Interfacial and bulk rheological properties of a thermoresponsive fatty acid assembly

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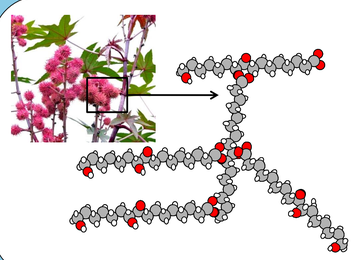
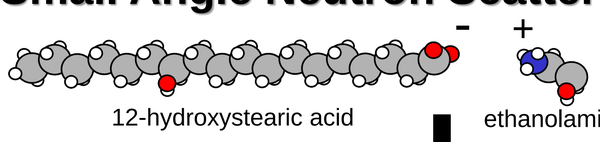
Background & Objectives



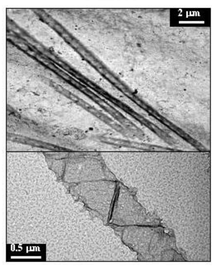
Fatty acids are surfactants of particular interest since they can be extracted from agricultural resources. However, long-chain fatty acids are generally insoluble in water at room temperature. Here, we dispersed the 12-hydroxy stearic acid using ethanolamine as counter-ion. One obtains self-assembled multilayer tubes. Those tubes have a temperature tunable diameter and melt into micelles at high temperature. These tubes can adsorb at the air/water interface and the structure is thermoresponsive at the interface. The aim of this work is to determine both the rheological properties of tubes in bulk and at the air/water interface with temperature in order to establish the links between the fatty acids supramolecular arrangements (in bulk and at interface) and the rheological properties, as a function of the temperature.

Bulk studies: Rheological properties of tubes in bulk?

