Tray for Greening of Surfaces and Process for Manufacturing a Tray for Greening of Surfaces

Description:

The application pertains to trays for greening of surfaces and to processes for manufacturing trays for greening of surfaces, in particular for greening of roofs of building structures.

There is a trend for greening of surfaces, for example greening of roofs of building structures, in particular for flat roof. Greening of surfaces such as roofs may contribute to fight global warning by conversion of carbon dioxide into plants, and may help to locally reduce the temperature, for example in cities having a high density of concrete buildings and little green spaces such as for example parks.

Some conventional systems for creating green roofs are constructed from a plurality of layers applied one after the other to a roof, for example a waterproofing layer to protect the roof structure against rain, a root barrier to prevent roots of plants to damage the waterproofing layer, a horizontal water drainage layer to drain off excess water, a substrate layer and in some cases a water retention layer to enable plants to grow, and plants.

As plants, sedum plants are commonly used, which can be cultivated on an appropriate substrate layer already applied onto the roof. However, cultivation on the roof involves manual labor and associated high costs as cultivation on the roof cannot be automated, since every roof is constructed differently.

The plants can also be pre-cultivated on mats in a greenery and then transported to and positioned on the prepared roof. After pre-cultivating of sedum mats, the mats can be rolled up, transported to the roof and rolled out onto the roof. Relatively long dry periods are harmful to the young plants in this phase. The plants may be damaged when the mats are being rolled up and placed on the roof. To cultivate the plants further on the roof, precise watering has to be ensured during the cultivation step, with associated high costs.

Alternative, plants can be cultivated in a greenery in cassettes or trays having discrete dimensions of for example 50 cm by 50 cm. Once the plants have been cultivated to a pre-determined level, e.g. regarding height of the plants and/or coverage of the cassette by the plants, the cassettes can be transported to and positioned on the prepared roof. The plants cultivated in the cassettes are not susceptible to damage by rolling and unrolling of mats.

Trays can be provided from a continuous plastic sheet which is deep-drawn into the desired three-dimensional shape, or by injection molding. However, such plastic trays generally require a second processing step to provide openings at least in the bottom of the tray to allow excess water to be drained from the tray. Deep-drawn plastic trays have the disadvantage that cultivation of plants in such plastic trays still involves a high level of manual labor and associated high costs as cultivation of plants in such plastic trays cannot be automated, since such plastic trays do not have the required compression resistance to allow equipment to rolled over or driven over the trays.

US 10,076,084 B2 discloses a roof-greening cassette having walls and/or bases made of a porous material having preferably open pores, wherein the porous material is water-retentive as well as water-permeable.

An example of a green roof cassette according to US 10,076,084 B2 is branded as Place ‘n Go® available from Sempergreen®, which comprises a bottom drainage layer onto which a tray is placed having a bottom layer and side walls made from a

lightweight recycled polyurethane molded foam. The foam tray holds a soil substrate wherein plants can be cultivated.

The foam tray is assembled in an elaborate process from several separate strips or panels forming the base and the walls of the tray, which strips or panels are made of flakes of recycled polyurethane foam having a selected density and/or a selected porosity. The foam tray is then placed on and preferably connected to a horizontal drainage layer.

The use of polyurethane foam makes it difficult to process the foam trays at the end of life of for example a green roof. A tray comprising polyurethane foam can for example not be biodegraded in an industrial bio-composting unit. A tray comprising polyurethane foam also does not allow for other mechanical recycling processing involving for example mechanically grinding the tray into small parts, melting the small parts, and forming new products by an extrusion process.

There remains a need for improved trays for greening of surfaces, in particular for roofs of building structures, and for improved processes for manufacturing trays for greening of surfaces overcoming, or at least reducing, the disadvantages of the prior art.

The object of the invention is thus to provide a tray for greening of surfaces overcoming, or at least reducing, the disadvantages of the prior art.

The object is solved by the process for manufacturing a tray for greening of surfaces according to claim 1 and by the tray for greening of surfaces according to claim 7.

Advantageous further improvements of the tray for greening of surfaces and of the process for manufacturing a tray for greening of surfaces are provided by the dependent claims.

A process comprising the steps of providing a composite material comprising a three-dimensional material layer comprising fibers and having a first main surface

and a second main surface, wherein the fibers comprise a thermoplastic polymer and at least a liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers, and shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, wherein the three-dimensional material layer comprising fibers comprised in the base has an open space of at least 50%, wherein the liquid permeable separation layer comprised in the base is oriented towards the inner surface of the open-top receptacle, enables to provide a tray for greening of surfaces which does not require a process of assembling a tray from separate strips or panels forming the base and the walls of the tray. The composite material may be shaped into a tray in a single process step. The process enables to provide a tray for greening of surfaces as a unitary structure. Preferably, the fibers comprise a synthetic thermoplastic polymer,

The term unitary structure is understood to mean that the tray is not assembled from a separate base and one or more separate upstanding walls. The process for manufacturing a tray for greening of surfaces providing the tray as a unitary structure enables to exclude an adhesive in the tray, as the tray is not assembled from a separate base and one or more separate upstanding walls connected to each other by an adhesive. The process may provide a tray which preferably excludes an adhesive.

The process may provide a tray which preferably excludes polyurethane foam, which improves the possibilities for processing of the tray at the end of life.

In the process, the liquid permeable separation layer comprised in the composite material is, after the step of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, oriented towards the inner surface of the open-top receptacle of the tray, enables to retain a substrate within the open-top receptacle of the tray wherein plants can be cultivated, while allowing an excess of water to

be drained from the tray through the liquid permeable separation layer and through the three-dimensional material layer comprising fibers. An excess of water retained within the tray could damage the plants being cultivated within the tray, for example due to rotting of roots of the plants.

The composite material being provided in the process may have an open space of at least 50%. Preferably, the composite material being provided in the process may have an open space of at least 75%, or preferably of at least 85%, more preferably of at least 90%, even more preferably of at least 95%, to improve draining of excess water from the tray. The open space of the three-dimensional material layer comprising fibers, in this context, is defined as the total volume between two planes directly sandwiching the three-dimensional material layer comprising fibers over a given area, minus the volume occupied by the fibers themselves of the three-dimensional material layer, as a percentage.

The three-dimensional material layer comprising fibers may be any type of three-dimensional material layer comprising fibers, provided that it has an open space of at least 50%, and may for example be selected from a three-dimensional knitted fabric, a three-dimensional woven fabric, or a three-dimensional mat of extruded entangled filaments.

The fibers comprised in the three-dimensional material layer may be thermally bonded to each other at contact points of the fibers, to provide improved resilience and/or improved compression resistance.

The fibers comprised in the three-dimensional material layer comprise a thermoplastic polymer. In an embodiment, the fibers comprised in the three-dimensional material layer are composed for at least 50 wt.% of thermoplastic polymer, preferably for at least 75 wt.%, more preferably for at least 90 wt.%, more preferably for at least 95 wt.% of thermoplastic polymer. The fibers comprised in the three-dimensional material layer may consist of thermoplastic polymer. Preferably, the fibers comprise a synthetic thermoplastic polymer,

The fibers comprised in the three-dimensional material layer may comprise, or consists of, any suitable thermoplastic polymer or a blend of thermoplastic polymers. Preferably, the fibers comprise a synthetic thermoplastic polymer or a blend of synthetic thermoplastic polymers, The fibers may comprise a polyolefin, such as for example polyethylene (PE) or polypropylene (PP), a halogenated polyolefin, such as for example polytetrafluorethylene (PTFE) or polyvinylidene difluoride (PVDF), a polyester, such as for example polyethylene terephthalate (PET) (based either on DMT or PTA), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN) and/or polylactic acid (PLA), a polyamide, such as for example polyamide-6 (PA6), polyamide-6,6 (PA6,6) and/or polyamide-6,10 (PA6,10), polyimides (PI), polysulfides (PS) such as polyphenylenesulfide (PPS), polyethyleneimide (PEI), polyoxymethylene (POM), thermoplastic elastomers (TPE) such as thermoplastic polyurethanes (TPU), and/or any copolymer or any blend thereof.

The fibers comprised in the three-dimensional material layer may preferably comprise, or consists of, a polyolefin, more preferably a polypropylene (PP).

