The invention relates to a capsule for use in a device for preparing beverages. The invention next relates to a method for manufacturing a capsule according to the invention. The invention further relates to an assembly of such a capsule and a device for preparing beverages. The invention moreover relates to the use of such a capsule according to the invention in a device for preparing beverages.
Capsule and device for preparing beverages and method for manufacturing a capsule

The invention relates to a capsule for use in a device for preparing beverages. The invention also relates to a closing element for use in a capsule according to the invention. The invention next relates to a method for manufacturing a capsule according to the invention. The invention further relates to an assembly of such a capsule and a device for preparing beverages.

Various capsules for use in a device for preparing beverages are known in the prior art. A known capsule, as described for example in EP05 12468, comprises an essentially frustoconical housing composed of a peripheral wall, an end inlet side connected to the peripheral wall, and an engaging edge connected laterally to the peripheral wall for clamping the capsule into a capsule holder of the device for preparing beverages. The engaging edge is connected to a perforable foil that also forms the outlet side of the capsule. The housing is filled with a substance to be extracted, such as ground coffee beans. This known capsule can be placed in a device for preparing a beverage. For this purpose, the capsule is placed in a capsule holder, into which the capsule is then clamped, thus causing the inlet side of the capsule to be perforated. After this, warm water at fairly high pressure (6-20 bar) is to be fed into the capsule holder and thus into the capsule via the inlet side, where the water is to come into contact with the substance, thus forming the final beverage. The pressure build-up in the capsule is to cause the foil to be deformed in such a way that the foil is perforated by the capsule holder, with the result that the formed beverage can leave the capsule. The housing of the capsule described in the aforementioned patent is composed of aluminium. Although aluminium has fairly favourable barrier properties, allowing it to preserve the coffee for a long period of time, the processing of aluminium is fairly problematic. Moreover, the capsule is to be discarded after use, generally by means of standard waste disposal, which leads to considerable environmental pollution.

An objective of the invention is to provide a fairly reliably functioning capsule for preparing beverages which, particularly after use, leads to reduced environmental pollution.
For this purpose, the invention thus provides a capsule of the type mentioned initially, comprising: an essentially closed housing which is at least partially filled with a substance to be extracted and/or dissolved, such as ground coffee, for preparing a beverage, wherein the housing is defined at least by a peripheral wall, a bottom wall connected to the peripheral wall, and a laterally protruding engaging edge connected to the peripheral wall at a distance from the bottom wall in order to allow the capsule to be clamped into a capsule holder of a device for preparing beverages; and at least one essentially closed closing element configured to allow beverage to flow from the capsule, which closing element is connected to the laterally protruding engaging edge for sealing the substance into the capsule, wherein at least a part of the closing element is composed of a laminated foil, said foil comprising: at least one weakened layer, which weakened layer is provided with at least one weakened area, and which weakened layer preferably faces the substance held by the housing, at least one carrier layer which is at least partially made of paper, in particular filter paper, and preferably at least one least oxygen barrier layer, which barrier layer is essentially impermeable to oxygen, and which oxygen barrier layer is situated in between said weakened layer and said carrier layer. The applied laminated foil used to hermetically seal the substance into the capsule allows the application of the application of more environmental friendly materials compared to aluminium, which leads to less environmental pollution. The foil applied to close the housing is essentially composed of paper and plastics (polymers), and preferably compostable paper and compostable plastics as will be elucidated hereinafter. Moreover, the composition of the laminated foil is such that, during use, the foil will tear in a controlled manner in order to allow the beverage to flow from the cartridge in a controlled manner. Preferably, no metal layer is applied in the foil. The oxygen barrier layer makes it possible to preserve, in an oxygen-free or low-oxygen manner, the substance contained in the capsule, generally ground coffee, tea leaves, instant soup, or (chocolate) milk powder for preparing coffee, soup, tea or (chocolate) milk respectively. The oxygen barrier layer is generally configured in a completely closed (non-perforated) manner. Hence preferably, the closed oxygen barrier layer is not weakened in order to make it possible to keep the oxygen barrier as favourable and uniform as possible. It is preferred in this case that the oxygen barrier have an essentially uniform layer thickness. The at least one weakened layer is commonly configured to carry, hold in place, and support the - generally thinner - oxygen barrier layer. The weakened layer is provided with at least one (previously - during production
of the foil-formed weakened area, with the result that the weakened layer as such is weakened. This weakened area can be formed in various ways, as will be explained in further detail below. The weakened area serves to allow the foil to tear in a simple, and preferably controlled, manner, when the capsule is used in a device for preparing beverages. If no weakened area is formed, a plastic (multilayer) foil tends to stretch rather than tear, which can make opening of the capsule on the outlet side considerably more difficult and even impossible. Because of the (site-selective) weakened area in at least one carrier layer, tearing of the foil is made considerably easier, and in general, the tearing behaviour of the foil will essentially be consistent with the tearing behaviour of a classic aluminium-based foil. The carrier layer which is at least partially, or preferably completely, composed of paper, in particular filter paper, is commonly configured as to carry other foil layers. Commonly, this carrier layer is the thickest layer of all foil layers to provide the foil sufficient firmness. Filter paper is paper which is paper which is sufficiently porous to allow a beverage to flow through while preventing - eventual - (average-sized) solid particles of the substance to flow through. Hence, apart from providing the foil an increased firmness, the filter paper also has a filtering function. Moreover, filter paper prevents that the foil as such undergoes (excessive) stretching during use (at typical operational temperatures of between 20 and 120 degrees Celsius), and hence prevents that the foil as such will be forced, due to water pressure, into discharge openings of the capsule holder of a device for preparing beverages, which secures proper functioning of both the capsule, the capsule holder, and hence the device. The filter paper used is also referred to as a non-woven web. Instead of composing the carrier layer of (filter) paper, it is conceivable that the carrier layer is composed at least partially of another material which does not soften and/or melt at a typical operation temperature range of between 70 and 120 degrees Celsius. Examples of alternative materials for filter paper are cellophane, cellulose acetate, and bio-based and/or compostable fibers composed of viscose, lignin, and/or soy.

The foil may conceivably comprise a plurality of carrier layers. It is also conceivable that the plurality of carrier layers of the foil may be configured in weakened form, which leads to a weakened carrier layer. This makes it possible to keep the foil sufficiently easy to tear while providing each carrier layer with its own functionality. For example, it is conceivable that each carrier layer could directly or indirectly play a role in supporting the oxygen barrier layer, with, for example, at least one first carrier
layer functioning primarily as a carrier, while at least one other carrier layer functions more as a moisture barrier. It is preferred that at least two of the weakened foil layers be adjacent to one another. More preferably, the weakened areas of the adjacent layers should be in line with one another. This can be carried out fairly easily by application of a heated stamp or laser that simultaneously processes the aforementioned carrier layers. Application of a stamp results in reduced local (site-selective) layer thickness, and thus a weakened area of the foil layer.

Commonly, the at least one carrier layer which is at least partially made of filter paper forms an outer layer of the foil facing away from the protruding engaging edge. Since this filter paper layer is commonly used as outer layer, this filter paper layer will commonly interact with the capsule holder of the device, during the use of the capsule. The oxygen barrier layer is commonly at least essentially composed of a polymer, preferably a compostable polymer, eventually enriched by one or more additives. The weakened layer is commonly (also) at least essentially composed of a polymer, preferably a compostable polymer, eventually enriched by one or more additives.

The laminated foil is preferably a composite foil (also called a composition foil or shortened to composite). A composite foil, in this case, is a foil made from three or more individual material layers with significantly different physical or chemical properties that, when combined, produce a laminate with characteristics different from the individual layers. In the laminated foil, the applied layers are mutually connected to each other and mutually indivisible. Hence, the laminated foil as such forms a single piece of material, and hence a single capsule component. The laminated foil is commonly flexible.

In a preferred embodiment, the at least one weakened (carrier) layer is provided with perforations. The perforations together defined the weakened area (or weakened section or weakened zone) of the weakened layer. The openings made in the at least one carrier layer are preferably composed of microperforations. The maximum dimension of each (micro)perforation is preferably between 1 and 10 millimetre, more preferably between 2 and 8 millimetre, and in particular between 3 and 6 millimetre. Said maximum dimension can be defined by the length, the width, and/or the diameter of each (micro)perforation applied. In this case, it can be preferred for at least a number of these
openings (perforations) to completely penetrate the at least one carrier layer. Hence, in this latter embodiment at least a number of the perforations form through-holes connecting opposing sides of the weakened layer. Consequently, in case this perforated weakened layer is applied as a layer facing the substance held by the housing, an adjacent foil layer will also partially facing the substance held by the housing of the capsule due to the through-holes of the perforated weakened layer. This adjacent foil layer can be formed by the oxygen barrier layer or by another layer, such as an intermediate primer layer. However, in order to prevent perforation of the oxygen barrier layer, it is commonly preferred that the openings do not form through-holes in the weakened layer. In this case the openings are made in a surface of the weakened layer facing away from the oxygen barrier layer. In this case, the openings merely extend to a limited depth in the weakened layer. This limited depth typically corresponds to 50-90% of the total thickness of the weakened layer. For example, in case the thickness of the weakened layer would be 27 micron, then the openings made in a surface of the weakened layer facing away from the oxygen barrier could have a depth of 20 micron. Hence, in this case the (single-side) openings are positioned at a distance from the oxygen barrier layer, which prevents unintentional damage (perforation) of the oxygen barrier layer during the production process.

