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Effect of cotton whiskers on the dynamic mechanical behavior of natural rubber nanocomposites

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Abstract –. The aim of this work was to evaluate the dynamic mechanical thermal performance of cotton whiskers reinforced natural rubber (NR) nanocomposites. Cellulose whiskers were extracted from the commercial cotton fibers and characterized. These cellulosic nanoparticles were used as reinforcing phase to prepare nanocomposite films using NR latex as matrix. The films were obtained by the casting/evaporation method. The properties of the nanocomposites were investigated using differential scanning calorimetry and dynamic mechanical analysis. Cellulose whiskers did not affect the Tg of the nanocomposites. The best results for the storage modulus were obtained for nanocomposites with 12% of whiskers.

During the last years there has been a growing interest in incorporating cellulose whiskers as nanoreinforcement in polymer matrixes [1]. The aim of this work was to evaluate the dynamic mechanical thermal performance of cotton cellulose whiskers reinforced natural rubber (NR) nanocomposites.

Cellulose whiskers were prepared by acid hydrolysis of Brazilian commercial cotton fibers. The acid hydrolysis was carried out with sulfuric acid solution 6.5M at 45 °C under vigorous stirring for 75 min. Natural rubber latex from RRIM 600 clone was obtained from an IAC experimental plantation. Rubber trees were tapped, and the stabilization of the samples was obtained using 4.7 mL of NH_4OH for 100 mL of latex. The aqueous suspension of cellulose whiskers and the latex were mixed in different proportions in order to obtain films by casting them on Teflon dishes followed by water evaporation at a moderate temperature. Dynamic mechanical thermal analyses (DMTA) were carried out with a TA DMA Q800 analyzer on 15mmx8mmx1mm rectangular samples, applying a heating rate of 2 °C/min from -120 °C to 100 °C, at a frequency of 1 Hz. The glass-transition temperature (Tg) of the samples was measured using a TA Instrument model Q100 DSC. The Tg was defined as the inflection point of the jump heat capacity using a scan rate of 10 °C/min within the temperature range from -80 °C to 100 °C, and determined from the second scan. DSC experiments were performed in order to evaluate the influence of cellulose whiskers in glass transition temperature (Tg) of NR.

The curve of E´, Figure 1, corresponding to the unfilled NR matrix is typical for fully amorphous high molecular weigh thermoplastic polymer [2]. Below Tg temperature, the changes in storage modulus (E´) are not significant, however above Tg a much more significant reinforcing effect of the whiskers was observed. The best results for E´ were obtained for nanocomposites with 12% of whiskers. The DSC curves showed that cellulose whiskers did not affect the Tg of NR, since nanocomposites with whiskers loading from 2% to 12% (w/w) have an average Tg values of -66, 5 ± 0,1 °C, Figure 2. The same behavior was observed by DMTA, whose Tg values were around -60 °C for all samples, in this temperature range, the loss angle passes through a maximum, Figure 1.

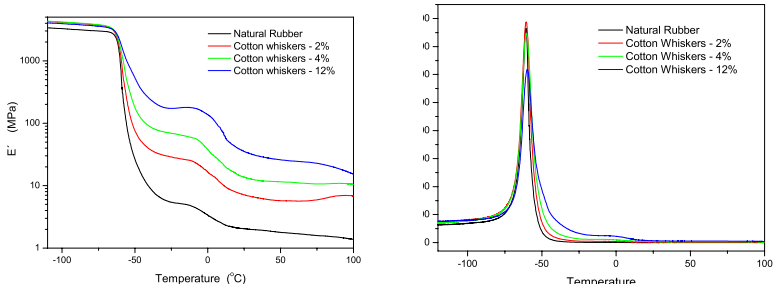

Figure 1: Storage modulus (E´) and mechanical loss factor (tan delta) for the natural rubber and the nanocomposites with cotton whiskers.

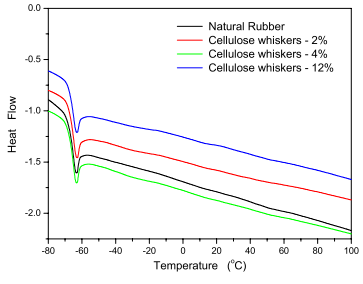

Figure 2 : DSC curves for the natural rubber and the nanocomposites.

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