In another embodiment, the fibers comprised in the three-dimensional material layer may comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers, preferably any suitable synthetic thermoplastic polymer or blend of synthetic thermoplastic polymers, which is bio-compostable, in accordance with EN13432, at the end of the lifetime of the tray, preferably a polymer made by a polycondensation reaction of hydroxylcarboxylic acids or a ring opening polymerization of lactides. Preferred synthetic polymeric materials comprise polymer(s) of α-, β-, γ-, δ-, or ε-hydroxylesters. Preferably, the polymer(s) comprised in the fibers comprised in the three-dimensional material layer are selected from the group of polyhydroxyalkanoates (PHA's), such as for example polyhydroxybutyrate (PHB), polyhydroxyvalerate (PHV), poly-(3-hydroxybutyrateco-3-hydroxyvalerate) PHVB or polyhydroxyhexanoate (PHH) as for example available from Metabolix under the Mirel brand name, polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone (PCL), poly-β-butyrolactone

(PBL), polybutylene succinate (PBS), cellulose derivates and/or blends thereof. In a preferred embodiment, the synthetic polymeric material comprised in the fibers comprised in the three-dimensional material layer is a polylactic acid (PLA).

The fibers comprised in the three-dimensional material layer may advantageously be macroscopic fibers having an apparent diameter of at least 0.1 mm, preferably of at least 0.2 mm, or preferably of at least 0.3 mm, or preferably of at least 0.4 mm, or preferably of at least 0.5 mm enabling to obtain large open spaces between the fibers of the three-dimensional material layer. The fibers comprised in the three-dimensional material layer may have an apparent diameter of at most 2.5 mm, preferably of at most 2.0 mm, or preferably of at most 1.5 mm, or preferably of at most 1.2 mm, or preferably of at most 1.0 mm, or preferably of at most 0.8 mm.

In an embodiment, the three-dimensional material layer comprising fibers is preferably a three-dimensional mat of extruded entangled filaments having an open space of at least 50%, preferably of at least 75%, or preferably of at least 85%, or more preferably of at least 90%, or even more preferably of at least 95%.

The three-dimensional mat of extruded entangled filaments can be easily cut enabling to cut a tray to smaller size to precisely fit the tray at the edges of the surface to be greened. Deep-drawn plastic trays of the prior art are difficult to cut precisely due to the breaking of the deep-drawn plastic trays.

The three-dimensional mat of extruded entangled filaments may advantageously be made of extruded filaments that are irregularly looped and entangled into a highly porous, three-dimensional structure having a large open space, wherein the extruded filaments are preferably bonded where they cross. Preferably, the extruded filaments are stretched only by gravity before being irregularly looped and entangled into a highly porous, three-dimensional structure having a large open space.

The extruded filaments may be irregularly looped and entangled into a highly porous, three-dimensional structure having a large open space by extruding filaments and collecting the extruded filaments into a three-dimensional structure by allowing the filaments to bend, to entangle and to come into contact with each other, preferably in a still molten state. The extruded filaments may be allowed to bend, to entangled and to come into contact with each other by allowing the extruded filaments to come into contact with a surface.

The surface may be the surface of a cooling bath comprising a cooling liquid, in particular cooling water, to solidify the extruded filaments after being irregularly looped and entangled into a highly porous, three-dimensional structure. Allowing the extruded filaments to come into contact with a surface of a cooling bath comprising a cooling liquid enables to form a three-dimensional mat of extruded entangled filaments wherein the filaments have a random distribution within the three-dimensional mat of extruded entangled filaments, which may have an essentially isotropic property distribution.

The three-dimensional mat of extruded entangled filaments may be a three-dimensional structured mat of extruded entangled filaments, which may be provided by extruding filaments and collecting the extruded filaments into a three-dimensional structure by allowing the filaments to bend, to entangle and to come into contact with each other, preferably in a still molten state. Bending and entangling of the extruded filaments are preferably initiated by collecting the filaments onto a profiled surface, which defines the structure of the three-dimensional structured mat of extruded entangled filaments. Preferably, the surface on which the filaments are collected is profiled such that the three-dimensional structured mat of filaments is shaped into a three-dimensional form which comprises hills and valleys, hemispheres, positive and/or negative cuspates, cups and/or waffles, pyramids, U-grooves, V-grooves, cones and/or cylinders capped with a hemisphere.

The filaments comprised in the three- three-dimensional mat of extruded entangled filaments may be thermally bonded to each other at contact points of the filaments, to provide improved resilience and/or improved compression resistance.

The extruded filaments comprised in the three-dimensional mat of extruded entangled filaments may advantageously have apparent diameter of at least 0.1 mm, preferably of at least 0.2 mm, or preferably of at least 0.3 mm, or preferably of at least 0.4 mm, or preferably of at least 0.5 mm for improving the resilience of the composite material. The fibers comprised in the three-dimensional material layer may have an apparent diameter of at most 2.5 mm, preferably of at most 2.0 mm, or preferably of at most 1.5 mm, or preferably of at most 1.2 mm, or preferably of at most 1.0 mm, or preferably of at most 0.8 mm.

The three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, may have a weight of at most 1500 g/m², preferably of at most 1200 g/m², or preferably of at most 1000 g/m², or preferably of at most 800 g/m², and the three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, may have a weight of at least 100 g/m², preferably of at least 200 g/m², or preferably of at least 300 g/m², or preferably of at least 400 g/m², to provide improved resilience.

The three-dimensional material layer comprising fibers in the composite material provided in the process enables to provide a tray wherein cultivation of plants can be automated, as the three-dimensional material layer may have sufficient resilience to allow equipment to rolled over or driven over the trays, without significantly reducing the thickness of tray. The composite material comprising the three-dimensional material layer comprising fibers may have a resilience of at least 75%, preferably at least 80%, or preferably at least 85%, or preferably at least 90%, preferably at least 95%. The resilience of the composite material is determined on samples of 10 cm by 10 cm with an Instron tensile tester applying

the following procedure. The sample is compressed between two horizontal plates until a pre-load of 1N is reached defining the initial thickness of the sample, after 2 seconds the load is increased to 0.5 kPa and then the load is 20 times cyclically increased to 32 kPa and decreased to 0.5 kPa, after which the remaining thickness of the sample is determined at a load of 1N. The resilience is then determined by the remaining thickness of the sample as a percentage of the initial thickness of the sample, for an average of three samples.

The composite material comprising the three-dimensional material layer comprising fibers may have a resilience at increased load of 500 kPa of at least 50%, of at least 75%, preferably at least 80%, or preferably at least 85%, or preferably at least 90%, preferably at least 95%. The resilience at increased load of 500 kPa of the composite material is determined similar to the resilience, with the difference that the load is 20 times cyclically increased to 500 kPa instead of 32 kPa.

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprised in the base of the tray may comprise a thermoplastic polymer. Preferably, the extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprised in the base of the tray comprise a synthetic thermoplastic polymer or a blend of synthetic thermoplastic polymers. In an embodiment, The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments are composed for at least 50 wt.% of thermoplastic polymer, preferably for at least 75 wt.%, more preferably for at least 90 wt.%, more preferably for at least 95 wt.% of thermoplastic polymer. The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments may consist of thermoplastic polymer.

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprised in the base of the tray may comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers. The extruded entangled filaments may comprise a polyolefin, such as for example

polyethylene (PE) or polypropylene (PP), a halogenated polyolefin, such as for example polytetrafluorethylene (PTFE) or polyvinylidene difluoride (PVDF), a polyester, such as for example polyethylene terephthalate (PET) (based either on DMT or PTA), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN) and/or polylactic acid (PLA), a polyamide, such as for example polyamide-6 (PA6), polyamide-6,6 (PA6,6) and/or polyamide-6,10 (PA6,10), polyimides (PI), polysulfides (PS) such as polyphenylenesulfide (PPS), polyethyleneimide (PEI), polyoxymethylene (POM), thermoplastic elastomers (TPE) such as thermoplastic polyurethanes (TPU), and/or any copolymer or any blend thereof.

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments may preferably comprise, or consists of, a polyolefin, more preferably a polypropylene (PP).

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments may comprise additives, such as for example spinning auxiliaries, fillers, flame retardant materials, UV inhibitors, crystallization retarders/accelerators, plasticizers, heat stabilizers, antimicrobial additives, antistatic agents, colouring agents or any combination thereof.

In another embodiment, the extruded entangled filaments of the three-dimensional mat of extruded entangled filaments may comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers, preferably any suitable synthetic thermoplastic polymer or blend of synthetic thermoplastic polymers,which is bio-compostable, in accordance with EN13432, at the end of the lifetime of the tray, preferably a polymer made by a polycondensation reaction of hydroxylcarboxylic acids or a ring opening polymerization of lactides. Preferred synthetic polymeric materials comprise polymer(s) of α-, β-, γ-, δ-, or ε-hydroxylesters. Preferably, the polymer(s) of which the three-dimensional entangled mat of extruded filaments is made is selected from the group of polyhydroxyalkanoates (PHA's), such as for example polyhydroxybutyrate (PHB),

polyhydroxyvalerate (PHV), poly-(3-hydroxybutyrateco-3-hydroxyvalerate) PHVB or polyhydroxyhexanoate (PHH) as for example available from Metabolix under the Mirel brand name, polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone (PCL), poly-β-butyrolactone (PBL), polybutylene succinate (PBS), cellulose derivates and/or blends thereof. In a preferred embodiment, the synthetic polymeric material of which the three-dimensional entangled mat of extruded filaments is made is a polylactic acid (PLA).