The (micro)perforation can fairly easily be formed by application of a laser that burns the perforation into the at least one - commonly polymer - weakened layer. In this case, the intensity and wavelength of the laser can be adjusted in such a way that only the weakened layer of the superposed foil layer is perforated, and that the underlying oxygen barrier layer (and other layers if applicable) are not damaged by the laser and thus stay(s) in tact. It is preferred in this case that the perforations be made in a pattern in the at least one weakened layer. Preferably, this pattern extends over the entire surface that is limited by the inner periphery of the lateral engaging edge, and therefore over the complete outlet side of the capsule. Experiments have shown that the controlled tearing of the foil can best be achieved if at least one perforation, and preferably each perforation, is formed by a plurality of interconnected line segments, wherein adjacent line segments mutually enclose an angle. Said angle is situated between, thus not including, 0 and 180 degrees, and result in a weakened point at the location wherein line segments are interconnected, which facilitates a controlled tearing of the foil significantly. The outer end of at least one line segment may be connected to
another line segment, which would result in a perforation having the shape of, for example, one of the following characters: W, E, T, Y, F, H, K, L, Z, V, N, M. It is also conceivable that at least two line segments are intersecting, which would result in a perforation having the shape of, for example, one of the following characters: +, X, $, #. It is preferred that at least two adjacent line segments mutually enclose an acute angle (angle between 0 and 90 degrees), which further improves a controlled tearing behaviour of the foil. Although commonly less advantageous, also simple, single line segments may be used (not being interconnected to other line segments) in order to define the perforations. A pattern composed of a plurality of broken lines (dashed lines or line segments) can be applied. In this pattern, preferably the broken lines are mutually essentially oriented in parallel. The perforations configured in succession forming a continuous line segment are preferably designed in an elongated manner, and it is particularly preferred if they are essentially rectangular. Such a design facilitates tearing of the film, wherein the film is to tear at the sites of the lines, with the lines determining the de facto location of the tearing seams. Instead of line segments, the perforations can also be formed by dots, wherein a dotted pattern can be formed acting as weakened area. Alternative tearing patterns can for example be achieved by forming of square shaped and/or rounded perforations. The thickness of the weakened layer is commonly between 10 and 50 micron, preferably between 10 and 30 micron.

In an alternative variant embodiment, at least one weakened layer is configured in a weakened manner by pre-damaging the at least one carrier layer, preferably a frontal side thereof, with the result that tearing of the carrier layer is also facilitated. Damaging of the carrier layer can be carried out, for example, by tearing of the carrier layer and/or etching of the carrier layer.

As already indicated above, the weakened layer preferably faces toward the substance held in the housing. This weakened layer is then the first layer to be exposed to water pressure build-up in the capsule. Because of the applied weakening, this (innermost) layer is also the first layer that can tear on pressure build-up in the capsule during injection of water into the capsule (generally via the bottom wall of the housing), with the result that the beverage can be displaced through this innermost layer. As the layers of the foil are preferably integrally connected to one another, thus forming a composite, tearing of the innermost layer will fairly quickly lead to tearing of the other layers.
according to the same tearing pattern. Hence, it is important to define the positioning, dimensioning, and design of the perforations (or alternative weakenings as indicated above) applied to position-selectively weaken the weakened layer as good as possible to realize a controlled tearing of the foil during use, and hence a controlled outflow of beverage from the capsule. Integral binding of the foil layers to one another can be carried out by welding/melting the various foil layers together and/or by gluing the foil layers together.

Under the effect of the pressure build-up in the capsule, the closing element, often merely formed by the laminated foil, is deformed and finally undergoes controlled tearing during interaction of the deformed foil with a perforation structure of a device for preparing beverages such as a coffee machine. At higher temperatures of between 90 and 100 °C, which are generally applied in extracting and/or dissolving the substance, it is specifically the oxygen barrier layer that tends to tear out and form around and/or over the perforation structure of the coffee machine instead of tearing and/or being perforated. By connecting the oxygen barrier layer to the at least one weakened carrier layer, one can force controlled rupturing of the oxygen barrier layer to occur, which facilitates the preparation process of the beverage.

The oxygen barrier layer is preferably at least partially manufactured from a material selected from the group composed of polyvinyl alcohol (PVOH), polyvinylpyrrolidone (PVP), polyvinyl acetate (PVAc), compostable ethylene vinyl alcohol (EVOH), a highly amorphous vinyl alcohol polymer (HAVOH), and nanofibrillated cellulose, (hemi)cellulose derivatives and copolymers, and polyglycolic acid (PGA). PGA provides an even better oxygen barrier than ethylvinyl alcohol (EVOH) commonly used for barrier films. PVOH and HAVOH are generally the most preferred of these substances, as PVOH can be fairly easily applied as a sealed oxygen-impermeable foil and has favourable adhesion properties. The oxygen barrier layer is preferably composed of a hybrid coating of an organic phase, for example by application of at least one of the aforementioned components, and an inorganic fraction that functions as a precursor. More preferably, the inorganic fraction is composed of silicon alkoxide (Si(OR)4), wherein R denotes an organic tail derived from one of the aforementioned organic molecules. Such hybrid coatings generally show particularly favourable composting properties, and also possess satisfactory impermeability to oxygen. As a
less environmentally-friendly alternative, the oxygen barrier layer may also be composed of, for example, polyvinylidene chloride (PVdC), ethene vinyl alcohol (EVOH), or a metal oxide such as SiO2 or Al2O3.

"Oxygen permeability" can e.g. be expressed by of calculating the amount (cc/m²/day) of oxygen permeated through a 20 micron thick oxygen barrier layer. This value (cc·20µm/m²/day) is referred to as an indication of the oxygen permeability. Based upon this calculation method, HAVOH has an oxygen permeability of 0.0023 cc·20µm/m²/day, PVOH of 0.0050 cc·20µm/m²/day, en EVOH of 0.42 cc·20µm/m²/day. Hence, based upon these oxygen barrier properties HAVOH and PVOH are commonly more preferred than EVOH. Moreover, HAVOH and PVOH are better compostable than (unmodified) EVOH, which makes the use of HAVOH and PVOH more attractive. However, EVOH is more stable in wet conditions than PVOH and HAVOH, wherein PVOH is more stable in wet conditions than HAVOH, as a result of which PVOH is commonly preferably used as main component of the oxygen barrier layer.

The oxygen barrier layer is preferably also essentially impermeable to water vapour. For example, when the capsule is provided with ground coffee, it is undesirable for water to come into contact with the coffee before the capsule is used to make the coffee. If water vapour reaches the ground coffee before the coffee is prepared, the ground coffee will absorb the water vapour and the machine will turn off. This adversely affects the quality of the coffee. This can also cause the extraction or the infusion process to be disturbed at a later time. However, the oxygen barrier layer, including for example a PVOH-based oxygen barrier layer, is usually moisture-sensitive, with the result that the moisture-sensitive oxygen barrier will generally disintegrate fairly rapidly and easily on contact with moisture (water). For this reason, it is particularly preferable if the oxygen barrier layer is surrounded (sealed in) on at least one side, and preferably two sides, by at least one shielding material layer that completely shields the oxygen barrier from the (moisture-containing) atmosphere surrounding the capsule. The surrounding atmosphere is understood to refer to the ambient air that surrounds the capsule. In this case, the surrounding material layer is manufactured from a material that is relatively insensitive to moisture and is relatively stable in a moist environment, and will therefore not readily disintegrate or degrade on contact with moisture. Preferably, this material layer that
shields and therefore protects the oxygen barrier should be completely or at least highly impermeable to moisture, with said shielding material layer thus functioning as a kind of moisture barrier layer, with the result that moisture cannot or at least cannot rapidly and easily come into contact with the underlying moisture-sensitive oxygen barrier layer. This leaves the oxygen barrier layer intact and makes the capsule and the contents thereof more durable. In this case, complete shielding by the oxygen barrier layer from the outside world (the immediate environment) is preferred. At least one shielding material layer, which also can function as a weakened or non-weakened carrier layer, is positioned on at least one outer side of the foil in order to function as a partition between the moisture-sensitive oxygen barrier layer and the immediate environment of the foil. A suitable material for such a shielding (carrier) layer is cellulose and/or a polyhydroxyalkanoates (PHA). Cellulose is generally (semi)transparent. One could therefore conceivably apply an image that is visible to the user or a visible pattern, motif, design, text, and/or piece of information between the oxygen barrier layer and the shielding transparent or semitransparent layer, for example by application of ink, in particular by means of a printing process. In this manner, the capsule can be effectively personalised and/or characterised, thus making it informative, recognisable, and/or attractive in nature. Preferably, the shielding layer is situated in between the oxygen barrier layer and the filter paper layer. Here, more preferably, the shielding layer is glued to both the oxygen barrier layer and the filter paper layer. The thickness of the shielding layer is typically situated between 10 and 50 micron, preferably between 10 and 30 micron.

In a preferred embodiment the filter paper used to compose the carrier layer has a paper density of between 10 and 30 g/m2. A paper density within this range provides the carrier layer sufficient firmness, also during use, while preventing the filter paper based layer to become too heavy which may hinder the tearing of the foil and the outflow of beverage from the capsule. For exactly the same reason, the thickness of the filter paper used to compose the carrier layer has a thickness of between 30 and 100 micron, preferably between 50 and 100 micron. In order to secure a proper filtering function of the filter layer based carrier layer, the filter paper used to compose the carrier layer preferably has a porosity exceeding 600 l/m2-s, preferably exceeding 800 l/m2-s. This porosity will commonly be sufficient to allow flow through of beverage and to prevent
flow through of (average-sized) solid substance particles, while preventing the flow resistance to become too high.

Preferably, the filter paper used to compose the carrier layer comprises a mixture of natural fibers and synthetic fibers, wherein the synthetic fibers are preferably composed of a compostable material, such as polylactic acid (PLA). In order to impart the desired properties to a paper or non-woven web, it is often desired to modify its composition. To this end, the (filter) paper used to compose the carrier layer comprises at least one crosslinking or functionalization agent, preferably selected from the group consisting of: polysaccharides, carboxylic acids, halogenated hetero-aromatic compounds and salts thereof. It has been found that a crosslinking or functionalization agent as described herein can impart specific desired properties to a paper or non-woven web, such as a high tensile strength in both a dry state and in a wet state even under severe conditions for instance extreme pH values. The porosity, adherence, wettability or hydrophilicity/hydrophobicity of the (filter) paper or non-woven web can be easily controlled to the desired properties by appropriately selecting a specific crosslinking or functionalization agent as described herein as well as its amount or by combining it with other additives, such as polysaccharide additives, for instance carboxymethyl cellulose (CMC). The term "crosslinking or functionalization agent" denotes a compound which is able to bind to fibers, preferably via covalent bonds, and is able to form crosslinks and/or to functionalize fibers. The terms "crosslinking" as used herein do not only encompass the linking of two fibers or a fiber and a further additive, such as a polysaccharide additive, but also encompass the crosslinking within one fiber. The terms "crosslinking" as used herein in particular encompasses linkages (e.g. the linking of two fibers, the linking of a fiber and a further additive, and/or the crosslinking within one fiber) within (in the interior) of the paper or non-woven web, and in particular not only on the surface of the paper or non-woven web. The term "functionalization" as used herein denotes providing the paper or non-woven web with a certain functionality or certain functionalities, such as hydrophilic properties, hydrophobic properties, wettability, adherence, stability, tensile strength, resistance, and the like.

