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HIERARCHICAL MATERIALS BASED ON NANOCELLULOSE AND POLY(LACTIC ACID)

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Palabras clave: Food packaging, barrier properties, biodegradable polymers.

Introducción. Nanocelluloses, i.e. cellulose nanocrystals and cellulose nanofibrils, have shown excellent gas barrier properties which makes them of the highest interest for the food packaging industry. However, the nanocelluloses moisture sensitivity thwarts these good gas barrier properties because at high relative humidity the water will start disturbing the nanocelluloses structure and facilitate the gas diffusion. A solution for this could be to protect nanocelluloses from water using a hydrophobic polymers, such as of polylactide (PLA). There have been many studies on the use of nanocelluloses as fillers in a PLA matrix. (1,2,3) However, the improvement of gas barrier properties was below expectations. Here we propose to change the architecture of the materials to multilayers in the aim to obtain high performance, even at high relative humidity.

Metodología. We produced multilayer films with a bar coater by deposit layers of nanocelluloses on PLA. The lack of adhesion between PLA and nanocelluloses was resolved through the combined use of an intermediate polymer and plasma treatment. Different types of nanocelluloses were used: cellulose nanocrystals, cellulose nanofibrils and cellulose nanofibrils TEMPO-oxidized. Nanocellulose layers were characterized by scanning electron microscopy and atomic force microscopy. The effect of nanocelluloses coating on O₂ barrier properties and water vapor barrier properties was characterized using permeation measurements.

Resultados. The coverage of PLA films by nanocelluloses was achieved using chitosan as a tie layer.

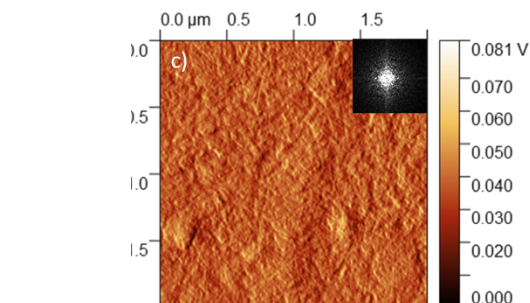
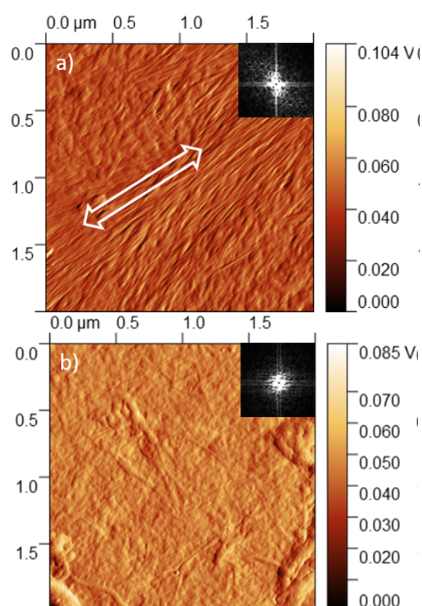


Fig. 1. AFM peak force images of PLA films coated with 10 deposits of CNC (a), CNF (b) and CNF TEMPO (c) and their corresponding Fast Fourier Transformation images

The Figure 1 shows AFM pictures of different types of nanocellulose coatings. The cellulose nanocrystals showed orientation, which was confirmed by FFT images. Although the obtained layer thickness of the nanocelluloses was lower than 1 μm, a gain in O₂ barrier properties of one order of magnitude was obtained (Figure 2). The performance was the same at 80 % relative humidity.

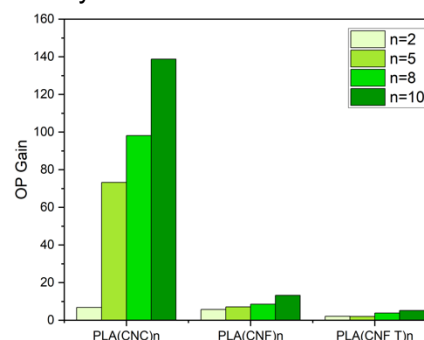


Fig. 2. Gain in oxygen barrier properties of coated PLA with respect to initial PLA

Conclusiones. The multilayer architecture is very efficient to obtain highly performing food packaging films and the protection of the nanocellulose layer by PLA allows to keep this performance over a large range of relative humidity.

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