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprising a suitable thermoplastic polymer or blend of thermoplastic polymers, preferably a suitable synthetic thermoplastic polymer or a blend of synthetic thermoplastic polymers, which is bio-compostable at the end of the lifetime of the tray may comprise additives, such as for example spinning auxiliaries, fillers, flame retardant materials, UV inhibitors, crystallization retarders/accelerators, plasticizers, heat stabilizers, antimicrobial additives, antistatic agents, colouring agents or any combination thereof. In a preferred embodiment, the extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprising a suitable thermoplastic polymer or blend of thermoplastic polymers, preferably a suitable synthetic thermoplastic polymer or a blend of synthetic thermoplastic polymers, which is bio-compostable at the end of the lifetime of the tray comprises a filler, in particular calcium carbonate.

The liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers may also comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers, preferably a suitable synthetic thermoplastic polymer or a blend of synthetic thermoplastic polymers, which is bio-compostable at the end of the lifetime of the tray, preferably a polymer made by a polycondensation reaction of hydroxylcarboxylic acids or a ring opening polymerization of lactides. Preferred synthetic polymeric materials comprise polymer(s) of α-, β-, γ-, δ-, or ε-hydroxylesters, allowing the tray to be bio-composted at the end of life. Preferably, the polymer(s) of which the liquid

permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers, is made is selected from the group of polyhydroxyalkanoates (PHA's), such as for example polyhydroxybutyrate (PHB), polyhydroxyvalerate (PHV), poly-(3-hydroxybutyrateco-3-hydroxyvalerate) PHVB or polyhydroxyhexanoate (PHH) as for example available from Metabolix under the Mirel brand name, polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone (PCL), poly-β-butyrolactone (PBL), polybutylene succinate (PBS), cellulose derivates and/or blends thereof. In a preferred embodiment, the synthetic polymeric material of which the liquid permeable separation layer comprised in the composite material is made is a polylactic acid (PLA).

In the process, the liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers may be any type of liquid permeable material, and may preferably be selected from a perforated film, a woven fabric or a nonwoven fabric. Preferably, the liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers is a nonwoven fabric.

The nonwoven fabric may in principle be any type of nonwoven, such as for example staple fiber nonwovens produced by well-known processes, such as carding processes, wet-laid processes or air-laid processes, or any combination thereof. The nonwoven fabric may also be a nonwoven composed of filaments produced by well-known spunbonding processes wherein filaments are extruded from a spinneret and subsequently laid down on a conveyor belt as a web of filaments and subsequently consolidated, also known as bonding, the web to form a nonwoven layer of fibers, or by a two-step process wherein filaments are spun and wound on bobbins, preferably in the form of multifilament yarns, followed by the step of unwinding the filaments or multifilament yarns and laying the filaments

down on a conveyor belt as a web of filaments and consolidating the web to form a nonwoven layer of fibers.

The nonwoven fabric may have been consolidated by any suitable known consolidation technology, including mechanical consolidation, for example by stitching, mechanical needling and/or hydrodynamic consolidation by fluid jets, in particular by hydroentanglement, by chemical consolidation, for example by applying a binder dispersion or a binder solution to the nonwoven layer of fibers, which is generally dried and optionally cured, and/or by thermal consolidation, for example by calendaring, ultrasonic bonding and/or hot air bonding.

The nonwoven fabric may comprise a higher melting polymer and a lower melting polymer, facilitating thermal bonding of the nonwoven fabric. The lower melting polymer may have a melting temperature which is at least 10°C, preferably at least 20°C, or preferably at least 50°C, lower than the melting temperature of the higher melting polymer.

The higher melting polymer may be comprised in a first type of mono-component fibers the lower melting polymer may be comprised in a second type of mono-component fibers.

The lower melting polymer comprised in the nonwoven fabric may be comprised in multicomponent fibers, preferably in bicomponent fibers. A basic distinction is being drawn between three types of bicomponent fibers: side-by-side types, core-sheath types and islands-in-the-sea types of bicomponent fibers. Preferably, the ratio of low melting polymer and high melting polymer in the bicomponent fibers, preferably sheath/core bicomponent fibers lies between 95/5 vol.% and 5/95 vol.%. More preferably the ratio of low melting polymer and high melting polymer lies between 50/50 vol.% and 95/5 vol.%.

The mono-component or multicomponent fibers comprised in the nonwoven fabric may have any cross sectional shape, including round, trilobal, multilobal or rectangular.

Preferably, the fibers in the nonwoven fabric are filaments in order to provide higher tensile strength and/or higher tear strength to the composite material.

The liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers may preferably be a nonwoven fabric composed of bicomponent sheath/core filaments comprising a core of a polyester, preferably a polyethylene terephthalate (PET), and a sheath of a copolyester (coPET).

The liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers may have a weight of at most 500 g/m², preferably of at most 400 g/m², or preferably of at most 300 g/m², or preferably of at most 200 g/m², and the liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers may have a weight of at least 25 g/m², preferably of at least 30 g/m², or preferably of at least 50 g/m², preferably of at least 100 g/m², enabling to retain a substrate within the open-top receptacle of the tray wherein plants can be cultivated, while allowing excess water to be drained from the tray.

The liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers may have a characteristic size of the openings (O-90) in accordance with NEN-EN-ISO 12956:200 of 200 µm or less, preferably 175 µm or less, or preferably 150 µm or less, or preferably 125 µm or less, or preferably 100 µm or less, or preferably 75 µm or less, or most preferably 50 µm or less, enabling to retain a substrate within the open-top receptacle of the tray wherein plants can be cultivated, while allowing an excess of water to be drained from the tray through the liquid permeable separation layer and through the three-dimensional material layer comprising fibers.

The process for manufacturing a tray for greening of surfaces may comprise the step of providing a second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers. The second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers may be provided over the full area of the second main surface of the three-dimensional material layer of fibers.

The second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers may alternatively be provided only over the area of the second main surface of the three-dimensional material layer of fibers which is shaped into the base of the tray.

The second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers may be liquid permeable, in particular water permeable, enabling an excess of water to be drained from the tray vertically through the three-dimensional material layer comprising fibers.

The second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers may be liquid impermeable, in particular water impermeable, to prevent that liquid, in particular water, being drained from the tray comes into contact with surface to be greened, which may be located below the tray, while the liquid, in particular water, can still be drained from the tray horizontally or under a slight angle of for example less than 5°, or less than 2°, to the horizontal. Additionally, the liquid impermeable, in particular water impermeable, second layer enables to reduce the risk of root penetration through the base of the tray.

The process for manufacturing a tray for greening of surfaces comprising the step of compression molding, preferably at elevated temperatures at which polymers comprised in the composite are softened, the composite material into the tray for greening of surfaces, preferably between an upper mold and a lower mold,

wherein the upper mold and lower mold are shaped such that, when the mold is closed, the composite material is shaped into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, wherein the three-dimensional material layer comprising fibers comprised in the base has an open space of at least 50%.

In the process of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, preferably by compression molding, preferably at elevated temperatures at which polymers comprised in the composite are softened, the composite material forming the base of the tray may be compressed such that the thickness of the composite material is reduced by at most 50%, preferably by at most 25%, or preferably by at most 20%, or preferably by at most 15%, or preferably by at most 10%, or most preferably by at most 5%, thereby enabling that the three-dimensional material layer comprising fibers comprised in the base has an open space of at least 50%, preferably of at least 75%, or preferably of at least 85%, more preferably of at least 90%, even more preferably of at least 95%, to ensure sufficient draining of excess water from the tray. In an embodiment, the composite material forming the base of the tray is not compressed in the process of shaping the composite material into a tray.

The thickness of the three-dimensional material layer comprising fibers in the composite material provided in the process may be varied, for example in view of the amount of excess water which is expected to be required to be drained from the tray, for example to the expected amount of rainfall in a geographical area. The thickness of the three-dimensional material layer comprising fibers in the composite material may be at most 200 mm, or preferably at most 150 mm, or preferably at most 100 mm, or preferably at most 75 mm, or preferably at most 50 mm, or preferably at most 40 mm, or preferably at most 30 mm, or most preferably at most 25 mm. The thickness of the three-dimensional material layer comprising fibers in the composite material may be at least 5 mm, or preferably at least 10 mm, or preferably at least 15 mm, or most preferably at least 20 mm.

