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(54) Title: COMPOSITE PRODUCTS COMPRISING COFFEE GROUNDS AND THE MANUFACTURE THEREOF

(57) Abstract: The present invention relates generally to composite products, in particular composite products comprising coffee grounds, and the manufacture thereof.

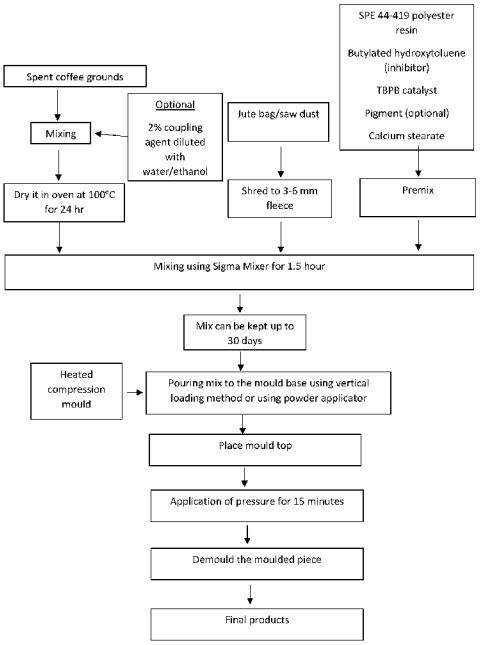

Figure 1

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COMPOSITE PRODUCTS COMPRISING COFFEE GROUNDS AND THE MANUFACTURE THEREOF

Field of the invention

[0001] The present invention relates generally to composite products, in particular composite products comprising coffee grounds, and the manufacture thereof.

Background of the invention

[0002] Any discussion of the prior art throughout this specification should in no way be considered as an admission that such prior art is widely known or forms part of the common general knowledge in the field.

[0003] The amount of waste produced by the global population continues to increase at an alarming rate. In the city of Sydney alone, about 3000 tonnes of coffee grounds are produced by cafes and coffee shops alone. The majority of these grounds are either sent to landfill or flushed down sinks.

[0004] The present inventors have developed a method for preparing composite products comprising coffee grounds that allow waste to be converted into useful products.

Summary of the invention

[0005] In a first aspect the present invention provides a composite product comprising a binder and coffee grounds.

[0006] The binder may be present in an amount between about 5% and about 45% by weight, or in an amount between about 10% and about 25% by weight, or in an amount between about 15% and about 20% by weight.

[0007] The binder may be obtained from a waste material.

[0008] The binder may be a polymer, such as for example polypropylene or glycol-modified polyethylene terephthalate.

[0009] The polymer may be a thermoset polymer.

[0010] The thermoset polymer may be, or may be obtained from, an epoxy resin, polyester resin or vinyl ester resin. In one embodiment the thermoset polymer is, or is obtained from, a polyester resin.

[0011] The coffee grounds may be present in an amount between about 2% and about 90% by weight, or in an amount between about 3% and about 80% by weight, or in an amount between about 5% and about 85% by weight, or in an amount between about 20% and about 80% by weight, or in an amount between about 20% and about 40% by weight.

[0012] The composite product may further comprise a cellulosic material.

[0013] The cellulosic material may be present in an amount between about 15% and about 75% by weight, or in an amount between about 40% and about 70% by weight.

[0014] The cellulosic material may be a powder, particulate, dust or fibers.

[0015] The cellulosic material may be obtained from waste.

[0016] The cellulosic material may be jute or timber.

[0017] The jute may be in the form of fibers.

[0018] The jute may be shredded jute.

[0019] The timber may be in the form of saw dust.

[0020] The composite product may be free, or substantially free, of glass.

[0021] The composite product may further comprise a coupling agent.

[0022] The composite product may further comprise a pigment.

[0023] The composite product may be in the form of a panel or a tile.

[0024] The composite product may comprise greater than about 50%, or greater than about 60%, or greater than about 70%, or greater than about 80%, or greater than about 90%, or greater than about

95% waste material by weight. In one embodiment, the composite product may be made entirely of waste material.

[0025] The composite product may further comprise a coating.

[0026] The coating may be a zinc oxide coating.

[0027] The composite may be prepared by hot pressing or casting.

[0028] In a second aspect the present invention provides a method for preparing a composite product comprising:

(i) forming a mixture comprising coffee grounds and a binder; and

(ii) applying heat and pressure to the mixture to form the composite product.

[0029] In step (ii) the heat applied may be less than about 300 °C, or less than about 250 °C, or less than about 240 °C.

[0030] In step (ii) the heat applied may be between about 120 °C and about 180 °C.

[0031] In step (ii) the pressure applied may be between about 5 MPa and about 20 MPa.

[0032] The binder may be present in the mixture in an amount between about 5% and about 45% by weight, or in an amount between about 10% and about 25% by weight, or in an amount between about 15% and about 20% by weight.

