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(54) Title: NATURAL FIBRE MATERIAL

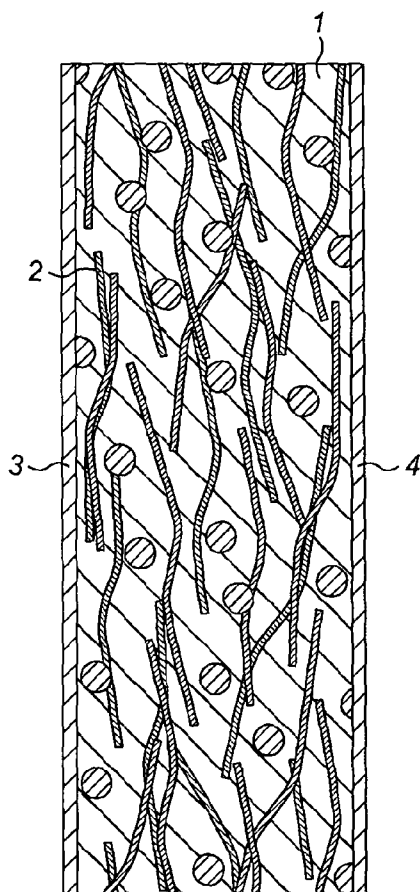


FIG. 1

(57) Abstract: A composite material comprising natural fibres, a natural flexible protein, a polysaccharide and a natural binding protein, wherein the natural fibres comprise bamboo and soy fibres, and wherein the natural flexible protein, the polysaccharide and the natural binding protein comprise gluten, methyl cellulose and albumin respectively.



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NATURAL FIBRE MATERIAL

The invention relates to a natural fibre material.

5 As people become more environmentally aware, there is a global trend for more natural and sustainable materials. The challenge is to find and develop a volumetrically scalable source of ingredients or component materials that can be produced in an environmentally friendly manner, yet provide the functional parameters of more traditional industrial materials.

10 This trend is especially true in the field of consumer packaging and more specifically bottles for beverages, in which thousands, or even millions, of tonnes of material are discarded every year. It is desired to find a packaging material that is bio-degradable, whilst providing the functional materials of more traditional packaging materials such as PET (polyethylene terephthalate), glass or metal. Additionally, it is desired to be able to manufacture materials, or the products
15 formed from the materials, in an environmentally friendly manner. This includes the sourcing, collation and conversion of the raw materials and processing into a final consumer product.

In the field of consumer products, particularly beverage containers, it is common to use metals, glass and plastics, e.g. PET. With an increased awareness
20 of the environment, there is an increasing use of natural, biodegradable materials, such as paper and card, to form items such as cups and plates. However, typically these materials can only contain wet food based products for up to 6 hours. Therefore, there is a need for a material which is sustainable and bio-degradable and can be used as a packaging material, which can contain food products and
25 beverages for longer periods of time, for example six months.

According to a first aspect, the present invention provides a composite material comprising natural fibres, a natural flexible protein, a polysaccharide and a natural binding protein, wherein the natural fibres comprise bamboo and soy fibres, and wherein the natural flexible protein, the polysaccharide and the natural binding
30 protein comprise gluten, methyl cellulose and albumin respectively.

The fibres may further comprise additional natural fibres, for example flax, cotton, or bagasse. . Bamboo fibres and soy fibres may be the only fibres used.

The natural flexible protein may further comprise additional plant proteins such as corn-zein or an animal protein such as casein or whey. The
35 polysaccharide may further comprise a cellulosic material such as

- 2 -

hydroxypropylmethylcellulose, methyl cellulose, starches, gums or chitin. The natural binding protein may further comprise albumin or a plant derived protein. Gluten, methyl cellulose and albumin may be the only natural flexible protein, polysaccharide and natural binding protein respectively

5 The material of the present invention comprises a natural bulking agent and a binding agent. The materials of the present invention are natural fibres and ingredients which are all sustainably sourced yet form a material with properties which are similar to more traditional industrial materials. The natural materials used absorb CO₂ as they grow which lowers the resulting carbon footprint of the material.
10 In this context the term "natural" means that they are not synthesised from non renewable resources, such as fossil fuels and that they are biodegradable or compostable. Advantageously, the ingredients used are also energy efficient to produce.

