A building material for roofing and the like has a UV curable top coating with a resin component and a photoinitiator component. The top coating may include pigments, such as those which increase reflectivity of the coating. The speed with which the coating can be cured permits use in a roofing material assembly line without slowing the feed rate and eliminates energy intensive drying procedures.
UV-CURED COATING FOR ROOFING MATERIALS

FIELD OF THE INVENTION

[0001] The present invention relates to building materials and compositions for making same, and more particularly, to a top coating composition for roofing material that promotes energy conservation, is durable, fire-retardant, and resists the growth of unwanted plant life, such as algae, moss, mold and fungi.

BACKGROUND OF THE INVENTION

[0002] Building materials, such as roofing materials, preferably exhibit weather, fire and rot resistance, structural strength and durability, as well as being economical to make and easy to use on the job site during the construction of buildings. Roofing materials are exposed to the effects of rain, wind and sun and are expected to have a long and trouble-free service life. Over the years, various types of roofing materials and roofing systems have been developed and used to meet these demands for commercial and residential buildings with varying roof pitches ranging from flat to steeply pitched, including stone, ceramic, wood, metal, rubber and asphalt/bitumen. Each type of material has benefits and limitations in performing its intended function.

[0003] Asphalt roofing materials have wide popularity and can be made in many forms and compositions to provide different desirable properties, depending upon the application. For example, asphalt roofing material may be reinforced using different fabric mat materials, such as fiberglass, polyester or other natural and synthetic materials. The asphalt may be modified by incorporating other compositions, such as styrene-butadiene-styrene (SBS) or atactic polypropylene (APP). Asphalt roofing material may be made in a variety of forms including shingles of various shapes and sizes, as well as continuous sheets of roofing (roll roofing). Asphalt roofing materials intended to be used as the top layer of a roofing system typically have an outer/upper surface incorporating crushed stone, ceramic or other hard, finely divided materials which are imbedded in the outer surface while the asphalt material is still hot and flowable. Selecting the color of the finely divided material determines the color of the roof material. Similarly, metal roofs have typically been painted to prevent corrosion and to control the color of the roof.

[0004] One significant implication of selecting a particular color for a roof is the degree to which the roof absorbs/reflects solar energy, with lighter roofs reflecting more energy and darker roofs absorbing more of the sun’s energy. This attribute of roof color has become more significant as energy costs have increased, since dark roofs increase the cost of air conditioning buildings in warm, sunny climates and seasons. Greater energy absorption also results in quicker degradation of the roofing materials.

[0005] Besides the natural incentive for building owners to decrease air conditioning costs and increase the useful life of their roofing systems, governmental entities have passed laws and regulations pertaining to the use of roofing materials having a prescribed reflectivity. The Cool Roof Rating Council has developed a system of standards whereby roofing materials may be tested and rated for reflectivity (the ENERGY STAR® rating). Paints and coatings have been proposed for applying a reflective top coat on asphalt-type roofing. These coatings are typically water-based acrylic coatings having a white pigment and may contain additives, such as reinforcing fibers, glycol, intumescents/fire retardants, and biocides. As with most painted-on coatings, these known coatings have limitations pertaining to convenience of application (painting a roof) coverage (the granular upper surface of asphalt roofing is rough and irregular with a three dimensional component), and retention to the surface (cracking, chipping and peeling with age and exposure to weather and temperature changes). Some of these issues are addressed by applying a prime coat, which represents an additional step, with associated costs and inconvenience.

[0006] Patent applications owned by the Assignee herein include publication Nos. 2005/0139126 A1, 2005/0145139 A1, 2005/0257875 A1, 2005/0261407 A1, all of which relate to coatings that are applied to roofing material. As noted in, e.g., Patent Publication No. 2005/0261407 A1, there are disadvantages associated with applying coatings to roofs on-site, such as the difficulty in attaining complete coverage and maximal adhesion due to non-optimal temperatures and weather conditions, as well as the generally difficult process of applying a liquid coating over a large, elevated and potentially sloped surface. Factory application of coatings alleviates some of these problems. Application of top coatings at the factory has other associated requirements, e.g., the coating must be cured prior to further processing of the roofing material, such as rolling the material into rolls, or cutting and packing it into bundles. Known curing methods utilizing heat require a large expenditure of energy in order to conduct curing at a rate which does not significantly slow production. Accordingly, alternative coating compositions and methods for applying and curing them remain of interest in the field.