As already mentioned above, suitable fibers are natural fibers or cellulosic fibers. Preferred examples include fibers of cellulose, viscose, lyocell, manila, jute, cotton,
hemp, sisal, rayon, abaca and others, and also include fibers of soft wood pulp and hard wood pulp. Further suitable fibers are synthetic fibers or heat-sealable fibers. Other examples include fibers of polyethylene (PE), polypropylene (PP), polyester, such as polyethylene terephthalate (PET), wherein a preferred example includes compostable synthetic fibers, for example composed of poly (lactic acid) (PLA). Further preferred examples include bicomponent fibers, preferably bicomponent fibers of the sheath-core type. Bicomponent fibers are composed of two different sorts of polymers having different physical and/or chemical characteristics, in particular different melting characteristics. A bicomponent fiber of the sheath-core type typically has a core having a higher melting point component and a sheath having a lower melting point component. Examples of bicomponent fibers, suitable for use in the present invention, include PET/PET fibers, PE/PP fibers, PET/PE fibers and PLA/PLA fibers.

As already indicated, it is also possible to use mixtures of the above fibers, such as mixtures of two or more natural fibers, mixtures of two or more synthetic fibers or heat-sealable fibers, mixtures of natural fibers and synthetic fibers or heat-sealable fibers and any combinations thereof. The length and the coarseness of the fibers are not particularly limited. The coarseness of a fiber is defined as the weight per unit length of the fiber. Typically, the natural fibers or cellulosic fibers have a length of 1 to 15 mm, preferably from 3 to 10 mm. Typically, the natural fibers or cellulosic fibers have a coarseness of from 30 to 300 mg/km, preferably from 70 to 150 mg/km. Typically, the synthetic fibers or heat-sealable fibers have a length of from 1 to 15 mm, preferably from 2 to 12 mm. The heat-sealable fibers suitable for use in the present invention typically have a coarseness of from 0.1 to 5 decitex, preferably from 0.3 to 3 decitex.

Tex is a unit of measure for the linear mass density of fibers, yarns and thread and is defined as the mass in grams per 1000 meters. The unit code is "tex", wherein the most commonly used unit is actually the decitex (abbreviated dtex), which is the mass in grams per 10,000 meters.

The foil should preferably be essentially fully compostable. As the capsule is manufactured from one of a plurality of (biologically) compostable materials, the capsule is to be discarded after use, preferably in VFG waste (vegetable, fruit, and garden waste), after which the capsule is biodegraded on the molecular level by microorganisms, if applicable after application of activation heat and moisture (water). In this
case, it is also preferred to manufacture the capsule components from biomaterials ("bio-
based materials"), which are materials originating from living or formerly living
organisms, as this further increases the durability of the capsule and further reduces
environmental pollution. In this process, organic molecules, of which the capsule is
essentially composed, are converted into smaller organic molecules, and finally into
water, carbon dioxide, and biomass (humus), and possible mineral components such as
salts. In industrial composting facilities, the entire composting process generally
requires several weeks. This type of composting process is also referred to as
biodegradation. Manufacturing of all of the components of the capsule from fully
compostable materials provides a considerable benefit with respect to environmental
pollution. This provides a solution in the ongoing efforts to keep the discharge of waste
to a manageable level and deal responsibly with residual waste. In addition to the
reduction in environmental pollution accompanying use of the capsule according to the
invention, the essentially closed capsule is extremely well-suited for allowing the
substance, generally coffee, to be preserved for long periods of time by using an oxygen
barrier, preferably in both the housing and the closing element. For this reason, no
separate packaging is required in order to maintain the quality of the substance,
specifically coffee.

In a preferred embodiment, the foil comprises at least one carrier layer that is composed
of a non-woven fabric (non-woven) and/or a woven fabric (woven). The layer
composed of a non-woven fabric (non-woven) and/or a woven fabric (woven) is
manufactured, for example, from polylactic acid (PLA) and/or cellulose. Polylactic acid
and cellulose are both compostable materials, with the result that the capsule can be
discarded after use and biodegraded. Moreover, both materials are relatively
impermeable to moisture. The layer composed of a non-woven fabric (non-woven)
and/or a woven fabric (woven) preferably faces toward the substance enclosed in the
capsule. The layer serves to stiffen the foil as such, having an open structure by nature,
and is therefore already configured in a weakened state and can tear fairly easily. The
non-woven and/or woven layer can also serve as a filter so that ground coffee particles
in the capsule cannot leave the capsule, while fluid (water) is allowed to penetrate. The
layer composed of a non-woven fabric (non-woven) and/or a woven fabric (woven) can
be glued to the oxygen barrier layer, for example by application of an essentially fully
compostable glue, preferably manufactured from polylactic acid (PLA). PLA is a
compostable material, with the result that the capsule can be discarded after use and biodegraded. The glue layer preferably has a thickness of approximately 2 microns.

The engaging edge of the capsule is generally connected, commonly integrally connected, to an end of the peripheral wall facing away from the bottom wall (bottom). In this manner, an asymmetrical capsule is obtained in case the symmetrical surface of the capsule is secured by the peripheral edge (flange). In general, the peripheral wall should have an essentially frustoconical design so that the capsule can be applied in known devices for preparing beverages. The bottom wall of the housing is commonly integrally connected to the peripheral wall. The bottom wall is preferably pierceable in order to allow water to be injected into the capsule via the bottom wall. The housing is preferably essentially rigid (shape-retaining). With respect to design, the capsule should preferably be consistent with the capsule described in the above-referenced patent EP05 12468.

Preferably, the housing is composed of a laminate of a plurality of material layers. In this case, each material layer should preferably be essentially compostable. By applying a laminate of material layers, it is possible to efficiently provide the housing with the desired properties. For example, at least one material layer may form a barrier layer against oxygen and/or water (vapour). One may use e.g. a plurality of synthetic or natural polymers such as nitrocellulose, polysaccharides such as hydroxyethylcellulose, polyvinyl alcohol (PVOH), or ethylene vinyl alcohol (EVOH), polylactic acid (PLA), polyvinylidene chloride (PVDC), chitosan, carboxymethylcellulose, polyacrylate, polyglycolide, polybutylene succinate (PBS), acrylonitrile-butadiene-styrene (ABS), polyolefins, polyester, co-polymers, polyamide, PLA/caprolactone copolymers, polyhydroxyalkanoates, biodegradable polyethylene (PE), polypropylene (PP), polybutene (PB) and copolymers and mixtures thereof, optionally mixed with starch. A barrier layer for oxygen comprising a plurality of synthetic or natural polymers may further include a crosslinker such as silane, glyoxal, melamine resin, and the like. This barrier layer for oxygen is preferably composed of compostable material, and natural polymers such as starch and chitosan and synthetic polymers such as PVOH, EVOH, and PLA are therefore preferred. In one embodiment, the material layer also comprises a wax and/or a filler, such as clay, which further strengthens the barrier function. Where applicable, the polymer is dispersed or dissolved in an aqueous or other solvent-based
medium, with said medium containing inorganic particles. Such inorganic particles are preferably composed of inorganic layered or plate-like particles containing natural or synthetic clay minerals such as mica, kaolinite, vermiculite, halloysite, montmorillonite, and the like. Where applicable, a metallised foil may also be used as an oxygen barrier and/or a water (vapour) barrier in the housing. For this purpose, an aluminium coating is preferably applied to a preformed material layer of the laminate. It is also conceivable to use a plurality of oxygen barriers, which can optionally be applied on top of one another. For example, it is conceivable to coat a PVOH layer with an aluminium coating. In this manner, a multiple oxygen barrier is produced. A further material layer of the laminate can optionally function as a shielding coating and/or a coloured layer in order to impart a desired colour to the housing of the capsule. An example of such a layer is composed of a compostable polymer selected from the group composed of compostable polyesters, PLA, polyhydroxyalkanoates, polycaprolactones, polybutylene succinate adipate, polybutylene adipate co-terephthalate, PLA/caprolactone copolymers, biodegradable polyethylene, and nitrocellulose.

All of the aforementioned material layers are preferably composed of a compostable material. The oxygen-impermeable barrier layer is generally sensitive to water, with the result that the barrier layer should preferably be shielded from water (vapour) by a surrounding material layer surrounding or enclosing the barrier layer, such that the at least one surrounding material at least partially, and preferably completely, protects the barrier layer from the atmosphere surrounding the capsule. More preferably, the surrounding material layer completely encloses the oxygen barrier layer. More details and embodiments of the capsule are disclosed in the international patent application PCT/IB2014/002648, the full content of which is incorporated in this document by reference.

The material layers of the laminate are preferably welded or glued to one another by application of an essentially fully compostable glue. An example of a compostable glue that can be used both in the housing and in the closing element concerns glue containing 1 to 70 wt% of a compostable polymer selected from the group composed of an aliphatic or partially aromatic polyester and a thermoplastic aliphatic polyester urethane. Another example of a compostable glue is composed of biodegradable acryl polymers, biodegradable polyesters, PLA, polyhydroxyalkanoates, polycaprolactones,
polybutylene succinate adipate, polybutylene adipate co-terephthalate,
PLA/caprolactone copolymers, starch, hydrocarbon resins, and of course pine resin. Preferably, the compostable glue contains a biodegradable acryl polymer or a polycaprolactone-based hot melt adhesive.

If applicable, the compostable glue also comprises an adhesiveness-imparting agent such as a resin. Such an adhesiveness-imparting agent preferably contains a vegetable resin such as a colophonium and phenol resin, a terpene polymer such as a terpene-phenol resin and aromatic modified terpene resin, a styrene resin, coumarone/indene resin, an alkyl phenol resin, a xylene resin, a C5 type petroleum resin, a C9 type petroleum resin, and an alicyclic hydrogenated resin. Preferably, the adhesiveness-imparting agent comprises a vegetable resin such as a colophonium, and/or a terpene polymer, in view of the fact that such adhesion-imparting agents show favourable adhesive strength in combination with the compostable polymer present in the compostable glue.

In a preferred embodiment, a layer of the foil which is connected to the protruding edge and a part of the protruding edge to which said layer of the foil is connected are composed of essentially the same materials. By using the (essentially) same (polymer) materials at the contact portion between the edge and the foil, a durable weld can easily and perfectly be realized. Preferably, an annular welding seam is formed by the foil and the protruding edge welded to each other. An annular welding seam secures a proper and complete connection between the foil and the edge, wherein the risk of leakage of water and/or substance via a space enclosed by the foil and the edge can be prevented.

