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(54) Title: ARTIFICIAL TURF INSTALLATION

(57) Abstract: Artificial turf installation, comprising: a pile fabric having a backing and a multiplicity of generally upstanding pile elements; and an infill overlying said backing and being interspersed between said upstanding pile elements, said infill comprising a loose, particulate material consisting of particles coated with a coating material, wherein said coating material comprises a biodegradable polymer.

Title: Artificial turf installation

The present invention relates to an artificial turf installation, comprising: a pile fabric having a backing and a multiplicity of generally upstanding pile elements; and an infill overlying said backing and being interspersed between said upstanding pile elements, said infill comprising a loose, particulate material consisting of particles coated with a coating material. The present invention furthermore relates to a loose, particulate material consisting of particles coated with a coating material.

Synthetic turf is a ground surfacing material designed to imitate both the appearance and function of natural grass. Within the sports world, synthetic turf gained popularity in 1966 when it was used in the Astrodome Stadium in Houston, Texas. Since then, over 11,000 synthetic turf fields have been installed in the United States and in Europe there are currently over 13,000 synthetic turf fields.

Synthetic turf fields have several advantages over natural grass fields. They do not require irrigation, fertilizers, or pesticide application, which saves water, labor, time, and reduces the likelihood that certain potentially toxic chemicals will be introduced into the environment. In addition, synthetic turf fields can be used more frequently because they do not become muddy after precipitation and do not require waiting periods between uses to facilitate repair and recovery. Although synthetic turf installation costs substantially more than natural grass, the overall long term expenses are lower.

Despite these practical advantages, there have been growing concerns about the safety of synthetic turf fields, particularly the infill materials. All synthetic turf fields share the same basic composition, i.e., polyethylene synthetic grass fibers, infill, and carpet backing. Crumb rubber is commonly used as the infill material and is mainly produced by fragmentation of scrap vehicle tires and consists of rubber polymer, reinforcing agents (e.g., carbon black), aromatic extender oil, vulcanization additives, antioxidants, anti-ozonants, and processing aids, such as plasticizers and softeners. The focus of concern has been on the crumb rubber infill due to its ubiquitous use, exposure potential, and components which may exert effects that are deleterious to human health. Human exposure to crumb rubber-derived chemicals may occur through inhalation, ingestion, and/or dermal contact.

Still today ground car tires are used as infill in an artificial turf installation but its use has become heavily debated and is generally less preferred due to leaching of heavy metals as well as polycyclic aromates, moreover smell related issues occur due to outgassing of the high content of butadiene residual monomer. The use of an infill in artificial grass sports fields has numerous draw backs. For example, an artificial grass sports field provided with an infill requires intensive maintenance. The initially uniform distribution of the granular infill can be disturbed by intensive usage. As a result, areas containing hardly any infill may form in particular in places where the field is played on very intensively, for example in the goal area, which has an adverse effect on the quality of play, but which above all leads to an increased risk of injury. The distribution and the amount of the granular material of an artificial grass sports field provided with an infill must be verified at regular intervals and repairs must be carried out, if necessary. Furthermore, it has become apparent that the weather affects the properties of the infill with the passage of time, which has a negative effect on the quality of the infill and thus on the playing characteristics of the artificial grass sports field. A negative factor, for example, is the strong compaction of the infill, as a result of which the artificial grass sports field will feel increasingly hard during play, with an increased risk of injury. Furthermore, the synthetic infill may change (harden or become brittle) under the influence of the weather conditions (sunlight, for example).

Artificial turf installations suitable for sports fields consisting at least of a substrate to which first artificial grass fibres are attached and of a granular infill, which is provided between said first artificial grass fibres are known from the prior art.

For example, US 2008/014557 relates to a recreational surface, comprising: a pile fabric having a backing and a multiplicity of generally upstanding pile elements; and an infill overlying said backing and being interspersed between said upstanding pile elements, said infill comprising resilient particles and particles of a rubber coated hard granular material. The synthetic rubber mentioned here is a butadiene rubber comprising from about 100% to about 60% by weight of the composition, especially polybutadiene or styrene-butadiene rubber. A source for the granulized synthetic rubber is recycled tires that are commercially available from numerous sources.

