INTERFACIAL RHEOLOGY OF MICROCAPSULES AND DYNAMICS IN FLOW

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A capsule is a drop bounded by a thin solid membrane providing specific mechanical properties. It is used to control the spatio-temporal delivery of substances in numerous processes and also as a model system of cells. Its dynamics under flow depends on its membrane characteristics. Moreover, the delivery of encapsulated drugs is controlled by its deformation. The interfacial rheology of microcapsules can be tuned according to their formulation. We will focus on cross-linked membrane made with human serum albumin and chitosan assembled with a surfactant via electrostatic interactions. The interfacial rheological properties of these soft microparticles are deduced from their dynamics of deformation in elongation and shear flows. In elongation flow, the surface shear modulus of the membrane is measured and related to the kind of biopolymer used and to the main parameters of the process of fabrication. In the regime of large deformations, the microcapsules can present a non-linear elastic response or plastic deformations. Non-linear elastic constitutive law is deduced by comparison of the evolution of the shape of the microcapsule in the two main planes of deformation of the capsule with numerical simulations. In shear flow, the rotation of the membrane, i.e. the tank-treading, is visualised and quantified by decorating the membrane of microcapsules with particles. The tracking of the distance between two close microparticles showed membrane contraction at the tips and stretching on the sides. This dynamic of deformation induce viscous dissipation inside the membrane. The order of magnitude of membrane viscosity is determined by comparison with numerical simulations. Wrinkling instability is observed in extensional flow and studied by varying the interfacial properties of the microcapsules. In this way, the phase diagram of wrinkle instability for microcapsules has been deduced as the scaling law between the wrinkles wave-length and the membrane thickness. Finally, we have developed a set of tools to characterize the interfacial viscoelasticity of microcapsules, their bending modulus and their non-linear elastic properties. We conclude the talk with some results on break-up of microcapsules in flow.

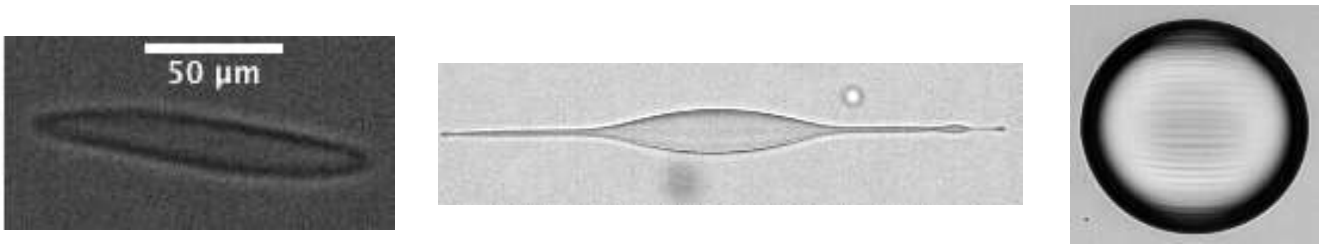

Figure 1: Microcapsules in flow. Left: A icrocapsule in shear flow. Middle: Break-up of a microcapsule in extensional flow. Right: Wrinkles on a microcapsule in flow.

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