Moreover, an annular welding seam commonly extends throughout all foil layers, wherein all foil layers are pressed together at the circumferential edge of the foil layers to form the welding seam. At the welding seam the foil layers are deformed which deformed annular portion of the foil acts as labyrinth for moisture, which prevents or impedes atmospheric moisture to migrate into the foil layers. The moisture barrier created in this manner is in particularly advantageous in case one or more moisture sensitive foil layers are applied, for example a PVOH based layer (acting as oxygen barrier layer), wherein the functionality of the individual foil layer and hence the foil as such can be secured in a relatively efficient and durable manner.
The capsule as such is preferably made essentially solely of a compostable bio based material, such as biodegradable biopolymers, (recycled) paper and/or cardboard and synthetic biodegradable polymers. Biodegradable polymers preferably include biodegradable polyesters, PLA, polyhydroxyalkanoates, polycaprolactones, polybutylene succinate adipate, polybutylene adipate co-terephthalate, PLA/caprolactone copolymers, biodegradable polyethylene, and nitrocellulose. PLA can comprise both the L-enantiomer (PLLA homopolymer) and the D-enantiomer (PDLA homopolymer).

In a particularly preferable embodiment, the capsule is manufactured from a bio based polymer (biopolymer). This relates to materials which are manufactured from biologically renewable (recyclable) raw materials. This therefore concerns the origin of the materials. Examples are bioplastics, a term used to refer to plastics made from natural products, such as starch obtained from potatoes or corn, and also from cellulose. These are in fact artificial biopolymers. Biopolymers can be selected from carbohydrates, polysaccharides (for example cellulose, starch, glycogen, hemicellulose, chitin, fructan, inulin, lignin, and/or pectin substances), rubbers, proteins, possibly grains, vegetables and/or animal proteins (such as gluten, whey proteins, and/or gelatine), colloids (such as hydrocolloid, for example natural hydrocolloid such as rubbers), other polyorganic acids (such as PLA, polyglycolide and polyhydroxyalkanoate (PHA)), and mixtures and/or modified derivates thereof.

The bio based materials can be renewed (recycled) after use, but they can also be composted. As mentioned above, composting relates to the microbiological breakdown of the materials from which the capsule is manufactured in a relatively short period of time into at least water, carbon, and biomass (humus), and possibly methane. Preferably, materials, particularly polymers, are used which under strict conditions (with respect to temperature, moisture, time, etc.) within a maximum of 6 months are converted into water, carbon dioxide, biomass, and methane. These polymers meet the requirements of EN13432, an international standard for compostable polymers. This standard defines both the test programme and the evaluation criteria which must be met by compostable packaging, as well as the speed and extent to which a biodegradable polymer must degrade under commercial composting conditions. Whether or not a polymer product is compostable depends among other factors on the product geometry
and possible additives, such as for example talc, compostable plasticisers including glycerine, and/or compostable filling materials, including starch.

Where applicable, the capsule is partially composed of cellulose, such as regenerated cellulose, cellophane, and/or cellulose diacetate. In cases where the housing and/or the closing element is at least partially manufactured from cellulose, the type of cellulose used should be able to withstand relatively high temperatures up to the boiling point of water. For this reason, the capsule is preferably manufactured from a composition comprising at least 20 to 90 wt% of cellulose ester, wherein the percent by weight is calculated with respect to the weight of the total composition, at least 15 to 50 wt% (w/w) of a plasticiser, wherein the percent by weight is calculated with respect to the weight of cellulose ester present in the composition and at least 5 to 70 wt% of an organic filler, wherein the percent by weight is calculated with respect to the weight of the total composition.

The plasticisers are preferably selected from the group comprising glycerine, triacetin, triethylene glycol, triphenylphosphate, polyethylene glycol, propylene glycol, ethyl lactate, methyl lactate, glycerol triacetate, acetyl tributyl citrate, triethyl citrate, diethyl citrate, glycerol acetate, phthalate, sorbitol, maltitol, xylitol, erythritol, fatty acid esters, and mixtures thereof. Preferably, the filler comprises silicate such as talc.

Preferably, the capsule, i.e. the housing and/or the closing element, is at least partially manufactured from polylactic acid or a derivative thereof. The polylactic acid can optionally be mixed with a starch in order to improve the speed of decomposition of the material. Where applicable, the layer composed of polylactic acid comprises approximately 2% (w/w) to approximately 20% (w/w) of starch. In a variant embodiment, the polylactic acid also comprises a transition metal stearate such as a stearate salt of aluminium, antimony, barium, bismuth, cadmium, cerium, chromium, cobalt, copper, gallium, iron, lanthanum, lead, lithium, magnesium, mercury, molybdenum, nickel, potassium, rare earth metals, silver, sodium, strontium, tin, tungsten, vanadium, yttrium, zinc, and zirconium. Where applicable, the layer composed of polylactic acid comprises approximately 0.5% (w/w) to approximately 5% (w/w) of a metal stearate. In cases where the housing and/or the closing element is at least partially manufactured from polylactic acid (PLA), the polylactic acid should be
able to withstand relatively high temperatures of up to the boiling point of water. However, a pure polylactic acid is generally not suitable for use due to the relatively low glass transition temperature \( T_g \) of 50°C. Moreover, polylactic acids, particularly the homopolymers PDLA and PLLA, show a relatively low crystallisation rate, which is generally too slow to allow sufficient crystallisation during production of the relevant component(s).

For this reason, it is advantageous if the material used is a liquid polylactic acid composition that comprises at least 94% (w/w) of acidic components. It has been found that such a liquid polylactic acid composition does not crystallise above a temperature of 10°C. Such a liquid polylactic acid composition can therefore be used to form a polylactic acid material layer which can withstand relatively high temperatures of up to the boiling point of water. Preferably, the composition comprises a total concentration of acidic components of at least 95% (w/w), and more preferably, the concentration of acidic components is at least 96% (w/w), 97% (w/w), 98% (w/w), or 99% (w/w).

Particularly favourable properties are obtained if the liquid polylactic acid composition contains a total concentration of acidic components of 100% (w/w). It has also been found that it is advantageous if the material used has a composition comprising: a compostable resin of PLLA with a limited fraction (≤5 mol%) of PDLA, enriched with at least one nucleating agent. Preferably, the nucleating agent comprises a combination of (i) preferably between 0 and 25 wt% of an inorganic nucleating agent, preferably talc, and (ii) preferably between 0 and 30 wt% of an inorganic filler, preferably with a lamellar, preferably a clay mineral, in particular an aluminium mineral such as kaolin.

The housing and the closing element can be manufactured from essentially the same material composition. In this case, the common main component is preferably composed of PLA and/or cellulose. If applicable, the PLA may be plate-selectively enriched with one of a plurality of additives, in order for example to allow regulation of thermal resistance and/or the elastic modulus. An additional advantage of manufacturing the housing and the closing element from the same polymer is that both components can be fused to one another, with the result that no glue is required.

Preferably, the capsule comprises a substantially compostable substantially annular sealing element which is preferably attached, more preferably welded, to the protruding engagement edge and configured to substantially seal a space between the capsule and
in a capsule holder a device for preparing beverages while the capsule is clamped in the
device. The sealing element is preferably composed of a compostable material. This
compostable sealing element is preferably made of polyester, more preferably from a(n)
(amorphous) polylactic acid (PLA). This amorphous structure may, for example, be
obtained by injection-moulding the PLA at relatively low temperatures of between 20
and 40°C, preferably of between 25 and 30°C. At this low processing temperature, the
PLA does not have the opportunity to crystallize, resulting in an amorphous state.
However, if the temperature is increased (to above 55-60°C), for example during
regular use of the capsule, the amorphous state of the PLA will be crystallized in part,
resulting in a semicrystalline state. This process is also referred to as "cold
crystallization". At this elevated temperature of the crystallizing PLA, the PLA becomes
rubbery, with the molecular tension decreasing and relaxation occurring. After cooling
of the capsule, following use, the semicrystalline state of PLA in the sealing element,
which becomes hard and stiff at lower temperature, will continue, significantly
facilitating the subsequent ejection of the capsule from a capsule holder. The sealing
element is preferably also with at least one additive, in particular reinforcing (inorganic)
fibres and/or talc, in order to improve the strength of the sealing element. It is also
advantageous if the (annular) sealing element is at least partly made of an elastomer
based on compostable thermoplastic copolyester (TPC) in order to provide more
flexibility for the sealing element, which may benefit the sealing capacity of the sealing
element. Usually, the sealing element comprises between 80 and 90% by weight of
PLA. Preferably, the sealing element comprises between 10 and 20% by weight of TPC.
A suitable TPC is a polymer having the molecular formula -(A)m-(B)n-, in which m>1,
n>1, and "A" is formed by rigid polybutene terephthalate (PBT) segments, and "B" is
formed by longer chains of soft, amorphous polyether/polyester, such as for example
poly(tetramethylene ether glycol terephthalate). By adjusting the ratio of "A" segments
and "B" segments, it is possible to change the properties of the TPC. If the sealing
element comprises talc, it is also preferably 1-5% by weight. The addition of talc also
contributes to the flexibility of the sealing element.

Preferably, the sealing element is at least partly fused together with the engagement
dge. This is usually achieved by means of welding, preferably by means of ultrasonic
welding. Due to the fact that the contact surfaces of the engagement edge and the
sealing element are usually made of substantially the same material, in particular PLA, a
relatively strong connection can be produced by fusion. This makes it possible to make the capsule from components which are successively attached to one another to form the ultimate capsule, which usually benefits the manufacturing process and in particular the design and functionality of components. The weld seam (or fusion seam) preferably runs completely around the (peripheral wall of the) housing, as a result of which leaks between the engagement edge and the sealing element can be prevented. It is advantageous if an outer edge of the sealing element is connected to the engagement edge, while an inner edge of the sealing element is not connected to the engagement edge. This improves the flexibility of the (annular) sealing element. In this case, it is conceivable that the width of the outer edge of the sealing element is substantially equal to the width of the inner edge of the sealing element. A part of the sealing element, including for example (inter alia) the inner edge of the sealing element, is preferably situated at a distance from the engagement edge. As a result thereof, gaps or air chambers are formed between the engagement edge and the sealing element, which also benefits the flexibility of the sealing element. In a preferred embodiment, the annular sealing element has a width which substantially corresponds to the width of the engagement edge. The sealing element can be composed at least partially of a resilient (elastic) material. The sealing element can (also) be composed at least partially of a plastically deformable material. More details and embodiments of the sealing element, in particular the sealing ring, are disclosed in the international patent application PCT/IB2014/002648, the full content of which is incorporated in this document by reference.

