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(54) **STACKABLE CUPS**

(57) A stackable cup, a method of forming such cups and a system for dispensing such cups is disclosed. The cup has a side wall and a base. The side wall has inner and outer portions, surfaces of which form the interior and exterior of the cup. The inner portion and outer portions each comprise a polymer and the talc is present in each of the inner portion and outer portion in an amount from 5% to 30% by weight of the inner or outer portion.

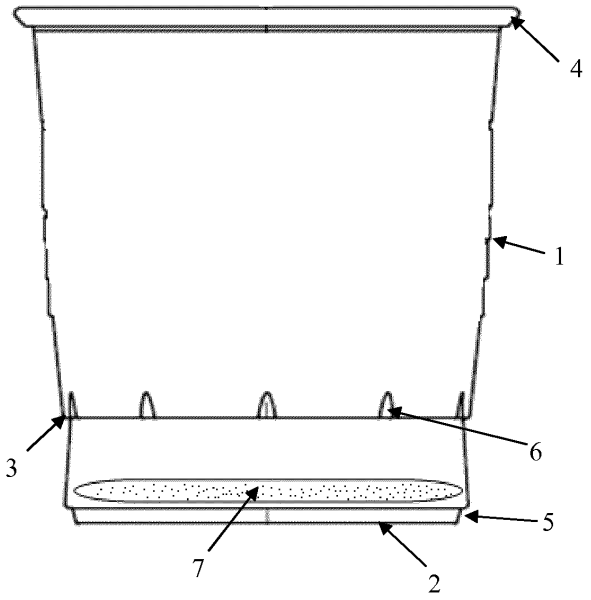

FIG.1

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Description

Background

[0001] The present application relates to stackable cups, preferably for use in in-cup beverage dispensing systems.

[0002] In-cup beverage dispensing systems are based on stacks of disposable cups, each cup containing some quantity of food or beverage concentrate in the bottom of the cup. The cups are nested together in the stack, and the stack is then packaged, stored and transported conveniently by the vending operator. In use, the stack is removed from its packaging and loaded into the dispenser of a dispensing machine. In response to a dispense command, the machine automatically splits a cup from the bottom of the stack and fills it with water to form the desired beverage. A typical in-cup system is available under the Registered Trade Mark KLIX from the Mars Drinks division of Mars, Incorporated, for example, as described in US4597506.

[0003] In-cup beverage dispensing systems provide the advantage that the beverage concentrate can be supplied within the cups, so that the stocking and operation of the beverage dispenser is simplified. The stack of cups is compact and easy to transport, and the water for dilution of the beverage is provided at the dispensing machine, typically from a conventional water supply, with optional purification, heating or cooling in the dispensing machine.

[0004] Stackable cups require a sufficient unlock force to ensure that the cups do not come apart during transit. This prevents any food or beverage ingredient from spoiling or leaking.

[0005] However, a problem with current stackable cups for in-cup beverage dispensing systems is that two cups are sometimes dispensed at once, or cups may split during vending. This causes the machine to become jammed or inoperable, which often requires a service engineer to be called. Another issue is the unpredictability in the unlock force between stackable cups, leading to dispensing difficulties in the machine. This has been observed particularly for cups made from polystyrene.

[0006] There is therefore a desire to 1) reduce the unlock force and 2) increase the consistency of the unlock force between stacked cups to reduce the likelihood of a jam during vending. However, a sufficient unlock force is still required to prevent the cups coming apart during shipment.

Summary of the Invention

[0007] In a first aspect, there is provided a stackable cup, the cup having a side wall and a base, wherein the side wall has an outer portion having a surface forming the exterior of the cup and an inner portion having a surface forming the interior of the cup, the inner portion and outer portion each comprising a polymer and talc, the talc being present in each of the inner portion and outer portion in an amount of from 5 % to 30% by weight of the inner or outer portion.

[0008] In a preferred embodiment, the polymer is a non-aromatic polyolefin and wherein optionally the polymer is selected from polypropylene or polyethylene, optionally wherein the polymer is polypropylene.

[0009] In another preferred embodiment, the polymer is present in each of the inner portion and outer portion in an amount of from 60 to 95% by weight of the inner or outer portion.

[0010] In a further preferred embodiment, the talc is present in either the inner or outer portion is present in an amount from 8-22% by weight of the inner or outer portion, and wherein optionally the talc has a particle size, D50, ranging from 1 μm to 10 μm, optionally from 2 to 7 μm, optionally from 3 to 6 μm.

[0011] At least one of the inner or outer portions may comprises an antistatic agent.

[0012] The thickness of the side-wall is preferably between 1.0 to 2.0 mm.

[0013] In a preferred embodiment, the inner and outer portions together form a single layer of the side wall, or wherein the inner and outer portions are each a separate layer, optionally with one or more further layers disposed between the inner and outer portions.

[0014] In another preferred embodiment, the side-wall further comprises at least one internal portion disposed between the inner and outer portions, the internal portion, inner and outer portion each forming layers of the side wall;

wherein optionally the inner and outer surface portions each have a thickness that is 5 to 15% the total thickness of the side wall, optionally between 8 to 12% the total thickness of the side-wall; and
wherein optionally the internal portion is free or substantially free of talc.

[0015] In a further preferred embodiment, the cup (the 'first' cup) is shaped such that, when stacked with a cup of the same shape (the 'second' cup) with the first cup being inside the second cup, an exterior surface of the base of the first cup does not contact the interior surface of the base of the second cup;

wherein optionally a telescoping prevention feature is provided on or as part of the side wall, to prevent the exterior surface of the base of the first cup contacting the interior surface of the base of the second cup; and

wherein optionally the telescoping prevention feature includes one or more protrusions disposed on the interior or exterior surface of the side wall, which, when stacked with the second cup cooperate with one or more recesses disposed on the exterior or interior surfaces, respectively, of the second cup.

[0016] In a preferred embodiment, the side-wall tapers inwards from the base to a narrowed portion, and tapers outward from the narrowed portion to a rim of the cup;

wherein optionally the narrowed portion is present at a vertical height of 2 to 30 mm from an exterior surface of the base of the cup, optionally from 5 to 25 mm from an exterior surface of the base of the cup;
wherein optionally a food or beverage ingredient is present within the cup on or adjacent an interior surface of the base of the cup; and
wherein optionally the stackable cup is suitable for an in-cup beverage dispensing system.

[0017] In a second aspect, there is provided a method of forming a stackable cup, comprising:

extruding a mixture of polymer and talc to form a sheet, the talc being present in an amount of from 5 % to 30% by weight of the mixture; and
thermoforming the sheet to form a stackable cup.

[0018] In a preferred embodiment, the mixture is co-extruded to form a multi-layered sheet, wherein at least the surface layers of the multi-layered sheet comprise the mixture of polymer and talc, the talc being present in an amount from 5 % to 30%.

[0019] The stackable cup formable or formed by the method may be as defined in the first aspect.

[0020] In a third aspect, there is provided a stack of cups comprising a plurality of cups according to the first aspect.

[0021] In a fourth aspect, these is a system for dispensing an in-cup beverage using the stack of cups according to the third aspect.

