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Research area: Product aims

Raw materials // Fillers, pigments, chemical additives

Key words:

Coating, cellulose nanocolloids, synthesis, properties, barrier, surface energy, mineral oil

TITLE:

New barrier layers based on cellulose nano-colloids

Background/Problem area

In many areas in the functional finishing of paper, barrier layers constitute an important basis for the performance of a wide range of paper grades. Nowadays, coating materials (plastics, metal laminates, etc.) are often used that are difficult to recycle. Often used are also barrier materials that cannot be used in all fields of application (e.g. in contact with foodstuffs) to create barriers, e.g. for water vapour, fats or gases (oxygen, mineral oils, etc.) owing to substances they contain. Barriers of "regenerative raw materials" frequently suffer from the disadvantage that they are either very expensive or they do not perform adequately when compared to the afore-cited materials. Initial studies undertaken by the MAP Chair at Dresden Technical University have given rise to novel, cellulose-based, hydrophobic nano-colloids that are ideally suited for coating paper and selectively adjusting surface properties.

Objectives/Research results

The objective of the research project is to study the barrier properties of paper coatings comprised of hydrophobic cellulose nano-colloids, and to derive from this information whether or not these coatings would be a "sustainable" alternative for conventionally used barrier layers.

The studies shall focus on properties such as water vapour transmission and the ability of prevent the transfer of mineral oils. Whereas the cellulose nano-colloids were produced and applied to model papers at Dresden Technical University (MAP), the barrier properties of these novel coatings are to be studied and understood at PTS. Another objective is to evaluate a variety of different application processes in the light of the barrier properties that result. The latter is to be investigated in particular dependent on temperature, since the morphology of the films changes at 70 °C, thus changing the barrier properties as well - thus allowing them to be "thermally switched" in the event of a successful outcome. Last but not least, the recyclability of the barrier layers is to be investigated.

The project is designed in such a way that the work will be subsequently continued in the form of a publicly funded project (e.g. IGF).

Proceeding from microfibrillated cellulose, a variety of different cellulose esters were created with saturated fatty acids. Using a special procedure (nanoprecipitation in an aqueous solution), colloid cellulose ester particles could be obtained with average diameters of 100-200 nm. The particles were characterised based on their chemical and thermal properties and then applied to paper surfaces and other substrate surfaces using different application methods (spray process, screening). The films are only a few microns thick and exhibit very interesting properties in contact with aqueous solutions: the surfaces show superhydrophobic properties at temperatures less than approx. 60 °C. This can be traced back to the particular nature of the films and thus the associated roughness on the nanometre and micron scales. At temperatures greater than approx. 60 °C, the colloids fuse to form a compact layer that continues to possess hydrophobic properties.

The surfaces were characterised in respect to their homogeneity, morphology and chemical composition. The next steps will be as follows: to better understand the barrier properties of these films that are of utmost importance, to evaluate the different application methods with a view to their possible technological use, and finally to derive the relationships that exist between the film structure and the film properties.

Application/Economic benefits

Barrier layers based on regenerative raw materials can be an alternative to existing systems for a number of applications in the packaging and specialty paper sectors. The raw materials required to produce the nano-colloids (cellulose and fatty acids) are 100% regenerative. The proposed approach thus aims to develop "sustainable" solutions for novel barrier layers.

Period of time: 01.01.2015 – 31.12.2015

Remarks

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