the organic solvent prior to the UV curing step, which is energy-consuming and could generate air pollutions. In addition, the formulations use photoinitiators that generates cationic species to initiate polymerization. The cationic species is typically water-sensitive, and thus exclusion of moisture that contains water is necessary for the UV curing.

US Patent No. 8,796,351 also discloses PSAs from UV-initiated free radical polymerization of acrylated epoxidized soybean oil that contains acrylate groups with other acrylic monomers. U.S. Provisional Patent Application No. 62/770,091 also discloses UV-cured PSAs from plant oil-based formulations that contain polymerizable activated C=C groups such as acrylate groups. The curing of the above formulations involves free-radically polymerization of the acrylate groups, which is initiated by the radicals that are generated with UV radiation. The free radical polymerization is readily inhibited by oxygen from the air environment. Thus, it is necessary to exclude the formulations from oxygen, e.g., by purging nitrogen gas, in the UV curing step, which considerably increases the production cost of the PSAs.

SUMMARY

Disclosed herein is an ultraviolet radiation-curable composition comprising a polyester having at least one pendant ultraviolet radiation-curable moiety covalently bonded to the polyester, wherein the polyester does not contain any free-radically polymerizable activated C=C groups.

In one aspect of the present disclosure, there is provided an ultraviolet radiation-curable composition comprising a polyester having at least one pendant ultraviolet radiation-curable moiety covalently bonded to the polyester, wherein the polyester does not contain any free-radically polymerizable activated C=C groups, wherein the composition is made from reacting (i) at least one modified epoxidized plant oil that contains the covalently bonded ultraviolet radiation-curable moiety with (ii) at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof.

In another aspect of the present disclosure, there is provided a pressure sensitive adhesive composition made by ultraviolet radiation curing of the composition disclosed herein.

In another aspect of the present disclosure, there is provided a pressure sensitive adhesive construct comprising:

(A) a backing substrate; and

(B) the pressure sensitive adhesive composition disclosed herein disposed on the backing substrate.

In a further aspect of the present disclosure, there is provided a method comprising:

reacting (a) at least one epoxidized plant oil with (b) a compound that contains at least one -COOH group and at least one UV-active moiety, wherein the UV-active moiety is benzophenone or thioxanthone; a compound that contains at least one -OH group and at least one UV-active moiety, wherein the UV-active

moiety is benzophenone, thioxanthone or acetophenone; phenylglyoxylic acid; or a mixture thereof, resulting in covalently bonding the at least one UV-active moiety to the epoxidized plant oil; and

reacting the resulting modified epoxidized plant oil that contains the at least one covalently bonded UV-active moiety with (c) at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof, to form a resin.

In a further aspect of the present disclosure, there is provided a method comprising:

reacting at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof with (i) at least one epoxidized plant oil or a monocarboxylic acid-modified epoxidized plant oil under reaction condition that the molar ratio of –COOH groups of the at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof to the epoxy groups of the at least one epoxidized plant oil or a monocarboxylic acid-modified epoxidized plant oil is greater than 1.0 to form a polyester that is capped with -COOH groups at chain ends; and

reacting the resulting polyester with a modified epoxidized plant oil that contains at least one covalently bonded UV-active moiety.

In another aspect of the present disclosure, there is provided a method of making a construct comprising:

applying the composition disclosed herein to a backing substrate; and

subjecting the composition to ultraviolet radiation to form a pressure sensitive adhesive from the composition.

The composition can be ultraviolet radiation cured to form a pressure sensitive adhesive composition.

A construct (e.g. a tape) having a backing substrate upon which the pressure sensitive adhesive composition is disposed is also disclosed.

Also disclosed herein is a method comprising reacting (a) at least one epoxidized plant oil with (b) a compound that contains at least one -COOH group and at least one UV-active moiety, wherein the UV-active moiety is benzophenone or thioxanthone; a compound that contains at least one -OH group and at least one UV-active moiety, wherein the UV-active moiety is benzophenone, thioxanthone or acetophenone; phenylglyoxylic acid; or a mixture thereof, resulting in covalently bonding the at least one UV-active moiety to the epoxidized plant oil; and

reacting the resulting modified epoxidized plant oil that contains the at least one covalently bonded UV-active moiety with (c) at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof, to form a resin.

