SHEAR-BANDING FLOW IN POLYMER-LIKE MICELLES. A CRITICAL PHENOMENON OR MECHANICAL STABILITIES

Jorge E. Puig

Departamento de Ingeniería Química, Universidad de Guadalajara
Guadalajara, Jal. 44430, MÉXICO ***puigje@mail.udg.mx***

Polymer-like micellar solutions often exhibit a discontinuity in the shear stress versus shear rate flow relationship, known as shear banding flow. In this regime the stress remains constant between two critical shear rates, $\dot{\gamma}_{c1}$ and $\dot{\gamma}_{c2}$. Below $\dot{\gamma}_{c1}$ and above $\dot{\gamma}_{c2}$, Newtonian behavior is observed. This is because, and in contrast to polymer solutions, polymer-like micelles can relax by reptation or by breaking-and-reformation of the micelles. The ratio of the breaking to the reptation times ($\zeta = \tau_{Break}/\tau_{Rep}$) determines whether the relaxation is diffusion-controlled or kinetic-controlled. Here it is proven that shear banding flow occurs only when relaxation is kinetic. Moreover, it is demonstrated by irreversible thermodynamics arguments that the stress plateau in the shear banding region is set by the criterion of equal areas below and above the stress plateau in the Gibbs free energy versus shear rate plot. Arguments are presented that support that shear banding flow is akin to a shear-induced first-order phase transition and that a critical point appears above which shear banding flow vanishes.