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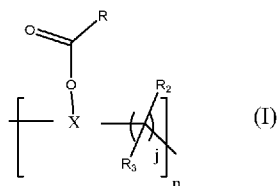
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(54) Title: MACROMOLECULAR CORROSION (MCIN) INHIBITORS: STRUCTURES, METHODS OF MAKING AND USING
THE SAME

(57) Abstract: Disclosed are multifunctional compounds represented by structural
formula (I), methods of producing compounds represented by structural formula (I)
and their use in inhibiting corrosion in corrodible material.



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MACROMOLECULAR CORROSION (McIn) INHIBITORS:
STRUCTURES, METHODS OF MAKING AND USING THE SAME

5 RELATED APPLICATION

This application claims the benefit of U.S. Provisional Application No. 62/465,666, filed on March 1, 2017. The entire teachings of the above application are incorporated herein by reference.

GOVERNMENT SUPPORT

10 This invention was made with government support under IIP-1632258 from the National Science Foundation. The government has certain rights in the invention.

FIELD OF INVENTION

This invention relates newly developed multifunctional environmentally friendly macromolecular corrosion inhibitors utilize mainly the renewable and biobased raw material source. Most of the current corrosion inhibitors used in the industrial applications are not necessarily environmentally friendly and are based on petroleum based chemicals involving organic and inorganic species.

BACKGROUND OF THE INVENTION

This invention is directed to multifunctional macromolecular corrosion inhibitors and to fluid compositions containing minor amounts thereof. Multifunctional properties of this inhibitor include but not limited to rust inhibition, copper corrosion inhibition, and water and oil separating (demulsifier) capabilities. Fluids include but not limited to lubricants, biolubricants, bio-oils, bio-based oils, synthetic lubricants, fuels, bio-fuel, greases, bio-greases, aviation fuels, kerosene, gasoline, diesel, biodiesel, adhesives, and paints etc.

25 Corrosion in general terms is the degradation of a material caused by an aggressive environment such as water, air (oxygen), chemicals (acids, bases), organic liquids, oil, and gas, etc. Materials subject to corrosion include metals and their alloys, plastics, paints and coatings, concrete, or composites. Corrosion is a major concern in the durability of these materials, impacting safety, causing environmental damage, and incurring enormous repair and replacement costs. This is a major national concern. According to one United States
30 federal government study in 2002, the total estimated cost of corrosion is a staggering \$276

billion (approximately 3.1% of GDP) (Report FHWA-RD-01-156). If indirect costs are included, this increases to 6% of GDP (\$552 billion), because of loss of productivity, delays, material failures, etc. It does not appear that newer studies exist. The direct effects of metal corrosion are (a) loss of mechanical strength and structural failure, (b) perforation of fluid transmission pipes, storage tanks, and ships, leading to leakage of harmful fluids into the environment, (c) contamination of fluid due to leaching of metal species from vessels' inner surfaces, (d) mechanical damage causing failure of structures, engines, pumps, and valves, and (e) events hazardous to human life due to excessive structural failure. Corrosion inhibitors play a key role in mitigating some of these corrosion issues. Corrosion inhibitors are typically added or treated (0.001% to 5%) to the corroding materials (metals, lubricants, fuels, plastics, oils and gas, adhesives, greases, paints and coating materials, cement, water reservoir, etc.) to protect against the corrosion from the surrounding environments like fluid, water, oxygen, moisture, weather, temperature, or their combinations, etc.

Environmental risks associated with corrosion inhibitors are forcing to seek more environmentally friendly products. Some products are also increasingly subject to restrictions by government agencies in the USA and other countries. These harmful substances can enter the environment directly when formulated fluids like lubricants come in contact with water, soil, or air, via leakage or spillage from industrial equipment, ships, automobiles, engines, earth-moving equipment, drilling, metal working fluids, hydropower plants, hydraulics and turbines (wind, water, steam, aviation), transformers, chain saw, gears, elevators, wire and ropes, two-stroke engines, *etc.* Corrosion inhibitors are added to fluids based on petroleum, synthetic and/or bio-oils, bio-based oils like lubricants, greases, adhesives, and fuels; and paints and coating materials. Thus, there is need to replace harmful compounds with environmentally-friendly and sustainable corrosion inhibitors without sacrificing performance. The present invention is a new material composition technology, Macromolecular Corrosion Inhibitors (McIn), described herein. McIn is envisioned as a disruptive technology that adds value to the supply chains of multiple market sectors.

BRIEF SUMMARY OF THE INVENTION

This invention is essentially directed to macromolecular corrosion inhibitors that are (a) the composition of polymers which are the reaction products of the starting materials comprising a substituted phenol and an aldehyde that is esterified further with an alkyl

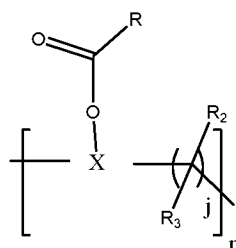
acid through oxalyl chloride or thionyl chloride or alkyl acids and using catalysts, if required to accelerate the esterification process,

- 65 (b) the composition of polymers which are the reaction products of the starting materials comprising a substituted phenol and an aldehyde and are further reacted with an alkenyl succinic anhydride to form a half ester products having free carboxylic acid groups in the repeating units,
- (c) the composition of polymers which are the reaction products of the starting materials
70 comprising a substituted phenol and an aldehyde and are further reacted with alkylene oxides (e.g. propylene oxide) to form phenol-derived alcohols in the repeating units,
- (d) the composition of polymers that are the reaction products of the starting materials of a substituted phenol and an aldehyde which are esterified further with oleic acid and then reacted with a maleic anhydride to form succinic anhydride adduct, and
75 finally reacted with an alkyl alcohol to form a half ester product having free carboxylic acid groups in the repeating units,
- (e) the composition of reaction products derived from a maleic anhydride and an oleate which are the condensation products of oleic acid and alkyl alcohol that are further reacted with alkyl alcohol to form a half ester product having free carboxylic acid
80 groups,
- (f) the composition of reaction products derived from a maleic anhydride and a substituted phenol-oleate further reacted with an alkyl alcohol to form a half ester product having free carboxylic acid groups. Substituted phenol-oleate is the condensation product of oleic acid and a substituted phenol,
- 85 (g) the composition of reaction products of the starting materials comprising a substituted phenol and an alkylene oxides (e.g. propylene oxide) is further reacted with an alkenyl succinic anhydride to form a half ester product having free carboxylic acid groups, or
- (h) the composition of polymers which are the reaction products of the starting materials
90 comprising a substituted phenol and an aldehyde and are further reacted with alkylene oxides (e.g. propylene oxide) to form phenol-derived alcohols in the repeating units, is further reacted with an alkenyl succinic anhydride to form a half ester product having free carboxylic acid groups,
- (i) the composition of polymers that are the reaction products of a substituted phenol and
95 an aldehyde which are reacted with an alkylene oxide (e.g. propylene oxide) and then esterified further with an oleic acid and then reacted with a maleic anhydride to form

succinic anhydride adduct, and finally reacted with an alkyl alcohol to form a half ester product having free carboxylic acid groups in the repeating units.

100 The present invention pertains to a compound represented by structural formula I and IA:

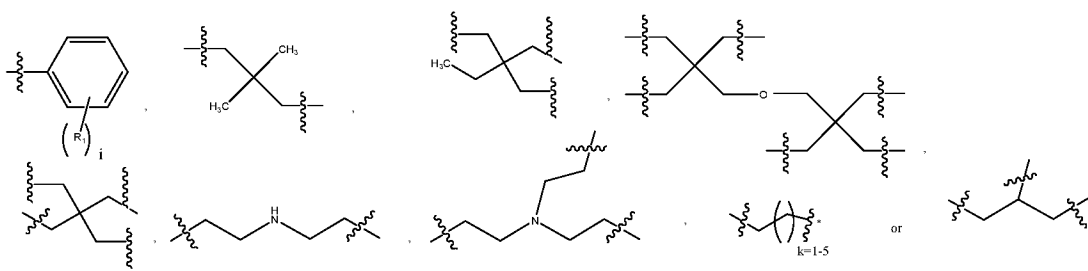
Structural Formula I



105

wherein:

X is:



110

each R₁ is H, independently an optionally substituted C₁-C₂₀ alkyl group, an optionally substituted C₁-C₁₀ alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, an optionally-CH(R''')(R''')COOH wherein each R''' independently C₁-C₁₀ linear or branched alkyl chain, -OH, -SH or -NH₂ or an optionally substituted carbocyclic or heterocyclic non- aromatic ring;

115

$$i = 0, 1, 2, 3;$$

$$j = 0 \text{ or } 1;$$

120

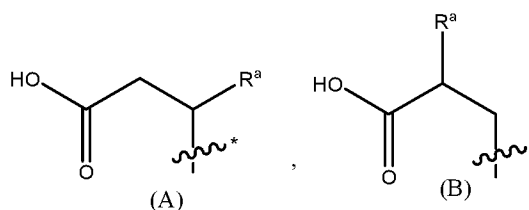
n is an integer from 1 to 1000, or an integer from 1 to 100, or an integer from 1 to 50, or an integer from 1 to 25, or an integer from 1 to 15, or preferably an integer from 1 to 10;

when n = 1, then j = 0;

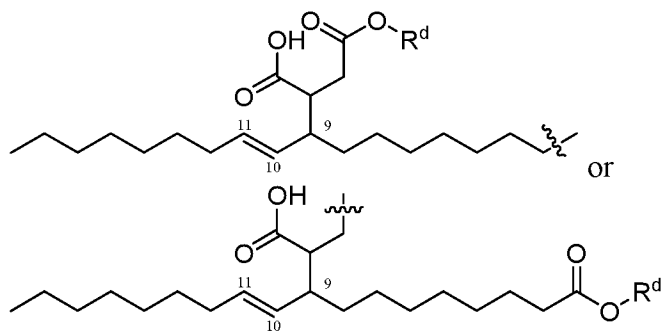
when n > 1 then j = 1;

125 each R_2 and R_3 is independently H, a C₁-C₈ linear or branched or cyclic alkyl
 chain, an optionally substituted C₁-C₂₀ alkyl group, an optionally substituted C₁-C₁₀
 alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally
 substituted aryl group, and optionally substituted alkoxy group, an optionally
 substituted carbonyl group, an optionally substituted alkoxy carbonyl group, or -
 130 CH(R''')(R''' COOH);

R is a C₁-C₂₄ linear or branched alkyl chain, alkenyl chain, or an isomerized
 structure or a mixture of isomerized (A) and (B):



135 wherein R^a is a C₁-C₂₄ alkenyl linear or branched chain,
 when n is 1 and j is 0,
 R in Structure I is a mixture of isomerized structures of



140 R^d is a C₁-C₂₄ linear or branched alkyl chain ; and

DETAILED DESCRIPTION OF THE INVENTION

Definitions

145 For convenience, before further description of the present invention, certain terms
employed in the specification, examples and appended claims are collected here. These
definitions should be read in light of the remainder of the disclosure and understood as by a
person of skill in the art. Unless defined otherwise, all technical and scientific terms used
herein have the same meaning as commonly understood by a person of ordinary skill in the
150 art.

The articles “a” and “an” are used herein to refer to one or to more than one (i.e. to at
least one) of the grammatical object of the article. By way of example, “an element” means
one element or more than one element.

155 The terms “comprise” and “comprising” are used in the inclusive, open sense,
meaning that additional elements may be included.

The term “including” is used herein to mean “including but not limited to”.
“Including” and “including but not limited to” are used interchangeably.

160 The term “polymer” is art-recognized and refers to a macromolecule comprising a
repeating monomeric unit. The number of repeat units may vary as low as 2 and as high as
million. In the present invention this number may vary from 2 to about 10,000, or less than
1,000, or less than about 100, or even less than about 10.

The term “monomer” is art-recognized and refers to a compound that is able to
combine in long chains with other like or unlike molecules to produce.

165 The terms “number average molecular weight”, or “Mn”, “weight average molecular
weight”, “Z-average molecular weight” and “viscosity average molecular weight” are art-
recognized. When the term “molecular weight” or an exemplary molecular weight is
described herein, the measure of molecular weight will be clear from the context and/or will
include all applicable measures.

170 “Small molecule” is an art-recognized term. In certain embodiments, this term refers
to a molecule which has a molecular weight of less than about 2000 amu, or less than about
1000 amu, and even less than about 200 amu.

The term “aliphatic” is an art-recognized term and includes linear, branched, and cyclic alkanes, alkenes, or alkynes. In certain embodiments, aliphatic groups in the present invention are linear or branched and have from 1 to about 30 carbon atoms.

175 The term “alkyl” is art-recognized and includes saturated aliphatic groups, including straight-chain alkyl groups, branched-chain alkyl groups, cycloalkyl (alicyclic) groups, alkyl substituted cycloalkyl groups, and cycloalkyl substituted alkyl groups. In certain
embodiments, a straight chain or branched chain alkyl has about 30 or fewer carbon atoms in
its backbone (e.g., C₁-C₃₀ for straight chain, C₃-C₃₀ for branched chain), and alternatively,
180 about 20 or fewer. Likewise, cycloalkyls have from about 3 to about 10 carbon atoms in their
ring structure, and alternatively about 5, 6 or 7 carbons in the ring structure. The term “alkyl”
is also defined to include halosubstituted alkyls.

The term “aralkyl” is art-recognized, and includes alkyl groups substituted with an aryl group (e.g., an aromatic or heteroaromatic group).

185 The terms “alkenyl” and “alkynyl” are art-recognized, and include unsaturated aliphatic groups analogous in length and possible substitution to the alkyls described above, but that contain at least one double or triple bond respectively.

Unless the number of carbons is otherwise specified, “lower alkyl” refers to an alkyl group, as defined above, but having from one to ten carbons, alternatively from one to about
190 six carbon atoms in its backbone structure. Likewise, “lower alkenyl” and “lower alkynyl”
have similar chain lengths.

The term “heteroatom” means nitrogen, oxygen, or sulfur and includes any oxidized form of nitrogen and sulfur and the quaternized form of any basic nitrogen. Also, the term “nitrogen” includes substitutable nitrogen of a heteroaryl or non-aromatic heterocyclic group.
195 As an example, in a saturated or partially unsaturated ring having 0-3 heteroatoms selected from oxygen, sulfur or nitrogen, the nitrogen may be N (as in 3,4-dihydro-2*H*-pyrrolyl), NH (as in pyrrolidinyl) or NR” (as in N-substituted pyrrolidinyl), wherein R” is a suitable substituent for the nitrogen atom in the ring of a non-aromatic nitrogen-containing heterocyclic group.

200 The term “aryl” is art-recognized, and includes 5-, 6- and 7-membered single-ring aromatic groups that may include from zero to four heteroatoms, for example, benzene, pyrrole, furan, thiophene, imidazole, oxazole, thiazole, triazole, pyrazole, pyridine, pyrazine, pyridazine and pyrimidine, and the like. Those aryl groups having heteroatoms in the ring

structure may also be referred to as “aryl heterocycles” “heteroaryls,” or “heteroaromatics.”

205 The aromatic ring may be substituted at one or more ring positions with such substituents as described above, for example, halogen, azide, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, alkoxy, amino, nitro, sulfhydryl, imino, amido, phosphonate, phosphinate, carbonyl, carboxyl, silyl, ether, alkylthio, sulfonyl, sulfonamido, ketone, aldehyde, ester, heterocyclyl, aromatic or heteroaromatic moieties, -CF₃, -CN, or the like. The term “aryl”
210 also includes polycyclic ring systems having two or more cyclic rings in which two or more carbons are common to two adjoining rings (the rings are “fused rings”) wherein at least one of the rings is aromatic, e.g., the other cyclic rings may be cycloalkyls, cycloalkenyls, cycloalkynyls, aryls and/or heterocyclyls.

The terms ortho, meta and para are art-recognized and apply to 1, 2-, 1, 3- and 1, 4-
215 disubstituted benzenes, respectively. For example, the names 1, 2-dimethylbenzene and ortho-dimethylbenzene are synonymous.

The terms “heterocyclyl” and “heterocyclic group” are art-recognized, and include 3-
to about 10-membered ring structures, such as 3- to about 7-membered rings, whose ring
structures include one to four heteroatoms. Heterocycles may also be polycycles.

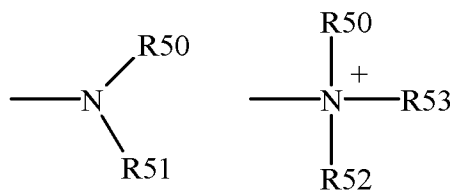
220 Heterocyclyl groups include, for example, thiophene, thianthrene, furan, pyran, isobenzofuran, chromene, xanthene, phenoxathiin, pyrrole, imidazole, pyrazole, isothiazole, isoxazole, pyridine, pyrazine, pyrimidine, pyridazine, indolizine, isoindole, indole, indazole, purine, quinolizine, isoquinoline, quinoline, phthalazine, naphthyridine, quinoxaline, quinazoline, cinnoline, pteridine, carbazole, carboline, phenanthridine, acridine, pyrimidine,
225 phenanthroline, phenazine, phenarsazine, phenothiazine, furazan, phenoxazine, pyrrolidine, oxolane, thiolane, oxazole, piperidine, piperazine, morpholine, lactones, lactams such as azetidiones and pyrrolidinones, sultams, sultones, and the like. The heterocyclic ring may be substituted at one or more positions with such substituents as described above, as for
230 example, halogen, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, amino, nitro, sulfhydryl, imino, amido, phosphonate, phosphinate, carbonyl, carboxyl, silyl, ether, alkylthio, sulfonyl, ketone, aldehyde, ester, a heterocyclyl, an aromatic or heteroaromatic moiety, -CF₃, -CN, or the like.

The terms “polycyclyl” and “polycyclic group” are art-recognized, and include
structures with two or more rings (e.g., cycloalkyls, cycloalkenyls, cycloalkynyls, aryls
235 and/or heterocyclyls) in which two or more carbons are common to two adjoining rings, e.g., the rings are “fused rings”. Rings that are joined through non-adjacent atoms, e.g., three or

more atoms are common to both rings, are termed “bridged” rings. Each of the rings of the polycycle may be substituted with such substituents as described above, as for example, halogen, alkyl, aralkyl, alkenyl, alkynyl, cycloalkyl, hydroxyl, amino, nitro, sulfhydryl, imino, amido, phosphonate, phosphinate, carbonyl, carboxyl, silyl, ether, alkylthio, sulfonyl, ketone, aldehyde, ester, a heterocyclyl, an aromatic or heteroaromatic moiety, -CF₃, -CN, or the like.

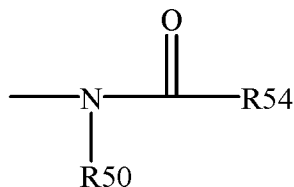
The term “carbocycle” is art recognized and includes an aromatic or non-aromatic ring in which each atom of the ring is carbon. The following art-recognized terms have the following meanings: “nitro” means -NO₂; the term “halogen” designates -F, -Cl, -Br or -I; the term “sulfhydryl” means -SH; the term “hydroxyl” means -OH; and the term “sulfonyl” means -SO₂.

The terms “amine” and “amino” are art-recognized and include both unsubstituted and substituted amines, e.g., a moiety that may be represented by the general formulas:



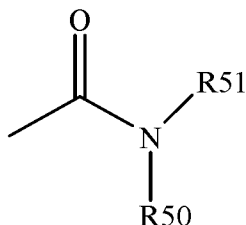
wherein R50, R51 and R52 each independently represent a hydrogen, an alkyl, an alkenyl, -(CH₂)_m-R61, or R50 and R51, taken together with the N atom to which they are attached complete a heterocycle having from 4 to 8 atoms in the ring structure; R61 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is zero or an integer in the range of 1 to 8. In certain embodiments, only one of R50 or R51 may be a carbonyl, e.g., R50, R51 and the nitrogen together do not form an imide. In other embodiments, R50 and R51 (and optionally R52) each independently represent a hydrogen, an alkyl, an alkenyl, or -(CH₂)_m-R61. Thus, the term “alkylamine” includes an amine group, as defined above, having a substituted or unsubstituted alkyl attached thereto, i.e., at least one of R50 and R51 is an alkyl group.

The term “acylamino” is art-recognized and includes a moiety that may be represented by the general formula:



wherein R50 is as defined above, and R54 represents a hydrogen, an alkyl, an alkenyl or -
 265 $(\text{CH}_2)_m\text{-R61}$, where m and R61 are as defined above.

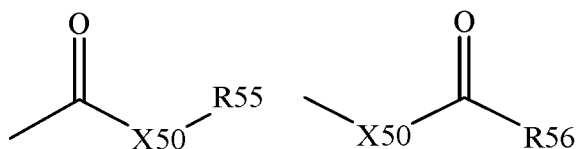
The term “amido” is art recognized as an amino-substituted carbonyl and includes a moiety that may be represented by the general formula:



wherein R50 and R51 are as defined above. Certain embodiments of the amide in the present
 270 invention will not include imides which may be unstable.

The term “alkylthio” is art recognized and includes an alkyl group, as defined above, having a sulfur radical attached thereto. In certain embodiments, the “alkylthio” moiety is represented by one of -S-alkyl, -S-alkenyl, -S-alkynyl, and -S- $(\text{CH}_2)_m\text{-R61}$, wherein m and R61 are defined above. Representative alkylthio groups include methylthio, ethyl thio, and
 275 the like.

The term “carbonyl” is art recognized and includes such moieties as may be represented by the general formulas:

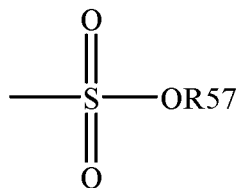


wherein X50 is a bond or represents an oxygen or a sulfur, and R55 represents a hydrogen, an
 280 alkyl, an alkenyl, $(\text{CH}_2)_m\text{-R61}$ or a pharmaceutically acceptable salt, R56 represents a hydrogen, an alkyl, an alkenyl or $(\text{CH}_2)_m\text{-R61}$, where m and R61 are defined above. Where X50 is oxygen and R55 or R56 is not hydrogen, the formula represents an “ester”. Where X50 is oxygen, and R55 is as defined above, the moiety is referred to herein as a carboxyl group, and particularly when R55 is hydrogen, the formula represents a “carboxylic acid”.
 285 Where X50 is an oxygen, and R56 is hydrogen, the formula represents a “formate”. In

general, where the oxygen atom of the above formula is replaced by sulfur, the formula represents a “thiocarbonyl” group. Where X50 is a sulfur and R55 or R56 is not hydrogen, the formula represents a “thioester.” Where X50 is a sulfur and R55 is hydrogen, the formula represents a “thiocarboxylic acid.” Where X50 is a sulfur and R56 is hydrogen, the formula represents a “thioformate.” On the other hand, where X50 is a bond, and R55 is not hydrogen, the above formula represents a “ketone” group. Where X50 is a bond, and R55 is hydrogen, the above formula represents an “aldehyde” group.

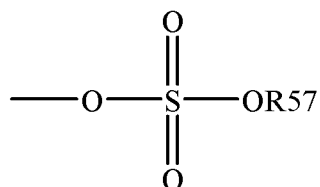
The terms “alkoxyl” or “alkoxy” are art recognized and include an alkyl group, as defined above, having an oxygen radical attached thereto. Representative alkoxyl groups include methoxy, ethoxy, propyloxy, tert-butoxy and the like. An “ether” is two hydrocarbons covalently linked by an oxygen. Accordingly, the substituent of an alkyl that renders that alkyl an ether is or resembles an alkoxyl, such as may be represented by one of -O-alkyl, -O-alkenyl, -O-alkynyl, -O-(CH₂)_m-R61, where m and R61 are described above.

The term “sulfonate” is art recognized and includes a moiety that may be represented by the general formula:



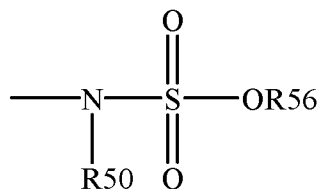
in which R57 is an electron pair, hydrogen, alkyl, cycloalkyl, or aryl.

The term “sulfate” is art recognized and includes a moiety that may be represented by the general formula:



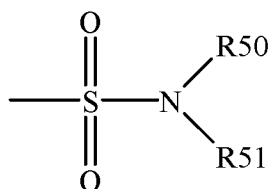
in which R57 is as defined above.