Additionally disclosed herein is a method comprising reacting at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof with (i) at least one epoxidized plant oil or a monocarboxylic acid-modified epoxidized plant oil under reaction condition that the molar ratio of –COOH groups of the at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof to the epoxy groups of the

What is claimed is:

1. An ultraviolet radiation-curable composition comprising a polyester having at least one pendant ultraviolet radiation-curable moiety covalently bonded to the polyester, wherein the polyester does not contain any free-radically polymerizable activated C=C groups, wherein the composition is made from reacting (i) at least one modified epoxidized plant oil that contains the covalently bonded ultraviolet radiation-curable moiety with (ii) at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof.

~~2. The composition of claim 1, wherein the composition is made from reacting (i) at least one modified epoxidized plant oil that contains the covalently bonded ultraviolet radiation-curable moiety with (ii) at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof.~~

~~3~~2. The composition of claim 1, wherein the at least one modified epoxidized plant oil (i) is made from reacting (a) at least one epoxidized plant oil with (b) a compound that contains at least one -COOH group and at least one UV-active moiety, wherein the UV-active moiety is benzophenone or thioxanthone; a compound that contains at least one -OH group and at least one UV-active moiety, wherein the UV-active moiety is benzophenone, thioxanthone or acetophenone; phenylglyoxylic acid; or a mixture thereof.

~~4~~3. The composition of claim ~~3~~2, wherein the compound (b) is a -COOH-containing benzophenone or a -COOH-containing thioxanthone.

~~5~~4. The composition of claim ~~3~~2, wherein the compound (b) is 2-benzoylbenzoic acid, 4-benzoylbenzoic acid or 2-(4-benzoylphenoxy)acetic acid.

~~6~~5. The composition of claim ~~3~~2, wherein the compound (b) is thioxanthone-2-carboxylic acid or thioxanthone-4-carboxylic acid.

~~7~~6. The composition of claim ~~3~~2, wherein the compound (b) is phenylglyoxylic acid.

~~8~~7. The composition of claim 2~~3~~, wherein the compound (b) is a -OH-containing benzophenone, a -OH-containing thioxanthone, or a -OH-containing acetophenone.

~~9~~8. The composition of claim ~~2~~3, wherein the compound (b) is 4-hydroxybenzophenone or 3-hydroxybenzophenone.

~~10~~9. The composition of claim ~~3~~2, wherein the compound (b) is 2-hydroxythioxanthen-9-one.

~~11~~10. The composition of claim ~~3~~2, wherein the compound (b) is 4'-hydroxyacetophenone or 3'-hydroxyacetophenone.

~~12~~11. The composition of claim ~~2~~3, wherein component (a) is monocarboxylic acid-modified epoxidized soybean oil.

~~13~~12. The composition of claim ~~12~~11, wherein the monocarboxylic acid modifier is formic acid, acetic acid, propionic acid, butyric acid, valeric acid, caproic acid, enanthic acid, caprylic acid, pelargonic acid, capric acid, undecylic acid, lauric acid, tridecylic acid, myristic acid, pentadecylic acid, palmitic acid, margaric acid, stearic acid, nonadecylic acid, arachildic acid, heneicosylic acid, behenic acid, tricosylic acid, and lignoceric acid, naphthalene acid, oleic acid, linoleic acid, myristoleic acid, palmitoleic acid, sapienic acid, elaidic acid, vaccenic acid, linoelaidic acid, linolenic acid, arachidonic acid, eicosapentaenoic acid, erucic acid, docosahexanenoic acid, abietic acid or tall oil rosin that contains abietic acid, benzoic acid, phenylacetic acid, 1-naphthaleneacetic acid, 2-naphthaleneacetic acid, 1-naphthoic acid, 2-naphthoic acid, 2-furoic acid, 3-methylpyridine-2-carboxylic acid, 1-methylpyrrole-2-carboxylic acid, pyrimidine-2-carboxylic acid, or an anhydride thereof, or a mixture thereof.

~~14~~13. The composition of claim 1, wherein the epoxidized plant oil is epoxidized soybean oil.

~~15~~14. The composition of claim ~~2~~1, wherein component (ii) is malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, and brassylic acid, phthalic acid, isophthalic acid, terephthalic acid, dimer acid, trimer acid, or an anhydride thereof, or a mixture thereof.

