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(54) **A recyclable sheet material and a container thereof**

(57) The present invention relates to a recyclable sheet material as defined below and a container, preferably a cup, based on cellulosic material for water containing foodstuff formed of such recyclable sheet material comprising

- a paper board containing a water repellent and optionally fat repellent sizing agent,
- an adhesive layer based on at least one polymer having a water solubility equal or less than 4 % per weight / 100 ml water at 25 °C and a surface energy of equal or greater 38 mJ/m² at 20 °C (test liquid:water) in an amount of providing a Cobb value of equal or less than 15 g/M²

per 60 sec is coated on at least one uncoated surface of the paper board and combined with the paper layer c),
c) a paper layer impregnated with a water barrier impregnation in an amount of providing a Cobb value of equal or less than 17 g/M² per 60 sec,
d) a heat sealable and water barrier coating on said impregnated paper layer c) in an amount of providing a Cobb value of equal or less than 8 g/M² per 600 sec of the coated board which coating is based on a polymer having a Tg of equal or less than 30 °C (measured according to DSC).

EP 2 682 523 A1

Description

[0001] The present invention relates to a recyclable sheet material as defined below and a container, preferably a cup, based on cellulosic material for water containing foodstuff formed of such recyclable sheet material comprising

- a) a paper board containing a water repellent and optionally fat repellent sizing agent,
- b) an adhesive layer based on at least one polymer having a water solubility equal or less than 4 % per weight / 100 ml water at 25 °C and a surface energy of equal or greater 38 mJ/m² at 20 °C (test liquid: water) in an amount of providing a Cobb value of equal or less than 15 g/m² per 60 sec is coated on at least one uncoated surface of the paper board and combined with the paper layer c),
- c) a paper layer impregnated with a water barrier impregnation in an amount of providing a Cobb value of equal or less than 17 g/m² per 60 sec,
- d) a heat sealable and water barrier coating on said impregnated paper layer c) in an amount of providing a Cobb value of equal or less than 8 g/m² per 600 sec of the coated board which coating is based on a polymer having a T_g of equal or less than 30 °C (measured according to DSC).

[0002] So called fast food restaurants are a major and growing supplier of nutrition. Predominantly, the logical concept of fast food restaurants is based on the single use package, like a single use container. Single use means that after the consumption of the food, the package of the food is discarded.

[0003] Since such packages may consist of both cellulosic material, predominantly in form of fibres, like paper, paper board or other molded fibre items, or plastic materials like polyethylene, polypropylene or polyethylenterephthalate or of a mixture of cellulosic material and plastic material, a waste management based on recycling the material could be difficult, even impossible.

[0004] Although it is known that the big advantage of single use package is that the used package need not be taken back for cleaning and thus a lot of energy consumption, like for heating dishwater and/or drying of the cleaned single use packages, is avoided, besides maintaining high and reliable hygienic standards for public use, the main stream of single use packages is worldwide a big problem.

[0005] The problem is related to the nature of the waste stream of single use packages. As already mentioned, this waste consists of a mixture of plastic material and cellulosic material typically. In order to recycle this waste, it is necessary to separate the different materials which could be recycled after separation from each other. However, the waste stream containing a mixture of these materials makes it often impossible to separate and recycle the different materials economically.

[0006] Traditionally, in the manufacture of paper and paper board, paraffin waxes and synthetic polymers as plastic material are used as moisture retardants, water repellents, oil repellents, stiffness strengtheners and release agents. Consequently, the waste of such paper and paper board of which single use packages traditionally are made, is not only difficult, but often impossible to be repulped and recycled in standard paper mill processes, because the polymers, in particular the waxes derived from petroleum, are not biodegradable in mill white waters (circulated process waters) and discharge effluents. Additionally, the residue of the waxes that can't be removed from the pulp fibers during the repulping and recycling process can cause severe problems due to buildups that occurs on the screens and felts used during the process of forming and making the paper or paper-board sheet.