[0022] The present inventors have developed a stackable cup that is an improvement over conventional stackable polymer cups. The addition of talc to the inner and outer surface portions of the side-wall was found to both i) decrease the friction and unlock force between two identical stackable cups, compared to a polymer cup lacking talc and, and ii) produce an unlock force that is more consistent.

[0023] As such, these cups can be used in in-cup dispensing machines to improve reliability during vending. Notably, the unlock force between stackable cups is still sufficient to prevent stacked cups coming apart during transit. This minimises the risk that any ingredient within the stacked cup is spilt or exposed.

Brief description of Figures

[0024]

Figure 1 shows a stackable cup according to an embodiment of this disclosure. The stackable cup comprises a side wall 1 and a base 2. The side wall tapers inwards from the base to a narrowed portion 3, before tapering outwards towards the rim 4. The side wall contains recesses at the foot of the side-wall 5, and protrusions 6 which project from the inner portion of the cup. Food or beverage ingredient 7 sits within the bottom of the cup.

Figure 2 shows a perspective view of a stackable cup according to an embodiment of this invention. The side-wall 1 comprises an inner portion 8, and internal portion 9 and an outer portion 10.

Figure 3 shows a cross-section of a co-extruded multi-layered sheet used to make an embodiment of the side-wall 1, inner portion 8, internal portion 9 and outer portion 10.

Figure 4 shows an apparatus used to measure unlock force.

Detailed Description

[0025] Optional and preferred features of the aspects are disclosed herein. Any optional or preferred feature can be combined with any aspect and/or with any other optional or preferred feature, unless indicated otherwise.

[0026] All percentages in the present disclosure are listed as percent by weight on the total weight of the material or mixture of the relevant portion or layer, unless explicitly noted otherwise.

[0027] A stackable cup described herein refers to any cup which can be stacked inside, or nested within, another

identical cup, preferably such that the exterior surface of the side wall of one cup contacts the interior surface of the side wall of another cup, preferably completely around the perimeter of both cups.

[0028] Any polymer described herein refers to any molecule composed of repeated subunits or monomers. The definition of a polymer includes both homopolymers and copolymers.

[0029] Any homopolymer described herein refers to a polymer derived from one species of monomer. Any copolymer described herein refers to a polymer formed from more than one species of monomer. A block copolymer defined herein is a copolymer which comprises two or more homopolymer subunits linked together via a covalent bond. A random copolymer defined herein is a copolymer wherein the two or more monomers are randomly arranged along the polymer molecule.

[0030] A polyolefin described herein refers to any polymer formed from alkene monomers. An alkene is any unsaturated hydrocarbon that comprises a carbon-carbon double bond.

[0031] A non-aromatic polyolefin described herein refers to any polymer formed from non-aromatic alkene monomers.

[0032] An antistatic agent described herein refers to any compound that can reduce or eliminate the build-up of static electricity.

[0033] Skeletal waste described herein refers to any reprocessed plastic waste. It includes waste material generated during thermoforming, wherein the waste material is re-melted, homogenised and reprocessed.

[0034] Extrusion or extruding described herein is the process in which plastic or polymer material is melted and pushed through a die to form a sheet of fixed cross-sectional profile or thickness. Co-extrusion described herein is the process of extruding two or more materials together to produce a sheet with multiple layers.

[0035] Thermoforming or thermoformed described herein refers to a manufacturing process wherein a plastic sheet is heated and moulded to form a specific shape.

[0036] The talc described herein includes any substance comprising hydrated magnesium silicate of formula $Mg_3Si_4O_{10}(OH)_2$ or variants thereof. The variants of $Mg_3Si_4O_{10}(OH)_2$ include variants wherein Si is substituted with Al or Ti, or wherein Mg is substituted with Al, Mn, Fe or Ca. The definition of talc herein therefore includes pyrophyllite ($Al_2Si_4O_{10}(OH)_2$), wherein Al completely replaces Mg.

[0037] An in-cup beverage dispensing system defined herein is a dispensing system based on stacks of disposable cups, each cup containing a portion of food or beverage concentration within the cup. The cups are nested together in the stack, meaning the stack is efficiently packaged, stored and transported by the vending operator. In use during vending, the stack is removed from its packaging and loaded into the dispenser. In response to a dispense command, the machine splits a cup from the bottom of the stack, moves it to an appropriate position and fills it with water, typically hot water, to form the desired beverage or food product.

[0038] Unlock force described herein is the force required to separate two identical stacked, or nested, cups.

[0039] The present invention provides the first and second aspects defined above. Also described herein are optional and preferred features of the aspects. Any optional or preferred feature is applicable to any aspect unless specifically stated otherwise, and may be combined with any other optional or preferred feature.

[0040] According to the first aspect, the stackable cup may have any suitable size or shape. The side-wall may be in the form of a tubular body which is connected to the base, which extends transversely across the bottom of the side-wall. The side-wall may be tapered such that the diameter of cup (i.e. the distance from side wall to opposite side wall) is less than at the base of the cup than at its top. The stackable cup is typically open at its widest end, such that one cup can be nested or placed inside a second identical stackable cup. The part of the side wall forming the opening at the opposite end of the cup from the base may be termed a rim of the cup. The stackable cup optionally has an outwardly projecting rim or lip at the top of the side-wall, i.e. the opening of the cup. This provides increased rigidity and stiffness at the top of the cup, allowing sufficient force to be applied to the rim when splitting one cup from another in a stack.

[0041] The stackable cup optionally contains a food or beverage ingredient, which may also be termed a food or beverage concentrate. The food or beverage ingredient may be present within the cup on or adjacent an interior surface of the base of the cup. The food or beverage ingredient may be a solid, water-soluble or water dispersible ingredient and is preferably shelf-stable. The food or beverage ingredient may be, for example, be selected from soluble coffee solids, soluble tea solids, soluble hot chocolate solids, soluble soup solids and a drink concentrate, for example, a fruit drink concentrate. Optionally, the total weight of the food or beverage concentrate in each cup is about 0.1 g to about 100 g, optionally from about 0.5 g to about 20 g. Alternatively, the cup may be free of food or beverage ingredient. Alternatively, the food or beverage may be added during vending.

[0042] The stackable cup may be of any suitable size. The vertical height of the cup may be from 30 mm to 150 mm, optionally 50 mm to 150 mm, optionally 50 mm to 100 mm, optionally 60 mm to 100 mm or optionally from 30 mm to 60 mm. The cups may have any suitable weight, optionally from 3 grams to 10 grams, optionally from 4 grams to 9 grams, and optionally from 5 grams to 7 grams. The side-wall may have any suitable thickness, optionally from 0.8 mm to 2.2 mm, optionally from 1.0 mm to 2.0 mm, and optionally from 1.2 to 1.7 mm. The diameter of the top of the cup may be from 70 mm to 78 mm, in an example about 74 mm. The diameter of the base of the cup may be from 30 mm to 100 mm, in an example about 30 mm to 60 mm or in an example about 60 mm to 90 mm. The stackable cup may have a

volume of from 50 ml to 300 ml, optionally a volume from 50 ml to 100 ml or or a volume of from 100 ml to 300 ml.

