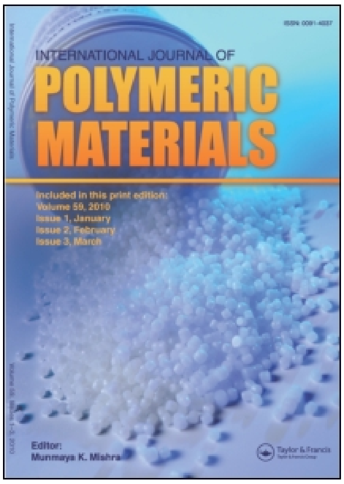

International Journal of Polymeric Materials
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713647664

PP/Rosin Blends: Mechanical and Rheological Properties

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To cite this Article Mendes, L. C. , Cardoso, R. S. , Chagas, B. S. , Oliveira, M. L. C. and Moares, G. F.(2000) 'PP/Rosin Blends: Mechanical and Rheological Properties', International Journal of Polymeric Materials, 46: 1, 395 — 402
To link to this Article: DOI: 10.1080/00914030008054869
URL: http://dx.doi.org/10.1080/00914030008054869

Intern. J. Polymeric Mater., 2000, Vol. 46, pp. 395-402
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PP/Rosin Blends: Mechanical and Rheological Properties

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(Received 10 December 1998)

Melting mixtures of polypropylene (PP) and glycerol ester of hydrogenated rosin (ester gum) were prepared under select conditions using up to 50% of rosin. The addition of modified rosin on PP increased the elastic modulus which maximum value was observed in the 70/30 PP/ROSIN blend. The stress dropped monotonically with rosin content. Above 10% rosin, the elongation at yield diminished and reached a constant value. The elongation at break dropped abruptly above 10% of rosin. The density and hardness of blends increased with amount of rosin. The melt flow index of blends increased exponentially with the rosin content while the torque decreased monotonically with the composition and the processability was improved.

Keywords: Polypropylene; rosin; blend; mechanical properties; rheology

INTRODUCTION

In our laboratory we study the effect of low molecular weight resins on polyolefins. Recently, the morphology, mechanical and thermal behavior of high density polyethylene (HDPE)/oligo(ciclopentadiene) (HOCP) and PP/HOCP blends were studied [1-3]. These systems were partially miscible and an increase in elastic modulus was detected. The action of HOCP on the morphology of iPP/HDPE binary blends was also investigated [4]. The morphology, mechanical and rheological properties of HDPE/ROSIN (ester) blends prepared by melt mixing

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were presented in previous work [5]. The morphology, thermal and dynamic-mechanical behavior of HDPE/ROSIN (ester) mixtures were also presented in another paper [6]. The aim of this work is to show the mechanical and rheological properties of PP/ROSIN (ester) blends.

EXPERIMENTAL

Materials

Commercial polypropylene (PP) produced by OPP Petroquímica S.A., Brazil, density = 0.9 g/cm^3, degree of crystallinity = 40% (by DSC), rockwell hardness = 101 (R scale), melt flow index (MFI) = 3,5 g/10 min.

Commercial glycerol ester of partially hydrogenated rosin (ester gum) was by Hercules Inc., Brazil; M_w = 1190, M_n = 920 (by GPC), density = 1.1 g/cm^3, color WG, acid number [7] = 8.7, softening point [8] = 101.5°C.

Blend Preparation

The blends were prepared by melt mixing in a Haake Rheocord 9000 at 200°C, 32 rpm for 10 minutes. The following PP/ROSIN w/w ratios were blended: 100/0, 90/10, 80/20, 70/30, 60/40 and 50/50.

Specimen Preparation

Sheets of 9 × 7 × 0.1 cm were compression moulded. The sample was left for 5 minutes at 220°C without pressure to melt completely. After this, a pressure of 2.5 MPa was applied for 5 minutes and then cooled in air to 110°C. Finally, the mold was put in another press with water circulation to reach room temperature.