[0007] It is also known that such waxes resist biodegradation and composting when disposed off in landfills and other waste disposal systems. Consequently, paper and paper board coated or impregnated with traditional synthetic polymers and waxes are often difficult, and even impossible to repulp and recycle owing to their resistance to separate from the fibres in the standard repulping processes resulting in significant fibre losses in efforts to repulp and thus recycle them. Moreover, often such synthetic polymers are also not biodegradable and therefore resist composting.

[0008] Although it is known that such impregnated paper and/or paper board can be repulped by using specialized repulping machinery that separates the pulp fibres from the laminated films and/or impregnation material, this is far more expensive in terms of operating costs and/or recycled pulp fibre yields in comparison to standard repulping processes. The action of separating the fibres from any impregnating synthetic and/or plastic material damages some fibres causing them to be selected out of the recycled pulp and to be lost for reuse. Additionally a separated plastic material waste carries some of the fibres out of the repulped when its adherence to the fibres is not hindered by the repulping process. Likewise, not only synthetic material used as sheets for the manufacture of paper and paper board, but also coatings and impregnating products made from synthetic materials like waxes, can be repulped for recycling only in specially configured repulping equipment that removes and separates the waxes. However, these more intense physical and chemical requirements of these repulping processes coupled with a loss of fibres that become trapped in the wax cause the recyclable repulped fibre levels to fall far below those of the standard repulping processes. In addition, packages made from such products are not biodegradable and must be separated and deposited in separate landfill areas.

[0009] It is an indispensable requirement that a recyclable sheet material should not only be repulpable and recyclable according to standard paper mill processes but should also maintain a sufficient high water barrier

after exposure to high mechanical forces which are necessary for example during folding a paper board or other sheet material based on cellulosic material in order to form a container. This folding is known to have sometimes an impairing effect on the water resistance of a sheet material by cracking of a water coating or water impregnation during the forming of a container used for foodstuff containing water. For this use a considerable risk exists that by using a sheet material having only one surface coating or impregnation as water barrier the water barrier is considerably reduced after forming a container.

[0010] It is therefore an object of the present invention to provide a recyclable sheet material especially for forming a container thereof, preferably for single use, based on cellulosic material, preferably on a paper board, which can be repulped and recycled according to standard paper mill processes and provides a sufficient high water barrier for foodstuff containing water even after being used for the production of containers of various kinds, especially single use cups, under exposure to mechanical forces. In addition, the residue of the repulped sheet material if any is also preferably biodegradable and can be composted when disposed of in a landfill or other dispose systems.

[0011] This object is solved by providing a recyclable and preferably repulpable sheet material comprising

- a) a paper board containing a water repellent and optionally fat repellent sizing agent,
- b) an adhesive layer based on at least one polymer having a water solubility equal or less than 4 % per weight / 100 ml water at 25 °C and a surface energy of equal or greater 38 mJ/m² at 20 °C (test liquid: water) in an amount of providing a Cobb value of equal or less than 15 g/m² per 60 sec is coated on at least one uncoated surface of the paper board and combined with the paper layer c),
- c) a paper layer impregnated with a water barrier impregnation in an amount of providing a Cobb value of equal or less than 17 g/m² per 60 sec,
- d) a heat sealable and water barrier coating on said impregnated paper layer c) in an amount of providing a Cobb value of equal or less than 8 g/m² per 600 sec of the coated board which coating is based on a polymer having a T_g of equal or less than 30 °C (measured according to DSC).

[0012] In order to achieve the recyclability of the inventive sheet material respectively any container formed thereof according to standard paper mill processes the water barrier coating, water barrier impregnation respectively sizing of the inventive sheet material must not interfere with these processes, however must guarantee a sufficient high water and optionally grease barrier, especially for any water containing foodstuff even after producing a container especially a cup by forming like folding the inventive sheet material into such a container.

[0013] Inventively, this can only be guaranteed if the inventive sheet material is composed in such way that each layer a) - d) has a certain extend of a water barrier, preferably each layer a different high water barrier, especially preferably a water barrier increasing from layer a) - d).