[0043] When a first stackable cup is stacked with (or nested in) a second identical stackable cup, the spacing between an exterior surface of the base of the first cup and interior surface of the base of the second identical cup is from 2 mm to 30 mm, optionally from 5 mm to 25 mm, optionally from 10 mm to 20 mm, optionally from 10 mm to 15 mm, optionally from 15 mm to 20 mm.

[0044] In an embodiment, the cup (to be termed a 'first' cup) is shaped such that, when stacked with a cup of the same shape (to be termed a 'second' cup) with the first cup being inside the second cup, an exterior surface of the base of the first cup does not contact the interior surface of the base of the second cup. In other words, there is a cavity between the base of the first cup and the base of the second cup. In an embodiment, a telescoping prevention feature is provided on or as part of the side wall, to prevent the exterior surface of the base of the first cup contacting the interior surface of the base of the second cup.

[0045] In an embodiment, the telescoping prevention feature includes one or more protrusions (which may also be termed ribs) disposed on or forming part of the interior or exterior surface of the side wall, which, when stacked with the second cup, cooperate with one or more recesses disposed on the exterior or interior surfaces, respectively, of the second cup. In certain embodiments, the thickness of the side-wall is substantially constant, such that for any protrusion disposed on or forming part of the interior surface of the side wall, a corresponding recess is provided in the exterior surface of the side wall. The protrusion(s) may be configured as a complete or partial ring that extends around the circumference of the side-wall. In an embodiment, the protrusions extend from the narrowed portion of the side-wall. Alternatively, the stackable cup may be free of ribs or protrusions.

[0046] In an embodiment, the side-wall tapers inwards from the base to a narrowed portion, and tapers outward from the narrowed portion to a rim of the cup. In an embodiment, the narrowed portion is present at a vertical height of 2 to 30 mm from an exterior surface of the base of the cup, optionally from 5 to 25 mm from an exterior surface of the base of the cup, optionally from 10 mm to 20 mm, optionally from 10 mm to 15 mm, optionally from 15 mm to 20 mm. The narrowed portion may function as a shelf within the interior of the cup on which the base of another cup can reside when they are stacked together, providing a spacing between the bases of two adjacent cups, i.e. providing a cavity in which a food or beverage ingredient may reside. In other words, the narrowed portion may function as a telescoping prevention feature. The narrowed portion of one cup, together the base of another cup with which it is stacked, may form a seal for the food or beverage.

[0047] In another embodiment, the side-wall comprises, on its interior surface, a recess or groove, which may be nearer the base of the cup than the rim of the cup. The groove or recess is suitably configured in the first cup so that it engages and cooperates with the protrusion(s) present in a second cup when stacked.

[0048] The inner and outer portions of the side-wall comprise a polymer. The polymer may be any suitable polymer, including but not limiting to, polystyrene (including high-impact polystyrene (HIPS)), polyvinyl chloride, polyethylene terephthalate, polypropylene, polyethylene, polylactic acid or any copolymers or combinations thereof. The polymer may be obtained from non-renewable sources or renewable/bio-based sources. In an embodiment, the polymer comprises a polyolefin, which may be selected from polyethylene, polypropylene, polymethylpentene, polybutene-1, polyisobutene, polystyrene or copolymers thereof. In an embodiment, the polymer is a non-aromatic polyolefin, which optionally comprises polyethylene and polypropylene, or is optionally selected from polyethylene and polypropylene. The polyethylene may be high-density, medium-density or low-density polyethylene. The polypropylene may be atactic, syndiotactic or isotactic. The polypropylene may be a biaxially-orientated polypropylene (BOPP) or a non-orientated polypropylene. The polypropylene may be a homopolymer, or a copolymer comprising polypropylene. The polypropylene copolymers may be a random copolymer or a block copolymer of polypropylene. The polypropylene copolymers optionally contain at least 70% polypropylene by weight of the total polymer, optionally at least 80%, optionally at least 85% polypropylene by weight of the total polymer. The polypropylene copolymer may optionally be a copolymer or polypropylene and polyethylene. In an example, the polymer is a polypropylene homopolymer.

[0049] In an embodiment, the polymer, which may be as described above, e.g. it may be a propylene homopolymer, may have a melt flow rate of from 1 to 10 g/10 min, optionally from 1 to 6 g/10 min, optionally from 2 to 5 g/10 minutes, optionally about 3 g/10 min. The melt flow rate is measured using ISO 1133 (at 230 °C/2.16 kg).

[0050] The polymer may be present in an amount or about 95% or less by weight of the inner and outer portions of the side-wall, optionally 90% or less, optionally 87% or less, optionally 85% or less, optionally 80% or less, optionally 75% or less, and optionally 70% or less by weight of the inner and outer portions of the side wall. The polymer may be present in an amount of at least 50% of the weight of the inner and outer portions of the side-wall, optionally of at least 55%, optionally of at least 60%, optionally of at least 65%, optionally of at least 70%, optionally of at least 75%, optionally of at least 80%, optionally of at least 82%, optionally of at least 85%, optionally of at least 87%, optionally of at least 90% by weight of the inner and outer portions of the side wall. The polymer may be present in an amount of from 60% to 95% by weight of the inner and outer portions of the side-wall, optionally from 70% to 95%, optionally from 80% to 95%, optionally from 75% to 92%, optionally from 82% to 92% by weight of the inner and outer portions of the side wall. In an example the polymer is present in an amount of about 85% by weight of the inner and outer portions of the side-

wall, in another example about 90% by weight of the inner and outer portions of the side-wall. In an embodiment, the inner and outer portions contain the same weight percentage of polymer by weight of the inner and outer portion.

[0051] The polymer may be present in an amount 95% or less by weight of the inner portion of the side-wall, optionally 90% or less, optionally 87% or less, optionally 85% or less, optionally 80% or less, optionally 75% or less, optionally 70% or less by weight of the inner portion of the side wall. The polymer may be present in an amount of at least 50% of the weight of the inner portion of the side-wall, optionally of at least 55%, optionally of at least 60%, optionally of at least 65%, optionally of at least 70%, optionally of at least 75%, optionally of at least 80%, optionally of at least 82%, optionally of at least 85%, optionally of at least 87%, optionally of at least 90% by weight of the inner portion of the side-wall. The polymer may be present in an amount from 60% to 95% by weight of the inner portion of the side-wall, optionally from 70% to 95%, optionally from 75% to 92%, optionally from 82% to 95%, optionally from 82-92% by weight of the inner portion of the side-wall. In an example, the polymer is present in an amount of about 85% by weight of the inner portion of the side-wall.

[0052] The polymer may be present in an amount of 95% or less by weight of the outer portion of the side-wall, optionally 90% or less, optionally 87% or less, optionally 85% or less, optionally 80% or less, optionally 75% or less and optionally 70% or less. The polymer may be present in an amount of at least 50% of the weight of the outer portion of the side-wall, optionally of at least 55%, optionally of at least 60%, optionally of at least 65%, optionally of at least 70%, optionally of at least 75%, optionally of at least 80%, optionally of at least 82%, optionally of at least 85%, optionally of at least 87%, optionally of at least 90%, optionally about 95%. The polymer may be present in an amount from 60-95% by weight of the outer portion of the side-wall, optionally from 70% to 95%, optionally from 75% to 92%, optionally from 82% to 92%, optionally from 82% to 95% by weight of the outer portion of the side-wall. In an example, the polymer is present in an amount of about 90% by weight of the outer portion of the side-wall.