 Bamboo and soy fibres are used as the bulking agent as they are strong
15 and flexible, available in high volumes and the appropriate lengths and diameters for manufacturing. Appropriate fibre materials are supplied by Europa Wools Limited, United Kingdom. Additionally, bamboo and soy fibres are suitable for manufacturing processes, which means that they are wettable, conformable and that they shrink on drying. The materials are also renewable, sustainable and can bio-
20 degrade and thus provide the required properties to minimise the environmental impact of the material.

 The binding agents, methyl cellulose, gluten and albumin, are beneficial because they are strong, flexible and stable. Also, they are compatible with the soy and bamboo fibres, and combine with these fibres to form an effective composite
25 material. Additionally, they can be processed at low temperatures which reduces the energy used during manufacture of the material, they form a continuous, homogeneous 3-dimensional structure and are not hygroscopic. These properties result in a material with good physical properties which can be used in many different applications.

30 Methyl cellulose is produced by heating cellulose with caustic solution (e.g. a solution of sodium hydroxide) and treating it with methyl chloride. In the substitution reaction that follows, the hydroxyl residues (-OH functional groups) are replaced by methoxide (-OCH₃ groups). Methyl cellulose is soluble in cold water and forms a viscous hydrocolloid structure. The methyl cellulose may be
35 MethocelTM as supplied by Dow Corning Corporation. The albumin may be

albumen powder supplied by Parmovo S.r.l. The gluten may be gluten supplied by Tereos Syral.

Additional ingredients may be added to the material to modify the structural, physical, chemical or aesthetic properties of the material. The material may also
5 comprise additives to change the colour and/or surface finish of the material. For example, the surface finish may be rough, smooth, matt, polished, gloss or a combination of more than one finish. Additionally, additives may be used to improve the barrier properties of the material, specifically the gas permeation and moisture transfer properties.

10 Preferably, when the material is dry, the fibres comprise 30 to 50 % by mass of the material, and more preferably they comprise 40 % by mass of the material.

The ratio of fibres to binding agent changes the mechanical properties of the material. If the material comprises too much fibre, then the fibres will not adhere well and the binder cannot form a continuous structure around the fibres. As a
15 result, the mechanical properties and barrier properties of the material will be compromised. If the material comprises too low a percentage of fibres then the toughness and strength of the material will be reduced. The preferred compositions provide an effective compromise that optimises the properties of the material.

20 Preferably the fibres have an average diameter of between about 5 μm and about 15 μm , more preferably an average diameter of about 10 μm .

Preferably the fibres comprise two fibres present in a ratio between about 2:1 and about 1:2 and more preferably in a ratio of about 1:1. Preferably the bamboo and soy fibres are present in a ratio of 2:1 and 1:2 and more preferably in a ratio of about 1:1.

25 The exact ratios chosen can vary depending on the natural fibres used and the desired properties of the material being formed. This, to a certain extent, will depend on the end use of the material. These preferred ratios ensure the material has a balance of the properties provided by two different fibres.

30 Preferably the natural flexible protein, polysaccharide and natural binding protein have a ratio of about 1:1:1. The exact ratios can vary depending on the exact materials used and the desired properties of the material, which will depend on the end use of the material.

The material of the present invention may be formed or moulded into different shapes. In a preferred embodiment the material is formed into a sheet or a
35 thin walled body, such as a bottle. The material is also capable of being drilled,

machined or further shaped using various mechanical treatments or finishing operations. The material is suitable for use in a large number of applications in many areas of technology. The applications for the material may include, but are not limited to, packaging for food, beverages, cosmetics and paints etc, such as bottles, cartons, lids and boxes, packaging for consumer products such as compact-disks or electronics and for use in DIY or automotive industries.

