Modelling of Shear-induced Mixing Behaviour of Polymer Blends

Sabine Enders[1, C] and Jonas Jaske[1, S]

[1]*KIT, Karlsruhe, Germany*
sabine.enders@kit.edu

Polymer blends tend to separate often showing a large miscibility gap. In the absence of shear, the miscibility gap can be modelled using lattice theories, such as the Flory-Huggins approach [1, 2], or the Lattice Fluid Theory proposed by Sanchez and Lacombe [3]. If a special shear rate is applied to polymer blends, the miscibility gap will be extended or reduced, depending on the rheological properties of the considered polymer blends. The rheological behaviour is mostly shear thinning, which is the non-Newtonian behaviour of fluids whose viscosity decreases under shear strain. The impact of shear on the phase behaviour can be modelled according to the theoretical framework of Wolf [4] and Horst and Wolf [5]. The principal idea of this theoretical framework is the addition of the Gibbs energy of mixing and the stored energy during flow, which reflects the rheological properties of the blend. Unfortunately, no analytical expression for the stored energy during flow with respect to the blend composition is provided [4, 5]. The aim of this contribution is to present an analytical expression for the chemical potential that incorporates the rheological properties of the polymer blend, enabling the utilization of experimental rheological data in the calculation. The new approach is inspired by Soontaranun et al. [6], who consider only Newtonian fluids. With the new approach, rheological data and the phase behaviour of quiescent polymer blends can be utilized to predict the behaviour of these polymer blends under the influence of shear. The model is applied to experimental data from the literature [7, 8] for both the polystyrene/poly(vinyl methyl ether) system and the styrene-acrylonitrile copolymer/poly(methyl methacrylate) system. Our own rheological measurements are shown for the first system. In addition, both the use of a G^E- model and an equation of state for the description of the Gibbs energy of polymer blends are discussed.

References

1. P.J. Flory, J. Chem. Phys. 10 (1942) 51.
2. M.L. Huggins, J. Chem. Phys. 9 (1941) 440.
3. I. Sanchez, R. Lacombe, J. Phys. Chem. 80 (1976) 2352.
4. B.A. Wolf, Macromolecules 17 (1984) 615.
5. R. Horst, B.A. Wolf, Macromolecules 25 (1992) 5291.
6. W. Soontaranun, J. Higgins, T.D. Papathanasiou, Fluid Ph. Equilib. 121 (1996) 273.
7. K.A. Mazich, S.H. Carr, J. Appl. Phys. 54 (1983) 5511.
8. H.W. Kammer, C. Kummerloewe, J. Kressler, J. Melior, Polymer 32 (1991) 1488.