Mechanical Test

Tensile parameters were obtained using an Instron machine (model 4204), according to ASTM D 1708-93 [9]. The cross head speed and gage length were 10 mm/min and 22.25 mm, respectively. The mechanical parameters were calculated using the average of 10 specimens.

Density

The density was evaluated according to ASTM D 297-81 [10].

Hardness

The hardness was measured according to ASTM D 2240-86 [11], using durometer type A and specimen with 6 mm thickness.

Melt Flow Index

The melt flow index was evaluated following to ASTM D 1238-90b [12], condition 190°C/0, 385 kg, using small pieces cutting from sheets of compression moulded.

Torque Measurements

The torque developed from the blends was evaluated from the torque x time curves provided by the Haake equipment.

RESULTS AND DISCUSSION

The mechanical curve of 100/0 PP/ROSIN blend showed behavior as a semicrystalline polymer with yielding, necking, cold-drawing and fiber rupture. The curve of 90/10 PP/ROSIN blend presented similar behavior. Above 10% of rosin, the mechanical curves of the blends showed that the samples broke immediately after yielding. Figures 1 – 5 show the variation of tensile parameters with rosin content. The elastic modulus (Fig. 1) increased with the rosin content and showed a maximum at 30% of rosin, meaning that rosin had a antiplasticizing effect on PP. The yield stress (Fig. 2) decreased monotonically with rosin content. The elongation at yield (Fig. 3) decreased and reached a near constant value above 10% of oligomer. The stress at break

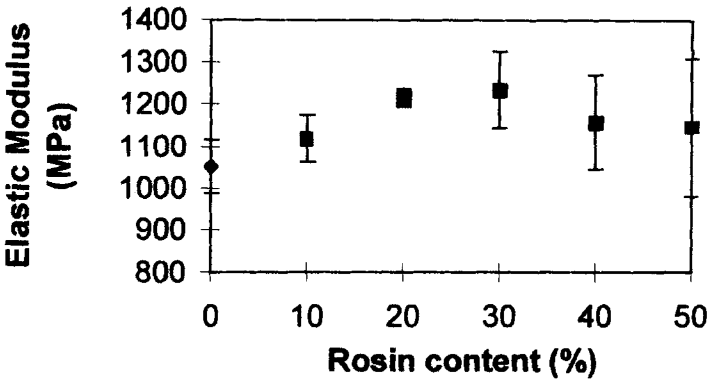

FIGURE 1 Elastic modulus *versus* rosin content of blends.

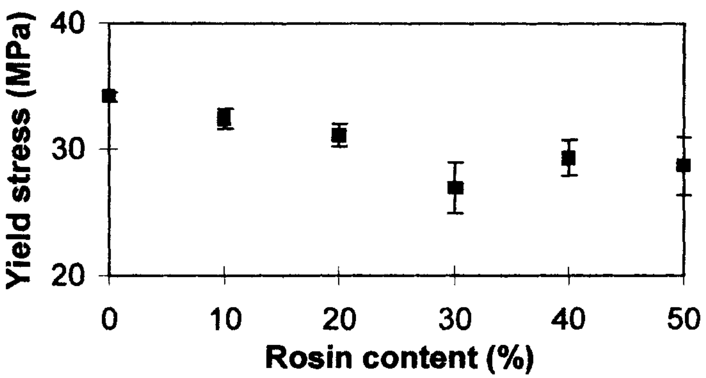

FIGURE 2 Yield stress *versus* rosin content of blends.

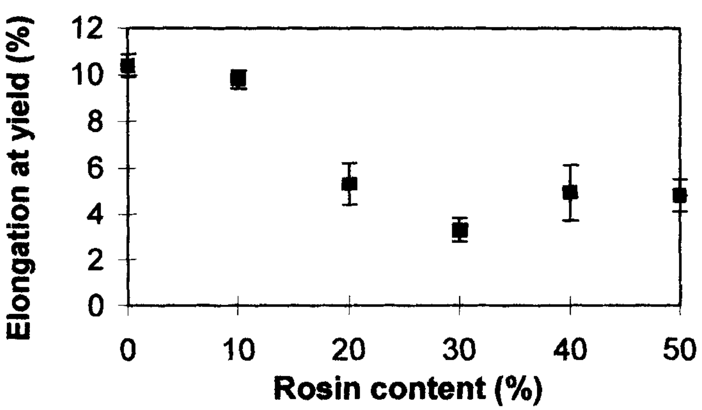

FIGURE 3 Elongation at yield *versus* rosin content of blends.