The term “sulfonamido” is art recognized and includes a moiety that may be represented by the general formula:



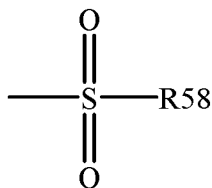
310 in which R50 and R56 are as defined above.

The term “sulfamoyl” is art-recognized and includes a moiety that may be represented by the general formula:



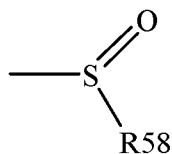
in which R50 and R51 are as defined above.

315 The term “sulfonyl” is art recognized and includes a moiety that may be represented by the general formula:



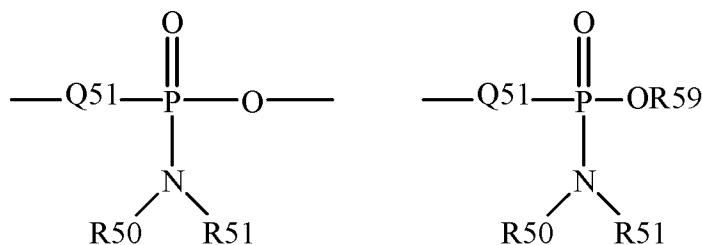
in which R58 is one of the following: hydrogen, alkyl, alkenyl, alkynyl, cycloalkyl, heterocyclyl, aryl or heteroaryl.

320 The term “sulfoxido” is art recognized and includes a moiety that may be represented by the general formula:



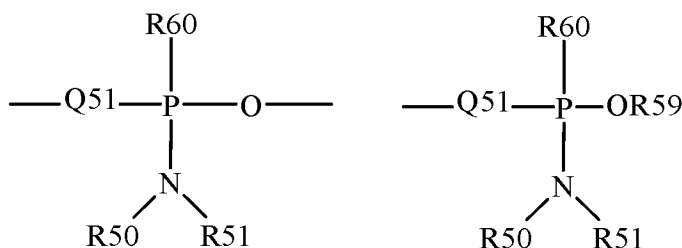
in which R58 is defined above.

325 The term “phosphoramidite” is art recognized and includes moieties represented by the general formulas:



wherein Q51, R50, R51, and R59 are as defined above.

The term “phosphoramidite” is art recognized and includes moieties represented by the general formulas:



330

wherein Q51, R50, R51, and R59 are as defined above, and R60 represents a lower alkyl or an aryl.

As used herein the term non-aromatic carbocyclic ring as used alone or as part of a larger moiety refers to a non-aromatic carbon containing ring which can be saturated or
 335 unsaturated having three to fourteen atoms including monocyclic and polycyclic rings in which the carbocyclic ring can be fused to one or more non-aromatic carbocyclic or heterocyclic rings or one or more aromatic (carbocyclic or heterocyclic) rings.

An optionally substituted aryl group as defined herein may contain one or more substitutable ring atoms, such as carbon or nitrogen ring atoms. Examples of suitable
 340 substituents on a substitutable ring carbon atom of an aryl group include halogen (e.g., -Br, Cl, I and F), -OH, C1-C4 alkyl, C1-C4 haloalkyl, -NO₂, C1-C4 alkoxy, C1-C4 haloalkoxy, -CN, -NH₂, C1-C4 alkylamino, C1-C4 dialkylamino, -C(O)NH₂, -C(O)NH(C1-C4 alkyl), -C(O)(C1-C4 alkyl), -OC(O)(C1-C4 alkyl), -OC(O)(aryl), -OC(O)(substituted aryl), -OC(O)(aralkyl), -OC(O)(substituted aralkyl), -NHC(O)H, -NHC(O)(C1-C4 alkyl),
 345 -C(O)N(C1-C4 alkyl)₂, -NHC(O)O-(C1-C4 alkyl), -C(O)OH, -C(O)O-(C1-C4 alkyl), -NHC(O)NH₂, -NHC(O)NH(C1-C4 alkyl), -NHC(O)N(C1-C4 alkyl)₂, -NH-C(=NH)NH₂, -SO₂NH₂, -SO₂NH(C1-C3alkyl), -SO₂N(C1-C3alkyl)₂, NHSO₂H, NHSO₂(C1-C4 alkyl) and optionally substituted aryl. Preferred substituents on aryl groups are as defined throughout the specification. In certain embodiments aryl groups are unsubstituted.

350 Examples of suitable substituents on a substitutable ring nitrogen atom of an aryl group include C1-C4 alkyl, NH₂, C1-C4 alkylamino, C1-C4 dialkylamino, -C(O)NH₂, -C(O)NH(C1-C4 alkyl), -C(O)(C1-C4 alkyl), -CO₂ R^{**}, -C(O)C(O)R^{**}, -C(O)CH₃, -C(O)OH, -C(O)O-(C1-C4 alkyl), -SO₂NH₂, -SO₂NH(C1-C3alkyl), -SO₂N(C1-C3alkyl)₂, NHSO₂H, NHSO₂(C1-C4 alkyl), -C(=S)NH₂, -C(=S)NH(C1-C4 alkyl), -C(=S)N(C1-C4 alkyl)₂, -C(=NH)-N(H)₂, -C(=NH)-NH(C1-C4 alkyl) and -C(=NH)-N(C1-C4 alkyl)₂,

An optionally substituted alkyl group or non-aromatic carbocyclic or heterocyclic group as defined herein may contain one or more substituents. Examples of suitable substituents for an alkyl group include those listed above for a substitutable carbon of an aryl and the following: =O, =S, =NNHR^{**}, =NN(R^{**})₂, =NNHC(O)R^{**}, =NNHCO₂ (alkyl), 360 =NNHSO₂ (alkyl), =NR^{**}, spiro cycloalkyl group or fused cycloalkyl group. R^{**} in each occurrence independently is -H or C1-C6 alkyl. Preferred substituents on alkyl groups are as defined throughout the specification. In certain embodiments optionally substituted alkyl groups are unsubstituted.

A “spiro cycloalkyl” group is a cycloalkyl group which shares one ring carbon atom 365 with a carbon atom in an alkylene group or alkyl group, wherein the carbon atom being shared in the alkyl group is not a terminal carbon atom.

Analogous substitutions may be made to alkenyl and alkynyl groups to produce, for example, aminoalkenyls, aminoalkynyls, amidoalkenyls, amidoalkynyls, iminoalkenyls, iminoalkynyls, thioalkenyls, thioalkynyls, carbonyl-substituted alkenyls or alkynyls.

370 The definition of each expression, e.g. alkyl, m, n, etc., when it occurs more than once in any structure, is intended to be independent of its definition elsewhere in the same structure unless otherwise indicated expressly or by the context.

The term “selenoalkyl” is art recognized and includes an alkyl group having a substituted seleno group attached thereto. Exemplary “selenoethers” which may be 375 substituted on the alkyl are selected from one of -Se-alkyl, -Se-alkenyl, -Se-alkynyl, and -Se-(CH₂)_m-R₆₁, m, and R₆₁ are defined above.

The terms triflyl, tosyl, mesyl, and nonafllyl are art-recognized and refer to trifluoromethanesulfonyl, *p*-toluenesulfonyl, methanesulfonyl, and nonafluorobutanesulfonyl groups, respectively. The terms triflate, tosylate, mesylate, and nonaflate are art-recognized 380 and refer to a trifluoromethanesulfonate ester, *p*-toluenesulfonate ester, methanesulfonate ester, and nonafluorobutanesulfonate ester functional groups and molecules that contain said groups, respectively.

The abbreviations Me, Et, Ph, Tf, Nf, Ts, and Ms are art recognized and represent methyl, ethyl, phenyl, trifluoromethanesulfonyl, nonafluorobutanesulfonyl, *p*-toluenesulfonyl and methanesulfonyl, respectively. A more comprehensive list of the abbreviations utilized by organic chemists of ordinary skill in the art appears in the first issue of each volume of the *Journal of Organic Chemistry*; this list is typically presented in a table entitled Standard List of Abbreviations.

The abbreviations OSA is for octenyl succinic anhydride, DDSA is for dodecenyl succinic anhydride, ODSA is for octadecenyl succinic anhydride, and PIBSA is for polyisobutylene succinic anhydride preferably with low molecular weights (300 - 1500 molecular weight), and OASA is for oleic acid succinic anhydride.

The term an isomer is understood a molecule with the same molecular formula as another molecule, but with a different chemical structure. Isomers contain the same number of atoms of each element but have different arrangements of their atoms. Isomers do not necessarily share similar properties unless they also have the same functional groups. In structural isomers, sometimes referred to as constitutional isomers, the atoms, and functional groups are joined together in different ways. The chain isomers whereby hydrocarbon chains have variable amounts of branching; position isomers, which deals with the position of a functional group on a chain; and functional group isomerism, in which one functional group is split up into different ones. All such isomers, as well as mixtures thereof, are intended to be included in this invention.

Certain monomeric subunits of the present invention may exist in particular geometric or stereoisomeric forms. In addition, and other compositions of the present invention may also be optically active. The present invention contemplates all such compounds, including cis- and trans-isomers, *R*- and *S*-enantiomers, diastereomers, (D)-isomers, (L)-isomers, the racemic mixtures thereof, and other mixtures thereof, as falling within the scope of the invention. Additional asymmetric carbon atoms may be present in a substituent such as an alkyl group. All such isomers, as well as mixtures thereof, are intended to be included in this invention.

If, for instance, a particular enantiomer of a compound of the present invention is desired, it may be prepared by asymmetric synthesis, or by derivation with a chiral auxiliary, where the resulting diastereomeric mixture is separated and the auxiliary group cleaved to provide the pure desired enantiomers. Alternatively, where the molecule contains a basic

415 functional group, such as amino, or an acidic functional group, such as carboxyl,
diastereomeric salts are formed with an appropriate optically active acid or base, followed by
resolution of the diastereomers thus formed by fractional crystallization or chromatographic
means well known in the art, and subsequent recovery of the pure enantiomers.

It will be understood that “substitution” or “substituted with” includes the implicit
420 proviso that such substitution is in accordance with permitted valence of the substituted atom
and the substituent, and that the substitution results in a stable compound, e.g., which does
not spontaneously undergo transformation such as by rearrangement, cyclization, elimination,
or other reaction.

The term “substituted” is also contemplated to include all permissible substituents of
425 organic compounds. In a broad aspect, the permissible substituents include acyclic and cyclic,
branched and unbranched, carbocyclic and heterocyclic, aromatic and nonaromatic
substituents of organic compounds. Illustrative substituents include, for example, those
described herein above. The permissible substituents may be one or more and the same or
different for appropriate organic compounds. For purposes of this invention, the heteroatoms
430 such as nitrogen may have hydrogen substituents and/or any permissible substituents of
organic compounds described herein which satisfy the valences of the heteroatoms. This
invention is not intended to be limited in any manner by the permissible substituents of
organic compounds.

For purposes of this invention, the chemical elements are identified in accordance
435 with the Periodic Table of the Elements, CAS version, Handbook of Chemistry and Physics,
67th Ed., 1986-87, inside cover. The term “hydrocarbon” is art recognized and includes all
permissible compounds having at least one hydrogen and one carbon atom. For example,
permissible hydrocarbons include acyclic and cyclic, branched and unbranched, carbocyclic
and heterocyclic, aromatic and nonaromatic organic compounds that may be substituted or
440 unsubstituted.

The phrase “protecting group” is art recognized and includes temporary substituents
that protect a potentially reactive functional group from undesired chemical transformations.
Examples of such protecting groups include esters of carboxylic acids, silyl ethers of
alcohols, and acetals and ketals of aldehydes and ketones, respectively. The field of
445 protecting group chemistry has been reviewed. Greene et al., *Protective Groups in Organic
Synthesis* 2nd ed., Wiley, New York, (1991).

The phrase “hydroxyl-protecting group” is art recognized and includes those groups intended to protect a hydroxyl group against undesirable reactions during synthetic procedures and includes, for example, benzyl or other suitable esters or ethers groups known
450 in the art.

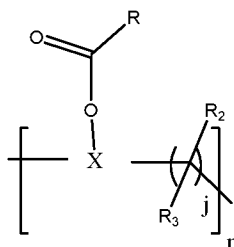
The term “electron-withdrawing group” is recognized in the art and denotes the tendency of a substituent to attract valence electrons from neighboring atoms, i.e., the substituent is electronegative with respect to neighboring atoms. A quantification of the level of electron-withdrawing capability is given by the Hammett sigma (σ) constant. This well
455 known constant is described in many references, for instance, March, *Advanced Organic Chemistry* 251-59, McGraw Hill Book Company, New York, (1977). The Hammett constant values are generally negative for electron donating groups (σ (P) = - 0.66 for NH_2) and positive for electron withdrawing groups (σ (P) = 0.78 for a nitro group), σ (P) indicating para substitution. Exemplary electron-withdrawing groups include nitro, acyl, formyl,
460 sulfonyl, trifluoromethyl, cyano, chloride, and the like. Exemplary electron-donating groups include amino, methoxy, and the like.

Contemplated equivalents of the or oligomers, subunits and other compositions described above include such materials which otherwise correspond thereto, and which have the same general properties thereof, wherein one or more simple variations of substituents are
465 made which do not adversely affect the efficacy of such molecule to achieve its intended purpose of the present invention. In general, the methods of the present invention may be methods illustrated in the general reaction schemes as, for example, described below, or by modifications thereof, using readily available starting materials, reagents and conventional synthesis procedures. In these reactions, it is also possible to make use of variants which are
470 in themselves known but are not mentioned here.

The present invention pertains to a compound represented by structural formula I:

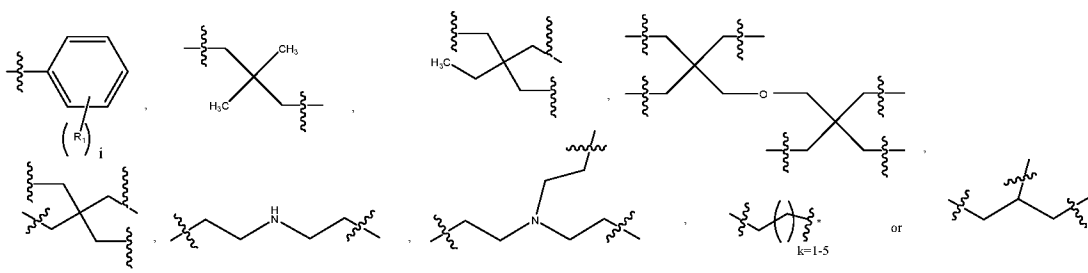
Structural Formula I

475



wherein:

X is:



480

Each R_1 is H, independently an optionally substituted C_1 - C_{20} alkyl group, an optionally substituted C_1 - C_{10} alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, an optionally- $CH(R''')(R''')COOH$ wherein each R''' independently C_1 - C_{10} linear or branched alkyl chain, $-OH$, $-SH$ or $-NH_2$ or an optionally substituted carbocyclic or heterocyclic non- aromatic ring;

485

$i = 0, 1, 2, 3$;

490

$j = 0$ or 1 ;

n is an integer from 1 to 1000, or an integer from 1 to 100, or an integer from 1 to 50, or an integer from 1 to 25, or an integer from 1 to 15, or preferably an integer from 1 to 10;

when $n = 1$, then $j = 0$;

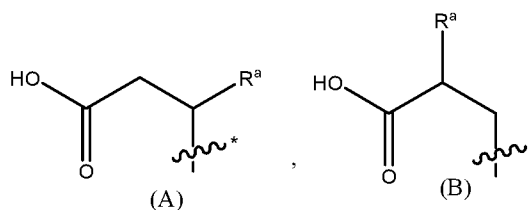
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when $n > 1$ then $j = 1$;

each R_2 and R_3 is independently H, a C_1 - C_8 linear or branched or cyclic alkyl chain, an optionally substituted C_1 - C_{20} alkyl group, an optionally substituted C_1 - C_{10} alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, or $-CH(R''')(R''')COOH$;

500

R is a C_1 - C_{24} linear or branched alkyl chain, alkenyl chain, or an isomerized structure or a mixture of isomerized (A) and (B):



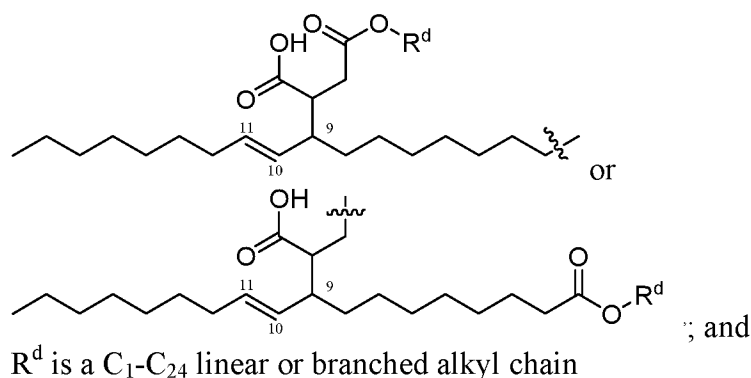
505

wherein R^a is a C₁-C₂₄ alkenyl linear or branched chain.

In another embodiment, the present invention addresses that relate to a compound of Structure I wherein

510

n = 1;
 j = 0;
 R is a mixture of isomerized structures of

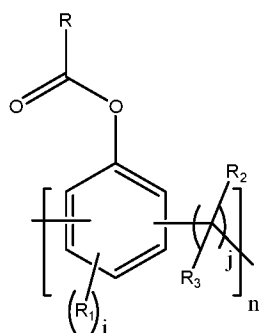


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520

In another embodiment, the present invention addresses that relate to a compound represented by structural formula II derived from Structural Formula I

Structural Formula II



525

. Each R₁ is H, independently an optionally substituted C₁-C₂₀ linear or branched alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and an optionally substituted C₁-C₂₀ linear or branched alkoxy group, an optionally

substituted carbonyl group, an optionally substituted C₁-C₂₀ linear or branched
 alkoxy carbonyl group, an optionally-CH(R''')(R'''COOH) wherein each R''' independently
 530 is C₁-C₁₀ linear or branched alkyl chain, -OH, -SH or -NH₂ or an optionally substituted
 carbocyclic or heterocyclic C₁-C₁₂ non- aromatic ring.

i= 0 or 1 or 2 or 3;

j=0 or 1;

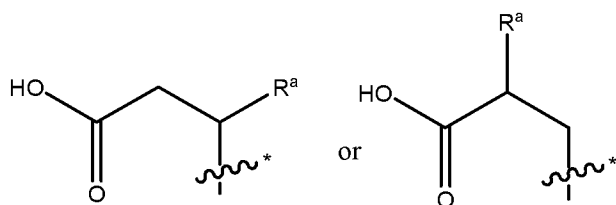
n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10,

535 when n=1, then j is always 0;

when n>1 then j is 1;

Each R₂, R₃, R₄ independently is H, methyl, or a C₁-C₂₄ linear or branched or cyclic alkyl
 chain. Each R₂, R₃, R₄ is H, independently an optionally substituted C₁-C₂₄ alkyl group, an
 optionally substituted C₁-C₁₀ alkyl group, a tertiary carbon group, a methyl group, a methoxy
 540 group, an optionally substituted aryl group, and optionally substituted C₁-C₂₀ alkoxy group,
 an optionally substituted C₁-C₂₀ carbonyl group, an optionally substituted C₁-C₂₀
 alkoxy carbonyl group, an optionally-CH(R''')(R'''COOH) wherein each R''' independently
 C₁-C₁₀ linear or branched alkyl chain, -OH, -SH or -NH₂ or an optionally substituted
 carbocyclic or heterocyclic C₁-C₁₂ non- aromatic ring.

545 R is a C₁-C₂₄ linear or branched alkyl chain, C₁-C₂₄ alkenyl chain or



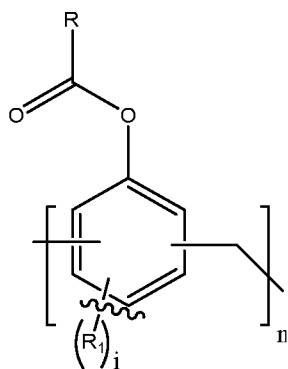
wherein R^a is a C₁-C₂₄ alkenyl linear or branched chain.

In yet another embodiment of the present invention is a compound of Structure II
 550 wherein each R₂, R₃ is independently an optionally a methyl group or H; independently an
 optionally a C₁-C₈ linear, branched, a cyclic alkyl group or H.

In another embodiment of the present invention is a compound represented by the
 Structural Formula III:

555

Structural Formula III



wherein, R is a linear or branched C₁-C₂₆ alkyl chain,

Each R₁ is H, independently an optionally substituted C₁-C₂₀ linear or branched alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and an optionally substituted C₁-C₂₀ linear or branched alkoxy group, an optionally substituted carbonyl group, an optionally substituted C₁-C₂₀ linear or branched alkoxy carbonyl group, an optionally-CH(R''')(R'''COOH) wherein each R''' independently is C₁-C₁₀ linear or branched alkyl chain, -OH, -SH or -NH₂ or an optionally substituted carbocyclic or heterocyclic C₁-C₁₂ non- aromatic ring, and

i is 0, 1, 2 or 3,

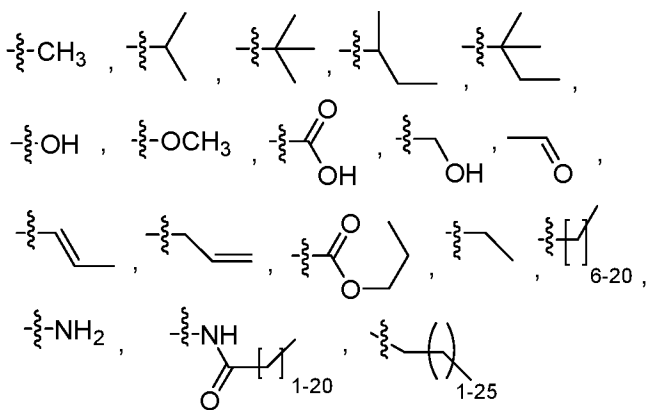
n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10

In another embodiment of the present invention is a compound of structural formula (III) where R is a saturated fatty acid derived from natural resources like plants, vegetable oils or animal fats.

In another embodiment of the present invention is a compound of structural formula (III) where R is a saturated fatty acid, caprylic acid (8:0), capric acid (10:0), lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0), stearic acid (18:0), arachidic acid (20:0), behenic acid (22:0), lignoceric acid (24:0), or cerotic acid(26:0).

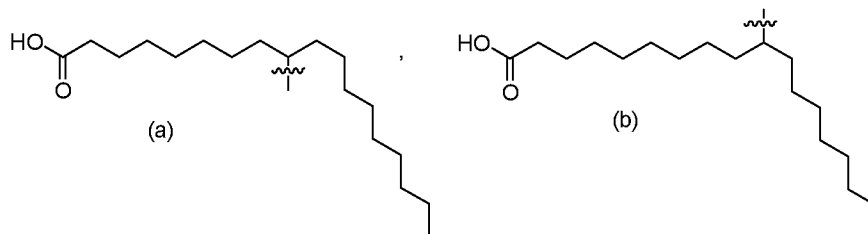
In another embodiment of the present invention is a compound of structural formula (III) where R is a mixture of saturated alkyl chains of saturated fatty acids derived natural resources like plants, vegetable oils or animal fat.

In another embodiment, the present invention is a compound of structural formula (III) where R₁ independently for each occurrence is selected from the group consisting of



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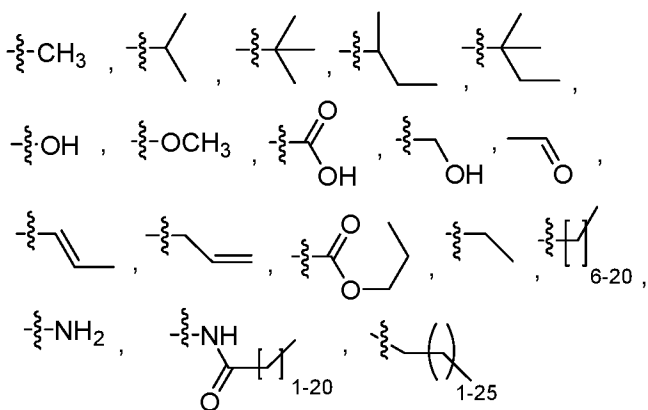
In another embodiment, the present invention is a compound of structural formula (III) where R is represented by



or a mixture of structural isomers.