SUMMARY OF THE INVENTION

[0007] The limitations of prior art building and roofing materials are overcome by the present invention which involves the provision of a building material having a substrate with a bottom surface and a top surface, the bottom surface being applied proximate to a building when the substrate is used. A top coating applied to the top surface has a resin component and a photoinitiator component. The photoinitiator component functions to induce polymerization of the resin component when a mixture of the resin component and the photoinitiator component are exposed to UV radiation, curing the top coating.

BRIEF DESCRIPTION OF THE FIGURES

[0008] The novel features of the present invention will be more readily apparent upon reading the following description in conjunction with the accompanying drawings, in which:

[0009] FIG. 1 is a diagrammatic cross-sectional view of a portion of roofing material made in accordance with an embodiment of the present invention; and

[0010] FIG. 2 is a diagrammatic view of a manufacturing apparatus and method for making roofing material in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0011] FIG. 1 shows roofing material 10 having a reinforcing mat 12, which is made from fiberglass or polyester,
and asphalt layers 14, 16, each of which is formed from modified asphalt such as SBS or APP. A layer of granules 18, such as crushed stone, ceramic or minerals, is embedded in the asphalt layer 16. The granules 18 are covered with a coating 20, such as those described in any of the following applications, which are owned by the present Assignee and were published as: 2005/0139126 A1, 2005/0145139 A1, 2005/0257875 A1 and/or 2005/0261409 A1, each of which is incorporated by reference herein. As further alternatives, the coating 20 may be eliminated or it may be modified to include a UV-curable coating as disclosed in the present application. After the granules 18 are embedded in the asphalt layer 16, a UV-curable coating layer 22 is applied over them.

[0012] The roofing material 10 in accordance with the present invention therefore utilizes at least one UV-curable coating, i.e., on the individual granules 18 and/or applied as the coating layer 22. While the present invention has been explained with reference to granule-faced roofing material, the UV-curable coating may be applied to roofing material that does not have granules.

[0013] A bottom coating 24 is embedded or otherwise adhered to the asphalt layer 14. The bottom coating 24 may be conventional, such as a coating of sand or talc. Before describing the composition and preparation of the UV-curable material used in forming the UV-curable coating layer 22, the method and apparatus for making the roofing material 10 will be described below with reference to FIG. 2.

[0014] FIG. 2 shows fiberglass or polyester mat material 30 being provided to mat unwinder stand and splicer apparatus 32, which produces a continuous woven mat or felt 34 forming a fibrous reinforcement for the roofing material to be produced. Simultaneously, asphalt 36, modifying polymers 38 and optional mineral stabilizers 40 are added to a mixing tank 42 from which liquefied modified asphalt 44 issues and which is directed to impregnation vat 46. The impregnation vat 46 receives the continuous mat 34, which is then dipped into liquid modified asphalt contained in the vat 46, producing an asphalt impregnated mat 48. Optionally, granules 50 and a granule coating 52 are introduced to a granule coater 54, producing coated granules 56. The coated granules 56 may be coated with a coating that is heat or air curable or it may be a UV-curable coating in accordance with the present invention. In the latter case, the coated granules 56 would be exposed to UV radiation 58 before being fed to the granule application station 60. Alternatively, uncoated granules 50 may be fed to the granule application station 60 and applied to the mat 48. The granule application station 60 distributes the granules 50 or 56 onto the asphalt impregnated mat 48 producing a granule-faced roofing material 62. The granules 50/56 will embed into the surface of the asphalt impregnated mat 48 due to the temperature of the asphalt and its softened state at high temperatures.

[0015] The granule-faced roofing material 62 is then fed through water cooling trays 64 to lower the temperature of the asphalt for further processing and to lock the applied granules 50/56 onto the surface of the mat 48. After leaving the water cooling tray 64, the cool roofing material 66 has a backing material 68 applied at a backing applicator station 70. The backing is typically sand or talc. The backed roof material 72 is then cooled and dried by air knives and/or cooling fans 74, and passed to the top coater 78. The top coater 78 receives the top coating composition 76 and applies it to the roofing material 72 producing top coated roofing material 80. In the event that the top coating 76 is UV-curable in accordance with the present invention, it is cured by UV light 82 after leaving the top coater 78. The top coater 78 may apply a top coating using any of the well-known methods for applying coatings, such as by roller, brush, spray, dip and knife coating methods. The cured, top coated roofing material 80 is accumulated on a finish looper (accumulator) 84 and then fed to a roll winder/cutter 86 to produce the finished roofing material 88, either in the form of roll roofing or cut shingles which are then placed in storage 90.