The material may be coated to improve the properties of the material, such as the mechanical properties and the barrier properties, to improve the surface finish of the material, to provide a layer to carry a fungicide and/or to allow the material to be printed on. Additionally, the coating may act to protect the composite material. In a preferred embodiment the coating is a natural layer which will decompose and thus preferably it is not a polymeric or metal layer. The exact coatings used and the average coating thickness will depend on the desired properties of the material and the end use. For example, if the material is used as a vessel for holding a beverage, the coatings can be tailored to prevent taint and smells from the ambient environment and from the material itself affecting the beverage. The average coating thickness may be between 100 and 500 μm and in a preferred embodiment is between 200 and 300 μm .

In a preferred embodiment, at least a part of one side of the material is preferably coated with a coating comprising beeswax and damar resin. This coating reduces the water vapour and oxygen permeability of the material. At 23°C at 100% RH a beeswax/damar film laminated on to an A4 sheet of paper has a water transmission rate between 120 and 214 $\text{mg}/(\text{m}^2 \cdot \text{day})$ and a water vapour permeability of 0.0105 and 0.0216 $\text{g} \cdot \text{mm}/(\text{m}^2 \cdot \text{day} \cdot \text{kPa})$. The coating may be applied by spray coating, spin coating, dip coating, chemical vapour deposition or any other known processes for applying coatings. The beeswax and damar resin may be combined with a solvent to apply the coating.

Alternatively or additionally, at least a part of one side of the material is preferably coated with a coating comprising shellac. Shellac is an odour and stain blocker and is an excellent barrier against water vapour penetration. This coating can act as an additional barrier to gasses and liquids entering the material from the ambient environment, can provide additional strength to the material and can provide a good surface finish. This coating can be applied at room temperature in a rapid drying solvent, can adhere well to the underlying substrate, and can be applied by any of the methods listed above.

The material may be coated with an undercoat or primer to improve the surface, change the colour and/or improve the adhesion of a top coat which provides a protective barrier and is visually and tactilely appealing. The undercoats may comprise calcium carbonate, china clay, pink mica and/or any other known suitable materials. Graphics may be applied to the coating. In a preferred embodiment the graphics are robust and visually and tactilely appealing.

The appearance of the material may be changed through various surface treatments which include, dipping into a coating solution, impregnation, electrostatic powder coating, dying with inks, pigments, stains or other colorants or a combination of treatments.

By changing various parameters such as the composition, shape and the manufacturing and finishing operations the properties of the material can be tailored to the intended use of the material. Properties such as the hoop strength, top load strength, burst strength, denting performance, density, hardness, toughness, porosity, barrier properties etc and the rate of bio-degradation can be optimised.

According to a second aspect, the present invention provides a vessel formed from a material comprising natural fibres, a natural flexible protein, a polysaccharide and a natural binding protein, wherein the natural fibres comprise bamboo and soy fibres, and wherein the natural flexible protein, the polysaccharide and the natural binding protein comprise gluten, methyl cellulose and albumin respectively.

The preferred constituents of the material used for the vessel are the same as discussed in relation to the first aspect of the invention and have been chosen for the same as reasons given above. The relative amounts of the constituents may be the same as discussed in relation to the material of the first aspect.

The vessel may comprise an inner and an outer surface, of which at least a part of one of the surfaces is coated to improve the barrier properties of the material. The coating can be tailored to allow the vessel to be suitable for holding certain products, particularly liquids or moist or wet products.

Preferably the vessel is coated on the inner surface with a coating comprising beeswax and damar resin. The benefits of this coating are the same as discussed above. The inside surface may be either partially coated or completely coated with the beeswax and damar resin coating. For example, if the vessel is a bottle for holding a beverage, the top of the vessel near the closure may not be coated or may be coated with a different coating which aids sealing of the vessel.