585

In another embodiment the present invention is a compound of structural formula (III) where R is a $\text{C}_1\text{-C}_{26}$ linear or branched alkyl chain or a mixture of $\text{C}_8\text{-C}_{24}$ linear or branched alkyl chains, i is an integer from 0 to 3, and R_1 independently for each occurrence is selected from the group consisting of

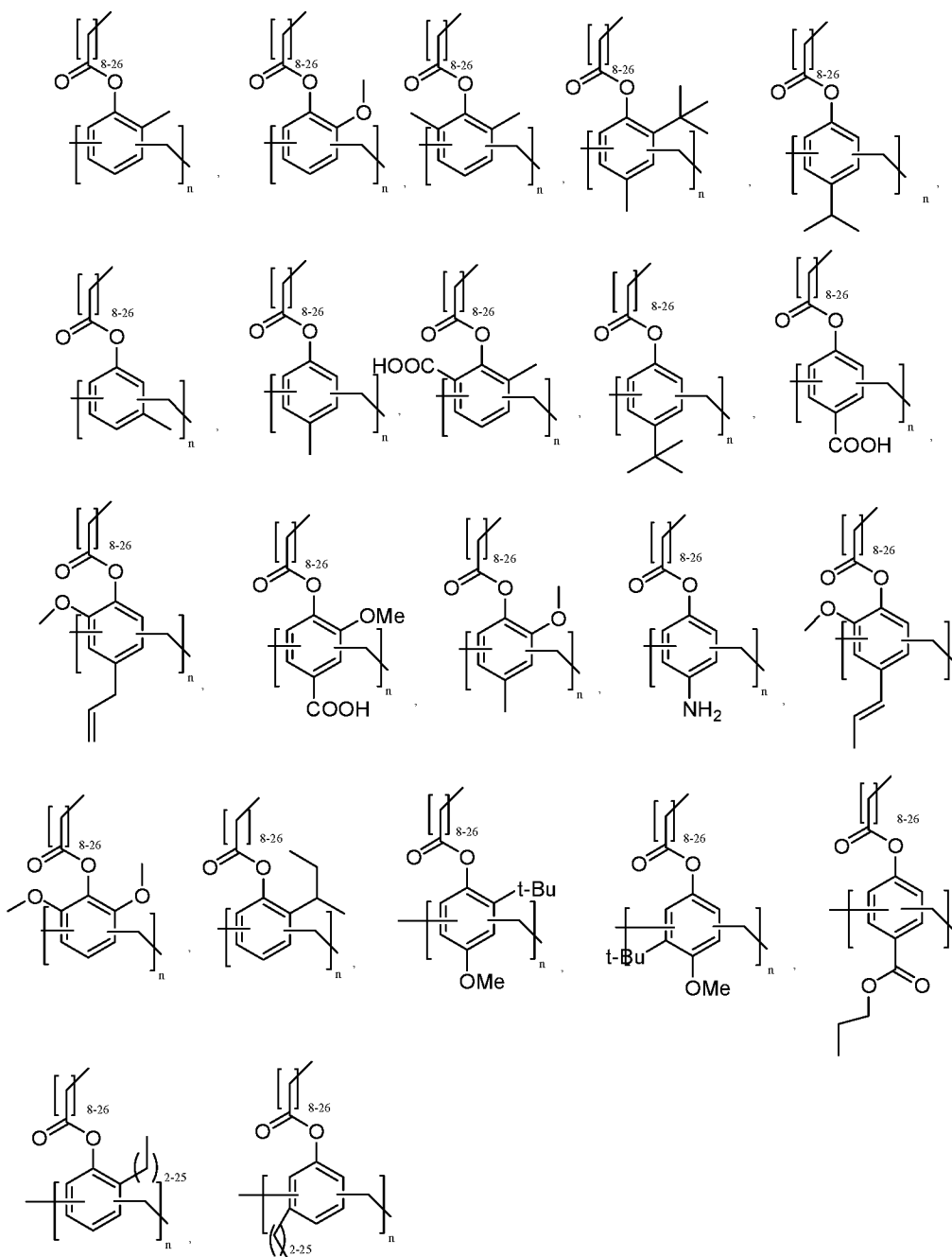


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In certain embodiments of the present invention the compounds are represented by the following structural formulas:

595

Structural Formulas IV

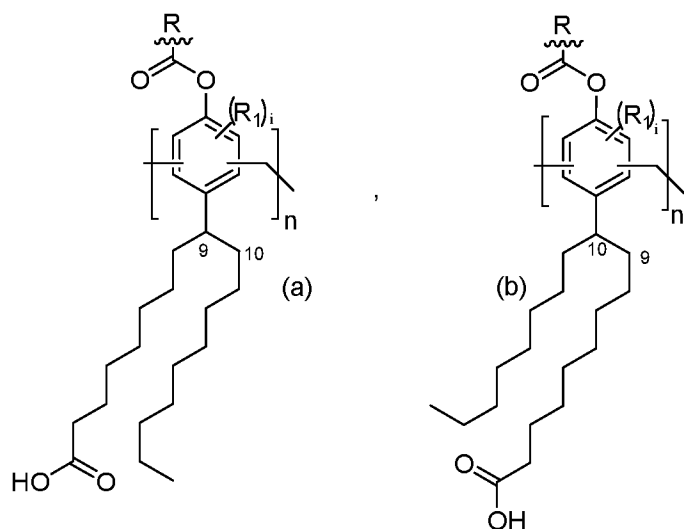


wherein n is an integer from 0 to 100 or 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10

In another embodiment of the present invention is a compound of structural formula (IV-a):

600

Structural Formula IV-a



or a mixture of structural isomers.

wherein R is a C₁-C₂₆ linear or branched alkyl chain or an alkyl chain of saturated fatty acids
 605 derived from renewable resources like plant oils like Jatropha, vegetable oils like canola oil, palm oil, vegetable oils like canola, rapeseed oil, soy oil, palms oil, and alike, and animal fats like tallow oil. The saturated fatty acids are, caprylic acid (8:0), capric acid (10:0), lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0), stearic acid (18:0), arachidic acid (20:0), behenic acid (22:0), lignoceric acid (24:0), or cerotic acid(26:0),

610 . Each R₁ is H, independently an optionally substituted C₁-C₂₀ linear or branched alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and an optionally substituted C₁-C₂₀ linear or branched alkoxy group, an optionally substituted carbonyl group, an optionally substituted C₁-C₂₀ linear or branched alkoxy carbonyl group, an optionally-CH(R''')(R'''COOH) wherein each R''' independently
 615 is C₁-C₁₀ linear or branched alkyl chain, -OH, -SH or -NH₂ or an optionally substituted carbocyclic or heterocyclic C₁-C₁₂ non- aromatic ring.

i= 0 or 1,

n is an integer from 0 to 100 or 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10.

620 In yet another embodiment, the present invention is a compound or a mixture of compounds represented by Structural formula III, IV or IVa wherein the compound is the composition of that are the reaction products of a substituted phenol and an aldehyde which are esterified further with a linear or branched alkyl alcohol containing a C₁-C₅₀ linear or branched alkyl chain or a mixture of C₁-C₅₀ linear or branched alkyl chains or preferably

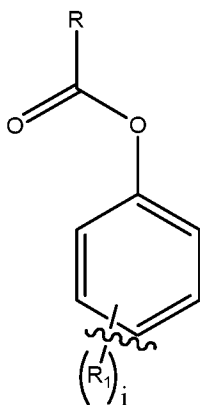
625 linear C₁-C₂₆ linear or branched alkyl chain or a mixture of linear or branched C₁-C₂₆ alkyl chains or more preferably C₁₂-C₁₈ lineal alkyl chain or a mixture of C₁₂-C₁₈ alkyl chains.

In another embodiment of the present invention is a compound of structural formula

V:

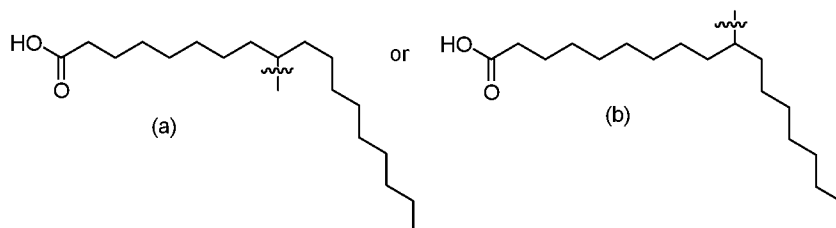
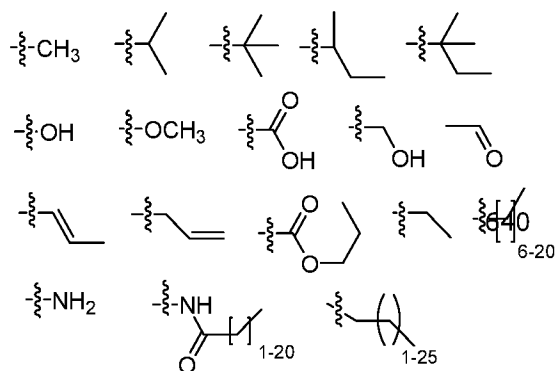
630

Structural Formula V



wherein R is a C₁-C₂₆ linear or branched alkyl chain or a mixture of C₈-C₂₄ alkyl chains, i is an integer from >1 but ≤3, and each R₁ independently is selected from the group consisting of

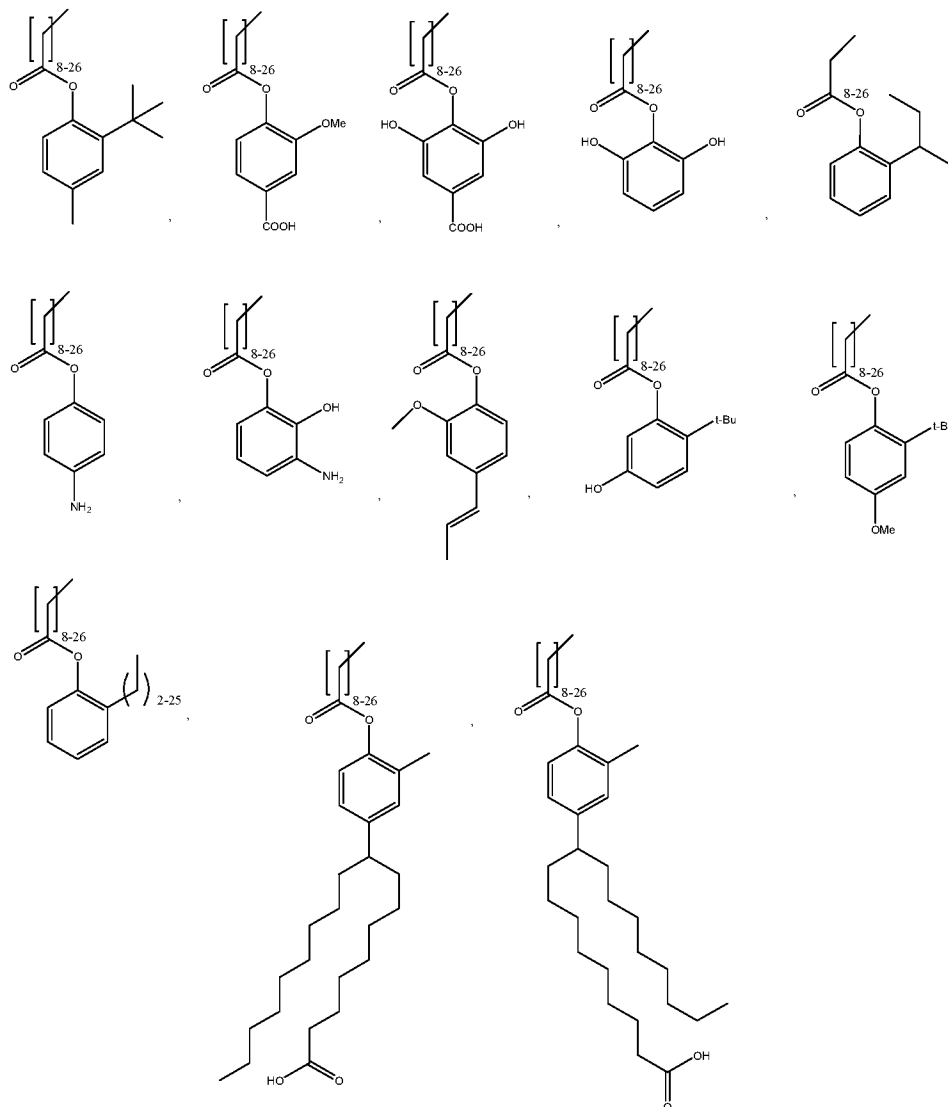
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645

In yet another embodiment, the present invention is a compound or a mixture of compounds represented by structural formulas VI:

Structural Formula VI

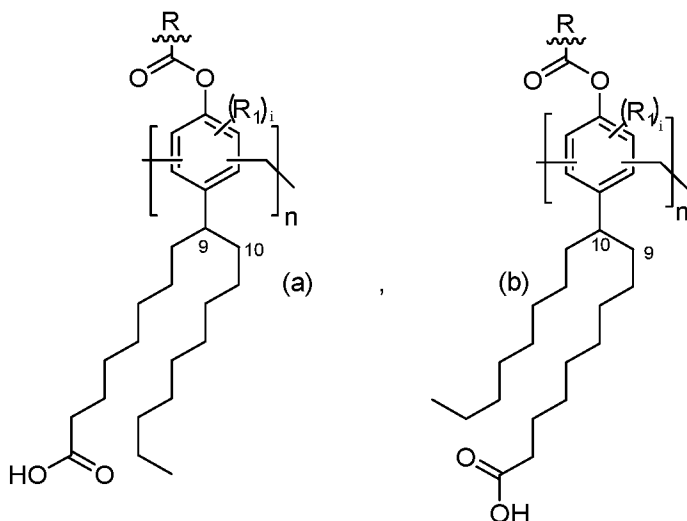


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In another embodiment of the present invention represented by structural formulas IV-V where in R is a C₁-C₂₆ linear or branched alkyl chain or a saturated fatty acid or mixture of saturated fatty acids derived from renewable resources like plant oils like Jatropha, vegetable oils like canola oil, palm oil, vegetable oils like canola, rapeseed oil, soy oil, palms
 655 oil, and alike, and animal fats like tallow oil. The saturated fatty acids are, caprylic acid (8:0), capric acid (10:0), lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0), stearic acid (18:0), arachidic acid (20:0), behenic acid (22:0), lignoceric acid (24:0), or cerotic acid(26:0).

In another embodiment of the present invention is represented by an isomerized
 660 structural formula (VI-a):

Structural Formula VI-a

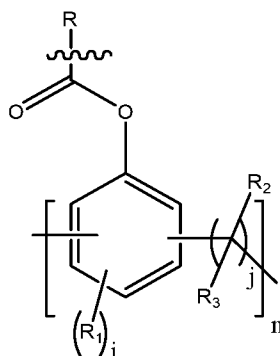


or a mixture of structural isomers.

665 wherein R is a C₁-C₂₆ linear or branched alkyl chain or a saturated fatty acid or saturated fatty acids derived from renewable resources like plant oils like Jatropha, vegetable oils like canola oil, palm oil, vegetable oils like canola, rapeseed oil, soy oil, palms oil, and alike, and animal fats like tallow oil. The saturated fatty acids are, caprylic acid (8:0), capric acid (10:0), lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0), stearic acid (18:0),
 670 arachidic acid (20:0), behenic acid (22:0), lignoceric acid (24:0), or cerotic acid(26:0), and the remaining variables are as described in the immediately preceding paragraph or for structural formula (I), (II) or (III).

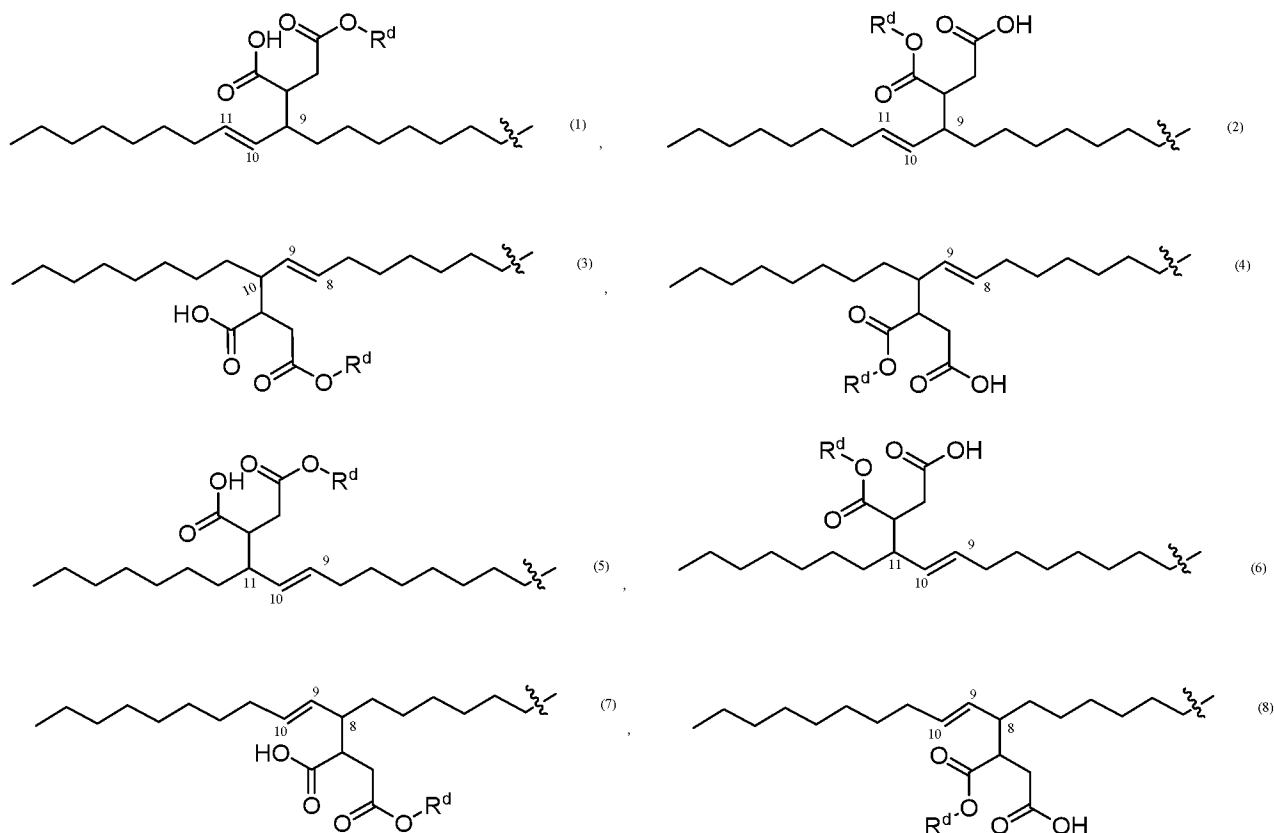
In another embodiment, the present invention addresses to a compound represented by
 675 structural formula VII

Structural Formula VII



wherein

680 R is an alkenyl isomer represented by



or a mixture of structural isomers,

685 R^d is H or a C_1 - C_{18} linear or branched alkyl chain, $-[CH_2]_p-CH_3$ with p being an integer from 0 to 30. In some instances p is from 3 to 25, in some instances p is 7 to 17, in some instances p is from 11 to 17, in some instances p from 13-15, in some instances p is from 15 to 17, in some instances p is 0, 7, 9, 11, 13, 15, or 17 or a mixture thereof,

Each R_1 is H, independently an optionally substituted C_1 - C_{20} linear or branched alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl
 690 group, and an optionally substituted C_1 - C_{20} linear or branched alkoxy group, an optionally substituted carbonyl group, an optionally substituted C_1 - C_{20} linear or branched alkoxy carbonyl group, an optionally- $CH(R''')(R''')COOH$ wherein each R''' independently is C_1 - C_{10} linear or branched alkyl chain, $-OH$, $-SH$ or $-NH_2$ or an optionally substituted carbocyclic or heterocyclic C_1 - C_{12} non- aromatic ring.

695 $i=0$ or 1 ,

$j=0$ or 1 ;

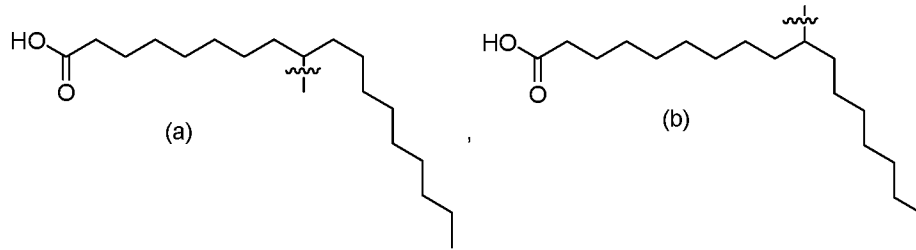
n is an integer from 0 to 100 or 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10;

when $n=1$, then j is always 0;

when $n>1$ then $j=1$;

700 each R_2, R_3 , independently is H, methyl, or a C_1 - C_8 linear or branched or cyclic alkyl chain.

In another embodiment, the present invention is a compound of structural formula (VII) where R₁ is an isomerized structure represented by

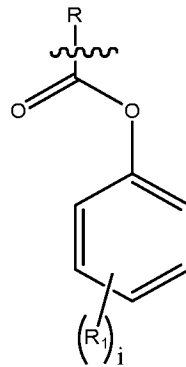


or a mixture of isomers.

