Ultrasonic Speckle Velocimetry under shear

The Ultrasonic Speckle Velocimetry (USV) set-up allows simultaneous measurements of the velocity profile in complex fluids sheared in Couette geometry and of standard rheological data.

Working principle

USV is based on the interaction between a high-frequency ultrasonic pulse and particles suspended in the fluid. In some cases, the fluid microstructure may scatter ultrasound efficiently enough so that seeding the sample with particles is not needed. Backscattered pressure signals that result from successive pulses sent by the transducer are recorded as a function of time. These signals constitute an ultrasonic « speckle » that is directly linked to the spatial distribution of the scatterers along the acoustic beam. By cross-correlating two successive speckle signals over small time windows, one can measure the displacements of the scatterers at various positions along the beam and thus the velocity profile across the gap of a Couette cell. Classical rheological data are recorded using a standard rheometer (TA Instruments AR 1000) simultaneously to the local velocity profiles.

Instrument specifications

Temporal resolution : 0.02 to 2 s per velocity profile depending on the shear rate.
Spatial resolution : 40 µm (i.e. 25 measurement points per profile across a 1 mm gap).

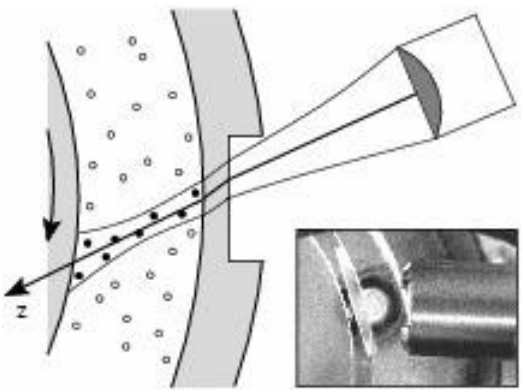
Temperature control

Temperature control is achieved through a water circulation around the cell in which the transducer is immersed (see picture). Working temperatures range from 5°C up to 50°C.

Applications

Local velocity measurements can be performed in any complex fluid (even in optically opaque media) as long as ultrasonic scattering remains in the single scattering regime. It has been applied in a wide variety of surfactant-based systems, such as lyotropic lamellar phases or wormlike micellar systems, as well as copolymer solutions, organogels, clay suspensions, and fractal colloidal gels. Velocity profiles recorded simultaneously to global rheological data provide useful information on wall slip, fractures, shear-induced transitions, shear-banding, or other spatio-temporal phenomena in complex fluids under shear.

Sketch of the USV set-up seen from above



General view of the rheo-USV setup