ABOUT KARLSTAD UNIVERSITY
As one of the youngest universities in Sweden, our ambition is to contribute to the development of knowledge at international, regional and individual levels. Thanks to our openness, creativity and multidisciplinary, we have already attained a significant level of academic achievement. All our education and research is underpinned by a close dialogue with private companies and public organizations.

16 000 students and 1 200 employees make the University an inspiring place to work and study. We offer approximately 40 Bachelor’s degree programs, 30 Master’s level degree programs and 900 courses in the humanities and fine arts, social and economic sciences, natural sciences, engineering and technology, health care and teacher training.

VIPP stands for values created in fibre based processes and products and is a unique partnership in Swedish higher education. This is a long-term project financed by the Knowledge Foundation and the partner companies. The partnership was launched in 2011 and presently 18 doctoral students are busy with as many research projects. Three strong industrial graduate school environments:

• pulp, paper and graphic technology
• environment and energy
• service innovation and customer satisfaction

Here the disciplines of chemistry, chemical engineering, environmental and energy systems, physics, mechanical and materials engineering and the Service Research Center (CTF) at Karlstad University are collaborating.

The doctoral students share their time between Karlstad University and their respective company. Their academic supervisors and industrial mentors participate actively throughout the whole process.

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ÅSA NYFLÖTT
DOCTORAL THESIS FEBRUARY 10TH 2017

STRUCTURE-PERFORMANCE RELATIONS OF OXYGEN BARRIERS FOR FOOD PACKAGING
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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.


LIST OF PUBLICATIONS


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

