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(54) **HEAT-SEALABLE WRAPPING PAPER**

(57) The present invention relates to a, preferably
heat-sealable, coated paper comprising a cellulose layer
and at least a coating on at least one side of the cellulose
layer, wherein the coating comprises a styrene-buta-

diene copolymer and a packaging comprising the coated
paper, as well as a method of manufacturing coated
paper.

EP 4 516 999 A2

Description**Technical field of the invention**

5 [0001] The present invention relates to a coated paper, and method for the manufacture thereof.

Prior art

10 [0002] In the last ten decades, plastics became the dominant material for the production of a multitude of products due to their low costs and durability. On the other hand, the chemical structure of plastics renders them resistant to many natural processes of degradation and as a result, they are slow to degrade. The high level of plastic production together with the extremely slow degradation of this material have led to a high prominence of plastic pollution in the environment, especially in the oceans. In order to reduce the amount of plastic produced, it has been proposed a total single use plastic ban. Single use plastics, or disposable plastics, are used only once before they are thrown away. These items include, among others, most packaging materials.

15 [0003] The use of plastic films as packaging materials was considered advantageous in that the material can be folded according to the outer shape of the object and this can then be heat-sealed.

[0004] There is a need for a heat-sealable wrapping paper that does not contain plastic.

Summary of the invention

20 [0005] It is an object of the present invention to provide a coated paper that can be used for single use packaging (such as toilet, kitchen paper rolls etc.). The coated paper of the present invention, has good workability (i.e. can be easily folded) and can be produced on standard paper machine. The coated paper is preferably heat-sealable and more preferably a heat-sealable wrapping paper. The heat-sealability of the paper renders the same suitable to be utilized on the same machine used for plastic packaging. This is a big advantage for companies manufacturing packaging of different products in that the change of raw material for the packaging will not require additional investment.

25 [0006] A further advantage of the coated paper of the present invention, compared to standard paper, is that the application of additional adhesive material on the sealing lines of the packaging is not necessary. This leads to a reduction of the costs for the production (i.e. simpler devices).

30 [0007] The coated paper according to the present invention has a coating as described in the appending claims and can be used as packaging of different products such as toilet and kitchen paper rolls.

Detailed Description of the Invention

35 [0008] The present invention provides a coated, preferably heat-sealable, paper comprising (or consisting of) a cellulose layer and a coating on at least one side of the cellulose layer, wherein the coating comprises styrene-butadiene copolymer.

40 [0009] The coated paper according to the invention is particularly suitable for packaging, in particular by utilizing the heat-sealability of the coated paper, and offers an environmentally friendly alternative to plastic packaging. The heat-sealing functionality is achieved during the paper production process using standard paper machines. In addition, the paper performs well on existing form-, fill- and seal packing lines. Accordingly, the present invention is also concerned with a packaging comprising the coated paper according to the present invention and with a packaging prepared using the coated paper according to the present invention, namely heat-sealing the coated paper.

45 [0010] The coating comprising styrene-butadiene copolymer (also "SBR" hereinafter) shows many advantages over other coatings and these will be apparent from the description below.

SBR-Based Coating

50 [0011] In one embodiment of the present invention, the coating preferably comprises at least 50 wt.-%, more preferably at least 80 wt.-%, still more preferably at least 90 wt.-%, and most preferably at least 95 wt.-% of SBR in terms of the weight of the coating, with the remainder preferably being other polymers. The other polymers are preferably selected from the group consisting of polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, acrylates, polyurethanes and combinations, in particular blends thereof.

55 [0012] Any styrene-butadiene copolymer can be used in the present invention provided that said copolymer can be dispersed in water. Styrene butadiene latex is preferably used for forming the coating. Examples thereof include LITEX SX 9130 sold by Synthomer.

[0013] In the present invention, the coating can be present on one side only of the cellulose layer or on both sides.

[0014] The SBR coating on at least one side of the cellulose layer has a basis weight of 1 to 10 g/m² and preferably from 2 to 7 g/m². When the SBR coating is applied on both sides of the cellulose layer the basis weight is 1 to 10 g/m² and, preferably, 2 to 7 g/m², per each side. More specifically, when the cellulose layer comprises an SBR coating on both sides the total basis weight of the SBR coating is 2 to 20 g/m² and preferably 4 to 14 g/m².

[0015] The SBR coating used in the present invention is not sticky at room temperature and will seal only at temperature of 120-250 °C, preferably 150-200 °C. The SBR coating is particularly suitable for this application in that it shows excellent heat-sealability even for very little amount of SBR on the layer.

Coating Comprising a Wax

[0016] In another embodiment of the present invention, the coating may comprise a wax.

[0017] A coating on the cellulose layer which comprises a wax results in improved hydrophobicity, improved slip properties and improved non-abrasive properties of the coated paper. Such coating also enhances surface and barrier characteristics in aqueous coating systems.

[0018] The wax may preferably be a plant wax or an animal wax and is more preferably a plant wax.

[0019] Animal and plant waxes are bio-renewable compounds. Therefore, the use of such waxes as a substitute for petroleum-based compounds improves the sustainability of the coated paper. In addition, animal and plant waxes are biodegradable and non-toxic, so that a coating comprising animal or plant waxes is more environmentally friendly. In view of the above, the full or partial replacement of petroleum-based organic compounds such as paraffin wax-based compounds or petroleum-based polymers by animal or plant waxes improves the resource's sustainability of the coated paper and its carbon footprint and renders it more environmentally friendly. Thus, a more environmentally friendly and more sustainable packaging material can be obtained.

[0020] Animal waxes typically consist of wax esters derived from a variety of fatty acids and carboxylic alcohols. The animal wax may be a wax selected from the group of insects secrete waxes, spermaceti and lanolin.

[0021] The insect wax is preferably beeswax. A major component of beeswax is myricyl palmitate which is an ester of triacontanol and palmitic acid. The melting temperature of beeswax is in the range of 60 to 65°C. Spermaceti occurs in large amounts in the head oil of the sperm whale. Spermaceti comprises cetyl palmitate as a main constituent. Lanolin is a wax obtained from wool and comprises esters of sterols.

