Rheology of complex fluid-fluid interfaces

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Interfaces between two fluids can become structured as surface active materials accumulate, and display a structure whose response to deformations entails a surface rheological responses. Surface rheology enters many problems of materials design and engineering, as a boundary condition to fluid mechanical problems. Interfacial rheology is relevant in areas as diverse as oil field engineering, food science and technology, polymer engineering and there are several biomedical applications.

Unlike bulk fluids, interfaces are however compressible and can change their composition by exchange with the surrounding bulk phases. This entails that engineering the response of complex fluid-fluid interfaces on the one hand necessitates a more elaborate characterization and description of the response, but with a more positive outlook on life one can argue that there are several ways to engineer the interface to impart stability against a hydrodynamic destabilization. We will review the measurement strategies and devices to be used.

For monolayers, selected applications will include the stability of lung surfactant replacements[1] and engineering the response of particle laden interfaces exploiting shape our particle roughness[2-4]. The rheological properties and structure of non-spherical particles will be addressed.

We will also address a challenge where we try to understand the rheological properties of minimal model biomembranes. Existing methods to fabricate free-standing model membranes currently have significant limitations. Bilayer sizes are often tens of micrometers, decoupling curvature or substrate effects, orthogonal control over tension, and solvent exchange combined with microscopy techniques is not possible, which restricts the studies that can be performed. Here, we describe a versatile platform to generate free standing, planar, phospholipid bilayers with millimeter scale areas, with some first steps in membrane rheology[5].

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