Influence of deposition technique on functionalization of poly (l-lactic acid) films with nano layers of chitosan and nanocellulose crystals

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Poly (lactic acid) (PLA) is a non-toxic, compostable bio-based material derived from starch and/or sugar and has high mechanical strength and plasticity. It is accepted as GRAS by the Food and Drug Administration and suitable for use in food and beverage packaging. One of the strategies to incorporate active compounds on these materials is the deposition of uniform (a crucial step in the final properties) layers with active compounds (e.g. antimicrobials). In this work, two different coating techniques - dip-coating and ultrasonic spray coating - were evaluated for the deposition of nanolayers on PLA films. Chitosan (Ch), a naturally occurring cationic polysaccharide, with antimicrobial properties and cellulose nanocrystals (CNC) with the ability to enhance the barrier properties were used to functionalize PLA films. During the production step, PLA films were modified by oxygen plasma during 15 min with high voltage, to improve the adhesion of hydrophilic molecules. Afterwards, the multilayer system was developed with six active layers of chitosan and cellulose nanocrystal (Ch-CNC-Ch-CNC-Ch-CNC). For dip-coating, PLA films were immersed alternatively in each polyelectrolyte solution (1 % (w/w) of Ch and 1 % (w/w) of CNC) during 15 min and dried with nitrogen between layers, as reported by Pinheiro et al. (2012). For the deposition with the ultrasonic spray, layers were optimised using different flow rates (0.005-0.1 mL/min) and different speeds (50000, 100000 and 150000 mm/sec). The film surface resulting from each deposition step was analysed using ATR−FTIR spectroscopy and contact angle measurements. An XPS analysis was used to determine the effect of chemical changes during the formation of the multilayer system. Also, changes in structure and surface roughness were investigated using scanning electron microscopy (SEM). This work revealed that ultrasonic spray coating is the most efficient technique (faster and economic) allowing to obtain a homogeneous active layer.

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