[0022] Plant waxes are complex mixtures of hydrocarbons, alcohols, aldehydes, ketones, esters, acids, and combinations of these that are deposited in a layer outside the epidermal cells. Plant waxes are generally water-repellent components found in an amorphous layer on the outer surface of plants. Plant waxes within the meaning of the present invention also comprise waxes obtained from plant oils or vegetable oils by chemical reactions such as hydrogenation.

[0023] The plant wax may be more preferably one or more selected from the group consisting of candelilla wax, carnauba wax, rice bran wax, soy wax and sunflower wax.

[0024] Candelilla wax is mainly obtained from the leaves of plant *Euphorbia antisiphilitica* Zuccarini. Unpurified candelilla wax contains approximately 40-45 wt.-% hydrocarbons, 35-45 wt.-% wax, resin and sitosteroyl esters, 5-10 wt.-% free wax and resin acids, 4-8 wt.-% lactones, and 2-8 wt.-% free wax and resin alcohols.

[0025] Carnauba wax is mainly obtained from the Brazilian palm *Coernicia cerifera* Martius, also known as carnauba wax palm. It is found on the upper and lower surface of the palm leaves. Carnauba wax contains a high proportion of unesterified alcohols, x-hydroxy esters and esters of hydroxylated cinnamic acid. Carnauba wax is one the hardest plant waxes and has a melting temperature of about 80°C.

[0026] Rice bran wax is another high melting wax found in husks of rice *Oryza sativa*. It is obtained as a by-product from the de-waxing of rice bran oil. The major components of rice bran wax are even-numbered aliphatic acids and higher alcohol esters. Other constituents include free fatty acids (palmitic acid), phospholipids, phytosterols and squalene. The hydrocarbon content of rice bran wax is typically as low as 2 wt.-%.

[0027] Sunflower wax is found in the seed and seed hulls of *Helianthus annuus* (sunflower). It is obtained through the winterization of sunflower oil. Sunflower wax is a hard, high melting wax mainly consisting of long chain saturated fatty esters.

[0028] Soy wax can be obtained by hydrogenation of soybean oil. It is a triglyceride, containing a high proportion of stearic acid. It is typically softer than paraffin wax and has a lower melting temperature compared to paraffin wax. Its melting point is in the range from about 50°C to about 80°C.

[0029] The wax is preferably applied to the cellulose layer in the form of a water-based emulsion. The emulsion may comprise one or more waxes, preferably one or more plant waxes. The emulsion preferably contains an emulsifier. Emulsifiers are compounds that typically have a polar moiety and a non-polar moiety. Surfactants may be used as the emulsifier. Examples of water-based emulsions of a wax are Eurika Coat SW 166 from Eurikas and HydroWax RV from Sasol. Eurika Coat SW 166 is a water-based emulsion comprising a soy wax, a vegetable-based wax and an anionic emulsifier. HydroWax RV is an anionic emulsions of finely dispersed wax particles in water, wherein the wax is a mixture of synthetic waxes and plant waxes. HydroWax RV is preferably used.

[0030] The coating used in the present invention may preferably comprise 35 to 65 wt.-% of the styrene-butadiene copolymer and 5 to 40 wt.-% of the wax, based on the total weight of the coating. When such coating is applied to the cellulose layer, it was surprisingly found that the heat-sealability of the coated paper is significantly improved compared to a paper coated with pure styrene-butadiene latex. In addition, a paper coated with a coating comprising 35 to 65 wt.-% of the styrene-butadiene copolymer and 5 to 40 wt.-% of the wax exhibits a reduced gloss and smoothness compared to a paper coated with styrene-butadiene latex. Thus, a coated paper which combines a paper-like look and feel with a workability comparable to a plastic film can be obtained.

[0031] The coating more preferably comprises 40 to 60 wt.-% of the styrene-butadiene copolymer, 5 to 30 wt.-% of the wax, 15 to 50 wt.-% of a filler, 0 to 5 wt.-% of a thickener, and 0 to 3 wt.-% of a surfactant, based on the total weight of the coating. A coated paper having such coating exhibits an even better heat-sealability and an improved paper-like look and feel.

[0032] For example, the coating may comprise 47 wt.-% of the styrene-butadiene copolymer, 27 wt.-% of the wax, 23 wt.-% of the filler, 0.3 wt.-% of the thickener, and 3 wt.-% of the surfactant, based on the total weight of the coating.

[0033] The filler is preferably a pigment. The pigment is preferably based on naturally occurring raw materials such as clay, for reasons of sustainability and environmental protection. The pigment is more preferably clay with a naturally engineered steep particle size distribution. In a most preferred embodiment, 90 wt.-% of the pigment particles have a particle size of less than 5 μm . Such a particle size distribution results in improved print and sheet gloss. The pigment is preferably applied in the form of a slurry. For example, a high brightness coating pigment such as CAPIM DG slurry from Capim Kaolin may be used. The good rheological properties of a slurry of pigment particles with the above-described particle size distribution allows for high speed application of the filler, for example in high speed blade and metered size press applications.

[0034] The coating preferably comprises at least 0.1 wt.-% of the thickener and more preferably 0.1 to 1.0 wt.-% of the thickener. The thickener is preferably a cross-linked copolymer and more preferably a cross-linked acrylic copolymer. The copolymer may be used in the form of an emulsion. For example, an acid containing cross-linked acrylic emulsion copolymer may be used. When such emulsion is diluted with water and neutralized with a base, the emulsion particles are swelling, so that the shear rate viscosity can be improved. As a result, a high level of texture, excellent sag resistance, improved spatter resistance and microbe-enzyme resistance can be achieved, when a cross-linked copolymer is used as the thickener in the coating composition. For example, ACRYCOL ASE-60 from Rohm and Haas may be used as the thickener.

[0035] The coating preferably comprises at least 0.1 wt.-% of the surfactant and more preferably 0.5 to 3.0% of the surfactant. The surfactant is preferably a silicon-free wetting agent. The wetting agent reduces the surface tension and can thus improve the wetting of a surface. As a result, the adhesion of the coating to the cellulose layer is increased. In addition, the use of a coating comprising a silicon-free wetting agent results in improved workability of the coated paper. An example of the silicon-free wetting agent is BYK DYNWET 800N purchased from BYK.