WO 2018/183756 relates to an artificial turf assembly comprising: a turf carpet having a plurality of spaced apart synthetic grass blades; and an infill material dispersed onto the turf carpet between the grass blades, the infill material including sand and a plurality of wood particles having a specific ratio between a length dimension a width or a thickness dimension.

US 2018/0371708 relates to an artificial turf field system, comprising: a plurality of synthetic turf strands attached to a backing layer; an infill material positioned between the synthetic turf stands, the infill material including a plurality of porous particles, wherein at least a portion of the porous particles are at least partially covered in a coating. The coating mentioned here is a polymer coating including one of acrylic resin, Low Density Polyethylene (LDPE), High Density Polyethylene (HDPE), Polypropylene (PP), Polyvinyl Chloride (PVC), Polystyrene (PS), Nylon, Polytetrafluoroethylene (PTFE), Thermoplastic polyurethanes (TPU), acrylate monomers, Methacrylates, Methyl acrylate, Ethyl acrylate, 2-Chloroethyl vinyl ether, 2-Ethylhexyl acrylate, Hydroxyethyl methacrylate, Butyl acrylate, Butyl methacrylate, trimethylolpropane triacrylate (TMPTA), Polymethyl acrylate, polymethyl methacrylate, alkyl acrylate copolymer (ACM) and combinations thereof, and the porous particles include porous ceramic particles, wherein the infill material is substantially free of crumb rubber and sand.

WO 2004/022853 relates to a loose, particulate material consisting of silica sand grains coated with an elastomeric coating material, wherein the coating material comprises a thermoplastic polymer having a melt index of 20-40 g/10 min and Shore A hardness of 40-90. The thermoplastic polymer used here is an Engage (trademark) 8400 polyolefin elastomer produced by DuPont Dow Elastomer, namely an ethylene alpha-olefin copolymer with 24% octane comonomer, a melt index of 30 g/10 minutes and a density of 0.870 g/cc.

US 4,337,283 relates to a playing surface for athletic games comprising: a firm, stable subsurface a pile fabric having a flexible backing and normally upstanding pile elements resembling grass, and a compacted top-dressing layer comprising a mixture of from 25 to 95 volume percent resilient particles and from 5 to 75 volume percent fine sand interspersed among the pile elements, wherein said resilient particles comprise cork granules or rubber particles, wherein said rubber is natural rubber or a synthetic rubber selected from the group consisting

of styrene-butadiene rubber, butyl rubber, cis-polyisoprene rubber, neoprene rubber, nitrile rubber and urethane rubber.

US 2003/161996 relates to a synthetic grass assembly for installation on a supporting substrate, the assembly comprising: a pile fabric with a flexible sheet backing and a plurality of upstanding synthetic ribbons; an infill layer of particulate material disposed interstitially between the upstanding ribbons, the particulate material selected from the group consisting of hard and resilient granules, wherein the resilient granules are selected from the group consisting of cryogenically ground rubber; rubber; cork; polymer beads; synthetic polymer foam; styrene; perlite, neoprene, and EPDM rubber, and wherein the hard granules are selected from the group consisting of sand; hard aggregate; silica sand; gravel; slag; granulated plastic; and polymer beads.

WO 16/190744 relates to an artificial turf system comprising: a resilient layer; an artificial grass layer comprising a substrate and pile fibres upstanding from the substrate; an infill layer, disposed on the substrate and interspersed between the pile fibres, the infill layer comprising smooth, hard granules having a mean size of between 2.0 mm and 10 mm, wherein the granules comprise a thermoplastic material, selected from the group comprising: PE, PP, PA, PU, PS, ABS, PC, PET, PEF, PHA and PLA.

US 6,818,274 relates to an artificial turf system that uses support material for an infill layer, wherein the particulate matter of infill layer may include both hard granules or particles, such as sand, rocks or other hard particles, as well as resilient particles chosen from the group of rubber, such as butyl rubber, nitrile rubber, crumb rubber or ground tire rubber, cryogenic rubber particles, neoprene, and polyethylene foam.