The thickness of the three-dimensional material layer comprising fibers in the base of the tray may be at most 200 mm, or preferably at most 150 mm, or preferably at most 100 mm, or preferably at most 75 mm, or preferably at most 50 mm, or preferably at most 40 mm, or preferably at most 30 mm, or most preferably at most 25 mm. The thickness of the three-dimensional material layer comprising fibers in the base of the tray may advantageously be at least 3 mm, or preferably at least 4 mm, or preferably at least 5 mm, or preferably at least 10 mm, or preferably at least 15 mm, or most preferably at least 20 mm.

The three-dimensional material layer comprising fibers in the base of the tray preferably has a thickness of at least 15 mm, more preferably of at least 20 mm to prevent, or at least reduce, that plants, substrate and/or water retention layer come in contact with water puddling on a waterproofing layer located beneath the tray for a prolonged period of time, in particular when the tray is to be installed on an essentially flat surface, such as a roof, having an angle of inclination between 0° and 2° to the horizontal.

The three-dimensional material layer comprising fibers in the base of the tray preferably has a thickness of at least 3 mm, more preferably of at least 4 mm, or more preferably of at least 5 mm, in particular when the tray is to be installed on an slightly inclined surface, such as a roof, having an angle of inclination between 2° and 10° to the horizontal.

The three-dimensional material layer comprising fibers in the base of the tray may have a thickness less than 3 mm, in particular when the tray is to be installed on an inclined surface, such as a roof, having an angle of inclination between 10° and 45° to the horizontal. In the process of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, preferably by compression molding, preferably at elevated temperatures at which polymers comprised in the composite are softened, the composite material forming the upstanding walls of the tray may be compressed such that the thickness of the composite material is reduced by at

least 50%, preferably by at least 60%, or preferably by at least 70%, or preferably by at least 80%, or most preferably by at least 90%.

The upstanding walls of the tray may be liquid permeable, in particular water permeable, to some extent after the step of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, allowing to distribute liquid, in particular water, from the tray to another tray positioned adjacent to the tray.

However, the upstanding walls of the tray may also be liquid impermeable, in particular water impermeable, for example when the composite material forming the upstanding walls of the tray may be compressed to a high percentage.

The thickness of the three-dimensional material layer comprising fibers in the upstanding walls of the tray may be at most 20 mm or at most 10 mm. Preferably, the thickness of the three-dimensional material layer comprising fibers in the upstanding walls of the tray is at most 7.5 mm, or preferably at most 5 mm, or preferably at most 3 mm, or preferably at most 2 mm, or preferably at most 1 mm, as determined at the top edge of the upstanding wall. The thickness of the three-dimensional material layer comprising fibers in the base of the tray may be at least 0.5 mm, or preferably at least 0.75 mm, or preferably at least 1 mm, or preferably at least 1.5 mm. Reducing the thickness of the upstanding walls of the tray enables to obtain a greened surface having a more uniform appearance, and enables improved cross fertilization of plants across multiple trays placed on the surface to be greened as the plants are closer together. A cassette according to the prior art which comprises a bottom drainage layer onto which a tray is placed having a bottom layer and side walls made from a lightweight recycled polyurethane molded foam has a wall thickness of about 10 mm, which means that when two cassettes are placed next to each other on the surface to be greened, the total thickness of the two walls combined is about 20 mm, on top of which no plants are cultivated resulting in a visible line in the greened surface.

In the process of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, preferably by compression molding, preferably at elevated temperatures at which polymers comprised in the composite are softened, the composite material forming the upstanding walls of the tray may be shaped such that the upstanding walls may have a height of at least 20 mm, preferably at least 30 mm, or preferably at least 50 mm, or preferably at least 75 mm, or preferably at least 100 mm, or preferably at least 125 mm, or preferably at least 150 mm. The height of the upstanding walls comprised in the tray may be varied.

The height of the upstanding walls comprised in the tray may be in the range of 30 mm to 50 mm, which is advantageous for cultivating plants whose roots grow particularly in a horizontal direction, such as for example sedum plants. The amount of substrate within the open-top receptacle of the tray wherein plants can be cultivated can then be kept to a minimum enabling to provide a particularly light weight tray comprising cultivated plants.

The height of the upstanding walls comprised in the tray may be in the range of 50 mm to 150 mm, which is advantageous for cultivating plants whose roots grow particularly in a vertical direction, such as for example herbs or wildflowers. The height of the upstanding walls comprised in the tray in the range of 50 mm to 150 mm is also advantageous when the tray comprises a water retention layer in the open-top receptacle of the tray, for example on the inner surface of the open-top receptacle.

The process may comprise the step of providing a water retention layer in the open-top receptacle of the tray, wherein the water retention layer may have a thickness of 5 mm to 100 mm, preferably of 7.5 mm to 75 mm, or preferably of 10 mm to 40 mm, and wherein the water retention layer may be a layer of glass wool, a layer of mineral wool, a layer of shoddy recycled textile material, or a nonwoven fabric. The water retention layer reduces the required amount of substrate within the open-top receptacle of the tray enabling to provide a particularly light weight

tray comprising cultivated plants, while providing retention of water to facilitate plant growth over a prolonged period of time.

In the process of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, preferably by compression molding, preferably at elevated temperatures at which polymers comprised in the composite are softened, the composite material forming the upstanding walls of the tray may be compressed such that the upstanding walls the angle alfa between the base and the upstanding walls at the inner surface of the tray is larger than 90°. The angle alfa may be at least 92°, or preferably at least 94°, or preferably at least 95°, enabling to stack multiple trays into each other when the trays are not yet filled with a substrate facilitating easy transport of the empty trays.

In the process of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, preferably by compression molding, preferably at elevated temperatures at which polymers comprised in the composite are softened, the composite material forming the upstanding walls of the tray may be shaped such that the upstanding walls comprise a first part of a form fit connection configured to connect to a second part of a form fit connection in another tray which can be placed adjacent to tray on the surface to be greened, thereby ensuring that a continuous layer of trays can be formed on the surface to be greened. Preferably, the composite material forming the upstanding walls of the tray may be shaped such that a first upstanding wall of the tray comprises a first part of a form fit connection, and a second upstanding wall of the tray opposite to the first upstanding wall comprises a second part of a form fit connection, enabling to connect a series of trays, improving ease of installation and/or to improve wind-uplift resistance.

In the process of shaping the composite material into a tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an

outer surface, preferably by compression molding, preferably at elevated temperatures at which polymers comprised in the composite are softened, the composite material forming the base of the tray may be shaped such that the base has any desired shape. Preferably, in the process the composite material forming the base of the tray is shaped such that the base has a shape such that multiple trays can be placed adjacent to each other such that a continuous layer is formed. The base of the tray may for example have a triangular shape, a parallelogram shape, a hexagon shape, a rectangular shape, or a square shape. The dimensions of the base of the tray may be varied.

The base of the tray preferably has dimensions selected such that the tray can be lifted and handled manually by a person installing the tray on the surface to be greened. The largest dimension of a side of the base of the tray (large side length) may be at most 120 cm, preferably at most 100 cm, or preferably at most 80 cm, or preferably at most 60 cm. The smallest dimension of a side of the base of the tray (short side length) may be of at most 60 cm, preferably at most 50 cm, or preferably at most 40 cm.

The base of the tray may have a rectangular shape having a large side length of at most 120 cm, preferably at most 100 cm, or preferably at most 80 cm, or preferably at most 60 cm, and a short length of at most 60 cm, preferably at most 50 cm, or preferably at most 40 cm.

The base of the tray may have a square shape having a side length of at most 100 cm, preferably at most 80 cm, or preferably at most 60 cm, or preferably at most 50 cm.

However, in greening of surfaces also trays having different shape for the base of the trays may be provided, which preferably can form a continuous layer when multiple trays are placed adjacent to each other, for example trays having an octagon shape and trays having a rectangular shape wherein the side edges of the base octagon shaped base and the side edges of the base of the rectangular shaped base have the same length. Greening of surfaces with trays having a

different shape for the base of the trays allows to create a specific pattern of plants on the surface to be greened when each type of tray comprises different types of plants.

A tray for greening of surfaces is provided comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, wherein the fibers comprise a thermoplastic polymer, preferably a synthetic thermoplastic polymer, wherein the base comprises a three-dimensional material layer comprising fibers and having a first main surface and a second main surface and at least a first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base, wherein the three-dimensional material layer comprising fibers comprised in the base has an open space of at least 50%, wherein the upstanding walls comprise a material layer comprising fibers and having a first main surface and a second main surface, and at least a second separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the material layer of fibers comprised in the upstanding walls, wherein the first liquid permeable separation layer comprised in the base and the second separation layer comprised in the upstanding walls are oriented towards the inner surface of the open-top receptacle.

The tray for greening of surfaces may advantageously be a unitary structure. The tray as a unitary structure is not assembled from a separate base and one or more separate upstanding walls. The tray preferably excludes an adhesive.

The tray preferably excludes polyurethane foam, which improves the possibilities for processing of the tray at the end of life.