[0036] In addition, improved wetting is particularly important for processes, wherein the application of the coating liquid occurs under high speed, as in the finishing of paper in a paper-making process. Thus, when a surfactant is used, the coated paper can be produced more efficiently in a standard paper machine.

[0037] The coating can be present on one side only of the cellulose layer or on both sides. The coating on at least one side of the cellulose layer has a basis weight of 1 to 10 g/m² and preferably from 2 to 7 g/m². When the coating is applied on both sides of the cellulose layer, the basis weight is 1 to 10 g/m² and, preferably, 2 to 7 g/m², per each side. More specifically, when the cellulose layer comprises a coating on both sides the total basis weight of the coating is 2 to 20 g/m² and preferably 4 to 14 g/m².

General Description of the Cellulose Layer

[0038] The cellulose layer used in the present invention preferably is a nonwoven comprising natural fibers or mixture thereof. A person skilled in the art knows, on account of his knowledge and experience, that the correct composition of natural fibers can be specifically selected depending on the desired properties. Examples of natural fibers are cellulose, cotton, wool, hemp, Eucalyptus, NSBK, regenerated celluloses and fibrillated celluloses. Preferably, the cellulose layer used in the invention consists of natural fibers. In other words, only natural fibers are present in the cellulose layer and no other types of fibers. However, the cellulose layer can comprise other substances such as additives and sizing agents.

[0039] Any additive commonly used in the field of paper making can be present in the cellulose layer.

[0040] The cellulose layer can comprise sizing agents in an amount of 0.1-5.0 wt.-% and preferably 1.5-2.5 wt.-% based on the total weight of the cellulose layer. If the cellulose layer is also saturated (as explained below), the amount of sizing agent is calculated based on the total weight of the cellulose layer before saturation (and, accordingly, before coating). Any known sizing agent as used in the paper industries can be used in the cellulose layer. The sizing agent is preferably added to the cellulose pulp (i.e. is an internal sizing agent). Examples thereon include alkyl ketene dimers and/or styrene-acrylate-copolymers. In accordance with the present invention, the sizing agent(s) will improve the deposition of the

coating on the cellulose layer and enhance the effectiveness of the coating in the sense that less coating is needed to achieve the desired effect.

Method For Preparing Coated Paper

[0041] The present invention also provides a method for preparing coated paper, in particular the coated paper as defined above, comprising the steps of providing a cellulose layer, applying an aqueous dispersion of a styrene-butadiene copolymer to at least one surface of the cellulose layer and drying the cellulose layer with the aqueous dispersion of a styrene-butadiene copolymer on its surface to form a coating, and optionally saturating the cellulose layer before forming the coating.

[0042] Preferably, in the step of forming the coating on the cellulose layer, the styrene-butadiene copolymer is applied to both sides of the cellulose layer.

[0043] In another preferred embodiment, the cellulose layer is saturated and the coating is formed on only one side of the cellulose layer.

[0044] The cellulose layer can optionally be saturated before application of the SBR coating. Any resin, commonly used to saturate paper, can be used in the present invention but the saturation is preferably performed with aqueous dispersion based on styrene butadiene latex. In the present invention, the resin used to saturate the cellulose layer comprises at least 50 wt.-%, more preferably at least 80 wt.-%, still more preferably at least 90 wt.-%, and most preferably at least 95 wt.-% of SBR copolymer in terms of the weight of the total polymer present in the saturation, with the remainder preferably being other polymers. The other polymers are preferably selected from the group consisting of polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, acrylates, polyurethanes and combinations, in particular blends thereof. In the present specification, the term "saturation" is understood as synonymous with "impregnation". The amount of saturation resin in the heat-sealable paper is 2-15 g/m², preferably 3 to 12 g/m², and even more preferably 4-10 g/m². It is preferable to saturate the cellulose layer when the coating is applied on only one side of the cellulose layer. By using a saturated cellulose layer, the cohesion between the uncoated side and the coated side of the cellulose layer can be improved. This is advantageous for the use as heat-sealable wrapping paper.

[0045] A "coating" within the meaning of the present invention is a film formed on the surface of the cellulose layer. The coating is preferably a polymer-based film on the surface of the cellulose layer, more preferably a polymer-based film, adherent film, and most preferably a continuous film covering the complete surface of at least one side of the cellulose layer. That is, preferably no fibers of the cellulose layer are exposed to the outside in the coated paper according to the present invention. The coating allows the provision of a paper having high gloss and high smoothness of the surface. Conventional saturated or impregnated paper exhibits much lower surface gloss and smoothness. The coating can bind through heat-sealing the coated paper to itself or to another material, in particular to another coated paper according to the present invention, thus avoiding the need of further adhesive. The coating is preferably the above-described SBR-based coating or the above-described coating comprising a wax.

[0046] The coating may be formed by applying a surface coating composition to the surface of the cellulose layer and subsequently curing and/or drying the surface coating composition. The surface coating composition may be applied to the surface of the cellulose layer by spraying, brushing, or rolling. Upon application to the surface, the surface coating composition undergoes film formation. Preferably, a liquid surface coating composition of relatively low viscosity is applied to the cellulose layer and is cured to form a solid, high-molecular-weight, polymer-based adherent film. The coating may also be formed by coalescence-based film formation. Coalescence-based film formation takes place with polymer particles dispersed in a liquid phase, preferably with latex polymers, and most preferably with water-dispersed styrene-butadiene copolymers.

[0047] An aqueous dispersion of a styrene-butadiene copolymer within the meaning of the present invention is an "SBR latex" or a "styrene-butadiene latex".

[0048] The surface coating composition may comprise a film-forming component and a solvent. The film-forming component is preferably a water-dispersible polymerizable material and more preferably water-dispersed styrene-butadiene copolymer. The surface coating composition may optionally comprise pigments and/or other additives. For example, the surface coating composition may comprise one or more of a wax such as a plant wax or an animal wax, a filler, a surfactant, and a thickener.

[0049] Saturation can be distinguished from coating in that during saturation the resin penetrates into the cellulose layer. In contrast, the coating remains on the surface of the layer. Thus, saturation does not result in the formation of a continuous film on the surface of the cellulose layer.

[0050] The coated paper of the present invention can be produced using wet-laying processes known to the skilled person. When additives such as wet strength- and/or sizing agents are present in the cellulose layer, these are added to the pulp.