[0033] The coffee grounds may be present in the mixture in an amount between about 5% and about 85% by weight, or in an amount between about 20% and about 80% by weight, or in an amount between about 20% and about 40% by weight.

[0034] The mixture may further comprise a cellulosic material.

[0035] The cellulosic material may be present in an amount between about 15% and about 75% by weight, or in an amount between about 40% and about 70% by weight.

[0036] The binder and the cellulosic material used in the second aspect may be as defined herein in connection with the composites of the first aspect.

[0037] The binder, coffee grounds and cellulosic material may be present in the mixture in any of the amounts recited herein in connection with the composites of the first aspect.

[0038] The coffee grounds may be dried prior to forming the mixture.

[0039] The coffee grounds may be dried at a temperature of at least about 80 °C prior to forming the mixture.

[0040] The mixture may further comprise a catalyst.

[0041] The catalyst may be present in the mixture in an amount between about 0.1% and about 10% by weight, or in an amount between about 0.5% and about 5% by weight of the binder.

[0042] The mixture may further comprise a pigment.

[0043] The mixture may further comprise an inhibitor.

[0044] The inhibitor may be present in the mixture in an amount between about 0.01% and about 2% by weight, or in an amount between about 0.05% and about 0.5% by weight of the binder.

[0045] The mixture may further comprise a coupling agent.

[0046] The coupling agent may be present in an amount between about 0.5% and about 3% by weight, or in an amount between about 0.5% and about 2% by weight, based on the weight of the mixture.

[0047] Prior to forming the mixture the coffee grounds may be screened through 1 mm mesh.

[0048] The mixture may be free, or substantially free, of glass.

Definitions

[0049] Throughout this specification, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps. Thus, in the context of this specification, the term "comprising" means "including principally, but not necessarily solely".

[0050] In the context of this specification the terms "a" and "an" are used herein to refer to one or to more than one (i.e to at least one) of the grammatical object of the article. By way of example, "an element" means one element or more than one element.

[0051] The term "about" is understood to refer to a range of numbers that a person of skill in the art would consider equivalent to the recited value in the context of achieving the same function or result.

[0052] The term "substantially free" as used in reference to glass content means that glass constitutes less than about 2% by weight, such as less than 1% by weight, preferably less than 0.5% by weight, or more preferably, less than 0.1% by weight, or even more preferably less than 0.01% by weight.

[0053] The term "cellulosic material" is understood to refer to any material containing cellulose. The material may be natural or synthetic and may contain additional components, such as for example hemicellulose, lignin and/or pectin. The material may comprise at least 15%, at least 20%, at least 30%, at least 40%, at least 50%, at least 60%, at least 70%, or at least 80% by weight of cellulose.

Brief Description of Drawings

[0054] Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, in which:

Figure 1: Methods for preparation of composite products in accordance with one embodiment of the invention.

Figure 2: Composite panels in accordance with one embodiment of the invention.

Detailed description

[0055] The present invention broadly relates to composite products comprising coffee grounds. In a first aspect the present invention relates to a composite product comprising a binder and coffee grounds.

[0056] The coffee grounds may be present in an amount between about 2% and about 90% by weight, or in an amount between about 3% and about 80% by weight, or in an amount between about 5% and about 85% by weight, or in an amount between about 20% and about 80% by weight, or in an amount between about 20% and about 40% by weight..

[0057] In other embodiments the coffee grounds may be present in an amount between about 2% and about 15% by weight, or in an amount between about 3% and about 10% by weight, or in an amount between about 50% and about 90% by weight, or in an amount between about 50% and about 80% by weight, or in an amount between about 55% and about 75% by weight, or in an amount between about 60% and about 70% by weight.

[0058] In one embodiment the coffee grounds may be charred.

[0059] The binder may be present in an amount between about 5% and about 55% by weight, or in an amount between about 5% and about 45% by weight, or in an amount between about 10% and about 50% by weight, or in an amount between about 5% and about 40% by weight, or in an amount between about 5% and about 35% by weight, or in an amount between about 5% and about 30% by weight, or in an amount between about 5% and about 25% by weight, or in an amount between about 10% and about 25% by weight, or in an amount between about 15% and about 20% by weight, or in an amount between about 15% and about 45% by weight, or in an amount between about 15% and about 40% by weight, or in an amount between about 20% and about 35% by weight, or in an amount between about 20% and about 40% by weight.

[0060] In some embodiments, the coffee grounds and the binder may be present in any combinations of the amounts recited above in paragraphs [0056], [0057] and [0059].