WO 2018/016956 relates to an artificial turf suitable for sports fields consisting at least of a substrate to which first artificial grass fibers are attached and of a granular infill, which is provided between said first artificial grass fibers, wherein the granular infill is made of a foam material comprising polylactic acid or a derivative thereof. The granular infill mentioned in this International application may further comprises one or more bio-based polymers chosen from the group of polybutylene succinate (PBS), polycaprolactone (PCL), poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), polyhydroxyalkanoate (PHA) and polyhydroxybutyrate

(PHB), or one or more fossil-based polymers chosen from the group of copolyester of butandiol, adipic acid and terephthalic acid (PBAT), poly(methyl methacrylate), polystyrene and polyolefins. This WO 2018/016956 fails to disclose an infill comprising a core and a surface material, wherein the core material is different from the surface material.

KR 102 018 068 relates to a method of manufacturing a hybrid filler for artificial turf comprising silicone 10 to 15% by weight, styrene-butadiene copolymer (styrene butadiene copolymer) 10 to 15% by weight, polyester 5 to 10% by weight %, paraffinic or paraffinic naphthenic mineral oil 10 to 30% by weight, talc or calcium carbonate 30 to 50% by weight, quartzite powder that radiates far-infrared rays and negative ions to the composition of 0.01 to 0.5% by weight of inorganic pigment, clay powder and wood herb liquor, wherein it is formed by applying a filler chip (Pf) formed by cutting a filler chip composition produced by adding 2 to 10% by weight of the extract to a particle size between 1.4 mm and 3.35 mm on the top of than artificial turf layer. The role of polylactic acid in this composition of the hybrid filler is a binder of the other ingredients, and consequently its amount in the composition is low.

IT MI20 110 144 relates to a filament for artificial grass whose cross section includes a central portion from which a first arm and a second arm extend, wherein the arms extend for different lengths and they are divergent. The artificial grass filament is made of a thermoplastic material, a material chosen from the group comprising polyolefins and polyamides, in particular made of polyethylene, polypropylene, nylon, or a polymeric material of origin vegetable, therefore renewable, chosen from the group of biopolymers, in particular polylactic acid, PLA. This Italian document is totally silent about the use of an infill in an artificial turf installation, let alone its composition.

US 2017/319943 relates to an artificial turf installation, comprising a base structure, a layer of resilient material supported on the base structure, an artificial turf supported by the layer of resilient material and a layer of infill material, wherein the layer of infill material defines a playing surface and consists of a particulate having an exterior surface comprising a polymeric material.

The amount of butadiene rubber applied in artificial grass sports fields is affecting the impact resistance of the system. In addition, the application of the

technique to apply an expensive rubber coating on sand will still lead to an abrasive system that cause skin injuries. Furthermore, it will be clear that such butadiene rubber will lead to the issues of leaching and emission of residual monomer with all safety and health issues related to it.

An object of the present invention is to provide an infill in artificial grass sports fields that will overcome or minimize one or more of the drawbacks as discussed above.

Another object of the present invention is to provide an infill in artificial grass sports fields that fulfils the requirements of the international sports federations, such as FIFA and UEFA, and ultimately has its origin in biodegradable materials.

The present invention thus relates to an artificial turf installation, comprising:

a pile fabric having a backing and a multiplicity of generally upstanding pile elements; and

an infill overlying said backing and being interspersed between said upstanding pile elements, said infill comprising a loose, particulate material consisting of particles coated with a coating material, wherein said coating material comprises a biodegradable polymer.

On basis of the above artificial turf installation one or more objects are achieved. The use of a coating material comprising a biodegradable polymer has an environmental advantage. The ability of microorganisms to break down these polymers results in the production of $H_2O$ and $CO_2$. Despite the release of $CO_2$ into the environment, a coating material comprising a biodegradable polymer leaves a smaller footprint than petroleum-based coating materials that accumulate in landfills and may cause heavy pollution.

The present inventors surprisingly found that the present infill does not behave as regular sand anymore. Instead it acts as a rubbery sand in a very flexible way such that it become smoother to thread on than expected and in addition it creates a flexible rebound, such that it only needs to be mixed in a relatively simple artificial standard and therefore low cost artificial grass configuration, without the need for expensive foamed EPP undercovers. Applying a biodegradable polymer coating layer to a loose, particulate material provides a beneficial effect, because the loose, particulate material becomes apparently elastic and rubbery due to the

reduced friction between the individual loose, particulate materials due to the coating with the biodegradable polymer.