The Preparation and Composition of the UV Curable Coating

[0016] An exemplary UV-curable coating in accordance with the present invention includes resin, pigment and photoinitiator component packages as follows, in the weight percentages indicated. The operable weight percentage range is stated first, followed by a preferred weight percentage applicable to the specific example given.

Resin Package

[0017] Between 10.00%-40.00%, preferably 30.00% BE-111 low viscosity, non-yellowing, polyester acrylate (primary oligomer);
[0018] Between 6.00%-25.00%, preferably 17.5% PONGDA propoxylated neopentylglycol diacrylate (primary monomer due to its good pigment/filler compatibility, its good diluent properties and low cost);
[0019] Between 2.00%-15.00%, preferably 7.7% DPGDA dipropylene glycol diacrylate (a secondary monomer, being an economical high cross-linker with good physical properties);
[0020] Between 0.50%-7.00%, preferably 3.0% PETA pentacrythritol triacrylate (another high cross-linking secondary monomer). The foregoing resins are obtainable from San Ester (www.sanesters.com).

Pigment Package

[0021] Between 0.30%-5.50%, preferably 2.5% Disperbyk 168 (disperse aid for limestone);
[0022] Between 0.02%-1.50%, preferably 0.3% Disperbyk 111 (disperse aid or TiO2);
[0023] Between 0.10%-1.50%, preferably 0.5% BYK 1790 (non-silicone de-foamer, for UV applications); Each of the foregoing may be obtained from BYK Chemie (www.byk-chemie.com);
[0024] Between 5.00%-45.00%, preferably 23.5% Omyacarb #10 (limestone) available from Omya AG (omya.com);
[0025] Between 5.00%-40.00%, preferably 6.0% Titanium Kronos 2160;
[0026] Between 5.00%-40.00%, preferably 5.0% Titanium Ukraine 2160; The foregoing pigments may be obtained from Kronos, Inc. (kronostio2.com).

Photoinitiator Package

[0027] Between 0.50%-5.50%, preferably 3.0% Omnirad 481;
[0028] Between 0.10%-5.50%, preferably 1.0% Omnirad TPO; The foregoing can be obtained from IGM Resins (igmresins.com).
Adding the weight percents of all of the foregoing compounds in the resin, pigment and photoinitiator packages gives a total weight percent of 100%. To combine these components into the UV-curable coating, the BE-111 and the PONGIDA may be utilized as the grind media for the pigment/extender package to form an intermediate resin/pigment dispersion. The DPGIDA and the PEIA may be utilized together as a solvent for the photoinitiator package to form a resin/photoinitiator solution. The resin/pigment dispersion and the resin/photoinitiator solution are then mixed together using low to medium shear mixing. It is preferable to degas the resin/pigment dispersion before combining it with the resin/photoinitiator solution. While mixing the resin/pigment dispersion with the resin/photoinitiator solution to form the UV-curable coating of the present invention, it is preferable to minimize the introduction of air.

An iron-doped or, more preferably, a gallium-doped UV bulb producing at or above 300 watts per inch of power would be suitable to cure the UV-curable coating of the present invention. The lower the viscosity of the coating, the quicker the cure time. Since non-aqueous acrylated systems rarely support the growth of microbes, fungus, moss or other unwanted flora or fauna, a biocide is not required for most applications. For tropical or other bio-promoting environments/applications, a biocide, such as Nuosept from International Specialty Products Corporation (ispcorp.com) may be added.

The foregoing UV-curable coating composition can be applied using conventional apparatus and methods for applying coatings, such as roller coating, spray coating, etc. The coating starts to cure immediately upon exposure to UV light and when using a 300 W/in bulb can cure in two to four seconds, thus allowing movement of the roofing material through the production line at a normal speed, i.e., the curing of the top coating composition is accomplished at a quicker rate than other processes used during manufacture of the roofing material, e.g., application of the granules, cooling of the hot roofing material, etc., which are conducted at a slower rate than curing.

While the present invention has been described in reference to a specific embodiment thereof, those with normal skill in the art may see the potential to change certain aspects of the disclosed embodiment without departing from the scope of the present invention. It is therefore intended that such variations fall within the scope of the appended claims. For example, various pigments may be used as alternatives to those listed above to obtain different colors for the UV-cured top-coating composition. In the event that the color of the granular layer is the desired finish color, the UV-curable composition can be made without adding a pigment resulting in a clear coating. A clear coating may be desired to lock in, unify and protect the granular layer, while still permitting the color of the granular layer to show through the coating. Similarly, the granules may be coated with a clear coating prior to being embedded in the asphalt. If granules are not utilized on the roofing material, the UV-curable coating may be applied to the upper surface of the roofing material.

