Dynamics and rheology of phase transitions in polymer systems

T. Kawakatsu

Department of Physics, Tohoku University, Sendai 980-8578, Japan

1. INTRODUCTION

For describing phase separated domain structures formed in polymer blends and block copolymer melts, density functional theories such as the self-consistent field (SCF) theory and the Ginzburg-Landau (GL) theory are very useful and successful techniques [1,2]. Especially, the SCF theory is now very reliable and useful in predicting phase separated domain structures even in a quantitative sense. However, its dynamical extensions have not yet been fully developed. We review recent developments in the SCF theories and computer simulations on dynamics of inhomogeneous polymer blends and polymer solutions.

2. DYNAMICAL SCF THEORIES

The simplest version of the dynamic SCF theory relies on a simple diffusion dynamics [2]. Based on such a dynamical assumption, there have been several trials to simulate dynamical problems in polymeric systems. Typical examples of the target phenomena are formation dynamics of complex domain structures in multi-component polymer mixtures [3], formation of complex structures in constrained systems [4,5], structural phase transitions of domain structures induced by external fields [6-8]. Another direction of the dynamical extension of SCF theory is to combine it with complex dynamics, such as hydrodynamics [9] and viscoelastic properties of the constituent polymer chains [10]. We show latest results on these dynamical studies.

3. CONCLUSION

With the use of the dynamic SCF theories, it would be possible to make a quantitative prediction not only on the domain structures but also on the viscoelastic properties of such domain systems based on the molecular architecture of the constituent polymer chains.

ACKNOWLEDGEMENT

TK thanks H.Honda, A.V.Zvelindovsky, D.Q.Ly, H.Morita, M.Doi, and X.F.Yuan for fruitfull collaborations.

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