IMPROVEMENT OF BARRIER PROPERTIES AND WETTABILITY OF BIODE-GRADABLE COATED PAPER AND CARDBOARD

Ileana Recalde, **Alejandro Devis, Luis Prats, Susana Aucejo**

Instituto Tecnológico del Embalaje Transporte y Logística (ITENE), Parque Tecnológico de Paterna, C/ Albert Einstein No.1, CP: 46980 Paterna (Valencia), España

Introduction

The continuous growth of the use of paper and cardboard substrates for food packaging application has favoured the development of researches in order to modify the superficial structure of cellulosic materials for packaging industry. In this development we find out two highlights: the interest in improving the water and oil paper resistance, and the need to increase lipid oxidation resistance for cellulosic packages that contain fatty foodstuffs. Cellulosic substrate with a controlled wettability degree, water vapour resistance and oxygen barrier properties can be obtained through the application of polymeric coating. A good and ecological alternative to this improvement is the use of coating by bio-polymers and nano-particles reinforcement approved for use in food packaging.

In this work the development and characterization of new bio-coating composite materials for cellulosic substrates are presented. The coating solutions have been obtained from renewable polymers and nano-reinforcements. The degradable coatings materials have the purpose to improve oil and water resistance properties of the substrate over which they are applied. At the same time, the presence of nano-clays, in the internal coating layer of a cellulosic substrate, improve the barrier properties of the packaging materials and increase the mechanical properties of the substrates.

Experimental

Coating solutions were prepared from mixtures of two biopolymers, PHB and PCL, in different percentages (0-100; 30-70; 50-50; 70-30; 100-30); as reinforcement material were used commercial nano-clays, and as plasticizer was used tributyl citrate. 100 micros of composite dissolutions were applied on four different air permeance cellulosic substrates, at 35±2ºC, with motorised film applicators (Elcometer 4340). The coating films and the coated and uncoated cellulosic substrate were characterized.

For this work, different commercial cellulosic packagings were tested, for reference. The thickness average of the PP coating layer in these packagings was 60 microns, being greater than the coating layers resulting of this work. The final thickness of the coating films was determined with a calliper micrometer (Mitutoyo-547-401), at ten different positions on each specimen. The reinforcement dispersion in the composites was characterized by WAXS (PHILIPS PW2400). Thermal properties were tested by DSC (TA-Instruments Q2000), and the effective percentage of clays was confirmed by TGA (TA-Instruments Q5000).

Water vapour transmission rate (WVTR) of the coated and uncoated substrate was measured according to the modified ASTM E-96-90, desiccant method, using glass cylindroid cups. Detailed wetting studies of the prepared cellulosic materials were made using contact angle measurements. The dynamic contact angles of the water and oil drops, on the composite films, as well as on the coated and uncoated substrates, were measured with an OCA 15 DATAPHYSICS. Mechanical behaviour of the films and the cellulosic specimens were tested on an MTS mechanical testing machine, model 2/ME. The width of the sample was 15 mm and the clamping distance was 12 mm.

Results and discussion

Effective nanocomposite coating films, totally biodegradable, for cellulosic paper and cardboard substrate were obtained. The coated cellulosic substrate decreased its surface roughness and increased its brightness.

The WAXS characterization showed a good dispersion of the nano-clays into the biopolymer matrixes. WVRT test showed that the increase of percentage of reinforcing between 0,5% and 1.5% in the coating composite films improved its water vapour resistance. By contrast, the presence of higher percentages did not affect positively the value obtained in the biopolymeric matrixes.

DSC´s results reflected that the addition of tributilcitrate improved the miscibility of the biopolymer mixtures. The tensile elastic characterization of the coating films showed a considerably increase of the Young's modulus of the composites films in comparison with the films without reinforcement. Mechanical tests on the coated substrates with nanocomposite showed a slight increase on the rigidness compared with uncoated substrates.

The coating materials obtained improved the water and oil absorption of the substrates. The commercial cellulosic packaging tested, with PP coating layer, showed a water contact angle a little higher after 30 min; but they were thrice thicker than the coating layers applied in this work. The contact angle of the oil and water drop on the uncoated paper and cardboard decreased very quickly and reached the critical angle, which could not be measured by the camera, after 1 min. By contrast, the bio-coated substrates achieved, after 20 min, a water and oil contact angle of 80º and 40º, respectively.

Conclusions

The bio-nanocomposites films obtained are a good alternative to substitute the conventional polymeric coating on papers and cardboards for packaging. These coating could be useful as a water or oil absorption barrier, and give barrier properties to the packaging materials without affecting the mechanical properties of the substrates. In addition, once the coating useful life is ended, no permanent wastes, that pollute the environment, are generated.

References

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