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## Preface

The observation that blending existing polymers can produce new and improved materials with the beneficial features of each component has focused attention on understanding the phase behavior of polymer blends because the resulting composites may form homogeneous phases or may be phase separated with a particular desirable morphology. While Flory–Huggins theory correctly predicts that liquid-state polymers generally do not tend to mix, its predictive ability for designing these new materials are rather limited. Thus, in order to rectify this deficiency in the theory, several approaches have been used to develop more ambitious theories, while experimental efforts have been devoted to devising various strategies for improving mixing including, for instance, the use of flow, as described in the article by Clarke in this volume. Thus, progress in elucidating the factors affecting and promoting blend miscibility has benefited from strong interactions between experimental and theoretical groups, as emphasized by the articles herein.

The subject of the phase behavior of polymer blends is quite vast and much too large to fit in a single volume of *Advances in Polymer Science*, so the present volume is the first in a planned series. The lead article in this volume by Schwahn describes his small angle neutron scattering experiments for a variety of polymer blend systems, including homopolymer and copolymer blends, as well as the fascinating mixtures of diblock copolymers with homopolymers and the technologically important influences of pressure and additives on blend phase behavior. Schwahn's article focuses on the important influences of critical fluctuations on the phase behavior and emphasizes the need for analyzing experimental data accordingly in order to provide meaningful comparisons between experiments and theories of polymer blends, which are generally of the mean field variety. The second article by Freed and Dudowicz is devoted to a description of several applications of the lattice cluster theory (LCT) in the simplified high molecular weight, incompressible limit to demonstrate how monomer molecular structure strongly affects the phase behavior of polymer blends. Examples of LCT predictions that can not be obtained from Flory–Huggins theory involve, for instance, the possibility of lower critical solution temperature phase behavior for incompressible binary blends and microphase ordering of diblock copolymers upon heating. When applied to copolymer systems, LCT provides a significant extension of Flory–Huggins

type theories for copolymers by incorporating the important contributions from the temperature-independent portion of the Flory effective interaction parameter. Several direct comparisons of the LCT to experiments serves to illustrate the utility of this simple approach to interpret measurements and to elucidate the physics governing blend miscibility. The last article by Clarke describes both theoretical methods and experimental observations of the influence of shear flow on the properties of polymer blends. Comparisons are made between the predictions of two conflicting theories: a quasiequilibrium theory in which a shear-dependent contribution is appended to the free energy, and a theory based on the modification of the equations of motion by the presence of the shear flow. Clarke discusses several of the challenges towards further theoretical progress.

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