705

In another embodiment, the present invention addresses to a compound represented by structural formula VIII:

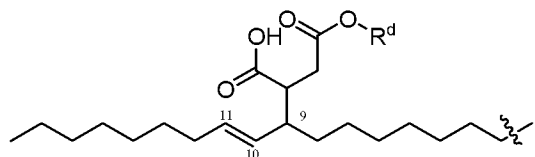
Structural Formula VIII



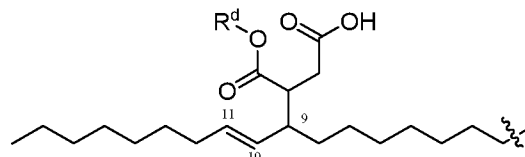
710

wherein,

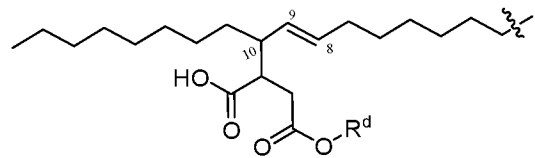
R is an alkenyl isomer represented by



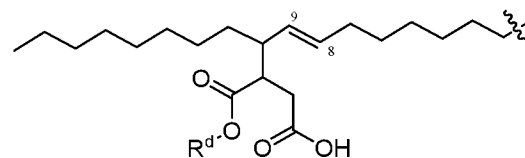
(1)



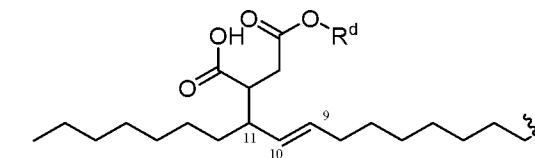
(2)



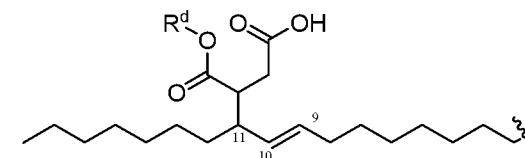
(3)



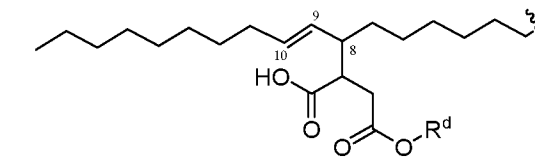
(4)



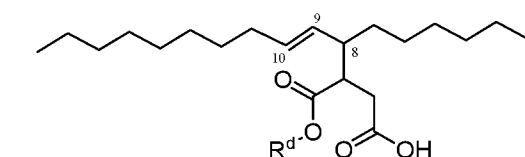
(5)



(6)



(7)



(8)

715

or a mixture of isomerized structures;

R^d is H or C_1 - C_{18} linear or branched alkyl chains, $-[CH_2]_p-CH_3$ with p being an integer from 0 to 30. In some instances p is from 3 to 25, in some instances p is 7 to 17, in some instances p is from 11 to 17, in some instances p from 13-15, in some instances p is from 15 to 17, in some instances p is 0, 7, 9, 11, 13, 15, or 17 or a mixture thereof;

720

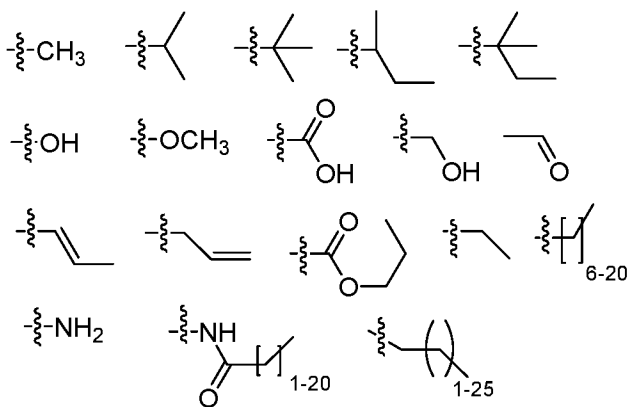
. Each R_1 is H, independently an optionally substituted C_1 - C_{20} alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted C_1 - C_{20} alkoxy group, an optionally substituted carbonyl group, an optionally substituted C_1 - C_{20} alkoxy carbonyl group, an optionally- $CH(R''')(R''')COOH$ wherein each R''' independently is C_1 - C_{10} linear or branched alkyl chain, $-OH$, $-SH$ or $-NH_2$ or an optionally substituted carbocyclic or heterocyclic C_1 - C_{12} non- aromatic ring;

725

$i = 0$ or 1 or 2 or 3;

In another embodiment, the present invention is a compound of structural formula VIII where R_1 is selected from the group consisting of

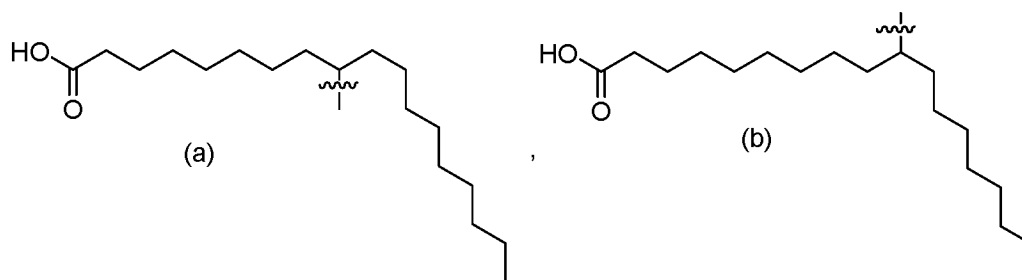
730



and,

in proviso substituted phenol is not a phenol, 2,4-dimethylphenol or resorcinol if R is arising from DDSA (dodecenyl succinic anhydride), ODSA (octadecenyl succinic anhydride), OSA (octenyl succinic anhydride), or PIBSA (polyisobutylene succinic anhydride).

In another embodiment, the present invention is a compound of structural formula (VIII) where R₁ is an isomerized structure represented by



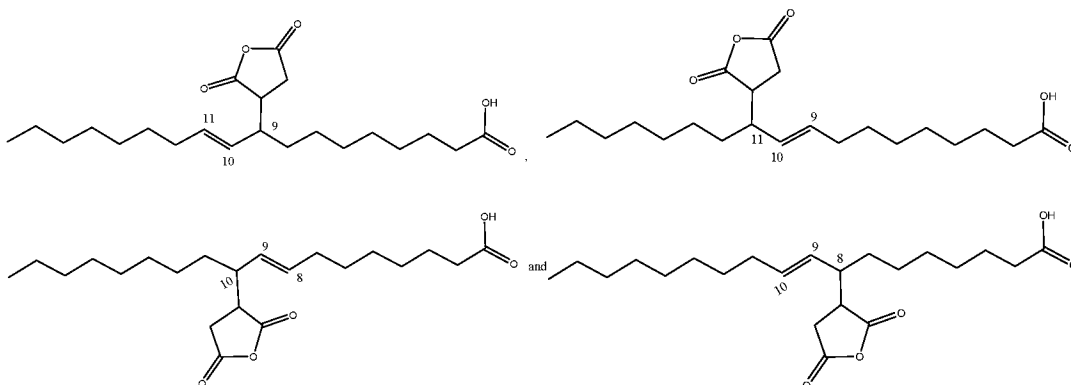
or a mixture of isomers.

740

In yet another embodiment of the present invention is a compound or a mixture of compounds represented by structural formulas VIII where is R is an alkenyl portion of [monosaturated fatty acid succinic anhydride] isomers when their anhydride rings are opened by a saturated fatty alcohol selected from the chain lengths ranging from C₈ to C₂₆. The preferred monosaturated fatty acid-succinic anhydride is an oleic acid-succinic anhydride (OASA). The isomer structures of an OASA are consisting of

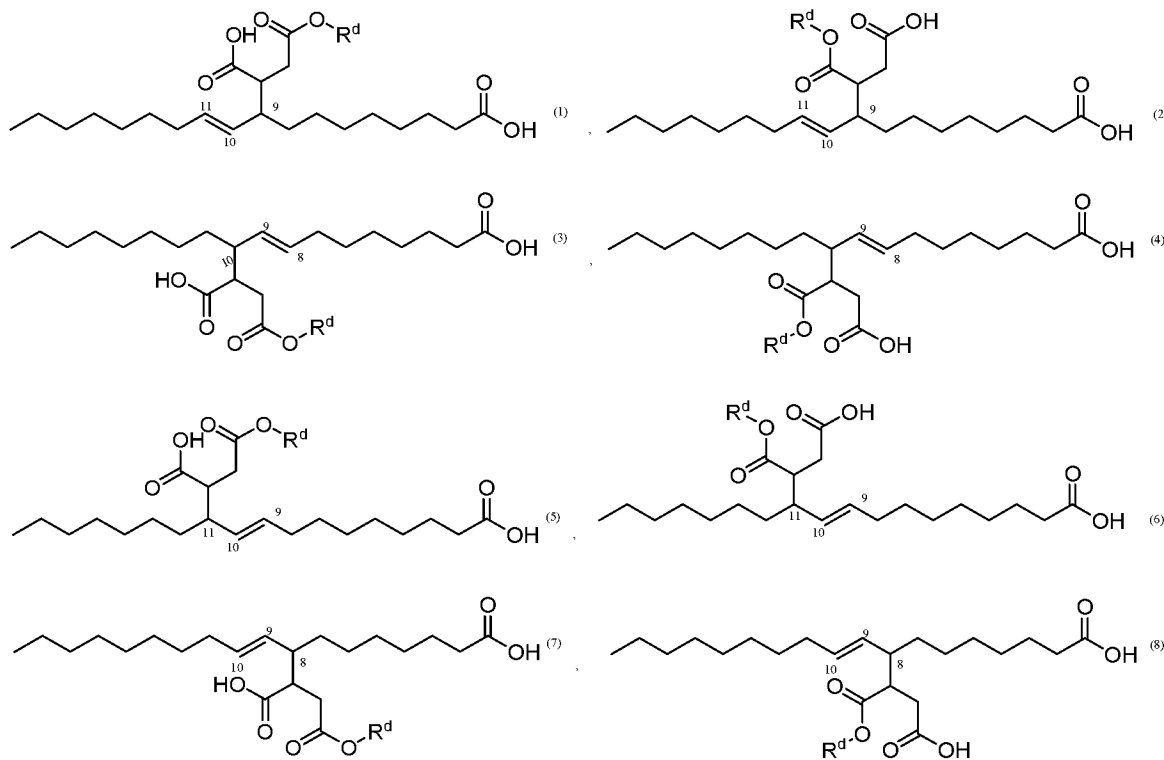
745

Isomer Structures of OASA



750

In yet another embodiment of the present invention is a compound or a mixture of compounds represented by structural formulas VIII where R is an alkenyl portion of [monosaturated fatty acid-succinic anhydride] isomers when their anhydride rings are opened by a fatty alcohol selected from the chain lengths ranging from C₈ to C₂₆. The preferred monosaturated fatty acid-succinic anhydride compound is oleic acid-succinic anhydride (OASA) and the fatty acid alcohol is stearyl alcohol (CH₃(CH₂)₁₇OH). The isomer structures of OASA after reacting with a fatty alcohol, R^d-OH are:

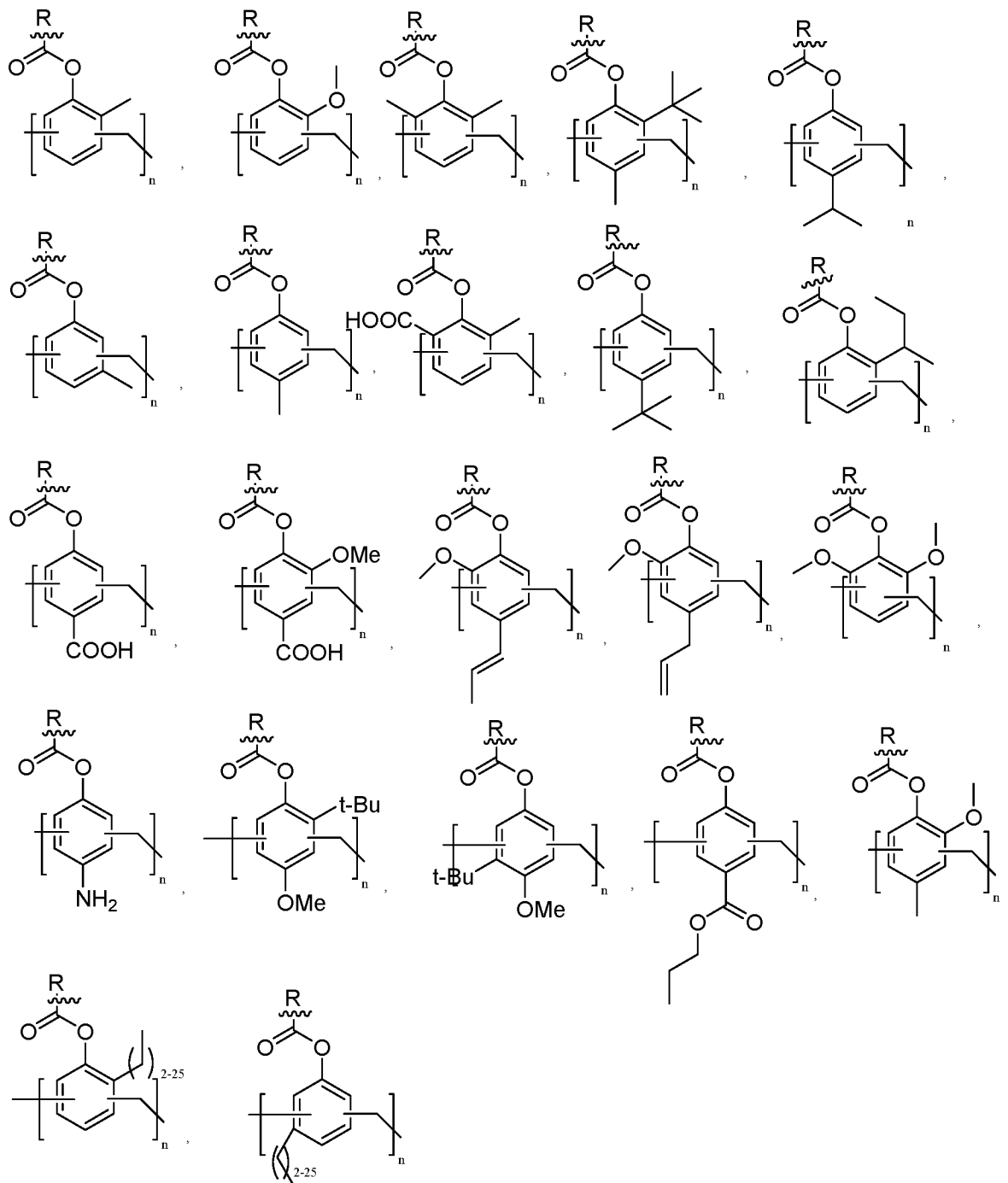


760

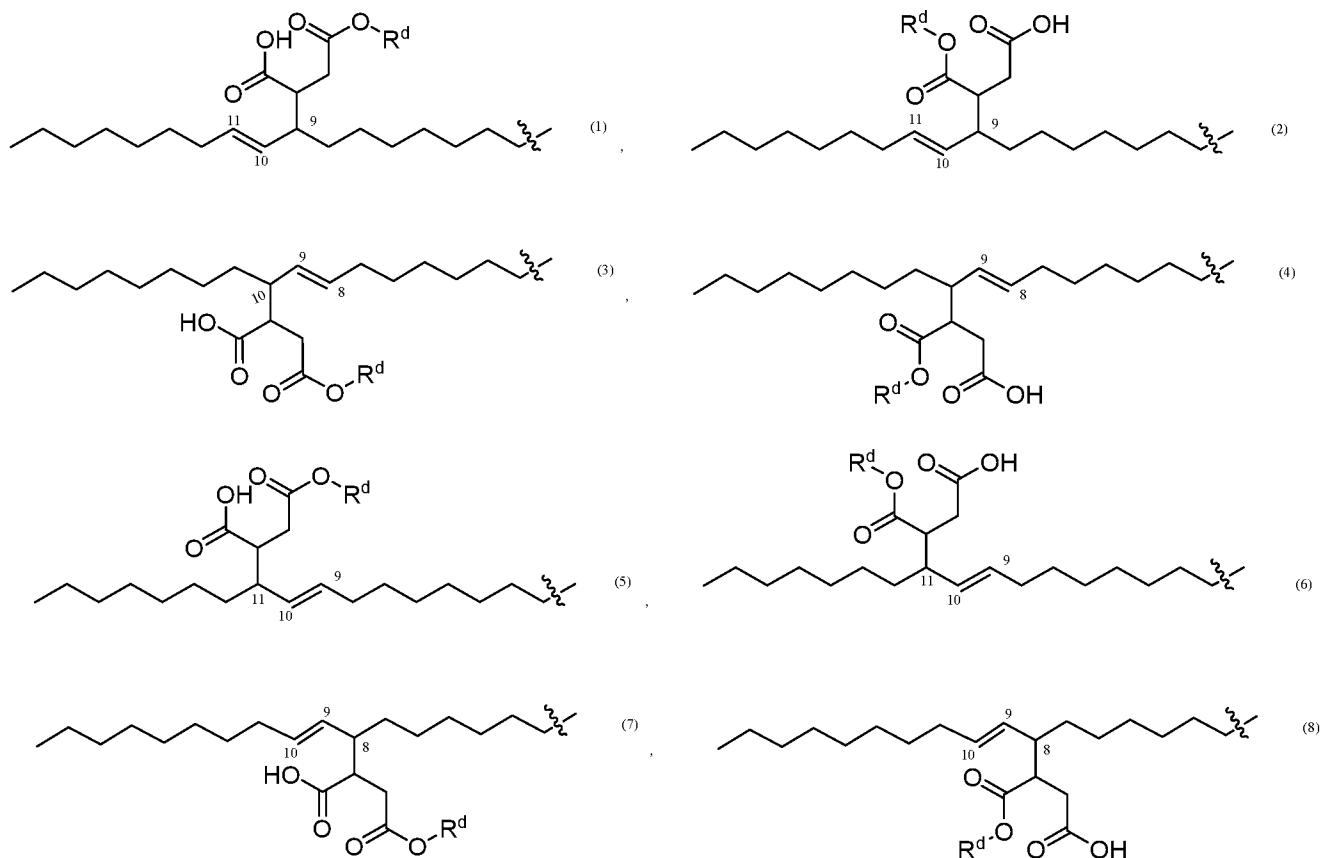
wherein, R^d is H or C₁-C₁₈ linear or branched alkyl chains, - [CH₂]_p-CH₃ with p being an integer from 0 to 30. In some instances p is from 3 to 25, in some instances p is 7 to 17, in some instances p is from 11 to 17, in some instances p from 13-15, in some instances p is from 15 to 17, in some instances p is 0, 7, 9, 11, 13, 15, or 17 or a mixture thereof.

In yet another embodiment, the present invention is a compound or a mixture of compounds represented by structural formulas IX:

Structural Formulas IX



770 wherein R is an alkenyl structural isomer represented by



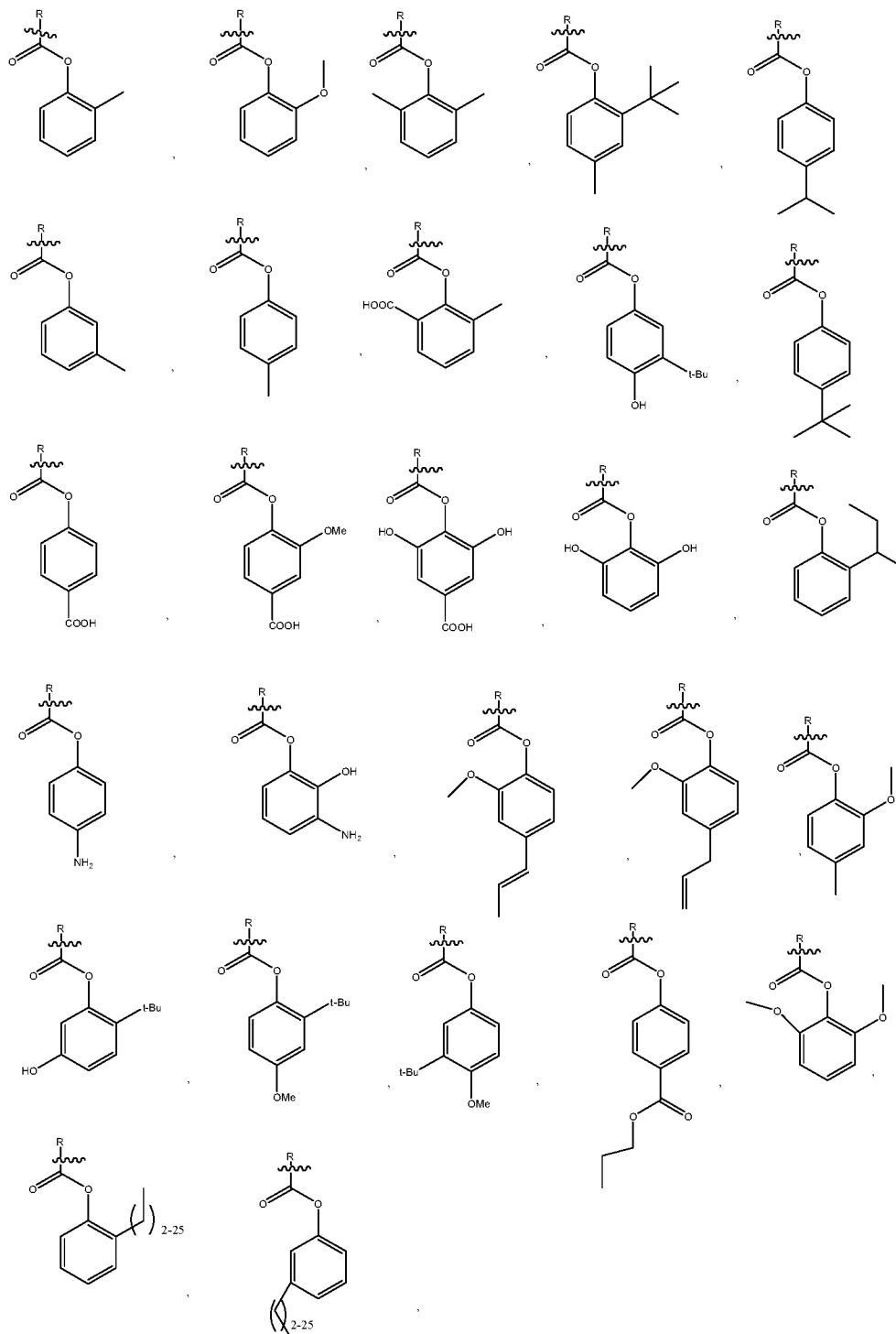
or a mixture of isomers;

R_d is H or C_1 - C_{18} linear or branched alkyl chains, $- [CH_2]_p-CH_3$ with p being an integer from 775 0 to 30. In some instances p is from 3 to 25, in some instances p is 7 to 17, in some instances p is from 11 to 17, in some instances p from 13-15, in some instances p is from 15 to 17, in some instances p is 0, 7, 9, 11, 13, 15, or 17 or a mixture thereof.

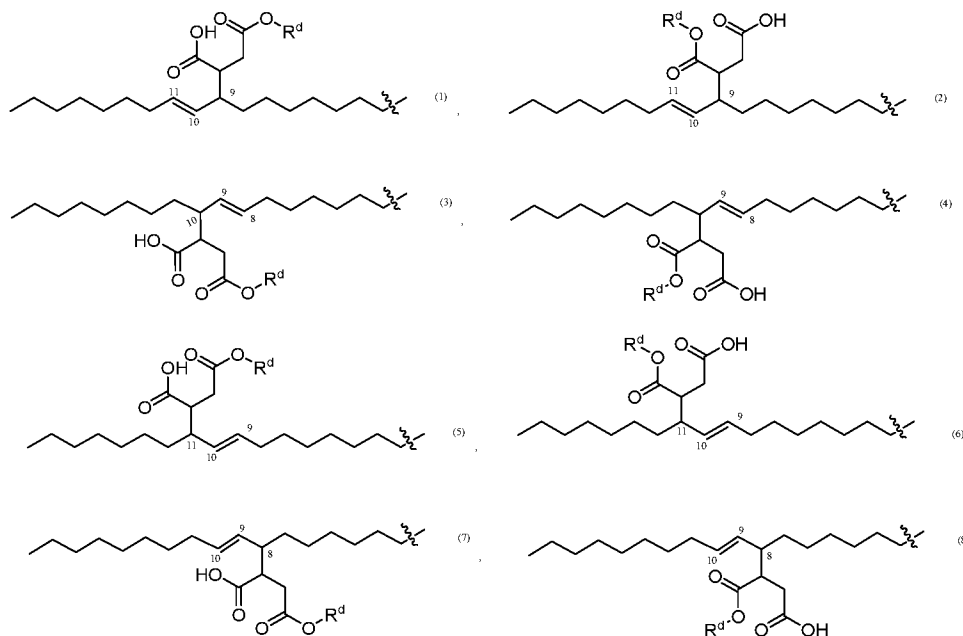
In yet another embodiment, the present invention is a compound or a mixture of compounds represented by structural formulas X:

780

Structural Formulas X



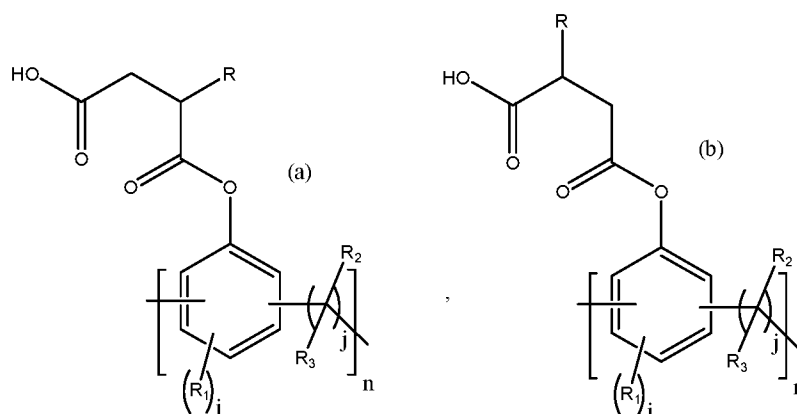
wherein R is an alkenyl structural isomer represented by



785 or a mixture isomer structures,

wherein R^d is H or C_1 - C_{18} linear or branched alkyl chains, $- [CH_2]_p-CH_3$ with p being an integer from 0 to 30. In some instances p is from 3 to 25, in some instances p is 7 to 17, in some instances p is from 11 to 17, in some instances p from 13-15, in some instances p is from 15 to 17, in some instances p is 0, 7, 9, 11, 13, 15, or 17 or a mixture thereof. In certain embodiments, the present invention relates to a compound represented by structural formula XI (a mixture of structural isomers):

Structural Formula XI

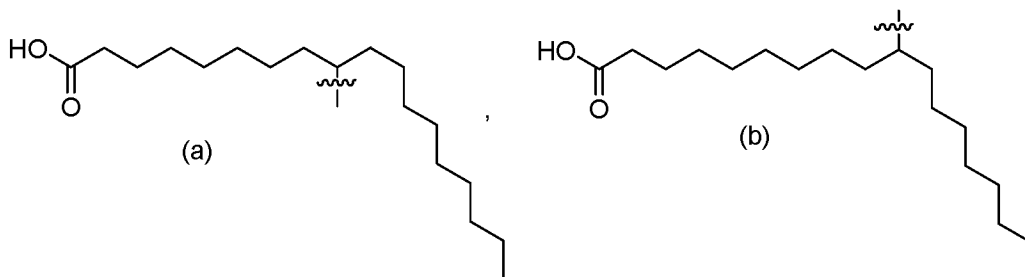


795 or a mixture of isomers,
wherein,

R is a C₁-C₁₈ linear or branched alkyl chain, or an alkenyl chain of PIBSA, OSA, DDSA, and ODSA, and the remaining variables are as described for structural formula (I), (II) or (III).

