Mechanical Properties of Electron Beam Irradiated Polyamide 6,6

Eddy Segura Pino and Maria A. S. Colombo

Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN-SP) São Paulo, SP, Brazil, espino@ipen.br

OBJECTIVE

To apply the ionizing radiation to improve the natural mechanical properties of polyamide 6,6. Also, to evaluate the irradiation parameters, and the mechanical performance of the irradiated polymer in order to use the cross-linking, induced by ionizing radiation, as substitute of additives and fillers.

INTRODUCTION

• Radiation Processing has been applied to improve product quality, energy saving and to manufacture products with special properties as a result of inducing reactions in solid state at room temperature;

• This radiation processing brings, many advantages comparing to the conventional chemical processing;

INTRODUCTION

- Polyamide 6,6 due to its excellent mechanical, thermal and electrical properties and its great performance in multiple industrial applications is considered one of the most important engineering polymer;

- However, in specific applications, some of its properties need to be improved by means of additives or fillers to reach the required properties, which also increase its final cost.

EXPERIMENTAL

• Samples

The material used in this work was Polyamide 6,6 without additives. Samples for the mechanical tests were injection-molded using a Battenfeld injector;

• EB irradiation conditions

EB irradiation was carried out at the IPEN facilities using a Dynamitron JOB 188 electron accelerator with 1.5 MeV and 37.5 kW, and the overall doses were 70, 100, 150, and 200 kGy. These irradiated samples were conditioned at 23°C and 50% humidity for 40 hours before being mechanically tested.

EXPERIMENTAL

- **Mechanical tests**

Tensile strength measurements were made with an EMIC Universal Testing Machine, model MEM-10000. Izod Impact measurements were carried out with notched samples. Hardness Shore D was measured with a Zwick equipment using a load of 1kgf for 10 seconds. Wear measurements were made with an abrasion tip, using a load of 250 g for 3 h.

All measurements were carried out in air and at room temperature.

RESULTS AND DISCUSSION

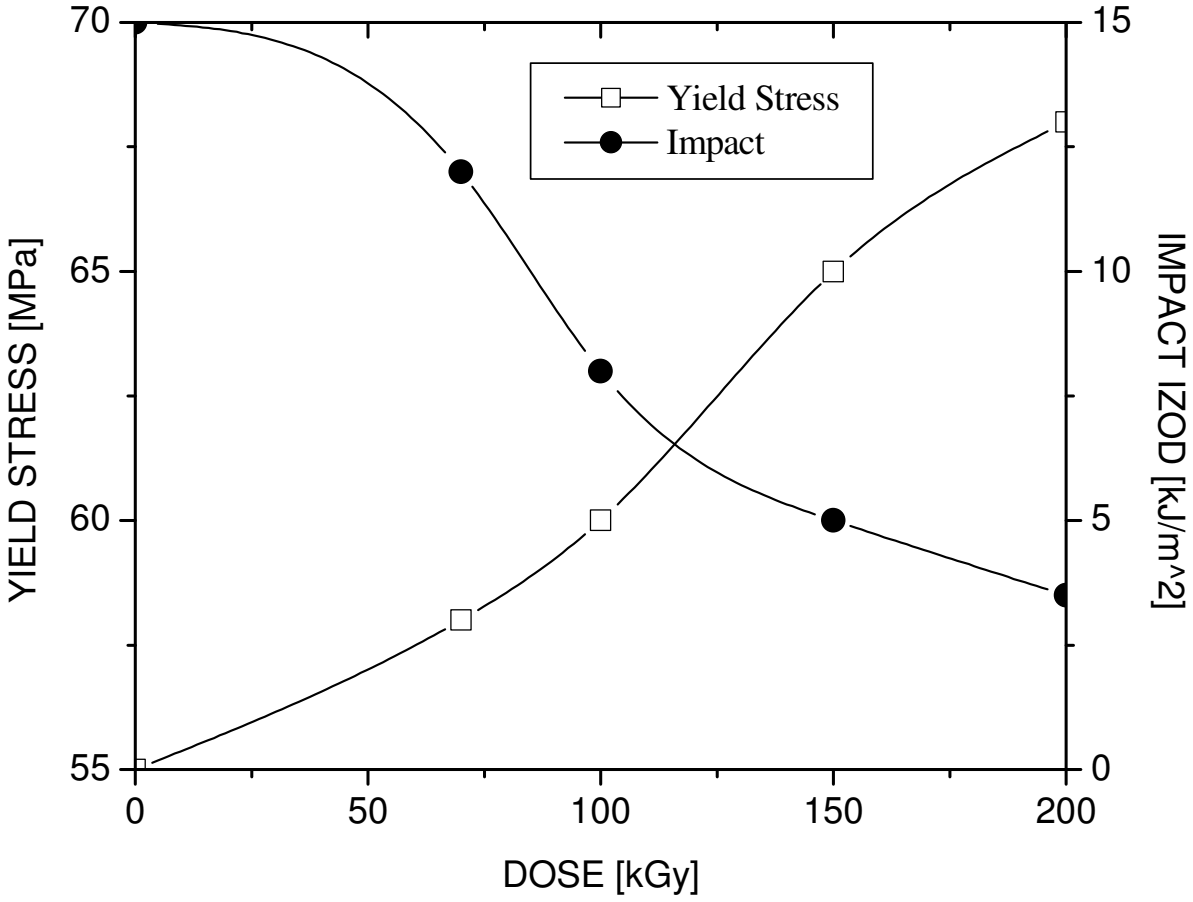

Fig.1 Yield Stress and Impact behavior of Polyamide 6,6 as function of radiation dose.