[0061] Typically, the binder is a polymer. Suitable polymers include, but are not limited to, acrylonitrile butadiene styrene, polylactic acid, styrene acrylonitrile, polypropylene, polyethylene, high density polyethylene, low density polyethylene, linear low density polyethylene, ultra-high molecular weight polyethylene, polyvinyl chloride, polyethylene terephthalate, nylon, polystyrene, high impact polystyrene, polyoxymethylene (acetal), poly(methyl methacrylate), polyester and polycarbonate.

[0062] In some embodiments, the polymer is a thermoset polymer. A thermosetting polymer, resin, or plastic, also referred to as "a thermoset", is a polymer that is irreversibly hardened by curing from a soft, solid or viscous liquid prepolymer or resin. Curing may be induced by heat or radiation, promoted by high pressure, or by mixing with a catalyst. Curing results in extensive cross-linking between polymer chains to produce an infusible and insoluble polymer network. Examples of thermoset polymers include, but are not limited to, polyester resin, polyurethanes, polyurea/polyurethane, vulcanized rubber, bakelite, duroplast, urea-formaldehyde, melamine resin, diallyl phthalate, epoxy

resin, benzoxazines, polyimides, bismaleimides, cyanate esters, furan resins, silicone resins, thiolyte and vinyl ester resins. In some embodiments the thermoset polymer may be, or may be obtained from, an epoxy resin, polyester resin or vinyl ester resin. In other embodiments, the thermoset polymer may be, or may be obtained from, an unsaturated polyester resin.

[0063] The use of thermoset polymers provides a further advantage in that composites made using them are able to be recycled.

[0064] Preferably, the polymer/resin has a melting point below about 300 °C, or below about 290 °C, or below about 280 °C, or below about 270 °C, or below about 260 °C, or below about 250 °C, or below about 240 °C.

[0065] In some embodiments, the polymer may be obtained from waste materials.

[0066] Depending on the type of thermoset polymer, a catalyst may also be used in the manufacture of the composites. The catalyst is used to promote cross-linking of the polymer which leads to hardening, otherwise known as "curing" of the polymer. Appropriate hardeners/catalysts will be known to those skilled in the art and include radical initiators, such as for example organic peroxides. Non-limiting examples of organic peroxides include benzoyl peroxide, 2-butanone peroxide, methyl ethyl ketone peroxide (MEKP) and *t*-butylperoxybenzoate (TBPB).

[0067] When preparing the composites, the catalyst may be added to the mixture in an amount between about 0.1% and about 10% by weight, or in an amount between about 0.5% and about 5% by weight, or in an amount between about 0.5% and about 4% by weight, or in an amount between about 0.5% and about 3% by weight, based on the weight of the binder to be included in the composite.

[0068] In some embodiments, an inhibitor is used in the manufacture of the composites. Inhibitors are antioxidant molecules that act to scavenge free radicals thereby preventing the premature, spontaneous initiation and propagation of free-radical polymerisation, and hence curing of the thermoset polymer. The inhibitors can therefore be used to control the curing rate of the polymers. Suitable inhibitors will be known to those skilled in the art, and include butylated hydroxytoluene (BHT) and monomethyl ether hydroquinone (MEHQ).

[0069] When preparing the composites, the inhibitor may be added to the mixture in an amount between about 0.01% and about 2% by weight, or in an amount between about 0.05% and about 1%

by weight, or in an amount between about 0.05% and about 0.5% by weight, or in an amount between about 0.1% and about 0.5% based on the weight of the binder to be included in the composite.

[0070] The composites may further comprise a coupling agent. In some embodiments, the coupling agent is a maleic polyolefin-based coupling agent. Maleic polyolefin-based coupling agents may be used to enhance bonding between the coffee grounds (and cellulosic material when present) and polyolefin binders (for example polyethylene (PE), polypropylene (PP), high density polyethylene (HDPE) or polyvinyl chloride (PVC)). The coupling agent typically comprises two main components, one of the polyolefin-type polymers (listed above) and maleic anhydride functional groups grafted onto the polymer backbone. In another embodiment the coupling agent may comprise styrene. In further embodiments the coupling agent may comprise methyl methacrylate (MMA) or acrylated epoxidized soybean oil.

[0071] The coupling agent may be present in an amount between about 0.5% and about 3% by weight, or in an amount between about 0.5% and about 2% by weight, based on the weight of the composite.

[0072] The composite may further comprise a cellulosic material. Examples of cellulosic materials that may be used include, but are not limited to: timber, cotton, jute, hemp, sisal, flax, coir, ramie, coconut husk and bamboo. The cellulosic material may be a powder, particulate, dust or fibers.

[0073] The cellulosic material may be obtained from waste. For example, in some embodiments the cellulosic material is obtained from waste jute bags and/or waste timber.