We claim:
1. A building material, comprising a substrate having a bottom surface and a top surface, the bottom surface being applied proximate to a building when said substrate is used; and a top coating applied to said top surface, said top coating having a resin component and a photoinitiator component, said photoinitiator component inducing polymerization of said resin component when a mixture of said resin component and said photoinitiator component is exposed to UV radiation to thereby cure said top coating.
2. The building material of claim 1, further including a pigment in said top coating.
3. The building material of claim 2, wherein said substrate is a modified asphalt roofing material.
4. The building material of claim 3, wherein said modified asphalt roofing material includes a granular coating on said top surface, said top coating applied over said granular coating.
5. A method for making a roofing material, comprising the steps of:
   1. A building material, comprising a resin component and a photoinitiator component, said photoinitiator component inducing polymerization of said resin component when a mixture of said resin component and said photoinitiator component is exposed to UV radiation to thereby cure said top coating.
6. The top coating of claim 5, wherein said resin component includes an oligomer and a monomer.
7. The top coating of claim 6, wherein said oligomer is polyester acrylate and said monomer is neopentylglycol diacylate.
8. The top coating of claim 7, wherein said resin component further includes dipropylene glycol diacrylate and pentaerythritol triacrylate.
9. The top coating of claim 8, wherein the following constituent compounds are present in the following approximate weight percentages: polyester acrylate 10.00% to 40.00%, propoxylated neopentylglycol diacrylate 6.00% to 25.00%, dipropylene glycol diacrylate 2.00% to 15.00%, pentaerythritol triacrylate 0.50% to 7.00%.
10. The top coating of claim 7, further comprising a pigment component.
11. The top coating of claim 10, wherein said pigment component includes CaCO$_3$ and TiO$_2$.
12. The top coating of claim 11, wherein said pigment component further includes at least one dispersal aid.
13. The top coating of claim 12, further comprising a dispersal aid for each of said CaCO$_3$ and TiO$_2$ pigments.
14. The top coating of claim 13, further comprising a defoamer.
15. The top coating of claim 14, wherein the following constituent compounds are present in the following approximate weight percentages: CaCO$_3$ 5.00% to 40.00%, TiO$_2$ 5.00% to 40.00%, dispersal aids 0.30% to 7.00%, defoamer 0.10% to 1.50%.
16. The top coating of claim 15, wherein said photoinitiator component includes a plurality of photoinitiators with a combined total weight percentage of 0.60% to 11.00%.
17. The top coating of claim 9, wherein the following constituent compounds are present in the following approximate weight percentages: polyester acrylate 30.00%, propoxylated neopentylglycol diacrylate 17.5%, dipropylene glycol diacrylate 7.7%, pentaerythritol triacrylate 3.00%, CaCO$_3$ 23.5%, TiO$_2$ 11.0%, dispersal aids 2.8%, defoamer 0.5%, said plurality of photoinitiators having a combined total weight percentage of 4.0%.
18. A method for making a roofing material, comprising the steps of:
(a) providing an asphalt-based substantially planar substrate with top and bottom surfaces;
(b) preparing a flowable UV-curable coating;
(c) applying the UV-curable coating to the top surface of the substrate; and
(d) curing the coating with UV radiation to solidify the coating.

19. The method of claim 18, wherein said step of preparing includes the steps of:
   (f) mixing at least one resin with at least one pigment to form an intermediate pigment mixture;
   (g) mixing at least one photoinitiator with at least one other resin to form an intermediate photoinitiator solution;
   (h) mixing the intermediate pigment mix and the intermediate photoinitiator mix.

20. The method of claim 19, wherein said step (f) of mixing includes mixing the following constituent compounds in the following approximate weight percents: polyester acrylate 10.00% to 40.00%, propoxylated neopentylglycol diacrylate 6.00% to 25.00%, CaCO₃ 5.00% to 45.00%, Titanium Kronos 2160 5.00% to 40.00%, Titanium Ukraine 2160 5.00% to 40.00%, Disperbyk 168 0.30% to 5.50%, Disperbyk 111 0.02% to 1.50%, BYK 1790 0.10% to 1.50%, and said step (g) includes mixing the following constituent compounds in the following weight percents: dipropylene glycol diacrylate 2.00% to 15.00%, pentaerythritol triacrylate 0.50% to 7.00%, Omnirad 481 0.50% to 5.50% and Omnirad TPO 0.10% to 5.50%.

21. The method of claim 20, wherein said step of curing is conducted under a UV light emitting greater than or equal to about 300 watts per inch.

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