The three-dimensional material layer comprising fibers comprised in the base of the tray has an open space of at least 50%. The three-dimensional material layer comprising fibers comprised in the base of the tray may have an open space of at least 75%, preferably of at least 85%, more preferably of at least 90%, even more preferably of at least 95%, to improve draining of excess water from the tray.

The three-dimensional material layer comprising fibers comprised in the base of the tray may be any type of three-dimensional material layer comprising fibers, provided that it has an open space of at least 50%, and may for example be selected from a three-dimensional knitted fabric, a three-dimensional woven fabric, or a three-dimensional mat of extruded entangled filaments.

The fibers comprised in the three-dimensional material layer may be thermally bonded to each other at contact points of the fibers, to provide improved resilience and/or improved compression resistance.

The fibers comprised in the three-dimensional material layer comprise a thermoplastic polymer, preferably a synthetic thermoplastic polymer. In an embodiment, the fibers comprised in the three-dimensional material layer are composed for at least 50 wt.% of thermoplastic polymer, preferably for at least 75 wt.%, more preferably for at least 90 wt.%, more preferably for at least 95 wt.% of thermoplastic polymer. The fibers comprised in the three-dimensional material layer may consist of thermoplastic polymer.

The fibers comprised in the three-dimensional material layer may comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers, preferably any suitable synthetic thermoplastic polymer or blend of synthetic thermoplastic polymers. The fibers may comprise a polyolefin, such as for example polyethylene (PE) or polypropylene (PP), a halogenated polyolefin, such as for example polytetrafluorethylene (PTFE) or polyvinylidene difluoride (PVDF), a polyester, such as for example polyethylene terephthalate (PET) (based either on DMT or PTA), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN) and/or polylactic acid (PLA), a polyamide, such as for example polyamide-6 (PA6), polyamide-6,6 (PA6,6) and/or polyamide-6,10 (PA6,10), polyimides (PI), polysulfides (PS) such as polyphenylenesulfide (PPS), polyethyleneimide (PEI), polyoxymethylene (POM), thermoplastic elastomers (TPE) such as thermoplastic polyurethanes (TPU), and/or any copolymer or any blend thereof.

The fibers comprised in the three-dimensional material layer may preferably comprise, or consists of, a polyolefin, more preferably a polypropylene (PP).

In another embodiment, the fibers comprised in the three-dimensional material layer may comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers, preferably a suitable synthetic thermoplastic polymer or a blend of synthetic thermoplastic polymers, which is bio-compostable, in accordance with EN13432, at the end of the lifetime of the tray, preferably a polymer made by a polycondensation reaction of hydroxylcarboxylic acids or a ring opening polymerization of lactides. Preferred synthetic polymeric materials comprise polymer(s) of α-, β-, γ-, δ-, or ε-hydroxylesters. Preferably, the polymer(s) comprised in the fibers comprised in the three-dimensional material layer are selected from the group of polyhydroxyalkanoates (PHA's), such as for example polyhydroxybutyrate (PHB), polyhydroxyvalerate (PHV), poly-(3-hydroxybutyrateco-3-hydroxyvalerate) PHVB or polyhydroxyhexanoate (PHH) as for example available from Metabolix under the Mirel brand name, polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone (PCL), poly-β-butyrolactone (PBL), polybutylene succinate (PBS), cellulose derivates and/or blends thereof. In a preferred embodiment, the synthetic polymeric material comprised in the fibers comprised in the three-dimensional material layer is a polylactic acid (PLA).

In an embodiment, the three-dimensional material layer comprising fibers comprised in the base of the tray is preferably a three-dimensional mat of extruded entangled filaments having an open space of at least 50%, preferably of at least 75%, or preferably of at least 85%, or more preferably of at least 90%, or even more preferably of at least 95%.

The three-dimensional mat of extruded entangled filaments comprised in the base of the tray can be easily cut enabling to cut the tray to smaller size to precisely fit the tray at the edges of the surface to be greened. Deep-drawn plastic trays or injection molded trays of the prior art are difficult to cut precisely due to the

breaking of hard and relatively brittle plastic shape in combination with a substrate such as soil within such deep-drawn or injection molded plastic trays.

The three-dimensional mat of extruded entangled filaments comprised in the base of the tray may advantageously be made of extruded filaments that are irregularly looped and entangled into a highly porous, three-dimensional structure having a large open space of at least 50%, wherein the extruded filaments are preferably bonded where they cross. Preferably, the extruded filaments are stretched only by gravity before being irregularly looped and entangled into a highly porous, three-dimensional structure having an open space of at least 50%.

The extruded filaments may be irregularly looped and entangled into a highly porous, three-dimensional structure having an open space of at least 50% by extruding filaments and collecting the extruded filaments into a three-dimensional structure by allowing the filaments to bend, to entangle and to come into contact with each other, preferably in a still molten state. The extruded filaments may be allowed to bend, to entangled and to come into contact with each other by allowing the extruded filaments to come into contact with a surface.

The surface may be the surface of a cooling bath comprising a cooling liquid, in particular cooling water, to solidify the extruded filaments after being irregularly looped and entangled into a highly porous, three-dimensional structure. Allowing the extruded filaments to come into contact with a surface of a cooling bath comprising a cooling liquid enables to form a three-dimensional mat of extruded entangled filaments wherein the filaments have a random distribution within the three-dimensional mat of extruded entangled filaments, which may have an essentially isotropic property distribution.

The three-dimensional mat of extruded entangled filaments comprised in the base of the tray may be a three-dimensional structured mat of extruded entangled filaments, which may be provided by extruding filaments and collecting the extruded filaments into a three-dimensional structure by allowing the filaments to bend, to entangle and to come into contact with each other, preferably in a still

molten state. Bending and entangling of the extruded filaments are preferably initiated by collecting the filaments onto a profiled surface, which defines the structure of the three-dimensional structured mat of extruded entangled filaments. Preferably, the surface on which the filaments are collected is profiled such that the three-dimensional structured mat of filaments is shaped into a three-dimensional form which comprises hills and valleys, hemispheres, positive and/or negative cuspates, cups and/or waffles, pyramids, U-grooves, V-grooves, cones and/or cylinders capped with a hemisphere.

The filaments comprised in the three- three-dimensional mat of extruded entangled filaments may be thermally bonded to each other at contact points of the filaments, to provide improved resilience and/or improved compression resistance.

The three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, comprised in the base of the tray may have a weight of at most 1500 g/m², preferably of at most 1200 g/m², or preferably of at most 1000 g/m², or preferably of at most 800 g/m², and the three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, comprised in the base of the tray may have a weight of at least 100 g/m², preferably of at least 200 g/m², or preferably of at least 300 g/m², or preferably of at least 400 g/m², to provide improved resilience.

The three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, comprised in the base of the tray may have a desired thickness. The three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, comprised in the base of the tray may have a desired thickness of at most 200 mm, or preferably at most 150 mm, or preferably at most 100 mm, or preferably at most 75 mm, or preferably at most 50 mm, or preferably at most 40 mm, or preferably at most 30 mm, or most preferably at most 25 mm. The three-dimensional material layer comprising fibers, preferably a three-dimensional mat of

extruded entangled filaments, comprised in the base of the tray may advantageously have a thickness of at least 3 mm, or preferably at least 4 mm, or preferably at least 5 mm, or preferably at least 10 mm, or preferably at least 15 mm, or most preferably at least 20 mm.

The three-dimensional material layer comprising fibers in the base of the tray preferably has a thickness of at least 15 mm, more preferably of at least 20 mm to prevent, or at least reduce, that plants, substrate and/or water retention layer come in contact with water puddling on a waterproofing layer located beneath the tray for a prolonged period of time, in particular when the tray is to be installed on an essentially flat surface, such as a roof, having an angle of inclination between 0° and 2° to the horizontal.

The three-dimensional material layer comprising fibers in the base of the tray preferably has a thickness of at least 3 mm, more preferably of at least 4 mm, or more preferably of at least 5 mm, in particular when the tray is to be installed on an slightly inclined surface, such as a roof, having an angle of inclination between 2° and 10° to the horizontal.

The three-dimensional material layer comprising fibers in the base of the tray may have a thickness less than 3 mm, in particular when the tray is to be installed on an inclined surface, such as a roof, having an angle of inclination between 10° and 45° to the horizontal.

The three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, comprised in the base of the tray may have sufficient resilience to allow equipment to rolled over or driven over the trays, without significantly reducing the thickness of tray. The three-dimensional material layer comprising fibers, preferably a three-dimensional mat of extruded entangled filaments, comprised in the base of the tray may have resilience of at least 75%, preferably at least 80%, or preferably at least 85%, or preferably at least 90%, preferably at least 95%.