[0074] The cellulosic material may be present in an amount between about 10% and about 80% by weight, or in an amount between about 15% and about 75% by weight, or in an amount between about 40% and about 70% by weight, or in an amount between about 20% and about 75% by weight, or in an amount between about 20% and about 60% by weight, or in an amount between about 25% and about 75% by weight, or in an amount between about 30% and about 75% by weight, or in an amount between about 2% and about 10% by weight.

[0075] In some embodiments, the coffee grounds, binder and cellulosic material may be present in any combinations of the amounts recited above in paragraphs [0056], [0057], [0059] and [0074].

[0076] Conveniently, with the exception of drying, coffee grounds can be incorporated into the present composites without any further processing. However, in some embodiments the coffee grounds may be screened through 1 mm mesh in order to provide a more consistent particle size. Preferably, the coffee grounds have a moisture content of less than about 10%, 9%, 8%, 7%, 6%, 5%, 4%, 3%, 2% or 1%.

[0077] The composites may also comprise one or more pigments. Pigments may be selected depending on the desired colour of the composites. In one embodiment, a natural pigment such as TiO_2, Fe_2O_3, carbon or fly ash is added in the form of a powder. In other embodiments, synthetic powders or liquid pigments can be incorporated into the present composite products to yield diverse colour palettes.

[0078] The composites may further comprise a coating. The coating provides the composite with improved wear and water resistance properties, as well as a smooth surface finish. In some embodiments, the coating may be an epoxy coating, a polyaspartic or a polyurethane coating. The coating may have a Shore D hardness value between about 70 and 90, or about 80.

[0079] In other embodiments the composites may be coated with zinc oxide. A zinc oxide coating may provide one or more of the following properties: photocatalytic self-cleaning, anti-microbial, UV protection, flame retardant, conductive and thermal insulation.

[0080] In some embodiments the composite products may be prepared in the form of panels which can be used as replacements for medium density fibreboard (MDF) and high-density fibreboard (HDF). Where the panels are made from waste materials they are cheaper to produce than commercially available fibreboards. Composites in accordance with the present invention also have a natural insect repellent property due to the caffeine content in waste coffee grounds being preserved. The composites are also naturally odour neutralising due to the presence of coffee grounds. In other embodiments, composites in the form of acoustic tiles can be prepared using a combination of coffee grounds and jute. In further embodiments, the composite product may be in the form of; tiles, bench tops, table tops, shades, panels, seats and splash backs, In a further embodiment, the composite product may be in the form of a molded composite product.

[0081] By using waste streams to prepare the composite products, waste materials that would otherwise be disposed of in landfill are used to prepare valuable new products. In some embodiments

the composites may comprise greater than about 50%, or greater than about 60%, or greater than about 70%, or greater than about 80%, or greater than about 90%, or greater than about 95% by weight of waste material. In one embodiment, the composite product may be made entirely of waste material.

[0082] In some embodiments the composite product may comprise (w/w): about 35% to 50% of a binder, about 45% to 65% timber and about 3% to 20% coffee grounds. The timber may be in the form of saw dust. Preferably, the binder is polypropylene.

[0083] In another embodiment the composite product may comprise (w/w): about 35% to 50% of a binder, about 5% to 25% of a cellulosic material and about 30% to 50% coffee grounds. The timber may be in the form of saw dust. Preferably, the binder is polypropylene.

[0084] In another embodiment the composite product may comprise (w/w): about 15% to 30% of a binder and about 70% to 85% coffee grounds.

[0085] In a further embodiment the composite product may comprise (w/w): about 8% to 20% of a binder which is, or is obtained from, unsaturated polyester resin and about 80% to 92% coffee grounds.

[0086] In still a further embodiment the composite product may comprise (w/w): about 8% to 20% of a binder, about 60% to 80% of a cellulosic material and about 5% to 20% coffee grounds. The cellulosic material may be timber. Preferably, the binder is, or is obtained from, unsaturated polyester resin.

[0087] In yet another embodiment the composite product may comprise (w/w): about 20% to 30% of a binder, about 50% to 70% of a cellulosic material and about 10% to 20% coffee grounds. The cellulosic material may be timber.

[0088] Composites in accordance with the invention may be prepared by hot pressing. In one embodiment, the composites are prepared by the method shown in Figure 1. In this embodiment cellulosic materials (i.e. jute and saw dust) are included. Coffee grounds are dried in an oven at 100 °C for 24 hours. Optionally, the coffee grounds may first be mixed with a coupling agent in a mixture of water and ethanol. Jute and/or saw dust are provided, with the jute being obtained from bags which are shredded to provide a 3 mm fleece. The binder (such as for example a polyester resin) may be mixed with an inhibitor, a catalyst, a mold releasing agent (calcium stearate for

example) and, optionally a pigment, to form a premix. The premix, dried coffee grounds and the jute and/or saw dust are then thoroughly mixed using, for example, a sigma mixer. The resultant mixture is then laid in a carbon steel die by a vertical loading method or by using a powder applicator. The mixture is then flattened and sealed with a steel lid. The sealed die is loaded into a hydraulic hot press which is pre-heated at 145 °C. A pressure of 7 MPa is then applied for a period of 7 minutes. The sample is then removed from the mold and cooled under pressure (5 kg) to minimize warpage.