In an embodiment of the present invention the biodegradable polymer is chosen from the group of PLA copolymers, PLA, PLLA, PDLA, PHBH, PHBV, PBAT, PHA, PHB, PBS, cellulose, PCL and thermoplastic starch, and mixtures of said biodegradable polymers.

In an embodiment of the present invention the biodegradable polymer has a MFI (Melt Flow Index) in a range of 2-50, preferably in a range of 12-20, measured according to ISO 1133.

In an embodiment of the present invention the biodegradable polymer comprises PLA. Polylactic acid is thermoplastic aliphatic polyester synthesized from renewable biomass, typically from fermented plant starch such as from corn, cassava, sugarcane or sugar beet pulp.

In an embodiment of the present invention the loose particulate material consists of sand, wherein the diameter of the loose particulate material is in a range of 0,05-3 mm, preferably 0,9-1,6 mm, more preferably 0,9-1,1 mm in diameter, with a bulk density of the coated loose particulate material of 500-2500 $kg/m^3$, preferably of 900-1500 $kg/m^3$.

In an embodiment of the present invention the coating material constitutes 1 - 10% % by weight of the loose particulate material, preferably 1,9-2,5% % by weight of the loose particulate material.

The present infill comprises a loose, particulate material consisting of loose particulate material coated with a coating material and is thus not an infill consisting of 100% (biodegradable) polymer. Thus, an infill material made of 100% polymer does not fall within the scope of protection of the present invention and is thus excluded thereof. The present infill thus comprises several types of materials, i.e. the coating material is different from the core material.

In an embodiment of the present invention a coupling agent is provided between the loose particulate material and the coating material, so as to improve the binding between the loose particulate material and the coating material, wherein the coupling agent preferably comprises a silane having a methacrylate group. The coupling agent is provided on the outer surface of the loose particulate material and

subsequently the coating material is provided on the loose particulate material provided with the coating material.

In an embodiment of the present invention the pile elements are made from polymers chosen from the group of PE, PP, SMA, PA, PLA, PDLA, PLLA, star shaped PLA polymer, and/or copolymers of PLA, PBS, PHBH, cellulose or combinations thereof, wherein a pole height of said multiplicity of generally upstanding pile elements is preferably in a range of 20-60 mm, more preferably 30-35 mm.

In an embodiment of the present invention the pile elements further comprise one or more additives, chosen from the group of antistatic additives, colorants, UV stabilizers, anti-microbial substances, fire retardants, cross linkers, coupling agents, melt flow enhancers and anti-slip agents.

The present invention also relates to a loose, particulate material consisting of particles coated with a coating material, wherein said coating material comprises a biodegradable polymer.

The loose particulate material preferably consists of sand and said biodegradable polymer is chosen from the group of PLA copolymers, PLA, PLLA, PDLA, PHBH, PHBV, PBAT, PHA, PHB, PBS, cellulose, PCL and thermoplastic starch, and mixtures of said biodegradable polymers.

In an embodiment of the present invention the loose, particulate material comprises one or more elements chosen from the group of sand, sand coated with said biodegradable polymer and sand coated with non-biodegradable polymers like PE, PP, copolymers of PS/PE, ABS, TPU, TPE, PS, EPDM, SBR, PA, PU, PC, PET, PTFE, SBS, SEBS, PEF, chloroprene rubber, nitrile rubber, isoprene rubber, neoprene rubber, polyacrylic rubber, silicones, latex or cellulose acetate. This means that such an infill is not 100% sand coated with a biodegradable polymer, but that other sand type particles are present, such as sand, i.e. sand that is not coated with a coating material at all, and sand coated with another type of polymer, i.e. non-biodegradable polymers as mentioned above. In another embodiment other infill materials may be present in minor amounts, such as rubber coated granular materials, for example synthetic rubber, e.g. butadiene rubber.

Reference will now be made in detail to compositions, embodiments, and methods of the present invention known to the inventors. However, it should be

understood that disclosed embodiments are merely exemplary of the present invention which may be embodied in various and alternative forms. Therefore, specific details disclosed herein are not to be interpreted as limiting, rather merely as representative bases for teaching one skilled in the art to variously employ the present invention.

