Effect of Various Added Compatibilizers on the Crystalline Structure of Polypropylene Homopolymer/Polybutylene Terephthalate and Polypropylene Copolymer/Polybutylene Terephthalate Polymer Blends

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Received 16 August 2001; accepted 29 April 2002

ABSTRACT: Blends of semicrystalline isotactic polypropylene homopolymer and polypropylene copolymer with polybutylene terephthalate with different compatibilizers [i.e., styrene acrylonitrile, Surlyn, styrene–ethylene–butadiene styrene (SEBS), block copolymer and SEBS block copolymer grafted with maleic anhydride] were prepared by melt blending. Wide angle-X-ray scattering patterns of injection moldings were obtained. The crystallinity index and *d*-spacing were calculated with different concentrations of different compatibilizers. X-ray results in the structural investigation of the compatibilized blends correlated well with the different compatibilizer concentrations. © 2002 Wiley Periodicals, Inc. J Appl Polym Sci 87: 1190–1193, 2003

Key words: compatibilization; copolymerization blends

INTRODUCTION

The[1] properties of semicrystalline polymers depend on the degree of crystallinity and the character of the crystalline phase. The addition of compatibilizers can influence the crystallization process in the polymer.[1–3] On the other hand, mixture with a polymer can lead to structural changes in both components of blends. The determination of structural changes in both components in modified polymers (blends) and the dependence on composition can help explain the mechanical properties of the blends.[4]

In this study, the structures of polypropylene homopolymer (PPHP)/polybutylene terephthalate (PBT) and polypropylene copolymer (PPCP)/PBT blends with different compatibilizers [i.e., styrene acrylonitrile (SAN), Surlyn, styrene–ethylene–butadiene (SEBS) block copolymer, and SEBS block copolymer grafted with maleic anhydride (SEBS-*g*-MAH)] were examined over different concentrations of compatibilizers. Wide-angle X-ray scattering (WAXS) was used for characterization of the investigated samples.

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Journal of Applied Polymer Science, Vol. 87, 1190–1193 (2003)

EXPERIMENTAL

Materials

Isotactic PPHP (Koylene, M-0030) and PPCP (Koylene, MI-0030) produced by Indian Petrochemicals Corp. Ltd. (Baroda, India), PBT (Arnite, T-06 200) supplied by Cenka Plastics (Pune, India), SAN supplied by Polychem India Limited. SEBS block copolymers (Kraton G-1652) and SEBS-*g*-MAH (Kraton G- 1901 X) supplied by Shell Chemicals Co., and ionomer (Surlyn-8660) supplied by Dupont Ltd. (UK) were used in these investigations.

Melt blending and injection molding

Before melt blending, PBT was dried for 5 h at 120°C; PPHP, PPCP, SAN, SEBS, and SEBS-*g*-MAH were dried at 85°C for 2 h and Surlyn was dried at 45–50°C for 4 h in a dehumidifying oven. The materials were melt blended with a Werner and Pfledierer (ZSK-30) (NJ) corotating twin-screw extruder. PPHP/PBT and PPCP/PBT 80/20 blends with different concentrations of compatibilizers were prepared and injection molded in a DGP-Windsor (SP-80) injection-molding machine (Pune, India) equipped with a two-cavity ASTM test specimen mold. Typical molding conditions for ternary blends were as follows:

- Barrel temperature: 200, 220, 230, and 220°C.

