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(54) Title: ROOT-RESISTANT SEALANT OR TAPE

(57) Abstract: A sealant composition comprising: (i) a rubber or polyurethane; (ii) a filler; and (iii) a herbicide.

ROOT-RESISTANT SEALANT OR TAPE

[0001] This application claims the benefit of U.S. Provisional Application Serial No. 61/581,144, filed on December 29, 2011, which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] One or more embodiments of the present invention relate to a root-resistant sealant. In certain embodiments, a green roofing assembly is provided that includes a plurality of overlapping membranes and one or more penetrations through one or more of the membranes, where the penetrations are sealed with a root-resistant sealant.

BACKGROUND OF THE INVENTION

[0003] The construction industry commonly uses single ply membranes to provide a waterproof barrier on flat or low-slope roofs. Because it is expensive and difficult to produce and transport a single membrane sized to cover an entire roof surface, a roof is typically covered by a plurality of individual membranes oriented in an overlapping arrangement. The overlapping portions, or splices, of these individual membranes must be secured together to ensure that the plurality of membranes form a single waterproof surface.

[0004] A number of methods can be employed to secure the individual membranes together. For example, the lap seams formed between the roofing membranes may be adhered with a liquid-applied adhesive to form a weather-impermeable sealing barrier. Alternatively, an adhesive sealing tape can be used to secure the membranes together.

[0005] Additionally, the roof systems are rendered waterproof by securing the membranes to terminations or objects in the roof structure, such as parapet walls, or the various other penetrations or obstructions that exist on the roof such as pipes that may extend through the roof surface. These areas of the roof are rendered waterproof by the use of various sealants such as caulks, pourable sealants such as those for making penetration pockets, and general purpose

sealants for securing membrane or flashing to brick, concrete, masonry, metal, and wood.

[0006] In addition, various attachment techniques are employed in the art to secure the membrane to a roof substrate. For example, membrane panels can be fully adhered to the roof substrate (or to an intermediary surface, such as a roof insulation, that has been secured to the roof substrate). In certain situations, membrane panels include a factory applied adhesive layer substantially covering one planar surface of the panel. In other situations, attachment strips are secured to the roof or an intermediary layer of a roofing system by mechanical means (such as by use of a fastener and plate or a batten strip). In still other situations, membrane panels are secured to a roof deck or intermediary layer of a roofing system by employing mechanical means that direcdy engage or secure the membrane panel. Because these fastening systems pierce the membrane panel, they must be covered to ensure the waterproof integrity of the membrane system.

[0007] Another method of attachment involves using weighted objects placed upon the membrane to secure it over a roof substrate. Objects commonly placed on the membrane include ballast pavers, rocks, and planting pots. The weight of these objects counters wind uplift forces acting on the membrane, and prevents the membrane from moving relative to the roof substrate or insulation layer thereunder. In addition, roofing trays are sometimes placed on the membrane to secure it in place. The roofing trays are adapted to be filled with dirt and plants once positioned on the roof surface.

[0008] Roofing ballast devices containing vegetation offer a number of advantages. For example, they extend the longevity of traditional roofing membranes by providing a protective cover; they are environmentally friendly; they help to control temperatures within the building; they absorb rain water; and they allow for easy maintenance and/or replacement of the roofing membrane. However, ballasts containing vegetation produce roots that can be extremely harmful to the structure of the roofing membrane. These intrusive and disruptive roots often grow between the membranes' lap seams and eventually under the membranes. As a result, the weather-impermeable seal between the membranes is broken, water seeps under the roofing membranes, and the roofing structure's durability is significantly compromised.

[0009] Thus, there is a need to prevent plant life from compromising the various sealed areas of roofing membranes or similar weather-impermeable or water-impermeable membrane systems, such as geomembrane systems.

SUMMARY OF THE INVENTION

[0010] One or more embodiments of the present invention provide a sealant composition comprising: (i) a rubber or polyurethane; (ii) a filler; and (iii) a herbicide.

[0011] Other embodiments of the present invention provide a root-resistant 100% solids tape comprising: (i) a rubber; and (ii) dispersed within the rubber a herbicide.

[0012] Other embodiments of the present invention provide a roofing system comprising: (i) a roof deck; (ii) a polymeric or asphaltic membrane covering the roof deck; and (iii) sealed seams, sealed terminations, or sealed penetrations within the polymeric or asphaltic membrane, where at least one of the seams, terminations, and penetrations are sealed with (a) a root-resistant sealant including a rubber or polyurethane, a filler, and a herbicide, or (b) a root-resistant tape including a rubber and a herbicide dispersed within the rubber.

[0013] Other embodiments of the present invention provide a geomembrane construction comprising: (i) a geomembrane applied over a location, where the geomembrane includes one or more mated seams; and (ii) one or more mated seams within the geomembrane, where at least one of the mated seams is sealed with (a) a root-resistant sealant including rubber or polyurethane, a filler, and a herbicide, or (b) a root-resistant tape including a rubber and a herbicide dispersed within the rubber.

