

CHAPTER II

LITERATURE SURVEY

2.1 The Morphology and Interfacial Situation in Blends

The emulsifying effect of block copolymers in immiscible homopolymers were studied theoretically by Noolandi and Hong (1982) using a general formalism for an inhomogeneous multicomponent polymer system. The greater exclusion of the homopolymer from the interphase region with increasing of molecular weight was determined.

A relation between interfacial tension and interfacial thickness was suggested by Wu (1987). Statistical mechanical theories of polymer interfaces leads to the relations

$$\gamma_{12} \propto \chi^{1/2} \quad (2.1)$$

and

$$L \propto \chi^{-1/2} \quad (2.2)$$

where L is the interfacial thickness and χ is the Flory-Huggins interaction parameter. Therefore, we have

$$\gamma_{12} \propto L^{-1} \quad (2.3)$$

thus, γ_{12} should be inversely proportional to L . However, a least-square regression of the experimental data gives:

$$\gamma_{12} = 7.6 L^{-0.86} \quad (2.4)$$

where γ_{12} is in mN/m and L is in nm.

Tang and Huang (1994) found that, when the compatibilizer used is either a block or graft copolymer, each is present at the interface and as micelles in matrix or dispersed phases. A greater quantity added only led to

less effective participation as a compatibilizer. Moreover, at low concentration of the compatibilizer, each molecule occupies more interfacial area than at the higher concentration where the molecules arrange themselves more compactly in the interfacial area.

Jo *et al.* (1996) found that in the Polystyrene/Polyisoprene (PS/PI) blends with Polystyrene-isoprene (SI) copolymer, the surface tension reduction increased with the longer isoprene block in the copolymer

Model prediction and manipulation of the phase morphologies of multiphase polymers were shown by Guo *et al.* (1997). The interfacial tension plays the major role in establishing the phase structure, where a less significant role (but still important) is played by the surface area of the dispersed phase. In addition, the phase structures of multiphase polymer blends can be changed by an addition of suitable interfacial active agent such as a block copolymer. Moreover, the driving force to minimize the free energy is strong so that the phase structure having the lowest free energy level is formed even under the non-equilibrium mixing condition.

Ohlsson *et al.* (1998) showed that the 50/50, PP/PA melt mixing blends were made using up to 25% of thermoplastic elastomer as a compatibilizer, either SEBS or SEBS-g-MA. Even at high concentration, unmodified SEBS was found to be a poor compatibilizer. On the other hand, SEBS-g-MA showed a strong tendency to develop a separated PP/PA interface. The total surface area of PA phase seemed to increase with increasing SEBS-g-MA content. The thickness of the interphase layer (shell thickness) almost stays constant and is independent of the compatibilizer concentration. The interphase layer thickness was estimated to be about 15 nm. At high concentrations of SEBS-g-MA (15% and 20%), the PA domain

form the large interphase, held together by a thermoplastic elastomer interphase network.

The morphology of the 80/20 Styrene-acrylonitrile copolymer and Poly(cyclohexyl metacrylate (SAN/PCHMA) blended with poly(styrene-*b*-methylmethacrylate) (PS-*b*-PMMA) compatibilizer (up to 5%wt) was studied by Kim et al. (1998). PS-*b*-PMMA copolymer diffuses to the interface while the remainder stays inside the PCHMA droplets as swollen micelles. The exothermic interaction between the PS-*b*-PMMA copolymer and SAN matrix influences drop size via thermodynamic control (lower interfacial tension). Increasing the exothermic interaction results in a smaller droplet size by inhibiting coalescence.

Jeon and Kim (1998) studied the 75/25 poly(butylterephthalate) and polystyrene (PBT/PS) blends showed that the dispersed phase diameter increased with annealing time and the irregular shape domain became spherical within 30 s in order to reduce the interfacial tension. When the PS-*g*-MA was added, the drop size decreased within a short time.

Interfacial graft copolymer formation in nylon6 and poly(styrene-*g*-maleic anhydride (PA6/PS-*g*-MA) blends were studied by Dedecker and Groeninckx (1999). A further increasing of the MA content resulted in a further decrease of the particle size. The interfacial thickness from the model increased with the increasing particle core diameter.

Luzinov *et al.* (2000) found that in PS/SBR/Polyolefin blends, the core-shell structure was formed. Compression molding process does not change the blend morphology, except the sizes of the polyolefin and SBR

domains and the thickness of the rubbery layer around the core, which increases as a result of coalescence.

2.2 Effect of Morphology on Blend Properties

Oshinski *et al.* (1992) reported that in Nylon6/[SEBS/SEBS-g-MA] using nylon6 80 %wt and varying the weight ratio between SEBS/SEBS-g-MA, the particle sizes of dispersed phase were varied from 0.05 to 5 μm . The particle size decreased with increasing SEBS-g-MA composition. Only, the particle sizes in the range of 0.1-1 μm showed higher Izod impact strength than those having upper or lower size. And, the SEBS-g-MA blends show the higher impact strength than SEBS blend.

The PA6/polycarbonate (PC)/SEBS and PA6/PC/SEBS-g-MA blends were studied by Horiuchi *et al.* (1997). The SEBS-g-MA reacts with the amine end groups of PA6 and induces the change of two dispersed phase formations; i.e. from stack to capsule formation. The driving force of this morphology development is assumed to be the reduction of the interfacial tension by the interfacial reaction. The SEBS-g-MA also worked as an impact modifier for PA6 matrix as well as a coupling agent for the adhesion between the PA6 matrix and PA6 domains. The impact strength increased with an increasing amount of SEBS-g-MA.

Sierra *et al.* (1997) found that the high tensile strength of SEBS results from the extensive network created as the extensive network created as polystyrene block form domains. The initial modulus and the tensile strength at break increase with increasing styrene block of SEBS.

Van Duin *et al.* (1997) studied the Nylon6 or Nylon 6,6 and EPDM-g-MA or poly(styrene-co-maleic anhydride) (SMA) blend and shown that the degree of crystallinity of the PA phase is decreased only when the size of PA phase between the MA-containing polymer domain approaches the PA crystalline lamellar thickness.

Luzinov *et al.* (1999) studied the morphology of the ternary PS/styrene butylene rubber (SBR)/PE blends when PE was a core dispersed phase and SBR was a shell dispersed phase. The comparison of the experimental shear modulus with Kener model was shown that the maximum stress transfer from matrix to shell and to core occurred when the ratio between the size of the core and the thickness of the SBR layer is high enough.

Wilkinson *et al.* (1999) studied the PP/[PA6/SEBS] blends having various ratio of PA6: SEBS. The 70/30 PP/PA6 blend showed very coarse morphology and poor mechanical properties. In 70/[15/15] PP/[PA6/SEBS] isolated dispersed phase of PA6 and SEBS were exhibited. Using the reactive compatibilizer, SEBS-g-MA, PA6 was encapsulated by SEBS-g-MA and the impact strength was increased.

Hong and Jo (2000) reported that the low molecular weight SEBS is more effective in increasing the impact strength of PS/EPR blends than high molecular weight. The blocks in low molecular weight SEBS penetrate into the corresponding phase more easily than the blocks in the high molecular weight SEBS.

Luzinov *et al.* (2000) found that in PS/SBR/Polyolefin blends, The core-shell structure is formed and the stress transfer from the PS matrix to the polyolefin core through the SBR shell depends on the modulus of SBR shell.

The ultimate mechanical properties of the ternary blends are sensitive to the stiffness of the core.