



Preparation and morphological characterization of chitosan/clay nanocomposites

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Abstract – Films of chitosan/clay (Na-bentonite, Cloisite 30B or Nanocor I-24) nanocomposites were prepared by solvent casting. Mechanical properties were improved with addition of a small amount of polyethylene glycol as plastificant. Transmission electron microscopy (TEM) images indicated that the silicate layers were dispersed in the chitosan matrix and atomic force microscopy (AFM) images showed different morphologies depending of the clay used to prepare the nanocomposites. Better results were obtained using Cloisite 30B or Nanocor I-24 as nanoreinforcement.

There is an urgent need for the development of green polymeric materials that would not involve the use of toxic component in their manufacture and could be degrade in the natural environmental products. For these reasons, the development of biodegradable materials with controlled properties has been a subject of great research challenge to the community of materials scientists and engineers. Nanoreinforcements of biodegradable polymers have strong promise in designing eco-friendly green nanocomposites for several applications. Various nanoreinforcements are currently being developed, but the most heavily researched type of nanocomposites uses layered silicate clay as the reinforcing phase due to its easy availability, low cost and more importantly environmentally friendly [1]. Furthermore, nanoclays can improve some of the properties of biodegradable polymers, giving materials with higher thermal stability, gas barrier properties, strength and low melt viscosity if compared to the conventional composites.

Chitosan is a natural polymer found in the exoskeletons of crustaceans that dissolves readily in dilute organic acids, providing clear, homogeneous, and viscous solution, that possess the ability to form films, fibers or gels. On the basis of this background, we prepare films of chitosan/clay silicate nanocomposites aiming to improve mechanical properties of the chitosan films.

In a typical synthetic procedure, chitosan solutions were first prepared by the addition of the corresponding amounts of polysaccharide to 0.25 mol L⁻¹ acetic acid, and after that the resulting solution was stirred for about 24 h and then mixed with the clay suspension (Na-bentonite, Cloisite 30B or Nanocor I-24). Chitosan solutions containing 50 mg of biopolymer in 5.0 mL of solution were slowly added to a 0.5% or 2.5% clay suspension to obtain nanocomposites with different chitosan/clay ratios. In all of the cases, the resulting mixture was stirred for two days.

It was observed that the films prepared using the chitosan/clay ratio of 1/0.025 were rigid, easy to break and opaque, mainly when the clay was Na-bentonite. Better results were obtained using Cloisite 30B or Nanocor I-24 as nanoreinforcement and the lower chitosan/clay ratio (1/0.005). Even so, it was necessary to add polyethylene glycol (5 % w/w) as plastificant to improve the mechanical properties of these nanocomposite films. Figure 1 shows the TEM images of chitosan/Cloisite 30B 1/0.005 and chitosan/Nanocor I-24 1/0.005 nanocomposites with addition of polyethylene glycol. It is possible to demonstrate that the silicate layers were dispersed in the chitosan matrix.

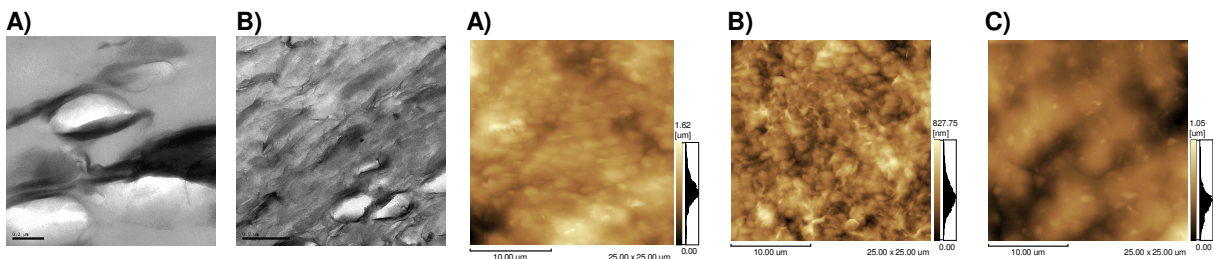


Figure 1: TEM images of (A) chitosan/Cloisite 30B and (B) chitosan/Nanocor I-24 nanocomposites.

Figure 2: AFM images of (A) chitosan/Cloisite 30B, (B) chitosan/Nanocor I-24 and (C) chitosan/Na-bentonite.

The morphological parameters of the films surface (roughness, superficial area) were acquired by the analysis of the AFM images. It was observed different surface morphologies depending of the clay used to prepare the nanocomposites, Figure 2. The nanocomposite structure (intercalated or exfoliated) will be identified by XRD analysis.

References

[1] S.S. Ray and M. Bousmina, Progress in Materials Science 50 (2005) 962-1079.