheological response

Laurence Noirez

► **To cite this version:**

Laurence Noirez. When liquids meet solids: An amazing microscale frontier that may govern the macroscopic rheological response. ÖGR Meeting 2024 - 3rd annual conference of the austrian society for rheology, Oct 2024, Vienne, Austria. hal-04770973

**HAL Id: hal-04770973**

**<https://hal.science/hal-04770973v1>**

Submitted on 7 Nov 2024

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## WHEN LIQUIDS MEET SOLIDS: AN AMAZING MICROSCALE FRONTIER THAT MAY GOVERN THE MACROSCOPIC RHEOLOGICAL RESPONSE

LAURENCE NOIREZ

Laboratoire Léon Brillouin (CEA-CNRS), Université Paris-Saclay, CEA-Saclay, France



At the liquid-surface interface, the interfacial force field modifies the liquid dynamics and introduces a local thermodynamic state. The interfacial energy is typically responsible for the change in internal pressure, in transition temperatures, or for liquid-liquid phase separation in confined dimensions even when the miscibility is complete. This transition zone where liquid-liquid and liquid-solid interactions compete is intensively studied and still puzzling. The contribution of non-extensive parameters (interactions with the surface, dimensions, etc.) becomes non-negligible revealing liquid properties that are not those "commonly accepted" at macroscopic scale. This is typically one of the reasons of success of emergent topics like the microfluidics now established as a discipline in its own right. What about rheology? A recent breakthrough discovery was the observation of a solid-like response ( $G' \gg G''$ ) in mesoscopic fluids when the interaction forces between the substrate and the fluid are taken into account. Molten polymers, molecular glass formers, simple or complex liquids, blood plasma [1], respond elastically at the submillimeter scale and do not flow as usually described. As a result, the viscoelastic behavior cannot be considered as universal and as the substrate is approached, another behavior is identified, signature of a dynamic (vibratory) coupling that becomes possible between the solid and liquid states. Thus, similar to external fields such as electric, magnetic, or flow fields, the vicinity of a solid surface can preclude the liquid molecules from relaxing to equilibrium, pointing out the difficulty of defining universal scale-independent properties of liquids [2]. The interface can definitely no longer be considered as a simple means of limiting the propagation of a fluid [3]...

1. U. Windberger, P. Baroni, L. Noirez, *Capillary-size flow of human blood plasma: Revealing hidden elasticity and scale dependence*, *Biomed Mater Res A*. 2022 110(2):298. doi: 10.1002/jbm.a.37286.
2. A. Zaccone, L. Noirez, *Universal  $G' \sim L^{-3}$  Law for the Low-Frequency Shear Modulus of Confined Liquids*, *J. Phys. Chem. Lett.* 2021, 12, 1, 650.
3. *Theory of Liquids, From Excitations to Thermodynamics*, K. Trachenko, Cambridge Uni. Press 2023 – DOI: 10.1017/9781009355483.