RESULTS AND DISCUSSION

Figure 1 shows that the yield stress, of the tensile measurements, increases continuously up to about 24 % of the value of non-irradiated samples in the dose range applied. In this same dose range, the impact values decreases relatively fast from 15 to about 8 kJ m^{-2} in a doses range from 0 to about 100 kGy and then the decay is slow up to 3.5 kJ m^{-2} at 200 kGy. The total decrease is about 77 %.

RESULTS AND DISCUSSION

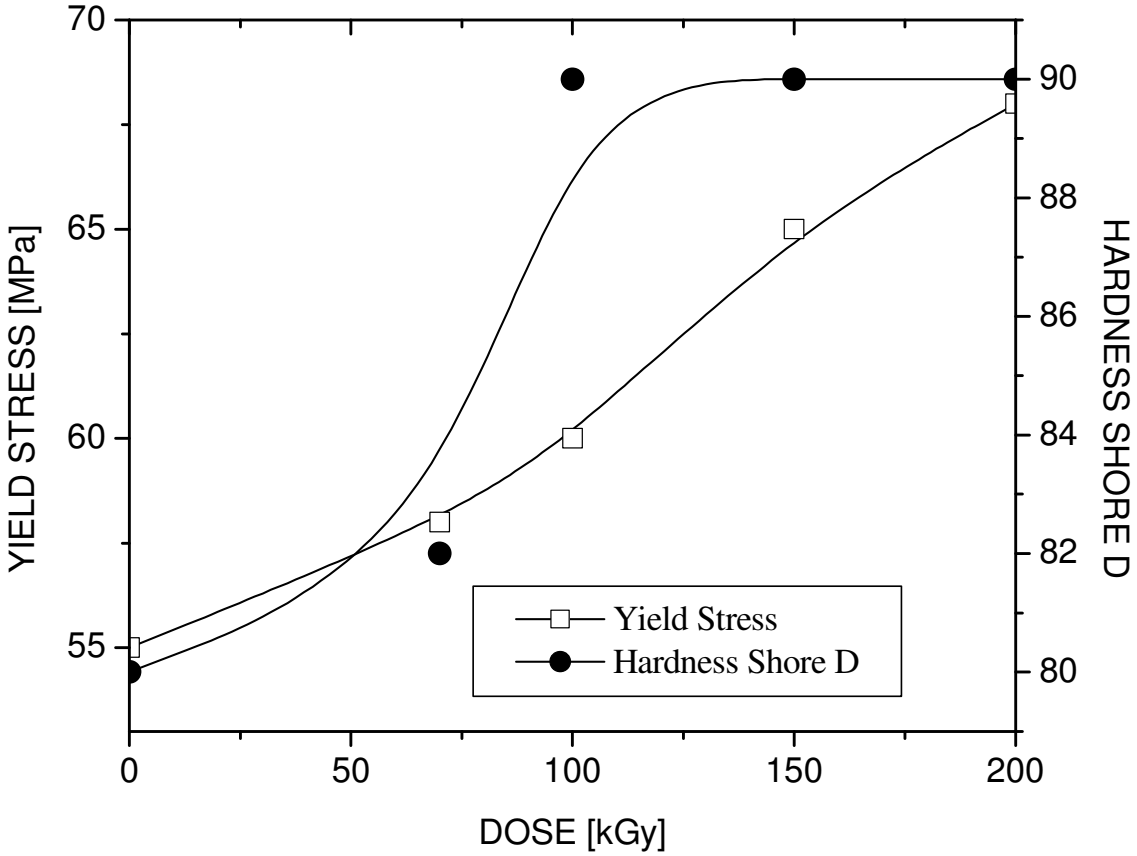

Fig.2 Yield Stress and Hardness behavior of Polyamide 6,6 as function of radiation dose.

RESULTS AND DISCUSSION

Fig. 2 shows that the Shore D hardness values increase only 13 % as compared with the values of the non-irradiated samples, in this dose range studied. Beside that, above 100 kGy these values remain stable at about 90. The crosslinking density data reach its maximum value about 120 kGy and it is at this dose that the hardness also reaches its maximum value, remaining constant up to 200 kGy.