800 In yet another embodiment, the present invention is a compound or a mixture of compounds represented by Structural formula XI wherein the polymers that are the reaction products of a substituted phenol and an aldehyde which is further esterified with PIBSA, DDSA, ODSA, or OSA.

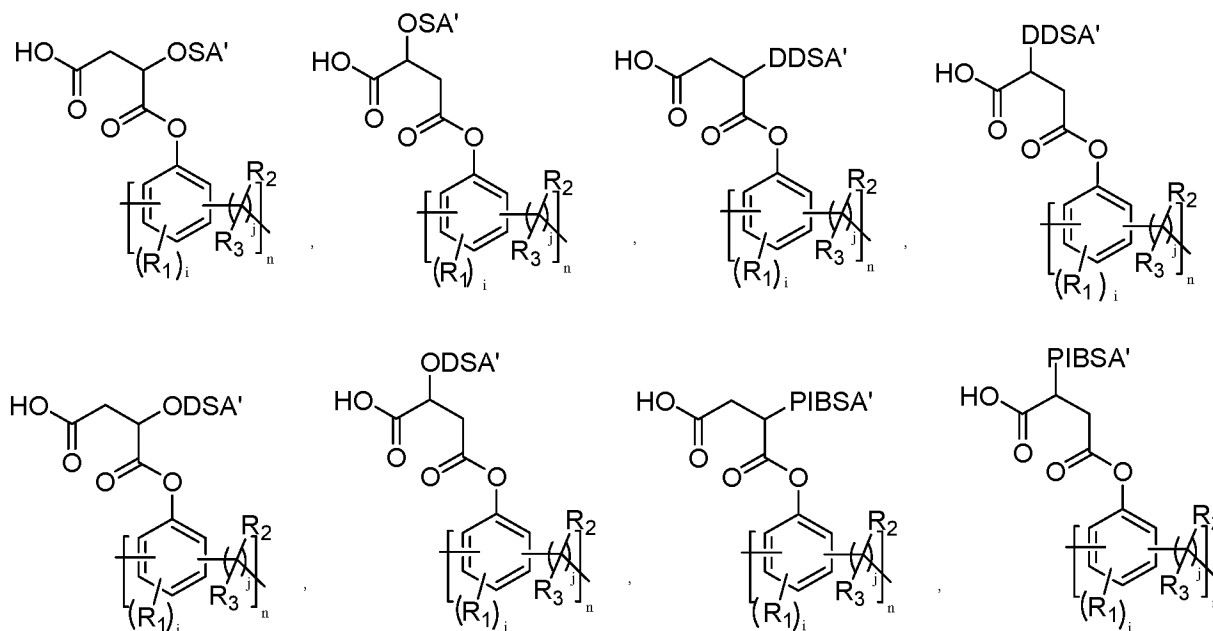
805 In another embodiment, the present invention is a compound of isomerized structural formula (XI) where R₁ is represented by



or a mixture of isomers.

810 In yet another embodiment, the present invention is a compound represented by structural formulas XII with optionally their corresponding structural isomer or mixture of structural isomers:

Structural Formula XII



815

wherein,

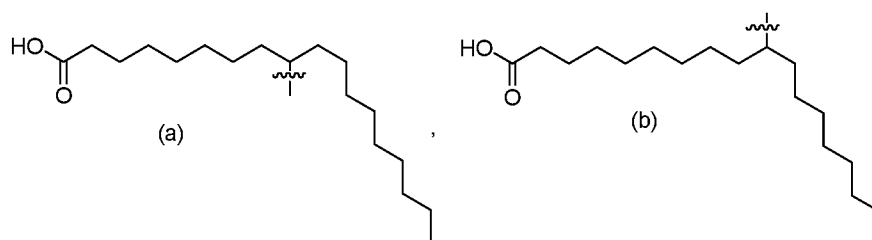
OSA', DDSA', ODSA', PIBSA' are alkenyl chain portion of OSA, octenyl succinic anhydride; DDSA, dodecenyl succinic anhydride; ODSA, octadecenyl succinic anhydride; PIBSA, polyisobutylene succinic anhydride (low molecular weight, 300 - 1500 molecular weight), respectively;

820

each R₂, R₃ is independently an optionally a methyl group or H; independently an optionally a C₁-C₈ linear, branched, a cyclic alkyl group, the remaining variables are as described for structural formula (I), (II) or (III).

825

In another embodiment, the present invention is a compound of structural formula (XII) where R₁ is represented by

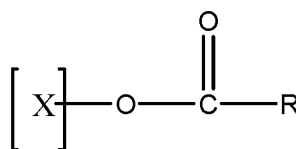


or a mixture of structural isomers.

830

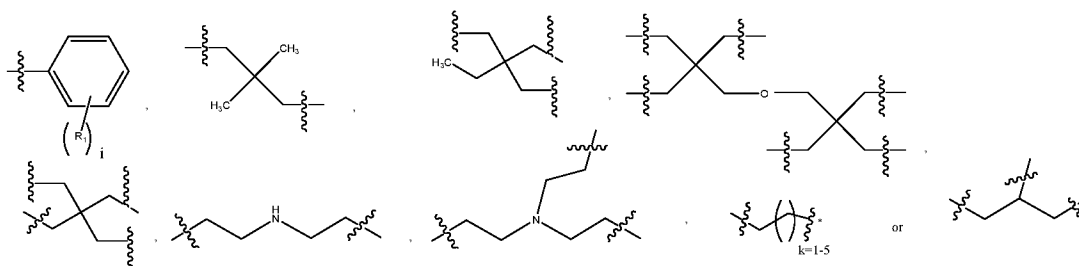
In yet another embodiment, the present invention is a compound represented by structural formula I where n is 1, j is 0,

Structural Formula XIII

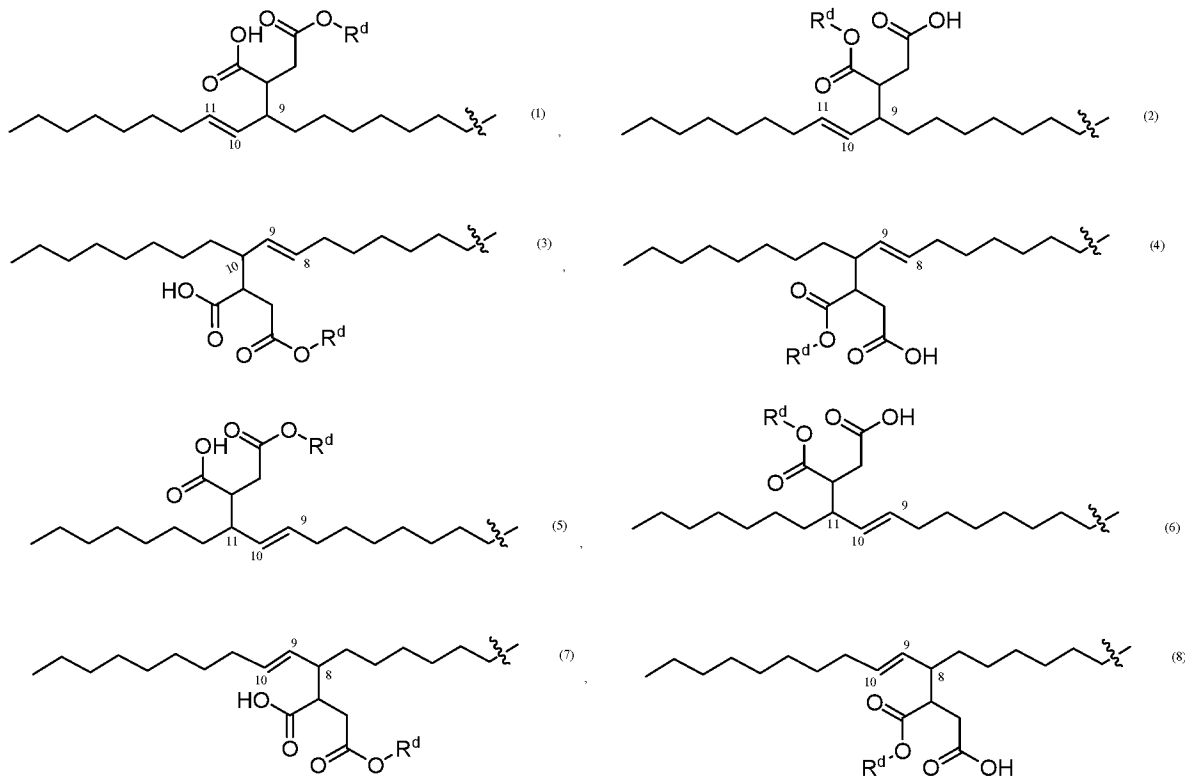


835

wherein [X] is



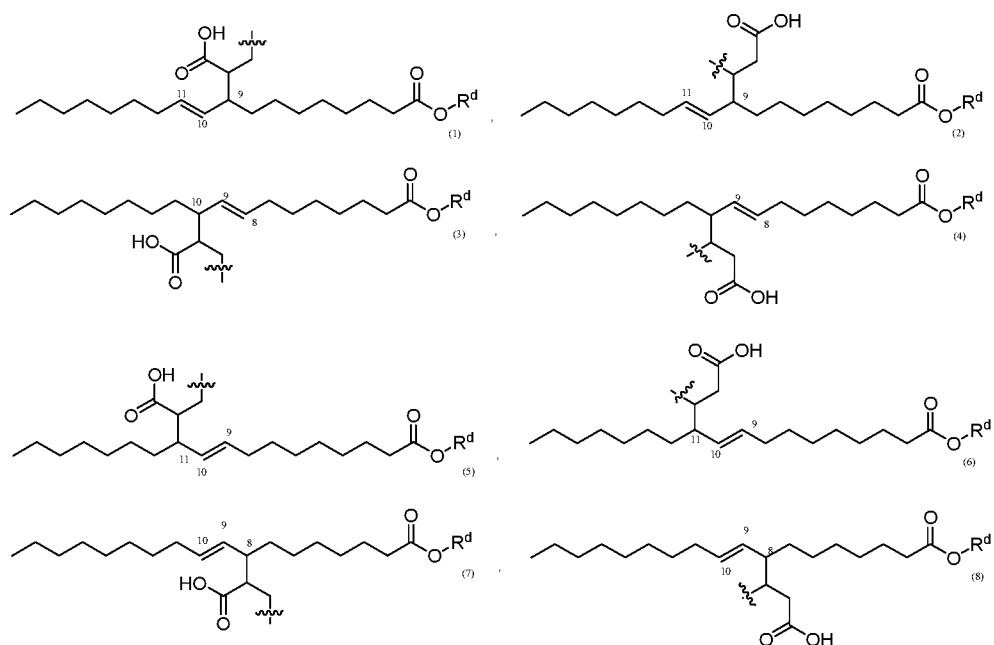
R is an isomerized alkenyl chain represented by



840

or a mixture of isomers; and
each R^d is a C₁-C₂₄ alkyl chain.

In another embodiment of the present invention is an isomeric compound represented
845 by structural formula XIII wherein, R is an isomerized alkenyl chain represented by



or their isomer mixtures (1)-(8); and
each R^d is a C₁-C₂₄ alkyl chain.

each R_1 is H, independently an optionally substituted C_1 - C_{20} alkyl group, an optionally substituted C_1 - C_{10} alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, an optionally- $CH(R''')(R''')COOH$ wherein each R''' independently C_1 - C_{10} linear or branched alkyl chain, $-OH$, $-SH$ or $-NH_2$ or an optionally substituted carbocyclic or heterocyclic non- aromatic ring.

875 $I = 0, 1, 2, 3;$

$j = 0$ or $1;$

n is an integer from 1 to 1000 or 1 to 100, 1 to 50 or 1 to 25, 1 to 15, or preferably 1 to 10,

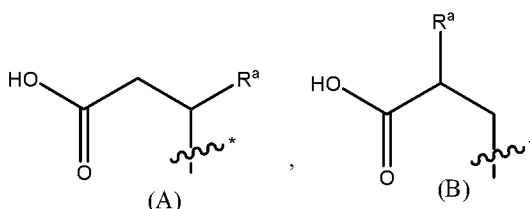
when $n = 1$, then $j = 0;$

885 when $n > 1$ then $j = 1;$

each R_2 and R_3 is independently H, a C_1 - C_8 linear or branched or cyclic alkyl chain, an optionally substituted C_1 - C_{20} alkyl group, an optionally substituted C_1 - C_{10} alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, or $-CH(R''')(R''')COOH$

890

R is a C_1 - C_{24} linear or branched alkyl chain, alkenyl chain, or an isomerized structure or a mixture of isomerized (A) and (B):



895

wherein R^a is a C_1 - C_{24} alkenyl linear or branched chain,

the method comprising:

- (a) reacting X in a solvent with an aldehyde selected from the group of formaldehyde, acetaldehyde, valeraldehyde, butyraldehyde, isovalrealdehyde, 2-methyl butanal, benzaldehyde, cyclohexanecarbaldehyde, 3-methylcyclohexanecrabaldehyde, glyceraldehyde, glucose aldehyde,

900

- 905 (b) Reacting the product in (a) with an alkyl acyl chloride, an oleoyl chloride, or alkenyl succinic anhydride selected from the group of octenyl succinic anhydride (OSA), dodecenyl succinic anhydride (DDSA); octadecenyl succinic anhydride (ODSA); polyisobutylene succinic anhydride (PIBSA) having a molecular weight from 300 to 1500;
- 910 (c) Reacting the product of (b) with maleic anhydride if the reactant used in (b) is an oleoyl chloride, and then finally,
- (d) Reacting the The succinic anhydride group of product in (c) is reacting with a C₁-C₂₄ linear or branched or cyclic alcohol.

915 If the reactant used in (b) is not oleoyl chloride, then (c) can include reacting the product of (b) with oleic acid.

In certain embodiments the methods of present invention, a polymer that is a reaction product of starting materials comprising a substituted phenol and an aldehyde that is further esterified with an alkyl acid through the use of oxalyl chloride or thionyl chloride.

920 In certain embodiments the alkyl acid used in the methods of the present invention is selected from the group consisting of an alkyl with at least about 4 carbon atoms, preferably C₅ to C₂₆ acid such as saturated straight chain fatty acid including caprylic acid (8:0), capric acid (10:0), lauric acid (12:0), myristic acid (14:0), palmitic acid (16:0), stearic acid (18:0), arachidic acid (20:0), behenic acid (22:0), lignoceric acid (24:0), or cerotic acid(26:0).

925 In certain embodiments the substituted phenol used in the methods of the present invention is selected from the group consisting the structural formulas XIV shown below:

Structural Formula XIV

940 aldehyde is selected from formaldehyde, acetaldehyde, valeraldehyde, butyraldehyde, isovalrealdehyde, 2-methyl butanal, benzaldehyde, cyclohexanecarbaldehyde, 3-methylcyclohexanecarbaldehyde, glyceraldehyde, glucose aldehyde; all of the remaining variables are as described above or Structural formula III, n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10, all of the remaining variables are as
945 described above or Structural formula II.

It is understood the use of phrase 'substituted phenol-aldehyde polymer' refers to the product in Scheme IA.

In yet another embodiment, in the method involves adding concentrated sulfuric acid to the reaction mixture of a substituted phenol and an aldehyde in distilled water and keep at
950 the ice-bath temperature.

In yet another embodiment, in the reaction of a substituted phenol and an aldehyde, the ratio of a substituted phenol to a suitable solvent is 1:1-10, 1:1-5, 1:1-3, 1:2 or 1:1 by volume.

In another embodiment, in the method above involves refluxing the reaction mixture under inert atmosphere between 1-48 hours, between 3 and 9 hours, between 6 and 12 hours,
955 or between 12 and 36 hours.

In another embodiment, in the above method involves cooling the reaction mixture to room temperature and separating the product and washing with water.

In yet another embodiment, the reaction solvent for the mixture of a substituted
960 phenol and an aldehyde is selected from toluene, xylene, 1, 2-dichloroethane, tetrachloroethylene, dioxane or methylethyl ketone at reflux temperature under inert atmosphere.

In another embodiment, in the above method, an acid added to the reaction mixture of a substituted phenol and an aldehyde in above solvents is selected from hydrochloric acid, p-toluenesulfonic acid, or oxalic acid, solid based acids, phosphoric acid and acetic acid.
965

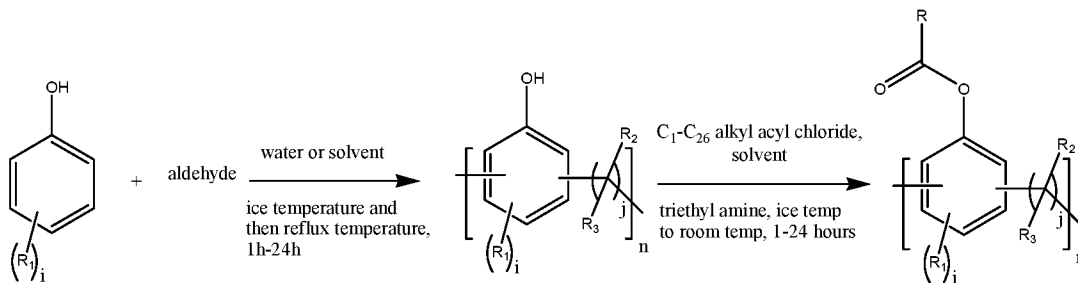
In yet another embodiment, in the above method involves reacting alkyl chloride to the above (substituted phenol-aldehyde) product in a suitable solvent first at ice bath temperature and then bring it to the room temperature while stirring the reaction mixtures for 1 to 48 hours, 3 to 12 hours, or 6 to 24 hours.

970 In yet another embodiment, in the above method involves adding triethyl amine to the reaction mixture.

In yet another embodiment, in the above method involves, the alkyl acid chloride with carbons in the alkyl chain ranging from C₁ to C₂₆. Preferred alkyl acid chlorides are, C₈, C₁₂, C₁₄, C₁₆, or C₁₈ linear or branched carbon alkyl acid chlorides.

975 In other embodiments, the methods of the present invention, when the solvent is used it can be recycled by separating the solvents from the reaction mixture using distillation.

The following schemes illustrate particular embodiments of this method:

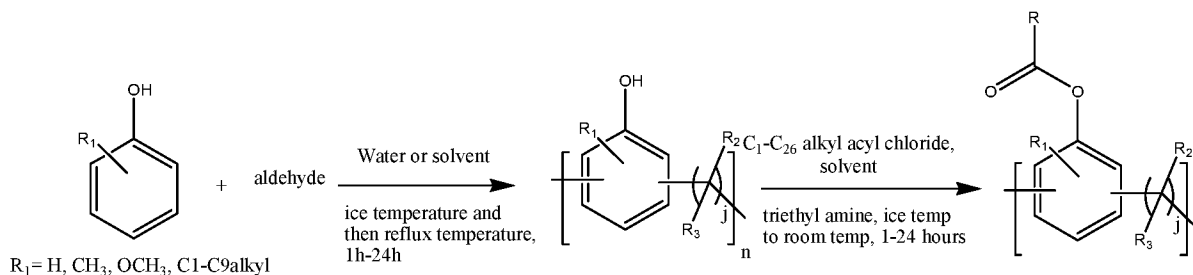


Scheme I

980

wherein, substituted phenols selected from Structural formula XIV, aldehyde is selected from formaldehyde, acetaldehyde, valeraldehyde, butyraldehyde, 985 isovalrealdehyde, 2-methyl butanal, benzaldehyde, cyclohexanecarbaldehyde, 3-methylcyclohexanecrabaldehyde, glyceraldehyde, glucose aldehyde; all of the remaining variables are as described above or Structural formula III ; n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10.

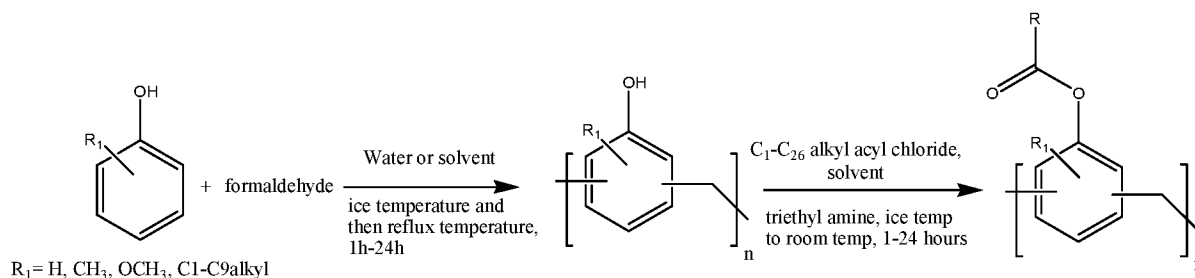
990 In yet another embodiment the present invention is a method of producing a compound in Scheme I



Scheme II

995 wherein, R is a linear or branched alkyl C₁-C₂₆ chain, an alkyl C₁₂ or an alkyl C₁₆ or an alkyl C₁₈ or a mixture of alkyl C₁₂, C₁₄, C₁₆ and C₁₈ chains; n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10, all of the remaining variables are as described above or Structural formula II.

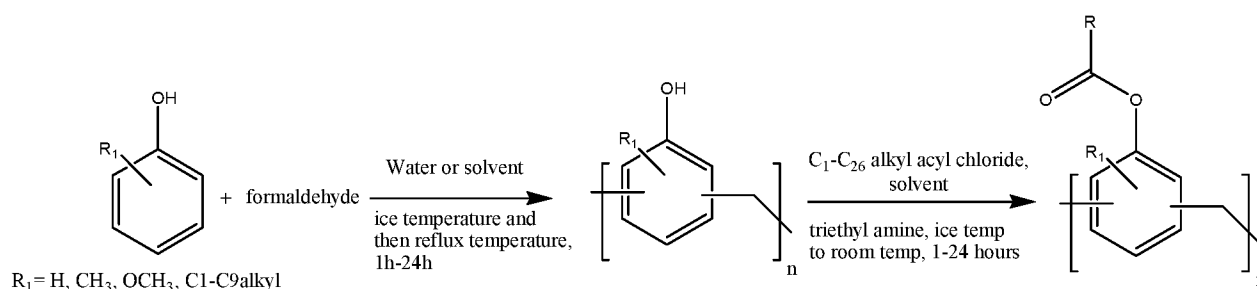
In yet another embodiment the present invention is a method of producing a compound in Scheme II:



Scheme III

wherein an aldehyde is selected from a group of formaldehyde, acetaldehyde, valeraldehyde, butyraldehyde, isovalrealdehyde, or 2-methyl butanal, benzaldehyde; preferably formaldehyde or acetaldehyde; wherein, R is a linear or branched alkyl C₁-C₂₆ chain, an alkyl C₁₂ or an alkyl C₁₆ or an alkyl C₁₈ or a mixture of alkyl C₁₂, C₁₄, C₁₆ and C₁₈ chains; n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10.