Example

Material Preparation

Coffee grounds

[0089] Coffee ground were screened through 1 mm mesh and dried in an oven to achieve a moisture level of below 5%, or for about 24 hours at 80 °C.

Binder

[0090] The binder used in this example was SPE 44-419 ortho base polyester resin from Allnex Resins, Australia.

Saw dust

[0091] Saw dust was obtained from a timber CNC mill dust bag and passed through a 3 mm screen prior to use.

Jute

[0092] Jute bags were shredded through a textile shredder using a 3 mm screen. This resulted in short strands about 3 mm or less in length.

Method

[0093] The composite panels listed in Table 1 below were prepared by the process described above and in Figure 1 using the relevant amounts of each component:

Table 1: Composite panels prepared

No.	Sample Label				Polyester resin	Other chemicals				Pigment	Density (g/cm^3)
		Spent coffee ground	Timber	Jute bag		TBPB (from resin wt%)	Inhibitor (from resin wt%)	Calcium Stearate (From total wt%)	Styrene (From total wt%)		
1	C80_0	76.4%			17.5%	3.5 %	0.23%	2 %	3%	0.41 %	1.2

2	C0_T80		76.4 %		17.5%	3.5 %	0.23%	2 %	3%	0.41 %	1.2
3	C3_T73.4	3%	73.4 %		17.5%	3.5 %	0.23%	2%	3%	0.41 %	1.2
4	C20_T56.4	20%	56.4 %		17.5%	3.5 %	0.23%	2%	3%	0.41 %	1.2
5	C20_T51.4_J5	20%	51.4 %	5%	17.5%	3.5 %	0.23%	2%	3%	0.41 %	1.2
6	C0_T80		80%		17.5%	3.5 %	0.23%	2 %			0.8
7	C20_T56.4	20%	56.4 %		17.5%	3.5 %	0.23%	2%	3%		0.8

Mechanical Testing

[0094] With the objective of comparing the wood-coffee composites with commercial wood panels, modulus of rupture (MOR) and Modulus of elasticity (MOE) were calculated from the 3-point bending test. MOR and MOE respectively represent the bending strength and stiffness of the panels produced and were evaluated according to American Society for Testing and Materials (ASTM) D1037, using an Instron (model 5566) universal mechanical testing machine. A load of 5 kN was used with the strain rate, span, width and length set based on the thickness of the corresponding specimens.

- Width = 76 mm if thickness > 6 mm

  50 mm if thickness < 6mm
- Length = 50 mm + 24* sample thickness (mm)
- Strain rate was calculated based on the formula below:

$$N = \frac{0.005 * S^2}{6 * d}$$

where: S = span (Span = 24* sample thickness(mm))

d = Thickness of sample (mm)

N = Strain rate/ rate of motion of moving head (mm/min)

Water absorption and thickness swelling

[0095] Water absorption and thickness swelling measurements on the wood-coffee composites can be used to determine the durability of the corresponding products when exposed to high moisture environmental conditions. The samples were first weighed dry, then immersed in water for 24 h. They were then surface dried with a damp cloth and weighed to the nearest 0.01 g. By measuring the weight difference between the dry and wet samples, water absorption can be calculated based on equation (1). Similarly, thickness swelling measures the change of the thickness prior to and post-immersion of the composite in water.

Absorption weight% = $\frac{(B-A)}{A} x\ 100$

where A = weight of the dried specimen, (g) and

B =weight of the specimen after immersion, (g)

[0096] The results of the mechanical testing and water absorption and thickness swelling are shown below:

No.	Sample	Density	Curing time (or tested after panel has been left cured for ___min/ days)	Flexural strength (MPa)	Water absorption	Thickness swelling	ISO 16893
1	C80_0	1.2	-	-	-	-	-
2	C0_T80	1.2	30 min	33.75 ± 0.35	4.518 ± 0.210	2.12 – 6.56%	Pass
3	C3_T76.4	1.2	4 days	42.40 ± 2.32	3.758 ± 0.629	0.71 – 4.12%	Pass
4	C20_T56.4	1.2	1 days	35.55 ± 1.35	-	-	-
5	C20_T51.4_J5	1.2	-	-	-	-	
6	C0_T80	0.8	4 days	3.41 ± 0.85	-	-	Fail
7	C20_T56.4	0.8	4 days	-	-	-	-

Claims

1. A composite product comprising a binder and coffee grounds.

2. The composite product of claim 1, wherein the binder is present in an amount between about 5% and about 45% by weight, or in an amount between about 10% and about 25% by weight, or in an amount between about 15% and about 20% by weight.

