Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Mechanical and Thermal Properties of Poly(Ethylene 2,6 Naphtalate) and Poly(Ethylene Terephtalate) Blends

Marek Szostak [a]

[a] Polymer Processing Laboratory, Institute of Materials Technology, Poznan University of Technology, Piotrowo 3, 61-138, Poznan, Poland

Version of record first published: 24 Sep 2006

To cite this article: Marek Szostak (2000): Mechanical and Thermal Properties of Poly(Ethylene 2,6 Naphtalate) and Poly(Ethylene Terephtalate) Blends, Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals, 354:1, 347-352

To link to this article: http://dx.doi.org/10.1080/10587250008023626

Mol. Cryst. and Liq. Cryst., 2000, Vol. 354, pp. 347-352
Reprints available directly from the publisher
Photocopying permitted by license only

Mechanical and Thermal Properties of Poly(Ethylene 2,6 Naphtalate) and Poly(Ethylene Terephtalate) Blends

MAREK SZOSTAK

Polymer Processing Laboratory, Institute of Materials Technology, Poznan University of Technology, Piotrowo 3, 61–138 Poznan, Poland

The paper presents the results of investigations of mechanical and thermal properties of poly(ethylene naphthalate) and poly(ethylene terephtalate) blends. The elongation, tensile and impact strength, Brinell hardness and thermal properties has been presented in this paper. It has been observed that thermal resistance of the blends improves with the increase of PEN share in the blends. The mechanical properties show the small increase with increasing the PEN share in the blends, only the elongation of the PEN/PET blends shows a great increase to compare with PET. DSC study show that all blends have double glass transition and melting temperatures and allowed to determine the crystalinity of the blends.

Keywords: mechanical and thermal properties; PEN/PET blends

INTRODUCTION

There has been great interest in polyester blends from viewpoints of industrial applications and academic interest. Many studies[1-3] have been focused on the miscibility and transestrification in polymer blends. The same concern also the PEN/PET blends[4-6], because in many industrial areas PET, PEN and their blends have been enjoying a wide variety of application for fibres, films and bottles. PET is an excellent material especially for beverage bottles and it's blends with PEN are expected to be still better, because of their low permeability toward oxygen. Unfortunatelly PEN is also much more expensive than PET and this has limited it use. One potential approach for

combining the atractive economics of PET with the better barrier and thermal properties of PEN is through blends of that polymers. In this paper the mechanical and thermal properties of PEN/PET blends and their phase behaviour was investigated.

EXPERIMENTAL

Samples used in this study were commercial grade PET with IV = 0,80 dl/g produced by Tongkook Corp. – South Korea and PEN with IV = 0,56 dl/g kindly supplied by Eastman Chemicals Company – Switzerland. The blends were prepared by injection molding using the Engel machine ES 80/20 HLS with L/D = 18 and D = 22mm. The barrel temperature warry from 270-290 °C. The following blends has been prepared : (0/100, 5/95, 10/90, 20/80, 35/65, 50/50, 75/25 and 100/0 wt./wt.) PEN/PET. The tensile strength and elongation has been measured on INSTRON-1115 tensile machine, Charpy's impact strength on impact hammer INSTRON - PW5, and Brinell hardness on the hardness equipment HPK 8206. The thermal analysis was performed on a Polymer Laboratories /England/ differential scaning calorimeter (DSC) and all scans were conducted at heating rate 10°C/min. The softening temperature of the blends have been measured using the VICAT methods. The applied load was 10N and the heating rate 10 °C/min.

RESULTS AND DISCUSSION

The results of mechanical properties of PEN/PET blends are presented at drawing 1-4. Figure 1 shows a high increase of elongation from 37% for PET samples to 180% for PEN samples. The bigest increase is observed for a small percentage share of PEN in PET blends (5-10%), after the influence of PEN on the elongation proces is much lower. On the figure 2 we can see the small increase of tensile strength from 54,5 MPa for PET to 60,6 MPa for PEN. The results for the blends are warrying between this values.

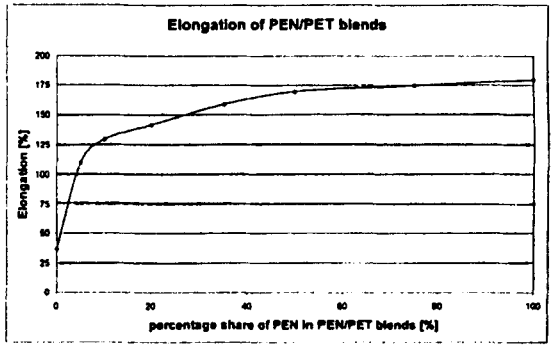

FIGURE 1 The elongation of PEN/PET blends.

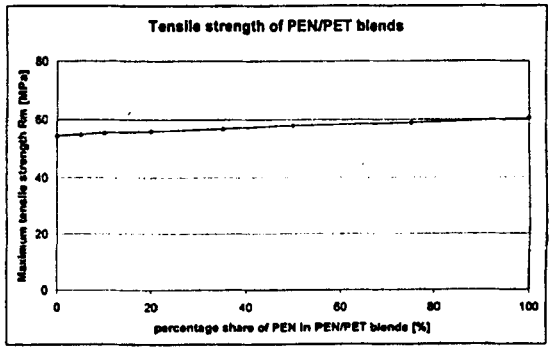

FIGURE 2 The tensile strength of PEN/PET blends

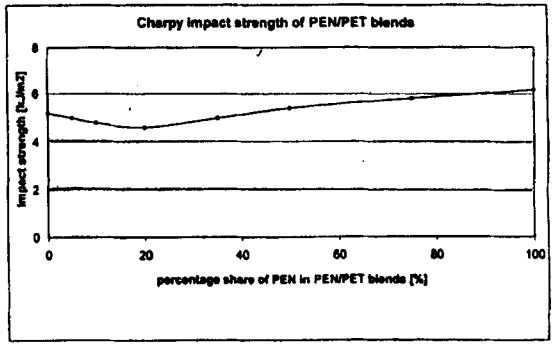

FIGURE 3 Charpy's impact strength of PEN/PET blends.