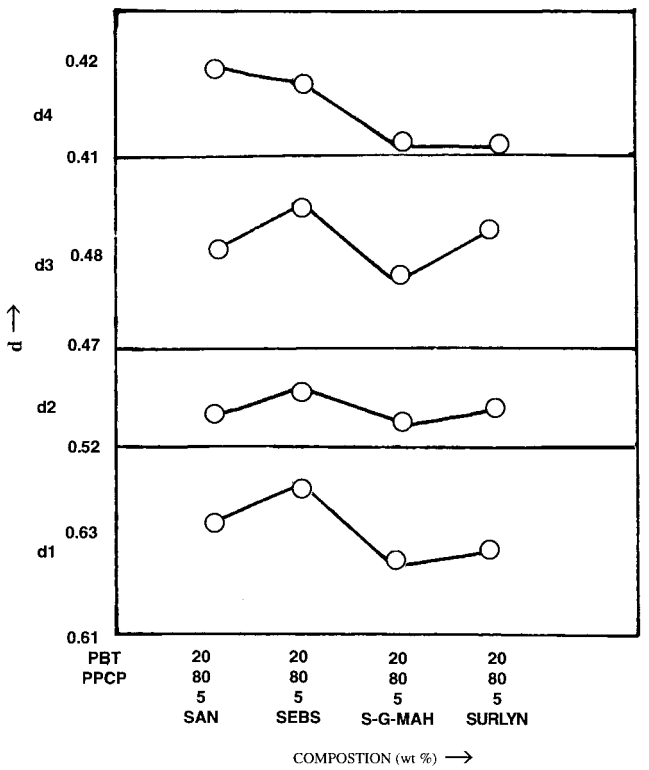

Figure 1 Variation of *d*-spacing with a PPCP/PBT 80/20 blend with different compatibilizers (i.e., SAN, SEBS, SEBS-*g*-MAH, and Surlyn).

- Screw speed: 100 rpm.
- Injection pressure: 75 kg/cm^2.
- Overall cycle time: 45 s.

Wide angle X-ray scattering WAXS

The structure and orientation of the PPHP/PBT and PPCP/PBT blends with different compatibilizers investigated with wide-angle X-ray diffraction patterns were obtained on a Philips diffractometer (Pune, India) with a chart recorder with identical settings for all samples. Cu Kα radiation was used. The samples for these measurements were used from injection-molded tensile specimen.[5]

Crystallization characteristics were measured with ternary blends of different compatibilizers. For the comparison, PPHP and PPCP alone were also measured.

RESULTS

A plot of *d*-spacing for various intense PPCP peaks is shown in Figure 1 for a 5% concentration of different compatibilizers (i.e., SAN, Surlyn, SEBS, and SEBS-*g*-MAH). The addition of SEBS may have caused a slight swelling of the PPCP matrix, with a large amorphous ethylene content. The increase in *d*-spacing was of the order of 0.5–1%. PPCP/PBT blends with SEBS compatibilizer also reflected a similar trend as the PPHP/PBT/SEBS plot shown in Figure 1.

The crystallinity index for the PPHP/PBT blend with a 5% concentration of different compatibilizers is shown in Figure 2. Again, a minimum crystallinity index was observed for the PPHP/PBT/SEBS system; this was due to the interaction between the polypropylene and ethylene segments of block SEBS.

After an initial drop for PPHP/PBT/SEBS, the crystallinity index again rose with an increase in concentration of SEBS from 5 to 15% (Fig. 3). A similar trend was observed for the PPHP/PBT/SEBS-*g*-MAH and PPCP/PBT/SEBS-*g*-MAH systems (Figs. 4 and 5). The PPCP/PBT/SEBS system, being an exception, showed a continuous drop in the crystallinity index with increasing SEBS concentration (Fig. 6).

These investigations highlighted a decrystallizing phenomenon occurring at 5% concentration of added compatibilizer and a simultaneous increase of prominent lattice spacing.

DISCUSSION

Nonreactive compatibilizers are used successfully in many commercial blends. A common approach is to

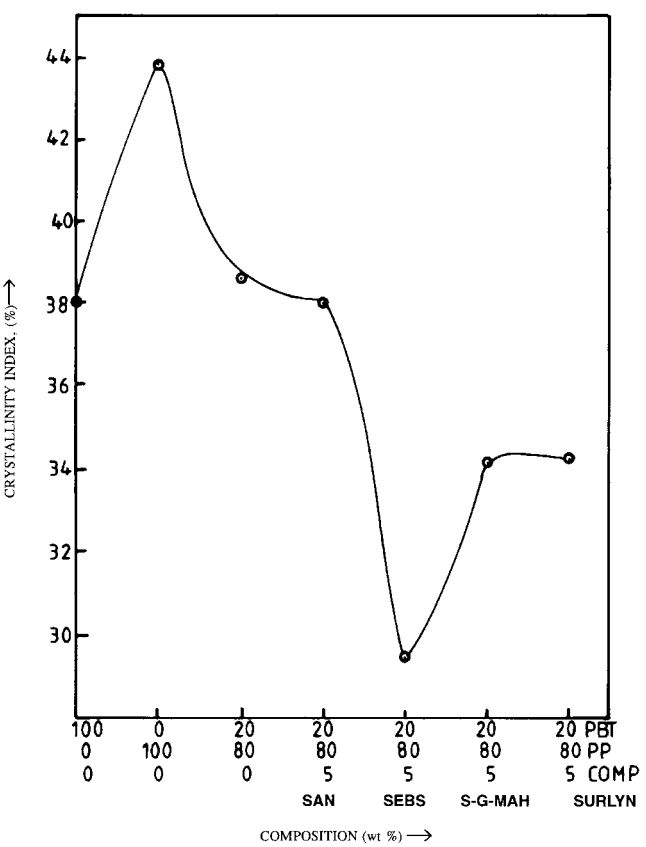

Figure 2 Variation of crystallinity index with a PPHP/PBT 80/20 blend with different compatibilizers (i.e., SAN, SEBS, SEBS-*g*-MAH, and Surlyn).

