Further Study on the Miscibility of Poly(ethylene Terephthalate)–Polycarbonate Blends

Because the poly(ethylene terephthalate)-polycarbonate blends is a very good polymer with commercial value, the miscibility of PET and PC has been of fundamental interest in recent years. Many studies have been made by thermogram analysis, dynamic mechanical relaxation, infrared absorption spectroscopy, and so on. It is known that the blends with total miscibility between two components would present one single glass transition temperature in DMA. Otherwise, two glass transition peaks will be observed. Nassar et al.[1] found that PET/PC blends are in total miscibility if the content of PET is above 70 wt %. However, Chen and Bireley[2] pointed out that, in the entire composition range, PET/PC is immiscible. Later, Suzuki et al.[3] made further study with the help of phase contrast microscopic observation, which also supported the latter conclusion. The above situation obviously gave rise to great confusion and disadvantages to the fundamental study and application of such blends. In this note, the internal friction technique similar to the DMA method was used to further study the problem. It is proved that PET and PC are not miscible in total composition.

Internal friction is a powerful technique capable of reflecting the structural change and defect movement of materials. It is represented by the phase angle that strain lags behind stress when materials are in force vibration. The measurements of internal friction and elastic modulus were taken with a multifunction internal friction apparatus with ascending temperature at the rate of 4°C/min. The strain amplitude in use was below 2×10^{-5}. Melt blending was done in a PLE-311 Brabender plasticorder at 315°C, where PET and PC had been dried at 100°C for 10 h. The samples consisting of 85/15, 50/50, 30/70, and 15/85 (PC/PET) were obtained that were all in water-quenching state.

It is true that when the content of PET is 15%, two glass transition temperature are both observed, as shown in Figure 1. With the increase of PET, two internal friction peaks become closer (curve C), where the high temperature side of PC peak was not measured. But after the sample is annealed at 160°C for 0.5 h, the two peaks decrease and shift to higher temperature. When the content of PET reaches 70%, there still appears two internal fric-

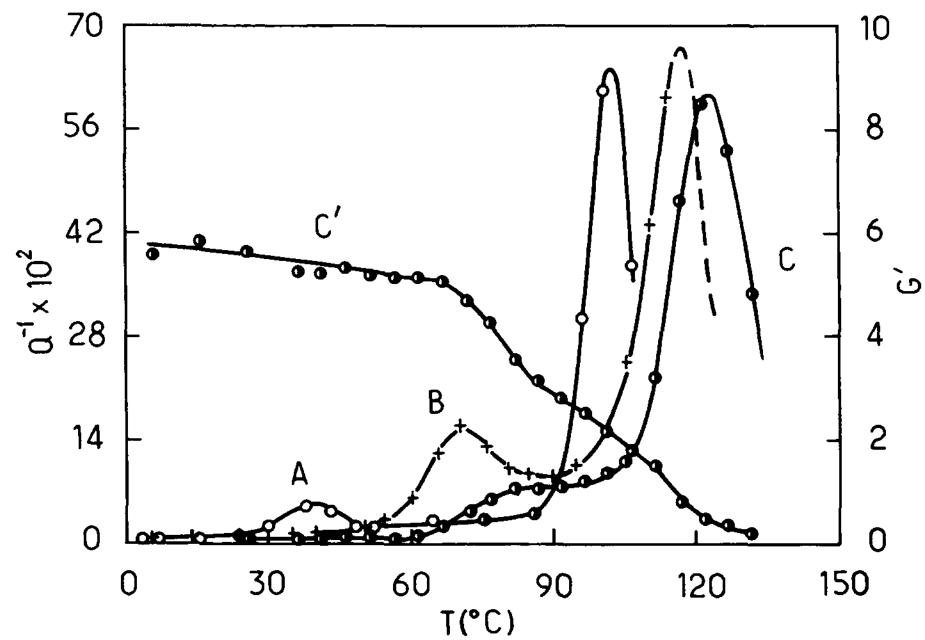

Figure 1 Variations of internal friction and elastic modulus with temperature for PET/PC blends with various composition ratios. Curves A, B, C–C′: PET/PC = 15/85, 50/50, 50/50 (after annealing at 160°C for 0.5 h). $f = 0.3$ Hz.