- 6 -

Other areas of the inside of the vessel may not be coated or may be provided with an alternative coating. In a preferred embodiment the inner surface is entirely coated with a coating comprising beeswax and damar resin to prevent the ingress of taint and smells from the outside environment and the material itself to the inside of the vessel and the product it contains. Additional or alternative components of the coating include rosin, multi-purpose wax, candelilla wax or grey carnauba wax.

Preferably the vessel is coated on the outer surface with a coating comprising shellac. This coating provides the same benefits as discussed above in relation to the material of the first aspect of the invention. The outer surface may be either partially coated or completely coated with the shellac coating. For example, if the vessel is a bottle for holding a beverage, the outside surface may have a different coating in areas subjected to the highest amount of stress. Other areas of the outside of the vessel may not be coated or may be provided with an alternative coating. Additional or alternative components include rosin, white vegetable wax, glycerol, and a mix of beeswax and linseed oil. An external finish may be provided using red mica and/or food colour.

The vessel may be used as a container for holding a beverage, for example a beverage selected from non-carbonated, non-alcoholic beverages such as water, dairy based beverages, juices, teas and coffees. Preferably the vessel should be able to hold between about 300 ml and about 500 ml of liquid. In one preferred embodiment the vessel is designed to hold about 330 ml of liquid. The vessel may have a maximum useable capacity at the volume(s) stated above, i.e. a maximum of between about 300 ml and about 500 ml, preferably a maximum useable capacity of about 330 ml.

Additionally, in a preferred embodiment the packaging is re-sealable and has a visual and/or audible tamper evident seal on first opening.

The vessel can be any number of different shapes and sizes and this may depend on factors such as the use of the vessel, the brand of the product being held or the manufacturing process used. The vessel may comprise embossed or debossed structural or decorative features. For example, if the vessel is a bottle for holding a beverage these variations may include variability of the diameter and/or height of the mouth, neck, body and base portions of the bottle.

Advantageously, the vessel is able to reliably hold a beverage for up to six months. This means that under normal conditions the vessel should not break, leak or allow beverage to seep through the vessel walls within a six month period of

- 7 -

storage when full of beverage. Additionally, the container should protect the beverage from the ambient environment of the container to allow the beverage to be suitable for consumption for up to six months after filling and sealing.

5 In a preferred embodiment, the vessel is designed to be filled with a beverage and then easily conveyed through existing supply chains and routes to market.

Since the vessel is made from a sustainable and biodegradable material the vessel is also sustainable and biodegradable.

10 Preferably the vessel is provided with a closure. In a preferred embodiment the closure provides a barrier from the external environment to prevent gasses and/or liquids coming in contact with the product inside the vessel (for example, a beverage) and/or the internal surface of the vessel. The closure is preferably removable and re-sealable to create a liquid seal post opening, preferably able to support any directly applied graphics or branding, preferably provides additional
15 strength and preferably able to provide tamper evidence.

The closure may be a single component such as a rigid closure which screws externally or internally to the vessel or a compliant closure such as a press cap or a plug or bung. Alternatively, the closure maybe a multiple component part in which there is a part connected to or moulded in the mouth of the vessel to which
20 a second closure part can attached. The closure may also comprise a compliant cap wad.

The vessel may include any or all of the optional features discussed above in relation to the material of the first aspect of the invention.

25 According to a third aspect, the present invention provides a method of manufacturing a vessel comprising: forming the vessel from a material comprising natural fibres, a natural flexible protein, a polysaccharide and a natural binding protein, wherein the natural fibres comprise bamboo and soy fibres, and wherein the natural flexible protein, the polysaccharide and the natural binding protein comprise gluten, methyl cellulose and albumin respectively.