decreased with rosin content as shown in Figure 4. The elongation at break is shown in Figure 5. Over 10% of rosin the elongation diminished markedly and it was noted an abrupt drop. The mechanical parameters of the 90/10 PP/ROSIN blend were quite similar to those observed for 100/0 PP/ROSIN. Seems that in the 90/10 mixture the rosin molecules must be dissolved or homogeneously dispersed in PP matrix and above this rosin content exists a marked phase separation in the blends.

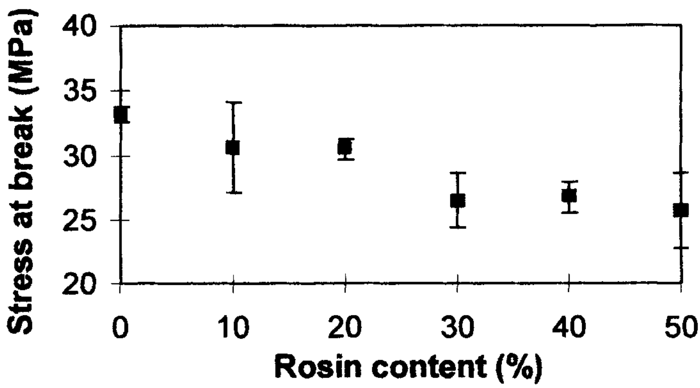

FIGURE 4 Stress a break *versus* rosin content of blends.

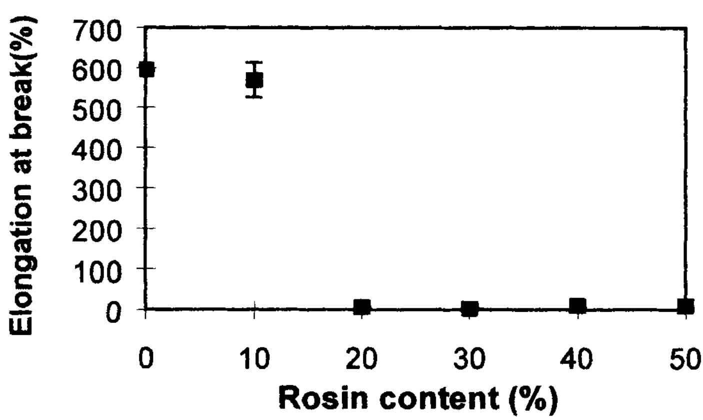

FIGURE 5 Elongation at break *versus* rosin content of blends.

The density (Fig. 6) increases with the rosin content. The hardness of blends shown in Figure 7 increases and reaches a constant value above 30% of rosin. The melt flow index presented in Figure 8 changes exponentially with the rosin content. The torque (Fig. 9) decreases montonically with amount of rosin. The presence of rosin improved the processability of the PP as was found for HDPE/ROSIN system [5].

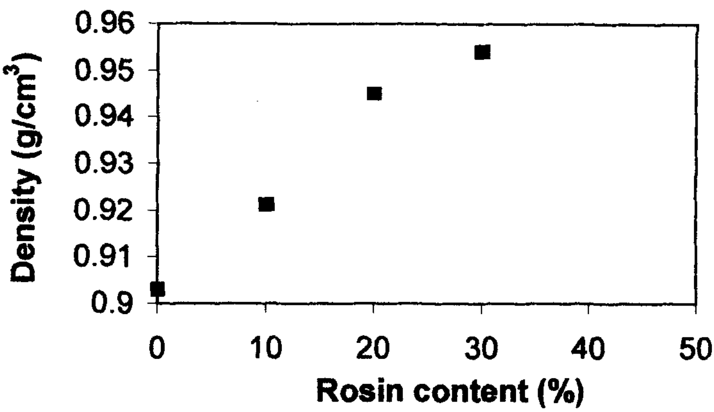

FIGURE 6 Density *versus* rosin content of blends.