[0014] This arrangement of different high water barrier also allows that the amount of the water repellent impregnation (a, c)), the amount of adhesive layer (b)) and of the water barrier coating (d)) can be as low as possible in order to avoid any fibre clouding during the repulping process although guaranteeing a sufficient high water barrier for a formed container.

[0015] The inventive recyclable sheet material comprises a) a paper board or paper as substrate sheet each having a grammage of 150 - 350 g/m², preferably 170 - 300 g/m². Preferably this paper board or paper contains already a water repellent and optionally fat repellent sizing agent in an amount of 0,5 - 4 kg/ton of dry paper board.

[0016] Usually such an amount is sufficient to achieve a Cobb value of equal or less than 25 g/m² per 60 sec. as water barrier. Preferably as sizing agent at least one water repellent and optionally fat repellent sizing agent selected from the group comprising alkyl ketene dimers, alkenyl succinic anhydrides, starch and mixtures thereof can be used.

[0017] The paper board or paper used as substrate is especially containing such sizing agents in order to prevent any wicking in of water, especially at the edges of the inventive sheet material having been formed into a container if the container is in contact with any liquid.

[0018] At least one uncoated surface of the paper board or paper used as substrate is coated with an adhesive layer based on at least one polymer having a water solubility ≤ 4 wt% / 100 ml water, preferably 1 - 2 wt% / 100 ml water at 25 °C and a surface energy of equal or greater 38 mJ/m² at 20 °C (test liquid: water), preferably a surface energy from 38 mJ/m² - 55 mJ/m² at 20 °C (test liquid: water).

[0019] The adhesive layer is based on at least one polymer preferably with polar groups selected from the group comprising polyvinylacetates, ethylene/vinyl acetate copolymers, polyvinyl alcohols, ethylene/vinylalcohol copolymers, polyacrylates, acrylate copolymers, acrylate/styrene copolymers and mixtures thereof having a surface energy of ≥ 38 mJ/m² at 20 °C (test liquid: water).

[0020] Preferably the T_g of these polymers is at least ≤ 30 °C, more preferably 10 - 30 °C according to DSC.

[0021] Especially preferably a copolymer of ethylene/vinylacetate or a styrene/butylacrylate copolymer or a mixture thereof can be used to provide the adhesive layer b).

[0022] Preferably the adhesive layer is applied in an amount sufficient to provide enough adhesion between the substrate and layer c) and also a Cobb value of equal or less than 15 g/m² per 60 sec.

[0023] The adhesive layer can be applied to the substrate layer, namely the paper board or paper impregnated

ed with a water repellent and optionally fat repellent sizing agent as aqueous dispersion of at least one adhesive polymer and optionally at least one usual auxiliary agent.

[0024] These auxiliary agents can be present in the adhesive layer b) in an amount of 1 - 10 dried wt%. Preferably at least one agent selected from the group comprising thickening agents, defoaming agents, dispersants, cross-linking agents, slip additives and anti-blocking agents is used.

[0025] A preferred adhesive layer b) is based on a copolymer of ethylene/vinylacetate in an amount of 90 - 99 dried wt% and 1 - 10 dried wt% of at least one auxiliary agent.

[0026] Another preferred adhesive layer b) is composed of 60 - 90 dried wt% of styrene/butylacrylate copolymer and 10 - 40 dried wt% of ethylene/vinylacetate copolymers and optionally at least one of the before mentioned auxiliary agents.

[0027] The adhesive layer b) can be applied to at least one uncoated surface of the substrate, namely the impregnated paper board respectively paper, preferably as aqueous dispersion in an amount of 3 - 10 g/m², preferably 5 - 7 g/m², which is sufficient to achieve the Cobb value mentioned before.