The invention also relates to a laminated foil for use in a capsule according to the invention, comprising: at least one weakened layer, which weakened layer is provided with at least one weakened area, at least one carrier layer which is at least partially made of (filter) paper and/or of another, preferably porous, material which does not soften and/or melt at a temperature between 70 and 120 degrees Celsius, and preferably at least one least oxygen barrier layer, which barrier layer is essentially impermeable to oxygen, and which oxygen barrier layer is situated in between said weakened layer and said carrier layer. Further embodiments and advantages of the foil have already been described above in a comprehensive manner.
The invention also relates to a method for manufacturing a capsule for preparing beverages, particularly a capsule according to the invention, comprising the steps: A) manufacturing of a housing of the capsule, preferably from at least one compostable material, wherein the housing is essentially closed, and wherein the housing is defined at least by a peripheral wall, an bottom wall connected to the peripheral wall, and a laterally protruding engaging edge connected to the peripheral wall at a distance from the bottom wall in order to allow the capsule to be clamped into a capsule holder of a device for preparing beverages; B) manufacturing of a laminated foil, which foil comprises at least one weakened layer, which weakened layer is provided with at least one weakened area, and which weakened layer preferably faces the substance held by the housing, at least one carrier layer which is at least partially made of (filter) paper and/or of another material which does not soften and/or melt at a typical operation temperature range of between 70 and 120 degrees Celsius, and preferably at least one least oxygen barrier layer, which barrier layer is essentially impermeable to oxygen, and which oxygen barrier layer is situated in between said weakened layer and said carrier layer, C) at least partial filling of the housing with a substance to be extracted and/or dissolved, such as ground coffee, for preparing a beverage; and D) connecting of the foil to the housing in such a way that the substance is enclosed in the capsule in an essentially airtight manner. Preferably, the housing is manufactured during step A) by co-injecting various essentially compostable, liquefied materials into a mould, after which the housing is cooled to a temperature below the lowest melting temperature of the materials. More preferably, the housing is manufactured during step A) by means of co-injecting in a mould (i) at least one liquefied compostable material in order to form at least one oxygen barrier layer, and (ii) at least one liquefied compostable material in order to form the at least one material layer surrounding the oxygen barrier layer, following which the housing is cooled to a temperature below the lowest melting temperature of the materials. Here, during manufacture of the housing by means of co-injection in step A), the oxygen barrier layer is preferably completely enclosed by at least one surrounding material layer. In general, injection of various materials into the mould is carried out successively, so that an already-injected material layer can cool to become shape-retaining before one or a plurality of successive material layers are injected into the mould. Instead of co-injection, the housing can also be manufactured by means of thermoforming, generally of a laminate manufactured by co-extrusion.
Manufacturing of the foil during step B is preferably conducted in partial steps. In a first partial step, the various polymer foil layers, including at least one carrier layer and at least one oxygen barrier layer, are first connected to one another, for example by fusing and/or gluing. In a subsequent partial step, at least one carrier layer is weakened, preferably by means of laser perforation of the at least one carrier layer. In this case, the laser should preferably not damage the oxygen barrier layer. The initial perforation of the at least one carrier layer and subsequent gluing of the carrier layer to a further foil layer should cause the created openings (perforations) to fill with still-liquid glue, which would counteract formation of the desired weakened area of the carrier layer. It is therefore preferred to complete manufacturing of the laminate before making layer-selective and site-selective perforations in the laminate.

Preferably, the method according to the invention also comprises step E) comprising of providing and connecting an annular sealing element to the engaging edge. As already indicated above, the presence of a sealing element increases the sealing effect between the capsule and a capsule holder during clamping.

Manufacturing of the foil according to step B is commonly realised by mutually connecting at least one carrier layer, at least one oxygen barrier layer, and at least one layer to be weakened (step B1), after which said at least one layer to be weakened is provided with at least one weakened area (step B2). Step B2 is commonly carried out by creating perforations in the layer to be weakened, preferably by means of a laser. During step B1, preferably the oxygen barrier layer is coated onto the layer to be weakened, for example by using a physical vapour deposition (VPD) technique (sub step B1i), after which the carrier layer (at least partially made of paper) is glued onto the oxygen barrier layer (sub step B1ii). During sub step B1ii, preferably an intermediate cellulose (based) layer is also applied, which is more preferably glued in between the oxygen barrier layer and the carrier layer. This cellulose (based) layer protects the oxygen barrier layer from damage and moisture. In a most preferred embodiment, step B1 comprises the sub steps of:

B1a) B1a) applying a primer layer onto a layer to be weakened,
Bib) Bib) applying an oxygen barrier layer onto the primer layer, preferably by coating, for example by using a physical vapour deposition (VPD) technique,
Applying a first adhesive layer onto a side of the oxygen barrier layer facing away from the primer, which first adhesive layer is preferably composed of a two components adhesive,

applying a cellulose comprising layer onto a side of the first adhesive layer facing away from the oxygen barrier layer,

applying a second adhesive layer onto a side of the cellulose comprising layer facing away from the first adhesive layer, which second adhesive layer is preferably composed of a single component adhesive, and

applying a carrier layer, at least partially composed of (filter) paper onto a side of the second adhesive layer facing away from the cellulose based layer.

The first adhesive layer composed of a two (or more) component adhesive does not need air to harden, which is in particularly advantageous in case a moisture sensitive oxygen barrier layer is applied in sub step Bib). Application of the oxygen barrier layer can take place in dry conditions and even vacuum conditions preventing degradation of the moisture sensitive oxygen barrier during the production process. The second adhesive layer is preferably a single component adhesive due to its decreased viscosity compared to two components adhesives, which prevents the final layer, the carrier layer at least partially made of (filter) paper will absorb a considerable amount of adhesive, which would hinder tearing of the foil and outflow of beverage during use of the foil in a capsule.

The invention further relates to an assembly of a capsule according to the invention and a device for preparing beverages, which device comprises a capsule holder for holding the capsule. In this case, the capsule holder should generally comprise a plurality of holder parts which are moveable with respect to one another between an open position in which the capsule can be placed in the capsule holder and a closed position in which the engaging edge and the sealing element of the capsule are clamped by the holder parts in an essentially fluid-impermeable manner.

The invention moreover relates to the use of a capsule according to the invention in a device for preparing beverages.
The invention also concerns the use of a capsule according to the invention in a device for preparing beverages.

The invention will be explained by means of the non-limiting working examples depicted in the following figures. Specifically:

- figure 1 shows a schematic depiction of a capsule according to the present invention,
- figure 2 shows a perspective view of a capsule according to the invention,
- figure 3 shows a cross section of the capsule according to figure 2,
- figure 4 shows a detailed cross section of the capsule according to figures 1 and 2,
- figure 5 shows a detailed cross section of the film used in the capsule according to figures 2-4,
- figure 6 shows a view of a perforation pattern made in the film according to figure 5,
- figure 7 shows a schematic depiction of a method for manufacturing a capsule according to the invention,
- figure 8 schematically shows the perforation of a film according to the present invention on a perforation plate of a coffee machine;
- figure 9a-9d schematically show different shapes of weakened zones according to the invention; and
- figure 10 schematically shows the connection of the film and a capsule according to the present invention.

Figure 1 shows a schematic view of a capsule 1 provided with a closing foil, also referred to as a closing film 2. The film 2 is composed of a laminate of various layers 3, 4, 5. The first layer is a locally weakened inner layer 3, for instance made of at least compostable polylactic acid (PLA) or polypropylene (PP), in which perforations 6 are applied position-selectively weaken the layer 3, which facilitates tearing of the film 2 during use of the capsule. The first layer 3 could comprise compostable PLA, which could form a racemic mixture. The racemic mixture provides an improved thermic stability due to its (semi-)amorphous structure. The racemic mixture also improves compostability of the first layer 3, as the PLA is arranged in a (semi-)amorphous
structure as opposed to a more crystalline structure in which PLA of a single enantiomer would be arranged.

The first layer 3 may further comprise a filler material, such as talc. The first layer 3 may also comprise polyethylene glycol (PEG) or polybutylene terephthalate (PBT). These materials add to the viscosity of the first layer 3, which viscosity is a desired property when the first layer 3 is to be injection moulded.

The first layer 3 preferably has a melting temperature above 130 degrees Celsius and has a preferred thickness of less than 25 micrometres.

The second layer 4 is an oxygen barrier layer 4, which can for instance be made from PVOH. The second layer 4 may be attached to the first layer 3 by means of a (non-shown) adhesive, but could also be coated onto the first layer 3. The oxygen barrier layer 4 prevents oxygen from penetrating the film 2 such that the ingredients of the capsule 1 remain fresh during storage.

The third layer 5 is a paper layer 5, for instance made from filter paper 5. The paper 5 preferably has density of less than 25 grams per square meter, in particular a density between 10 and 25 grams per square meter. The paper 5 is porous, such that when the capsule 2 is used to produce coffee, the resulting liquid can flow from the capsule 2, through the filter paper 5.

The paper 5 adds structural integrity to the film 2. The paper 5 is for instance attached to the second layer 4 by means of a (non-shown) adhesive. The first 3 and second 4 layers of the film 2 tend to soften when exposed to hot water temperatures typically used for brewing coffee. The first 3 and second 4 layers therefore tend to fold around a perforating plate of a (non-shown) coffee machine, rather than be perforated by the plate. The paper 5 prevents the first 3 and second 4 layers from doing so, as the paper layer 5 is not temperature sensitive, and maintains its structural and porous characteristics when subjected to the hot water temperatures. The paper layer 5 is bio based, and may comprise cellulose fibres.
The weakened areas formed by perforations 6 of the first layer 3 are for instance provided by means of a laser. A laser is able to remove material very locally, and is thus able to provide weakened areas 6 very locally. The laser is used to provide the weakened areas 6 into the first layer 3 of the film 2, meaning that the laser should be adjusted such that, when a laser beam is applied to the film 2, only the first layer 3 is affected by the beam, and that the second layer 4 remains intact. The perforations 6 may form through-holes made in the first layer 3 connecting opposing sides of said first layer 3 and/or may position-selectively reduce the thickness of the first layer 3 (without forming through-holes).

