HMSPP - NEW DEVELOPMENTS

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Polypropylene is a widely used thermoplastic due to its low cost and versatile properties, but it is often used in applications that require technical characteristics. Conventional PP shows poorer rheological properties in the molten state, which make it difficult to process by some methods such as calendering, injection moulding, thermoforming, foam formation, etc. It's a typical polymer suitable for cross-linking, grafting or degradation reactions with ionizing irradiation in the presence of polyfunctional monomers or peroxide alone. The aim of PP cross-linking was to improve some of its physico-mechanical properties, like reduced cold flow and increased impact resistance that might also result in preparation of PP foam materials. The chemical modification initiated by radicals and grafting of isotactic polypropylene (iPP) and other polyolefines in the solid state has been reviewed and discussed in the literature. Different technologies to obtain modified polymers, especially polypropylene, are also well known. In the last years, a new family of modified PP was developed, the well-known high melt strength polypropylene (HMS-PP). This product is characterized by a small content of long-chain branches and high polydispersity; the presence of long-chains has an enormous influence on its melt properties. There are many routes for production of HMS-PP; some were develop by Montell (now Bassell), by Borealis and by Dow Chemical. Montell introduced long-chain branches by radical reactions using an electron beam radiation process. A novel way of monomer grafting during the radical-driven reactions of PP with peroxides to create long-chain branches was develop by Borealis (Daploy). Recently, Dow Chemical introduced a new grade of branched PP (Inspire). It is well know that the physical and mechanical properties of a polymeric material are strongly dependent on its structure, morphology and relaxation process, which reflect its internal changes and molecular motions. These properties maybe study in the molten state, for example, by measuring melt flow rate (MFR), G' (storage modulus), G"(loss modulus), melt strength, elongational viscosity and *(complex viscosity) over the frequency range 10^{-2}-10^{3} s^{-1}. In this sense, (FIG.1) shows melt strength as a function a draw velocity for random PP in acetylene and nitrogen atmosphere. The doses were 25 to 200 kGy.

From the melt strength results shown in (FIG.1) and (TAB.1) it can be observed that samples A075 and A200 have higher melt strength and drawability than pure RP. This is probably due to the presence of grafting and branching chains on those samples. On the other hand, in samples A50, A100, N50, N100 and N200 drawability is higher and the melt strength values are lower when compared with pure RP. This behavior may be ascribed to the dependence of PP melt strength on its molecular weight, polydispersity, degree of long-chain branches and entanglement density. However, the melt extensibility strongly depends on the existence of a high level of molecule entanglements. The melt processing will lead to the entanglement and homogenization of the products. Thus, the melt strength is sensitive to processing conditions, and the level of melt drawability is not as sensitive to the modification level as the melt strength. In this sense, the drawability values obtained for samples A50, A100, N50, N100 and N200 are coherent. In other words, smaller drawability arises from higher degradation process.

The complex viscosity curves for all samples are plotted in (FIG.2) as a function of angular frequency at 200°C and a constant strain of 10%. Under this condition samples A075, A025 and A50 showed higher zero-shear viscosity than pure RP. Consequently, it may be considered that they present high average molar mass. Additionally, complex viscosity agrees with the melt strength and drawability values of sample A075, despite the fact that these values were obtained at different temperatures (180 and 200°C).

TABLE 1 - Influence of different irradiation doses in the melt flow rate of ethylene-propylene copolymer, under acetylene and nitrogen atmospheres.

SAMPLES	DOSE (kGy)	MFR (g/10 min.)
RP-Pure	-	1.50
A025	2.5	1.70
A075	7.5	0.82
A050	50.0	1.60
A100	100.0	1.70
A200	200.0	1.30
N50	50.0	2.20
N100	100.0	3.10
N200	200.0	3.90

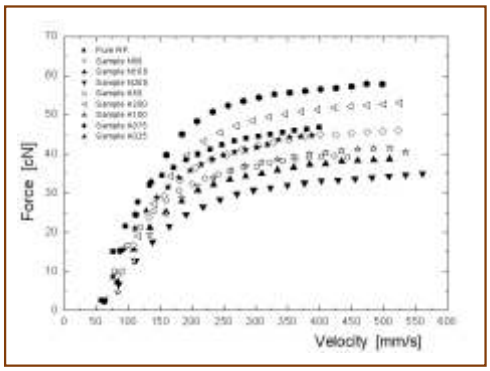

FIGURE 1 - Melt strength of modified iPP-random at different irradiation doses and two distinct atmospheres (acetylene and nitrogen), as a function of draw velocity at 180 °C.

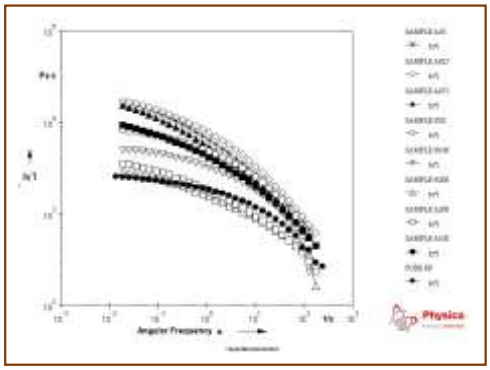

FIGURE 2 - Evolution of the complex viscosity curves as a function of angular frequency for all samples, at 200 °C.