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**Modeling the Inhomogeneous Response of Steady and Transient Flows of Entangled Micellar Solutions**[1]

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Surfactant molecules can self-assemble in solution into long flexible structures known as wormlike micelles. These structures entangle, forming a viscoelastic network similar to those in entangled polymer melts and solutions. However, in contrast to 'inert' polymeric networks, wormlike micelles continuously break and reform leading to an additional relaxation mechanism and the name 'living polymers'. Observations in both classes of entangled fluids have shown that steady and transient shearing flows of these solutions exhibit spatial inhomogeneities such as 'shear-bands' at sufficiently large applied strains. In the present work, we investigate the dynamical response of a class of two-species elastic network models which can capture, in a self-consistent manner, the creation and destruction of elastically-active network segments, as well as diffusive coupling between the microstructural conformations and the local state of stress in regions with large spatial gradients of local deformation. These models incorporate a discrete version of the micellar breakage and reforming dynamics originally proposed by Cates and capture, at least qualitatively, non-affine tube deformation and chain disentanglement. The 'flow curves' of stress and apparent shear rate resulting from an assumption of homogeneous deformation is non-monotonic and linear stability analysis shows that the region of non-monotonic response is unstable. Calculation of the full inhomogeneous flow field results in localized shear bands that grow linearly in extent across the gap as the apparent shear rate increases. Time-dependent calculations in step strain, large amplitude oscillatory shear (LAOS) and in start up of steady shear flow show that the velocity profile in the gap and the total stress measured at the bounding surfaces are coupled and evolve in a complex non-monotonic manner as the shear bands develop and propagate.

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