In yet another embodiment the present invention is a method of producing a compound in Scheme III:



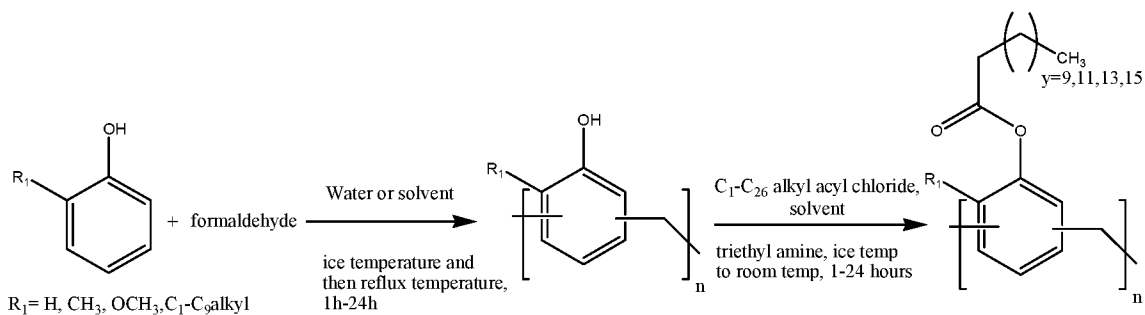
Scheme IV

wherein, R is a linear or branched alkyl C₁-C₂₆ chain, an alkyl C₁₂ or an alkyl C₁₆ or an alkyl C₁₈ or a mixture of alkyl C₁₂, C₁₄, C₁₆ and C₁₈ chains; n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10, all of the remaining variables are as described above or Structural formula II.

In yet another embodiment the present invention is a method of producing a compound in Scheme IV where in a substituted phenol is selected from Structural formula XIV.

1015

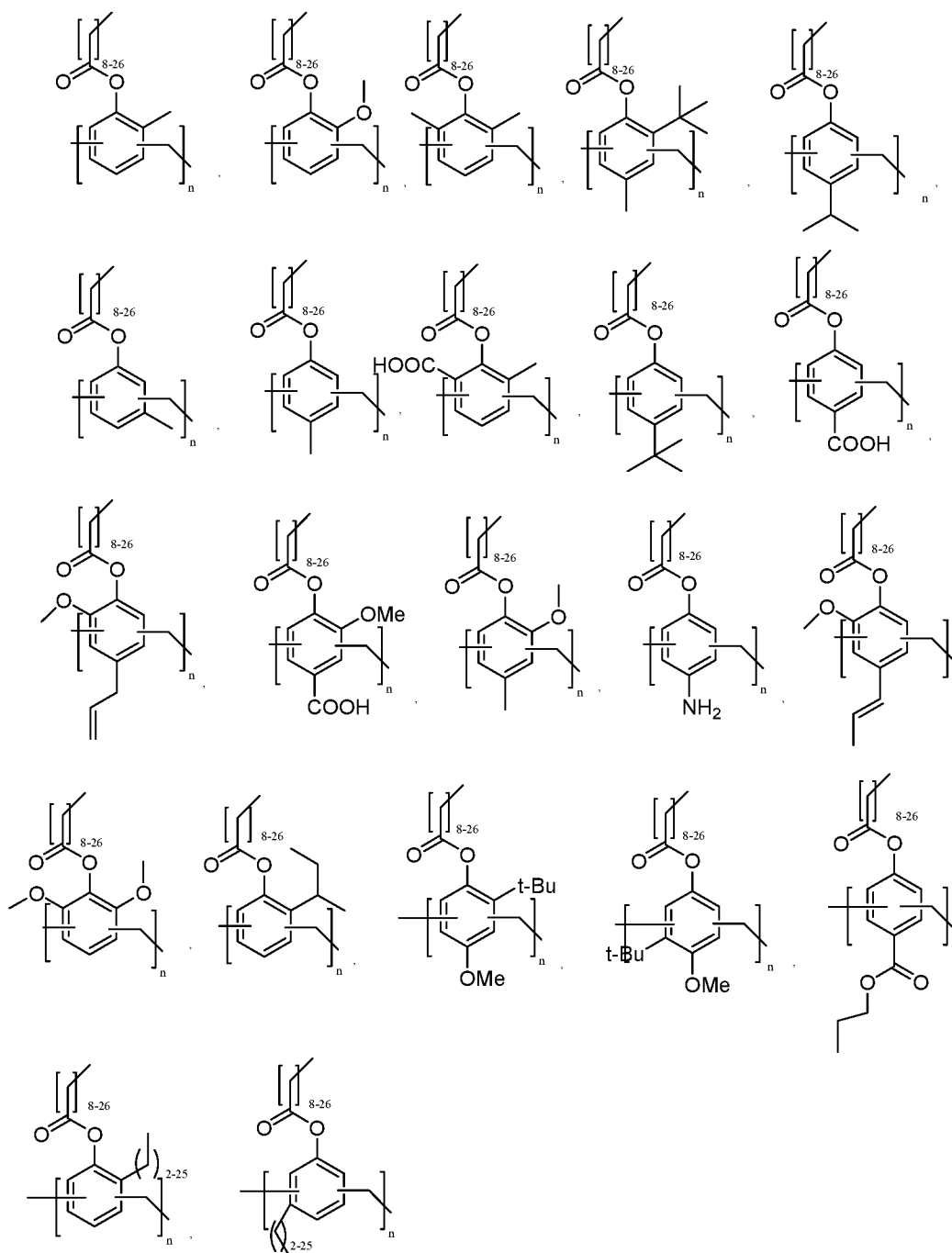
In another embodiment, the present invention is a method of producing a compound in Scheme IV wherein a substituted phenol is selected from Structural formula XIV.



Scheme V

1020 In another embodiment the present invention is a method of producing a compound in Scheme V wherein a substituted phenol is a phenol, ortho-cresol or a mixture of ortho, meta, para-cresols, or o-methoxyphenol, and R is a linear alkyl C₁₂ or a C₁₆ or C₁₈ or a mixture of alkyl C₁₂, C₁₄, C₁₆ and C₁₈ chains, and n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10.

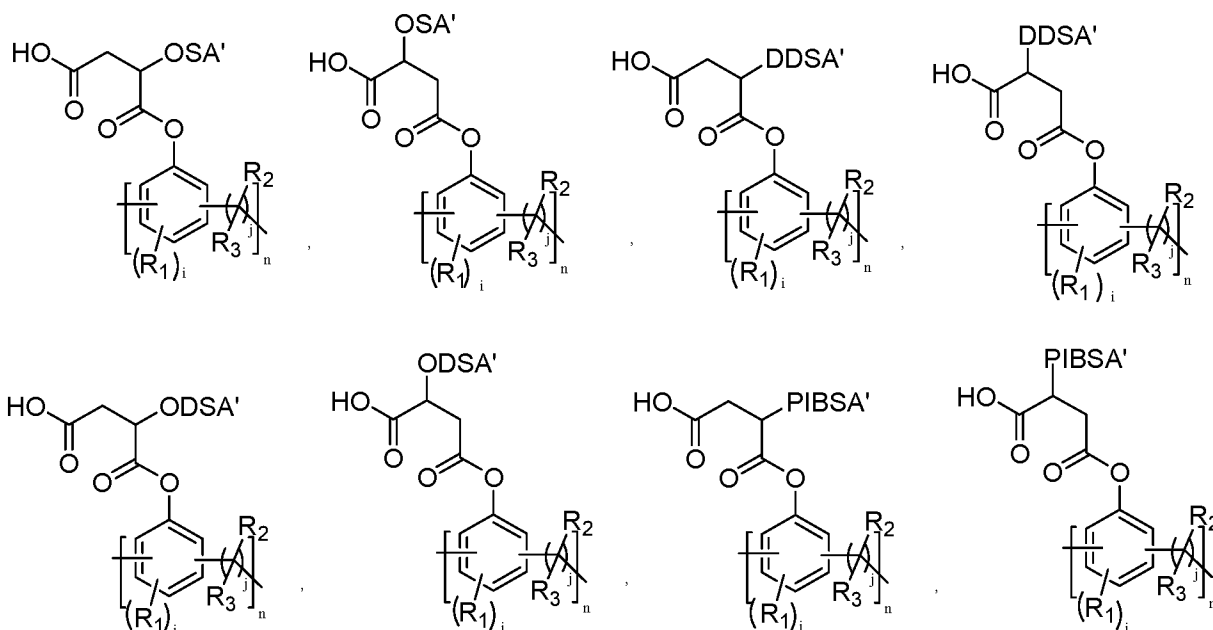
1025 In another embodiment the present invention is a process of producing a compound in Structural Formulas IV:



wherein n is an integer from 0 to 100 or 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10

In certain embodiments of this invention relates to a macromolecular corrosion inhibitor that is a polymer which is the reaction product of the starting materials comprising a substituted phenol and an aldehyde and is further reacted with an alkenyl succinic anhydride to form an isomerized half ester product having a free carboxylic acid group in the repeating unit.

In another embodiment, the substituted phenol is selected from the Structural formulas XIV and an aldehyde is selected from formaldehyde, acetaldehyde, valeraldehyde,



wherein OSA', DDSA', ODSA', PIBSA' are alkenyl chain portion of OSA, octenyl succinic anhydride; DDSA, dodeceny succinic anhydride; ODSA, octadeceny succinic anhydride; PIBSA, polyisobutylene succinic anhydride (low molecular weight, 300 - 1500 molecular weight), respectively; and n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10, and all of the remaining variables are as described above or Structural formula II.

In another embodiment the present invention is a method of producing a compound with mixture of isomers (A) and (B) in Structural formulas XII wherein the mixture of a substituted phenol-aldehyde polymer reacted with an alkenyl succinic anhydride selected from the group consisting of DDSA, dodeceny succinic anhydride; ODSA, octadeceny succinic anhydride; PIBSA, polyisobutylene succinic anhydride (low molecular weight, 300 - 1500 molecular weight) reaction temperatures between 80 °C to 175 °C between 1 and 24 hours, between 3 to 12 hours, or between 6-24 hours.

In yet another embodiment the present invention is a method of producing a compound with mixture of isomers (A) and (B) in Structural formulas XII wherein a substituted phenols is selcted from Structural formulas XIV and an aldehyde is selected from an aldehyde is selected from formaldehyde, acetaldehyde, valeraldehyde, butyraldehyde, isovalrealdehyde, 2-methyl butanal, benzaldehyde, cyclohexanecarbaldehyde, 3-methylcyclohexanecrabaldehyde, glyceraldehyde, glucose aldehyde.

In yet another embodiment the present invention is a method of producing a compound with a mixture of isomers (A) and (B) in Structural formulas XII wherein an aldehyde is formaldehyde or acetaldehyde.

In yet another embodiment the present invention is a method of producing a compound
1080 with a mixture of isomerized structures in Structural formulas XII.

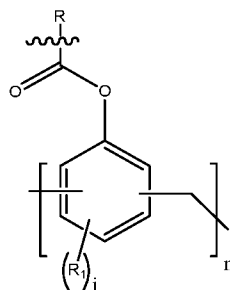
In yet another embodiment of this invention relates to a macromolecular corrosion
inhibitor that is a polymer which is the reaction product of the starting materials comprising a
substituted phenol and an aldehyde are further reacted with an alkylene oxide (e.g. propylene
oxide) to form a phenol-derived alcohol in the repeating unit and is further reacted with an
1085 alkyl acid. Generally, Fischer esterification of a phenol with an alkyl acid is not an efficient
one. However, the reaction is efficient if the phenolic-OH is converted to an alkyl alcohol and
is further reacted with a linear or branched C₁-C₂₆ alkyl acid. The substituted phenol is
selected from the structural formulas (XIV) and an aldehyde is selected from formaldehyde,
acetaldehyde, valeraldehyde, butyraldehyde, isovalrealdehyde, 2-methyl butanal,
1090 benzaldehyde, cyclohexanecarbaldehyde, 3-methylcyclohexanecarbaldehyde, glyceraldehyde,
glucose aldehyde.

In certain embodiments, the methods of the present invention to produce a compound that
includes the esterification of a substituted phenol-aldehyde polymer (Schemes I-A , VII-A) by
reacting with an oleoyl chloride followed by reacting with maleic anhydride and finally
1095 reacted with an alkyl alcohol to form an isomerized alkenyl chain containing half acid ester
groups
(Scheme VII-I).

In one embodiment of the method of producing a compound with substituted phenol
group consisting of a substituted phenol is selected from Structural formula XIV; and an
1100 aldehyde is selected from formaldehyde, acetaldehyde, valeraldehyde, butyraldehyde,
isovalrealdehyde, 2-methyl butanal, benzaldehyde, cyclohexanecarbaldehyde, 3-
methylcyclohexanecarbaldehyde, glyceraldehyde, glucose aldehyde; all of the remaining
variables are as described above or Structural formula III.

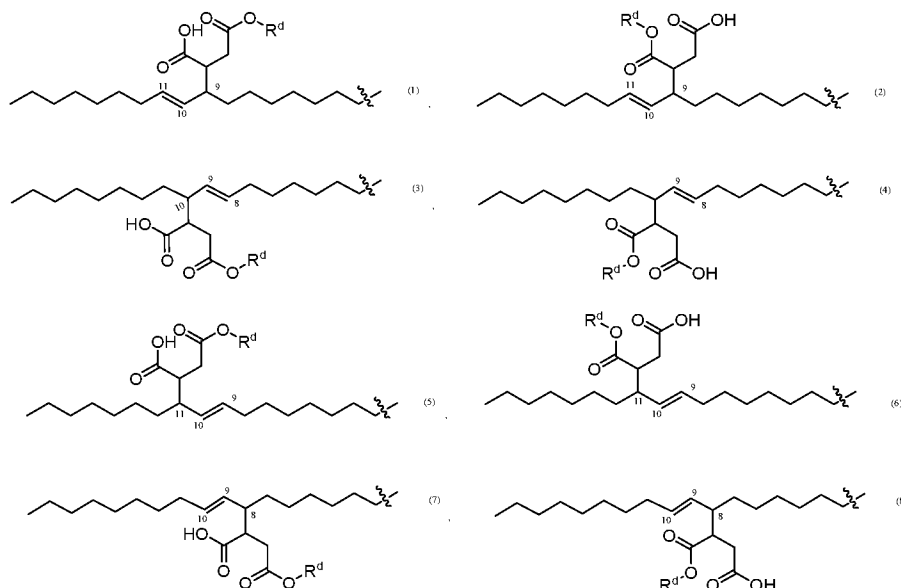
In certain embodiments of the present invention is a method of producing an isomerized
1105 compound is represented by

Structural Formula III

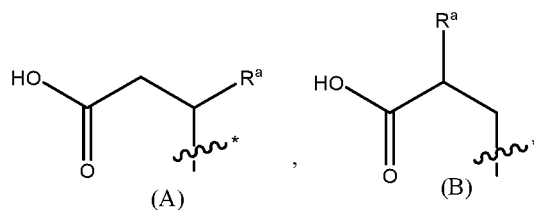


1110 wherein,

R is a C₁-C₂₄ linear or branched alkyl chain, an isomerized alkenyl chain or a mixture of isomerized alkenyl chains represented by

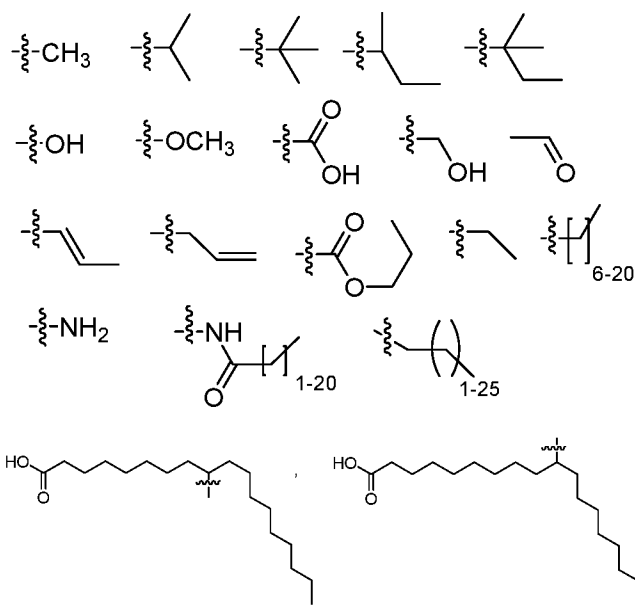


1115 wherein R^d is a linear or branched C₁-C₂₄ alkyl chain; or an isomerized structure or a mixture of isomerized (A) and (B)



1120 wherein R^a is a C₁-C₂₄ linear or branched alkenyl chain, an alkenyl chain portion of OSA, octenyl succinic anhydride; DDSA, dodecyl succinic anhydride; ODSA, octadecyl succinic anhydride; PIBSA, polyisobutylene succinic anhydride (low molecular weight, 300 - 1500 molecular weight, and

R₁ is selected from the group consisting of



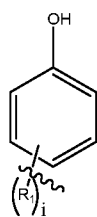
1125

n is an integer from 1 to 1000 or 1 to 100, 1 to 50 or 1 to 25, 1 to 15, or preferably 1 to 10,

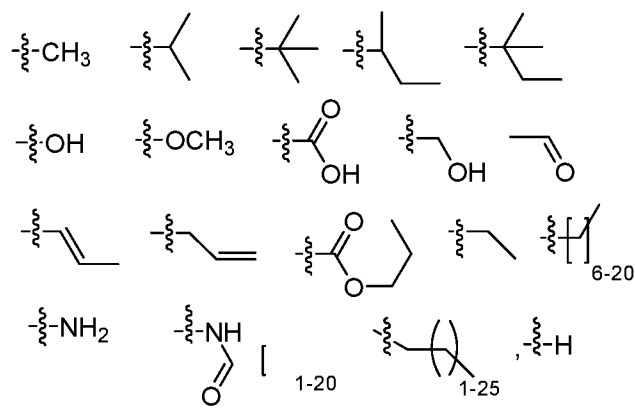
a method comprising:

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(a) Reacting in a solvent at reflux a phenol having the following formula:



wherein R₁ is selected from the group consisting of

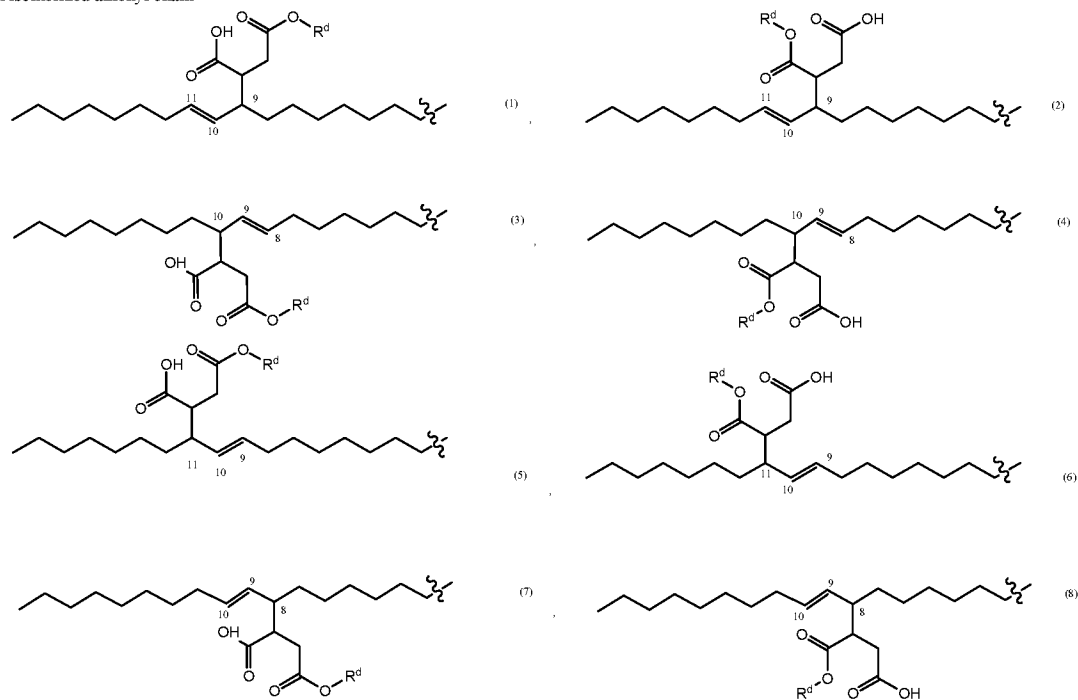


1135

an isomerized alkyl acid chain or a mixture of isomerized alkyl acid chains as shown below

wherein variables are described for structural formula III, and R^d is an isomerized alkenyl chain, and n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10,

wherein R^d is an isomerized alkenyl chain

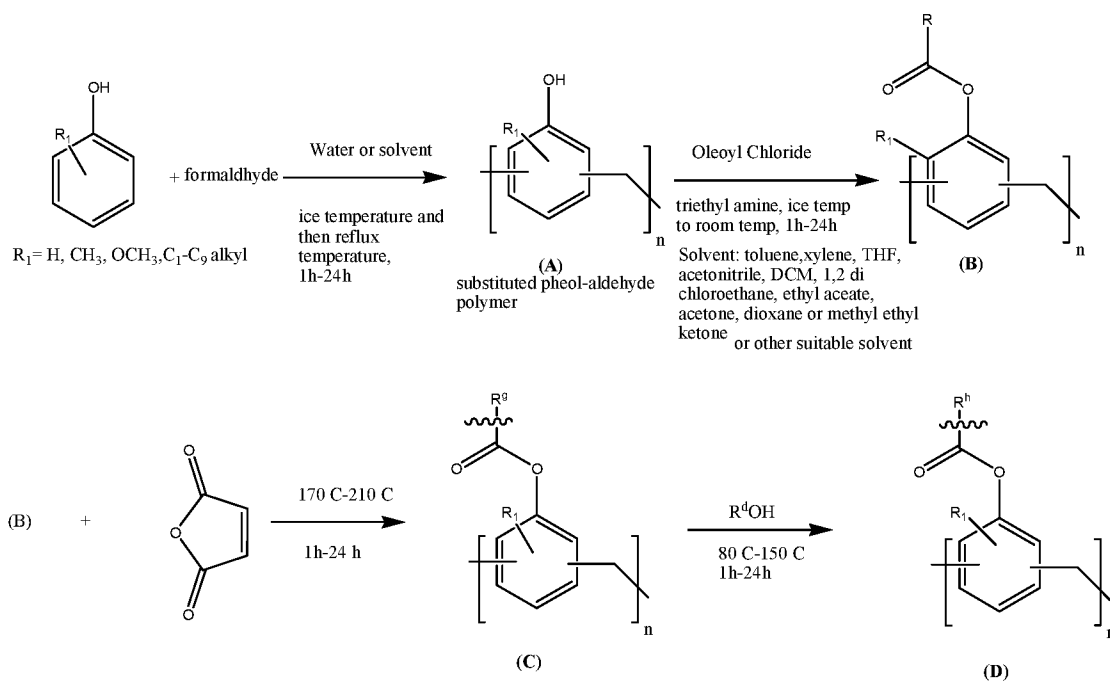


Scheme VII-I

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wherein R^g is an isomerized oleate succinic anhydride chain (Scheme VII-I), R^d is an isomerized oleate half-acid ester chain.

