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DOCTORAL THESIS FEBRUARY 10TH 2017

STRUCTURE-PERFORMANCE RELATIONS OF OXYGEN BARRIERS FOR FOOD PACKAGING

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Åsa Nyflött is employed at Stora Enso, Karlstad, Sweden, since 2010. She has a Master of Science in Engineering Physics since 2011. Her thesis focuses on the mass transport of oxygen in order to gain deeper knowledge of, and thereby optimise, the performance of barrier coatings

STRUCTURE-PERFORMANCE RELATIONS OF OXYGEN BARRIERS FOR FOOD PACKAGING

DOCTORAL THESIS
FEBRUARY 10TH 2017

ABSTRACT

Food packaging should ensure the safety and quality of food, minimize spoilage and provide an easy way of storing and handling it. Barrier coatings are generally used to meet the demands placed on fibre-based food packages, as these have the ability to regulate the amount of gases that can enter them. Some gases are detrimental to food quality: oxygen, for example, initiates lipid oxidation in fatty foods. Using both experimental data and computer modelling, this thesis explains some aspects of how the structure of barrier coatings influences the mass transport of oxygen with the aim of obtaining essential knowledge that can be used to optimize the performance of barriers.

Barrier coatings are produced from polyvinyl alcohol and kaolin blends that are coated onto a polymeric support. The chemical and physical structures of these barriers were characterized according to their influence on permeability in various climates. At a low concentration of kaolin, the crystallinity of polyvinyl alcohol decreased; in the thinner films, the kaolin particles were orientated in the basal plane of the barrier coating. The experimental results indicated a complex interplay between the polymer and the filler with respect to permeability.

A computer model for permeability incorporating theories for the filled polymeric layer to include the polymer crystallinity, addition of filler, filler aspect ratio and surrounding moisture was developed. The model shows that mass transport was affected by the aspect ratio of the clay in combination with the clay concentration, as well as the polymer crystallinity. The combined model agreed with the experiments, showing that it is possible to combine different theories into one model that can be used to predict the mass transport.

Four barrier coatings: polyethylene, ethylene vinyl alcohol + kaolin, latex + kaolin and starch were evaluated using the parameters of greenhouse gas emissions and product costs. After the production of the barrier material, the coating process and the end-of-life handling scenarios were analysed, it emerged that starch had the lowest environmental impact and latex + kaolin had the highest.

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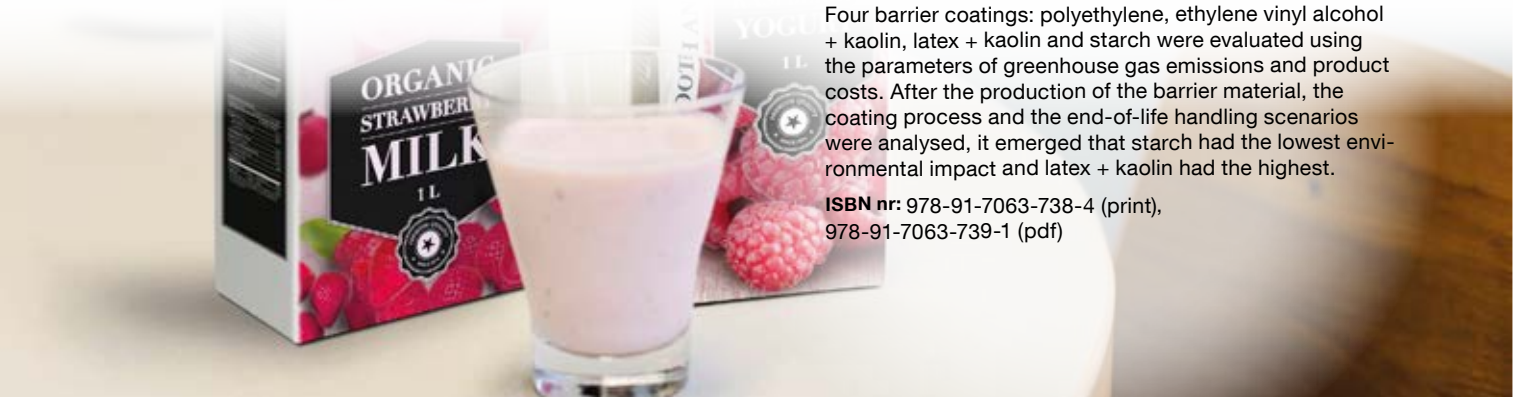

LIST OF PUBLICATIONS

I. Nyflött, Å., Axrup, L., Carlsson, G., Järnström, L., Lestelius, M., Moons, E., and Wahlström, T., Influence of kaolin addition in polyvinyl alcohol dispersion coating on the dynamics of oxygen mass transport, Nordic Pulp and Paper Research Journal, 30 (3), p. 385-392, 2015.

II. Nyflött, Å., Moons, E., Bonnerup, C., Carlsson, G., Järnström, L., and Lestelius, M., The influence of clay orientation in dispersion barrier coatings on oxygen permeation, Applied Clay Science, 126, p. 17-24, 2016.

III. Nyflött, Å., Petkova-Olsson, Y., Moons, E., Bonnerup, C., Järnström, L., Carlsson, G., Lestelius, M., and Minelli, M., Modelling of oxygen permeation through filled polymeric layers for barrier coatings,
Accepted for publication in Journal of Applied Polymer Science

IV. Nyflött, Å., Meriçer, Ç., Minelli, M., Moons, E., Järnström, L., Lestelius, M., and Giacinti Baschetti, M., Influence of moisture content on polymer structure in dispersion barrier coatings of polyvinyl alcohol and its effect on oxygen mass transport
Submitted for publication

V. Venkatesh, G., Nyflött, Å., Lestelius, M., and Bonnerup, C., An economic-environmental analysis of selected barrier coating materials used in packaging food products – A Swedish case study
Submitted for publication

Related Work by the Same Author

Nyflött, Å., Axrup, L., Carlsson, G., Järnström, L., Lestelius, M., Moons, E., and Wahlström, T., Effects of dispersion barrier coating structure on oxygen barrier performance, Nordic Polymer Days, Gothenburg, 10-12 June 2014

Nyflött, Å., Bonnerup, C., Carlsson, G., Järnström, L., Moons, E., and Lestelius M., Modeling of oxygen diffusion in flake-filled polymer system, 8th ECNP International Conference on Nanostructured Polymers and Nanocomposites, Dresden, 16-19 September 2014

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Nyflött, Å., Bonnerup, C., Järnström, L., Moons, E., Carlsson, G., Minelli, M., Giacinti Baschetti, M., and Lestelius, M., Influence of structure and humidity on polyvinyl alcohol dispersion barrier coating permeability: experimental and modeling approach, Tappi Advanced Coating Symposium, Stockholm, 4-6 October, 2016