DETAILED DESCRIPTION OF THE ILLUSTRATIVE EMBODIMENTS

[0014] Embodiments of the present invention are based on the discovery of a sealant or tape composition that is useful in roofing and/or geomembrane applications. The sealant and/or tape is a root-resistant sealant to the extent that it can prevent or inhibit the growth or penetration of plant life into the seams or other sealed areas of a roofing or geomembrane system. More specifically, aspects of the present invention are based on the use of a herbicide within a sealant or

tape composition of the type used in preparing a roofing or geomembrane system. Practice of the present invention is particularly useful in the preparation of green roofing systems where plant life is placed upon membrane systems. These sealants and/or tapes are particularly advantageous because they can prevent or inhibit the expansion or growth of the plant life into or through the membrane systems at locations such as lap edges or penetrations. The sealants and/or tapes of the present invention are also useful in geomembrane systems, especially in those areas where plant life can be problematic near lap edges or penetrations.

HERBICIDE

[0015] Herbicides include those compounds that kill targeted plant life. Those skilled in the art also appreciate that the term herbicide can loosely be employed to refer to plant growth regulators, which include those compounds that stunt, inhibit, or cease further plant growth life, without necessarily being fatal to the plant. Accordingly, unless otherwise stated, the use of the term herbicide within this application shall refer to traditional herbicides as well as plant growth regulators. In particular embodiments, where specifically stated, the compositions of the present invention include traditional or conventional herbicides in the absence of plant growth regulators.

[0016] In one or more embodiments, the herbicide is compatible with the other constituents of the sealant or tape composition. For example, in certain embodiments, the herbicide is inert with respect to the other constituents within the sealant or tape composition, which refers to the fact that the herbicide will not react with or otherwise interact with one or more constituents of the sealant or tape composition, especially in a manner that will be deleterious to the usefulness of the sealant or tape. In one or more embodiments, the herbicide is in the form of a liquid, and in other embodiments the herbicide is in the form of a solid. In either event, the herbicide may be introduced to the sealant or tape composition together with an inert carrier, the carrier being inert with respect to the herbicide and in one or more embodiments, the other constituents of the sealant composition.

[0017] In one or more embodiments, the herbicide (optionally together with a carrier) is dissolved in the solids portion of the sealant or tape composition. In other embodiments, the herbicide (optionally together with a carrier) is dissolved within the solvent portion of the sealant composition. In yet other embodiments,

the herbicide (optionally together with the inert carrier) is dispersed as discrete solid particles within the solids portion of the sealant or tape composition.

[0018] In one or more embodiments, the herbicide is a pre-emergent herbicide. The pre-emergent herbicide component may consist of a single pre-emergent herbicide or a combination of pre-emergent herbicides. Pre-emergent herbicides are chemicals that inhibit root and weed development by interrupting mitosis and preventing target seeds from germinating. In addition, pre-emergent herbicides prevent seedlings from growing to maturity by preventing target root and weed cells from adequately dividing shortly after germination begins. Examples of suitable pre-emergent herbicides include atrazine, benefin, bensulide, DCPA (chlorthal dimethyl), dithiopyr, ethalfluralin, isoxaben, pendimethalin, prodiamine, oryzalin, oxadiazon, oxyfluorfen, siduron, and trifluralin. In particular embodiments, the herbicide is a dinitroaniline herbicide. Specific types of dinitroaniline herbicides include a,a,a-trifluoro-2,6-dinitro -*N*,*N* -dihydrocarbyl-p-toluidines. A specific example of a,a,a-trifluoro-2,6-dinitro -*N*,N-dihydrocarbyl-p-toluidine is a,a,a-trifluoro-2,6-dinitro -*N*,*N* -dipropyl-p-toluidine, which is also known as trifluralin.

AMOUNT OF HERBICIDE

[0019] In one or more embodiments, the herbicide employed in the present invention may be added to known sealant or tape compositions without the need to alter the other constituents of the sealant or tape compositions. In one or more embodiments, the amount of herbicide included within the sealant or tape compositions may be defined based on the solids component of the sealant and/or tape. In particular embodiments, the amount of herbicide employed may be from 0.1 to about 10% by weight, in other embodiments from 0.25 to about 5% by weight, in other embodiments from 0.35 to about 2% by weight, and in other embodiments from 0.5 to about 1% by weight based upon the total weight of the solids component of the sealant or tape composition.

SEALANT OR TAPE COMPOSITION

[0020] In one or more embodiments, the sealant composition containing the herbicide according to the practice of the present invention may be selected from the group of pourable sealants, lap sealants (which may also be referred to as all-

purpose sealants), and caulks. In other embodiments, the compositions of the present invention include a solids tape composition in which the herbicide is dispersed within the solids. As those skilled in the art appreciate, pourable sealants are designed for sealing penetration pockets within roof constructions. Lap sealants are designed for seaming the edges of adjoining membranes to each other or to other constructions on the roof, including those fabricated from brick, concrete, wood, and steel. And caulks are designed as general purpose non-sag sealants that can be used to adhere to polymeric sheet material, sheet metal, masonry, brick, and concrete block. The sealant compositions of the present invention generally share the characteristics of including one or more polymer constituents (e.g., rubber or polyurethane), filler, and optionally solvent. The compositions generally differ in the solids content of the composition (prior to application) and in the complimentary constituents employed in each recipe. The tapes are generally designed as solids tapes that are typically used for splicing membrane panels or splicing membrane panel to flashing.

