Oxygen permeability and economic-environmental impact studies of some polyvinyl alcohol dispersion barrier coatings for packaging applications

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Abstract

Purposes of employing barrier coatings in packaging, and in particular food packaging, can be to increase the shelf life, preserve colour, odour, and taste, and to protect from a harmful environment in general. Barrier coatings can thus help to reduce food waste along the value chain until end use. Including both materials choice for packaging and the possible fates of the used package, even further knowledge can be provided for decisions on choices of packaging solutions. To that end, we have conducted several experimental and transport modelling studies on oxygen barrier coatings performance. The coating system of choice has been dispersion coatings of poly vinyl alcohol (PVOH), with additions of kaolin. Physical and chemical features of the coatings were characterized to obtain information on polymer crystallinity, free volume and filler orientation as these characteristics are influential to the oxygen mass transport performance. In turn, the oxygen mass transport was also measured, both in steady state and dynamically. In so doing, we obtained information useful for developing a general model to describe the oxygen permeability taking into account the physical and chemical features, described above, of the coating layer.[1] Attempts on describing the interdependence and impact, for instance between crystalline and amorphous polymer regions and moisture, was added to the model.[2] The model showed agreement to experimental data for PVOH-kaolin coating in this particular case. However, the basic permeability model has been applied to many different polymers.[3]

To further explore the potential of these types of coating, which are technically possible to produce in paperboard production, an economic-environmental impact comparison to other existing material solutions was made.[4] Four barrier material alternatives – starch, polyethylene, ethyl vinyl alcohol (chosen as an alternative for PVOH, where data was difficult to obtain) and kaolin, and latex and kaolin, were analysed with respect to cost and global warming potential. Weighting and comparing cost to environmental aspect, weighting factors based on interviews with experts in the packaging value chain, starch emerges as the most sustainable alternative. However, previous coating and mass transport studies also show that these renewable materials require some further technical development to be competitive.

The mass transport model can serve as a tool for customizing barrier coatings and to predict the barrier performance, as permeability is obtained and thus shelf-life estimation is possible. The overall concept, the combination of assessment of structural performance and the environmental studies, can be employed to find sustainable food packaging solutions.