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments may comprise a thermoplastic polymer, preferably a synthetic thermoplastic polymer. In an embodiment, The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments are composed for at least 50 wt.% of thermoplastic polymer, preferably for at least 75 wt.%, more preferably for at least 90 wt.%, more preferably for at least 95 wt.% of thermoplastic polymer. The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments may consist of thermoplastic polymer.

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprised in the base of the tray may comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers. The extruded entangled filaments may comprise a polyolefin, such as for example polyethylene (PE) or polypropylene (PP), a halogenated polyolefin, such as for example polytetrafluorethylene (PTFE) or polyvinylidene difluoride (PVDF), a polyester, such as for example polyethylene terephthalate (PET) (based either on DMT or PTA), polybutylene terephthalate (PBT), polytrimethylene terephthalate (PTT), polyethylene naphthalate (PEN) and/or polylactic acid (PLA), a polyamide, such as for example polyamide-6 (PA6), polyamide-6,6 (PA6,6) and/or polyamide-6,10 (PA6,10), polyimides (PI), polysulfides (PS) such as polyphenylenesulfide (PPS), polyethyleneimide (PEI), polyoxymethylene (POM), thermoplastic elastomers (TPE) such as thermoplastic polyurethanes (TPU), and/or any copolymer or any blend thereof.

The extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprised in the base of the tray may preferably comprise, or consists of, a polyolefin, more preferably a polypropylene (PP).

In another embodiment, the extruded entangled filaments of the three-dimensional mat of extruded entangled filaments comprised in the base of the tray may comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers, preferably a suitable synthetic thermoplastic polymer or a

blend of synthetic thermoplastic polymers, which is bio-compostable, in accordance with EN13432, at the end of the lifetime of the tray, preferably a polymer made by a polycondensation reaction of hydroxylcarboxylic acids or a ring opening polymerization of lactides. Preferred synthetic polymeric materials comprise polymer(s) of α-, β-, γ-, δ-, or ε-hydroxylesters. Preferably, the polymer of which the three-dimensional entangled mat of extruded filaments is made is selected to comprise polymer(s) from the group of polyhydroxyalkanoates (PHA's), such as for example polyhydroxybutyrate (PHB), polyhydroxyvalerate (PHV), poly-(3-hydroxybutyrateco-3-hydroxyvalerate) PHVB or polyhydroxyhexanoate (PHH) as for example available from Metabolix under the Mirel brand name, polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone (PCL), poly-β-butyrolactone (PBL), polybutylene succinate (PBS), cellulose derivates and/or blends thereof. In a preferred embodiment, the synthetic polymeric material of which the three-dimensional entangled mat of extruded filaments is made is a polylactic acid (PLA).

The first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base of the tray and/or the second separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the material layer of fibers comprised in the upstanding walls of the tray may independently from each other comprise, or consists of, any suitable thermoplastic polymer or blend of thermoplastic polymers, preferably any suitable synthetic thermoplastic polymer or a blend of synthetic thermoplastic polymers, which is bio-compostable at the end of the lifetime of the tray, preferably a polymer made by a polycondensation reaction of hydroxylcarboxylic acids or a ring opening polymerization of lactides. Preferred synthetic polymeric materials comprise polymer(s) of α-, β-, γ-, δ-, or ε-hydroxylesters, allowing the tray to be bio-composted at the end of life. Preferably, the polymer of which the first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the

base of the tray and/or the second separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the material layer of fibers comprised in the upstanding walls of the tray, is made is selected to comprise polymer(s) from the group of polyhydroxyalkanoates (PHA's), such as for example polyhydroxybutyrate (PHB), polyhydroxyvalerate (PHV), poly-(3-hydroxybutyrateco-3-hydroxyvalerate) PHVB or polyhydroxyhexanoate (PHH) as for example available from Metabolix under the Mirel brand name, polylactic acid (PLA), polyglycolic acid (PGA), polycaprolactone (PCL), poly-β-butyrolactone (PBL), polybutylene succinate (PBS), cellulose derivates and/or blends thereof. In a preferred embodiment, the synthetic polymeric material of which the first liquid permeable separation layer and/or the second separation layer is made is a polylactic acid (PLA).

The first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base of the tray may be any type of liquid permeable material, and may preferably be selected from a perforated film, a woven fabric or a nonwoven fabric. Preferably, the first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base of the tray is a nonwoven fabric.

The nonwoven fabric may in principle be any type of nonwoven, such as for example staple fiber nonwovens produced by well-known processes, such as carding processes, wet-laid processes or air-laid processes, or any combination thereof. The nonwoven fabric may also be a nonwoven composed of filaments produced by well-known spunbonding processes wherein filaments are extruded from a spinneret and subsequently laid down on a conveyor belt as a web of filaments and subsequently consolidated, also known as bonding, the web to form a nonwoven layer of fibers, or by a two-step process wherein filaments are spun and wound on bobbins, preferably in the form of multifilament yarns, followed by the step of unwinding the filaments or multifilament yarns and laying the filaments

down on a conveyor belt as a web of filaments and consolidating the web to form a nonwoven layer of fibers.

The nonwoven fabric may have been consolidated by any suitable known consolidation technology, including mechanical consolidation, for example by stitching, mechanical needling and/or hydrodynamic consolidation by fluid jets, in particular by hydroentanglement, by chemical consolidation, for example by applying a binder dispersion or a binder solution to the nonwoven layer of fibers, which is generally dried and optionally cured, and/or by thermal consolidation, for example by calendaring, ultrasonic bonding and/or hot air bonding.

The nonwoven fabric may comprise a higher melting polymer and a lower melting polymer, facilitating thermal bonding of the nonwoven fabric. The lower melting polymer may have a melting temperature which is at least 10°C, preferably at least 20°C, or preferably at least 50°C, lower than the melting temperature of the higher melting polymer.

The higher melting polymer may be comprised in a first type of mono-component fibers the lower melting polymer may be comprised in a second type of mono-component fibers.

The lower melting polymer comprised in the nonwoven fabric may be comprised in multicomponent fibers, preferably in bicomponent fibers. A basic distinction is being drawn between three types of bicomponent fibers: side-by-side types, core-sheath types and islands-in-the-sea types of bicomponent fibers. Preferably, the ratio of low melting polymer and high melting polymer in the bicomponent fibers, preferably sheath/core bicomponent fibers lies between 95/5 vol.% and 5/95 vol.%. More preferably the ratio of low melting polymer and high melting polymer lies between 50/50 vol.% and 95/5 vol.%.

The mono-component or multicomponent fibers comprised in the nonwoven fabric may have any cross sectional shape, including round, trilobal, multilobal or rectangular.

Preferably, the fibers in the nonwoven fabric are filaments in order to provide higher tensile strength and/or higher tear strength to the composite material.

The first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base of the tray may preferably be a nonwoven fabric composed of bicomponent sheath/core filaments comprising a core of a polyester, preferably a polyethylene terephthalate (PET), and a sheath of a copolyester (coPET).

The first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base of the tray may have a weight of at most 500 g/m², preferably of at most 400 g/m², or preferably of at most 300 g/m², or preferably of at most 200 g/m², and the first liquid permeable separation layer comprised in the composite material and which is oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers may have a weight of at least 25 g/m², preferably of at least 30 g/m², or preferably of at least 50 g/m², preferably of at least 100 g/m², enabling to retain a substrate within the open-top receptacle of the tray wherein plants can be cultivated, while allowing excess water to be drained from the tray.

The first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base of the tray may have a characteristic size of the openings (O-90) in accordance with NEN-EN-ISO 12956:200 of 200 µm or less, preferably 175 µm or less, or preferably 150 µm or less, or preferably 125 µm or less, or preferably 100 µm or less, or preferably 75 µm or less, or most preferably 50 µm or less, enabling to retain a substrate within the open-top receptacle of the tray wherein plants can be cultivated, while allowing an excess of water to be drained from the tray through the first liquid permeable separation layer and through the three-dimensional material layer comprising fibers comprised in the base of the tray.

The first liquid permeable separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base of the tray may, however, have a characteristic size of the openings (O-90) in accordance with NEN-EN-ISO 12956:200 higher than 200 µm, for example when the tray comprises a water retention layer in the open-top receptacle of the tray, for example on the inner surface of the open-top receptacle.

The first liquid permeable separation layer comprised in the tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, is oriented towards the inner surface of the open-top receptacle of the tray, which enables to retain a substrate within the open-top receptacle of the tray wherein plants can be cultivated, while allowing an excess of water to be drained from the tray through the first liquid permeable separation layer and through the three-dimensional material layer comprising fibers. An excess of water retained within the tray could damage the plants being cultivated within the tray, for example due to rotting of roots of the plants.

The second separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the material layer of fibers comprised in the upstanding walls of the tray may be any type of liquid permeable material which has the capability to retain a substrate within the open-top receptacle of the tray wherein plants can be cultivated, and may preferably be selected from a continuous closed film, a perforated film, a woven fabric or a nonwoven fabric, and may more preferably be selected from a perforated film, a woven fabric or a nonwoven fabric.