[0021] In one or more embodiments, lap sealants generally include a polymer, filler, tackifier oil, thixotropic agent, and a solvent. Lap sealants typically include from about 50 to about 80% by weight, in other embodiments from about 55 to about 75% by weight, and in other embodiments from about 60 to about 70% by weight solids, with the remaining portion including a solvent. The solids portion typically includes about 2 to about 20% by weight, in other embodiments from about 2 to about 10% by weight, and in other embodiments from about 3 to about 7% by weight polymer (***e.g.,*** rubber or polyurethane), based upon the weight of the solids component. The filler generally accounts for about 40 to about 80% by weight, in other embodiments from about 50 to about 70% by weight, and in other embodiments from about 55 to about 65% by weight of the solids component. And, about 10 to about 50% by weight, in other embodiments, from about 20 to about 40% by weight, and in other embodiments from about 25 to about 35% by weight of the solids component is a tackifier oil.

[0022] Pourable sealants are generally 100% solids compositions based upon two-part polyurethane systems. These compositions may include from about 30 to

about 95% by weight, in other embodiments from about 40 to about 80% by weight, and in other embodiments from about 45 to about 70% by weight filler.

[0023] Caulk compositions are generally high solids compositions that include from about 70 to about 99% by weight, in other embodiments from about 85 to about 98% by weight, and in other embodiments from about 90 to about 97% by weight solids. The solids portion of typical caulks may include from about 2 to about 20% by weight, in other embodiments from about 3 to about 10% by weight, and in other embodiments from about 4 to about 8% by weight polymer (e.g., rubber or polyurethane), based upon the total weight of the solids. Also, the solids portion of the caulk compositions typically include from about 70 to about 97% by weight, in other embodiments from about 80 to about 95% by weight, and in other embodiments from about 90 to about 95% by weight filler, based upon the total weight of the solids component.

[0024] The solids tape compositions in which the herbicide may be dispersed according to one or more aspects of the present invention may include a rubber tape. As is known in the art, these rubber tapes may be flexible and include a cured rubber, partially cured rubber, and/or uncured rubber. Useful rubbers include, but are not limited to, EPDM, butyl and halobutyl rubbers, chlorinated polydienes such as neoprene, and the like. Because these tapes are typically 100% solids tapes, they are two-sided tapes; that is, they can be adhered on both of the opposing planar surfaces of the tape. Typical sealant tapes are characterized by being about ½ to 4 inches wide and are about 20 to 40 mils thick; in certain embodiments, the sealant tapes are about 1 to 3 inches wide and about 35 to 35 mils thick. These tapes are typically removably laminated to a release film or paper. Exemplary tapes are described in U.S. Patent Nos 4,855,172, 5,242,727, 5,504,136, 5,545,685, 5,563,217, 5,612,414, and 6,426,129.

[0025] In preparing the sealant compositions described above, one or more of the following ingredients may be employed. Similar ingredients are used in preparing solids tapes.

[0026] Examples of suitable rubber, which may also be referred to as elastomers, include halogenated polyisobutylene (bromobutyl rubber), polyisobutylene (butyl rubber) including copolymers of isobutylene with

comonomer such as paramethyl styrene, polybutadiene, polyisoprene, halogenated polyisobutylene paramethyl styrene, chlorinated polyisoprene *(e.g.,* neoprene), ethylene-propylene rubber (EPR), ethylene-propylene-diene rubber (EPDM), and polyvinyl chloride. Suitable halogenated elastomers include halogenated butyl containing elastomers. These halogenated butyl elastomers include, but are not limited to, chloro butyl, bromobutyl, crosslinked bromobutyls and halogenated polyisobutylene paramethyl styrene.

[0027] In particular embodiments, the rubber employed is EPDM. EPDM is a commonly used abbreviation for ethylene-propylene diene monomer rubber. The monomers are used to synthesize EPDM polymers include ethylene, propylene, and small amounts of a nonconjugated diene such as hexadiene, dicyclopentadiene, or ethylidene norborene. These polymers are useful in roofing applications, after vulcanization, because of their elastomeric nature and resistance to moisture, to UV attack, and to temperature aging. The preferred terpolymers contain from about 40 to about 80 weight percent ethylene and from about 1 to about 10 weight percent of the diene with the balance of the terpolymer being propylene. For typical commercially available EPDM rubbers, the Mooney viscosity is from about 1 to 80.

[0028] The diene monomer utilized in forming the EPDM terpolymer is preferably a non-conjugated diene. The diene component of the terpolymer can be any of those commercially available, including, but not limited to, ethylidene norbornene, 1-4-hexadiene or dicyclopentadiene, or mixtures thereof, with ethylidene norbornene (ENB) being preferred. Other illustrative examples of non-conjugated dienes which may be employed are alkyldicyclopentadiene, 1,4-pentadiene, 1,5-hexadiene, 1,4-heptadiene, 2-methyl-l,5-hexadiene, cyclooctadiene, 1,4-octadiene, 1,7-octadiene, 5-ethylidene-2-norbornene, 5-n-propylidene-2-norbornene, 5-(2-methyl-2-butenyl)-2-norbornene and the like.

[0029] In certain embodiments, the polyurethane may derive from a one part urethane system, or in other embodiments it may derive from a two-part urethane system.

