Rheological characterizations of wormlike micellar solutions containing cationic surfactant and anionic hydrotropic salt

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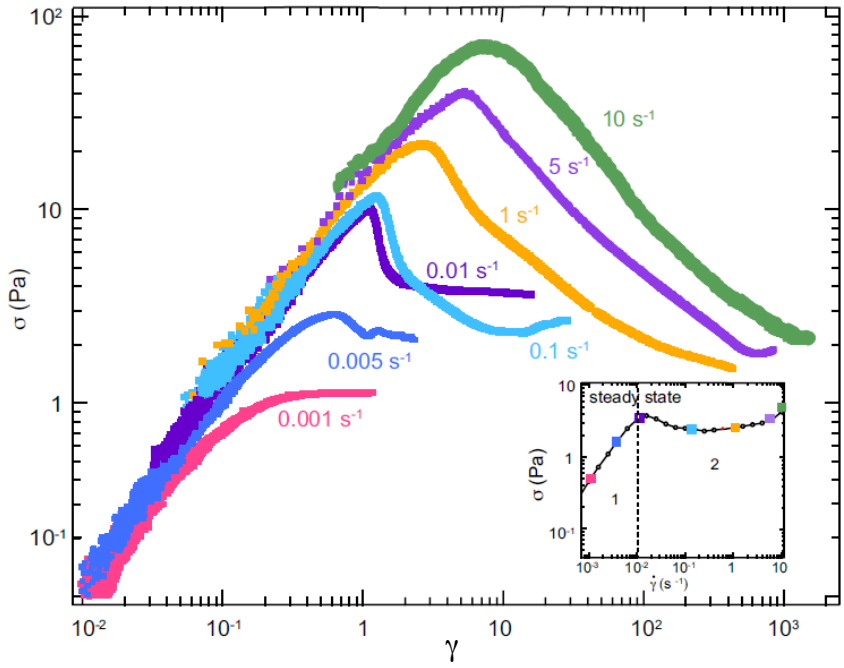
Aqueous micellar solutions of cationic surfactant cetyltrimethylammonium bromide (CTAB) and organic hydrotropic salt 3-hydroxy naphthalene-2-carboxylate (SHNC) in the semidilute regime have been characterized by linear and nonlinear rheology, and dynamic light scattering. The strong hydrophobicity and naphthalene structure present in the SHNC induces significant growth of CTAB wormlike micelles and promotes stable micellar network formation. Focusing primarily on 75mM CTAB/SHNC solution, we correlate the rich rheological behaviour with structural transitions of the micellar network under different deformation histories with temperatures in the range of 20 °C < T < 40 °C. Viscous dissipation dominates at low temperature, while short range interactions among micellar head groups, reorganization of micellar networks play important roles at higher temperatures, leading to complex stress responses under large deformations. The influence of double benzene rings on the response of transient and large amplitude oscillatory shear flows in the system was further elucidated by comparing the rheological behavior of CTAB/SHNC with CTAB/NaSal at the same salt and surfactant concentrations. Our studies distinguished SHNC as a stable hydrotrope in a semidilute cationic surfactant system under thermal variations, with potential applications such as drag reduction and fracturing fluids in oil recovery.



Transient shear stress plotted as a function of shear strain from flow startup experiments in a rotational rheometer. The inset shows shear stress versus shear rate in the steady flow and was divided into 2 regimes. Regime 1 is the elastic deformation regime where the shear rate $\dot{\gamma} \leq 10^{-2}$ s^{-1}. Regime 2 for $\dot{\gamma} > 10^{-2}$ s^{-1} is the shear banding regime.