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STUDIES OF NATURAL RUBBER OF THE BRAZILIAN CLONES FROM IAC SERIES 500

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Raw natural rubber from the *Hevea brasiliensis* is employed in a wide range of applications mainly because of its excellent dynamic properties such as elasticity, green strength, and resistance to heat buildup. In this work, technological and thermal properties, elemental chemical analysis, NMR, and FTIR of natural rubber obtained from new Brazilian clones of the IAC series 500 were evaluated. All samples showed Po and PRI higher than the minimum established by Brazilian standard, and could be considered class I in relation to Mooney viscosity results, indicating higher quality rubber. IAC series 500 clones showed good thermal stability up to 300 °C. The glass transition temperature obtained was approximately –65 °C. There are no differences in the thermal behavior among rubber from different clones studied.

Introduction

Natural rubber is an essential and strategic raw material used in the manufacturing of several products [1]. Nowadays, efforts to establish new zones for rubber cropping in Brazil in order to improve the national production are really important. The main goal of the genetic improvement of the *Hevea brasiliensis* is to develop species which are resistant to diseases, more productive and which produce rubber with higher quality. Agronomic Institute (IAC) and Embrapa Instrumentation (Embrapa/CNPDIA) have been conducting a Brazilian *Hevea* breeding with emphasis on the development of new clones more appropriated to the soil and climate of São Paulo state and on the evaluation of the properties of the latex and rubber from these new clones. Field tests on the new IAC 500 series clones are being carried out in Votuporanga/São Paulo. The genetic materials used in the experiment were 15 Hevea genotypes (clones), developed by IAC, and the control RRIM 600, developed by the Rubber Research Institute of Malaysia (RRIM), which were evaluated in a small-scale trial. The clones were budded onto established GT 1 clonal rootstocks in a nursery. The trees were opened for tapping at the sixth year [2]. The aim of this work is to evaluate natural rubber obtained from these new Brazilian clones of IAC series 500.

Experimental

Natural rubber latex from different clones of IAC series 500 (IAC 500, 501, 502, 503, 504 and 505) and RRIM 600 clone (used as a control) was obtained from the IAC experimental plantation in the region of Votuporanga/São Paulo State/Brazil. Technological properties of the lattices and dry natural rubber were evaluated by the standard methods for determining the dry rubber content (% DRC), Wallace plasticity (Po), Mooney viscosity (V_R), plasticity retention index (PRI), nitrogen content (% N), ash content (% ash), and acetone extract (% AE), according to standard ABNT-NBR 11597 methods

Thermogravimetric analysis was obtained in a TA Instrument model Q500, from 25 °C to 600 °C, at a heating rate of 10 degree/min. in inert (nitrogen) atmosphere. The glass-transition temperature (Tg) of the samples was measured using a DSC from a TA Instrument model Q100 with a scan rate of 10 °C/min, from -80 °C to 100 °C.

The NMR spectra were acquired in a Varian Inova 400 spectrometer (9.4 T) by the high-resolution solid-state ^{13}C NMR and by the single pulse technique. Fourier transform infrared (FTIR-ATR) spectra were recorded with a PerkinElmer model Paragon 1000 spectrophotometer in a range from 4000 to 400 cm-1. Elemental chemical analysis was obtained by ICP OES technique.

Results and Discussion

The results obtained indicated that the natural rubber from the new Brazilian clones have good quality and performance comparable with the Malaysian clone, RRIM 600. DRC represents the content of dry rubber in the latex, whose composition is more than 90% of poly (cis-1,4-isoprene). The highest DRC was obtained for IAC 500 clone (51%) and the lowest for IAC 503 (39%), Table 1. V_R and Po are related to the polyisoprene chain length; Po provides a picture of the microstructure of the raw material [3]. All samples showed Po higher than the minimum established by the Brazilian standard, 35. According to the classification established by Yip [1], all samples can be considered class I in relation to V_R results. PRI is an indication of the resistance of natural rubber to thermal oxidation. All samples showed PRI higher than the minimum established by the Brazilian standard, 60, and IAC 500 showed the highest PRI value, 87. Except for IAC 502, the other samples displayed acetone extract above the maximum established by the Brazilian standard, 3.5. Only IAC 502 showed ash content within the maximum value required by the Brazilian standard, 0.5. The variations observed in the technological properties seem to occur because of variable quantities of non-rubber constituents, which influence the formation of crosslinking, molar masses, and their distributions [4].