[0030] In one or more embodiments, the polyurethane component includes highly branched polyurethane, which derive from multi-functional polyisocyanates

and/or multi-functional polyols. As those skilled in the art will also appreciate, polyurethanes are best described with respect to the reactants that form the polyurethane.

[0031] In one or more embodiments, the polyurethane may be formed from a two-component system that includes reacting an isocyanate with a polyol. In other embodiments, the polyurethane may be formed from a single-component system that includes reacting an isocyanate with moisture from the air. Catalysts may be present during the reaction.

[0032] Useful isocyanates include compounds having at least one isocyanate functionality (NCO), including polymeric or monomeric isocyanates. In particular embodiments, isocyanates having three NCO functionalities are employed (i.e., tri-functional isocyanates). Examples of monomeric isocyanates include toluene diisocyanate (TDI), diphenylmethane diisocyanate (MDI), hexamethylene diisocyanate (HDI), 1,6-hexane diisocyanate, and isophorone diisocyanate (IPDI). An example of a polymeric isocyanate includes polymeric diphenylmethane diisocyanate (polymeric MDI). Polymer MDI is available under the name Rubinate™ 1850 or 9257 (ICI Polyurethane, Inc.; West Deptford, New Jersey), and trimers of 1,6-hexane diisocyanate are available under the tradename Desmodur™ (Bayer Fiber Organics and Rubber; Akron, Ohio). Polymeric isocyanates with high 2,4 content are commercially available as Rubinate™ 9485 and Rubinate™ 9433.

[0033] Useful polyols include compounds having at least one isocyanate-reactive functionality. Any polyol conventionally employed in the production of polyurethanes can be used. This includes both polyether polyols and polyester polyols, as well as those containing primary and secondary hydroxyl groups. In preferred embodiments, the conventional polyols include blends of primary and secondary polyols. Conventional polyols can have from two to about six hydroxyl functionalities, but it is preferred that the polyol contain from about two to about three hydroxyl functionalities. Inasmuch as the adhesive in certain embodiments includes both a conventional polyol and the polyhydroxyl phenol-containing compound, the term conventional polyol, or simply polyol, will refer to those polyols other than the polyhydroxyl phenol-containing compound.

[0034] Polyols are widely available, and non-limiting examples include Stepanol™ PS2502A (Stephan Chemical Co.; Northfield, Illinois), which is a primary polyester polyol or Voranol™ 800, 490, 360 or 220-260 (Dow Chemical Co.; Midland, Michigan), which are secondary polyether polyols. Non-limiting exemplary blended polyols include Poly-G VHP™ 85-36, Poly-G VHP™ 55-37, Poly-G VHP™ 55-173, and Poly-G VHP™ 83-26 (Arch Incorporated; Indianapolis, Indiana), which are blends of primary and secondary polyether polyols.

[0035] In particular embodiments, the polyols include polyhydroxyl phenol-containing compounds. Polyhydroxyl phenol-containing compounds include at least two hydroxyl groups attached to one or more phenol substituents. Non-limiting examples of these compounds include phenolic resins, m-dihydroxybenzene (resorcinol), p-dihydroxybenzene (quinol), and o-dihydroxybenzene (catechol).

[0036] Phenolic resins, which derive from the polymerization of alkyl phenols and formaldehydes, are preferably employed in. In synthesizing phenolic resins, the ratio of alkyl phenol to formaldehyde is typically about 1.5:1. Phenolic resins are commercially available under the tradename SP 560™, SP 1068™, or SP 1090™ (Schenectady International: Schenectady, New York), or under the name Dyphene™ 8318, Dyphene™ 8330, or Dyphene™ 8340 (PMC Specialties Group, Inc.; Cleveland, Ohio). Resol resins are also useful. A resol resin is the reaction product of an alkyl phenol and formaldehyde where the ratio of alkyl phenol to formaldehyde is less than about 1:1.

[0037] Useful catalysts include alkali metal phenolates, alkali metal carboxylates, and alkoxides. The phenolates may also be referred to as phenoxides. Exemplary alkali metals include lithium, sodium, potassium, rubidium, cesium, and francium. Exemplary phenolate ligands include p-nonylphenolate, p-octylphenolate, p-tert-butylphenolate, and various alkylphenol-formaldehydes. Preferred alkali metal phenolates include potassium, sodium, and lithium p-nonylphenolate. Alkali metal phenolates, such as potassium p-nonylphenoxide, can be formed from the reaction of p-nonylphenol and potassium hydroxide, preferably within toluene or ethyl acetate. Alkali metal carboxylates such as

potassium, sodium, and lithium carboxylates include salts of 2-ethylhexanoic acid, acetic acid, propionic acid butyric acid and the like.

[0038] Other polyurethane catalysts include those catalysts typically employed in the art to expedite or facilitate the reaction between ethylene oxide or propylene oxide polyols and isocyanates. Conventional polyurethane catalysts include, but are not limited to, tin+4 salts such as dibutyltin dilaurate, dimethyltin dilaurate and dibutyltin diacetate. These catalysts are commercially available under the tradename Formrez SUL-4(Witco Corp; Greenwich, Connecticut), and Dabco T-12 (Air Products; Allentown, Pennsylvania). Certain compounds can act as both the polyol and catalyst component. These compounds include primary amine terminated polyols, which are available under the name Jeffamine T-5000, and autocatalytic secondary and primary terminated polyols such as Jeffamine R-350-X.