RESULTS AND DISCUSSION

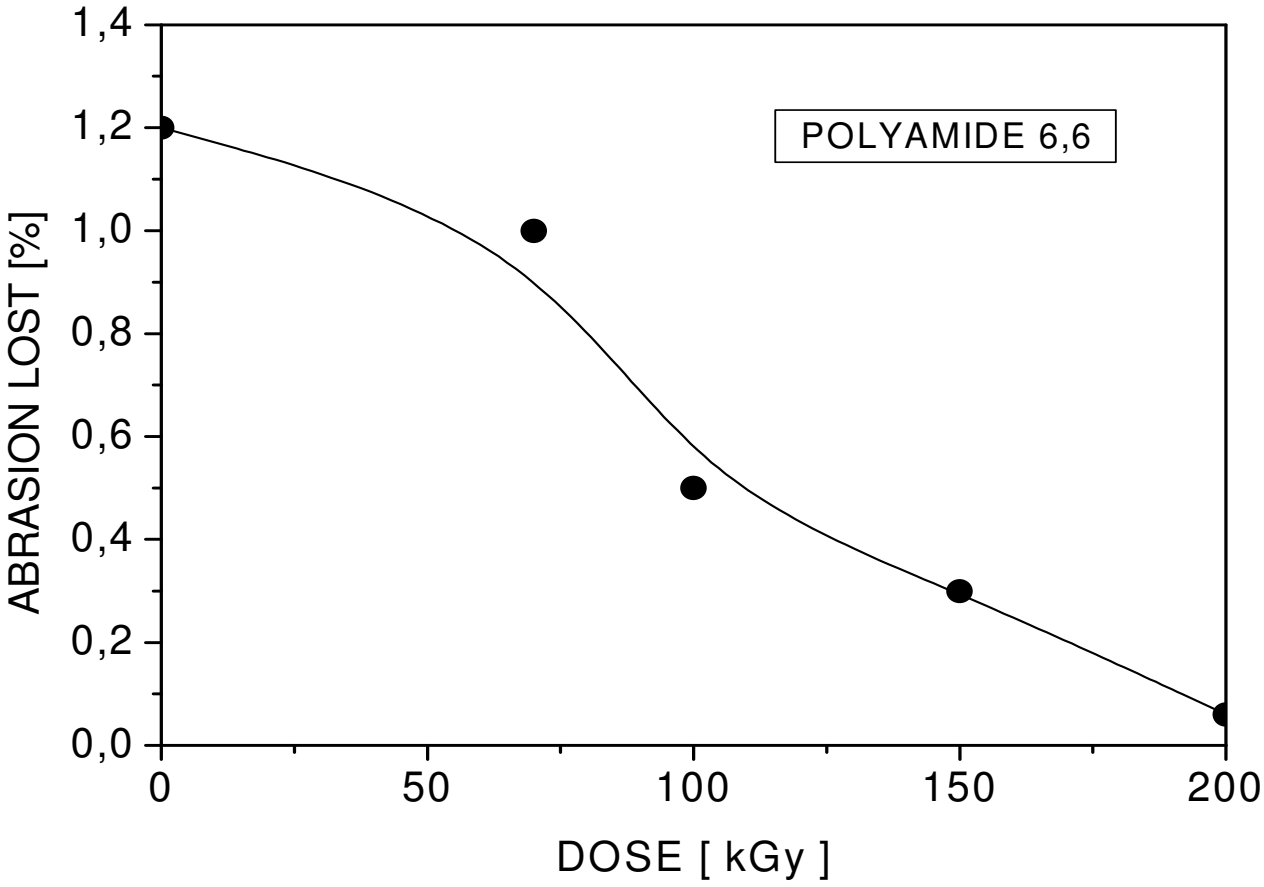

Fig. 3 Wear behavior of Polyamide 6,6 as function of radiation dose.

RESULTS AND DISCUSSION

Figure 3 shows the wear measurements data. It was observed that the abrasion loss decrease 20 times between 0 and 200 kGy. This result was the most important effect produced by the electron beam irradiation on the surface properties of Polyamide 6,6.

CONCLUSIONS

• The experimental results of this work have shown that, the ionizing radiation in the dose range from 0 to 200 kGy, improves tensile strength, hardness and resistance to abrasion of Polyamide 6,6;

• On the other hand, the radiation induced cross-linking has a negative effect on the impact properties of this polymer;

• Therefore, it can be stated that, the cross-linking induced by radiation can replace efficiently the use of additives or fillers to improve some mechanical properties of Polyamide 6,6.

REFERENCES

[1] UENO, K., “The Radiation Crosslinking Process and New Products”, Radiat. Phys. Chem. **35** (1990) 126-131.

[2] MACHI, S., “New Trends of Radiation Processing Applications”, Radiat. Phys.Chem. **47** (1996) 333-336.

[3] TABATA, Y., “Fundamentals of Radiation Chemistry”, Radiat. Phys. Chem. **18** (1981) 43-58.

[4] WELGOS. R.J., “Polyamides, Plastics”, Encyclopedia of Polymers Science and Engineering, Vol. 11 (KROSCHWITZ, J.I, Executive Editor), Wiley &Sons, New York (1990) 445-476.