30 The preferred constituents of the material used in the method of manufacturing a vessel are the same as discussed in relation to the first aspect of the invention and have been chosen for the same as reasons. The relative amounts of the constituents may be the same as discussed in relation to the material of the first aspect.

Preferably the method comprises mixing the natural flexible protein, the polysaccharide and the natural binding protein with water to create a wet mix, and combining the natural fibres with the wet mix to form the vessel.

5 To create the wet mix the ratio of the dry binding components, gluten natural flexible protein, the polysaccharide and the natural binding protein to water is preferably about 10:1. Although the exact ratio can vary depending on a number of factors including the vessel size and the desired drying time.

10 The vessel may be formed by laying up or winding fibres on to a rotating mandrel and the wet mix may be applied to the fibres before, during or after laying up or winding of the fibres onto the rotating mandrel. The fibres may be placed randomly on the mandrel or in a controlled and organised non-woven manner which may include aligning the fibres.

15 The wet mix may be applied by painting, dip coating, spray coating, powder coating and then spraying with water, pre-impregnating the fibres or spin coating or any other known technique.

The rotating mandrel may have a collapsible core to allow the vessel to be formed as a single component which can easily be removed from the mandrel. Preferably the rotating mandrel has the desired shape of the vessel being formed or a precursor shape so that the vessel formed on the rotating mandrel has the
20 desired shape or precursor shape. The vessel may be formed in a precursor shape because later manufacturing operations such as the drying and finishing steps may cause the final shape of the vessel to change. For example, shrinkage may occur during the drainage process.

25 Alternatively the fibres could be provided as a knitted sock or tube which have been made in a desired shape, or precursor shape, before the wet mix is applied according to any of the techniques listed above.

Providing the fibres as a knitted sock can advantageously increase the lay up consistency and the speed of handling.

30 Additionally, an external split mould may be used during forming to provide definition to external surfaces such as openings and features used for the closure. This external mould may also use a vacuum to minimise shrinking and/or to aid the extraction of water from the formed shape. This alternative may include, as an alternative to the rotatable mandrel with a collapsible core, an expanding bladder part inside the split mould. In this case the shape the fibres and wet mix are placed
35 around an inflatable bladder which is then positioned in a mould. The mould is then

heated and the bladder is inflated. When the bladder is inflated the material is pressed against the inner wall of the mould cavity to form the desired shape or precursor shape. The inflation medium may be air or a hot liquid. When the process is complete the part is removed from the mould and then extracted from the bladder.

Once the fibres and the wet mix have been combined and formed into the shape or precursor shape for the vessel, a drying step is carried out. If the shape has been formed on a rotatable mandrel then the formed shape may either be removed from the mandrel and then dried or be dried, or at least part dried, on the mandrel before being ejected. Preferably the component is air dried at about 60°C and in a reduced humidity environment.

Once dried, finishing operations can be performed on the vessel, for example removing unnecessary material, trimming, smoothing, polishing and applying surface treatments and processes. If the vessel has been formed and then dried on a rotatable mandrel, the component may either be removed from the mandrel and then finished or be finished, or at least part finished, on the mandrel before being ejected.

The step of performing finishing operations of the vessel preferably comprises applying a coating to at least a part of the inner surface of the vessel. For the reasons discussed above, preferably at least a part of the inner surface of the vessel is coated with a coating comprising beeswax and damar resin. The step of performing finishing operations of the vessel preferably comprises applying a coating to at least a part of the outer surface of the vessel. For the reasons discussed above, preferably at least a part of the outer surface of the vessel is coated with a coating comprising shellac.

The finishing operations can also be used to create the desired surface texture and appearance and the desired wall thickness.

The method of manufacture may incorporate other known technologies such as pulp injection or compression moulding to improve physical and mechanical properties of the vessel being formed.

