Study of polypropylene modified in the presence of acetylene by gamma irradiation.

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PP has been used in various applications instead of polyvinylchloride, polyurethane or polyethylene. However, PP as linear polymer exhibits low melt strength. One of the effective approaches to achieve high melt strength is to add long chain branches onto backbone species using gamma radiation. Branching and grafting result from the formation of the structure, as a result of macroradicals combinations during irradiation process. Crosslinking and main chain scission in the polymer structure are also obtained during this process.

In this paper the gamma radiation technique was used to induce chemical changes in a polypropylene in an acetylene atmosphere. Acetylene was injected into polyethylene bags with H-503 PP. These samples were irradiated with a ^{60}Co source from Embrarad, at doses of 15, 20 and 50 kGy.

The crosslinking of polymer was studied by measuring gel content and this showed an increase with increasing dose value in the samples. Changes in the rheological properties of theses samples were observed as a function of melt strength and drawability obtained with a Rheotens apparatus and of melt index measurements.

The melt flow rate of the modified polypropylene was measured in a Melt flow equipment in which the samples were allowed to flow through a 2.00 mm diameter orifice in 10.0 min under a load of 2.16 Kg at 230°C (ASTM D 1238).

In the rheotens test, the tensile force needed to elongate of an extruded polymer filament was measured as a function of the draw ratio. The polymer was extruded in a Haake reometer (screw diameter) in combination with an Rheotens Mod. 71.97 (Göttfert). The extrusion melt temperature was 180°C and the die velocity varied between 40.0 at 575.0 $mm.s^{-1}$. It can be assumed that cooling of the extruded strand in the spinline is small, and therefore the polymer melt is elongated under isothermal conditions.

Gel content of the irradiated polymer was determined by extracting the soluble components in boiling xylene for 24 h at 135°C. After that, the residue was dried until constant weight for 24 hours. Six samples were used to determine the average gel content at each dose (ASTM D 2765).

Table 1- Results of melt index, melt strength, drawability and gel content.

	Melt index (g/10min)	**Melt strength (cN)**	**Drawability (cm/s)**	**Gel content (%)**
H-503	13	8,3	10,5	-
(H-503 + Acetylene) 15 kGy	229	5,2	14,2	1,1
(H-503 + Acetylene) 20 kGy	145	5,6	9,6	2,2
(H-503 + Acetylene) 50 kGy	35	5,8	6,6	7,8

Figures illustrate that H-503 polymer could not be effectively branched and grafted at these doses in the presence of acetylene. It can be clearly seen that H-503 samples irradiated in presence of acetylene at 15 and 20 kGy, main chain scissions are greatly promoted and this leads to decrease in molecular weight with consequent increase in melt index.

At 50 kGy, crosslinking process predominates. Hence, melt index and drawability decrease and the gel content increases.

Branching, grafting, crosslinking and main chain scissions processes compete and the process that predominates depends on the polymer type as well as applied dose, dose rate, radiation type and temperature. However, in this work an alternative for decrease the degradation behavior is to add antioxidant on spheres resin before radiation process.

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References

1. D. Han; S. Shin, S. Petrov *J. Rad. Phys. Chem.* 2004, *69*, 239.
2. S. Muke; I. Ivanov, N. Kao, S.N. Bhattacharya *J. Non-Newtonian Fluid Mech.* 2001, *101*, 73.
3. M. Rätzsch, M. Arnold, E. Borsig, H. Bucka, N. Reichelt. *Prog. Polym. Sci, 2002, 27,* 1195.