

Barrier properties and morphology of cellulose acetate nanocomposites

R. B. Romero⁽¹⁾, R. M. V. Alves⁽²⁾ and M. C. Gonçalves^{(1)*}

(1) Institute of Chemistry, Universidade Estadual de Campinas – Unicamp, CP 6154, 13084-862, Brazil, e-mail: maria@iqm.unicamp.br

(2) CETEA - Centro de Tecnologia de Embalagem do ITAL, CP 139, 13073-001, Brazil.

* Corresponding author.

Abstract – Bio-based polymer/layered silicate nanocomposites can be used to create new eco-friendly materials. The results obtained in the melt intercalation method showed the intercalation of the cellulose acetate chains into the silicate platelets, which was promoted by the favorable chemical affinity between the polymer, plasticizer and clay. Apart from this, the intercalated structures were partially delaminated by the shearing imposed during the extrusion process, resulting in nanocomposites formed by intercalated as well as exfoliated clay particles. Due to these characteristics, the nanocomposites presented enhanced mechanical and barrier properties compared to pure cellulose acetate.

Nanocomposites of bio-based polymers with layered silicates can be used to create new eco-friendly materials, and can open ways towards the innovative applications of polymers. These materials are interesting, mainly due to their easy preparation, as well as their chemical, physical and mechanical properties [1]. The objective of this work is to investigate the structure, morphology, mechanical and barrier properties of cellulose acetate (CA)/clay nanocomposites. Four different clays were used to prepare the CA nanocomposites: (1) sodium montmorillonite clay (P-NaMT); (2) sodium montmorillonite clay (C-NaMT); (3) a long chain quaternary alkyl ammonium salt chemically modified montmorillonite (V-OMT); and (4) a methyl tallow bis-2-hydroxyethyl quaternary ammonium montmorillonite (C-OMT). Melt processing via extrusion/injection was performed by using eco-friendly triethyl citrate as a plastifier. The CA polymer and CA nanocomposites were characterized by X-ray microtomography, X-ray diffraction (XRD), transmission electron microscopy (TEM) and water vapor permeability test. The X-ray microtomography results showed that the clay particles are well distributed in the polymer matrix without the presence of larger clay particle aggregates. The XRD results showed an increase of the clay gallery distance, indicating the presence of a population of polymer intercalated tactoids. The TEM micrographs (Fig. 1) showed the presence of partially exfoliated silicate platelets for all nanocomposites but indicated some differences. In the case of the CA/C-NaMT nanocomposite, a higher content of individual clay platelets was observed (Fig. 1b) whereas for the CA/C-OMT nanocomposite, the formation of a three-dimensional network with different clay platelet arrangements was verified (Fig. 1d). In addition, the morphologies of the CA/V-OMT nanocomposite showed the presence of tactoids as well as partially exfoliated silicate platelets with preferential orientation (Fig. 1c). The nano-reinforcement reduced the water vapor permeability of cellulosic plastic, where the permeability of the CA/C-NaMT and CA/C-OMT nanocomposites was reduced 21% and 30%, respectively, in relation to pure CA. The results showed that promoting favorable interactions between clay particles, plasticizer and CA polymer together with the controll of the processing conditions can lead to effective exfoliation and dispersion of clay layers in the CA matrix, that in turn are necessary for the desired enhancement of the barrier properties for these materials.

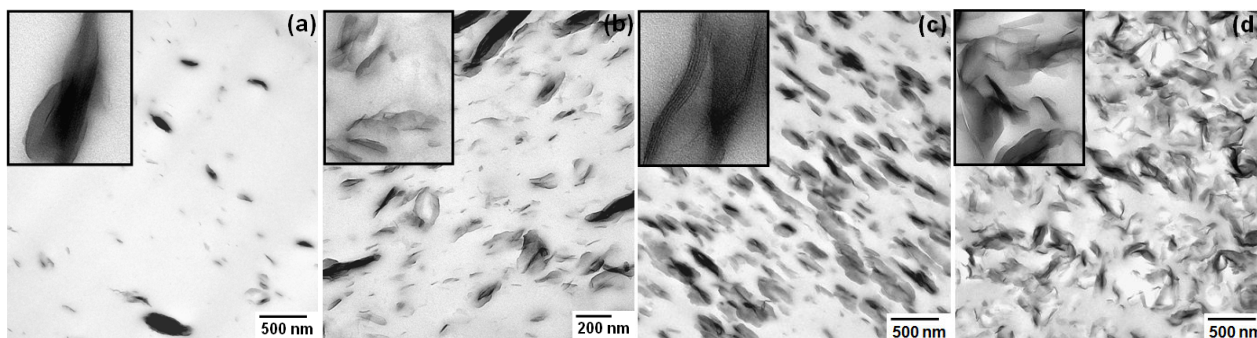


Figure 1: TEM micrographs: (a) CA/P-NaMT, (b) CA/C-NaMT, (c) CA/V-OMT and (d) CA/C-OMT nanocomposites.