Another advantage of the use of the natural materials of the aspects of the invention and of the preferred natural materials used herein is that some, if not all, of the steps of the method are carried out at near room temperature and pressure. This reduces the amount of energy used during manufacture and also reduces the complexity of the manufacturing facility. Not only does this reduce manufacturing

- 10 -

costs but it also reduces the carbon footprint of the vessel being manufactured. Advantageously the method of manufacturing the vessel may use less energy than the manufacture of a similar vessel from typical materials such as natural rubber, PET or natural rubber glass.

5 The vessel formed by the method of manufacturing may include any or all of the optional features discussed above in relation to both the material and the vessel of the first and second aspect of the invention.

 According to another aspect, the present invention provides a composite material comprising natural fibres, a natural flexible protein, a polysaccharide and a
10 natural binding protein.

 The fibres can be any natural fibres, for example flax, cotton, bagasse, bamboo or soy. In a preferred embodiment the natural fibres comprise bamboo and/or soy fibres. Bamboo fibres and soy fibres may be the only fibres used.

 The natural flexible protein may be gluten, or alternative plant proteins such
15 as corn-zein or an animal protein such as casein or whey. Preferably the natural flexible protein is gluten. The polysaccharide may be a cellulosic material such as hydroxypropylmethylcellulose, methyl cellulose, starches, gums or chitin. Preferably the polysaccharide is methyl cellulose. The natural binding protein may be albumin or a plant derived protein. Preferably the natural binding protein is
20 albumin.

 According to yet another aspect, the present invention provides a vessel formed from a material comprising natural fibres, a natural flexible protein, a polysaccharide and a natural binding protein.

 According to a further aspect, the present invention provides a method of
25 manufacturing a vessel comprising: forming the vessel from a material comprising natural fibres, a natural flexible protein, a polysaccharide and a natural binding protein.

 Certain preferred embodiments of the present invention will now be described by way of example only with reference to the accompanying drawings, in
30 which:

 Figure 1 is a schematic of a composite material; and

 Figure 2 is an example of a bottle manufactured from the composite material.

 A preferred embodiment of a composite material in schematic form is shown
35 in Figure 1. The composite material comprises a matrix 1 and natural fibres 2, with

coatings 3, 4 on either side of the material. In its preferred form, the material is a sheet or a thin-walled container. The preferred embodiment of the a composite material comprises bamboo and soy fibres 2 in a gluten, methyl cellulose and albumin matrix 1. When the material is dry, the bamboo and soy fibres 2 make up about 40 % by weight of the material. The bamboo and soy fibres 2 are present in substantially equal proportions, i.e. a 1:1 ratio, and the components of the matrix 1 are also present in substantially equal proportions, i.e. a 1:1:1 ratio. The material is formed into a thin walled body, such as a vessel for containing liquid. It is coated on one side with a coating 3 comprising beeswax and damar resin and on the other side is coated with a coating 4 comprising shellac.

A preferred embodiment of a vessel is a beverage container 5 (as shown in Figure 2) which can hold about 330 ml of liquid and is formed from the composite material of Figure 1. The vessel 5 comprises a base portion, a body portion, a short and wide neck portion and a mouth portion. The cross section of the vessel 5 at all portions is substantially circular. The vessel 5 has a height of 170 mm, the body portion of the vessel has a diameter of 60 mm and the point at which the mouth portion and the neck portion of the vessel meet has a diameter of 43 mm. The average thickness of the wall section is about 0.7 to 0.8 mm. The vessel is coated on the entire inner surface with a coating 3 comprising beeswax and damar resin coating and the vessel is coated on the entire outer surface with a coating 4 comprising shellac. The outside surface of the vessel 5 is coloured with dyes and pigments and printed with the branding of the product to be contained in the vessel.

The vessel 5 has a closure (not shown) that provides a barrier from the external environment to prevent gasses and/or liquids coming in contact with the beverage inside the vessel 5 and/or the internal surface of the vessel. The closure is removable and re-sealable to create a liquid seal after initial opening.