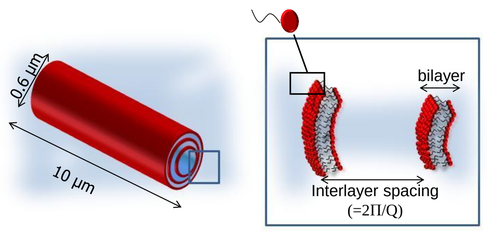
Small Angle Neutron Scattering study

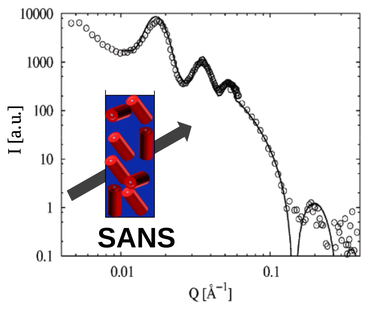


TEM

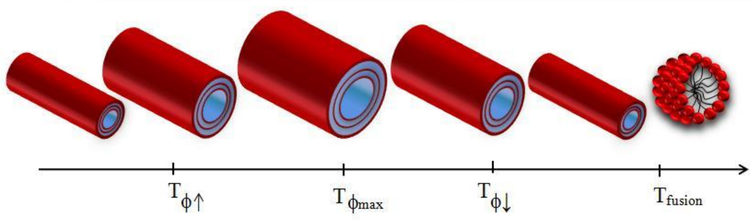


Self-assembled multilamellar tubes

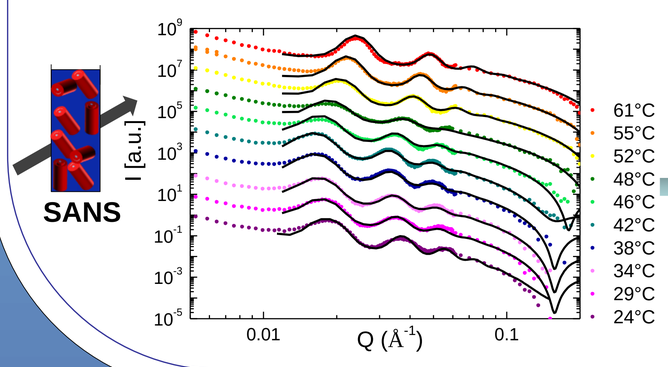


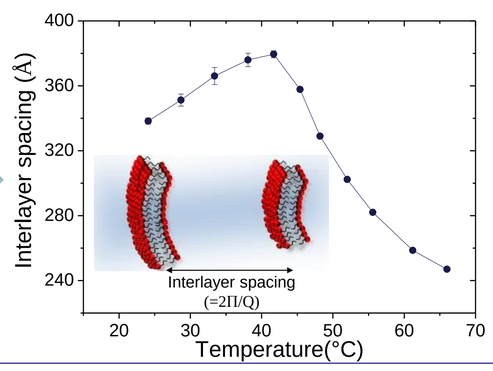


Evolution of the tube diameter as a function of the temperature



Thermoresponsive supramolecular assembly: transition between tubes and micelles





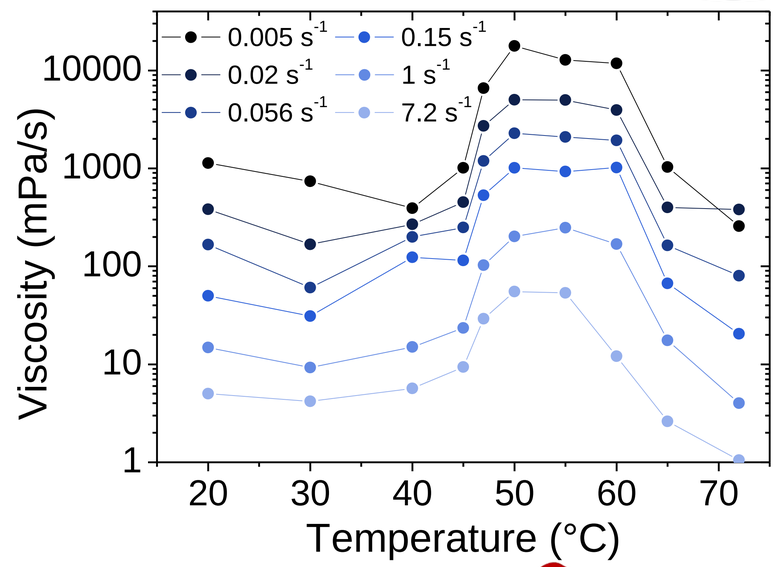
Interlayer spacing is tuned by the temperature.

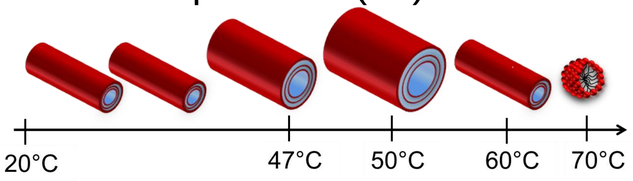
Rheological study

Viscosity measurements with temperature: Couette experiments

(Steady-shear measurements & gap of 1,1315 mm)

Solutions of tubes are very shear-thinning at all temperatures!

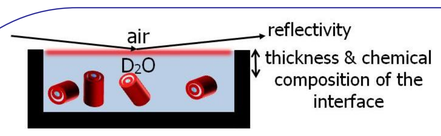


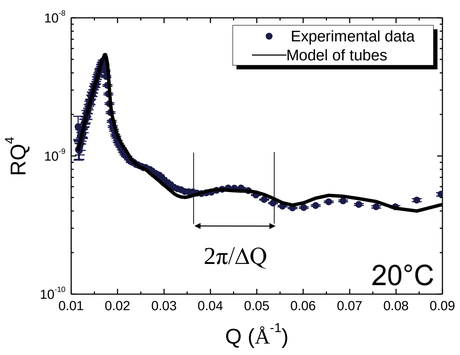


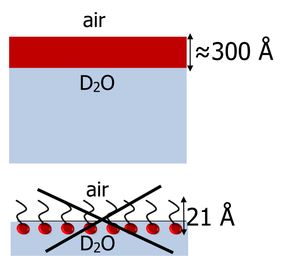
The viscosity of the tubes in bulk depends on the temperature and it is linked to the tubes structure (tubes diameter)!