~~16~~15. The composition of claim ~~2~~1, wherein component (ii) includes a dimer acid.

~~17~~16. The composition of claim 1, wherein ultraviolet radiation-curable moiety is benzophenone, thioxanthone or acetophenone.

~~18~~17. The composition of claim ~~2~~1, wherein component (ii) comprises a polyamide capped with a -COOH group at chain ends of the polyamide.

~~19~~18. The composition of claim ~~18~~17, wherein the -COOH-capped polyamide is made from polymerizing at least one dicarboxylic acid or polycarboxylic acid with at least one diamine or at least one polyamine under a reaction condition that the molar ratio of the –COOH groups of the dicarboxylic acid or polycarboxylic acid to the amine groups of the diamine or polyamine is greater than 1.0.

~~20~~19. A pressure sensitive adhesive composition made by ultraviolet radiation curing of the composition of claim 1.

~~21~~20. A pressure sensitive adhesive construct comprising:

(A) a backing substrate; and

(B) the pressure sensitive adhesive composition of claim ~~20~~ 19 disposed on the backing substrate.

~~22~~21. A method comprising:

reacting (a) at least one epoxidized plant oil with (b) a compound that contains at least one -COOH group and at least one UV-active moiety, wherein the UV-active moiety is benzophenone or thioxanthone; a compound that contains at least one -OH group and at least one UV-active moiety, wherein the UV-active moiety is benzophenone, thioxanthone or acetophenone; phenylglyoxylic acid; or a mixture thereof, resulting in covalently bonding the at least one UV-active moiety to the epoxidized plant oil; and

reacting the resulting modified epoxidized plant oil that contains the at least one covalently bonded UV-active moiety with (c) at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof, to form a resin.

~~23~~22. The method of claim ~~22~~21, wherein the resulting modified epoxidized plant oil has an average of from 0.01 mole to 1.8 moles of UV-active moiety per mole of plant oil molecule.

~~24~~23. The method of claim ~~22~~21, further comprising subjecting the resulting resin to ultraviolet radiation to form a crosslinked polymer.

~~25~~24. The method of claim ~~22~~21, further comprising modifying the at least one epoxidized plant oil with at least one monocarboxylic acid.

~~26~~25. The method of claim ~~25~~24, wherein the modifying of the at least one epoxidized plant oil comprises mixing together the at least one monocarboxylic acid, the at least one epoxidized plant oil (a), and compound (b).

~~27~~26. The method of claim ~~22~~21, comprising:

forming a mixture of the modified epoxidized plant oil that contains the at least one covalently bonded UV-active moiety and a monocarboxylic acid-modified epoxidized plant oil that does not contain a UV-active moiety; and

reacting the resulting mixture with the at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof.

~~28~~27. The method of claim ~~24~~23, wherein exclusion of oxygen is not necessary during subjecting the resulting resin to ultraviolet radiation.

~~29~~28. The method of claim ~~22~~21, wherein the at least one epoxidized plant oil is epoxidized soybean oil.

~~30~~29. The method of claim ~~22~~21, wherein component (c) is malonic acid, succinic acid, glutaric acid, adipic acid, pimelic acid, suberic acid, azelaic acid, sebacic acid, and brassylic acid, phthalic acid, isophthalic acid, terephthalic acid, dimer acid, trimer acid, or an anhydride thereof, or a mixture thereof.

~~31~~30. A method comprising:

reacting at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof with (i) at least one epoxidized plant oil or a monocarboxylic acid-modified epoxidized plant oil under reaction condition that the molar ratio of –COOH groups of the at least one dicarboxylic acid, at least one polycarboxylic acid, or a mixture thereof to the epoxy groups of the at least one epoxidized plant oil or a monocarboxylic acid-modified epoxidized plant oil is greater than 1.0 to form a polyester that is capped with -COOH groups at chain ends; and

reacting the resulting polyester with a modified epoxidized plant oil that contains at least one covalently bonded UV-active moiety.

~~32~~31. A method of making a construct comprising:

applying the composition of claim 1 to a backing substrate; and

subjecting the composition to ultraviolet radiation to form a pressure sensitive adhesive from the composition.