[0053] The inner and outer portions of the side-wall comprise talc. The talc is present in each of the inner portion and outer portion in an amount from 5 % to 30% by weight of the inner and outer portion, optionally in an amount from 6 % to 28% by weight of the inner and outer portion, optionally in an amount from 7 to 25% by weight of the inner and outer portion, optionally in an amount from 8 to 22% by weight of the inner and outer portion, optionally in an amount from 9 to 21% by weight of the inner and outer portion. In one example, the inner and outer portions contain talc in an amount of about 5 to 15 % by weight, optionally 8 to 12 % by weight, optionally about 10% by weight. In another example, the inner and outer portions contain talc in an amount of 15 to 25 % by weight, optionally 18 to 22 % by weight, optionally about 20% by weight. In an embodiment, the inner and outer portions contain substantially same weight percentage of talc by weight of the inner and outer portions, i.e. such that the weight percentage in the inner and outer portions differs by 5% or less. In an embodiment, the inner and outer portions contain the same weight percentage of talc by weight of the inner and outer portions.

[0054] The talc may be present in the inner portion in an amount from 6 % to 28% by weight of the inner portion, optionally in an amount from 7 to 25% by weight of the inner portion, optionally in an amount from 8 to 22% by weight of the inner portion, optionally in an amount from 9 to 21% by weight of the inner portion. In one example, the inner portion contains talc in an amount of about 5 to 15 % by weight, optionally 8 to 12 % by weight, optionally about 10% by weight. In another example, the inner portion contain talc in an amount of 15 to 25 % by weight, optionally 18 to 22 % by weight, optionally about 20% by weight.

[0055] The talc may be present in the outer portion in an amount from 6 % to 28% by weight of the outer portion, optionally in an amount from 7 to 25% by weight of the outer portion, optionally in an amount from 8 to 22% by weight of the outer portion, optionally in an amount from 9 to 21% by weight of the outer portion. In one example, the inner portion contain talc in an amount of about 5 to 15 % by weight, optionally 8 to 12 % by weight, optionally about 10% by weight. In another example, the inner portion contain talc in an amount of 15 to 25 % by weight, optionally 18 to 22 % by weight, optionally about 20% by weight.

[0056] The talc may be derived from any suitable mineral source, for example, soapstone or chlorite. The talc used herein may have a Mohs hardness of less than 1.6, for example about 1.0. The talc may consist essentially of hydrated magnesium silicate of formula $Mg_3Si_4O_{10}(OH)_2$.

[0057] The talc described herein may have any suitable particle size. The talc may have a particle size from 1.0 to 10.0 μm, optionally from 1.5 to 8.0 μm, optionally from 2.0 to 7.0 μm, optionally from 3.0 to 6.0 μm, optionally from 3.5 to 4.5 μm. In an example, the talc has a particle size of about 4.0 μm. Any particle size mentioned herein, unless otherwise specified, refers to D50.The particle size of the talc may be measured using any suitable technique, including, but not limited to, by sediagraph, i.e. by gravity sedimentation, e.g. using the AFNOR X11-683 standard.

[0058] In an embodiment, both the inner or outer portion comprises an anti-static agent. In an embodiment, the outer portion comprises an anti-static agent. The anti-static agent may be selected from esters amines and amides. The anti-static agent may be selected from aliphatic amines, optionally long-chain aliphatic amines (e.g. having a carbon chain length in the aliphatic group of 10 or more, optionally 15 or more), aliphatic amides, optionally long-chain aliphatic amides e.g. having a carbon chain length in the aliphatic group of 10 or more, optionally 15 or more), ethoxylated amides, ethoxylated amines, quaternary ammonium salts, esters of phosphoric acid, glycerol esters, e.g. glycerol monostearate,

polyols or polyethylene glycol. The anti-static agent is optionally present in an amount of from 0.1 % to 5 % by weight of the inner portion. The anti-static agent is optionally present in an amount of from 0.1 % to 5 % by weight of the outer portion.

[0059] In an embodiment, the inner and outer portion may comprise a coloured pigment. The coloured pigment may be present in an amount of from 1 % to 15 % by weight of the outer and/or inner portion, optionally in an amount of from 3 % to 10% by weight of the inner and/or outer portion.

[0060] In an embodiment, the inner and outer portions of the side-wall may additionally comprise a further inorganic additive. The inorganic additive may be selected from magnesite, mica, calcium carbonate, kaolin, chlorite, anthophyllite and tremolite or diatomaceous earth.

[0061] In an embodiment, the side-wall is formed of multiple portions. The portions referred to herein may be in the form of layers. The outer portion described herein may refer to the outer surface layer of the side-wall, and the inner portion described herein may refer to the inner surface layer of the side-wall. In an embodiment, the side-wall may be formed from the inner and outer portions only. In another embodiment, the side-wall comprises at least three portions, thereby comprising an inner portion, an outer portion and at least one internal portion disposed between the inner and outer portion. In an example, the side-wall comprises three layers or portions, thereby comprising an inner portion, an outer portion and one internal portion disposed between the inner and outer portion. An internal portion described herein is any portion of the side-wall which does not form part of the side wall surface.

[0062] The outer portion and inner portion may have any suitable thickness. The outer portion may have a thickness of at least 2% of the total thickness of the side wall, optionally of at least 3% of the total thickness of the side wall, optionally of at least 4% of the total thickness of the side wall, optionally of at least 5% of the total thickness of the side wall, optionally of at least 6% of the total thickness of the side wall, optionally of at least 7% of the total thickness of the side wall, optionally of at least 8% of the total thickness of the side wall, optionally of at least 9% of the total thickness of the side wall. The outer portion may have a thickness of 20% or less of the total thickness of the side-wall, optionally 17% or less, optionally 15% or less, or optionally 12% or less. In an example, the outer portion has a thickness of about 10% of the total thickness of the side-wall.

[0063] The inner surface portion may have a thickness of at least 2% of the total thickness of the side wall, optionally of at least 3% of the total thickness of the side wall, optionally of at least 4% of the total thickness of the side wall, optionally of at least 5% of the total thickness of the side wall, optionally of at least 6% of the total thickness of the side wall, optionally of at least 7% of the total thickness of the side wall, optionally of at least 8% of the total thickness of the side wall, optionally of at least 9% of the total thickness of the side wall. The inner surface portion may have a thickness 20% or less of the total thickness of the side-wall, optionally 17% or less, optionally 15% or less, or optionally 12% or less. In an example, the inner surface portion has a thickness of about 10% of the total thickness of the side-wall.

[0064] In an embodiment, the inner and outer surface portions have a thickness of from 5 to 15% the total thickness of the side wall, optionally from 8 to 12% of the total thickness of the side-wall.

[0065] The inner and outer portions may together form a single layer of the side wall. If the inner and outer portions together form a single layer of talc, the amount of talc in the layer as a whole will preferably be the same as the amount of talc for the inner and outer portions, which may be as stated herein.

