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Discovery of static shear-elasticity in liquids & melts

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On the basis of a Maxwell gas model (1867), it has long been suspected that liquids and polymer melts exhibit (shear) elasticity at sufficiently high solicitation frequencies (MHz or GHz) only. Recent experimental improvements indicate that liquids exhibit also shear elasticity at very low frequency (0.1 to 10Hz). This finding is of utmost importance, since it means that liquids are no fully viscous, but possess a weak but finite elastic threshold below which they are solids. The elastic property has been identified at sub-millimeter scale, both on simple liquids and complex fluids (polymer melts, molecular glass formers, Van der Waals liquids, ionic liquids, H-bond liquids) pointing out the generic characteristic of this neglected property that invalidates the single molecular approach of the viscoelasticity. We present the first experiments identifying static shear elasticity in the bulk from unentangled to entangled polymer melts. In particular, we show how the low frequency shear elasticity and the usual viscoelastic response are related. The low frequency shear elasticity involves collective processes and has profound implications on how the melt flows, on flow and surface instabilities, thermodynamics, fluidic transport mechanisms enables to foresee new effects as the cold production or the spectacular conversion of a liquid melt in a strain-driven optical harmonic oscillator.

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