[0028] The paper layer c) is impregnated with a water barrier impregnation in an amount of providing a Cobb value ≤ 17 g/m² per 60 sec, preferably a Cobb value of 10 - 15 g/m² per 60 sec. This paper layer is a thin paper layer having a grammage of 30 - 50 g/m² and preferably a smoothness of 200 ml/min or less according to Bendtsen, ISO 8791-2.

[0029] Preferably the paper layer c) is impregnated with a water barrier impregnation, preferably based on at least one saturated or α , β unsaturated fatty acid with at least 8 C-atoms, its derivatives, preferably esters or amides, and/or at least one saturated or α , β unsaturated dicarboxylic acid with at least 10 C-atoms, its derivatives, preferably dialkylesters of mono- or multivalent alcohols.

[0030] Preferably the amount of impregnation of the paper layer c) is equal or less than 10 wt% of the total weight of the impregnated paper layer c).

[0031] The impregnation of the paper layer c) can also be based on at least one polymer, preferably with polar groups selected from the group comprising acrylate polymers, acrylate copolymers, styrene copolymers, ethylene/vinyl acetate copolymers or mixtures thereof.

[0032] Preferably the impregnation is based on a dried water dispersion consisting of a styrene/butylacrylate copolymer in an amount of 95 - 99 dried wt% and 1 - 5 dried wt% of at least one auxiliary agent.

[0033] As auxiliary agents at least one agent selected from the group comprising thickening agents, defoaming agents, dispersants, cross-linking agents, slip additives and anti-blocking agents can be used.

[0034] The smoothness of the impregnated paper layer c) should be 200 ml/min or less according to Bendtsen, ISO 8791-2 to allow the use of an amount as low as possible for the water barrier impregnation in order to achieve

the Cobb value of less than 17 g/m² per 60 sec.

[0035] The inventive recyclable sheet material has as one of its surface layers a heat sealable and water barrier coating d) which is applied on top of the impregnated paper layer c) in an amount of providing a Cobb value of ≤ 8 g/m² per 600 sec, preferably 4 - 6 g/m² per 600 sec as sufficient high water barrier coating.

[0036] Preferably this heat sealable and water barrier coating d) is based on at least one polymer having a T_g of ≤ 30 °C, preferably 10 - 30 °C measured according to DSC.

[0037] Preferably the heat sealable and water barrier coating d) is based on at least one polymer having preferably polar groups like carboxylic-, carboxylic ester-, and/or OH-groups and is at least one polymer selected from the group comprising acrylate polymers, acrylate copolymers, styrene copolymers, preferably styrene/butylacrylate copolymers, ethylene/vinyl acetate copolymers providing a surface energy of ≥ 38 mJ/m² at 20 °C (test liquid:water) and on optionally auxiliary agents.

[0038] Preferably these polymers provide a surface energy of the coating d) of ≥ 38 mJ/m² at 20 °C (test liquid:water), preferably a surface energy of 38 - 55 mJ/m² at 20 °C (test liquid:water).

[0039] The heat sealable and water barrier coating d) is preferably applied as an aqueous dispersion which can also contain at least one auxiliary agent as already mentioned before.

[0040] Preferably the heat sealable and water barrier coating d) is based on 95 - 99 dried wt% of at least one of the before mentioned polymers and 1 - 5 dried wt% of at least one auxiliary agent selected from the group comprising thickening agents, defoaming agents, dispersants, cross-linking agents, slip additives, anti-blocking agents.

[0041] Most preferably the water barrier and heat sealable coating d) is composed of 95 - 99 dried wt% of styrene/butylacrylate copolymer and 1 - 5 dried wt% of one of the before mentioned auxiliary agents. The dried wt% are always amounting to 100 dried wt%.

[0042] The polymer component of the coating d) has preferably a melting point of 120 °C or less. More preferably the polymer component has a melting point in the range of 100 - 115 °C.

[0043] The heat sealable and water barrier coating is applied as a layer on the impregnated paper layer c).

[0044] Preferably the heat sealable and water barrier coating d) is applied in an amount of ≤ 12 g/m² providing a sufficient high Cobb value of equal or less 8 g/m².