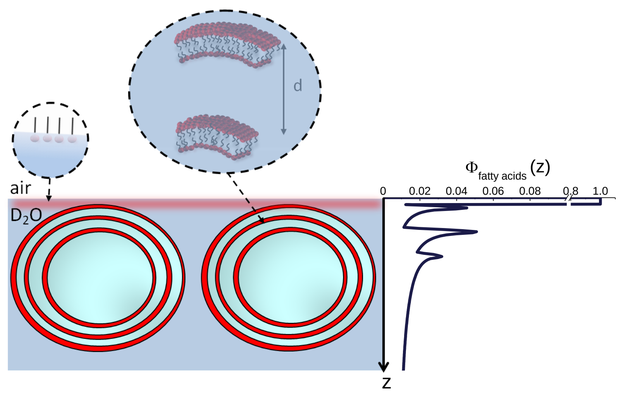
Interfacial studies: Rheological properties of tubes at the air/water interface?

Neutron Reflectivity study

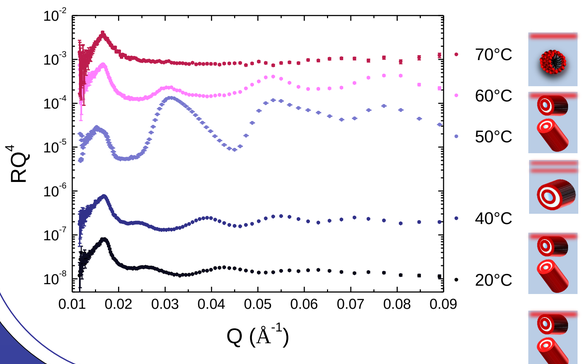


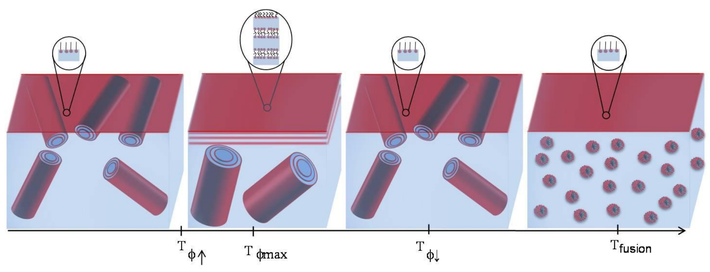






Adsorption of tubes at the interface below a fatty acid monolayer!

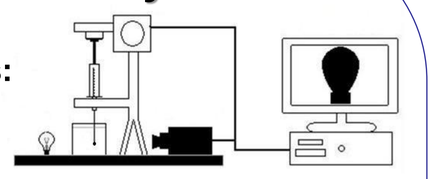




Tubes structure is thermoresponsive at the interface!

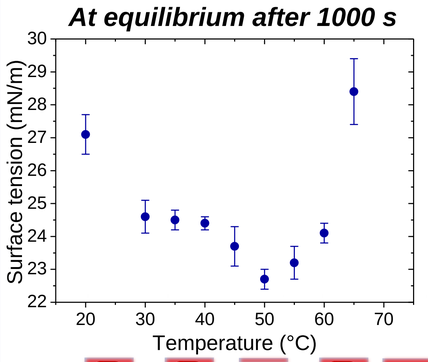
Rheological study

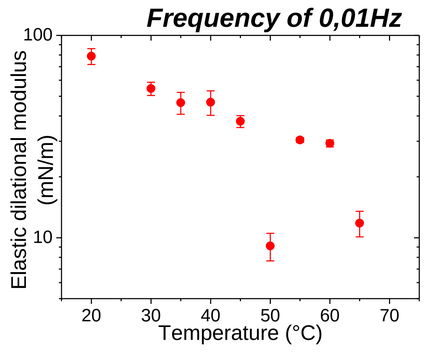
Tensiometry measurements: pendant drop method



Oscillation amplitude of 5% & Frequency of 0,01Hz

At equilibrium after 1000 s





The dilational interfacial viscoelastic moduli depend on the temperature and it is linked to the structure at the interface!

Conclusion

Rheological properties of tubes in bulk and at the interface are easily temperature tunable & Link between the tubes structure as a function of the temperature with their rheological properties

Link between microscopic scale (tubes structure) and macroscopic scale (rheological properties)

References

Fameau A.L. et al., J. Colloid Interface Science. **2010**, *241*, 38.
Fameau A.L. et al., J. Phys. Chem B. **2011**, *115*, 9033.
Fameau A.L. et al., J. Colloid Interface Science, **2011**, *362*, 397.
Fameau A.L. et al., Angewandte Chemie International Edition, **2011**, *50*, 8264.