3. The composite product of claim 1 or claim 2, wherein the binder is obtained from a waste material.

4. The composite product of any one of claims 1 to 3, wherein the binder is a polymer.

5. The composite product of claim 4, wherein the polymer is a thermoset polymer.

6. The composite product of claim 5, wherein the thermoset polymer is an epoxy resin, polyester resin or vinyl ester resin.

7. The composite product of any one of claims 1 to 6, wherein the coffee grounds are present in an amount between about 5% and about 85% by weight, or in an amount between about 20% and about 80% by weight, or in an amount between about 20% and about 40% by weight.

8. The composite product of any one of claims 1 to 7, further comprising a cellulosic material.

9. The composite product of claim 8, wherein the cellulosic material is present in an amount between about 15% and about 75% by weight, or in an amount between about 40% and about 70% by weight.

10. The composite product of claim 8 or claim 9, wherein the cellulosic material is a powder, particulate, dust or fibers.

11. The composite product of any one of claims 8 to 10, wherein the cellulosic material is obtained from waste.

12. The composite product of any one of claims 8 to 11, wherein the cellulosic material is jute or timber.

13. The composite product of claim 12, wherein the jute is in the form of fibers.

14. The composite product of claim 12, wherein the timber is in the form of saw dust.

15. The composite product of any one of claims 1 to 14, wherein the product is free, or substantially free, of glass.

16. The composite product of any one of claims 1 to 15, further comprising a coupling agent.

17. The composite product of any one of claims 1 to 16, further comprising a pigment.

18. The composite product of any one of claims 1 to 17, which is in the form of a panel or a tile.

19. The composite product of any one of claims 1 to 18, which comprises greater than about 50%, or greater than about 60%, or greater than about 70%, or greater than about 80% waste material by weight.

20. The composite product of any one of claims 1 to 19, further comprising a coating.

21. The composite product of claim 20, wherein the coating is a zinc oxide coating.

22. The composite product of any one of claims 1 to 21, which is prepared by hot pressing or casting.

23. A method for preparing a composite product comprising:

(i) forming a mixture comprising coffee grounds and a binder; and

(ii) applying heat and pressure to the mixture to form the composite product.

24. The method of claim 23, wherein in step (ii) the heat applied is less than about 300 °C, or less than about 250 °C, or less than about 240 °C.

25. The method of claim 23 or claim 24, wherein in step (ii) the heat applied is between about 120 °C and about 180 °C.

26. The method of any one of claims 23 to 25, wherein in step (ii) the pressure applied is between about 5 MPa and about 20 MPa.

27. The method of any one of claims 23 to 26, wherein the binder is present in an amount between about 5% and about 45% by weight, or in an amount between about 10% and about 25% by weight, or in an amount between about 15% and about 20% by weight.

28. The method of any one of claims 23 to 27, wherein the coffee grounds are present in an amount between about 5% and about 85% by weight, or in an amount between about 20% and about 80% by weight, or in an amount between about 20% and about 40% by weight.

29. The method of any one of claims 23 to 28, wherein the mixture further comprises a cellulosic material.

30. The method of claim 29, wherein the cellulosic material is present in an amount between about 15% and about 75% by weight, or in an amount between about 40% and about 70% by weight.

31. The method of any one of claims 23 to 30, wherein the coffee grounds are dried prior to forming the mixture.

32. The method of claim 31, wherein the coffee grounds are dried at a temperature of at least about 80 °C prior to forming the mixture.

33. The method of any one of claims 23 to 32, wherein the mixture further comprises a catalyst.

34. The method of claim 33, wherein the catalyst is present in the mixture in an amount between about 0.1% and about 10% by weight, or in an amount between about 0.5% and about 5% by weight of the binder.

35. The method of any one of claims 23 to 34, wherein the mixture further comprises a pigment.

36. The method of any one of claims 23 to 35, wherein the mixture further comprises an inhibitor.

37. The method of claim 36, wherein the inhibitor is present in the mixture in an amount between about 0.01% and about 2% by weight, or in an amount between about 0.05% and about 0.5% by weight of the binder.

38. The method of any one of claims 23 to 37, wherein the mixture further comprises a coupling agent.

39. The method of any one of claims 23 to 39, wherein prior to forming the mixture the coffee grounds are screened through 1 mm mesh.