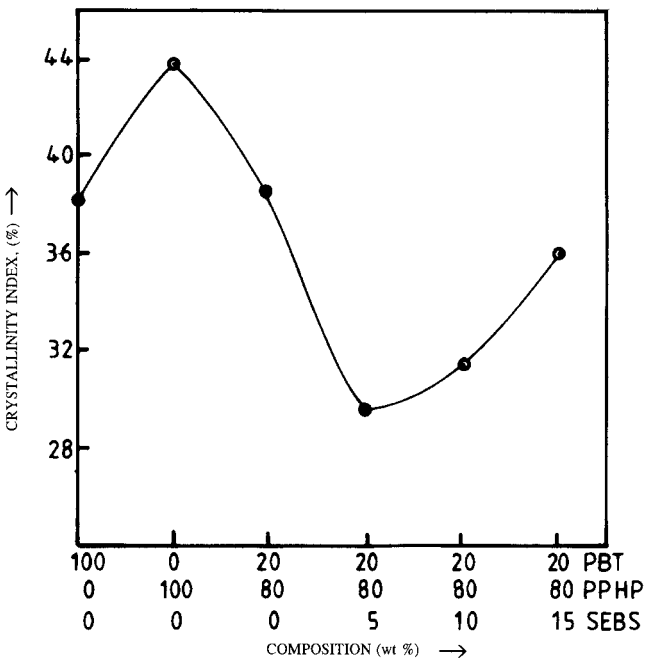

Figure 3 Influence of different weight percentages of SEBS compatibilizer (i.e., 5, and 10, and 15 wt %) in a PPHP/PBT 80/20 blend on the crystallinity index.

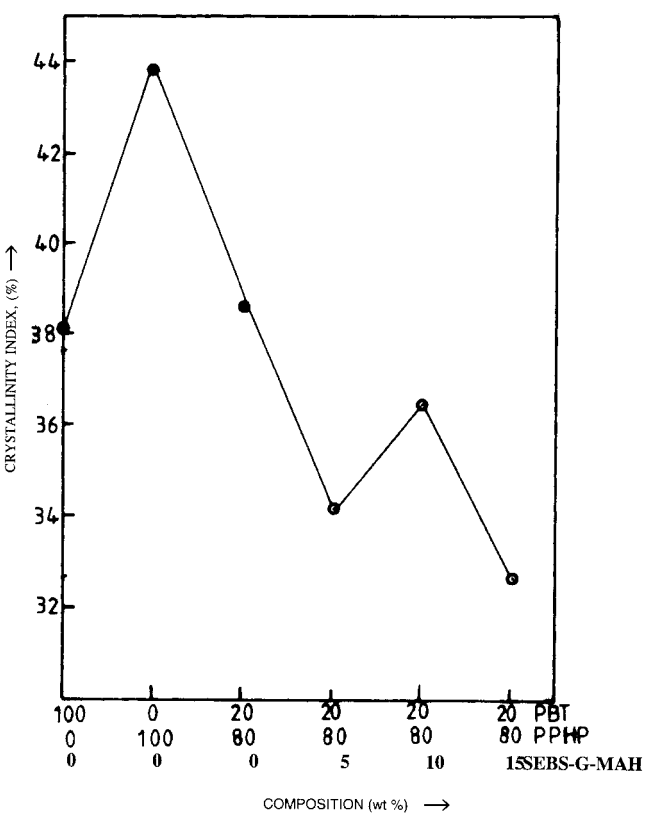

Figure 4 Influence of different weight percentages of SEBS-*g*-MAH compatibilizer (i.e., 5, and 10, and 15 wt %) in a PPHP/PBT 80/20 blend on the crystallinity index.