[0066] In an embodiment, the inner and outer portions are each a separate layer, optionally with one or more further layers disposed between the inner and outer portions. The composition of each layer, in terms of the nature and/or amount of the components, may be the same as or different from one another. For example, the polymer in the inner and outer portions may be the same and/or the amount of talc in the inner and outer portions may be the same, but optionally each may contain different additives. Alternatively, the polymer in the inner and outer portions is different from one another and/or the amount of talc in the inner and outer portions may be different from one another.

[0067] The side-wall may have any number of internal portions or layers. In an embodiment, the side-wall further comprises at least one internal portion disposed between the inner and outer portions, the internal portion, inner and outer portion each forming a layer in the side wall. In an embodiment, the side-wall may have a plurality of internal portions, which may be in the form of layers. The internal portion(s) may comprise any material or polymer. The internal portion(s) may comprise the same polymer or polymers as the inner and outer surface portions, or a different polymer to the inner and outer surface portions. The internal portion(s) may be substantially free of talc that is, containing 1 % or less talc by weight of the internal portion(s), optionally 0.5 % or less talc by weight of the internal portion(s), optionally 0.1 % or less talc by weight of the internal portion(s). The internal portion(s) may comprise skeletal or recycled plastic waste. The internal portion(s) may alternatively comprise air, to provide insulating properties, or may comprise paper. In an example, the internal portion(s) comprise polypropylene, and optional the polypropylene is selected from virgin polypropylene and water polypropylene and a mixture thereof. The waste polypropylene may be skeletal waste polypropylene. Use of skeletal or recycled plastic waste in the internal portion(s) is both cost-effective and environmentally friendly.

[0068] The internal portion(s), which may be in the form of a layer or layers disposed between the inner and outer portions, each of which is also in the form of a layer, may have a combined thickness of at least 50% of the total thickness

of the side-wall, of at least 60% of the total thickness of the side-wall, of at least 70% of the total thickness of the side-wall, of at least 80% of the total thickness of the side-wall, or of at least 90% of the total thickness of the side-wall. In an embodiment, the inner and outer surface portions each have a thickness of from 3% to 15% the total thickness of the side wall, and the internal portion(s) have a combined thickness of from 70% to 94% the total thickness of the side-wall, optionally wherein the inner and outer surface portions each have a thickness of from 6% to 12% the total thickness of the side-wall, and the internal portion(s) have a combined thickness of from 76% to 88% the total thickness of the side-wall. In an example, the inner and outer surface portions have a thickness of about 10% of the total thickness of the side-wall, and the single internal portion has a thickness of about 80% the total thickness of the side-wall.

[0069] The base of the stackable cup may be made of any suitable material. In an embodiment, the base is made from substantially the same material as the side-wall. The base may be integrally formed with the side wall of the cup. The base and side walls, for example, may have been formed from a sheet of material that has been thermoformed into the shape of a cup.

[0070] The stackable cups herein when nested within a second identical stackable cup have an unlock force of at least 20 N, optionally of at least 25 N, or optionally of at least 30N. This ensures that the interlocked cups do not come apart easily during transit. The stackable cups herein when nested with a second identical cup have an unlock force smaller than 60 N, smaller than 50 N, smaller than 45 N. This ensures that the cups can be easily dispensed. The stackable cups herein when nested within a second identical cup have an unlock force with a standard deviation of 10 N or less, optionally 7 N or less, or optionally 5 N or less. This ensures that the unlock force is consistent, meaning cups can be reliably separated during vending.

[0071] The stackable cup described herein can be used to form a stack consisting of at least 5 cups, optionally at least 10 cups, optionally at least 20 cups, optionally at least 50 cups, or optionally at least 100 cups per stack.

[0072] The stackable cup described herein is suitable for use in an in-cup beverage dispensing machine. The stackable cup herein is also suitable for any other beverage dispensing machine, in which a food or beverage product is added to the cup during vending.

[0073] The stackable cup herein may be formed by any method, preferably by first extruding a mixture comprising polymer and talc, the talc being present in an amount from 5 % to 30 %, and subsequently thermoforming the extruded sheet to form the cup.

[0074] According, to the second aspect, the mixture may be extruded by any method to form a sheet, and thermoformed by any method, preferably via an in-line thermoforming process. An in-line thermoforming method is one in which the sheet, after formation, e.g. by extrusion or co-extrusion, is fed directly into thermoforming equipment and thermoformed into the shape of a cup. In other embodiments, the sheet may be formed, e.g. by extrusion or co-extrusion, stored, e.g. in the form of a roll, and then use when desired and fed into the thermoforming equipment and thermoformed into the shape of a cup. The thermoforming may involve heating the sheet to a suitable temperature, sufficiently high to allow thermoforming to occur, but not so high as to degrade the polymeric material and/or the talc, and then thermoforming by forming the sheet into the shape of a cup in a mould. The temperature will depend on the nature of the polymer and can be determined by the skilled person. The temperature may be from 100 °C to 200 °C, optionally from 150 °C to 200 °C, optionally from 150 °C to 170 °C.

[0075] The mixture may comprise any suitable polymer including but not limiting to, polystyrene, (including high-impact polystyrene (HIPS)), polyvinyl chloride, polyethylene terephthalate, polypropylene, polyethylene, polylactic acid and copolymers or combinations thereof. The polymer may be obtained from non-renewable sources or renewable/bio-based sources. In an embodiment, the polymer comprises a polyolefin, the polyolefin may be selected from polyethylene, polypropylene, polymethylpentene, polybutene-1, polyisobutene, polystyrene or copolymers thereof. In an embodiment, the polymer is a non-aromatic polyolefin. The non-aromatic polyolefin optionally comprises polyethylene and polypropylene, or is optionally selected from polyethylene and polypropylene. The polyethylene may be high-density, medium-density or low-density polyethylene. The polypropylene may be atactic, syndiotactic or isotactic. The polypropylene may be a homopolymer, or a copolymer comprising polypropylene. The polypropylene copolymers may be a random copolymer or a block copolymer. The polypropylene copolymers optionally contain at least 70% polypropylene by weight of the total polymer, optionally at least 80%, or optionally at least 85%. The polypropylene copolymer may be a copolymer or polypropylene and polyethylene. In an example, the polymer is a polypropylene homopolymer.

[0076] The talc may be present in the mixture in an amount from 5 to 30% by weight of the mixture, optionally from 6 % to 28% by weight of the mixture, optionally in an amount from 7 to 25% by weight of the mixture, optionally in an amount from 8 to 22% by weight of the mixture, optionally in an amount from 9 to 21% by weight of the mixture. In one example, the mixture contains talc in an amount of about 10% by weight. In another example, the mixture contains talc in an amount of about 20% by weight.

[0077] The mixture may be extruded to give a sheet with any suitable thickness, optionally from 0.8 mm to 2.2 mm, optionally from 1.0 mm and 2.0 mm, optionally from 1.2 and 1.7 mm.

[0078] In a preferred embodiment, the sheet is a multi-layered sheet, wherein two layers comprising the polymer and talc, with the talc being present in an amount from 5 to 30% of each layer, are formed (corresponding to the inner and

outer portions), disposed between which is a further layer, which will be termed an internal layer, which may be talc-free. The two layer comprising talc and polymer may have thicknesses as described above for the inner and outer portions and the internal layer may have a thickness corresponding to the internal portion described above.