An example of a method of producing a loose, particulate material consisting of particles coated with a coating material comprises a step of placing a portion of a loose, particulate material in a mixer comprising mixing means, adding a portion of a coating material to the content of the mixer under continued operation of the mixing means, and directing an airflow through the content of the mixer so as to lower the temperature thereof. The coated particles are no longer mutually bonded and a loose, particulate product is obtained. The present inventors found that for using biodegradable polymer in such a coating application care should be taken for an unwanted hydrolisation of these polymers. In that context it is necessary to prevent that these polymers hydrolyze quickly. To this end a protective atmosphere with a very low moisture content may be used as a protective covering to process the biodegradable polymer. Typical ambient air conditions used in such a coating process include dry air with a dew point of –35°C.

Example 1

As a loose, particulate material an amount of 50 kg sand was treated with 0,2 %(m/m) silane A174 adhesion promoter. The sand had a diameter of 1 mm and was subsequently coated with 1 kg of a PLA Luminy (manufactured by Total Corbion) with an MFI of 18 (measured according to ISO1133:(230°C/ 2.16kg)), a PLA injection moulding polymer. The coated sand thus obtained was applied to standard 3rd generation artificial turf lawn grass with a pole height of 35 mm, where PE fibres are positioned into a woven backing of PP and that is coated with a latex. First a layer of 10-15 mm normal sand – without a coating- was applied and on top of that, an additional layer of 20-25 mm PLA coated sand, where the performance is shown in Table 1.

Example 2

As a loose, particulate material an amount of 50 kg sand was used. Sand having a diameter of 1 mm was coated with 2 kg of a PLA Luminy LX390 (manufactured by Total Corbion) with an MFI of 18 (measured according to

ISO1133:(230°C/ 2.16kg)), a PLA injection moulding polymer. The coated sand thus obtained was applied to standard 3rd generation artificial turf lawn grass with a pole height of 35 mm, where PE fibres are positioned into a woven backing of PP and that is coated with a latex. First a layer of 10-15 mm normal sand – without a coating- was applied and on top of that, an additional layer of 20-25 mm PLA coated sand, where the performance is described in Table 1 with the remark that for some sand particles a loose coating was observed.

Example 3

As a loose, particulate material an amount of 50 kg sand was used. Sand having a diameter of 1 mm was coated with 2 kg of a PLA Luminy LX390 (manufactured by Total Corbion) with an MFI of 18 (measured according to ISO1133:(230°C/ 2.16kg)), a PLA injection moulding polymer. The coated sand thus obtained was applied to standard 3rd generation artificial turf lawn grass with a pole height of 35 mm, where PE fibres are positioned into a woven backing of PP and that is coated with a latex. A layer of 30-35 mm thickness consisting of the PLA coated sand was applied to the artificial turf lawn grass. The performance is shown in Table 1 with the remark that that for some sand particles a loose coating was observed.

Example 4

As a loose, particulate material an amount of 50 kg sand was used. Sand having a diameter of 1 mm was coated with 2 kg of a PLA Luminy LX390 (manufactured by Total Corbion) with an MFI of 18 (measured according to ISO1133:(230°C/ 2.16kg)), a PLA injection moulding polymer. The coated sand thus obtained was applied to standard 3rd generation artificial turf lawn grass with a pole height of 35 mm, where PE fibres are positioned into a woven backing of PP and that is coated with a latex. First a layer of 10-15 mm of a PE coated sand (Sabic LDPE 1922N0 MFI 22 gr/10 min ISO 1133 (190 °C / 2.16 kg)) was applied and on top of that, an additional layer of 20-25 mm PLA coated sand, where the performance is described in Table 1 with the remark that for some sand particles a loose coating was observed.

Example 5: The application of a coupling agent on a loose, particulate material sand

Silane preparation

In a glass beaker 500 ml isopropyl alcohol (IPA) ≥99.7% (supplier Merck) was mixed with 500 ml demineralized water and 5 ml Silane type 3-(trimethoxysilyl)propyl methacrylate (supplier Merck). The mixture thus obtained was stirred continuously for 5 min every 10 min for a period of 2 hours.