[0051] The saturation can be carried out according to any known method such as in a dip bath, which is then squeezed off with rollers.

[0052] The coating can be applied with an air brush, a "Mayer Bar", a "Speed Sizer", a roller blade, an anilox roller or a "Blade Coater". Another possibility to apply the coating on the cellulose layer is by means of air knife coating.

[0053] The SBR coating, as well as the saturation step, where applicable, can be performed online and since the solvent is water no emission problem will arise.

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Non-creped Cellulose Layer

[0054] In one embodiment of the present invention, the cellulose layer of the coated paper is not creped. This embodiment is described in the following.

10 **[0055]** The cellulose layer has preferably a basis weight of 20 to 50 g/m² and, more preferably, 30 to 40 g/m². The cellulose layer has preferably a thickness of 40-70 µm, more preferably 50-60 µm.

[0056] The coated paper according to this embodiment of the present invention preferably has a basis weight of 25-70 g/m², more preferably 30-60 g/m² and even more preferably 35-55 g/m². Such a low grammage product has the required flexibility and stiffness so that it can be used as packaging material. If the basis weight is lower than 25 g/m², the paper easily tears so as to be unsuitable to be used as packaging. In contrast, if the basis weight is higher than 70 g/m², then the paper is not flexible anymore.

15 **[0057]** The coated paper according to this embodiment of the present invention may have a thickness of 35 - 70 µm, preferably 40 - 60 µm.

20 **[0058]** The tensile strength of the coated paper according to this embodiment of the present invention in machine direction is preferably 40-90 N/15mm, more preferably 60-80 N/15mm. The tensile strength of the heat sealable paper in cross direction is 20-70 N/15mm, preferably 30-50 N/15mm.

[0059] The bending stiffness of the coated paper according to this embodiment of the present invention in machine direction is preferably 0.12-0.5 Nmm and, more preferably 0.19-0.35 Nmm. The bending stiffness in cross direction is preferably 0.01-0.1 Nmm and, more preferably, 0.01-0.05 Nmm.

25 **[0060]** The Cobb value of the coated paper as measured on a side comprising the SBR coating is preferably 1-20 g/m² and, more preferably 2-12 g/m² and even more preferably 3-8 g/m².

[0061] The minimum folding endurance in machine direction is preferably 500-5000 number of double folds, more preferably 1500-4000 and even more preferably 1800-3500.

30 **[0062]** The minimum folding endurance in cross direction is preferably 300-4000 number of double folds, more preferably 1300-3500 and even more preferably 1800-3000.

[0063] The coated paper according to this embodiment of the present invention preferably has a tear resistance in machine direction of 80-400 mN, more preferably 100-320 mN and even more preferably 150-250 mN. The tear resistance in cross direction is preferably 80-450 mN, more preferably 120-350 mN and even more preferably 200-300 mN.

35 **[0064]** The coated paper according to this embodiment of the present invention preferably has an elongation at break in machine direction 1.5-4.5%, more preferably 1.8-4.0% and even more preferably 2.0-3.0%. The elongation at break in cross direction is preferably 6-20%, more preferably 8-15% and even more preferably 10-13%.

[0065] The coated paper according to this embodiment of the present invention has a Gurley smoothness (as measured on the side with the coating) equal to or higher than 200 Gurley seconds. The standard Gurley smoothness (as measured on the side with the coating) is preferably 200-850 Gurley seconds, more preferably 300-700 Gurley seconds and even more preferably 350-600 Gurley seconds.

40 **[0066]** The coated paper according to this embodiment of the present invention preferably has a gloss (as measured on the side with the coating), measured at 60°, of 8-40 GU (GU=gloss unit), preferably 9-30 GU and even more preferably 10-25 GU.

45 **[0067]** In a preferred embodiment, the coated paper according to the present invention has a basis weight of 30-60 g/m², a thickness of 35-70 µm, a tensile strength of the paper in machine direction of 40-90 N/15mm, and a tensile strength in cross direction of 20-70 N/15mm.

[0068] In a more preferred embodiment, the coated paper according to the present invention has a basis weight of 35-55 g/m², a thickness of 40-60 µm, a tensile strength of the paper in machine direction of 60-80 N/15mm, and a tensile strength in cross direction of 30-50 N/15mm.

50 **[0069]** In another preferred embodiment, the coated paper according to the present invention has a basis weight of 30-60 g/m², a thickness of 35-70 µm, a tensile strength of the paper in machine direction of 40-90 N/15mm, a tensile strength in cross direction of 20-70 N/15mm, a tear resistance in machine direction of 100-320 mN, a tear resistance in cross direction of 120-350 mN, an elongation at break in machine direction of 1.8-4.0%, and an elongation at break in cross direction of 8-15%.

55 **[0070]** In a more preferred embodiment, the coated paper according to the present invention has a basis weight of 35-55 g/m², a thickness of 40-60 µm, a tensile strength of the paper in machine direction of 60-80 N/15mm, a tensile strength in cross direction of 30-50 N/15mm, a tear resistance in machine direction of 150-250 mN, a tear resistance in cross direction of 200-300 mN, an elongation at break in machine direction of 2.0-3.0%, and an elongation at break in cross direction of

10-13%.

[0071] In another more preferred embodiment, the coated paper according to the present invention has a basis weight of 30-60 g/m², a thickness of 35-70 µm, a tensile strength of the paper in machine direction of 40-90 N/15mm, a tensile strength in cross direction of 20-70 N/15mm, a bending stiffness in machine direction of 0.12-0.5 Nmm, a bending stiffness in cross direction of 0.01-0.1 Nmm, a Cobb value measured on a side comprising the coating of 2-12 g/m², a minimum folding endurance in machine direction of 1500-4000 double folds, a minimum folding endurance in cross direction of 1300-3500 double folds, a tear resistance in machine direction of 100-320 mN, a tear resistance in cross direction of 120-350 mN, an elongation at break in machine direction of 1.8-4.0%, an elongation at break in cross direction of 8-15%, Gurley smoothness of 300-700 Gurley, and seconds, a gloss of 9-30 GU (GU=gloss unit).