[0079] The sheet may be thermoformed by any method, preferably via an in-line thermoforming process, such that the sheet is fed after extrusion to a thermoforming apparatus. The sheet is moulded to form the side-wall of the stackable cup, comprising an inner and outer portion. For the multi-layered sheet embodiment, one of the layers comprising polymer and talc forms the outer portion of the side-wall, and the other of the layers comprising polymer and talc forms the inner portion of the side-wall. The internal layer(s) form(s) the internal portion of the side-wall.

[0080] The internal layer(s) may comprise any material or polymer. The internal layer(s) may comprise the same polymer as the polymer and talc-containing layers between which it or they are disposed, or a different polymer. The internal layers may comprise talc, or be substantially free of talc, that is, containing 0.1% or less talc by weight of the internal layer(s). The internal layer(s) may comprise substantially the same material as the surface layer(s). The internal layer(s) may comprise air, to provide insulating properties, or paper. In an example, the internal layer(s) comprise polypropylene. In an example, the internal layer(s) additionally comprise skeletal or recycled plastic waste.

[0081] The internal layers(s) may have a combined thickness of at least 50% of the total thickness of the multi-layered sheet, optionally at least 60% of the total thickness of the multi-layered sheet, optionally at least 70% of the total thickness of the multi-layered sheet, optionally at least 80% of the total thickness of the multi-layered sheet, optionally at least 90% of the total thickness of the multi-layered sheet.

[0082] One of ordinary skill in the art will recognize that additional embodiments or implementations are possible without departing from the teachings of the present disclosure or the scope of the claims that follow. This detailed description, and particularly the specific details of the exemplary embodiments and implementations disclosed herein, is given primarily for clarity of understanding, and no unnecessary limitations are to be understood therefrom, for modifications will become obvious to those skilled in the art upon reading this disclosure and may be made without departing from the scope of the claimed invention(s).

EXAMPLES

[0083] The following illustrate examples of the compositions, methods and other aspects described herein. Thus, these Examples should not be considered as limitations of the present disclosure, but are merely in place to teach how to make embodiments of the stackable cup, and to illustrate embodiments of the method.

Method of forming stackable cup

[0084] First, a sheet having three layers was formed by co-extrusion. The three layers comprised an internal layer 9 disposed between another two layers 8 and 10 (these two layers corresponding to the inner and outer layers of the wall of the cup, once the sheet has been thermoformed into a cup). The internal layer consisted of polypropylene, which was a mixture of waste and virgin polypropylene. The layers 8 and 9 in the inventive Examples comprised a mixture of polypropylene, talc and one or more further additives (in the case of the inner layer: a colorant, typically in an amount of from 3 wt% to 10 wt% of the layer; in the case of the outer layer: a colourant, typically in an amount of from 3 wt% to 10 wt% of the layer and an anti-static additive (e.g. ADD-VANCE AS 4030, available from BYK additives and instruments and/or 10877-A Cast Antistatic PP (polypropylene) masterbatch, available from Ampacet). The layers 8 and 10 in the comparative Examples comprised a mixture of polypropylene and one or more further additives, which are the same as those in the inventive samples. In all of the Examples, both comparative and inventive, the internal layer 9 constituted 80 % of the thickness of the whole sheet, with each of the layers 8 and 10 constituting 10% of the thickness of the sheet. The total thickness of the sheet was between about 1.2 mm and about 1.7 mm (the former for cups weighing about 5 g and the latter for cups weighing about 7 grams). The talc used had a particle size, D50, of 4 μm and was supplied in masterbatch form (Granic 1081, available from GCR Group; the masterbatch was a polypropylene masterbatch containing 71 wt% talc and 29 wt% polypropylene - the masterbatch was mixed with polypropylene homopolymer lacking talc in a suitable amount to obtain the desired wt% talc in the relevant layer (e.g. as shown in Table 1 below). The polypropylene homopolymer lacking talc was Moplen HP640J, available from LyondellBasell.

[0085] After forming the three-layer sheets by extrusion, the sheets were thermoformed into a shape of a cup (the thermoforming equipment being in-line with the extrusion equipment), having a shape as shown in Figure 1 and the layers as shown in Figure 2. In the process, the sheet was formed by co-extrusion, as described above, and then fed directly into the thermoformer (i.e. in-line thermoforming). Alternatively, the three-layer sheet could be preformed by co-extrusion and made into reels, and the reels then unwound when required and the sheet fed into the thermoforming equipment. In the thermoforming equipment, the sheet was heated to around 160 °C, then formed into a tooling cavity (female tool) and assisted with a preform; air pressure and vacuum were also used to assist the process. The thermoformed cup is then punched out of the tool in the same process, then ejected from the tool. In all cups, the rim diameter

was 73.7 mm. Cups were produced in two sizes - standard (denoted 'HB') having a cup height from base to the rim of 75.6 mm and suitable for holding 175 ml of liquid and a larger size (denoted 'XL') having a cup height of 88 mm and suitable for holding 210 ml of liquid. All of the cups had a base portion for holding the food or drink concentrate of 13.2 mm in height (this is the portion defined by an inward tapering of the wall from the base to the narrowed portion, at which the wall starts to taper outward to the rim).

Example Cups

[0086] Example cups thermoformed from extruded sheets having three layers as described above were produced. The inventive Example cups differed from the comparative Examples only in the presence of talc in layers 8 and 10. Table 1 below sets out information about the Examples and Comparative Examples.

Table 1

	Wt% of talc present in inner layer 8 and outer layer 10 (wt% of the relevant layer)	**Polymer present in** inner layer 8 and outer layer 10	**Size of cup**	**Weight of cup (g)**
Comparative Example 1	0	Polypropylene	HB	6.0
Comparative Example 2	0	Polypropylene	HB	6.4
Comparative Example 3	0	Polypropylene	XL	5.9
Comparative Example 4	0	Polypropylene	XL	6.4
Example 1	10%	Polypropylene	HB	N/A
Example 2	10%	Polypropylene	HB	N/A
Example 3	20%	Polypropylene	HB	N/A
Example 4	20%	Polypropylene	XL	N/A
N/A = information not available				

Method of testing Unlock Force

[0087] The unlock force was tested for the example compositions (i.e. wherein the inner and outer portions comprise 5-30% by weight of talc), and comparative compositions (not comprising talc) as follows.

Equipment

[0088] The following equipment and apparatus are used:

(i) n. pairs of interlocked cups
(ii) Tensile testing machinery - 100N load cell

- 200mm/min cross-head speed,
- sensitivity 0.1 N

(iii) Top & bottom unlock yokes/sample cup holders (shaped for easy insertion from one side)

Method

[0089]

1. Securely fix the yoke/cup holders onto the tensile tester leaving about 1mm separation between the yokes.
2. From the side, slide the cups to be tested into the yoke/cup holders and locate the yoke fingers between the two cups.

3. Zero the tensile tester,
4. Start the tensile test, as the yokes move apart the fingers will engage with the cup rims and separate the pair of cups. The end of the test is recognised by the load reverting to zero.
5. Record the peak force achieved.
6. Remove the cups from the yokes and replace with the next pair of cups, so the fingers are again between the cup rims.
7. Repeat stages 1-6 until all pairs are tested

Record all individual max loads and total sample average & standard deviation.