Figure 2 shows a perspective view of a capsule 11 according to the invention. Figure 3 shows a cross section of the capsule 11 according to figure 2. The initially essentially closed capsule 11 comprises a housing 12, which has an essentially closed bottom wall 12a, a frustoconical peripheral wall 12b adjacent to the bottom wall 12a, and a laterally protruding engaging edge 12c (or flange) adjacent to the frustoconical peripheral wall 12b. This housing 12 is filled with coffee (not shown) and forms the basis of the capsule 11. The housing 12 is manufactured by co-injection technology, with the result that the housing 12 is composed of an (integrated) laminate of two material layers composed of PLA between which a material layer manufactured from PVOH is configured. This composition is fully compostable. Preferably, the PLA layers are in the amorphous state. The PLA layers fully enclose the PVOH layer. The PLA layers function specifically as a moisture barrier, while the PVOH layer functions as an oxygen barrier. An (under)sand of the engaging edge 12c facing away from the end side 12a is connected to an essentially compostable film 13 in order to enclose the coffee in the housing 12 in an essentially medium-tight manner. An upper side of the engaging edge 12a is connected to a surface-mounted sealing ring 14 (see figure 4). The sealing ring 14 determines the maximum diameter of the capsule 11, as the latter protrudes with respect to the peripheral edge of the engaging edge 12c. The sealing ring 14 is composed of one or a plurality of additives, such as talc, including amorphous PLA, and is therefore essentially fully compostable. As shown in figure 4, the sealing ring 14 is fused by means of two concentric weld seams 15a, 15b to the engaging edge 12c. An innermost peripheral edge 14a of the sealing ring 14 is not connected to the housing 12 and extends out in an upward direction. An outermost peripheral edge 14b of the sealing ring 14 is also free and not connected to the engaging edge 12c. These free ends 14a,
14b facilitate positioning of the sealing ring 14 during clamping of the capsule 11 into a capsule holder, which is beneficial to the sealing capacity of the sealing ring 14.

Between the free ends 14a, 14b, the sealing ring 14 is provided with a raised circular water-repellent edge 14c which further improves the sealing effect.

The film 13 closes off the housing 12 in an essentially airtight manner and is composed of an essentially fully compostable multi-layer composite, and is composed successively, as shown in figure 5, of a locally weakened inner layer 13a composed of PLA eventually provided with a primer layer, an oxygen barrier layer 13b composed of PVOH, a (two-component) first glue layer 13c, a cellulose layer 13d, a (single-component) second glue layer 13e, and an outer layer 13f of (filter) paper. The innermost layer, the locally weakened layer 13a, is processed by means of an infrared laser, causing a pattern to be made (only) in this layer 13a, with the result that the film 13 will tear more easily during use. The perforations 17 schematically shown preferably are arranged in 11 rows, as also shown in figure 6, wherein it is more particularly shown that each perforation has a cross-like design defined by intersecting line segments 17', 17". The outermost film layers, particularly the oxygen barrier layer 13b, the cellulose layer 13d, and the paper layer 13f are not configured in a weakened manner and remain fully intact during the laser processing.

The use of the capsule for preparing coffee can be described as follows. The capsule 1 is clamped into an opened capsule holder (not shown), after which the capsule holder is closed. During the closing of the capsule holder, the engaging edge 12c and the sealing ring 14 attached thereto are clamped in. During this clamping, the end side 12a is to be perforated by perforating elements of the capsule holder, and the sealing ring 14 manufactured from amorphous PLA is to partially form around a clamping edge of the capsule holder, thus creating a seal. After this, hot water having a temperature of about 95 °C is fed into the capsule holder, and via the end side 12a, into the capsule 11. This increase in pressure causes the film 13 to be deformed and, as a result of the weakened areas (perforations) made in the layer facing toward the coffee 13a of the film 13, to undergo controlled tearing on interaction with a perforation plate which is part of the capsule holder. By means of this perforation plate, the coffee can be caused to flow out of the capsule 11 and into the cup. During this extraction process, the sealing ring 14 will partially crystallise as a result of "cold crystallisation" into semi-crystalline form.
Above the glass transition temperature (Tg) of PLA of about 55-60 °C, moreover, the ring 14 will become somewhat rubbery, which improves the sealing effect. After the extraction process, the temperature of the sealing ring 14 will drop fairly quickly to below the aforementioned glass transition temperature, with the result that a relatively stiff, semi-crystalline sealing ring 14 is obtained. Because of the increased stiffness compared to its initial amorphous state, the sealing ring 14, and thus the capsule 11, can fairly easily be removed from the capsule holder.

Figure 7 shows a schematic depiction of a method for manufacturing a capsule 20 according to the invention. In manufacturing the capsule 20, a laminated plastic film 21 is produced. The film 21 comprises a plurality of plastic-containing layers 21a-21f, which are described separately in the following.

An inner layer 21a, as shown in figure 7, is composed of a compostable material such as PLA (polylactic acid) or compostable polypropylene (PP). The inner layer 21a could comprise compostable PLA, which can be made from a racemic mixture of left- and right-handed enantiomers of PLA. The racemic mixture provides an improved thermic stability. The racemic mixture also improves compostability of the first layer 21a, as the PLA is arranged in a semi amorphous structure as opposed to a more crystalline structure in which PLA of a single enantiomer would be arranged.

A subsequent layer 21b relates to an oxygen barrier layer. This layer is relatively thin and is preferably applied to the first layer 21a during the manufacturing process of the film 21, preferably by means of vapour deposition. Because of the low thickness, preferably between 1 and 5 microns, and more preferably about 2 microns, of the oxygen barrier layer 21b, one can also speak of a coating. The oxygen barrier layer 21b is preferably at least partially composed of a compostable material selected from the group composed of polyvinyl alcohol (PVOH), polyvinylpyrrolidone (PVP), and polyvinyl acetate (PVAc). PVOH is generally the most preferred of these substances, as PVOH can fairly easily be applied as a dense oxygen-impermeable film and has favourable adhesive properties. The oxygen barrier layer is preferably composed of a hybrid coating of an organic phase, for example formed by application of at least one of the aforementioned components, and an inorganic fraction which functions as a precursor. More preferably, the inorganic fraction is composed of silicon alkoxide
(Si(OR)4), wherein R denotes an organic tail derived from one of the aforementioned organic molecules. Such hybrid coatings generally show particularly favourable compostability, and also show satisfactory oxygen impermeability. As a less environmentally-friendly alternative, the oxygen barrier layer can be composed for example of polyvinylidene chloride (PVdC), ethene vinyl alcohol (EVOH), or a metal oxide such as Si02 or A1203.

A third layer 21c is composed of glue layer, and is preferably composed of a compostable glue layer. This glue layer is preferably formed by a two components (2k) adhesive. An important component of this glue layer (adhesive layer) may be soybean flour, which is used for example in combination with phenol resin, or is mixed with casein- or sodium silicate-based adhesives.

The fourth layer 21d relates to a cellulose and/or PLA layer. The fourth layer 21e shields the oxygen barrier layer 21b, making it possible to prevent damage to the oxygen barrier layer 21b. Moreover, this shielding leads to better preservation of the oxygen barrier layer 21b, as various oxygen barrier layers 21b are moisture-sensitive and disintegrate in a moist environment. By applying a moisture barrier layer, such as for example cellulose or PLA, it becomes possible to keep the oxygen barrier layer 21d intact for a longer period of time, with the result that the substance can be preserved longer in the capsule.

The fifth layer 21e is compost of a glue layer. A compostable adhesive is preferably used in this case. This glue layer is preferably formed by a single component (lk) component. A suitable compostable adhesive is for example a pressure-sensitive adhesive (“PSA”) that contains poly(D,L-lactide-co-glycolide-co-c-caprolactone). Alternatively, one may use a terpolymer blend comprising poly(D,L-lactide-co-glycolide-co-c-caprolactone) together with another poly(D,L-lactide-co-glycolide-co-c-caprolactone) or together with a poly(D,L-lactide-co-glycolide-co-mPEG). Of course, conceivable alternative adhesives may also be used.

The outer layer 21f is a paper layer 21f, for instance made from filter paper. The paper preferably has density of less than 25 grams per square meter, in particular a density between 10 and 25 grams per square meter. The paper is porous, such that when the
capsule is used to produce coffee, the resulting liquid can flow from the capsule, through the filter paper.

The paper adds structural integrity to the film. The other layer tend to soften when exposed to hot water temperatures typically used for brewing coffee, and tend to fold around a perforating plate of a (non-shown) coffee machine, rather than be perforated by the plate. The paper prevents the other layers from doing so, as the paper layer is not temperature sensitive, and maintains its structural and porous characteristics when subjected to the hot water temperatures. The paper layer is bio based, and may comprise cellulose fibres.

After manufacturing the laminated film 21, the film 21 is processed using an infrared laser 22 in such a way that the inner layer 21a is perforated and thus purposively damaged and weakened. The underlying layers 21b-21f are not exposed to the laser and thus remain intact, with the result that the film 21 is initially virtually impermeable to oxygen /gas. The laser 22 makes the perforations in the top layer 21a in patterns 23, wherein each pattern 23 is composed of a plurality of line segments. In this case, the dimensioning of each perforation is particularly small, and they have a typical micron-order length and width. After the perforations have been made in the film 21, the film 21 is cut using a cutting element 25 such as for example another laser, a punch, or a knife in such a way that circular (disk-shaped) film parts are formed which are to function as a closing element 25 for a capsule.

After manufacturing of the closing element formed by the processed film 21, the closing element is to be applied to a housing 27 filled with ground coffee 26 (and/or some other beverage component). In this case, the housing 27 is cup-shaped and configured in an essentially shape-retaining manner. The housing 27 comprises a closed inlet side 28 (end side), a tapered side wall 29, and a laterally protruding flange 30 which functions as an engaging edge. A sealing ring 31 is applied to the side of the flange 30 facing toward the side wall 29. The ring 31 is preferably inseparably connected to the flange 30. A more detailed description of the housing 27 and the ring 30 applied thereto is described in international patent application number PCT/IB2014/002648 of the applicant, not pre-published, the contents of which are incorporated herein by reference as constituting part of the contents of the present patent. The film 21 is glued and/or
welded to the flange 30, with the result that the coffee is packed into the capsule in an airtight manner. The film 21 is oriented in such a way that the perforated top layer faces toward the coffee 26. The film 21 functions as the outlet side of the capsule 27.