40. The method of any one of claims 23 to 39, wherein the mixture is free, or substantially free, of glass.

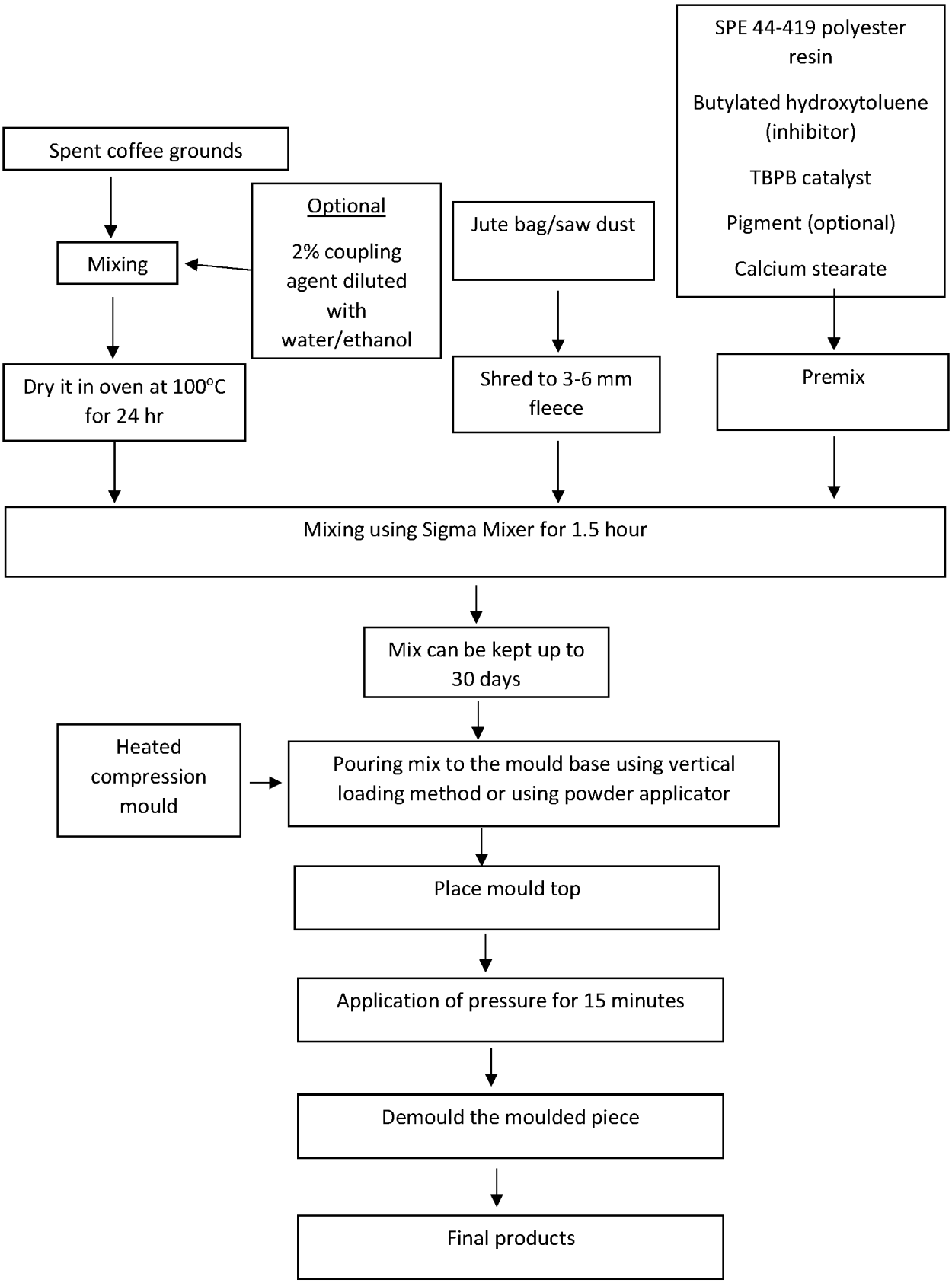
Spent coffee grounds
Optional
2% coupling agent diluted with water/ethanol
Mixing
Dry it in oven at 100°C for 24 hr
Jute bag/saw dust
Shred to 3-6 mm fleece
SPE 44-419 polyester resin
Butylated hydroxytoluene (inhibitor)
TBPB catalyst
Pigment (optional)
Calcium stearate
Premix
Mixing using Sigma Mixer for 1.5 hour
Mix can be kept up to 30 days
Heated compression mould
Pouring mix to the mould base using vertical loading method or using powder applicator
Place mould top
Application of pressure for 15 minutes
Demould the moulded piece
Final products