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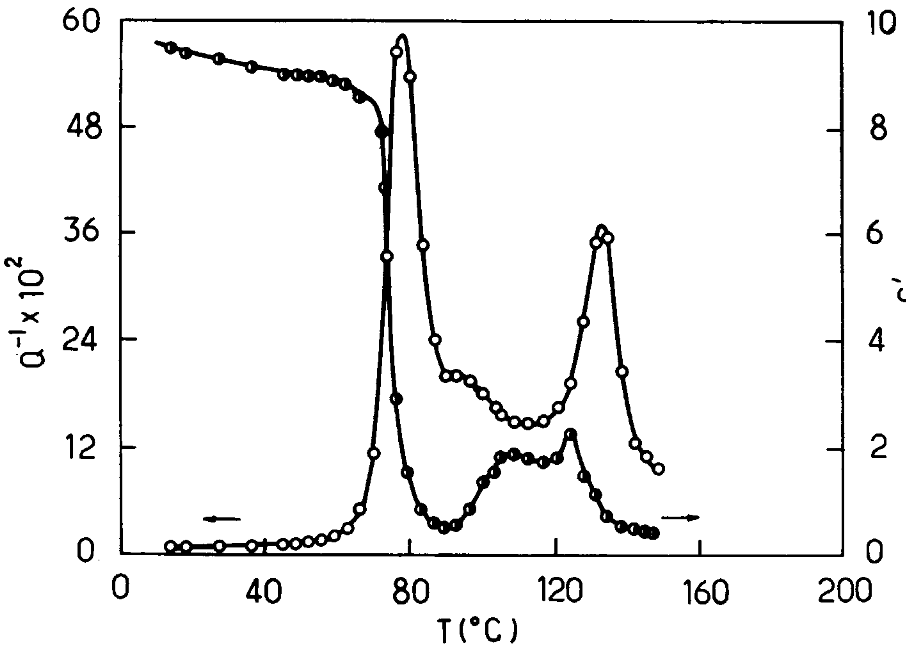

Figure 2 Glass transition internal friction peak and corresponding elastic modulus curve for 70 wt % PET blend. $f = 0.3$ Hz.

tion peaks due to glass transition as shown in Figure 2. It should be noticed that, in this case, a new small peak between them appears and the corresponding elastic modulus abnormally increases. The coexistence of two glass transition peaks due to PET and PC obviously differ from Nassar's results.[1] Even in a 85% PET blend, two distinct glass transition peaks are still observed, as shown in Figure 3. This evidence sufficiently indicates that, for PET/PC blends of all compositions, PET and PC are immiscible. In other words, there really exists considerable phase separation in such blends.

The different conclusion from Nassar's[1] can be ex-

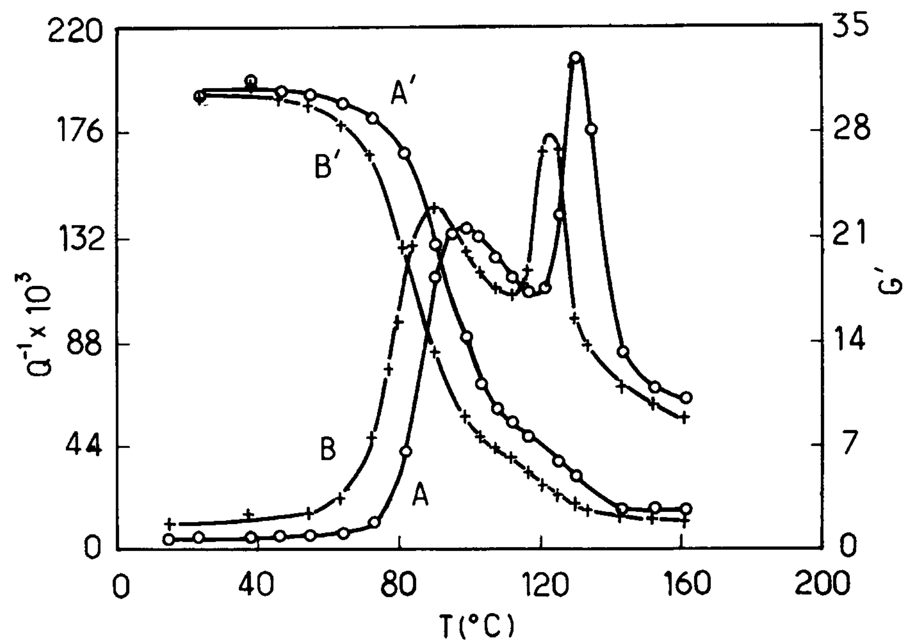

Figure 3 Effect of frequency on the glass transition internal friction peak and modulus for 85 wt % PET blend. Curves A–A', B–B': 3, 0.03 Hz.

plained when we notice the difference of frequency of measurement in two experiments. It can be seen from Figure 3 that two internal friction peaks shift with frequency of measurement in a nonlinear way, where the peak of PET shifts much more. As such, the two glass transition peaks can overlap to form a single internal friction peak at much higher frequency. In this case, such as 110 Hz in Ref. 1, an inappropriate conclusion that PET is miscible with PC might be made. Nevertheless, the limited degree of miscibility in such blends cannot be excluded. It is possible that an exchange reaction at molecular level has taken place. In addition, the drawing near of the two glass transition peaks and the appearance of the third internal friction peak for 70% PET blends may be evidence of the partial miscibility of PET and PC.

References

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