Index

COMPATIBILIZATION OF POLYAMIDE 6,6 /LINEAR LOW-DENSITY POLYETHYLENE BLEND BY ELECTRON IRRADIATION.

E. Segura Pino and M. Aparecida Colombo
Centro de Tecnologia das Radiações
Instituto de Pesquisas Energéticas e Nucleares, IPEN-CNEN/SP
Av. Prof. Lineu Prestes 2.242
05508-900 Cidade Universitária, São Paulo, SP, Brazil

espino@net.ipen.br

ABSTRACT

Polymer blending is a growing scientific and commercial development activity. In most cases, polymeric blends are formed by thermodynamically immiscible components. Such blends require the use of compatibiliezers that, often, are copolymers, graft copolymers or any means that improve the dispersion and adhesion of blend phases. Compatibility of a polymer blend plays an important role in determining the blend properties for their end use. In this work, the compatibilization of the polyamide 6,6/low-density polyethylene blend, using electron radiation, was carried out. Samples for mechanical test, with 75/25 %wt/wt composition were melt mixed in an extruder and then injection-molded. These samples were electron irradiated to doses of 50, 100, 150, and 200kGy. The tensile measurements show that the strength at break increases with an increase of the radiation doses. On the other hand, the elongation at break shows a rapid standing decrease as a function of the doses. Comparing these results with those obtained with no irradiated samples we have found an improvement of the mechanical properties of the PA6,6/LLDPE blend. We consider that the carboxylic groups produced in the polyethylene chains, during irradiation, react with the end amine end groups of the polyamide, acting as an interfacial bonding stabilizing this blend system.

Keywords: electron irradiation, polyamide, polyethylene, blend, compatibilization

I. INTRODUCTION

The main objective of polymer blending is to obtain commercially products having a good range of properties with a low cost/price ratio and to allow the recycling of degraded polymeric materials [1]. In most cases, the major problem in polymer blending is the immiscibility of its components mainly due to their extremely different chemical structure, which sets a thermodynamically unfavourable conditions for miscibility. Considerable efforts have been made to improve the miscibility among the blend components. The improvement of miscibility between the polymer components and the enhancement of blend performance is called compatibilization of the blend. This compatibilization can be achieved using copolymers, graft copolymers, or any other means, like irradiation, that will improve the dispersion and adhesion of the blend phases [2][3]. The performance of the compatibilization processes will depend of the physical and chemical interactions across the phase boundary, which, at the end, will determine the blend properties.

Blends based on expensive engineering thermoplastics, such as polyamides, and low cost polyolefins are very important polymeric systems, witch makes possible to obtain materials in a wide range of physical and mechanical properties at low cost, and also allows the recycling of wasted raw materials. Polyolefins improve the mechanical properties of the polyamide, and the polyamide increases the resistance to oxygen permeability, resulting in an adequate material for the packaging industry. Unfortunately, polyamides and polyolefins form highly incompatible blends due to its extremely different chemical structures, thus many efforts have been devoted to compatibilize such blends [4]. In this work, the compatibilization of the polyamide 6,6/linear low-density polyethylene blend, using ionizing radiation, and their mechanical performance were carried out.

Index

II. EXPERIMENTAL

The materials used used in this work were polyamide 6,6 (A216) and linear-low-density polyethylene (Dowlex 2500). Blends with composition PA6,6/LLDPE 75/25% wt/wt were prepared by melt mixing at 260°C during 15 minutes, using a Refenhauser extruder. The dumbbell-shaped specimens for tensile tests were injection-molded using a Battenfeld injector. These specimens were electron irradiated in air, at the IPEN-CTR irradiation facilities, to doses of 50, 100, 150, and 200kGy. After irradiation these specimens were kept at 23°C and 50% humidity for 40 hours before being mechanical tested. The tensile strength properties were done according to the ASTM D-638 standard, using an Instron Universal Testing Machine (Model Emic MEN – 10000). All measurements were carried out in air, at room temperature, crosshead speed of 50mm/min, and with a load module of 2000 N.

III. RESULT AND DISCUSSION

The tensile properties at break of the blend, as a function of radiation doses, are reported in Table I.

TABLE I. Tensile properties at break of PA6,6/LLDPE Blend.