Mixing of silane solution with sand

In a rotary cement type mixer 300 ml of the silane solution was added to 2 kg of round sand having a 1,0-1,1 mm diameter and this was rotated for 30 minutes, and then the content was emptied in a steel container which has a steel mesh (120 MESH) with sufficient openings to remove the excess liquid. The sand was put back in a heated oven and was heated to 115°C for 30 minutes. Subsequently the sand was removed from the oven and mixed with 10 gram of PBAT (polybutylene adipate terephthalate) granules type Ecoflex F blend C1200 (BASF) and put back in the oven while continuously mixing and heating to 250°C. An industrial bottle with compressed purging nitrogen (supplier Linde $N_2$ 5.0 instrument nitrogen quality) was connected during the period of heating and emptying such that the ambient air in the heated mixer assembly was purged when an improvised lid was closed over the aperture of the mixer. The objective being to reduce the amount of oxygen that could affect the quality of the PBAT polymer. The $N_2$ flow was about 2 liter/$N_2$ minute. The PBAT was seen to be flowing around the sand and thus wetting the sand by melting around the heated sand. After 15 minutes of mixing the sand was observed to be coated with PBAT and the thus coated sand was removed from the oven and quenched in a water bath at ambient temperature of 20°C. After a period of 15 minutes in the water bath the sand was put in the sieve to remove excess water and the sand was left to dry at ambient temperature. A brown discoloration of the sand was observed which is assumed to be a minor discoloration of the PBAT polymer. After 24 hours the sand was dry enough and was observed to behave in a rubbery way when compressed by hand unlike normal sand. This PBAT coated sand was used in artificial grass system

The artificial turf installation constructed with the infill material according to Example 1 did undergo several qualification tests as shown in Table 1. The results shown in Table 1 indicate that the artificial turf installation meets specific standards for sport fields, emission of hazardous components, weather and fire resistant.

Table1: Performance and measured properties of a 35 mm high layer of PLA coated sand in a standard 3rd generation artificial turf lawn grass with a pole height of 35 mm.

| Qualification test | RESULT | EXTERN INSTITUTE | COMMENT |
|---|---|---|---|
| Full FIFA test - incl Lisport XL | Approved | ERCAT, Belgium Centre for Textile Science and Engineering | FIFA QUALITY PRO/FIFA Quality Program |
| 18 PAH test (Polycyclic Aromatic Hydrocarbons) | 18 PAH<br>NONE present | Institut Dr. Lörcher, Germany | Hazardous Chemicals – cancer. Concentration limits for rubber granules from used tyres used as infill |
| MicroPlastic | Not MicroPlastic | MEDIATOR, Chemical and environment consultant agency in Denmark | infill is not by definition solid polymer containing particles (infill has only 2% polymer - not 100% solid) |
| Migration test DIN 18035-7:2014 | Approved | Institut Dr. Lörcher, Germany | Release of hazardous volatile gases and particles in the air, ground- and surface water |
| Weather-resistant/<br>UV–A test 5000 hours<br>EN 14836 (2005) | Approved colour + shape | ERCAT, Belgium<br>Centre for Textile Science and Engineering | UV-A ageing of 5000 hours test is approved<br>In colour + shape |
| Toy Safety EN/DS 71-3 | Approved | Institut Dr. Lörcher, Germany | Safety requirements for toys sold in EU |
| Fire resistance –<br>EN ISO 9239-1 (2010)<br>EN ISO 11925-2<br>EN 13501-1 | Classification<br>B<br>Smoke s1 | ERCAT, Belgium<br>Centre for Textile Science and Engineering | Approved |

Sand having a particle distribution as shown in Table 2 was used in all examples. The parameter of “a diameter of 1 mm” is to be understood as > 80% of all particles falls within a range of 1-0,9 mm, measured by a Retch CAMSIZER P4.

Table 2: particle distribution of sand

| | % |
|---|---|
| Retch technology Cam sizer P4 | |
| | |
| > 1mm | 2 |
| 1-0,9 mm | 82 |
| 0,9-0,5 | 9 |
| 0,5-0,1 | 6 |
| <0,1 | 1 |

Several polymers (see Table 3) were applied as a coating material on sand. These coating materials include both non-biodegradable polymers and biodegradable polymers. The process conditions are shown in Table 3.

