Similarities and Differences between the Aggregation States of PEES/PEEK Copolymers and Blends

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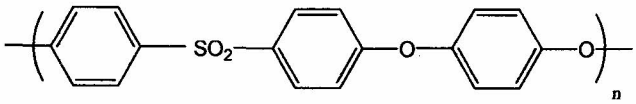
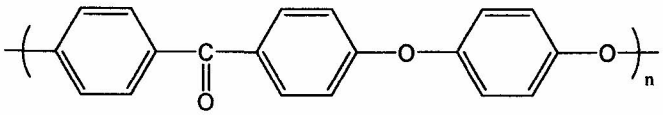
Abstract

Chemical structure of PEES (Poly ether ether sulfone)



Chemical structure of PEEK(Poly ether ether ketone)



It is obvious that the chemical structures of repeat units of the two polymers are very similar. The repeat unit of PEES consisted of three phenylene groups, two ether groups and one sulfone groups, and the repeat unit of PEEK consisted of three phenylene groups, two ether groups and one ketone groups, namely the sulfone group of PEES is displaced by the ketone group of PEEK. However, the small difference between their repeat units leads that their aggregation structures are different. PEES is amorphous polymer, but PEEK is semi-crystalline polymer.

In order to understand the effect of the chemical structure on aggregation structure, further research on the aggregation structure of the PEES/PEEK copolymers and blends was carried out.

1. DSC study for PEES/PEEK blends

The PEES/PEEK blend samples were prepared with the PEES/PEEK weight fraction ratio varying from 5/95 to 95/5, the thermal property of samples was measured by DSC. The result for PEES/PEEK (40/60) blend sample is shown in Figure 1. It can be seen that the PEES/PEEK (40/60) blend sample has two Tgs at about 150℃ and 200℃ respectively and one Tm at about 337℃ in Figure 1.

The above result suggested that the PEES/PEEK blend was incompatible system, which consisted of amorphous region of PEES (confirmed by the Tg at 200℃) and crystalline region of PEEK (confirmed by the Tg at 150℃ and Tm at 337℃).

The incompatibility between the aggregation structures of the PEES/PEEK blend system exists in all the samples with the PEES/PEEK weight fraction ratio varying from 5/95 to 95/5.

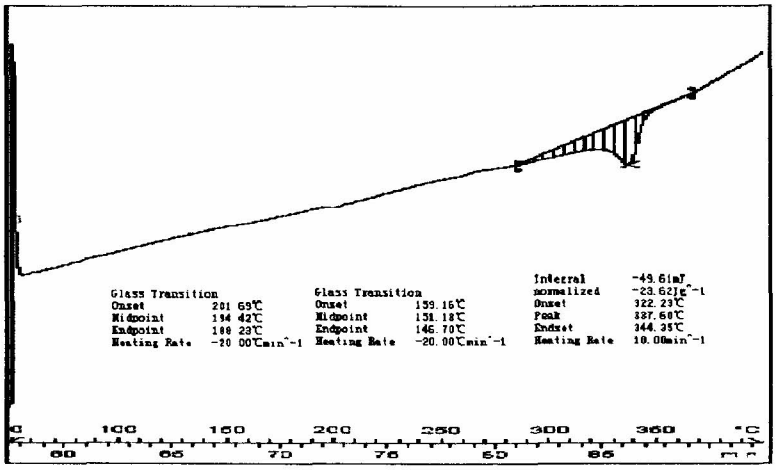


Figure 1 DSC thermographs for PEES/PEEK (40/60) blend sample

2. DSC study for PEES/PEEK copolymers

The chemical structure of PEES/PEEK random copolymers was the following: X was changed from 0.0 to 1.0. The copolymers of different composition were synthesized and were measured by DSC. The DSC result for the PEES/PEEK copolymer（x=0.4）is seen in Figure 2.

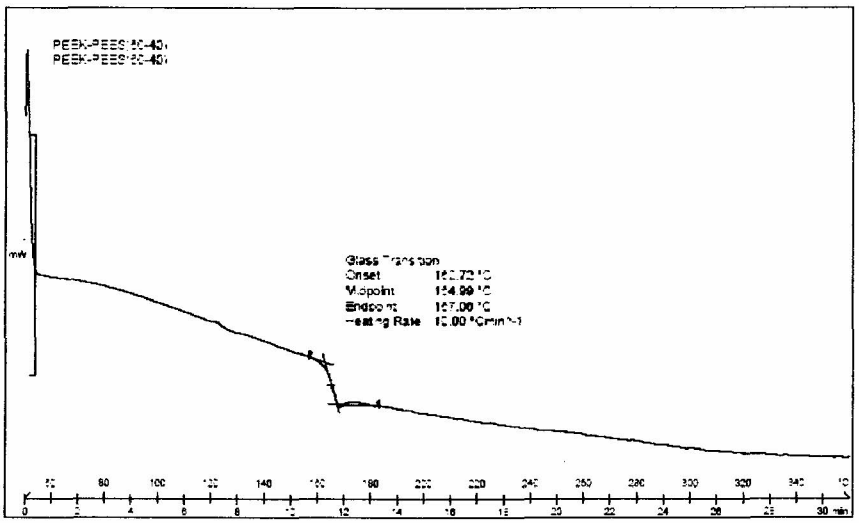


Figure 2 DSC thermographs for PEES/PEEK copolymer（x=0.4）

Only a single Tg at 164℃ is seen in Figure 2, the phenomenon shows the copolymer is homogeneous phase and amorphous structure, which is different from the blend of the same composition.

