The striking interfacial shear rheology of fatty acid/alcohol Langmuir monolayers

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Langmuir monolayers are monomolecular-depth films formed by insoluble surfactants on fluid-fluid interfaces. Monolayers of long chain fatty acids, fatty esters, or fatty alcohols are among the simplest insoluble surfactants, and therefore have been extensively studied in the last two decades. In most cases the focus has been on the study of the equilibrium behavior through the so-called surface pressure isotherms, Π vs. Γ, where Π is the difference between the surface tension of water and that of the monolayer, and Γ is the surfactant surface concentration. The study of the isotherms at different temperatures and for different chain lengths has pointed out a very rich phase diagram that allows for the study of different phase transitions upon changes of Γ or temperature [1].

Much is known about the structural properties of these monolayers through experimental techniques such as grazing incidence X-ray diffraction, fluorescence microscopy or Brewster angle microscopy. On the contrary, much less is known about its dynamics (rheology, diffusion) [2].

Recently we have reported on a new design of the Interfacial Shear Rheometer [3], based in magnetic tweezers (see Fig. 1), that extends the range of application of this technique to interfacial dynamic moduli down to 10^{-9} N/m. Moreover, it allows one to span eight orders of magnitude in interfacial dynamic moduli by playing with the probe characteristics and the optical system magnification.

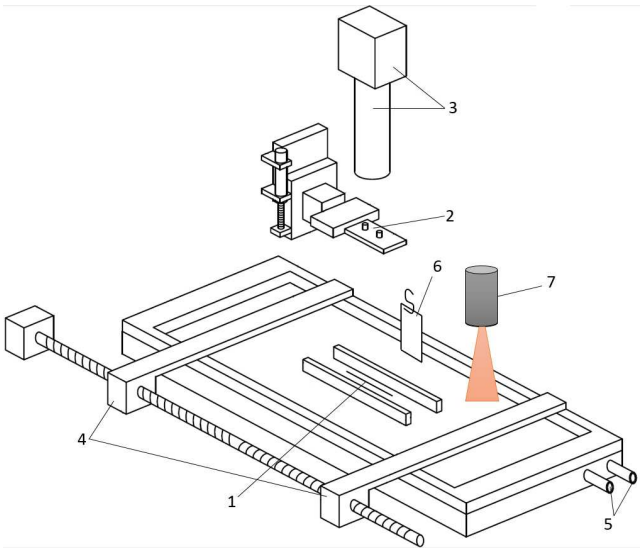

Figure 1: Schematics of the interfacial shear rheometer comprising the following elements: (1) magnetic probe, (2) magnetic tweezers, (3) optical inspection system, (4) mobile barriers, (5) thermostatic bath, (6) surface pressure sensor, and (7) infrared sensor.

We will briefly report on the new rheometer design, describing the magnetic tweezers and showing some aspects of its fundamentals. Then we will show the results obtained through the application of this new ISR to study the rheology of fatty acid and alcohol Langmuir monolayers. In particular, we will show how the phase transitions of these 2-D systems can be clearly observed on the rheological measurements, as can be seen in Fig. 2, yielding information about the viscoelastic character of each phase and the phase transition order.

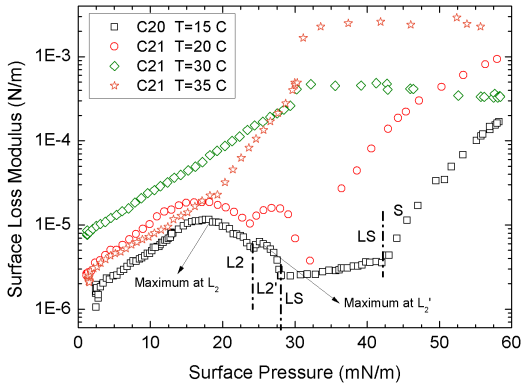

Figure 2: Surface loss moduli versus surface pressure for different fatty acids and temperatures.

Finally, we will focus on the rheology of the untilted S and LS phases, and we will confirm, by means of quasi-isobaric temperature sweeps, the striking thermal behavior of the viscosity of the LS phase that increases upon increasing temperature.

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[2] C. Alonso *et al.*, Phys. Rev. E **69**, 021602 (2004).

[3] J. Tajuelo *et al.*, J. Rheo. **60** (2006).