[0090] Note that if yokes are touching at the start of the test (effective compressive force), this will give false readings for unlock forces and give a value that is lower than the true value. The yoke holders should therefore be separated, leaving about 1mm separation between the yokes.

Results

[0091] The results are shown in Table 2 below.

Table 2

	Variant	**Standard Method**	**Sample Size**	**Mean**	**SD**
Comparative Example 1	Polypropylene HB Cup 6.0g	Unlock Force (N)	25	58	9
Comparative Example 2	Polypropylene HB Cup 6.4g	Unlock Force (N)	25	58	12
Comparative Example 3	Polypropylene XL13 Cup 5.9g	Unlock Force (N)	25	49	11
Comparative Example 4	Polypropylene XL13 Cup 6.4g	Unlock Force (N)	25	67	11
Example 1	Polypropylene, 10% talc HB Cup	Unlock Force (N)	25	32	3
Example 2	Polypropylene 10% talc HB Cup	Unlock Force (N)	25	41	4
Example 3	Polypropylene 20% talc HB Cup	Unlock Force (N)	25	43	2
Example 4	Polypropylene 20% talc XL13	Unlock Force (N)	25	34	3

[0092] It is seen that the addition of talc to the inner and outer surface portions/layers reduces the unlock force between two stackable cups compared to the comparative Examples. However, Examples 1-4 still had sufficient friction (> 25 N) to prevent the stackable cups coming apart during transit.

[0093] Notably, the addition of talc resulted in a more consistent unlock force compared to the comparative controls, as demonstrated by a smaller standard deviation.

[0094] These stackable cups can be used in an in-cup beverage dispensing system, for more reliable vending.

Claims

1. A stackable cup, the cup having a side wall and a base, wherein the side wall has an outer portion having a surface forming the exterior of the cup and an inner portion having a surface forming the interior of the cup, the inner portion and outer portion each comprising a polymer and talc, the talc being present in each of the inner portion and outer portion in an amount of from 5 % to 30% by weight of the inner or outer portion.

2. A stackable cup according to claim 1, wherein the polymer is a non-aromatic polyolefin and wherein optionally the polymer is selected from polypropylene or polyethylene, optionally wherein the polymer is polypropylene.

3. The stackable cup according to claim 1, wherein the polymer is present in each of the inner portion and outer portion in an amount of from 60 to 95% by weight of the inner or outer portion.

4. The stackable cup according to any of the preceding claims, wherein the talc is present in either the inner or outer portion is present in an amount from 8-22% by weight of the inner or outer portion, and wherein optionally the talc has a particle size, D50, ranging from 1 μm to 10 μm, optionally from 2 to 7 μm, optionally from 3 to 6 μm.

5. The stackable cup according to any of the preceding claims, wherein at least one of the inner or outer portions comprises an antistatic agent.

6. The stackable cup according to any of the preceding claims, wherein the thickness of the side-wall is from 1.0 to 2.0 mm.

7. The stackable cup according to any of the preceding claims, wherein the inner and outer portions together form a single layer of the side wall, or wherein the inner and outer portions are each a separate layer, optionally with one or more further layers disposed between the inner and outer portions.

8. The stackable cup according to any of the preceding claims, wherein the side-wall further comprises at least one internal portion disposed between the inner and outer portions, the internal portion, inner and outer portion each forming layers of the side wall;

wherein optionally the inner and outer surface portions each have a thickness that is 5 to 15% the total thickness of the side wall, optionally between 8 to 12% the total thickness of the side-wall; and
wherein optionally the internal portion is free or substantially free of talc.

9. The stackable cup according to any of the preceding claims, wherein the cup (the 'first' cup) is shaped such that, when stacked with a cup of the same shape (the 'second' cup) with the first cup being inside the second cup, an exterior surface of the base of the first cup does not contact the interior surface of the base of the second cup;

wherein optionally a telescoping prevention feature is provided on or as part of the side wall, to prevent the exterior surface of the base of the first cup contacting the interior surface of the base of the second cup; and
wherein optionally the telescoping prevention feature includes one or more protrusions disposed on the interior or exterior surface of the side wall, which, when stacked with the second cup cooperate with one or more recesses disposed on the exterior or interior surfaces, respectively, of the second cup.

10. The stackable cup according to any of the preceding claims, wherein the side-wall tapers inwards from the base to a narrowed portion, and tapers outward from the narrowed portion to a rim of the cup;

wherein optionally the narrowed portion is present at a vertical height of 2 to 30 mm from an exterior surface of the base of the cup, optionally from 5 to 25 mm from an exterior surface of the base of the cup;
wherein optionally a food or beverage ingredient is present within the cup on or adjacent an interior surface of the base of the cup; and
wherein optionally the stackable cup is suitable for an in-cup beverage dispensing system.

11. A stack of cups comprising a plurality of cups according to any one of claims 1 to 10.

12. A method of forming a stackable cup, comprising:

extruding a mixture of polymer and talc to form a sheet, the talc being present in an amount of from 5 % to 30% by weight of the mixture; and
thermoforming the sheet to form a stackable cup.

13. The method according to claim 12, wherein the mixture is co-extruded to form a multi-layered sheet, wherein at least the surface layers of the multi-layered sheet comprise the mixture of polymer and talc, the talc being present in an amount from 5 % to 30%.