The results show that the copolymers （x>0.6）are homogeneous phase and amorphous structure, this origins that only a single Tg is seen. The results show that the copolymers （x<0.2） are homogeneous phase and crystalline structure , this origins that a single Tg and Tm are seen in Figure 3.

The detailed DSC data of all the copolymers are seen in Figure 4.

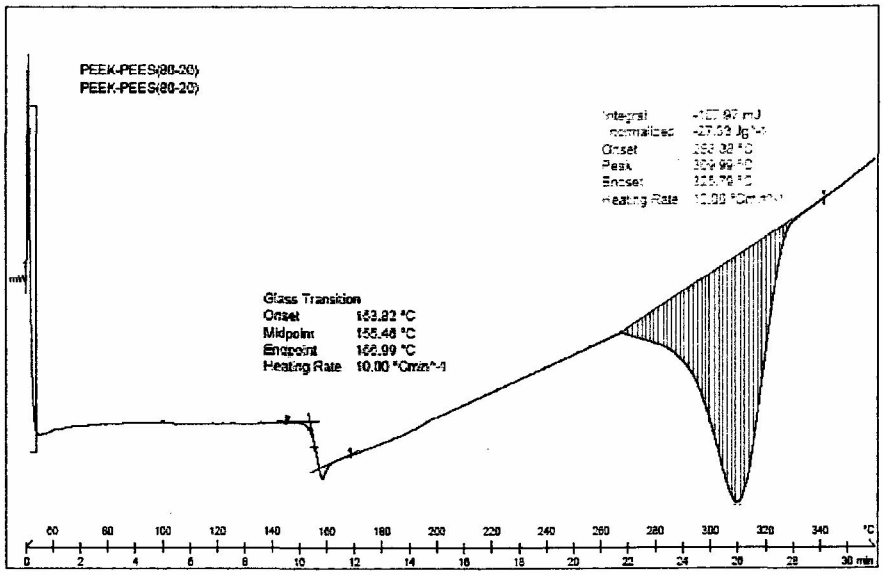


Figure 3 DSC thermographs for PEES/PEEK copolymer (x=0.2)

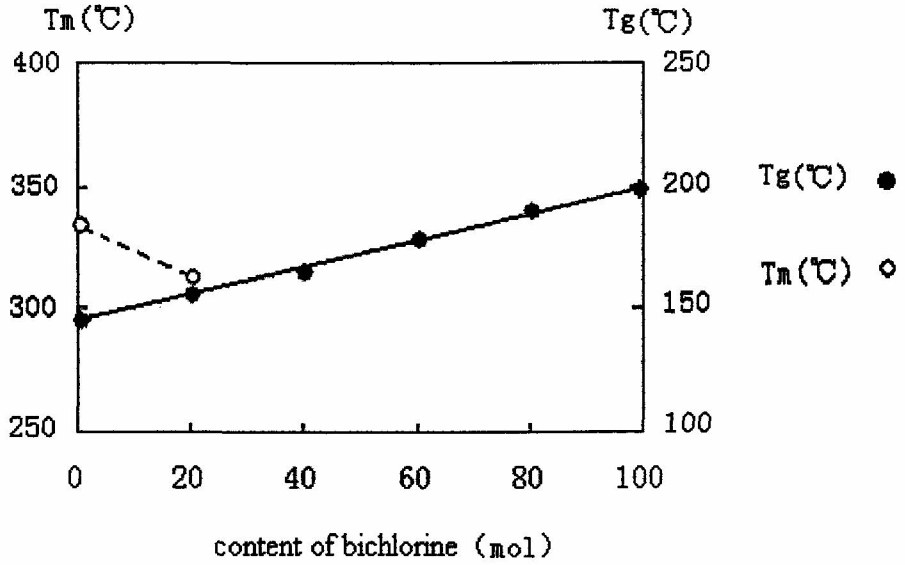


Figure 4 DSC thermographs for all PEES/PEEK copolymer

3. Conclusion

1. Although the chemical structure of PEES and PEEK are similar, the aggregation states of PEES and PEEK are amorphous and crystalline respectively, so two polymers with the PEES/PEEK weight fraction ratio varying from 5/95 to 95/5 are incompatible after blending.
2. For the PEES/PEEK random copolymer, the aggregation state of copolymer is amorphous ($x>0.6$) and the aggregation state of copolymer is crystalline ($x<0.2$). It is noticeable that all the copolymers are homogeneous phase.
3. When the random copolymers are changed into the alternate copolymer or the block copolymer, it is expected that the newly aggregation state appears. The work will be the research emphasis of us in the future.