Table 3: application of several types of coating material on sand

| grade | in short | supplier | MFI | MFI unit | Methode | atmosphere under which coating is applied onto sand | adehsion promoter 0,2%Silane A174 | relative result visual 10 =excellent , 1 =bad, 5 just ok |
|---|---|---|---|---|---|---|---|---|
| Sabic LDPE 1922N0 | PE | Sabic | 22 | g/10 min | ISO 1133 ( 190 °C / 2.16 kg ) | normal air | no | 9 |
| Sabic PP 412MK49 | PP | Sabic | 43 | g/10 min | ISO1133:(230°C/ 2.16kg) | normal air | no | 6 |
| Luminy® LX930 | PLA | Total Corbion | 18 | g/10 min | ISO 1133-A (210°C/2.16kg) | water free air | yes | 9 |
| bioplast 105 | PLA/ PBAT ompound | Biotec | 4 | g/10 min | ISO1133 (190°C/ 2.16 kg) | water free air | no | 5 |
| X151A | PHBH | Kaneka | 3 | g/10 min | ISO1133(165°C, 5kg)) | water free air | no | 7 |

CLAIMS

1. An artificial turf installation, comprising:

a pile fabric having a backing and a multiplicity of generally upstanding pile elements; and

an infill overlying said backing and being interspersed between said upstanding pile elements, said infill comprising a loose, particulate material consisting of particles coated with a coating material, wherein said coating material comprises a biodegradable polymer.

2. An artificial turf installation according to claim 1, wherein said biodegradable polymer is chosen from the group of PLA copolymers, PLA, PLLA, PDLA, PHBH, PHBV, PBAT, PHA, PHB, PBS, cellulose, PCL and thermoplastic starch, and mixtures of said biodegradable polymers.

3. An artificial turf installation according to any one or more of claims 1-2, wherein said biodegradable polymer has a MFI (Melt Flow Index) in a range of 2-50, preferably in a range of 12-20, measured according to ISO 1133.

4. An artificial turf installation according to any one or more of claims 2-3, wherein said biodegradable polymer comprises PLA.

5. An artificial turf installation according to any one or more of claims 1-4, wherein said loose particulate material consists of sand.

6. An artificial turf installation according to claim 5, wherein the diameter of said loose particulate material is in a range of 0,05-3 mm, preferably 0,9-1,6 mm, more preferably 0,9-1,1 mm in diameter, with a bulk density of the coated loose particulate material of 500-2500 kg/$m^3$, preferably of 900-1500 kg/$m^3$.

7. An artificial turf installation according to any one or more of claims 1-6, wherein the coating material constitutes 1 - 10% % by weight of the loose particulate material, preferably 1,9-2,5% % by weight of the loose particulate material.

8. An artificial turf installation according to any one or more of claims 1-7, wherein a coupling agent is provided between the loose particulate material and the coating material, so as to improve the binding between the loose particulate material and the coating material.

9. An artificial turf installation according to claim 8, wherein said coupling agent comprises a silane having a methacrylate group.

10. An artificial turf installation according to any one or more of claims 1-9, wherein said pile elements are made from polymers chosen from the group of PE, PP, SMA, PA, PLA, PDLA, PLLA, star shaped PLA polymer, and/or copolymers of PLA, PBS, PHBH , cellulose or combinations thereof.

11. An artificial turf installation according to any one or more of claims 1-10, wherein a pole height of said multiplicity of generally upstanding pile elements is in a range of 20-60 mm, preferably 30-35 mm.

12. An artificial turf installation according to any one or more of claims 1-11, wherein said pile elements further comprise one or more additives, chosen from the group of antistatic additives, colorants, UV stabilizers, anti-microbial substances, fire retardants, cross linkers, coupling agents, melt flow enhancers and anti-slip agents.

13. An artificial turf installation according to any one or more of claims 1-12, wherein said infill further comprises sand not coated with a coating material.

14. A loose, particulate material consisting of particles coated with a coating material, wherein said coating material comprises a biodegradable polymer.