The second separation layer may be liquid impermeable, in particular water impermeable, and may preferably be a continuous closed film.

The second separation layer may be liquid permeable, in particular water permeable, and may preferably be selected from a perforated film, a woven fabric or a nonwoven fabric. More preferably, the second separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the three-

dimensional material layer of fibers comprised in the base of the tray is a nonwoven fabric.

The tray may comprise a second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers comprised in the base of the tray.

The second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers comprised in the base of the tray may comprise, or may consist of, a knitted fabric, a woven fabric or a nonwoven fabric configured as the loop side of a hook and loop connection. The hook side of the hook and loop connection can be fixedly connected to the surface to be greened, for example the hook side of the hook and loop connection can be fixedly connected to a waterproofing layer, to improve wind-uplift resistance or to prevent, or at least reduce, sliding of the tray when installed on an inclined surface, for example at angle of more than 2°, or more than 5°, or more than 10° to the horizontal. The second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers comprised in the base of the tray preferably is a nonwoven fabric configured as the loop side of a hook and loop connection.

The tray may comprise a second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the material layer of fibers comprised in the upstanding walls of the tray.

The second layer comprised in the tray may be provided as a single continuous layer oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers comprised in the base of the tray and oriented plane-parallel, and preferably adjacent, to the second main surface of the material layer of fibers comprised in the upstanding walls of the tray.

The second layer comprised in the tray may be provided only oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers comprised in the base of the tray.

The second layer comprised in the tray oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers and/or oriented plane-parallel, and preferably adjacent, to the second main surface of the material layer of fibers comprised in the upstanding walls of the tray may be liquid permeable, in particular water permeable, enabling an excess of water to be drained from the tray vertically through the three-dimensional material layer comprising fibers and/or horizontally through the upstanding walls of the tray.

The second layer comprised in the tray oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers and/or oriented plane-parallel, and preferably adjacent, to the second main surface of the material layer of fibers comprised in the upstanding walls of the tray may be liquid impermeable, in particular water impermeable, to prevent that liquid, in particular water, being drained from the tray comes into contact with surface to be greened, which may be located below the tray, while the liquid, in particular water, can still be drained from the tray horizontally or under a slight angle of for example less than 5°, or less than 2°, to the horizontal. Additionally, the liquid impermeable, in particular water impermeable, second layer enables to reduce the risk of root penetration through the base of the tray and/or through the upstanding walls of the tray.

The tray may comprise upstanding walls which are liquid permeable, in particular water permeable, allowing to distribute liquid, in particular water, from the tray to another tray positioned adjacent to the tray on the surface to be greened.

The tray may also comprise upstanding walls which are liquid impermeable, in particular water impermeable, to prevent root penetration through the upstanding walls.

The tray may comprise upstanding walls having a thickness of the material layer comprising fibers the upstanding walls of the tray of at most 20 mm or at most 10 mm. The tray may comprise upstanding walls having a thickness of the material layer comprising fibers in the upstanding walls of the tray of at most 7.5 mm, preferably at most 5 mm, or preferably at most 3 mm, or preferably at most 2 mm, or preferably at most 1 mm, as determined at the top edge of the upstanding wall. The tray may comprise upstanding walls having a thickness of the material layer comprising fibers in the upstanding walls of the tray of at least 0.5 mm, preferably at least 0.75 mm, or preferably at least 1 mm, or preferably at least 1.5 mm. A lower thickness of the upstanding walls of the tray enables to obtain a greened surface having a more uniform appearance, and enables improved cross fertilization of plants across multiple trays placed on the surface to be greened as the plants are closer together. A cassette according to the prior art which comprises a bottom drainage layer onto which a tray is placed having a bottom layer and side walls made from a lightweight recycled polyurethane molded foam has a wall thickness of about 10 mm, which means that when two cassettes are placed next to each other on the surface to be greened, the total thickness of the two walls combined is about 20 mm, on top of which no plants are cultivated resulting in a visible line in the greened surface.

The height of the upstanding walls comprised in the tray may be varied. The tray may comprise upstanding walls having a height of at least 20 mm, preferably at least 30 mm, or preferably at least 50 mm, or preferably at least 75 mm, or preferably at least 100 mm, or preferably at least 125 mm, or preferably at least 150 mm.

The tray may comprise upstanding walls having a height in the range of 30 mm to 50 mm, which is advantageous for cultivating plants whose roots grow particularly in a horizontal direction, such as for example sedum plants. The amount of substrate within the open-top receptacle of the tray wherein plants can be cultivated can then be kept to a minimum enabling to provide a particularly light weight tray comprising cultivated plants.

The tray may comprise upstanding walls having a height in the range of 50 mm to 150 mm, which is advantageous for cultivating plants whose roots grow particularly in a vertical direction, such as for example herbs or wildflowers. The height of the upstanding walls comprised in the tray in the range of 50 mm to 150 mm is also advantageous when the tray comprises a water retention layer in the open-top receptacle of the tray, for example on the inner surface of the open-top receptacle.

The tray may comprise a water retention layer in the open-top receptacle of the tray, wherein the water retention layer may have a thickness of 5 mm to 100 mm, preferably of 7.5 mm to 75 mm, or preferably of 10 mm to 40 mm, and wherein the water retention layer may be a layer of glass wool, a layer of mineral wool, a layer of shoddy recycled textile material, or a nonwoven fabric. The water retention layer reduces the required amount of substrate within the open-top receptacle of the tray enabling to provide a particularly light weight tray comprising cultivated plants, while providing retention of water to facilitate plant growth over a prolonged period of time, or to temporarily store water in times of heavy rainfall for storm water management purposes.

The tray may comprise the upstanding walls at an angle alfa to the base of tray larger than 90°. The angle alfa may be at least 92°, or preferably at least 94°, or preferably at least 95°, enabling to stack multiple trays into each other when the trays are not yet filled with a substrate facilitating easy transport of the empty trays.

The tray may comprise one or more upstanding walls comprising a first part of a form fit connection configured to connect to a second part of a form fit connection in another tray which can be placed adjacent to tray on the surface to be greened, thereby ensuring that a continuous layer of trays can be formed on the surface to be greened. Preferably, the tray comprises a first upstanding wall of the tray comprising a first part of a form fit connection, and a second upstanding wall

opposite to the first upstanding wall comprising a second part of a form fit connection, enabling to connect a series of trays.

The tray may comprise a base having any desired shape. Preferably, the tray comprises a base having a shape configured for forming a continuous layer of trays when multiple trays are placed adjacent to each other on the surface to be greened. The tray may comprise a base having for example a triangular shape, a parallelogram shape, a hexagon shape, a rectangular shape, or a square shape. The dimensions of the base of the tray may be varied.

The base of the tray preferably has dimensions selected such that the tray can be lifted and handled manually by a person installing the tray on the surface to be greened. The largest dimension of a side of the base of the tray (large side length) may be at most 120 cm, preferably at most 100 cm, or preferably at most 80 cm, or preferably at most 60 cm. The smallest dimension of a side of the base of the tray (short side length) may be of at most 60 cm, preferably at most 50 cm, or preferably at most 40 cm.

The tray may comprise a base having a rectangular shape having a large side length of at most 100 cm, preferably at most 80 cm, or preferably at most 60 cm, and having a short length of at most 60 cm, preferably at most 50 cm, or preferably at most 40 cm.

The tray may comprise a base having a square shape having a side length of at most 100 cm, preferably at most 80 cm, or preferably at most 60 cm, or preferably at most 50 cm.

However, in greening of surfaces also trays having different shape for the base of the trays may be provided, which preferably can form a continuous layer when multiple trays are placed adjacent to each other, for example trays having an octagon shape and trays having a rectangular shape wherein the side edges of the base octagon shaped base and side edges of the base of the rectangular shaped base have the same length. Greening of surfaces with trays having

different shape for the base of the trays allows to create a specific pattern of plants on the surface to be greened when each type of tray comprises different types of plants.

The tray may comprise a substrate within the open-top receptacle of the tray. The substrate may comprise soil, fertilizer and/or inorganic substances, such as for example, lava, lightweight lava, natural pumice, expanded clay and/or expanded shale.

The tray may comprise mycelium, for example in combination with gardening waste such as pruning waste, enabling to form a substrate in-situ within the tray.

Figure 1 schematically depicts a side view of a composite material (100) comprising a three-dimensional material layer comprising fibers (110) and a liquid permeable separation layer (101) oriented plane-parallel, and adjacent, to the first main surface of the three-dimensional material layer of fibers (110), which may be provided into the process for manufacturing a tray.