The vessel 5 is rigid but is tough enough to survive 'normal' supply chain conditions, without the need for more than typical secondary packaging without leaking. The vessel can also survive the same usage (consumer handling) conditions as current packaging solutions e.g. PET beverage containers, without leaking.

A preferred embodiment of a method of manufacturing a vessel comprises a number of steps in sequence to produce a vessel 5 formed of a composite material which comprises bamboo and soy fibres 2 in a gluten, methyl cellulose and albumin matrix 1 for filling with a beverage. Initially the method comprises providing the

- 12 -

bamboo fibre and the soy fibre 2 in a 1:1 ratio and then blending, spinning and knitting the fibres 2 into a tube of the desired shape for the vessel being manufactured. In parallel, the binder materials 1 comprising gluten, methyl cellulose and albumin are mixed in a 1:1:1 ratio and then mixed with water in a 1:10 ratio to form a wet mix. The wet mix is then integrated with the knitted tube to form the vessel 5. The formed vessel 5 is then dried in air at 60°C at a reduced relative humidity.

The entire inner surface of the dried vessel 5 is then coated by means of spraying a blend comprising beeswax and damar resin. Next the entire outer surface of the vessel 5 is coated with shellac which has been formed into a solution.

Once completed the vessel 5 is either palletised or transferred on a conveyor to be filled and then sealed.

CLAIMS:

1. A composite material comprising natural fibres, a natural flexible protein, a polysaccharide and a natural binding protein, wherein the natural fibres
5 comprise bamboo and soy fibres, and wherein the natural flexible protein, the polysaccharide and the natural binding protein comprise gluten, methyl cellulose and albumin respectively.
2. A composite material as claimed in claim 1, wherein, when the
10 material is dry, the fibres are 30% to 50% by weight of the material.
3. A composite material as claimed in claim 1 or 2, wherein the bamboo and soy fibres are present in a ratio between 2:1 and 1:2.
- 15 4. A composite material as claimed in claim 1, 2 or 3, wherein the bamboo and soy fibres are present in a ratio of 1:1.
5. A composite material as claimed in any preceding claim, wherein the natural flexible protein, the polysaccharide and the natural binding protein are
20 present in a ratio of 1:1:1.
6. A composite material as claimed in any preceding claim, wherein the material is formed into a sheet or a thin walled body.
- 25 7. A composite material as claimed in any preceding claim, wherein the material is coated to improve the barrier properties of the material.
8. A composite material as claimed in any preceding claim, wherein the material is coated on one side with a coating comprising beeswax and damar resin.
30
9. A composite material as claimed in any preceding claim, wherein the material is coated on one side with a coating comprising shellac.