[0039] In one or more embodiments, the sealant compositions of the present invention may include fillers or pigments such as an organic filler and/or inorganic filler. Useful organic fillers include carbon blacks, coal filler, and ground recycled rubber. Useful inorganic fillers include clays, talc, mica, titanium dioxide, calcium carbonate, and silica.

[0040] In one or more embodiments, useful carbon blacks include those generally characterized by average industry-wide target values established in ASTM D-1765. Exemplary carbon blacks include GPF (General-Purpose Furnace), FEF (Fast Extrusion Furnace), and SRF (Semi-Reinforcing Furnace). One particular example of a carbon black is N650 GPF Black, which is a petroleum-derived reinforcing carbon black having an average particle size of about 60 nm and a specific gravity of about 1.8 g/cc. Another example is N330, which is a high abrasion furnace black having an average particle size about 30 nm, a maximum ash content of about 0.75%, and a specific gravity of about 1.8 g/cc.

[0041] Useful clays include hydrated aluminum silicates. In one or more embodiments, useful clays can be represented by the formula Al203Si02*XH20. Exemplary forms of clay include kaolinite, montmorillonite, atapulgite, illite, bentonite, halloysite, and mixtures thereof. In one embodiment, the clay is represented by the formula Al203Si02*3H20. In another embodiment, the clay is

represented by the formula $Al_2O_3SiO_2 \cdot 2H_2O$. In a preferred embodiment, the clay has a pH of about 7.0.

[0042] Useful talc include hydrated magnesium silicate. In one or more embodiments, talc can be represented by the formulae $Mg_3Si_4O_{10}(OH)_2$ or $3MgO \cdot 4SiO_2 \cdot H_2O$. Exemplary forms of talc include talcum, soapstone, steatite, cerolite, magnesium talc, steatite-massive, and mixtures thereof. Talc filler may contain various other minerals such as dolomite, chlorite, quartz, and the like. Talc used as filler may also exhibit characteristics such as hydrophobicity, organophilicity, non-polarity, and chemically inertness. In one embodiment, the talc has a specific gravity of from about 2.6 to about 2.8, a pH of from about 7.0 to 8.7, a refractive index of about 1.57 at 23°C, and a moisture content of less than about 0.5 weight percent. A representative talc is Talc 9107, which is available from Polar Minerals (Mt. Vernon, IN), which is non-abrasive, chemically inert, has a specific gravity of about 2.8, a pH of about 8.7, a refractive index of about 1.57 at 23°C, and a moisture content of less than about 0.3 weight percent.

[0043] Useful silicas include fumed silica and precipitated silicas.

[0044] In one or more embodiments, the sealant compositions of the present invention may include oil, which may also be referred to as processing oil or extender oil. These extenders may include high-boiling hydrocarbons. Examples of these oils include paraffinic oils, aromatic oils, naphthenic oils, vegetable oils, and low PCA oils including MES, TDAE, and SRAE, and heavy naphthenic oils, and various synthetic oils such as, but not limited, polybutene oils. In one or more embodiments, the oil employed is selected based upon its compatibility with the rubber, as well as its ability to provide advantageous properties to the final composition (e.g., green strength or tack).

[0045] In particular embodiments, a polybutene oil is employed. Useful polybutene oils include high-viscosity oils that may be characterized by a viscosity at 100 °C of at least 80 est, in other embodiments at least 100 est, or in other embodiments at least 120 est up to, for example, about 700. or 800 est. In these or other embodiments, the high viscosity polybutene oils may be characterized by a molecular weight of at least 1000 g/mole, in other embodiments at least 1200 g/mole, or in other embodiments at least 1300 g/mole up to, for example, 1400 or

1500 g/mole. An exemplary high-viscosity polybutene oil is available under the tradename Indapol H300 (Ineos) or PB32 (Soltex).

[0046] In one or more embodiments, the sealant compositions of the present invention may include thixotropic agents, which may also be referred to as thickeners. As generally known in the art, these agents may include those substances that increase the viscosity of a composition without affecting its other properties. Useful thixotropic agents include inorganic and organic thixotropic agents. Examples of inorganic thixotropic agents include, but are not limited to, clays, fumed silica, precipitated silica, fine talc, and chalk (calcium carbonate). Examples of organic thixotropic agents include, but are not limited to, polyethylene glycol, polyacrylic acid, and vegetable gums.

[0047] In addition to the foregoing constituents, the membranes of this invention may also optionally include homogenizing agents, processing aids such as waxes, flame retardants, zinc oxide, stearic acid, antioxidants, antiozonants, processing additives UV stabilizers, blowing agents, perfumants, anti-stats, insecticides, bacteriostats, fungicides, surfactants, plasticisers, other non-reactive diluents and the like, and mixtures thereof.