[0072] In another even more preferred embodiment, the coated paper according to the present invention has a basis weight of 35-55 g/m², a thickness of 40-60 µm, a tensile strength of the paper in machine direction of 60-80 N/15mm, a tensile strength in cross direction of 30-50 N/15mm, a bending stiffness in machine direction of 0.19-0.35 Nmm, a bending stiffness in cross direction of 0.01-0.05 Nmm, a Cobb value measured on a side comprising the coating of 3-8 g/m², a minimum folding endurance in machine direction of 1800-3500 double folds, a minimum folding endurance in cross direction of 1800-3000 double folds, a tear resistance in machine direction of 150-250 mN, a tear resistance in cross direction of 200-300 mN, an elongation at break in machine direction of 2.0-3.0%, an elongation at break in cross direction of 10-13%, Gurley smoothness of 350-650 Gurley, and seconds, a gloss of 10-25 GU (GU=gloss unit).

Creped Cellulose Layer

[0073] In another embodiment of the present invention, the cellulose layer of the coated paper is creped. In the following, the coated paper according to an embodiment of the present invention wherein the cellulose layer is creped will be denoted as "creped coated paper". This embodiment is described in the following.

[0074] In a preferred embodiment of the present invention, the cellulose layer is creped. Creping is a means for mechanically compacting paper in machine direction.

[0075] The creped coated paper exhibits improved elongation and elasticity, especially in machine direction. Thus, the creped coated paper exhibits mechanical properties comparable to plastic films, which are conventionally used as packaging material. Thus, the creped coated paper is even more suitable to be utilized on the same machine used for plastic packaging because of its increased elongation and elasticity.

[0076] In addition, it was surprisingly found that creping improves the heat-sealability of the coated paper. It is assumed that the improved heat-sealability is due to the uneven surface structure of the creped paper.

[0077] As a result, the creped coated paper is an even more suitable packaging material and exhibits an improved workability and heat-sealability compared to a coated paper which is not creped.

[0078] The creped paper can be produced according to any method to produce creped paper commonly known to the skilled person. The step of creping paper may be accomplished, for example, with a flexible blade against a dryer, preferably in a drum dryer. The drum dryer is designed to be pressurized with steam to provide a hot surface for completing the drying of paper-making webs at the end of the papermaking process. Alternatively, the step of creping paper may be accomplished in wet state with a flexible blade against a drum, the paper having a water content of 50-70 wt%.

[0079] The coating applied to the creped cellulose layer may be an SBR-based coating, i.e. a coating which preferably comprises at least 50 wt.-%, more preferably at least 80 wt. %, still more preferably at least 90 wt.-%, and most preferably at least 95 wt.-% of SBR in terms of the weight of the coating, with the remainder preferably being other polymers. The coating applied to the creped cellulose layer may also be a coating comprising a wax, preferably the above-mentioned coating composition comprising 35 to 65 wt.-% of the styrene-butadiene copolymer and 5 to 40 wt.-% of the wax and the corresponding more preferable embodiments of the coating comprising a wax.

[0080] When the cellulose layer is creped, it has preferably a basis weight of 20 to 80 g/m² and more preferably a basis weight of 40 to 60 g/m². The creped cellulose layer has preferably a thickness of 40 to 190 µm, more preferably 60 to 150 µm, and most preferably of 60 to 100 µm.

[0081] The creped coated paper according to an embodiment of the present invention preferably has a basis weight of 25 to 100 g/m², more preferably 35 to 90 g/m² and even more preferably 40 to 70 g/m². A creped paper having such grammage has the required flexibility and stiffness so that it can be used as packaging material. If the basis weight is lower than 25 g/m², the paper easily tears so as to be unsuitable to be used as packaging. In contrast, if the basis weight is higher than 100 g/m², then the paper is less flexible.

[0082] If the cellulose layer is creped, the coated paper according to the present invention may have a thickness of 40 to 200 µm, preferably 60 to 160 µm, more preferably 60 to 110 µm, and most preferably 70 to 100 µm.

[0083] The tensile strength of the creped coated paper in machine direction is preferably 40-120 N/15mm, more preferably 60-100 N/15mm. The tensile strength of the heat sealable paper in cross direction is 15-70 N/15mm, more preferably 20-60 N/15mm, and most preferably 30-50 N/15mm.

[0084] The bending stiffness of the creped coated paper in machine direction is preferably 0.05-0.4 Nmm and, more

preferably 0.10-0.25 Nmm. The bending stiffness in cross direction is preferably 0.01-0.1 Nmm and, more preferably, 0.01-0.06 Nmm.

[0085] The Cobb value of the creped coated paper as measured on a side comprising the SBR coating is preferably 1-20 g/m² and, more preferably 2-12 g/m² and even more preferably 3-8 g/m².

[0086] The minimum folding endurance of the creped coated paper in machine direction is preferably 500-5000 number of double folds, more preferably 1500-4000 and even more preferably 1800-3500. The minimum folding endurance of the creped coated paper in cross direction is preferably 200-3000 number of double folds, more preferably 1200-2500 and even more preferably 1700-2000.

[0087] The creped coated paper preferably has a tear resistance in machine direction of 100-800 mN, more preferably 200-600 mN and even more preferably 400-550 mN. The tear resistance in cross direction is preferably 100-1000 mN, more preferably 300-800 mN and even more preferably 500-700 mN.

[0088] The creped coated paper preferably has an elongation at break in machine direction 3.5-10.0%, more preferably 4.5-8.0% and even more preferably 6.0-7.0%. The elongation at break in cross direction is preferably 6-20%, more preferably 8-15% and even more preferably 10-13%.

[0089] The creped coated paper has a Gurley smoothness (as measured on the side with the coating) equal to or higher than 100 Gurley seconds. The standard Gurley smoothness (as measured on the side with the coating) is preferably 150-500 Gurley seconds, and more preferably 200-300 Gurley seconds.

[0090] The creped coated paper preferably has a gloss (as measured on the side with the coating), measured at 60°, of 25 GU (GU=gloss unit) or less, preferably 5-25 GU and even more preferably 10-20 GU.

[0091] In an even more preferred embodiment, the cellulose layer is creped and the above-mentioned coating composition comprising 35 to 65 wt.-% of the styrene-butadiene copolymer and 5 to 40 wt.-% of the wax is applied to the creped cellulose layer. The combination of a creped cellulose layer and the aforementioned coating results in a significantly improved heat-sealability. The heat-sealability and the paper-like look and feel is even more improved when the specific coating compositions as defined in claims 20 to 25 is applied to the creped cellulose layer.