Figure 8 schematically shows a film 42 according to the invention, which could have the same composition as and/or could be identical to the film 21 shown in the previous figures, which is perforated on a perforation plate 48 of a coffee machine. The film 42 comprises a paper layer 45 and a locally weakened inner layer 43. The film 42 is typically also provided with an (non-shown) oxygen barrier layer, coated onto the inner layer 43. This layer behaves similarly to the inner layer 43. Optionally a cellulose layer (not shown) is applied in between the oxygen barrier layer and the paper layer 45.

The locally weakened inner layer 43 is provided with weakened areas 47, which are arranged to tear when subjected to pressure. When torn, the weakened areas 47 allow fluid to pass from the interior of the capsule (A), to the perforation plate 18 and through holes 49 of the plate 48 towards a (non-shown) beverage dispensing location. The paper layer 45 prevents the inner layer 43 from folding over the holes 49 which would make the exit of coffee impossible, as the paper layer 45 provides structural integrity and firmness leaving an open space between the film 42 and the perforation plate 48 for liquid to pass.

Figures 9a, 9b, 9c and 9d show schematically weakened areas formed by (laser) perforations 57 of a first layer 53. The weakened areas 57 are formed by at least two interconnected line segments 57', 57", which mutually enclose an acute angle (a) between 0 and 90 degrees. The number of weakened areas 57 is typically about twice the number of perforating elements on a perforating plate of a coffee machine. In diameter, the number of weakened areas 57 is typically between 8 and 16. The acute angles between the line segments 57', 57", and thus the acute transition between a first 57' and a second 57" line segment provide a location where the first layer 53 will typically tear first when subjected to pressure.

Figure 9a schematically shows weakened areas 57 in the form of intersecting lines 57 or crosses 57. The crosses 57 comprise four connected line segments 57', 57", wherein two of those segments 57', 57" mutually enclose an acute angle (a) of about 90
degrees. Figure 3a shows about 14 weakened areas 57 in diameter direction, wherein the weakened areas 57 are distributed substantially equal over the first layer 53.

Figure 9b schematically shows weakened areas 57 in different shapes compared to figure 9a. The weakened areas 57 are V- and X-shaped. The X-shape basically comprises two mirrored V-shapes.

Figure 9c schematically shows weakened areas 57 in different shapes compared to figure 9a and 9b. The weakened areas 57 are Y-, Z- and asterisk-shaped.

Figure 9d schematically shows weakened areas 57 in different shapes compared to figure 9a, 9b and 9c. The weakened areas 57 are L-, step- and lighting-shaped.

Figure 10 schematically shows the attachment of a film 62 to a capsule 61. The film 62 is attached to the flange-like rim 68 of the capsule 61. The first layer 63 of the film 62 is welded onto the rim 68. The second layer 64 is applied to the first layer 63 by vapour deposition and the third layer 65 is glued to the second layer 64. The film 62, comprising the three different layers, is typically laminated first, and then welded to the rim 68. The welding typically involves pressing a hot welding element onto the film 62 and capsule 61, and leaves an annular imprint 69, wherein the film 62 is pressed or printed into the rim 68. The imprint 69 typically forms a labyrinth 69 which improves the water resistive properties of the film 62, and in particular of one or more moisture-sensitive layers of said film 62.

To allow the first layer 63 and the flange-like rim 68 to be welded together, they preferably comprise the same material. The first layer 63 and the flange-like rim 68 for instance both comprise PLA of PP. The same materials allow for a clean and solid weld, and thus for a solid connection of the film 62 and the capsule 61.

It will be apparent that the invention is not limited to the working examples shown and described herein, but that numerous variants are possible within the scope of the attached claims that will be obvious to a person skilled in the art.
The above-described inventive concepts are illustrated by several illustrative embodiments. It is conceivable that individual inventive concepts may be applied without, in so doing, also applying other details of the described example. It is not necessary to elaborate on examples of all conceivable combinations of the above-described inventive concepts, as a person skilled in the art will understand numerous inventive concepts can be (re)combined in order to arrive at a specific application.

The expressions "comprising" or "comprise", as used herein, do not only include the meaning of "comprising" or "comprise" but also encompass "consisting essentially of" or "consist essentially of" and "consisting of" or "consist of".
Claims

1. Capsule for preparing beverages, comprising:
   - an essentially closed housing which is at least partially filled with a
     substance to be extracted and/or dissolved, such as ground coffee, for
     preparing a beverage, wherein the housing is defined at least by a peripheral
     wall, a bottom wall connected to the peripheral wall, and a laterally
     protruding engaging edge connected to the peripheral wall at a distance from
     the bottom wall in order to allow the capsule to be clamped into a capsule
     holder of a device for preparing beverages; and
   - at least one essentially closed closing element configured to allow beverage
     to flow from the capsule, which closing element is connected to the laterally
     protruding engaging edge for sealing the substance into the capsule, wherein
     at least a part of the closing element is composed of a laminated foil, said
     foil comprising:
     - at least one weakened layer, which weakened layer is provided with at
       least one weakened area, and which weakened layer preferably faces the
       substance held by the housing,
     - at least one carrier layer which is at least partially composed of paper
       and/or of another material which does not soften and/or melt at a
       temperature between 70 and 120 degrees Celsius, and
     - preferably at least one least oxygen barrier layer, which barrier layer is
       essentially impermeable to oxygen, and which oxygen barrier layer is
       situated in between said weakened layer and said carrier layer.

2. Capsule according to claim 1, wherein the oxygen barrier layer is closed.

3. Capsule according to claim 2, wherein the oxygen barrier layer is not weakened.

4. Capsule according to one of the previous claims, wherein the foil layers are
   coupled to form a composite material.
5. Capsule according to one of the previous claims, wherein at least one carrier layer which is at least partially made of paper forms an outer layer of the foil facing away from the protruding engaging edge.

6. Capsule according to one of the previous claims, wherein the weakened area of at least one weakened layer is provided with perforations.

7. Capsule according to claim 6, wherein the perforations are arranged in a pattern in the at least one weakened layer.

8. Capsule according to claim 6 or 7, wherein at least one perforation is formed by a plurality of interconnected line segments, wherein adjacent line segments mutually enclose an angle.

9. Capsule according to claim 8, wherein at least two line segments are intersecting.

10. Capsule according to claim 8 or 9, wherein at least two adjacent line segments mutually enclose an acute angle.

11. Capsule according to one of claims 8-10, wherein each of the perforations is formed by a plurality of interconnected line segments, wherein adjacent line segments mutually enclose an angle.

12. Capsule according to one of the claims 6-11, wherein at least a number of the perforations form through-holes connecting opposing sides of the weakened layer.

13. Capsule according to claim 12, wherein the perforated weakened layer is facing the substance held by the housing, and wherein the oxygen barrier layer is coated onto the weakened layer.

14. Capsule according to claim 13, wherein a primer layer is situated between the weakened layer and the oxygen barrier layer.
15. Capsule according to one of claims 6-14, wherein maximum dimension of each perforation is between 1 and 10 millimetre.

16. Capsule according to one of the thickness of the weakened layer is between 10 and 50 micron, preferably between 10 and 30 micron.

17. Capsule according to one of the previous claims, wherein the weakened area extends throughout the essentially complete weakened layer.

18. Capsule according to one of the previous claims, wherein the oxygen barrier layer is at least partially composed of a material selected from the group composed of: polyvinyl alcohol (PVOH), polyvinylpyrrolidone (PVP), polyvinyl acetate (PVAc), compostable ethylene vinyl alcohol (EVOH), a highly amorphous vinyl alcohol polymer (HAVOH), nanofibrillated cellulose, (hemi)cellulose derivatives and copolymers, and polyglycolic acid (PGA).

19. Capsule according to one of the previous claims, wherein the oxygen barrier layer is at least partially composed of an organic fraction (R), and an inorganic fraction, wherein the inorganic fraction preferably is composed of silicon alkoxide (Si(OR)₄).

20. Capsule according to one of the previous claims, wherein the oxygen barrier layer is essentially impermeable to water vapour.

21. Capsule according to one of the previous claims, wherein the foil comprises at least one shielding facing a side of the oxygen barrier layer facing away from the housing of the capsule.

22. Capsule according to claim 21, wherein the shielding layer forms a moisture barrier layer.

23. Capsule according to claim 21 or 22, wherein the shielding layer is at least partially composed of cellulose and/or a polyhydroxyalkanoate (PHA).
24. Capsule according to one of claims 21-23, wherein the shielding layer is situated in between the oxygen barrier layer and the carrier layer.

25. Capsule according to claim 24, wherein the shielding layer is glued to both the oxygen barrier layer and the carrier layer.

26. Capsule according to one of claims 21-25, wherein the thickness of the shielding layer is between 10 and 50 micron, preferably between 10 and 30 micron.

27. Capsule according to one of the previous claims, wherein at least two adjacent foil layers are glued together.

28. Capsule according to one of the previous claims, wherein the paper used to compose the carrier layer has a paper density of between 10 and 30 g/m².

29. Capsule according to one of the previous claims, wherein the paper used to compose the carrier layer has a thickness of between 30 and 100 micron, preferably between 50 and 100 micron.

30. Capsule according to one of the previous claims, wherein the filter paper used to compose the carrier layer is filter paper, preferably with a porosity exceeding 600 l/m².s, preferably exceeding 800 l/m².s.

31. Capsule according to one of the previous claims, wherein the paper used to compose the carrier layer comprises a mixture of natural fibers and synthetic fibers, wherein the synthetic fibers are preferably composed of a compostable material, such as polylactic acid (PLA).

32. Capsule according to one of the previous claims, wherein the paper used to compose the carrier layer comprises at least one crosslinking or functionalization agent, preferably selected from the group consisting of: polysaccharides, carboxylic acids, halogenated hetero-aromatic compounds and salts thereof.
33. Capsule according to one of the previous claims, wherein the capsule is at least partially composed of at least one bio-based material.