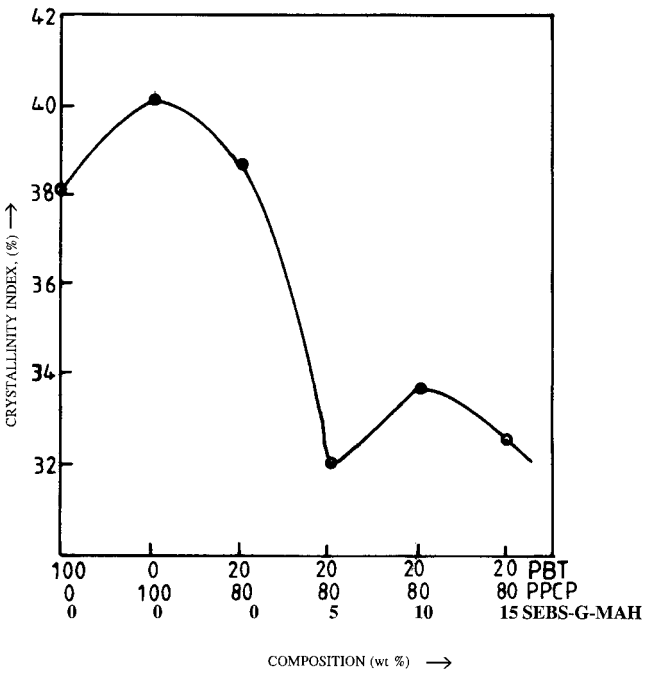

Figure 5 Influence of different weight percentages of SEBS-*g*-MAH compatibilizer (i.e., 5, and 10, and 15 wt %) in a PPCP/PBT 80/20 blend on the crystallinity index.

use a block copolymer with segments like those of two phases. Thus, an AB block copolymer would compatibilize a mixture of poly-A and poly-B. Although often successful, this approach has some limitations because

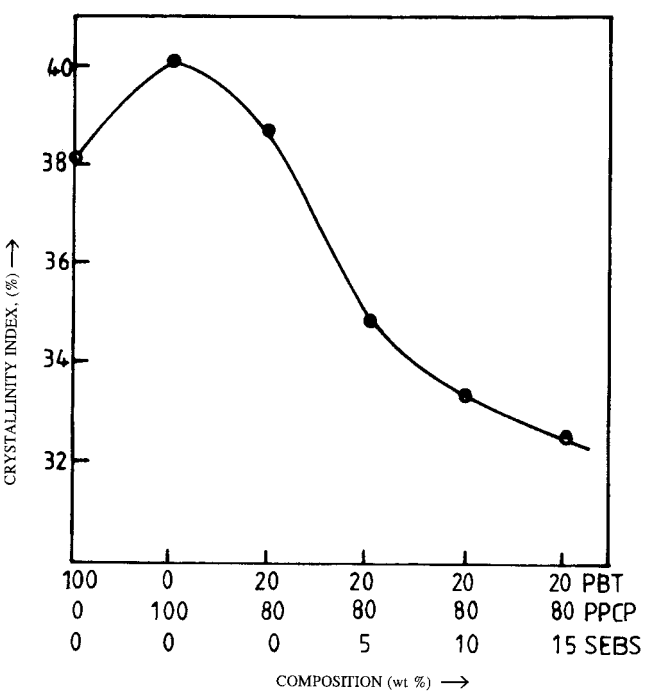

Figure 6 Influence of different weight percentages of SEBS compatibilizer (i.e., 5, and 10, and 15 wt %) in a PPCP/PBT 80/20 blend on the crystallinity index.

there is no driving force for the segments to enter the phase.

CONCLUSIONS

The role of morphology in blends, especially in blends containing a compatibilizer, is still not fully understood. The goal of this study was to clarify the influence of compatibilizers that do not consist of blocks of the blend components on the morphology and coalescence in a binary polymer blend.

We are grateful to Pune University Physics Department for the X-ray analysis. We also acknowledge the encouragement given by M. Ravindranathan, R. C. Jain, and S. K. Mehta of Indian Petro Chemicals Ltd., Research & Developement. We are also thankful to Padmanabh Alloys and Polymers Ltd. for providing the injection-molding facilities.

References

1. Jang, B. Z.; Uhlmann, S.; Vander Sande, J. B. J Appl Polym Sci 1985, 30, 2485.
2. Bartzak, Z.; Galeski, A.; Kransnikova, N. P. Polymer 1987, 28, 1627.
3. Gupta, A. K.; Purwar, S. N. J Appl Polym Sci 1984, 29, 1595.
4. Hlavata, D.; Plestil, J.; Zuchowska, D.; Steller, R. Polymer 1991, 32, 3313.
5. Hietaoja, P.; Heino, M.; Vaino, T.; Seppala, J. Polym Bull 1996, 37, 353.