Examples

Example 1

[0092] A heat sealable paper has been produced on a paper machine. Only cellulose fibers have been used for the cellulose layer (i.e. 100% cellulose fibers) in combination with other additives commonly used for paper production. Alkyl ketene dimers have been used as sizing agents. In this example the cellulose layer has been impregnated with 5 g/m² SBR latex and consequently coated on one side with 5 g/m² of SBR latex.

[0093] The features of the so obtained heat sealable paper are listed in Table 1. In table 1, the acronym MD means machine direction and CD means cross direction.

Table 1

	Heat sealable paper
Thickness (μm)	55
Basis weight (g/m ²)	46
Tensile strength MD (N/15 mm)	71.8
Tensile strength CD (N/15 mm)	40.8
Bending stiffness MD (Nmm)	0.24
Bending stiffness CD (Nmm)	0.02
Cobb Value (g/m ²)	4
Minimum Folding endurance MD (number of double folds)	3000
Minimum Folding endurance CD (number of double folds)	2000
Tear resistance MD (mN)	230
Tear resistance CD (mN)	250
Elongation at break MD (%)	2.5
Elongation at break CD (%)	12.5
Gurley smoothness ^A (Gurley seconds)	458

EP 4 516 999 A2

(continued)

	Heat sealable paper
Gloss ^A (GU)	11,4
^A Measured on the coated side	

Example 2

[0094] A heat sealable paper has been produced on a paper machine by means of a wet-creping technology. Only cellulose fibers have been used as fibers for the cellulose layer (i.e. 100% cellulose fibers) in combination with other additives commonly used for paper production. Alkyl ketene dimers have been used as sizing agents. In this example the cellulose layer has been impregnated with 15 g/m² SBR latex and consequently coated on both sides with 4 g/m² of SBR latex (on each sides).

[0095] The features of the so obtained heat sealable paper are listed in Table 2. In Table 2, the acronym MD means machine direction and CD means cross direction.

Table 2

	Heat sealable paper
Thickness (μm)	94
Basis weight (g/m ²)	87
Tensile strength MD (N/15 mm)	94.0
Tensile strength CD (N/15 mm)	47.0
Bending stiffness MD (Nmm)	0.16
Bending stiffness CD (Nmm)	0.06
Cobb Value (g/m ²)	11
Minimum Folding endurance MD (number of double folds)	2500
Minimum Folding endurance CD (number of double folds)	600
Tear resistance MD (mN)	550
Tear resistance CD (mN)	760
Elongation at break MD (%)	6.6
Elongation at break CD (%)	12.7
Gurley smoothness ^A (Gurley seconds)	350
Gloss ^A (GU)	11.7
Seal strength (N/25 mm)	4.7

Example 3

[0096] A heat sealable paper has been produced as described in Example 2 above, except that in this example the cellulose layer has been impregnated with 4 g/m² SBR latex and consequently coated on both sides with 4 g/m² of SBR latex (on each sides).

[0097] The features of the so obtained heat sealable paper are listed in Table 3. In Table 3, the acronym MD means machine direction and CD means cross direction.

Table 3

	Heat sealable paper
Thickness (μm)	60
Basis weight (g/m ²)	53
Tensile strength MD (N/15 mm)	52.3

EP 4 516 999 A2

(continued)

	Heat sealable paper
Tensile strength CD (N/15 mm)	18.7
Bending stiffness MD (Nmm)	0.10
Bending stiffness CD (Nmm)	0.01
Cobb Value (g/m ²)	16
Minimum Folding endurance MD (number of double folds)	100
Minimum Folding endurance CD (number of double folds)	250
Tear resistance MD (mN)	290
Tear resistance CD (mN)	330
Elongation at break MD (%)	4.6
Elongation at break CD (%)	9.2
Gurley smoothness ^A (Gurley seconds)	550
Gloss ^A (GU)	6.4
Seal strength (N/25 mm)	4.4

Example 4

[0098] A creped paper has been produced and impregnated as described in Example 2 above. The impregnated paper has been subsequently coated on one side with a coating composition consisting of 28 parts per weight of the water-based wax emulsion "Hydrowax RV", 50 parts per weight of the styrene butadiene latex "LITEX SX 9130", 17.5 parts per weight of the pigment slurry "Capim DG Slurry", 50 parts per weight of water, 1.5 parts per weight of the wetting agent "BYK Dynwet 800N" and 2 parts per weight the thickener "ACRYSOL ASE-60". The total amount of the coating in the final product is 4g/m².

[0099] The features of the so obtained heat sealable paper are listed in Table 4. In Table 4, the acronym MD means machine direction and CD means cross direction.

Table 4

	Heat sealable paper
Thickness (μm)	93
Basis weight (g/m ²)	82.5
Tensile strength MD (N/15 mm)	92.1
Tensile strength CD (N/15 mm)	47.3
Bending stiffness MD (Nmm)	0.15
Bending stiffness CD (Nmm)	0.07
Cobb Value (g/m ²)	17
Minimum Folding endurance MD (number of double folds)	2500
Minimum Folding endurance CD (number of double folds)	600
Tear resistance MD (mN)	530
Tear resistance CD (mN)	790
Elongation at break MD (%)	6.6
Elongation at break CD (%)	12.7
Gurley smoothness ^A (Gurley seconds)	100
Gloss ^A (GU)	5.0

(continued)

	Heat sealable paper
Seal strength (N/25 mm)	1.2

Example 5

[0100] A creped paper has been produced and impregnated as described in Example 3 above. The impregnated paper has been subsequently coated on one side with the same coating composition as used in Example 4 above. The total amount of coating in the final product is 4 g/m².

[0101] The features of the so obtained heat sealable paper are listed in Table 5. In Table 5, the acronym MD means machine direction and CD means cross direction.