34. Capsule according to one of the previous claims, wherein the foil is essentially fully compostable.

35. Capsule according to one of the previous claims, wherein the housing is essentially fully compostable.

36. Capsule according to one of the previous claims, wherein the housing comprises at least one oxygen barrier layer, which oxygen barrier layer is substantially impermeable to oxygen, and in which the housing comprises at least one material layer surrounding the barrier layer, in which the at least one surrounding material at least partially, and preferably completely, protects the barrier layer from the atmosphere surrounding the capsule.

37. Capsule according to one of the previous claims, wherein a layer of the foil which is connected to the protruding edge and a part of the protruding edge to which said layer of the foil is connected are composed of essentially the same materials.

38. Capsule according to one of the previous claims, wherein the foil and the protruding edge are welded to each other.

39. Capsule according to claim 38, wherein the foil and the protruding edge are welded to each other, such that an annular welding seam is formed.

40. Capsule according to claim 39, wherein the welding seam deforms at least a circumferential edge of the oxygen barrier layer.

41. Capsule according to the one of the previous claims, wherein the bottom wall is pierceable by the capsule holder in order to inject water into the capsule.
42. Capsule according to one of the previous claims, wherein the foil is configured so as to tear as a result of pressure build-up in the capsule when water is injected into the capsule.

43. Capsule according to one of the previous claims, wherein the closing element is glued to the housing, preferably by application of an essentially fully compostable glue.

44. Capsule according to Claim 43, wherein the glue contains 1 to 70 wt% of a compostable polymer selected from the group composed of: an aliphatic or partially aromatic polyester and a thermoplastic aliphatic polyester urethane.

45. Capsule according to one of the previous claims, wherein the housing is at least partially composed of polylactic acid (PLA) and/or cellulose.

46. Capsule according to one of the previous claims, wherein the engaging edge is connected to an end of the peripheral wall facing away from the bottom wall.

47. Capsule according to one of the previous claims, wherein the bottom wall, the peripheral wall, and the protruding edge are integrally connected to each other.

48. Capsule according to one of the previous claims, wherein the peripheral wall has an essentially frustoconical design.

49. Capsule according to one of the previous claims, wherein the housing is essentially rigid.

50. Capsule according to one of the previous claims, wherein the closing element is completely formed by the laminated foil.

51. Capsule according to one of the previous claims, wherein the foil is essentially flexible.

52. Capsule according to one of the previous claims, in which the capsule comprises a substantially compostable substantially annular sealing element which is preferably
attached to the protruding engagement edge and configured to substantially seal a space between the capsule and in a capsule holder a device for preparing beverages while the capsule is clamped in the device.

53. Capsule according to Claim 52, in which the sealing element is at least partly made from at least one compostable polyester, in particular a polylactic acid (PLA).

54. Capsule according to Claim 53, in which the sealing element is at least partly made from an amorphous polylactic acid (PLA).

55. Laminated foil for use in a capsule according to one of the previous claims, comprising:
   - at least one weakened layer, which weakened layer is provided with at least one weakened area,
   - at least one carrier layer which is at least partially made of paper, in particular filter paper and/or of another material which does not soften and/or melt at a temperature between 70 and 120 degrees Celsius, and
   - preferably at least one least oxygen barrier layer, which barrier layer is essentially impermeable to oxygen, and which oxygen barrier layer is situated in between said weakened layer and said carrier layer.

56. Method for manufacturing a capsule for preparing beverages, particularly a capsule according to one of claims 1-54, comprising the steps:
   A) manufacturing of a housing of the capsule, preferably from at least one compostable material, wherein the housing is essentially closed, and wherein the housing is defined at least by a peripheral wall, an bottom wall connected to the peripheral wall, and a laterally protruding engaging edge connected to the peripheral wall at a distance from the bottom wall in order to allow the capsule to be clamped into a capsule holder of a device for preparing beverages;
   B) manufacturing of a laminated foil, which foil comprises at least one weakened layer, which weakened layer is provided with at least one weakened area, and which weakened layer preferably faces the substance held by the housing, at least one carrier layer which is at least partially made of paper, in particular filter paper, and/or of another material which does not soften and/or melt at a
temperature between 70 and 120 degrees Celsius, and preferably at least one least oxygen barrier layer, which barrier layer is essentially impermeable to oxygen, and which oxygen barrier layer is situated in between said weakened layer and said carrier layer,

C) at least partial filling of the housing with a substance to be extracted and/or dissolved, such as ground coffee, for preparing a beverage; and

D) connecting of the foil to the housing in such a way that the substance is enclosed in the capsule in an essentially airtight manner.

57. Method according to Claim 56, wherein the housing is manufactured during step A) by co-injecting various essentially compostable, liquefied materials into a mould, after which the housing is cooled to a temperature below the lowest melting temperature of the materials.

58. Method according to claim 57, wherein the housing is manufactured during step A) by means of co-injecting in a mould (i) at least one liquefied compostable material in order to form at least one oxygen barrier layer, and (ii) at least one liquefied compostable material in order to form the at least one material layer surrounding the oxygen barrier layer, following which the housing is cooled to a temperature below the lowest melting temperature of the materials.

59. Method according to claim 58, wherein during manufacture of the housing by means of co-injection in step A), the oxygen barrier layer is completely enclosed by at least one surrounding material layer.

60. Method according to one of claims 56-59, wherein manufacture of the foil according to step B) is realised by the sub steps:

B1) mutually connecting at least one carrier layer, at least one oxygen barrier layer, and at least one layer to be weakened, and

B2) providing said at least one layer to be weakened with at least one weakened area.

61. Method according to claim 60, wherein sub step B1) comprises the following sub steps:
Bla) applying a primer layer onto a layer to be weakened,
Bib) applying an oxygen barrier layer onto the primer layer,
Blc) applying a first adhesive layer onto a side of the oxygen barrier layer facing away from the primer, which first adhesive layer is preferably composed of a two components adhesive,
Bid) applying a cellulose comprising layer onto a side of the first adhesive layer facing away from the oxygen barrier layer,
Ble) applying a second adhesive layer onto a side of the cellulose comprising layer facing away from the first adhesive layer, which second adhesive layer is preferably composed of a single component adhesive, and
Blf) applying a carrier layer, at least partially composed of (filter) paper onto a side of the second adhesive layer facing away from the cellulose based layer.

62. Assembly of a capsule according to one of claims 1-54 and a device for preparing beverages, which device comprises a capsule holder for holding the capsule.

63. Assembly according to claim 62, wherein the capsule holder comprises a plurality of holder parts which are moveable with respect to one another between an open position in which the capsule can be placed in the capsule holder and a closed position in which the engaging edge and the sealing element of the capsule are clamped in by the holder parts in an essentially fluid-impermeable manner.

64. Assembly according to claim 63, wherein the bottom wall of the housing, when closed, is perforated by the capsule holder.

65. Assembly according to claim 64, wherein, when the capsule holder is closed, the foil is perforated by the capsule holder as a result of pressure build-up in the capsule during injection of water into the housing via the bottom wall of the housing.

66. Use of a capsule according to one of Claims 1-54 in a device for preparing beverages.
Fig. 10
## A. CLASSIFICATION OF SUBJECT MATTER

INV. B65D85/804

**ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC.

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols): B65D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched.

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used): EPO-Internal

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>wo 03/002423 AI (NESTLE SA [CH] ; YOAKIM ALFRED [CH] ; MASEK PETR [CH] ) 9 January 2003 (2003-01-09) the whole document</td>
<td>1-66</td>
</tr>
<tr>
<td>X</td>
<td>wo 2013/178870 AI (AHLSTROEM 0Y [FI] ) 5 December 2013 (2013-12-05) the whole document</td>
<td>1-66</td>
</tr>
</tbody>
</table>

 Further documents are listed in the continuation of Box C. 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
  * "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
  * "Z" document member of the same patent family

Date of the actual completion of the international search: 21 June 2016

Date of mailing of the international search report: 30/06/2016

Name and mailing address of the ISA:

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV RIJSWIJK
Tel. (+31-70) 340-2040
Fax: (+31-70) 340-3016

Authorized officer: Brochado Garganta, M
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>WO 2013/157924 AI (BISERKON HOLDINGS LTD [CY]; ZWEED SANDER GORDON [NL]; ANDREAE JAN [NL]) 24 October 2013 (2013-10-24) the whole document</td>
<td>1-66</td>
</tr>
<tr>
<td>Patent document cited in search report</td>
<td>Publication date</td>
<td>Patent family member(s)</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>-----------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>WO 03002423 AI</td>
<td>09-01-2003</td>
<td>AR 034662 Al</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AT 310683 T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BR 0210662 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CA 2450701 Al</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CN 1520372 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 60115221 DI</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DE 60115221 T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>DK 1273528 T3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EP 1273528 Al</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ES 2252113 T3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 3896114 B2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>JP 2004533305 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MX PA03011894 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NZ 530769 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RU 2291092 C2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TW 590966 B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>US 2004115310 Al</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WO 03002423 Al</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ZA 200400653 A</td>
</tr>
</tbody>
</table>

| WO 2013178870 AI                      | 05-12-2013      | EP 2841263 AI           | 04-03-2015      |
|                                       |                 | FR 2991230 Al           | 06-12-2013      |
|                                       |                 | US 2015151508 Al        | 04-06-2015      |
|                                       |                 | WO 2013178870 Al        | 05-12-2013      |

| WO 2015082982 AI                      | 11-06-2015      | CA 2932176 Al           | 11-06-2015      |
|                                       |                 | EP 3030503 Al           | 15-06-2016      |
|                                       |                 | WO 2015082982 Al        | 11-06-2015      |

| WO 2015177591 A2                      | 26-11-2015      | NONE                    |                 |

|                                       |                 | AU 1505192 A            | 12-11-1992      |
|                                       |                 | CA 2067515 Al           | 11-11-1992      |
|                                       |                 | DE 69217113 DI          | 13-03-1997      |
|                                       |                 | DE 69217113 T2          | 15-05-1997      |
|                                       |                 | DK 0512468 T3           | 07-07-1997      |
|                                       |                 | EP 0512468 Al           | 11-11-1992      |
|                                       |                 | ES 2097831 T3           | 16-04-1997      |
|                                       |                 | FI 922065 A             | 11-11-1992      |
|                                       |                 | GR 3022936 T3           | 30-06-1997      |
|                                       |                 | JP H05132056 A          | 28-05-1993      |
|                                       |                 | NO 921812 A             | 11-11-1992      |
|                                       |                 | NZ 242567 A             | 22-12-1994      |

| WO 2013157924 AI                      | 24-10-2013      | NONE                    |                 |