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Nanocomposites based on natural rubber and cellulose nanocrystals from coconut fibers

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Abstract – In this work, nanocomposites of natural rubber reinforced with cellulose nanocrystals (CNCs) were obtained. The tensile behavior of these nanocomposites was investigated. The cellulose nanocrystals, prepared by acid hydrolysis of bleached coconut fiber, consisted of ultrathin CNCs with diameters as low as 4-5 nm and aspect ratio of up to 48. Nanocomposite films showed an increase of tensile strength by ca. 50% in and reduction of approximately 50% in the elongation at break, with filler content of 10 wt %.

Incorporation of cellulose nanocrystals (CNCs) into a polymeric matrix usually results in outstanding properties [1]. The objective of the present work was to produce and evaluate the tensile behavior of bio-nanocomposites from CNCs and natural rubber.

Nanocomposites were prepared from an aqueous suspension of CNCs and latex extracted from *Hevea brasiliensis*. CNCs with length ranging from 58 nm up to 447 nm and width of 5.5 ± 1.4 nm (Fig 1) were isolated from unripe coconut fibers by acid hydrolysis (64 wt%) at 45°C, for 150 min. The average aspect ratio of these whiskers was estimated to be close to 36 ± 12. The CNCs suspension was mixed with latex, stirred for 20 min and degassed, then cast onto glass plates and left at room temperature for 2 days before placing in an oven at 50°C for 12 hours to complete film drying. The CNCs content was 10% of the dry weight of the nanocomposites. The resulting films were placed in an oven at 50°C for 12 hours. The mechanical behavior of the films of neat rubber as well as the nanocomposites reinforced with CNCs was investigated by tensile testing at room temperature.

It can be observed in figure 2b that natural rubber/CNCs nanocomposites presented brown color, indicating that there was still a significant amount of lignin, left from the coconut fiber, after bleaching treatment. Also the uniformity in color is an indication that CNCs were uniformly dispersed in the matrix.

The incorporation of CNCs significantly changed the mechanical behavior of the material. The tensile strength of the natural rubber nanocomposites increased by about 50% compared with unreinforced film. This is an indication of good wettability and good interaction between the two components, allowing efficient stress transfer between the matrix and fibers. Tensile modulus of the nanocomposites increased and the elongation at break decreased approximately 50% with the addition of 10% CNCs.

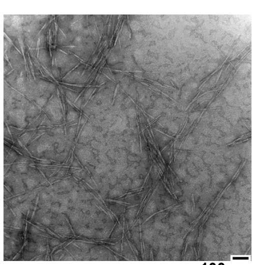

Fig 1: TEM of CNCs at 150 min

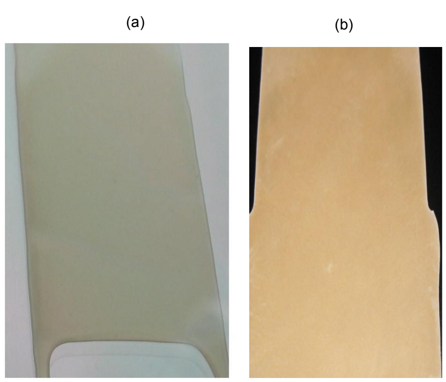

Fig 2: (a) Latex , (b) rubber/CNCs nanocomposite

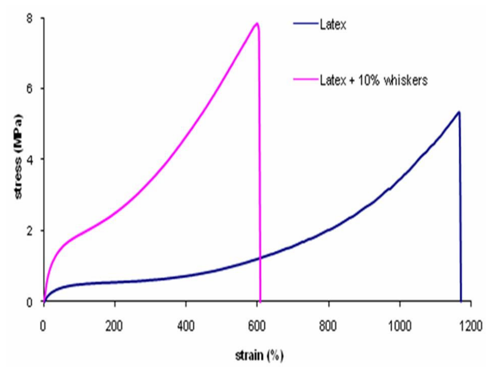

Fig 3: Stress-strain curves of rubber/CNCs nanocomposite

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References

[1] Angle` s M.N., Dufresne A. Macromolecules, 33 (2000), 8344 –8353