In yet another embodiment the present invention is a method of producing an isomerized compound in Scheme VIII:



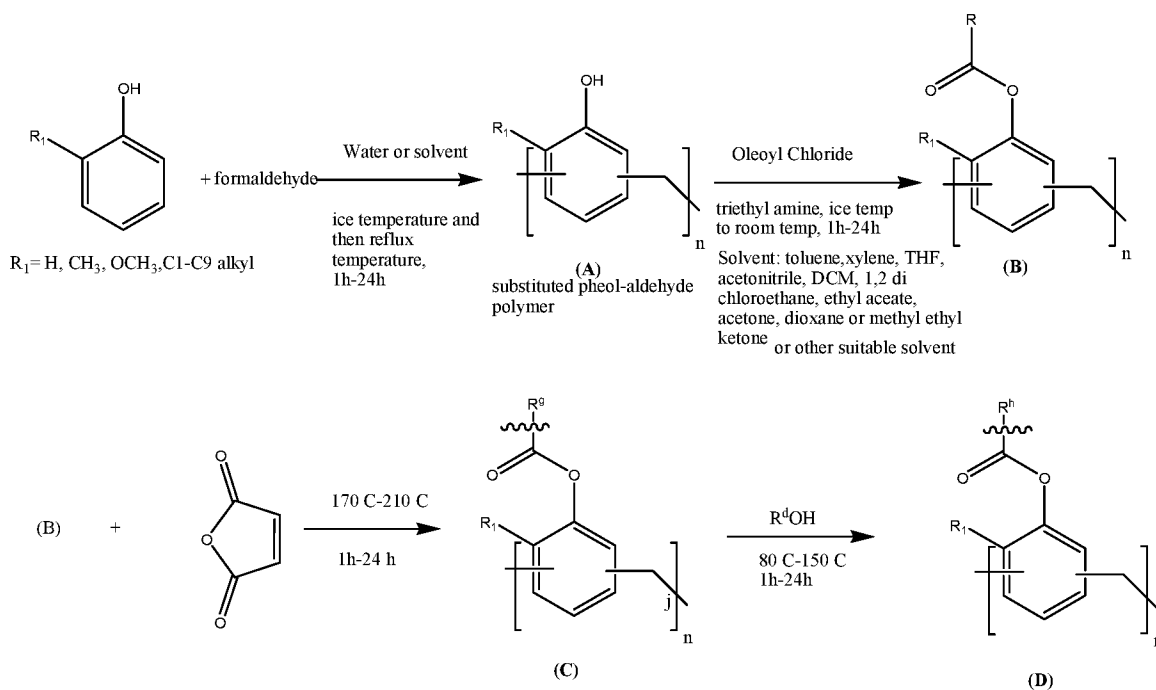
Scheme VIII

1165

wherein R^g is an isomerized oleate succinic anhydride chain (Scheme VII-I), R^d is an isomerized oleate half-acid ester, and n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10.

1170

In yet another embodiment the present invention is a method of producing an isomerized compound in Scheme IX:



Scheme IX

wherein R^g is an isomerized oleate succinic anhydride chain (Scheme VII-I),

R^d is an isomerized oleate half-acid ester chain; n is an integer from 1 to 1000 or 0 to 100, 0 to 50 or 0 to 25, 0 to 15, or preferably 0 to 10.

In one embodiment of the present invention is directed to forming a polymer by reacting a substituted phenol with a formaldehyde followed by post esterification of the reaction with oleoyl chloride is further reacted with maleic anhydride at reaction temperatures between 170 °C and 210 °C between 1 and 24 hours, between 3 to 12 hours, or between 6-24 hours.

In yet another embodiment, in the above method, the molar ratio of the reaction product (of a substituted phenol with formaldehyde followed by post esterification of the reaction with oleoyl chloride) and maleic anhydride is 1:0.8, 1:0.9, 1:1.0, or 1:2.

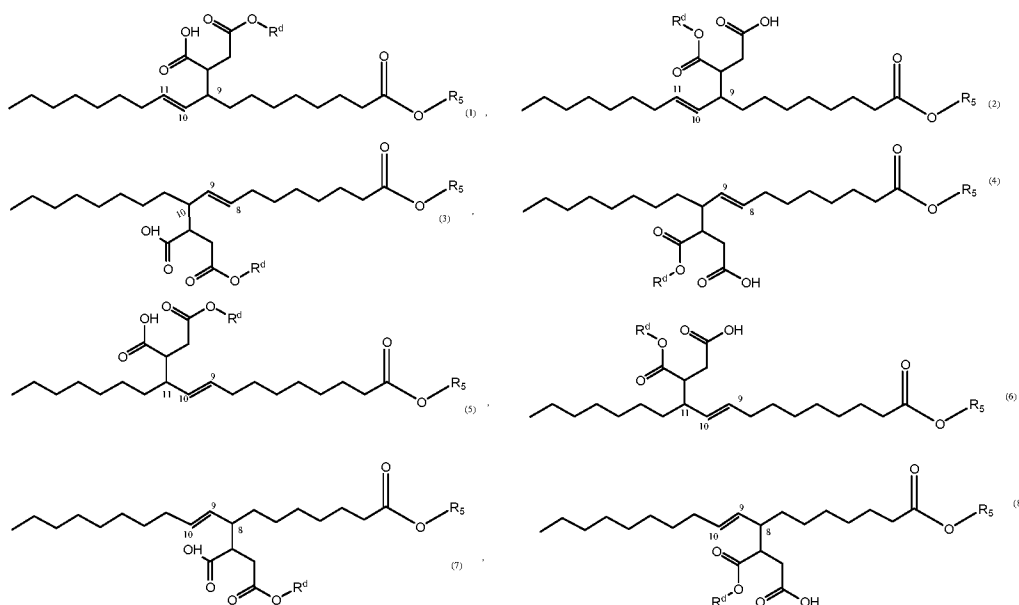
In yet another embodiment, in the above method, a suitable solvent is selected from the group consisting of toluene, xylene, chlorobenzene, dimethyl formamide, dimethyl sulfoxide, 1, 2-dichlorobenzene, dimethylsuccinate, diisobutyl adipate and diisobutyl glutarate.

In yet another embodiment, in the above method, the weight ratio of a solvent and the reaction product (a substituted phenols reacted with formaldehyde followed by post esterification of the reaction with oleoyl chloride further reacted with maleic anhydride) is 0.1 to 1.0: 1.0

In yet another embodiment, in the above method involves distilling the solvent from the reaction mixture.

In one embodiment of the present invention is directed to forming a polymer by reacting the reaction product (a substituted phenols reacted with formaldehyde followed by post esterification of the reaction with oleoyl chloride further reacted with maleic anhydride) is further reacted with an alkyl alcohol to form half acid ester selected from the group consisting of linear or branched C₁-C₂₄ chain at reaction temperatures between 80 °C and 150 °C between 1 and 24 hours, between 3 to 12 hours, or between 6-24 hours.

In another embodiment of the present invention is a method of producing a mixture of isomerized compounds in Scheme X:

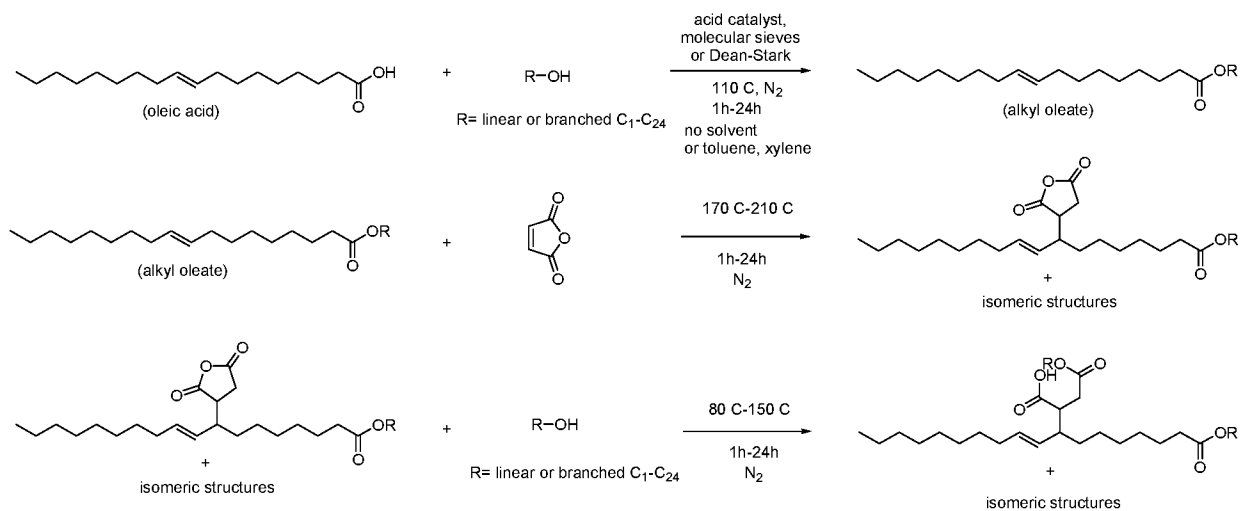


Scheme X

wherein each R₅, R^d independently is a linear or branched C₁-C₂₄ alkyl chain.

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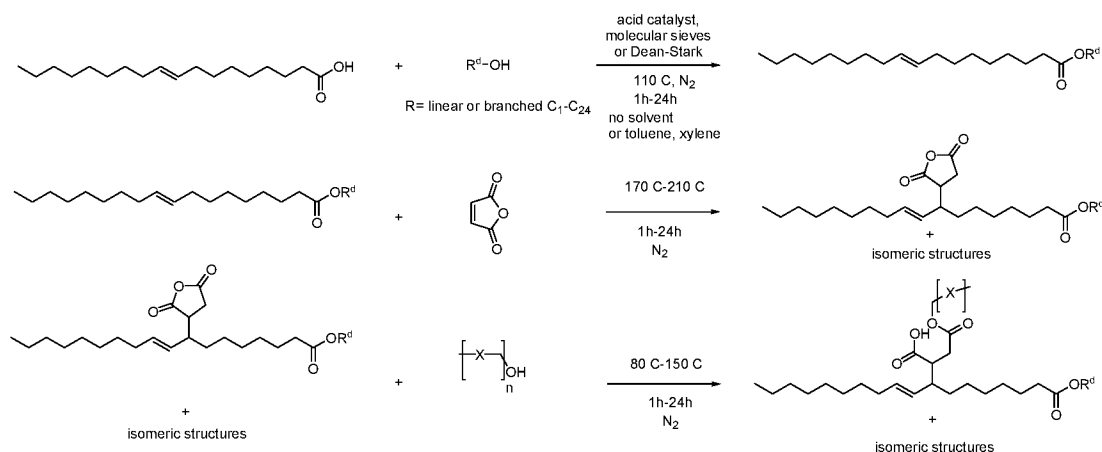
In certain embodiments of the present invention the compounds are in the salt forms to improve the solubility in certain fluids; for example, water or fluid mixtures, for example, metal working fluids, water based or oil based paints.



Scheme XI

1210

In another embodiment the present invention is a method of producing a mixture of the isomerized compounds in Scheme XII:

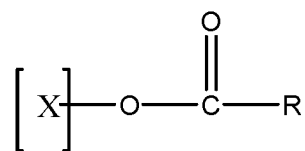


Scheme XII

1215

wherein R^d is an C₁-C₂₄ alcohol.

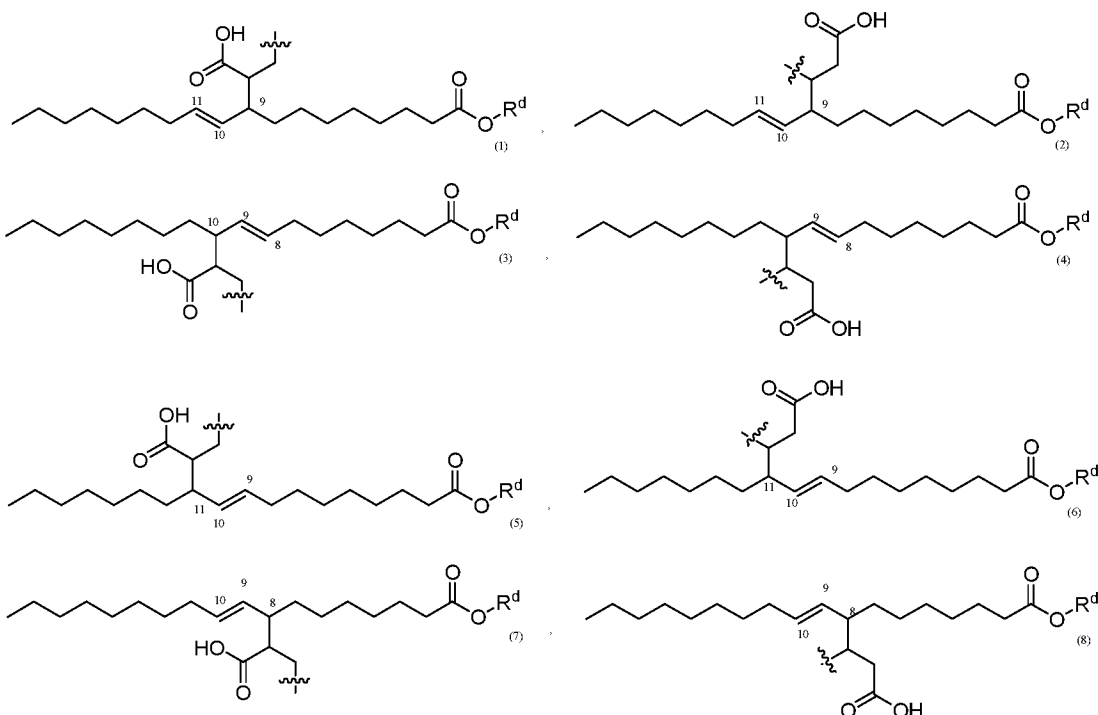
In another embodiment of the present invention is a method of making a compound having the following structure with a mixture of isomeric structures:



1220

wherein [X] is

R is an isomerized alkenyl chain represented by



1225 wherein R^d independently is a linear or branched C_1 - C_{24} alkyl chain, the method comprising:

- a. reacting in a solvent or in bulk an oleic acid with a C_1 - C_{24} linear or branched or cyclic alcohol,
- b. the product in (a) is reacting with a maleic anhydride at 170 °C-210 °C for 1 hour
- 1230 to 24 hours, and finally
- c. the succinic anhydride group of product in (b) is reacting with an X at 80 °C to 150 °C.

As used here, the terms “lubricants” and “lubricant oils” can be used interchangeably. Examples of lubricants suitable for use in the compositions and methods of the present

1235 invention include, but are not limited to: i) petroleum based oils (Group I, II and III), ii) synthetic oils (Group IV, V) and iii) biolubricant oils (vegetable oils such as canola, soybean, high oleic canola, high oleic soybean oil, corn oil, castor oil, jatropha, etc.). Group I oils, as defined herein are solvent refined base oils. Group II oils, as defined herein are modern conventional base oils made by hydrocracking and early wax isomerization, or

1240 hydroisomerization technologies and have significantly lower levels of impurities than Group I oils. Group III oils, as defined herein are unconventional base oils. Groups I-III differ in impurities, and viscosity index as is shown in Kramer *et al.* “The Evolution of Base Oil Technology” *Turbine Lubrication in the 21st Century* ASTM STP #1407 W.R. Herguth and T.M. Wayne, Eds., American Society for Testing and Materials, West Conshohocken, PA,

1245 2001 the entire contents of which are incorporated herein by reference. Group IV oils as defined herein are “synthetic” lubricant oils, including, for example, poly-alpha olefins (PAOs). Biolubricants, as defined herein, are lubricants which contain at least 51% biomaterial (see Scott Fields, Environmental Health Perspectives, volume 111, number 12, September 2003, the entire contents of which are incorporated herein by reference). Other
1250 examples of lubricant oils can be found in Melvyn F. Askew “Biolubricants-Market Data Sheet” IENICA, August 2004 (as part of the IENICA work stream of the IENICA-INFORRM project); Taylor *et al.* “Engine lubricant Trends Since 1990” paper accepted for publication in the Proceedings I. Mech. E. Part J, Journal of Engineering Tribology, 2005 (Vol. 219 p 1-16); and Desplanches *et al.* “Formulating Tomorrow’s Lubricants” page 49-52
1255 of The Paths to Sustainable Development, part of special report published in October 2003 by Total; the entire contents of each of which are incorporated herein by reference. Biolubricants are often but not necessarily, based on vegetable oils. Vegetable derived, for example, from rapeseed, sunflower, palm, and coconut can be used as biolubricants. They can also be synthetic esters which may be partly derived from renewable resources. They can be made
1260 from a wider variety of natural sources including solid fats and low grade or waste materials such as tallows. Biolubricants in general offer rapid biodegradability and low environmental toxicity.

As used herein, Group I, II and III oils are petroleum base stock oil. The petroleum industry differentiates their oil based on viscosity index and groups them as Group I, II and
1265 III. The synthetic oils are Group IV and Group V. Synthetic oils include hydrocarbon oil. Hydrocarbon oils include oils such as polymerized and interpolymerized olefins (polybutylenes, polypropylenes, propylene isobutylene copolymers, ethylene-olefin copolymers, and ethylene-alpha olefin copolymers, for example). Poly alpha olefin (PAO) oil base stocks are commonly used synthetic hydrocarbon oil. By way of example, PAOs derived
1270 from C₈, C₁₀, C₁₂, C₁₄ olefins or mixtures thereof may be utilized. In certain embodiments, PAO is a bio-based oil. In certain embodiments, synthetic oils are polyolesters for example diesters, polyolesters such as neopentyl glycols (NPGs), trimethylolpropanes (TMPs), penterthritols (PEs), and dipentaerythritols (DiPEs). In other embodiments, synthetic oils include monoesters and trimellitates. In other embodiments, synthetic oils include
1275 polyalkylene glycols (PAGs). In general, synthetic esters described herein are obtained by reacting one or more polyhydric alcohols with alkyl acids. Polyhydric alcohols preferably include the hindered polyols (such as the neopentyl polyols, e.g., neopentyl glycol, trimethylol ethane, 2-methyl-2-propyl-1,3-propanediol, trimethylol propane, pentaerythritol,

and dipentaerythritol) and alkyl acids include least about 4 carbon atoms, preferably C₅ to C₂₆
1280 acids such as saturated straight chain fatty acids including caprylic acid, capric acid, lauric
acid, myristic acid, palmitic acid, stearic acid, arachic acid, and behenic acid, or the
corresponding branched chain fatty acids or unsaturated fatty acids such as oleic acid, or
mixtures of any of these materials.

In certain embodiments of the present invention, mixtures of synthetic (Groups IV
1285 and V) and bio-oils or petroleum based oils (Groups I, II, III) and biooils, or petroleum based
oils and synthetic oils, or mixtures of bio-oils, synthetic oils and petroleum base oils may be
used.

In certain embodiments of the present invention, 0.001% to 10 % by weight of the
corrosion inhibitors of the present invention is added to lubricant oils. In certain other
1290 embodiments of the present invention, 10% to 5% by weight of the corrosion inhibitors of the
present invention are added to lubricant oils. In certain other embodiments of the present
invention, 0.001% to 2% by weight of the corrosion inhibitors of the present invention is
added to lubricant oils. In certain other embodiments of the present invention, 0.001% to
0.5% by weight of the corrosion inhibitors of the present invention is added to lubricant oils.
1295 This percentage varies depending upon their end application and type of the base oil.

In certain embodiments of the present invention, the corrosion inhibitors of the
present invention are usually added to lubricant oils with stirring at between 0 and 100 °C,
between 20 and 80°C or between 40-60°C.

In certain embodiments of the present invention, the corrosion inhibitors of the
1300 present invention are usually added to lubricant and fuel oils (based on petroleum, synthetic,
and/or bio-based oils) (examples, gasoline, diesel, biodiesel (B10, B20, up to B100 where
numbers after letter B corresponds to percentage of fatty acid methyl esters (FAME) content
in diesel) used in automotives, and industrial applications such as but not limited to
transmission fluid, engine oil, break oil, metal working fluids, greases, gear oils, hydraulic
1305 fluids, transformer oils, elevator oils wire and rope oils, drilling oils, turbine oils used for
hydro-power turbines, aviation turbines, wind turbines, metal working fluids, etc.

In certain embodiments, the mixture of corrosion inhibitors of the present invention is
preferred due to improved solubility characteristics as compared to a single component
corrosion inhibitor.

1310 In yet other embodiments of the present invention of corrosion inhibitoirs have
significantly improved solubility characteristics in petroleum (Group I-V oils), bio-based oils

and bio-oils. This is mainly attributed to the design of the molecules of the current invention containing alkyl chains to increase the solubility.

In certain embodiments of the present invention of corrosion inhibitors, The key innovative aspects of products include:

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1. Macromolecular product design, which improves efficiency by forming more effective molecular barrier films on metal surfaces. These barriers are responsible for inhibiting corrosion, thereby, maintaining superior performance with intelligent molecular design.

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2. Free from all inorganic species. No species such as Zn, Pb, Sn, P, Cr, Si, B, S, As, etc.
3. Environmentally friendly. Low aquatic toxicity, better biodegradability, and low/no bioaccumulation.
4. Produced with bio-based, renewable raw materials to the maximum extent possible (~85.0%)

1325

In certain embodiments of the present invention of corrosion inhibitors is preferred due to multifunctional characteristics to protect against rust corrosion, copper, aluminum and alloy corrosion and also water separability from oil (as a demulsifier). In general three independent additives each one providing desired rust inhibition, copper protection, and demulsifiers are used in the formulation. The present invention provides all three protections by a single compound. This significantly reduces the number of additives required in the lubricant formulation at least from three additives to one single additive providing rust inhibition, copper protection against corrosion and performs as a demulsifier to separate water from oil. It is economically attractive by reducing three additives to one for the lubricant formulation.

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In certain embodiments of the present invention are the most suitable for environmentally acceptable lubricants because of their low aqua toxicity to fish, daphnia, and algae.

In certain embodiments of the present invention of corrosion inhibitors is preferred in aftermarket automotive lubricant products.

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In certain embodiments of the present invention of corrosion inhibitors have excellent solubility in bio-oils, bio-based oils, synthetic oils, petroleum based oils.

In yet other embodiments of the present invention, the corrosion inhibitors of the present invention are usually added to lubricant and fuel oils along with other additional

1345 lubricant additives including but not limited to antioxidants, anti-foaming, a viscosity modifier, pour point depressants, and other phenolic and aminic antioxidants.

In one embodiment, the present invention is a composition comprising present invention corrosion inhibitors, and at least one additive selected from the group consisting of i) a surface additive; ii) a performance enhancing additive, and iii) a lubricant protective additive.

1350 In another embodiments the present invention is a lubricant composition comprising: a lubricant or a mixture of lubricants, a present invention corrosion inhibitor and at least one additive selected from the group consisting of i) a surface additive; ii) a performance enhancing additive, and iii) a lubricant protective additive.

1355 In yet another embodiment the present invention is a method of improving a composition comprising combining the composition with present invention corrosion inhibitor, and at least one additive selected from the group consisting of i) a surface additive; ii) a performance enhancing additive, and iii) a lubricant protective additive.

1360 In yet another embodiment the present invention is a method of improving a lubricant or a mixture of lubricants comprising combining the lubricant or mixture of lubricants with present invention corrosion inhibitor, and at least one additive selected from the group consisting of i) a surface additive; ii) a performance enhancing additive; and iii) a lubricant protective additive.

1365 The compositions and methods of the present invention generally provide increased shelf life, increased oxidative resistance, enhanced performance and/or improved quality to materials, such as, for example, lubricants and lubricant oils and fuels. Other examples include. biolubricants and biolubricant oils and biofuel such as biodiesel. In general, it is believed that because of the synergy of the corrosion inhibitors with the additives, the compositions described herein have superior corrosion resistance. The additives exhibit several key functions such as corrosion inhibition, detergency, viscosity modification, and antiwear performance, dispersant properties, cleaning and suspending ability. The disclosed compositions, in general, provide superior performance of lubricants in high temperatures applications due to the presence of high performance additives which are thermally stable at high temperatures with enhanced oxidation resistance.

1370 In yet another embodiment the present invention of corrosion inhibitors is suitable for other corrodible materials including but not limited to fuels, biofuel, diesel, biodiesel, aviation fuels, kerosene, etc.

In certain embodiments, the present invention of corrosion inhibitors is suitable for additive packages for lubricants and fuels. These packages are for aftermarket products to enhance the performance of lubricants and fuel. Other additive packages designed for
1380 formulating lubricants and fuel by adding to base stock oils; petroleum based (Group I-V oils), bio-based, bio-oils, and gasoline, diesel, and biodiesel.

In one embodiment, the present invention is an additive package composition comprising present invention corrosion inhibitors, and at least one additive selected from the group consisting of i) a surface additive; ii) a performance enhancing additive, and iii) a
1385 lubricant protective additive.

In another embodiments the present invention is an additive package composition comprising: a lubricant or a mixture of lubricants, a present invention corrosion inhibitor and at least one additive selected from the group consisting of i) a surface additive; ii) a performance enhancing additive, and iii) a lubricant protective additive.

In yet another embodiment the present invention is a method of improving an additive package composition comprising combining the composition with present invention corrosion inhibitor; and at least one additive selected from the group consisting of i) a surface additive; ii) a performance enhancing additive, and iii) a lubricant protective additive.