Table 5

	Heat sealable paper
Thickness (μm)	58
Basis weight (g/m ²)	49, 7
Tensile strength MD (N/15 mm)	50.3
Tensile strength CD (N/15 mm)	19.9
Bending stiffness MD (Nmm)	0.10
Bending stiffness CD (Nmm)	0.01
Cobb Value (g/m ²)	23
Minimum Folding endurance MD (number of double folds)	100
Minimum Folding endurance CD (number of double folds)	250
Tear resistance MD (mN)	310
Tear resistance CD (mN)	310
Elongation at break MD (%)	4.6
Elongation at break CD (%)	9.2
Gurley smoothness ^A (Gurley seconds)	120
Gloss ^A (GU)	3.8
Seal strength (N/25 mm)	1.0

Tests Methods

[0102] Standard atmospheres for conditioning and testing: according to DIN EN 20187:1993. The sample were first conditioned and then tested to determine the features indicated below.

Basis weight: according to ISO 536:2012.

Thickness: according to EN ISO 534:2011 with a compressive load of 1.0 bar.

Tensile strength and elongation at break: according to DIN EN ISO 1924-2:2008 but sample width of 15 mm; test length 100 mm; and rate of elongation of 150 mm/min.

Bending stiffness: measured with CREUSOT-LOIRE Instrumentation (adamel-Ihomargy 15 Avenue Jean Jaures 94201 Ivry/Seine; licence Kodak Pathe). Sample are conditioned according to DIN EN 20187. From these samples, at least 8 measuring strips 15 mm wide and 150 mm long are cut longitudinally and transversely to the machine direction. The samples shall be free from wrinkles, creases, creases, holes, watermarks and other irregularities. The experiments are carried out in the same climate in which the sample pretreatment has taken place. Before starting the test, check that the free length of zero (that is, if the sample top is flush with the top edge of the swing clamp), the display on

the scale is also zero. The resonance is achieved when the free length of the sample has a maximum deflection. When the resonance is reached, the free length, which is then equal to the resonance length, is read on the scale. After reading the resonance length, one will quickly come out of the resonance range by carefully pulling the sample further. (Can be repeated any number of times).

[0103] From the measured resonance lengths, the arithmetic mean value is calculated separately for samples along and transversely to the machine direction, and from this the specific bending stiffness is calculated.

$$S \text{ [N mm]} = 20 \times (l/100)^4 \times (m_A/100)$$

l= value read [mm] (Resonance length)

m_A = basis weight [g/m²]

S= bending stiffness

Biegesteifigkeit

[0104] Cobb Value: according to ISO 535:2014. The sample were measured after 10 minutes.

[0105] Folding endurance: This test is to find the number of double folds required to break a 15 mm wide strip of paper under a tension load of 1000 grams.

[0106] Instrument: A Massachusetts Institute of Technology Folding Endurance Tester made by Tinius Olsen Testing Machine Company (Phila. USA).

[0107] The test sample is a strip of 15 mm wide and at least 6"long.

[0108] Work instruction: i) ensure the switch is "off"; ii) turn the knob on the motor so that the jaws of the bottom clamp point upward; iii) place the strip in the top and bottom clamps so that it is straight and centered in the clamps; iv) tighten the top clamp; v) place 1 Kg weight onto the top platform, align the sample strip and tighten the bottom clamp; vi) remove weight from the platform and ensure the counter is set to zero; vii) turn the machine on; take the reading when the strip breaks. The test is repeated 5 times and the minimum folding endurance corresponds to the average value of the 5 tests.

[0109] Tear resistance: according to ISO 1974:2012 by using L & Tearing Tester from Lorentzen & Wettre (code 009, type 961701, number 5625) with pendulum: code A-pend, type 962035, number 1269. Two single layers have been used for the test.

[0110] Gloss: according to ISO 2813:2015-02. The measurement has been performed using BYK Gardner micro-Trio-gloss (CAT-No. 4520; Ser. No. 197383). The measuring angle depends on the gloss unit and corresponds to:

- 60° when the gloss is 10-70 GU;
- 85° when the gloss is <10 GU;
- 20° when the gloss is >70 GU.

[0111] Smoothness: measured using GENUINE GURLEY Automatic Densometer 4340 from Rycobel Group (Mod. 4340N; Ser. 1802947; Ref. 7216.9715). Setting: i) Test: Smoothness/Standard Gurley Smoothness; ii) Measuring surface: 1,0 square inch; iii) Air: 100 cc.

[0112] Seal strength: two samples are cut, each with a size of approx. 5 cm x 20 cm, the longer side being the machine direction.

[0113] The samples are placed with the sides to be sealed folded inwards, and heat sealed using a laminator, such as for example YOSAN LM-260. The setting temperature of the laminator is 160°C. The sample is moved once into the laminator and once back with a velocity of 650 mm/min and for a length of 15 cm, thereby having 5 cm in the entire length that is not sealed. After this step the sample is left to cool for 15 minutes at room temperature. The so obtained sealed sample is cut to a strip width of 25 mm by trimming both sides while the length is still 20 cm. The total length of the sample included 5 cm that are not sealed. The samples are then clamped in a universal testing machine such as Zwick/Roell Z0.5. In this step, the sample is clamped through the two parts of the sample which are not sealed and these two ends are pulled apart using a peeling test under the following conditions:

Program: Starting distance: 50 mm

Preload: 0.1N

Speed preload: 20 mm / min.

Measuring speed: 300 mm / min.

Starting length before measuring

Measuring path: 80 mm

[0114] The maximum force detected in the measuring path represents the seal strength (i.e. F max).

Embodiments of the present disclosure

5 **[0115]** The present disclosure further relates to the following embodiments.

(1) A coated paper comprising a cellulose layer and at least a coating on at least one side of the cellulose layer, wherein the coating comprises styrene-butadiene copolymer.

10 (2) The coated paper according to item (1), wherein the basis weight of the coating on one side of the cellulose layer is 1 to 10 g/m².

(3) The coated paper according to item (1) or (2), wherein the coating is present only on one side of the cellulose layer.

15 (4) The coated paper according to item (3), wherein the cellulose layer is saturated at least on the side of the cellulose layer opposite to the coating.

(5) The coated paper according to item (1) or (2), wherein the coating is present on both sides of the cellulose layer.

20 (6) The coated paper according to item (4), wherein the basis weight of the coating on each side of the cellulose layer is 1 to 10 g/m².

(7) The coated paper according to any one of items (1) to (6), wherein the cellulose layer comprises an internal sizing agent.