[0048] In one or more embodiments, the solvent serves to dissolve or disperse one or more of the solids constituents of the solids portion of the sealant. The solvent generally includes liquid organic compounds that do not undergo chemical reactions with the solids components. In one or more embodiments, these organic compounds are liquid at ambient temperature and pressure. Exemplary organic solvents include hydrocarbons with a low or relatively low boiling point such as aromatic hydrocarbons, aliphatic hydrocarbons, and cycloaliphatic hydrocarbons. Non-limiting examples of aromatic hydrocarbons include benzene, toluene, xylenes, ethylbenzene, diethylbenzene, and mesitylene. Non-limiting examples of aliphatic hydrocarbons include n-pentane, n-hexane, n-heptane, n-octane, n-nonane, n-decane, isopentane, isohexanes, isopentanes, isooctanes, 2,2-dimethylbutane, petroleum ether, kerosene, and petroleum spirits. And, non-limiting examples of cycloaliphatic hydrocarbons include cyclopentane, cyclohexane, methylcyclopentane, and methylcyclohexane. Mixtures of the above hydrocarbons may also be used. Other useful solvents includes polar solvents such as ketones and aldehydes. Useful ketones include acetone, diisobutyl ketone,

ethylisopropyl ketone, acetophenone, butanone, isophorone, mesityloxide, methylisopropyl ketone, 3-pentanone, and mixtures thereof.

[0049] In one or more embodiments, the root-resistant sealant comprises a solvent. Suitable solvents include, but are not limited to, toluene, hexane, xylene, heptane, methanol and ethanol. It should be understood that a blend of solvents may also be employed. In certain embodiments, solvents that are currently recognized by most environmental agencies as exempt may be used as solvents. These solvents may include parachlorobenzotrifluoride (PCBTF), 1-dodecene, methylene chloride, 1-tetradecene, chloroform, tetrachloro ethylene, and 1,1,1-trichlorethane.

PREPARATION OF SEALANT/TAPE

[0050] In one or more embodiments, practice of the present invention does not alter the methods of manufacturing the sealants and/or tapes of the present invention. In general, the herbicide employed in practicing the present invention may simply be added as one of the constituent ingredients employed during the manufacture of the sealant and/or tape. In one or more embodiments, the herbicide may be added to the compositions along with one or more of the other solid ingredients employed. In particular embodiments, the herbicide may be predispersed or dissolved in one of the other constituents of the composition. For example, the herbicide may be predispersed within an extender oil and then combined with the other ingredients. In other embodiments, the herbicide may be dissolved within a solvent and then added or combined with the other constituents.

INDUSTRIAL APPLICABILITY

[0051] In one or more embodiments, the sealant and/or tape compositions of the present invention may be employed to create a seal or splice or otherwise cover a seal or splice within a roofing system. In one or more embodiments, the compositions may be used to seal adjoining membrane panels (e.g., splice panels) or adjoin membrane panel to flashing. In other embodiments, the sealant compositions may be applied over an existing seal. For example, a liquid sealant or caulk can be applied over an existing lap seam or splice. In other embodiments, the sealing compositions of the present invention can be used as a contact adhesive

to secure membrane panel or flashing to components of the building such as parapet walls, pipes, HVAC or other appliances located on the roof surface. In still other embodiments, the adhesive tape compositions of the present invention can be used to form lap seams. In other embodiments, the compositions of the present invention, especially the caulk compositions, can be applied over any joints that are formed during construction of the roof surface. For example, the caulk can be used in conjunction with mechanical devices secured to vertical walls such as the use of termination bars. In other exemplary embodiments, a caulk can be use to cover splices formed at penetrations such as those that exist where pipe boots are installed.

[0052] In certain embodiments, the root-resistant sealant of the present invention may be used to secure roofing membranes together for use on a "green" roof containing vegetation. In particular embodiments, the roofing membranes include polymeric membranes, such as thermoset (e.g. EPDM) or thermoplastic (e.g. PVD or TPO) membranes, which are often used on flat or low-sloped roofs.

[0053] In other embodiments, the root-resistant sealant of the present invention may be used to secure a geomembrane lining system together for use in a water containment system. In one or more embodiments, the root-resistant sealant is applied to geomembrane lining seams to secure geomembranes together. Geomembrane lining systems are used for a variety of decorative and containment applications, including ponds for both commercial and residential uses, waterfalls, streams, irrigation canals, storm water retention ponds, agricultural pits and ponds, and aquaculture applications. Geomembrane lining systems may also be used for water containment systems on roofs.

[0054] The wide use of geomembrane lining systems over the alternative liners made of soil, clay, concrete, and steel may be attributable to the many advantages of the system over these other available options. These advantages may include secure water containment, enhanced water quality control, cleaning and disinfection capabilities, erosion protection, rapid and easy installation, low maintenance costs, long life and easy repairs.

[0055] Installation of a water containment system typically involves a number of steps, including excavating a basin, although an existing basin may be utilized in some cases. In one or several embodiments, an anchor trench may also be

excavated around a basin. The geomembrane liner is then placed within the basin and is formed to the shape of the basin, extending over the bank of the basin and into the anchor trench if such a trench has been provided. Once in place, overfill is provided over a portion of the geomembrane liner to secure it in place. The basin may then be filled with water or other liquid up to the level desired. The process of installing a particulate coating may occur at any point in the process of installing the water containment system after the geomembrane liner has been placed in the basin.

[0056] Practice of the present invention is not necessarily limited by the selection of a particular geomembrane. The geomembrane, which may also be referred to as a pond liner, or simply liner, may include any of those geomembranes currently employed in the art. In one or more embodiments, the geomembrane may be a thermoset material. In other embodiments, the geomembrane may be a thermoplastic or thermoformable material.

