Electronic Supplementary Material (ESI) for Soft Matter


# Supplemental material to "Inertio-elastic instability of non shear-banding wormlike micelles"

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## 1 Technical details on ultrasonic imaging

Our TC geometry is equipped with a recently developed two-dimensional ultrasonic velocimetry technique [1] that allows for the simultaneous measurement of 128 velocity profiles over 30 mm along the vertical direction in the TC geometry [1]. Ultrafast plane wave imaging [2] is used to collect ultrasonic images of the distribution of small acoustic contrast agents seeding the fluid, namely 1% w/w hollow glass beads (Potters Sphericel, mean diameter 6 $\mu$m, mean density 1.1). Cross-correlation of successive images lead to time-resolved maps of the component $v_y(r,z)$ of the velocity vector, $\mathbf{v} = (v_r, v_\theta, v_z)$ in cylindrical coordinates, projected along the acoustic propagation axis $y$ as a function of the radial distance $r$ to the rotor and of the vertical position $z$. Depending on the shear rate, the time interval between two images can be as low as 50 $\mu$s (see Ref.[1] for full technical details).

The acoustic axis $y$ is horizontal and makes an angle $\phi \simeq 10°$ with the normal to the outer cylinder so that $v_y = \cos\phi\, v_r + \sin\phi\, v_\theta$. We define the measured velocity as $v = \frac{v_y}{\sin\phi} = v_\theta + \frac{v_r}{\tan\phi}$, which coincides with the azimuthal velocity $v_\theta$ only in the case of a purely azimuthal flow $\mathbf{v} = (0, v_\theta, 0)$. More generally $v$ combines contributions from both azimuthal and radial velocity components. Nevertheless, close to instability onset, secondary flows are usually much weaker than the main flow, such that $v \simeq v_\theta$ as can be checked in Fig. 4 of the paper.

## 2 Supplemental Movie

Sup. Movie corresponds to Fig. 2 of the paper. The top part corresponds to the USV data. On the left is the map of the velocity $v(r,z;\dot{\gamma}(t))$ measured in the gap of the TC cell at the location of the ultrasonic beam. The dotted line at $r_0 = d/4$ gives the location chosen to draw the spatiotemporal diagram displayed on the right: $v(\dot{\gamma}(t), z; r_0)$. On the diagram, the dotted line gives the time corresponding to the velocity map. The bottom part corresponds to the data obtained with Kalliroscope platelets. On the left is the section of the outer cylinder illuminated by the LED backlight source, and on the right is the spatiotemporal diagram. The dashed lines fill the same purpose as in the top part.

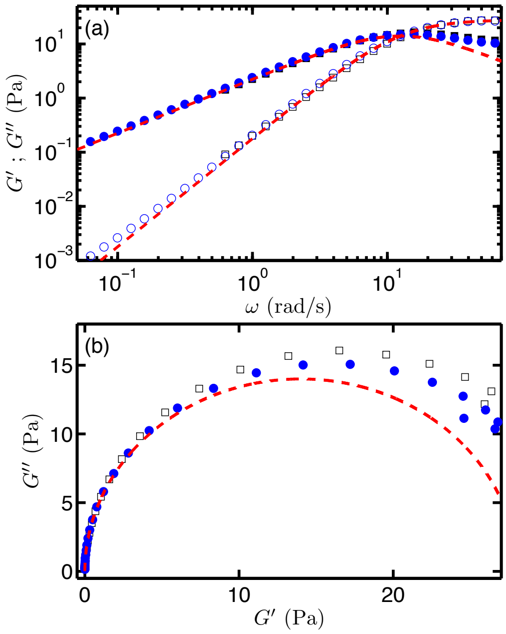


**Fig. 1** (a) Vicoelastic moduli $G'$ (filled symbols) and $G''$ (open symbols) as a function of frequency $f$ for a strain amplitude of 0.1% and (b) Cole-Cole representation $G''$ vs $G'$ for our wormlike micellar system with [CTAB]=0.1 M seeded with 1% w/w hollow glass spheres (□) and seeded with 1% w/w Kalliroscope platelets (blue •). The red dashed line shows the Maxwell model with a relaxation time $\tau_2 = 0.08$ s and an elastic modulus $G_0 = 28$ Pa.

## 3 Supplemental Figures

## References

1 T. Gallot, C. Perge, V. Grenard, M.-A. Fardin, N. Taberlet and S. Manneville, Rev. Sci. Instrum., 2013, **84**, 045107.
2 L. Sandrin, S. Manneville and M. Fink, Appl. Phys. Lett., 2001, **78**, 1155–1157.

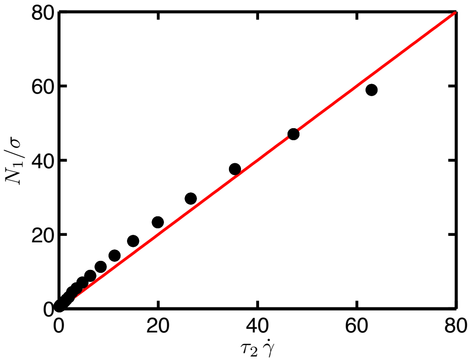


**Fig. 2** Weissenberg number determined as the ratio of the first normal stress difference $N_1$ to the shear stress $\sigma$ as a function of $\tau_2\dot{\gamma}$ in our wormlike micellar system with [CTAB]=0.1 M seeded with 1% w/w hollow glass spheres. The red line is $N_1/\sigma = \tau_2\dot{\gamma}$. Experiment performed in a cone-and-plate geometry of diameter 40 mm and cone angle 2 °.