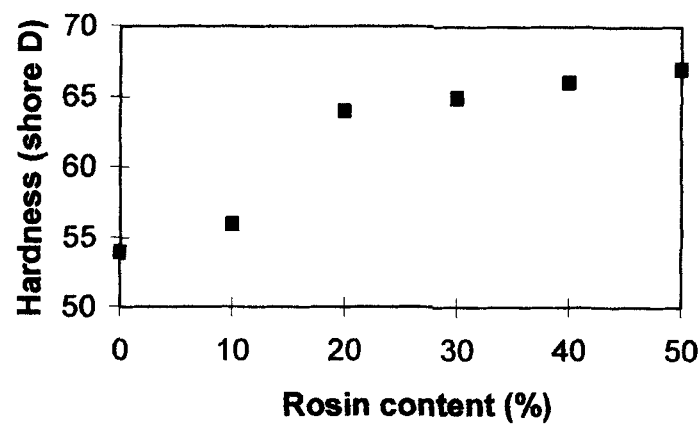

FIGURE 7 Hardness *versus* rosin content of blends.

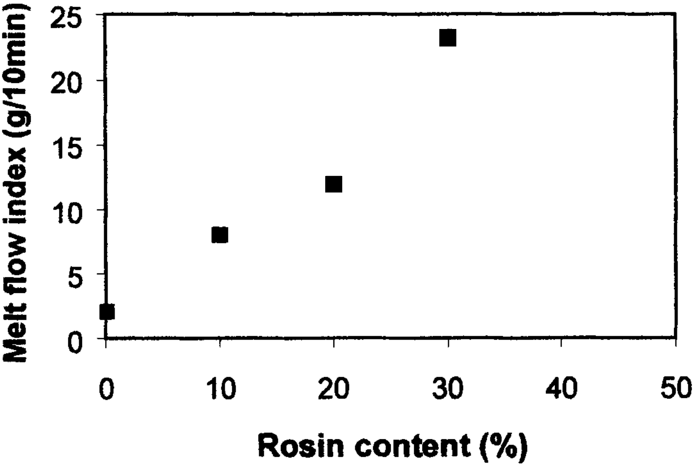

FIGURE 8 MFI *versus* rosin content of blends.

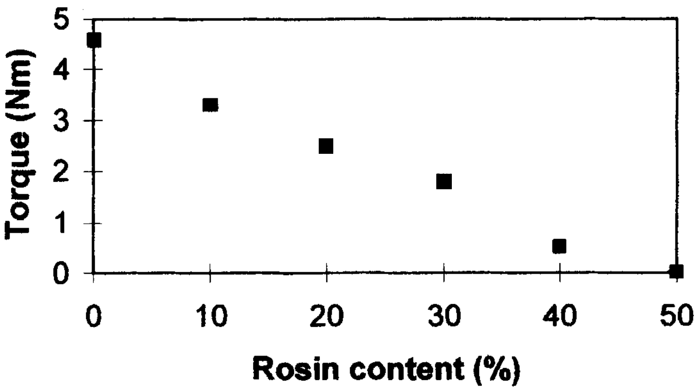

FIGURE 9 Torque *versus* rosin content of blends.

CONCLUSION

In the evaluation of mechanical properties of PP/ROSIN blends it was observed that for all mixtures the elastic modulus increased with rosin content. The 90/10 blend had the tensile behavior similar to PP alone, probably because the rosin molecules must be dissolved or homogeneously dispersed in the amorphous phase of PP. Above 10% of rosin the stress and elongation, at yield and at break, diminished with the amount of rosin, probably due to a marked phase separation. The density and hardness of blends decreased with rosin content. The blend melt flow index changed exponentially with amount of rosin. The torque diminished monotonically with the composition and the processability of PP was improved.

Acknowledgements

The authors thank to Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES, Brazil) and Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq, Brazil) for support this research.

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