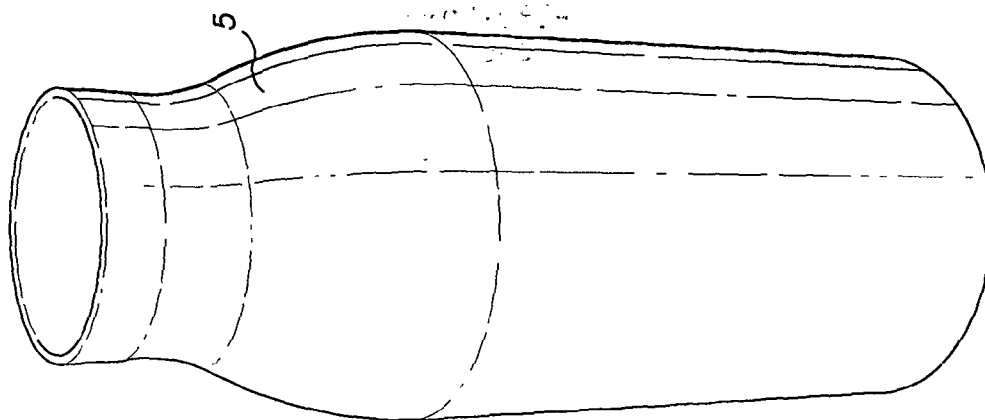


FIG. 2

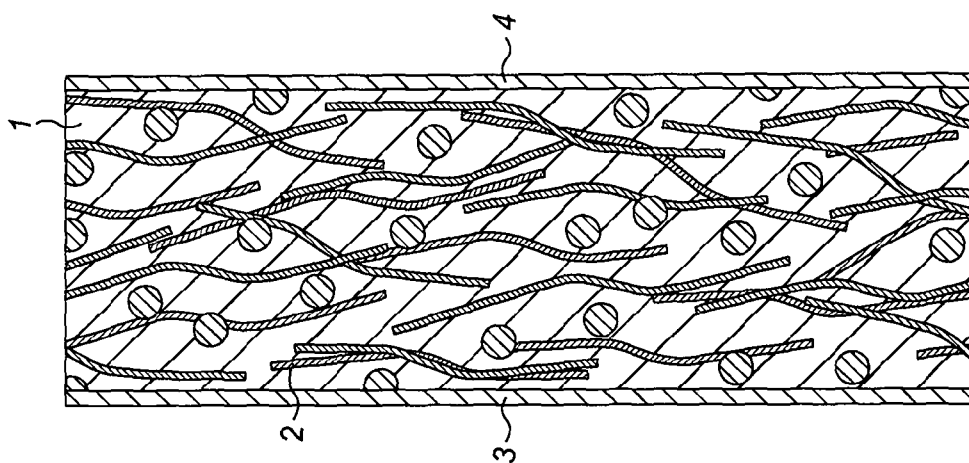


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/051275

A. CLASSIFICATION OF SUBJECT MATTER INV. B29C70/08 B65D1/00 C08J5/04 C08L1/28 C08L89/00 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B29C B65D C08J C08L		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008/268220 A1 (OLLIGES PAUL [US]) 30 October 2008 (2008-10-30) claims 1,5-9,16 -----	1-9
A	US 5 580 624 A (ANDERSEN PER J [US] ET AL) 3 December 1996 (1996-12-03) claims 1,7,15,17 -----	1-9
A	US 5 922 379 A (WANG SHU HUAN [US]) 13 July 1999 (1999-07-13) claims 1-3,5-7,10-12 -----	1-9
A	DE 100 27 297 A1 (SCHMERMUND VERPACKUNGSTECHNIK [DE]) 6 December 2001 (2001-12-06) paragraphs [0012], [0013]; claims 1,4,5 ----- -/--	1-9
☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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INTERNATIONAL SEARCH REPORT

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 317 037 A (GOLDEN CASEY V [US] ET AL) 31 May 1994 (1994-05-31) abstract; claims 1-3 -----	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/GB2012/051275

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008268220 A1	30-10-2008	US 2008268220 A1 WO 2008133962 A2	30-10-2008 06-11-2008
US 5580624 A	03-12-1996	US 5580624 A US 5705242 A US 5753308 A	03-12-1996 06-01-1998 19-05-1998
US 5922379 A	13-07-1999	AU 3642699 A CN 1299238 A DE 69928388 D1 DE 69928388 T2 EP 1075188 A1 JP 4302318 B2 JP 2002512929 A TW 522153 B US 5922379 A WO 9956556 A1	23-11-1999 13-06-2001 22-12-2005 03-08-2006 14-02-2001 22-07-2009 08-05-2002 01-03-2003 13-07-1999 11-11-1999
DE 10027297 A1	06-12-2001	AU 6230201 A DE 10027297 A1 EP 1290066 A1 US 2003161973 A1 WO 0194449 A1	17-12-2001 06-12-2001 12-03-2003 28-08-2003 13-12-2001
US 5317037 A	31-05-1994	JP 5042239 A US 5046730 A US 5317037 A	23-02-1993 10-09-1991 31-05-1994