Figure 1

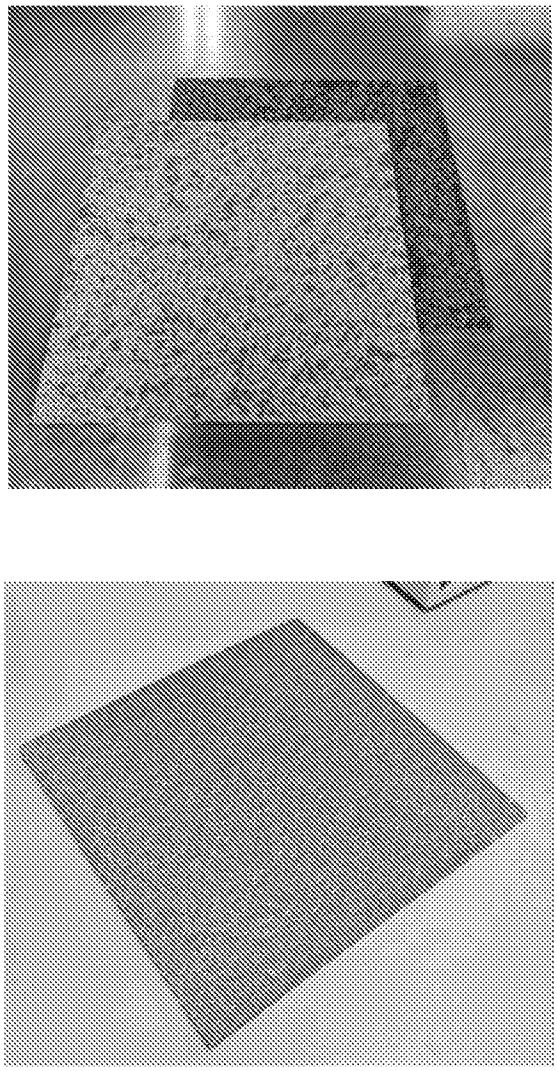

Figure 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2021/051180

A. CLASSIFICATION OF SUBJECT MATTER

B27N 1/02 (2006.01) B27N 3/08 (2006.01) E04C 2/26 (2006.01) E04C 2/20 (2006.01) C08J 5/04 (2006.01)

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)

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)

Patenw: IPC/CPC - E04C, B27N, E04B, C08J5/04/LOW, C08J5/18/LOW, B29C & Keywords (COFFEE, GROUND, WASTE, SPENT, REFUSE, MOULD, EXTRUDE, PRESSURE, JUTE, TIMBER, SAWDUST, CELLULOSE, POWDER, PARTICULATE, DUST, FIBER, RUBBISH, SCRAP, POWDER, BEAN, GRIND and like terms);

Google, Google Patents, Google Scholar, Espacenet search using a combination of the following keywords and like terms: coffee, grounds, grind, beans, binder, polymer, thermoset, resin, cellulosic, fiber, dust, particulate, powder, waste, rubbish, refuse, jute, timber, saw dust, coupling, pigment, bleach, panel, tile, fibreboard, MDF, HDF, building, construction, hot press, mould, cast, extrude, heat, pressure, catalyst, inhibitor, screen, sieve, mesh;

Applicant/Inventor names searched using DOCDB, DWPI and internal databases provided by IP Australia

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 December 2021	10 December 2021

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INTERNATIONAL SEARCH REPORT C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		International application No. **PCT/AU2021/051180**
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2019/0276671 A1 (CAMBOND LIMITED) 12 September 2019 paragraphs [0019, 24-26, 28-29, 64-65]	1-40
X	KR 102042857 B1 (JUNG YOUNG KIL et al.) 27 November 2019, English translation retrieved from Espacenet paragraphs [0014, 18-20, 22, 24, 64]	1-40
X	KR 20190143434 A (KIM JUNG KWON) 30 December 2019, English translation retrieved from Espacenet abstract, paragraphs [0004, 9], [0011-12, 15, 37]	1-40
X	KR 20170048090 A (이경숙) 08 May 2017, English translation retrieved from Espacenet paragraphs [0001], [0013-28]	1-40
X	Windahl, L., Decafé – grinding a halt to ground coffee waste [retrieved from internet on 5 November 2021] < URL: https://lessbydesign.org/2014/06/27/decafe-grinding-a-halt-to-ground-coffee-waste/ >, published on 27 June 2014 Whole document	1, 15, 23, 40
X	Interior products made from recycled coffee grounds, [retrieved from internet on 7 December 2021] < URL: https://materialdistrict.com/article/interior-products-recycled-coffee-grounds/ >, published on 3 December 2019 Whole document	1, 15, 18

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2021/051180**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
US 2019/0276671 A1	12 September 2019	US 2019276671 A1	12 Sep 2019
		CN 110520464 A	29 Nov 2019
		EP 3532533 A2	04 Sep 2019
		GB 2567532 A	17 Apr 2019
		WO 2018078391 A2	03 May 2018
KR 102042857 B1	27 November 2019	KR 20190097431 A	21 Aug 2019
		KR 102042857 B1	27 Nov 2019
KR 20190143434 A	30 December 2019	KR 20190143434 A	30 Dec 2019
		KR 102137916 B1	24 Jul 2020
KR 20170048090 A	08 May 2017	KR 20170048090 A	08 May 2017

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.