Table 1 – Technological properties of natural rubber of the IAC series 500

Clone	DRC	Po	PRI	V_R	AE	Ash	N
IAC 500	51	46	87	78	5.8	0.6	0.3
IAC 501	44	52	83	81	4.8	0.8	0.5
IAC 502	44	47	81	77	2.4	0.5	0.5
IAC 503	39	67	76	99	7.9	1	0.5
IAC 504	44	47	81	75	3.8	0.6	0.7
IAC 505	41	56	82	83	6.1	0.9	0.6
RRIM600	44	37	86	68	3.5	0.6	0.5

Figs. 1 shows TG and DTG curves obtained for the raw rubber from the IAC 500 series clones, respectively. TG and DTG curves of all clones evaluated have shown the same general shape, suggesting that the decomposition mechanisms are similar. Natural rubber from all the new clones was quite stable up to 300 ∘C. It can be seen that the TG curves have only one large plateau and the DTG curve has one primary degradation peak, indicating that the thermal degradation of the raw natural rubber from the IAC clones is mostly a one-stage process. The decomposition ranged from approximately 300 ∘C to 450 ∘C with a mass loss of about 98%, which can be assigned to the thermal decomposition of the natural rubber into monomers, dimers, trimers, etc. The temperature of the maximum mass loss rate or the peak temperature of the DTG curves is around 375 ∘C for all samples.

DSC curves exhibited changes in baseline in the temperature of approximately −65 ∘C, which are attributed to the glass transition temperature (Tg) of natural rubber. There are no significant differences among the Tg values of the different Brazilian clones in relation to the Malaysian clone RRIM 600, which is way below the room temperature, and that is important for several technological applications.

Investigation of the chemical structure of the rubber samples by FTIR, Fig. 2, and NMR confirmed that natural rubber from all clones studied are cis-1,4-polyisoprene form. There are no significant differences among the samples studied. Elemental chemical analysis results showed that IAC 501 and IAC 502 have the highest content of copper and manganese, respectively. IAC 504 showed the lowest content of copper and manganese.

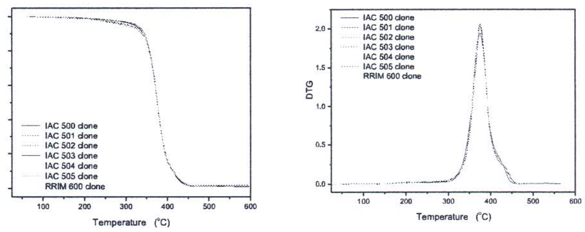

Figure 1 – TG curves of the IAC 500 series clones in inert atmosphere (10 ∘C/min).

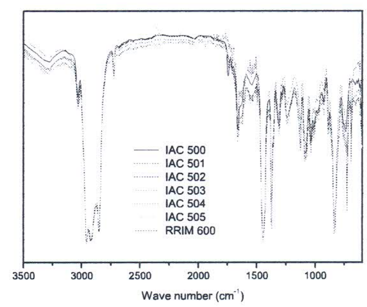

Figure 2 – FTIR curves of the IAC 500 series clones.

Conclusions

Natural rubber from the new Brazilian clones has good quality and performance. There are no differences in the thermal behavior among rubber from different clones studied. IAC series 500 clones have shown good thermal stability up to 300 °C. The glass transition temperature obtained was approximately –65 °C. The chemical structure of the rubber samples is cis-1,4-polyisoprene form.

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References

1. E. Yip *J. Natural Rubber Research* 1990, *5*, 52.
2. P.S. Gonçalves, E.J. Scaloppi Jr, M.A. Martins, R.M.B. Moreno, R.B.F. Branco, E.C.P. Gonçalves *Pesq. Agropec. Bras* 2011, *46*, 1643.
3. F. Bonfils, A. Flori, J. Sainte Beuve, *J Appl Polym Sci* 1999, *74*, 3078.
4. P.D. Galiani, M.A. Martins, P.S. Gonçalves, C.M. McMahan, L.H.C. Mattoso *J Appl Polym Sci* 2011, *122*, 2749.