From the figure 3, we can see that impact strength increase from 5,2 kJ/m^2 for PET to 6,2 kJ/m^2 for PEN material, while figure 4 shows that the hardness has decrease from 90 HB for PET to 80 HB for PEN.

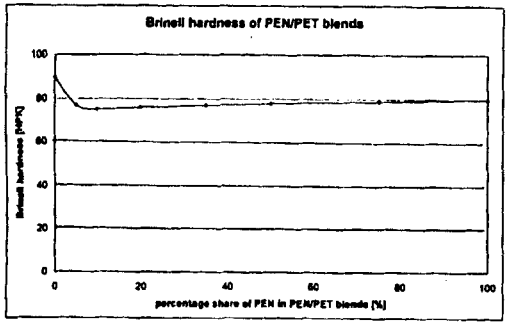

FIGURE 4 Brinell hardness of PEN/PET blends.

Summarizing the mechanical properties of PEN/PET blends, it's clearly see that adding the PEN material into PET we are increasing the plastic properties (elongation and impact strength) of the blends, keeping a good values of tensile strength and hardness.

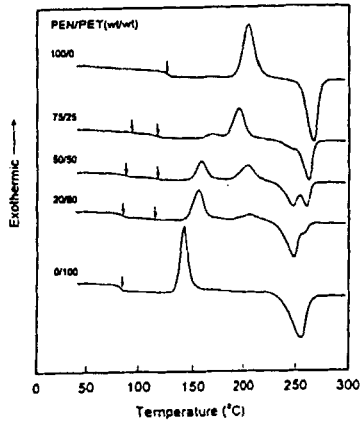

FIGURE 5 DSC curves for the PEN/PET blends. The arrows indicate the possition of the glass transition temperature.

Figure 5 shows the DSC curves obtained during heating the samples at heating rate 10°C/min. All the blend samples have double glass transitions, double cold-crystalization exotherms and double melting endotherms. This indicates that the blends obtained during injection process are immiscible.

The first T_g has been observed at 80°C and is responsible for PET glass transition, the second one at 121°C is connected with PEN phase. Also the melting temperature has two peaks: at 252°C, responsible for PET phase and at 266°C, responsible for PEN phase. The double cold-crystallization has been observed too.

The DSC study allowed to determine the crystallinity of clear polymers and their blends. The crystallinity for PET was 27%, for PEN 38% and the blends have the crystallinity between 32-34%.

The results of Vicat heat resistance test is shown in figure 6. As we can see on this figure, increasing the PEN share ratio in PEN/PET blends caused the increase of softening temperature from 76°C for PET to 120°C for PEN.

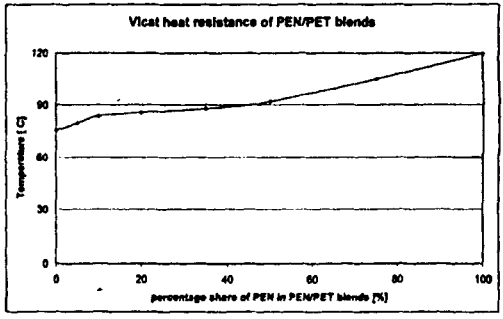

FIGURE 6 Vicat heat resistance of PEN/PET blends.

This increase of softening temperature is very important because, allowed to use PEN/PET blends for producing the bottles for hot filled beverages and juices .

Generally introducing the PEN material into PET allowed to obtain injection moulded pieces with high thermal resistance, very good elongation and impact strength and also good tensile strength and hardness. Such a results are also possible even for the blends with the share ratio 50/50 were PEN and PET are immiscible.

It must be remember that presence of PEN material in the blend cause the necessity of using the higher processing temperature and that the processing parameters have very big influence on the properties of obtained injection moulding parts.

CONCLUSIONS

1. The relationship between mechanical properties and composition ratio of PEN/PET blends was investigated.
2. It has been shown that elongation, tensile and impact strength increase with increasing PEN share in the blends. In contrary the hardness is decreasing.
3. The thermal resistant of PEN/PET blends also increase with increasing PEN share in blends.
4. The DSC study shown significant increse of crystallinity (from 27% to 38%) with increasing PEN share in PEN/PET blends.
5. The double glass transitions and melting temperature reflect the fact that PEN and PET are immiscible.
6. Taking into consideration the economic point of view, in industrial practice only the PEN/PET blends with small PEN share in them, can be used.

References

[1] J.S. Kollodg, R.S. Porter, *Macromolecules* 1995, **28,** p. 4097.
[2] J.S. Kollodg, R.S. Porter, *Macromolecules* 1995, **28,** p. 4106.
[3] J.L. Rodriguez, J.I. Equizubal, J. Nazabal, *Polymer Journal* 1996, **28,**p. 501.
[4] S. Lee, K. Yoon, H. Park, H. Kim, *Polymer* 1997, **38,** p. 4831.
[5] M. Okamoto, T. Kotali, *Polymer* 1997, **38,** p. 1357.
[6] J. Morikawa, Y. Husimoto, *Polymer*1997, **38,** p. 5397.