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Mechanical Properties of Nitrile Rubber (NBR)–Clay mixture obtained by Co-coagulation of the NBR Latex and Clay Aqueous Suspension

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Abstract – Blends of nitrile rubber (NBR) and sodium montmorillonite (MMT-Na) were prepared by co-coagulation of the NBR latex with aqueous suspension of clay and the content of MMT was varied from 0 to 7 phr. The X-ray diffraction (XRD) studies showed an increase in the basal spacing and broadening of peak corresponding to crystal structure of Na-MMT indicating the formation of intercalated/exfoliated clay layers in the NBR matrix. The mechanical properties of the nanocomposites were improved with addition of Na-MMT which is proportional to clay concentration. All results were compared to composition of NBR without MMT.

Recently polymer/clay mixtures have attracted significant attention due to their outstanding mechanical properties even at a considerably lower clay concentration. Among many clay minerals, sodium montmorillonite (Na-MMT) has been recognized as one of the potential candidates for improving physical-mechanical properties. The formation of intercalated and/or exfoliated structures can greatly be improved by treating the Na-MMT with organophilic agents through ion exchange reaction. However, the use of Na-MMT without organic treatment can greatly reduce the cost. The polymer/clay nanocomposites can generally be prepared by common methods such as in situ polymerization, solution and melt mixing and latex blending. Among these methods, latex blending has many advantages due to its simplicity, less capital investment and environmentally less harmful nature of the process [1]. Sodium montmorillonite (Argel Cn 35, Bentonit União Nordeste, Brazil) with cationic exchange capacity (CEC) of 110 mequiv/100 g was used in this work. Acrylonitrile-butadiene rubber (NBR, N-615B, NItriflex, Brazil) with acrylonitrile content of 33%, solid content of 27% and viscosity Brookfield of 13 cps, was selected as the rubber matrix. The clay aqueous suspension and the NBR latex were mixed and vigorously stirred for a given period of time. Then this mixture was coagulated in the electrolyte solution, washed with water, and dried in oven for 1 h at 100℃. Subsequently, the compounding ingredients for vulcanization (conventional cure system) were mixed with this in an open two-roll mill. The compounds were cured at 160 ºC in a heated press under a pressure of 180 Kgf/cm^2 for the optimum cure time, which was determined from an oscillating disk rheometer. The structure of the dispersed silicate layer in the composites was studied by XRD. Modulus, tensile strength, elongation at break and tear tests were obtained from a tensile tester according to the procedure described in ASTM D412. Hardness was determined by handheld Shore-A Durometer according to ASTM D-2240. The Resilience was determined according to ASTM D-7121. The diffraction peak of MMT-Na pure in 2θ = 7.06 ° (D001 = 12.52 Å), was shifted to lower diffraction angles (2θ = 5.93 °, 5.91 ° and 5.81 °) in the mixtures with 3, 5 and 7% of MMT-Na respectively (D_{001} = 14.90 Å, 14.95 Å and 15.21 Å). This result indicates that there was the formation of a structure interspersed in the NBR/Na-MMT mixtures. The mechanical properties improved with the increase of the amount of clay in the mixtures. The Figures 1, 2 and 3 shows the tensile strength, tear strength and Hardness.

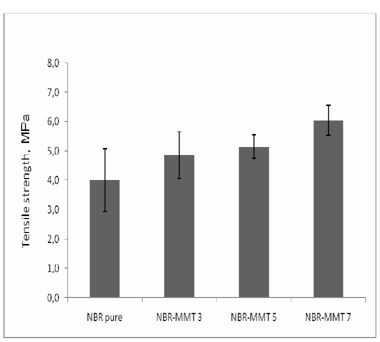

Figure 1: Tensile strength for NBR and mixtures NBR/MMT 3, 5 e 7.

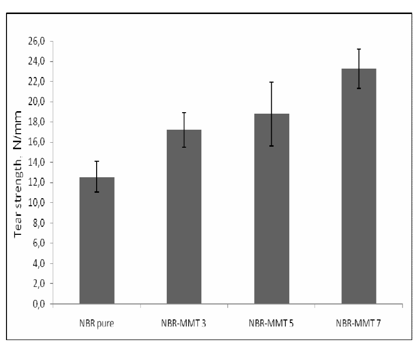

Figure 2: Tear strength for NBR and mixtures NBR/MMT 3, 5 e 7.

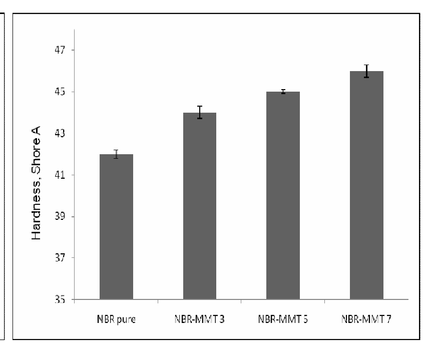

Figure 3: Hardness for NBR and mixtures NBR/MMT 3, 5 e 7.

[1] M.A. Kader, K. Kim, Y.S. Lee, C. Nah, J Mater Sci (2006) 41:7341–7352