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THERMAL ANALYSIS OF THE INTERACTION BETWEEN COMPONENTS IN POLYPROPYLENE AND POLYETHYLENE BLENDS

G.M. Kerch[x] and L.A. Irgen, Institute of Polymer Mechanics
The Latvian SSR Academy of Sciences, Riga, USSR

ABSTRACT

Differential thermal analysis method was used to study the effect of the composition on the melting and crystallization of polypropylene (PP) and low density polyethylene (LDPE) binary blend components. The interaction between components results in the enhancement of the rate of nucleation, decrease of width of the melting peak and partial amorphization of blend components. Increase of tensile modulus has been observed not only in PP but also in the PP filled with chalk in the presence of small amounts of LDPE.

INTRODUCTION

The microstructure of polymer blends can have a significant influence on mechanical properties. The non-isothermal crystallization of components with variable composition of PP and LDPE blends has been studied in this work. It can be concluded also about the changes in crystalline structure from the investigation of melting behavior of the PP/LDPE blends. It was the objective of this work to try to relate mechanical properties with structural changes and crystallization behavior of polymer blends.

MEASURING METHODS

For the study of melting and crystallization of polymer blends the Derivatograph Model Paulik-Paulik-Erdey manufactured by MOM was used. Tensile modulus was measured with the help of a device for thermomechanical testing (I) at a frequency of 0.67 Hz.

RESULTS AND DISCUSSION

Some results of thermal analysis and mechanical testing of polymer blends are summarized in Figure I. The rate of nucleation of PP as judged by the value of initial slope of the crystallization exotherm S_i for the blends is higher than that for the PP

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sample and shows a maximum at 15% LDPE content. This is in a good agreement with the result obtained recently (2) for the blend of PP and high density polyethylene. The rate of nucleation of LDPE does not change in the presence of PP.

Crystallinity of PP and LDPE, as represented by the area under the melting peak divided by the mass A/m, decreases with increasing the second component content and has a minimum value for both components at 50:50 composition. Only small enhancement of crystallinity of LDPE filled with 54 wt.% of chalk has been observed in the presence of 30wt.% of PP. Density of PP/LDPE blends is an additive function of the initial density of the individual components despite of the partial amorphization of components in the blend. It is considered that the increase in the density of amorphous phase due to a certain level of interaction or compatibility in amorphous regions of components can compensate for the decrease of density due to the decrease of crystallinity.

The temperatures where the melting endotherm shows the peak do not change, but the temperatures $(T_s)_{PP}$ and $(T_s)_{LDPE}$, which are the temperatures where the DTA curve initially departs from the base line, have the pronounced enhancement with decreasing PP or LDPE content in blends indicating the increase of the mean size of crystallites and the reduction of the size distribution of crystallites. It can be concluded therefore that the structure of the components of PP/LDPE blends are more homogeneous than that for the pure PP and LDPE. Cooperation of components results in the increase of tensile modulus E of PP in the presence of small amounts of LDPE. Morphological changes in this range of compositions have been reported in the literature (3,4). Spherulitic structure of PP becomes increasingly irregular and coarse with increasing polyethylene content.

CONCLUSIONS

The PP/LDPE and PP/LDPE filled with chalk systems show the pronounced synergistic effect in their tensile modulus which can be related to the increase in density of amorphous phase in PP/LDPE blends, to the more homogeneous structure of components in the blends and to the appearance of compressive residual stresses in the polymer matrix due to enhancement of the rate of crystallization.

REFERENCES

I M.G. Ciprin, L.A. Irgen, G.M. Kerch and Ju.Ju. Silis, Mechanika kompozitnych materialov, (1979) 942
2 A.K. Gupta, V.B. Gupta, R.H. Peters, W.G. Harland and J.P. Berry, J. Appl. Polym. Sci., 27 (1982) 4669
3 O.F. Noel and J.F. Carley, Pol. Eng. Sci., 24 (1984) 488
4 A.J. Lovinger and M.L. Williams, J. Appl. Sci., 25 (1980) 1703

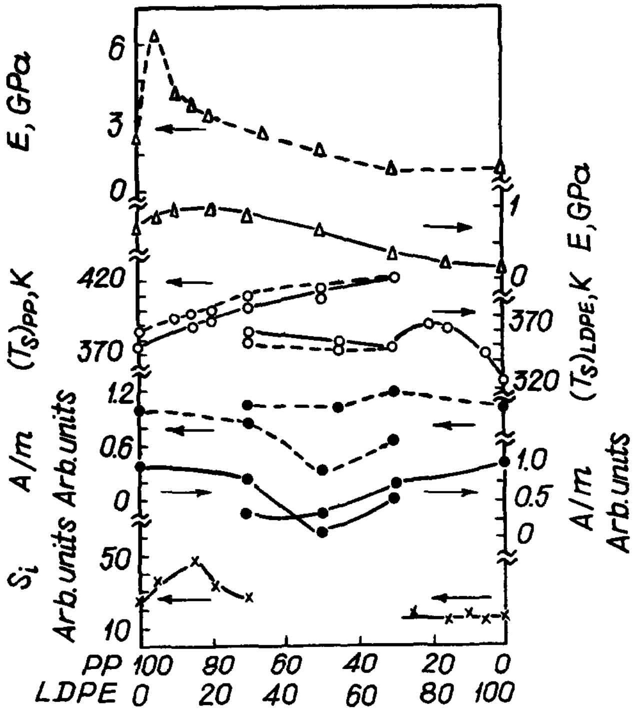

Fig.I. Variation of tensile modulus E, the temperatures of starting of melting for both components $(T_S)_{PP}$ and $(T_S)_{LDPE}$, the areas under melting peak divided by the mass $(A/m)_{PP}$ and $(A/m)_{LDPE}$ and initial slope S_i of crystallization exotherms in arbitrary units with composition for PP/LDPE blends (———) and for PP/LDPE blends containing 54 wt % of chalk (- - -).