Figure 2 schematically depicts a side view cross-section of a tray (200) shaped from the composite material of Figure 1, the tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface (211) and an outer surface (212). The base of the tray comprises a three-dimensional material layer comprising fibers (210) having an open space of at least 50%. The liquid permeable separation layer (201) comprised in the base is oriented towards the inner surface (211) of the open-top receptacle. The tray of Figure 2 comprises upstanding walls comprising a material layer comprising fibers (214), which may be formed by compressing the three-dimensional material layer comprising fibers (110) of Figure 1. The separation layer (201) comprised in the upstanding walls is oriented towards the inner surface (211) of the open-top receptacle.

Figure 3 schematically depicts a side view of another composite material (300) comprising a three-dimensional material layer comprising fibers (310) and a first liquid permeable separation layer (301) oriented plane-parallel, and adjacent, to

the first main surface of the three-dimensional material layer of fibers (310), which may be provided into the process for manufacturing a tray. The composite material (300) also comprises a second layer (302) oriented plane-parallel, and adjacent, to the second main surface of the three-dimensional material layer of fibers (310).

Figure 4 schematically depicts a side view cross-section of a tray (400) shaped from the composite material of Figure 3, the tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface (411) and an outer surface (412). The base of the tray comprises a three-dimensional material layer comprising fibers (410) having an open space of at least 50%. The liquid permeable separation layer (401) comprised in the base is oriented towards the inner surface (411) of the open-top receptacle. The second layer (402) comprised in the base is oriented towards the outer surface (412) of the open-top receptacle. The tray of Figure 4 comprises upstanding walls comprising a material layer comprising fibers (414), which may be formed by compressing the three-dimensional material layer comprising fibers (310) of Figure 3. The separation layer (401) comprised in the upstanding walls is oriented towards the inner surface (411) of the open-top receptacle. The second layer (402) comprised in the upstanding walls is oriented towards the outer surface (412) of the open-top receptacle.

Figure 5 schematically depicts a side view of yet another composite material (500) comprising a three-dimensional material layer comprising fibers (510) and a first liquid permeable separation layer (501) oriented plane-parallel, and adjacent, to the first main surface of the three-dimensional material layer of fibers (510), which may be provided into the process for manufacturing a tray. The composite material (500) also comprises a second layer (502) oriented plane-parallel, and adjacent, to the second main surface of the three-dimensional material layer of fibers (510). The second layer (502) is provided only over the area of the second main surface of the three-dimensional material layer of fibers (510) which is shaped into the base of the tray.

Figure 6 schematically depicts a side view cross-section of a tray (600) shaped from the composite material of Figure 5, the tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface (611) and an outer surface (612). The base of the tray comprises a three-dimensional material layer comprising fibers (610) having an open space of at least 50%. The liquid permeable separation layer (601) comprised in the base is oriented towards the inner surface (611) of the open-top receptacle. The second layer (602) comprised only in the base is oriented towards the outer surface (612) of the open-top receptacle. The tray of Figure 6 comprises upstanding walls comprising a material layer comprising fibers (614), which may be formed by compressing the three-dimensional material layer comprising fibers (510) of Figure 5. The separation layer (601) comprised in the upstanding walls is oriented towards the inner surface (611) of the open-top receptacle. There is no second layer comprised in the upstanding walls of the open-top receptacle of the tray (600).

Figure 7 schematically depicts a side view of another composite material (700) comprising a three-dimensional material layer comprising fibers (710) and a first liquid permeable separation layer (701) oriented plane-parallel, and adjacent, to the first main surface of the three-dimensional material layer of fibers (710), which may be provided into the process for manufacturing a tray. The composite material (700) also comprises a second layer (702) oriented plane-parallel, and adjacent, to the second main surface of the three-dimensional material layer of fibers (710).

Figure 8 schematically depicts a side view cross-section of a tray (800) shaped from the composite material of Figure 7, the tray comprising a base and upstanding walls forming an open-top receptacle having an inner surface (811) and an outer surface (812). The base of the tray comprises a three-dimensional material layer comprising fibers (810) having an open space of at least 50%. The liquid permeable separation layer (801) comprised in the base is oriented towards the inner surface (811) of the open-top receptacle. The second layer (802) comprised in the base is oriented towards the outer surface (812) of the open-top receptacle. The tray of Figure 8 comprises upstanding walls comprising a material

layer comprising fibers (814), which may be formed by compressing the three-dimensional material layer comprising fibers (710) of Figure 7. The separation layer (801) comprised in the upstanding walls is oriented towards the inner surface (811) of the open-top receptacle. The second layer (802) comprised in the upstanding walls is oriented towards the outer surface (812) of the open-top receptacle. The tray (800) is shaped such that the angle alfa, between the base and the upstanding walls at the inner surface of the tray is larger than 90°, indicated by the curved arrow in Figure 8, enabling to stack multiple trays into each other when the trays are not yet filled with a substrate facilitating easy transport of the empty trays.

Claims:

1. A process for manufacturing a tray for greening of surfaces comprising the steps of providing a composite material (100, 300, 500, 700) comprising a three-dimensional material layer comprising fibers (110, 310, 510, 710) and having a first main surface and a second main surface, wherein the fibers (110, 310, 510, 710) comprise a thermoplastic polymer, and at least a first liquid permeable separation layer (101, 301, 501, 701) oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers, and shaping the composite material (100, 300, 500, 700) into a tray (200, 400, 600, 800) comprising a base and upstanding walls forming an open-top receptacle having an inner surface (211, 411, 611, 811) and an outer surface (212, 412, 612, 812), wherein the three-dimensional material layer comprising fibers comprised in the base (210, 410, 610, 810) has an open space of at least 50%, wherein the liquid permeable separation layer (201, 401, 601, 801) comprised in the base is oriented towards the inner surface of the open-top receptacle.

2. The process for manufacturing a tray for greening of surfaces according to claim 1 comprising the step of providing a second layer (302, 502, 702) oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers (310, 510, 710).

3. The process for manufacturing a tray for greening of surfaces according to claim 2, wherein the second layer (302, 502, 702) is liquid permeable.

4. The process for manufacturing a tray for greening of surfaces according to claim 2, wherein the second layer (302, 502, 702) is liquid impermeable.

5. The process for manufacturing a tray for greening of surfaces according to any one or more of claims 1 to 4 comprising the step of compression molding the composite material into a tray (200, 400, 600, 800) for greening of surfaces.

6. The process for manufacturing a tray for greening of surfaces according to any one or more of claims 1 to 5 wherein the tray (200, 400, 600, 800) for greening of surfaces is a unitary structure.

7. A tray (200, 400, 600, 800) for greening of surfaces, in particular for roofs of building structures, comprising a base and upstanding walls forming an open-top receptacle having an inner surface and an outer surface, wherein the fibers (110, 310, 510, 710) comprise a thermoplastic polymer, wherein the base comprises a three-dimensional material layer comprising fibers (210, 410, 610, 810) and having a first main surface and a second main surface and at least a first liquid permeable separation layer (201, 401, 601, 801) oriented plane-parallel, and preferably adjacent, to the first main surface of the three-dimensional material layer of fibers comprised in the base, wherein the three-dimensional material layer comprising fibers comprised in the base has an open space of at least 50%, wherein the upstanding walls comprise a material layer comprising fibers (214, 414, 614, 818) and having a first main surface and a second main surface and at least a second separation layer oriented plane-parallel, and preferably adjacent, to the first main surface of the material layer of fibers comprised in the upstanding walls, wherein the first liquid permeable separation layer comprised in the base and the second separation

layer comprised in the upstanding walls are oriented towards the inner surface of the open-top receptacle.

8. The tray for greening of surfaces according to claim 7 wherein the base comprises a second layer (402, 602, 802) oriented plane-parallel, and preferably adjacent, to the second main surface of the three-dimensional material layer of fibers (410, 610, 810).

9. The tray for greening of surfaces according to any one or more of claims 7 to 8, wherein the upstanding walls comprise a second layer oriented plane-parallel, and preferably adjacent, to the second main surface of the material layer of fibers (414, 814).

10. The tray for greening of surfaces according to any one or more of claims 7 to 9, wherein the second layer (402, 602, 802) is water permeable.

11. The tray for greening of surfaces according to any one or more of claims 7 to 9, wherein the second layer (402, 602, 802) is water impermeable.

12. The tray for greening of surfaces according to any one or more of claims 7 to 11 wherein the upstanding walls have a thickness of at most 7.5 mm.

13. The tray for greening of surfaces according to any one or more of claims 7 to 12 wherein the tray comprises the upstanding walls at an angle alfa to the base of tray larger than 90°, preferably at least 92°, or preferably at least 94°, or preferably at least 95°.

14. The tray for greening of surfaces according to any one or more of claims 7 to 13 wherein the tray comprises a water retention layer.

15. The tray for greening of surfaces according to any one or more of claims 7 to14 wherein the tray is a unitary structure.