[0045] Each of the layers b) and d) can be applied to the surface of the substrate, preferably of the paper board, respectively of the paper layer c) according to known processes.

[0046] The application of the coatings can be carried out continuously on equipment already known in the art.

[0047] Preferably the application of the coating is carried out by laminating or extrusion, preferably in form of an aqueous dispersion.

[0048] The second surface of the impregnated paper board being used as substrate of the recyclable sheet material can also be coated with the same sequence of layers b) - d) if appropriate.

[0049] It is also possible to cover the second surface of the impregnated paper board being used as substrate with only the heat sealable and water barrier coating d) in an amount of providing a Cobb value of $\leq 8 \text{ g/m}^2$ per 600 sec.

[0050] A further object of the present invention is a container, preferably cup, most preferably a cup for single use, which is formed of the inventive recyclable sheet material.

[0051] In order to form the inventive container, the recyclable sheet material has to be formed by joining certain areas of the heat sealable and water barrier coating d) which have to be activated by heat, preferably by hot air, and combined by pressing.

[0052] The surface of the inventive recyclable sheet material with the coating sequence of a) - d) is the inner surface of the container wall and preferably the bottom part.

[0053] Since the inventive recyclable sheet material provides a sequence of layers, respectively impregnation, preferably each with a different extent of water barrier, the inventive recyclable sheet material is especially suitable for forming the bottom part of a container, especially a cup, because the sheet material even being formed maintains a sufficient high water barrier after folding under the influence of mechanical strength.

[0054] According to the present invention the term "recyclable" means that the whole content of cellulosic material (paper board) of the inventive sheet material, respectively inventive container is recyclable which means repulpable and the contents of the non-cellulosic material like any coatings are at least repulpable according to standard paper mill processes with standard process conditions without relying on any specially configured repulping equipment.

[0055] The amount of non-cellulosic material of the inventive sheet material, respectively of an inventive container formed of the inventive sheet material is at most 15 wt% of the whole sheet material or container.

[0056] The non-cellulosic material of the inventive sheet material, respectively inventive container built thereof which is at least repulpable according to the before described definition is water-dispersible or water-soluble, therefore preferably it can not only be repulped but also at least partially be recycled according to the standard paper manufacturing processes or be degraded biologically according to DIN EN 13432.

[0057] The Cobb value is determined according to DIN EN 20535:1994.

[0058] The inventive containers, preferably cups, can be produced according to known manufacturing processes.

[0059] The inventive containers are especially useful for providing hot or cold beverages, ice cream or other

hot or cold liquids respectively food.

[0060] A further object of the present invention is a container, preferably a cup, formed of the inventive recyclable sheet material, useful as a container for cold beverages, ice cream or other hot or cold liquids respectively food.

[0061] Additionally, it is evident that the inventive laminate can also be used to produce other containers, especially for single use, than cups like trays and optionally corresponding lids, packages for milk and juices, plates or folding cartons for frozen foodstuff. All these kinds of containers are especially suitable for single use.

15 Claims

1. A recyclable sheet material comprising

- a) a paper board containing a water repellent and optionally fat repellent sizing agent,
- b) an adhesive layer based on at least one polymer having a water solubility equal or less than 4 % per weight / 100 ml water at 25 °C in an amount of providing a Cobb value equal or less than 15 g/m² per 60 sec. and a surface energy of equal or greater 38 mJ/m² at 20 °C (test liquid: water) is coated on at least one uncoated surface of the paper board and combined with the paper layer c),
- c) a paper layer impregnated with a water barrier impregnation in an amount of providing a Cobb value of equal or less than 17 g/m² per 60 sec,
- d) a heat sealable and water barrier coating on said impregnated paper layer c) in an amount of providing a Cobb value of equal or less than 8 g/m² per 600 sec of the coated board which coating is based on a polymer having a T_g of equal or less than 30 °C (measured according to DSC).

