Multilayer assembly of polymers on liquid interfaces for encapsulation

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Microencapsulation offers a solution to protect, transport and deliver active substances. The efficiency of microcapsules depends on their thickness and mechanical properties. The goal of our study is to produce model capsules with controlled mechanical properties.

We developed a microfluidic method to produce capsules based on layer-by-layer assembly of polymers directly on oil droplets and to study their deformation in constrictions. First, the droplets are rinsed with different solutions to build the membrane. Then we use an extensional flow to apply a viscous stress on the capsules to probe the mechanical properties of the membrane.

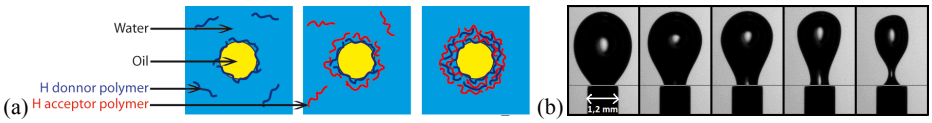

Figure: (a) Schematic construction of the microshell, on an oil droplet in polymer solutions..
(b) Steps of the compression of an air bubble covered by three layers of polymers.

In parallel we perform surface rheological measurements to characterize the shear and compression properties of the membranes assembled in model geometry. We show that the mechanical properties of the capsules depend on the type and strength of the interactions involved between the polymer layers [1]. Using an interplay of hydrogen bond and hydrophobic interactions we obtain a wide range of behaviours, from purely viscous to viscoelastic, where the elastic modulus and relaxation time can be varied over orders of magnitude.

References

[1] Le Tirilly, S., Tregouët, C., Bône, S., Geffroy, C., Fuller, G., Pantoustier, N., Perrin, P., Monteux, C., ACS Macro Letters (2015), 4, 25–29