15. A loose, particulate material according to claim 14, wherein said loose, particulate material consists of sand and said biodegradable polymer is chosen from the group of PLA copolymers, PLA, PLLA, PDLA, PHBH, PHBV, PBAT, PHA, PHB, PBS, cellulose, PCL and thermoplastic starch, and mixtures of said biodegradable polymers.

16. A loose, particulate material according to any one or more of claims 14-15, wherein said loose particulate material comprises one or more elements chosen from the group of sand, sand coated with said biodegradable polymer and sand coated with non-biodegradable polymers like PE, PP, copolymers of PS/PE, ABS, TPU, TPE, PS, EPDM, SBR, PA, PU, PC, PET, PTFE, SBS, SEBS, PEF, chloroprene rubber, nitrile rubber, isoprene rubber, neoprene rubber, polyacrylic rubber, silicones, latex or cellulose acetate.

17. A loose, particulate material according to any one or more of claims 14-16, wherein a coupling agent is provided between the loose particulate material and the coating material, so as to improve the binding between the loose particulate material and the coating material.

18. A loose, particulate material to claim 17, wherein said coupling agent comprises a silane having a methacrylate group.

5

# INTERNATIONAL SEARCH REPORT

International application No
PCT/NL2020/050673

A. CLASSIFICATION OF SUBJECT MATTER
INV. E01C13/08
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E01C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| X<br><br>Y<br>A | KR 102 018 068 B1 (DYECO CO LTD [KR])<br>4 September 2019 (2019-09-04)<br>paragraphs [0001], [0006], [0008],<br>[0014], [0029], [0030], [0041] - [0044]<br>claims 1,7; figures 1-4 | 1-7,<br>12-16<br>10,11<br>8,9,17,<br>18 |
| Y | IT MI20 110 144 A1 (TESSITURE PIETRO<br>RADICI S P A) 3 August 2012 (2012-08-03)<br>paragraphs [0004], [0036]<br>figures 1-3 | 10,11 |

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

[X] See patent family annex.

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

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"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 12 January 2021 | 21/01/2021 |

| Name and mailing address of the ISA/ | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016 | Kremsler, Stefan |

2

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| A | WO 2018/016956 A2 (SYNBRA TECH B V [NL]) 25 January 2018 (2018-01-25) cited in the application page 1, paragraph 1 page 5, paragraph 2 - page 6, paragraph 1 page 6, paragraph 5 - page 7, paragraph 1 page 7, paragraph 5 figures 1-16 | 1-18 |
| A | WO 2016/190744 A1 (TEN CATE THIOLON BV [NL]) 1 December 2016 (2016-12-01) cited in the application page 1, lines 5-8 page 2, lines 8-17 page 3, line 8 - page 4, line 2 page 4, lines 14-32 page 5, lines 4-9 page 7, lines 1-6 page 7, line 25 - page 8, line 12 claims 1,4; figures 1,2 | 1-18 |
| A | US 2017/319943 A1 (LEYDS JOHN ANTHONY [US] ET AL) 9 November 2017 (2017-11-09) paragraphs [0001], [0008] - [0010], [0016] - [0026] figures 1-4 | 1-18 |

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/NL2020/050673

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| KR 102018068 B1 | 04-09-2019 | NONE | |
| IT MI20110144 A1 | 03-08-2012 | NONE | |
| WO 2018016956 A2 | 25-01-2018 | EP 3332067 A2 | 13-06-2018 |
| | | WO 2018016956 A2 | 25-01-2018 |
| WO 2016190744 A1 | 01-12-2016 | AR 104745 A1 | 09-08-2017 |
| | | AU 2016267954 A1 | 25-01-2018 |
| | | CA 2987386 A1 | 01-12-2016 |
| | | CN 107735529 A | 23-02-2018 |
| | | DK 3303704 T3 | 21-12-2020 |
| | | EP 3303704 A1 | 11-04-2018 |
| | | NL 2014875 A | 08-12-2016 |
| | | US 2018171566 A1 | 21-06-2018 |
| | | WO 2016190744 A1 | 01-12-2016 |
| US 2017319943 A1 | 09-11-2017 | NONE | |