2. A recyclable sheet material as claimed in claim 1, wherein the paper board has a grammage of 170 - 350 g/m².

3. A recyclable sheet material as claimed in claim 1 or 2, wherein the sizing agent contained in the paper board in an amount of providing a Cobb value of equal or less than 25 g/m² per 60 sec.

4. A recyclable sheet material as claimed in any one of claims 1 - 3, wherein the polymer component of the adhesive layer b) has a T_g from 10 °C - 30 °C (measured according to DSC) and a water solubility of 1 - 2 % per weight /100 ml water at 25 °C.

5. A recyclable sheet material as claimed in any one of claims 1 - 4, wherein the adhesive layer b) is based on at least one polymer, preferably with polar groups,

- selected from the group comprising polyvinylacetates, ethylene/vinyl acetate copolymers, polyvinyl alcohols, ethylene/vinylalcohol copolymers, polyacrylates, acrylate copolymers, acrylate/styrene copolymers and mixtures thereof having a surface energy of equal or greater 38 mJ/m² at 20 °C (test liquid: water).
6. A recyclable sheet material as claimed in any one of claims 1 - 5, wherein the adhesive layer b) amounts to 3 - 10 g/m², preferably 5 - 7 g/m².
7. A recyclable sheet material as claimed in any one of claims 1 - 6, wherein the water barrier impregnation of the paper layer c) is based on at least one saturated or α , β unsaturated fatty acid with at least 8 C-atoms, its derivatives, preferably esters or amides, and/or at least one saturated or α , β unsaturated dicarboxylic acid with at least 10 C-atoms, its derivatives, preferably dialkylesters of mono- or multivalent alcohols.
8. A recyclable sheet material as claimed in any one of claims 1 - 6, wherein the impregnation of the paper layer c) is based on at least one polymer, preferably with polar groups, selected from the group comprising acrylate polymers, acrylate copolymers, styrene copolymers, ethylene/vinyl acetate copolymers and mixtures thereof.
9. A recyclable sheet material as claimed in any one of claims 1 - 8, wherein the impregnated paper layer c) is a thin paper layer having a grammage of 30 - 50 g/m² and a smoothness of 200 ml/min or less according to Bendtsen, ISO 8791-2.
10. A recyclable sheet material as claimed in any one of claims 1 - 9, wherein the heat sealable and barrier coating d) is based on a polymer, preferably with polar groups, having a surface energy equal or greater 38 mJ/m² at 20 °C (test liquid: water).
11. A recyclable sheet material as claimed in any one of claims 1 - 10, wherein the heat sealable and water barrier coating d) is based on at least one polymer selected from the group comprising acrylate polymers, acrylate copolymers, styrene copolymers, preferably styrene/butylacrylate copolymers, ethylene/vinyl acetate copolymers having a surface energy of equal or greater 38 mJ/m² at 20°C (test liquid: water) and optionally on auxiliary agents.
12. A recyclable sheet material as claimed in any one of claims 1 - 11, wherein the heat sealable and water barrier coating d) is based on 95 - 99 dried % per weight at least one of the polymers and 1 - 5 dried % per weight of at least one auxiliary agent.
13. A recyclable sheet material as claimed in any one of claims 1 - 12, wherein the T_g of said polymer on which the heat sealable and water barrier coating is based is between 10 - 30 °C (measured according to DSC)
14. A container, preferably a cup, formed at least partially of a recyclable sheet material as claimed in any one of claims 1 -13.
15. A container, preferably a cup, with a bottom part formed of a recyclable sheet material as claimed in any one of claims 1 -13.
16. A container, preferably a cup, as claimed in claim 14 or 15, useful as a container for cold or hot beverages, ice cream or other hot or cold liquids respectively food.



EUROPEAN SEARCH REPORT

Application Number
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Place of search Munich		Date of completion of the search 14 November 2012	Examiner Karlsson, Lennart
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EPO FORM 1503 03.82 (P04C01)



EUROPEAN SEARCH REPORT

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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