DUAL SLIP-LINK SIMULATION STUDY ON STRETCH-ORIENTATION-INDUCED REDUCTION OF FRICTION IN BI-DISPERSE BLENDS

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ABSTRACT

We investigated the rheological properties of bi-disperse entangled-polymer blends under high-deformation-rate flows by slip-link simulations with a friction reduction mechanism. The friction reduction mechanism induced by the stretch and orientation (SORF) is important to predict the viscoelasticity in highly nonlinear regime under uniaxial elongational flows. To examine the applicability of this mechanism for bi-disperse systems, we incorporated an expression of friction reduction (Yaoita et al. Macromolecules 45:2773–2782 2012) into the Doi-Takimoto slip-link model (DT model). For six experimental bi-disperse systems, i.e., four polystyrene blends and two polyisoprene blends, the extended DT model where the order parameter of the friction reduction mechanism is evaluated through the component averages succeeds in reproducing the data under uniaxial elongation and shear. This success is due to the suppression of the stretch of the longer chains using the statistical average over each component. Through this study, the SORF expression improves the rheological prediction for bi-disperse entangled polymer melts under uniaxial elongational flows with strain rates comparable to or larger than the inverse of the Rouse relaxation time of the longer chains. Additionally, the predictions with the SORF using the component average for the stretches reproduce the steady viscosities because under elongational flows, the states of the components with different molecular weights clearly differ from each other depending on their Rouse relaxation time. The finding means that for chain dynamics, the friction coefficient is determined by the state of the surrounding polymer chains and the state of the chain[1].

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REFERENCES

1. Miyamoto, S; Sato, T; Taniguch T, Stretch-orientation-induced reduction of friction in well-entangled bidisperse blends: a dual slip-link simulation study. Rheologica Acta **62**, 57-70, 2023.