Interfacial Shear Rheology: Principles, Experimental techniques and Some Applications.

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Interfaces appear everywhere in nature separating media or tissues with different constituents, properties, functions, and length scales. Examples of such interfaces are the cell membrane, which is essentially a phospholipid bilayer, the tear film external layer, or dividing surfaces appearing in industrial products such as emulsions, foams, etc.

Fluid-fluid interfaces allow for the preferential adsorption of chemical species, which may modify the physico-chemical properties of the interface. Such modifications are directly related to the interfacial micro-structure and the physico-chemical interactions between the different adsorbed species.

Changes in the surface mechanical properties (rheology) are crucial for the functionality of many industrial processes because they govern crucial aspects such as emulsion or foam stability. Unfortunately, experimental studies of interfacial rheology are difficult mainly due to two different aspects: i) to have a clear understanding of the results it is necessary to perturb the interface using a pure deformation mode, but this is not always easily accomplished in experiments, and ii) a probe at a planar interface feels the drag from both the interface and the bulk fluid phases, such that specific data analysis schemes have to be developed to decouple the interfacial and subphase contributions and extract the interfacial mechanical properties.

In this talk I will give a general description of interfacial rheology by: i) introducing the mathematical representation of interfacial rheological properties, ii) describing in detail the most recent developments in experimental techniques [1, 2, 3] and data analysis schemes [4] in interfacial shear rheology, and iii) presenting the application of such techniques to the study of the two-dimensional melting of fatty acid Langmuir monolayers.

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[1] J. Tajuelo, J.M. Pastor, F. Martínez-Pedrero, M. Vázquez, F. Ortega, R.G. Rubio, and M.A. Rubio, *Magnetic microwire probes for the magnetic rod interfacial stress rheometer*, Langmuir, **31**, 1410 (2015).

[2] J. Tajuelo, J.M. Pastor, and M.A. Rubio, *A magnetic rod interfacial shear rheometer driven by a mobile magnetic trap*. J. Rheol. **60**, 1095 (2016).

[3] Y. Tein, B.R. Thompson, C. Majkrzak, B. Maranville, D. Renggli, J. Vermant, and N.J. Wagner, *Instrument for measurement of interfacial structure–property relationships with decoupled interfacial shear and dilatational flow:"Quadrotrough"*, Rev. Sci. Inst. **93** 093903 (2022).

[4] P. Sánchez-Puga, J. Tajuelo, J. M. Pastor, and M.A. Rubio, *Flow field-based data analysis in interfacial shear rheometry*, Adv. Coll. Interf. Sci. **288**, 102332 (2021).