[0057] In one or more embodiments, the geomembrane may be EPDM (ethylene-propylene-diene-terpolymer) based. In other embodiments, the geomembrane liner may be TPO (thermoplastic-olefin) based. In yet other embodiments, the geomembrane liner may be PVC (polyvinyl chloride) based. In still other embodiments, the geomembrane may be a polypropylene-based sheet. In these or other embodiments, the geomembrane may be flexible and capable of being rolled up for shipment. In these or other embodiments, the geomembrane may include fiber reinforcement. Membrane reinforcement materials are well known to persons having ordinary skill in the art.

[0058] Useful EPDM geomembranes include those that are conventional and commercially available in the art. For example, EPDM geomembranes are commercially available under the tradename PONDGARD from the Firestone Specialty Products Company, LLC (Carmel, Ind.). Also, EPDM geomembranes are disclosed in numerous United States patents including U.S. Pat. Nos. 3,280,082, 4,732,925, 4,810,565, 5,162,436, 5,286,798, 5,370,755, 5,242,970, 5,512,118, 2,260,111, 5,256,228, 5,582,890, 5,204,148, 5,389,715, 5,854,327, 5,054,327, and 5,700,538, which are incorporated herein by reference for the purpose of teaching suitable geomembranes. Useful TPO membranes are available under the tradename ULTRAPLY™ TPO, and useful PVC membranes are available under the

tradename ULTRAPLY™ PVC. Useful flexible polypropylene sheets are available under the tradename MultilLiner RPP (Firestone Specialty Products).

MEMBRANE ASSEMBLY

[0059] In one or more embodiments, a roofing assembly includes a roof substrate which supports the other components of the roofing assembly. In one or more embodiments, an insulation layer may be provided over roof substrate. The insulation layer may be provided in any form known to those skilled in the art, and may be, for example, a polyisocyanurate foam board. In one or more embodiments, the insulation layer may be secured to roof substrate by any method known in the art, including by mechanical fasteners or with the use of adhesives.

[0060] In one or more embodiments, a plurality of roofing membranes is provided over an insulation layer or roof substrate. Suitable membranes are well known in the art of roofing systems, and may include, fof example, thermoplastic or thermo-set membranes. In one or more embodiments, roofing membranes may be an EPDM based material. In other embodiments, roofing membranes may be a TPO based material. In these or other embodiments, the membranes may be flexible and capable of being rolled up for shipment. In one or more embodiments, the membranes may include a fabric reinforcement. Membranes suitable for use in the roofing assembly are well known in the art, and the particular membrane used should not be viewed as limiting the scope of the present invention.

[0061] In one or more embodiments, a root-resistant sealant may be applied to the adjacent edges of the roofing membranes to seal and secure the membranes together. The root-resistant sealant may be a liquid-applied adhesive or an adhesive tape.

[0062] In one or more embodiments, the roofing membrane is held in place on the insulation layer or roof substrate by virtue of the weight of ballast objects containing vegetation. In one or more embodiments, the ballast objects include dirt. In one or more embodiments, the ballast objects include roofing trays that are filled with dirt or potting soil suitable for supporting vegetation. In these or other embodiments, geographically appropriate vegetation may be provided in roofing trays and planted in the soil. The vegetation contained in roofing trays acts to absorb moisture in the trays provided by rain water, and also acts to help insulate the space beneath the roof substrate.

ROOT RESISTANCE TESTING PROCEDURE

[0063] The roofing systems of one or more embodiments of the present invention include a seam or other sealed location that, by virtue of using the root-resistant sealants or tapes of the present invention, will satisfy the testing criteria developed by the Research Society for Landscape Development and Landscape Construction (FLL) developed for examining the root resistance of root protective membranes. The test is conducted in a vessel experiment and may last for the duration of a 4-year or 2-year period. If the test is conducted for a 4-year duration, it is carried out under open-air conditions with alder and couch grass being used as test plants. If the test is conducted for a 2-year duration, it is carried out in a climate controlled greenhouse using firethorn and couch grass.

[0064] Various modifications and alterations that do not depart from the scope and spirit of this invention will become apparent to those skilled in the art. This invention is not to be duly limited to the illustrative embodiments set forth herein.

CLAIMS

1. A sealant composition comprising:
   (i) a rubber or polyurethane;
   (ii) a filler; and
   (iii) a herbicide.

2. The composition of the preceding claim, where the herbicide is a dinitroaniline herbicide.

3. The composition of any of the preceding claims, where the herbicide is α,α,α- trifluoro-2,6-dinitro-N,*N*-dihydrocarbyl-p-toluidine.

4. The composition of any of the preceding claims, where the herbicide is a,a,a-trifluoro-2,6-dinitro -*N,N*-dipropyl-p-toluidine, wherein the sealant includes from 0.1 to 10% by weight herbicide, based upon the total solids content of the sealant.

5. The composition of any of the preceding claims, where the sealant is a polyurethane-containing lap sealant.

6. The composition of any of the preceding claims, where the sealant is a rubber-based lap sealant.

7. The composition of any of the preceding claims, where the sealant is a 2-part polyurethane pourable sealant.

8. The composition of any of the preceding claims, where the sealant is a caulking composition.

9. The composition of any of the preceding claims, where the herbicide is a pre-emergent herbicide.

10. A root-resistant 100% solids tape comprising:
    (i) a rubber; and
    (ii) dispersed within the rubber a herbicide.