14. The method according to claim 12, wherein the stackable cup is as defined in any one of claims 1 to 10.

15. A system for dispensing an in-cup beverage using the stack of cups of claim 11.

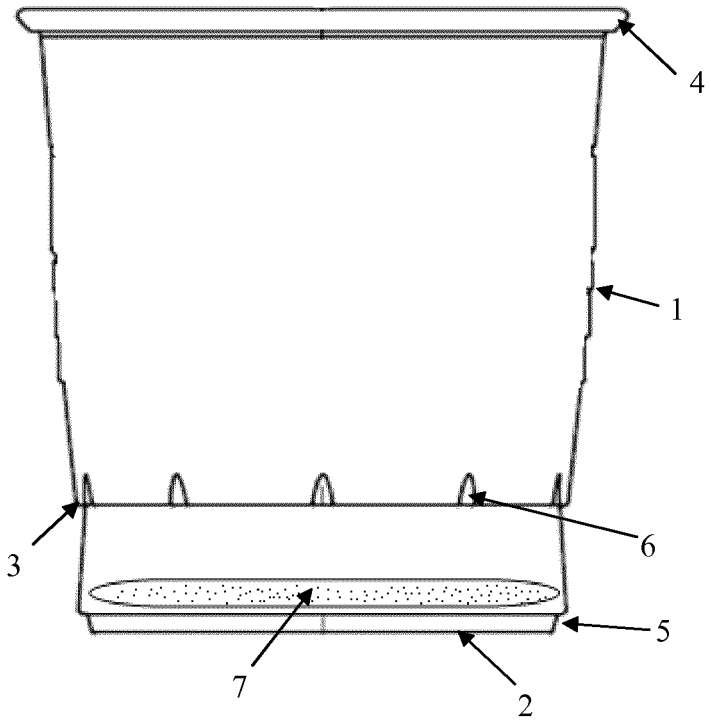

FIG.1

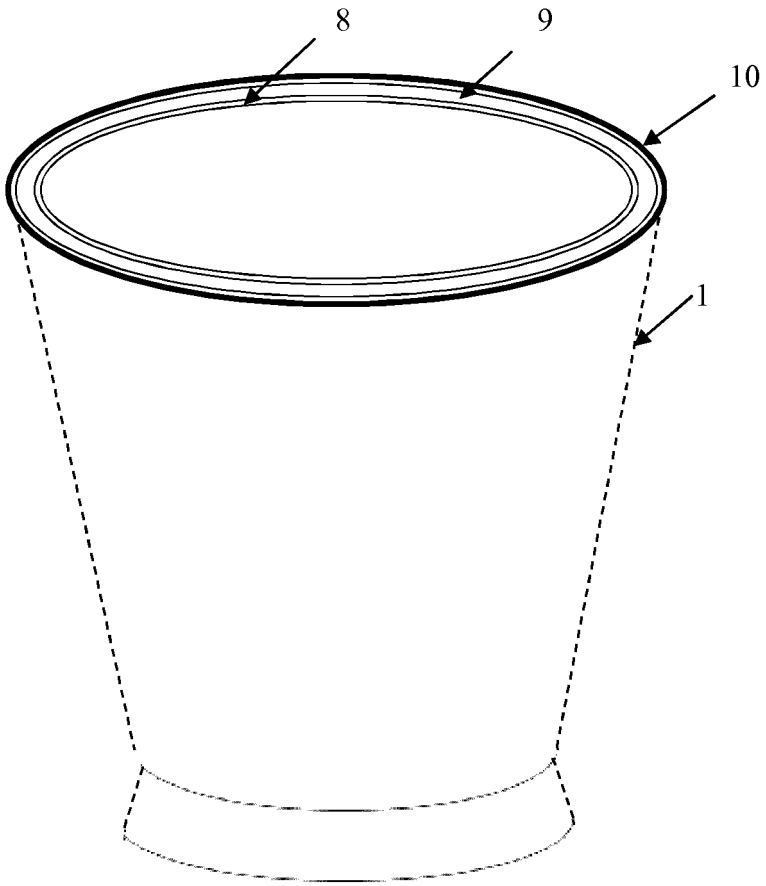

FIG. 2

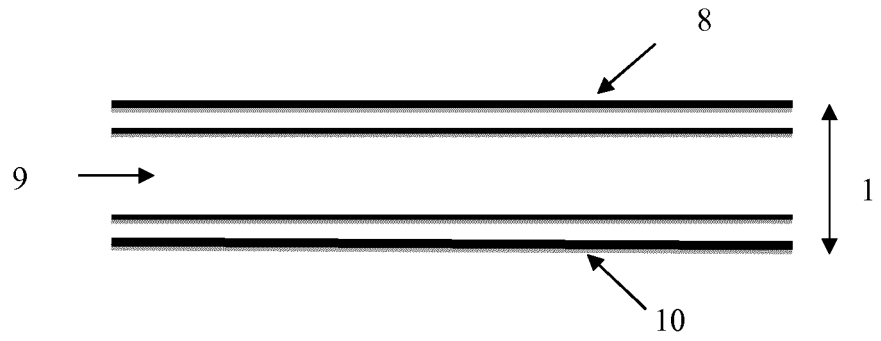

FIG. 3

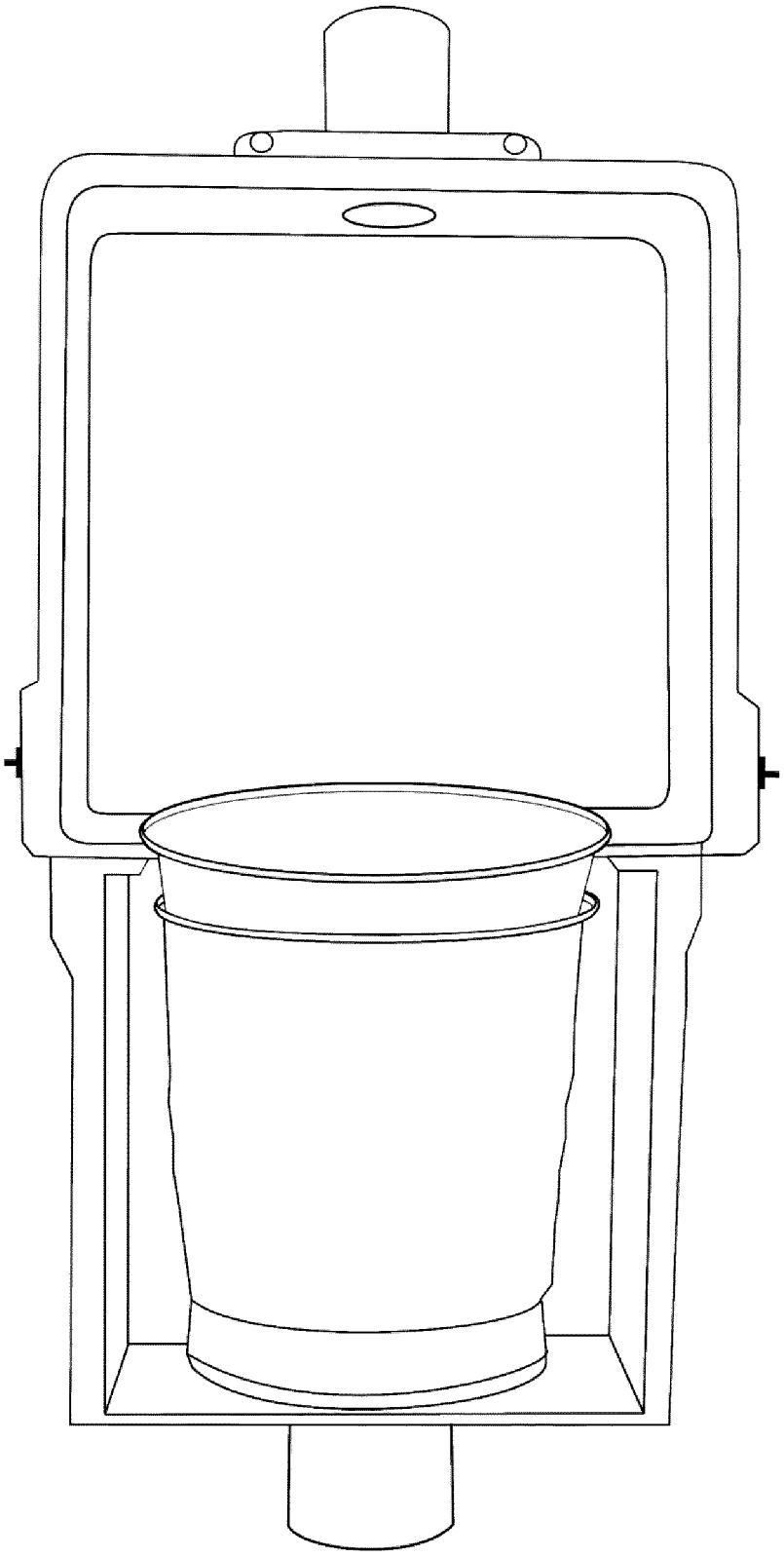

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 19 21 1029

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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	10 March 2020	Grondin, David

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