25 (8) The coated paper according to any one of items (1) to (7), which is heat sealable.

(9) The coated paper according to any one of items (1) to (8), wherein the cellulose layer has a basis weight of 20 to 50 g/m².

30 (10) The coated paper according to any one of items (1) to (9), which has a basis weight of 25 to 70 g/m².

(11) The coated paper according to any one of items (1) to (8), wherein the cellulose layer is creped.

35 (12) The coated paper according to item (11), wherein the cellulose layer has a basis weight of 20 to 80 g/m², preferably 40 to 60 g/m².

(13) The coated paper according to item (11) or (12), which has a basis weight of 25 to 100 g/m², preferably 35 to 90 g/m², and most preferably 40 to 70 g/m².

40 (14) The coated paper according to any one of items (11) to (13), wherein the cellulose layer has a thickness of 40 to 190 µm, preferably 60 to 150 µm, and most preferably 60 to 100 µm.

45 (15) The coated paper according to any one of items (11) to (14), which has a thickness of 40 to 200 µm, preferably 60 to 160 µm, and most preferably 60 to 110 µm.

(16) The coated paper according to any one of items (1) to (15), wherein the coating comprises a wax.

50 (17) The coated paper according to item (16), wherein the wax is a plant wax.

(18) The coated paper according to item (17), wherein the plant wax is one or more selected from the group consisting of candelilla wax, carnauba wax, rice bran wax, soy wax and sunflower wax.

55 (19) The coated paper according to any one of items (16) to (18), wherein the coating comprises 35 to 65 wt.-% of the styrene-butadiene copolymer and 5 to 40 wt.-% of the wax.

(20) The coated paper according to item (19), wherein the coating comprises

40 to 60 wt.-% of the styrene-butadiene copolymer,
 5 to 30 wt.-% of the wax,
 15 to 50 wt.-% of a filler,
 0 to 5 wt.-% of a thickener, and
 0 to 3 wt.-% of a surfactant,
 based on the total weight of the coating.

(21) The coated paper according to item (20), wherein the filler is a pigment.

(22) The coated paper according to item (20) or (21), wherein the coating comprises at least 0.1 wt.-% of the thickener.

(23) The coated paper according to item (22), wherein the thickener is a cross-linked copolymer.

(24) The coated paper according to any one of items (20) to (23), wherein the coating comprises at least 0.1 wt.-% of the surfactant.

(25) The coated paper according to item (24), wherein the surfactant is a silicon-free wetting agent.

(26) A packaging comprising the coated paper according to any one of items (1) to (25).

(27) A method of manufacturing coated paper comprising the steps of providing a cellulose layer,

applying an aqueous dispersion of a styrene-butadiene copolymer to at least one surface of the cellulose layer and drying the cellulose layer with the aqueous dispersion of a styrene-butadiene copolymer on its surface to form a coating, and

optionally saturating the cellulose layer before forming the coating.

(28) The method according to item (27), wherein in the step of forming the coating, the dispersion of styrene-butadiene copolymer is applied to both sides of the cellulose layer.

(29) The method according to item (27), wherein

the step of saturating the cellulose layer is performed, and in the step of forming the coating, the dispersion of styrene-butadiene copolymer is applied to only one side of the cellulose layer.

(30) The method according to any one of items (27) to (29), wherein the step of providing a cellulose layer comprises the step of creping the cellulose layer.

(31) The method according to item (30), wherein the step of creping the cellulose layer is carried out by mechanically compacting the cellulose layer in machine direction.

Claims

1. A coated paper comprising a cellulose layer and at least a coating on at least one side of the cellulose layer, wherein the coating comprises styrene-butadiene copolymer.
2. The coated paper according to claim 1, wherein the basis weight of the coating on one side of the cellulose layer is 1 to 10 g/m².
3. The coated paper according to claim 1 or 2, wherein the coating is present only on one side of the cellulose layer.
4. The coated paper according to claim 3, wherein the cellulose layer is saturated at least on the side of the cellulose layer opposite to the coating.

5. The coated paper according to claim 1 or 2, wherein the coating is present on both sides of the cellulose layer.
6. The coated paper according to claim 4, wherein the basis weight of the coating on each side of the cellulose layer is 1 to 10 g/m².
7. The coated paper according to any one of claims 1 to 6, wherein the cellulose layer comprises an internal sizing agent and/or wherein the coated paper is heat sealable.
8. The coated paper according to any one of claims 1 to 7, wherein the cellulose layer has a basis weight of 20 to 50 g/m² and/or wherein the coated paper has a basis weight of 25 to 70 g/m².
9. The coated paper according to any one of claims 1 to 7, wherein the cellulose layer is creped.
10. The coated paper according to claim 9, which has at least one of the following features (i) to (iv):
- (i) the cellulose layer has a basis weight of 20 to 80 g/m², preferably 40 to 60 g/m²;
 - (ii) the coated paper has a basis weight of 25 to 100 g/m², preferably 35 to 90 g/m², and most preferably 40 to 70 g/m²;
 - (iii) the cellulose layer has a thickness of 40 to 190 µm, preferably 60 to 150 µm, and most preferably 60 to 100 µm;
 - (iv) the coated paper has a thickness of 40 to 200 µm, preferably 60 to 160 µm, and most preferably 60 to 110 µm.
11. A packaging comprising the coated paper according to any one of claims 1 to 10.
12. A method of manufacturing coated paper comprising the steps of providing a cellulose layer,
- applying an aqueous dispersion of a styrene-butadiene copolymer to at least one surface of the cellulose layer and drying the cellulose layer with the aqueous dispersion of a styrene-butadiene copolymer on its surface to form a coating, and
- optionally saturating the cellulose layer before forming the coating.
13. The method according to claim 12, wherein
- in the step of forming the coating, the dispersion of styrene-butadiene copolymer is applied to both sides of the cellulose layer.
14. The method according to claim 12, wherein
- the step of saturating the cellulose layer is performed, and
- in the step of forming the coating, the dispersion of styrene-butadiene copolymer is applied to only one side of the cellulose layer.
15. The method according to any one of claims 12 to 14, wherein
- the step of providing a cellulose layer comprises the step of creping the cellulose layer wherein
- the step of creping the cellulose layer is preferably carried out by mechanically compacting the cellulose layer in machine direction.