11. The tape of any of the preceding claims, where the herbicide is a dinitroaniline herbicide.

12. The tape of any of the preceding claims, where the herbicide is α,α,α-trifluoro-2,6-dinitro -*N,N*-dihydrocarbyl-p-toluidine.

13. The tape of any of the preceding claims, where the herbicide is α,α,α-trifluoro-2,6-dinitro -*N,N* -dipropyl-p-toluidine, wherein the sealant includes from 0.1 to 10% by weight herbicide, based upon the total solids content of the sealant.

14. The tape of any of the preceding claims, where the herbicide is a pre-emergent herbicide

15. The tape of any. of the preceding claims, where the rubber includes butyl rubber or halobutyl rubber.

16. The tape of any of the preceding claims, where the rubber includes EPDM.

17. The tape of any of the preceding claims, where the tape further includes a filler.

18. The tape of any of the preceding claims, where the tape further includes a tackifier.

19. The tape of any of the preceding claims, where the tape is removably laminated to a release film or paper.

20. A roofing system comprising:

(i) a roof deck;

(ii) a polymeric or asphaltic membrane covering the roof deck; and

(iii) sealed seams, sealed terminations, or sealed penetrations within the polymeric or asphaltic membrane, where at least one of the seams, terminations, or penetrations are sealed with (a) a root-resistant sealant including a rubber or polyurethane, a filler, and a herbicide, or (b) a root-resistant tape including a rubber and a herbicide dispersed within the rubber.

21. The roofing system of any of the preceding claims, where the herbicide is a dinitroaniline herbicide.

22. The roofing system of any of the preceding claims, where the herbicide is α,α,α- trifluoro-2,6-dinitro -*N*,*N* -dihydrocarbyl-p-toluidine.

23. The roofing system of any of the preceding claims, where the herbicide is a,a,a-trifluoro-2,6-dinitro-N ,*N* -dipropyl-p-toluidine, wherein the sealant includes from 0.1 to 10% by weight herbicide, based upon the total solids content of the sealant.

24. The roofing system of any of the preceding claims, where the sealant is a polyurethane-containing lap sealant.

25. The roofing system of any of the preceding claims, where the sealant is a rubber-based lap sealant.

26. The roofing system of any of the preceding claims, where the sealant is a 2-part polyurethane pourable sealant.

27. The roofing system of any of the preceding claims, where the sealant is a caulking composition.

28. The roofing system of any of the preceding claims, where the herbicide is a pre-emergent herbicide.

29. The roofing system of any of the preceding claims, where the membrane is held to the roof deck using ballast objects that include trays having dirt contained therein.

30. A geomembrane construction comprising:

(i) a geomembrane applied over a location, where the geomembrane includes one or more mated seams; and

(ii) one or more mated seams within the geomembrane, where at least one of the mated seams is sealed with (a) a root-resistant sealant including rubber or polyurethane, a filler, and a herbicide, or (b) a root-resistant tape including a rubber and a herbicide dispersed within the rubber.

31. The geomembrane of any of the preceding claims, where the herbicide is a dinitroaniline herbicide.

32. The geomembrane of any of the preceding claims, where the herbicide is α,α,α- trifluoro-2,6-dinitro -*N,N* -dihydrocarbyl-p-toluidine.

33. The geomembrane of any of the preceding claims, where the herbicide is a,a,a-trifluoro-2,6-dinitro-N,*N* -dipropyl-p-toluidine, wherein the sealant includes from 0.1 to 10% by weight herbicide, based upon the total solids content of the sealant.

34. The geomembrane of any of the preceding claims, where the sealant is a polyurethane-containing lap sealant.

35. The geomembrane of any of the preceding claims, where the sealant is a rubber-based lap sealant.

36. The geomembrane of any of the preceding claims, where the sealant is a 2-part polyurethane pourable sealant.

37. The geomembrane of any of the preceding claims, where the sealant is a caulking composition.

38. The geomembrane of any of the preceding claims, where the herbicide is a pre-emergent herbicide.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/071191

A. CLASSIFICATION OF SUBJECT MATTER
INV. A01N33/18 C09K3/10 E04D5/Q6 E04D5/14
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)
A01N C09K E04D

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	US 2010/137141 Al (LI PINSKY EDWARD S [US] ET AL) 3 June 2010 (2010-06-03) paragraphs [0010] , [0020] - [0031] , [0034] - [0037] , [0048] , [0089] ; exampl es	1-38
X	W0 2010/063986 A2 (SYNGENTA PARTICI PATIONS AG [CH] ; CORNISH ALEXANDER [CH] ; WOLF HANN0 CH) 10 June 2010 (2010-06-10) page 1, paragraph 1 - page 3, paragraph 1; exampl e 1; table 1	1-38
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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents :

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

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

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

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

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

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

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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 May 2013	21/05/2013

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Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/071191

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 89/02050 A1 (BATTELLE MEMORIAL INSTITUTE [US]) 9 March 1989 (1989-03-09) page 1, line 3 - page 2, line 16 page 3, line 19 - page 4, line 5 page 5, lines 24-33 -----	1-18

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/071191

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