DOSE [kGy]	STRESS AT BREAK [MPa]	STRAIN AT BREAK [%]
0	10	340
50	12	300
100	15	220
150	18	190
200	20	180

The tensile strength and elongation at break are reported graphically in Fig. 1 and 2 respectively.

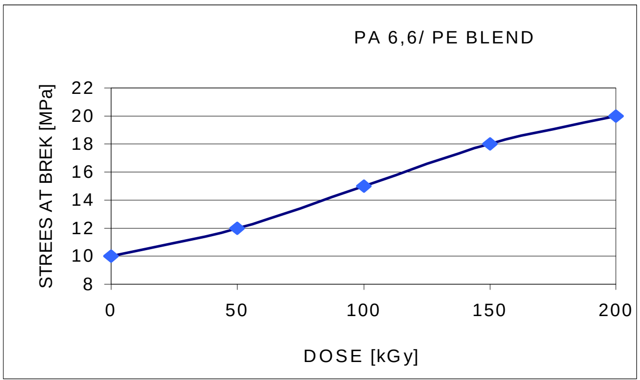

Figure 1. Tensile Strength at break of blend as a function of radiation doses.

In Fig.1, the tensile strength at break increases in a continuous way as the radiation doses increase. In the radiation doses range of 0 to 200kGy the improvement of the tensile strength at break increases in about 100% from the value of the no irradiated sample.

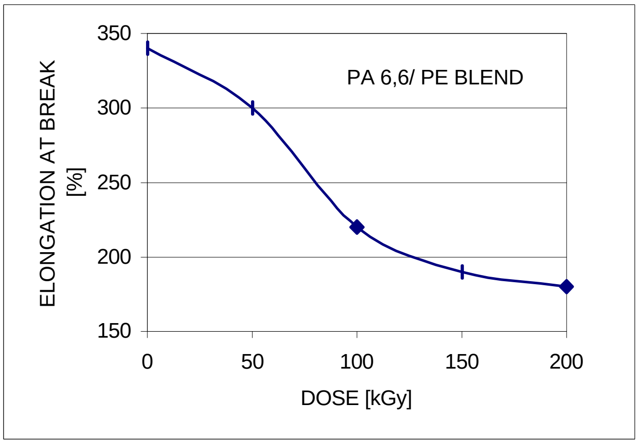

Figure 2. Elongation at break of PA6,6/LLDPE blend as a function of radiation dose.

In Fig. 2, the elongation at break shows a decrease of the value of the no irradiated sample, up to about 50% when the radiation dose reachs 200kGy.

The mechanical performance measured on the irradiated blend, and presented in Figures 1 and 2, can be attributed to chemical reactions that occur during the electron irradiation, mainly due to the interaction of the carboxylic groups formed in the polyethylene chains and the amine groups of the polyamide [4]. This results in an improvement of the adhesion between the blend continous phases. An effect that also contributes to the mechanical behavior of the irradiated blend is the amount of cross-linking, induced by radiation in each blend components, witch increases with the doses, and provides more rigidity to the blend.

IV. CONCLUSIONS

The experimental results in this work, on the improvement of the tensile properties of the irradiated blend, suggest the possibility of the use of electron irradiation to enhance the low compatibility between polyamide and polyethylene. This compatibilization effect is generally attributed to the chemical interactions of the oxidized functional groups, mainly carboxylic groups, induced in the irradiated polyethylene chains and the amine end groups of the polyamide, producing a graft copolymers which reinforce the adhesion between the polymer phases. Another effect of the ionizing radiation is the amount of cross-link, induced in each blend component during irradiation, which result in an increase of the rigidity of the blend with improvement on its mechanical performance.

Index

REFERENCES

[1] Paul, D.R.; Newman, S. **Polymer Blends**, Vol.I,Academic Press: New York, 1978.

[2] D.R. Paul, **in Polymer Blends**, D.R. Paul and S. Newman, Eds., Academic Press, New York, 1978, Chap. 12.

[3] D. Curto, A. Valenza, and F.P. La Mantia, **Blends of Nylon 6 with a Polyethylene Functionalized by Photooxidation**, Journal of Applied Polymer Science, Vol.39, 1990.

[4] G. Spadaro, D. Acierno, C. Dispenza, E. Calderaro and A. Valenza, **Physical and Structural Charcterization of Blends made with Polyamide 6 and Gamma Irradiated Poilyethylenes**, Radiat. Phys. Chem., Vol. 48, No2, 1996.