In yet another embodiment the present invention is a method of improving an additive
1395 package composition comprising combining the composition with present invention corrosion inhibitor comprising additives one or more of an antioxidant, a metal deactivator, rust inhibitor, copper corrosion inhibitor, viscosity index modifier, pour point depressant, dispersing agent, detergent, an extreme-pressure, a dye, seal swell agents, a demulsifiers, and an anti-foaming additive; each additive present in the range 0.005%-5% and a carrier oil. A
1400 suitable carrier from petroleum, biobased, bio-oil is the one that dissolves all additives and easy to pour into a lubricant or a fuel. The ratio between additives and carrier oil may range from 1:99 to 99:1 by weight %, 5: 95 by weight %, 10:90 by weight %, 20:90 by weight%, 30:70 by weight%, 40:60 by weight%, 50:50 by weight%, 60:40 by weight%, 70:30 by weight%, 80:20by weight% ,90:10 by weight%, 95:5 by weight%.

In yet another embodiment the present invention of corrosion inhibitors may typically apply to coatings and paints including multi-package systems which are usually mixed prior to use, the pigments, catalysts and other additives can be added.

In yet another embodiment the present invention applications include base coat and clear coat formulations especially in the automotive, aviation, and marine industry.

1410 STABILIZED LUBRICANT OIL COMPOSITIONS

Lubricants, lubricant oils, mixtures thereof and compositions comprising lubricants and lubricant oils can be improved by the methods of the present invention, by contacting the lubricant, lubricant oil, mixtures thereof or composition comprising the lubricant or lubricant oil or mixtures thereof with corrosion inhibitors, additives and mixtures thereof as described
1415 herein.

As used here, the terms “lubricants” and “lubricant oils” can be used interchangeably. Examples of lubricants suitable for use in the compositions and methods of the present invention include, but are not limited to: i) petroleum based oils (Group I, II and III), ii) synthetic oils (Group IV and V)) and iii) biolubricant oils (vegetable oils such as canola,
1420 soybean, corn oil etc.), and bio-based oils like polyol esters, biobased esters like estolides, bio-poly alpha olefins, bio alkylene glycols, bio poly alkylene glycols. Group I oils, as defined herein are solvent refined base oils. Group II oils, as defined herein are modern conventional base oils made by hydrocracking and early wax isomerization, or hydroisomerization technologies and have significantly lower levels of impurities than Group
1425 I oils. Group III oils, as defined herein are unconventional base oils. Groups I-III differ in impurities, and viscosity index as is shown in Kramer *et al.* “The Evolution of Base Oil Technology” *Turbine Lubrication in the 21st Century* ASTM STP #1407 W.R. Herguth and T.M. Wayne, Eds., American Society for Testing and Materials, West Conshohocken, PA, 2001 the entire contents of which are incorporated herein by reference. Group IV oils as
1430 defined herein are “synthetic” lubricant oils, including, for example, poly-alpha olefins (PAOs). Biolubricants, as defined herein, are lubricants which contain at least 51% biomaterial (see Scott Fields, *Environmental Health Perspectives*, volume 111, number 12, September 2003, the entire contents of which are incorporated herein by reference). Other examples of lubricant oils can be found in Melvyn F. Askew “Biolubricants-Market Data
1435 Sheet” IENICA, August 2004 (as part of the IENICA work stream of the IENICA-INFORRM project); Taylor *et al.* “Engine lubricant Trends Since 1990” paper accepted for publication in the Proceedings I. Mech. E. Part J, *Journal of Engineering Tribology*, 2005 (Vol. 219 p 1-16); and Desplanches *et al.* “Formulating Tomorrow’s Lubricants” page 49-52 of *The Paths to Sustainable Development*, part of special report published in October 2003 by
1440 Total; the entire contents of each of which are incorporated herein by reference. Biolubricants are often but not necessarily, based on vegetable oils. Vegetable derived, for example, from rapeseed, sunflower, palm, and coconut can be used as biolubricants. They can also be

synthetic esters which may be partly derived from renewable resources. They can be made from a wider variety of natural sources including solid fats and low grade or waste materials such as tallows. Biolubricants in general offer rapid biodegradability and low environmental toxicity.

ADDITIVES

Examples of first additives suitable for use in the compositions and methods of the present invention include but are not limited to, surface additives, performance enhancing additives and lubricant protective additives.

Surface additives: In certain embodiments of the present invention, surface additives can protect the surfaces that are lubricated from wear, corrosion, rust, and frictions. Examples of these surface additives suitable for use in the compositions and methods of the present invention include, but are not limited to: (a) rust inhibitors, (b) corrosion inhibitors, (c) extreme pressure agents, (d) tackiness agents, (e) antiwear agents, (f) detergents and dispersants, (g) compounded oil (like fat or vegetable oil to reduce the coefficient of friction without affecting the viscosity), (h) antimisting, (i) seal swelling agents and (j) biocides.

Performance Enhancing Additives: In certain embodiments of the present invention, performance enhancing additives improve the performance of lubricants. Examples of these performance enhancing additives suitable for use in the Compositions and methods of the present invention include, but are not limited to: (a) pour-point depressants, (b) viscosity index modifiers (c) emulsifiers, and (d) demulsifiers.

Lubricant Protective Additives: In certain embodiments of the present invention, lubricant protective additives maintain the quality of oil from oxidation and other thermal degradation processes. Examples of these lubricant protective additives suitable for use in the compositions and methods of the present invention include, but are not limited to: (a) oxidation inhibitors and (b) foam inhibitors.

OTHER LUBRICANT ADDITIVES

In certain embodiments, a second additive can be used in the compositions and methods of the present invention in combination with the first antioxidant and the first additive as described above. Examples of second additives suitable for use in the compositions and methods of the present invention include, include but are not limited to, for example, dispersants, detergents, corrosion inhibitors, rust inhibitors, metal deactivators,

antiwear and extreme pressure agents, antifoam agents, friction modifiers, seal swell agents,
1475 demulsifiers, viscosity index improvers, pour point depressants, and the like. See, for
example, U.S. Patent No. 5,498,809 for a description of useful lubricating oil composition
additives, the disclosure of which is incorporated herein by reference in its entirety.

Dispersants: Examples of dispersants suitable for use in the compositions and
methods of the present invention include, but are not limited to polybutenylsuccinic acid-
1480 amides, -imides, or -esters, polybutenylphosphonic acid derivatives, Mannich Base ashless
dispersants, and the like.

Detergents: Examples of detergents suitable for use in the compositions and methods
of the present invention include, but are not limited to metallic phenolates, metallic
sulfonates, metallic salicylates, metallic phosphonates, metallic thiophosphonates, metallic
1485 thiopyrophosphonates, and the like.

Corrosion Inhibitors: Examples of corrosion inhibitors suitable for use in the
compositions and methods of the present invention include, but are not limited to:
phosphosulfurized hydrocarbons and their reaction products with an alkaline earth metal
oxide or hydroxide, hydrocarbyl-thio-substituted derivatives of 1,3,4-thiadiazole, thiadiazole
1490 polysulphides and their derivatives and polymers thereof, thio and polythio sulphenamides of
thiadiazoles such as those described in U.K. Patent Specification 1,560,830, and the like.

Rust Inhibitors: Examples of rust inhibitors suitable for use in the compositions and
methods of the present invention include, but are not limited to: nonionic surfactants such as
polyoxyalkylene polyols and esters thereof, anionic surfactants such as salts of alkyl sulfonic
1495 acids, and other compounds such as alkoxyated fatty amines, amides, alcohols and the like,
including alkoxyated fatty acid derivatives treated with C9 to C16 alkyl-substituted phenols
(such as the mono- and di-heptyl, octyl, nonyl, decyl, undecyl, dodecyl and tridecyl phenols).

Metal Deactivators: Metal deactivators as used herein, are the additives which form
an inactive film on metal surfaces by complexing with metallic ions and reducing, for
1500 example, the catalytic effect on metal gum formation and other oxidation. Examples of metal
deactivators suitable for use in the compositions and methods of the present invention
include, but are not limited to N, N-disubstituted aminomethyl-1, 2, 4-triazoles, N, N-
disubstituted aminomethyl-benzotriazoles, mixtures thereof, and the like.

Antiwear and Extreme Pressure Additives: Antiwear and extreme pressure additives,
1505 as used herein, react with metal surfaces to form a layer with lower shear strength than metal,
thereby preventing metal to metal contact and reducing friction and wear. Examples of
antiwear additives suitable for use in the compositions and methods of the present invention

include, but are not limited to: sulfurized olefins, sulfurized esters, sulfurized animal and vegetable oils, phosphate esters, organophosphites, dialkyl alkylphosphonates, acid
1510 phosphates, zinc dialkyldithiophosphates, zinc diaryldithiophosphates, organic dithiophosphates, organic phosphorothiolates, organic thiophosphates, organic dithiocarbamates, dimercaptothiadiazole derivatives, mercaptobenzothiazole derivatives, amine phosphates, amine thiophosphates, amine dithiophosphates, organic borates, chlorinated paraffins, and the like.

1515 Antifoam Agents: Examples of antifoam agents suitable for use in the compositions and methods of the present invention include, but are not limited to: polysiloxanes and the like.

Friction Modifiers: Examples of friction modifiers suitable for use in the compositions and methods of the present invention include, but are not limited to: fatty acid
1520 esters and amides, organic molybdenum compounds, molybdenum dialkylthiocarbamates, molybdenum dialkyl dithiophosphates, molybdenum dithiolates, copper oleate, copper salicylate, copper dialkyldithiophosphates, molybdenum disulfide, graphite, polytetrafluoroethylene, and the like.

Seal Swell Agents: Seal swell agents, as used herein, react chemically with elastomers
1525 to cause slight swell thus improving low temperature performance especially in, for example, aircraft hydraulic oil. Examples of seal swell agents suitable for use in the compositions and methods of the present invention include, but are not limited to: dioctyl sebacate, dioctyl adipate, dialkyl phthalates, and the like.

Demulsifiers: Demulsifiers, as used herein promote separation of oil and water in
1530 lubricants exposed to water. Examples of demulsifiers suitable for use in the compositions and methods of the present invention include, but are not limited to: the esters described in U.S. Patent Nos. 3,098,827 and 2,674,619 incorporated herein by reference.

Viscosity Index Improvers: Examples of viscosity index improvers suitable for use in the compositions and methods of the present invention include, but are not limited to olefin
1535 copolymers, dispersant olefin copolymers, polymethacrylates, vinylpyrrolidone/methacrylate-copolymers, polyvinylpyrrolidones, polybutanes, styrene/-acrylate-copolymers, polyethers, and the like.

Pour Point Depressants: Pour point depressants as used herein reduce the size and cohesiveness of crystal structure resulting in low pour point and increased flow at low-
1540 temperatures. Examples of pour point depressants suitable for use in the compositions and

methods of the present invention include, but are not limited to: polymethacrylates, alkylated naphthalene derivatives, and the like.

OTHER ANTIOXIDANTS AND STABILIZERS

In certain embodiments, a second antioxidant or a stabilizer can be used in the compositions and methods of the present invention in combination with the first antioxidant and the first additive and optionally the second additive as described above. Examples of second antioxidants suitable for use in the compositions and methods of the present invention include, include but are not limited to:

1. Amine Antioxidants

- 1545 1.1. Alkylated Diphenylamines, for example octylated diphenylamine; styrenated diphenylamine; mixtures of mono- and dialkylated tert-butyl-tert-octyldiphenylamines; and 4,4'-dicumyldiphenylamine.
- 1550 1.2. Phenyl Naphthylamines, for example N-phenyl-1-naphthylamine; N-phenyl-2-naphthylamine; tert-octylated N-phenyl-1-naphthylamine.
- 1555 1.3. Derivatives of para-Phenylenediamine, for example N,N'-diisopropyl-p-phenylenediamine; N,N'-di-sec-butyl-p-phenylenediamine; N,N'-bis(1,4-dimethylpentyl)-p-phenylenediamine; N,N'-bis(1-ethyl-3-methylpentyl)-p-phenylenediamine; N,N'-bis(1-methylheptyl)-p-phenylenediamine; N,N'-diphenyl-p-phenylenediamine; N,N'-di-(naphthyl-2)-p-phenylenediamine; N-isopropyl-N'-phenyl-p-phenylenediamine; N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine; N-(1-methylheptyl)-N'-phenyl-p-phenylenediamine; N-cyclohexyl-N'-phenyl-p-phenylenediamine; N,N'-dimethyl-N,N'-di-sec-butyl-p-phenylenediamine.
- 1560 1.4. Phenothiazines, for example phenothiazine; 2-methylphenothiazine; 3-octylphenothiazine; 2,8-dimethylphenothiazine; 3,7-dimethylphenothiazine; 3,7-diethylphenothiazine; 3,7-dibutylphenothiazine; 3,7-dioctylphenothiazine; 2,8-dioctylphenothiazine.
- 1565 1.5. Dihydroquinolines, for example 2,2,4-trimethyl-1,2-dihydroquinoline or a polymer thereof.
- ### 2. Phenolic Antioxidants
- 1570 2.1. Alkylated monophenols, for example 2,6-di-tert-butyl-4-methylphenol; 2,6-di-tert-butylphenol; 2-tert-butyl-4,6-dimethylphenol; 2,6-di-tert-butyl-4-ethylphenol; 2,6-di-tert-butyl-4-n-butylphenol; 2,6-di-tert-butyl-4-isobutylphenol; 2,6-di-tert-butyl-4-sec-

- 1575 butylphenol; 2,6-di-tert-butyl-4-octadecylphenol; 2,6-di-tert-butyl-4-nonylphenol; 2,6-dicyclopentyl-4-methylphenol; 2-(β -methylcyclohexyl)-4,6-dimethylphenol; 2,6-dioctadecyl-4-methylphenol; 2,4,6-tricyclohexylphenol; 2,6-di-tert-butyl-4-methoxymethylphenol; 2,6-di-tert-butyl-4-dimethylaminomethylphenol; o-tert-butylphenol.
- 2.2. Alkylated hydroquinones, for example 2,6-di-tert-butyl-4-methoxyphenol; 2,5-di-tert-butylhydroquinone; 2,5-di-tert-amylhydroquinone; 2,6-di-phenyl-4-octadecyloxyphenol.
- 1580 2.3. Hydroxylated thiodiphenyl ethers, for example 2,2'-thiobis(6-tert-butyl-4-methylphenol); 2,2'-thiobis(4-octylphenol); 4,4'-thiobis(6-tert-butyl-3-methylphenol); 4,4'-thiobis(6-tert-butyl-2-methylphenol).
- 2.4. Alkylidenebisphenols, for example 2,2'-methylenebis(6-tert-butyl-4-methylphenol); 2,2'-methylenebis(6-tert-butyl-4-ethylphenol); 2,2'-methylenebis(4-methyl-6-(α -methylcyclohexyl)phenol); 2,2'-methylenebis(4-methyl-6-cyclohexylphenol); 2,2'-methylenebis(6-nonyl-4-methylphenol); 2,2'-methylenebis(4,6-di-tert-butylphenol); 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol); 2,2'-methylenebis[6-(α -methylbenzyl)-4-nonylphenol]; 2,2'-methylenebis[6-(α , α -dimethylbenzyl)-4-nonylphenol]; 4,4'-methylenebis(2,6-di-tert-butylphenol); 4,4'-methylenebis(6-tert-butyl-2-methylphenol); 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane; 2,6-di(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol; 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane; ethylene glycol bis[3,3-bis(3'-tert-butyl-4'-hydroxylphenyl)butyrate]; di(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene; di[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate.
- 1590 2.5. Benzyl compounds, for example 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene; di(3,5-di-tert-butyl-4-hydroxybenzyl)sulfide; 3,5-di-tert-butyl-4-hydroxybenzylmercaptoacetic acid isooctyl ester; bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithioterephthalate; 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)isocyanurate; 1,3,5-tris(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)isocyanurate; 3,5-di-tert-butyl-4-hydroxybenzylphosphonic acid dioctadecyl ester; 3,5-di-tert-butyl-4-hydroxybenzylphosphonic acid mono-ethyl ester calcium salt.
- 1600

- 1605 2.6. Acylaminophenols, for example 4-hydroxylauric acid anilide; 4-hydroxystearic acid anilide; 2,4-bis-octylmercapto-6-(3,5-di-tert-butyl-4-hydroxyaniline)-s-triazine; N-(3,5-di-tert-butyl-4-hydroxyphenyl)carbamic acid octyl ester.
- 2.7. Esters of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol; octadecanol; 1,6-hexanediol; neopentyl glycol; thiodiethylene glycol; diethylene glycol; triethylene glycol; pentaerythritol; 1610 tris(hydroxyethyl)isocyanurate; and di(hydroxyethyl)oxalic acid diamide.
- 2.8. Esters of β -(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol; octadecanol; 1,6-hexanediol; neopentyl glycol; thiodiethylene glycol; diethylene glycol; triethylene glycol; pentaerythritol; 1615 tris(hydroxyethyl)isocyanurate; and di(hydroxyethyl)oxalic acid diamide.
- 2.9. Amides of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid, e.g., N,N'-di(3,5-di-tert-butyl-4-hydroxyphenyl-propionyl)hexamethylenediamine ; N,N'-di(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamine; N,N'-di-(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazine.
- 1620 3. Sulfurized organic compounds, for example aromatic, alkyl, or alkenyl sulfides and polysulfines; sulfurized olefins; sulfurized fatty acid esters; sulfurized ester olefins; sulfurized oils; esters of β -thiodipropionic acid; sulfurized Diels-Alder adducts; sulfurized terpene compounds; and mixtures thereof.
4. Organo-borate compounds, for example alkyl- and aryl- (and mixed alkyl, aryl) 1625 substituted borates.
5. Phosphite and phosphate antioxidants, for example alkyl- and aryl- (and mixed alkyl, aryl) substituted phosphites, and alkyl- and aryl- (and mixed alkyl, aryl) substituted dithiophosphates such as O,O,S-trialkyl dithiophosphates, O,O,S-triaryldithiophosphates and dithiophosphates having mixed substitution by alkyl and 1630 aryl groups, phosphorothionyl sulfide, phosphorus-containing silane, polyphenylene sulfide, amine salts of phosphinic acid and quinone phosphates.
6. Copper compounds, for example copper dihydrocarbyl thio- or dithiophosphates, copper salts of synthetic or natural carboxylic acids, copper salts of alkenyl carboxylic acids or anhydrides such as succinic acids or anhydrides, copper dithiocarbamates, 1635 copper sulphonates, phenates, and acetylacetonates. The copper may be in cuprous (Cu^{I}) or cupric (Cu^{II}) form.
7. Zinc dithiodiphosphates, for example zinc dialkyldithiophosphates, diphenyldialkyldithiophosphates, and di(alkylphenyl)dithiophosphates.

1640 In one embodiment, the compositions for use in the methods of the present invention, include but are not limited to:

a. a first corrosion inhibitor (in the concentration range, from about 0.0001% to about 50%, from about 0.0005% to about 20%, from about 0.005% to about 10%, from about 0.05% to about 5% or from about 0.01% to about 1%) with a first additive selected from the group comprising an antioxidant, a surface additive, a performance enhancing additive and a lubricant performance additive, for example, in amounts of from about 0.0005% to about 50%, from about 0.0001% to about 20%, from about 0.005% to about 10%, from about 0.05% to about 5% or from about 0.01% to about 1% by weight, based on the weight of lubricant to be stabilized.

1650 b. the first corrosion inhibitor and the first additive as described in a. and a second additive, for example, in concentrations of from about 0.0001% to about 50% by weight, about 0.0005% to about 20% by weight, about 0.001% to about 10% by weight, from about 0.01% to about 5% by weight, from about 0.05% to about 1% by weight from about 0.1% to about 1% by weight based on the overall weight of the lubricant to be stabilized.

1655 c. the first corrosion inhibitor and the first additive as described in a. and optionally the second additive as described in b. and a second corrosion inhibitor, for example, Irgacor® 190, Irgacor® NPA, Cuvan® 303, Cuvan® 484, Cuvan® 826, in the concentration range, from about 0.0001% to about 50%, from about 0.0005% to about 20%, from about 0.005% to about 10%, from about 0.05% to about 5% or from about 0.01% to about 1%) by weight, based on the weight of lubricant to be stabilized.

1660 In yet another embodiment, the antioxidant compositions for use in the methods of the present invention include but is not limited to: the first antioxidant from the present invention and the second antioxidant from the section.

‘OTHER ANTIOXIDANTS AND STABILIZERS’.

1665 The antioxidant composition, where in the weight ratio of the second antioxidant to the first antioxidant of the present invention is from about 1:99 to 99:1, from about 10:90, 20:80, 30:70, 40:60, 50:50, 60:40, 70:30, 80:20, 90:10. The second antioxidant second antioxidant, for example, Irganox® L 57, Irganox® L64, Irganox® 1330, Irganox® 1076, Irganox® 5057 and Irganox® L 135, Polnox®7030, Polnox® 7070, Polnox® 8020, Polnox®8060, Polnox®8080.

1670

EXAMPLE 1

1675 Octanoyl chloride (1 mL, 5.82 mmol) was added slowly to the mixture of 2-t-butyl-4-methoxyphenol (1 g, 5.82 mmol) and triethylamine (0.81 mL, 5.82 mmol) dissolved in THF in ice-bath under a nitrogen atmosphere. The reaction mixture was stirred overnight at room temperature under nitrogen atmosphere. The completion of the reaction was confirmed by TLC and FTIR. The mixture was filtered to remove salt and then washed with THF. It was then concentrated under reduced pressure. The crude product was dissolved in EtOAc and extracted with saturated NaHCO₃ and brine. The organic phase was dried over anhydrous Na₂SO₄. Concentration in vacuo gave the target compounds as a light yellow liquid.

1680

EXAMPLE 2

The same method in Example 1 is used with a linear alkyl chain of C₁₂, C₁₆ and C₁₈ atoms and a branched alkyl chain with C₈ atoms.

EXAMPLE 3

1685 The same method in Example 1 is used for the synthesis of phenol and substituted phenols such as 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o, m, p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol, and phloroglucinol.

EXAMPLE 4

1690 The same method in Example 1 is used with a linear alkyl chain of C₁₂, C₁₆ and C₁₈ atoms and a branched alkyl chain of C₈ atoms for phenol and substituted phenols in Example 3.

EXAMPLE 5

1695 Oxalyl chloride (6 mL, 67.06 mmol) was added slowly to the mixture of o-cresol (5.74 g, 53.12 mmol) and stearic acid (15.11 g, 53.12 mmol) in dichloromethane (15 mL) with a catalytic amount (a couple of drops) of DMF in ice-bath under a nitrogen atmosphere. The reaction mixture was stirred for 30 min at this temperature under nitrogen atmosphere. Then, the reaction mixture was stirred at 60 °C for 6-10 h. The completion of the reaction was confirmed by TLC and FTIR. After cooling, the crude product was extracted with saturated

NaHCO₃ and brine. The organic phase was dried over anhydrous Na₂SO₄. It was then
1700 concentrated under reduced pressure. Concentration in vacuo gave the target compound.

EXAMPLE 6

The same method in Example 5 is used with a linear alkyl chain of C₁₂, C₁₆ and C₁₈ atoms
and a branched alkyl chain of C₈ atoms.

EXAMPLE 7

1705 Example 5 is synthesized using thionyl chloride instead of oxalyl chloride.

EXAMPLE 8

The same method in Example is used with a linear alkyl chain of C₁₂, C₁₆ and C₁₈ atoms and
a branched alkyl chain of C₈ atoms for phenol and substituted phenols such as 2-
methoxyphenol, 2-t-butyl-4-methoxyphenol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-
1710 sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol,
isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol and
phloroglucinol.

EXAMPLE 9

The same method in Example 7 is used with a linear alkyl chain of C₁₂, C₁₆ and C₁₈ atoms
1715 and a branched alkyl chain of C₈ atoms for phenol and substituted phenols such as 2-
methoxyphenol, 2-t-butyl-4-methoxyphenol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-
sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol,
isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol and
phloroglucinol.

1720 EXAMPLE 10

Concentrated H₂SO₄ (161.2 mL, 3 mol) was added slowly to a reaction mixture of 2-
methoxyphenol (150 g, 1.21 mol) and formaldehyde (37 % aq) (90.8 mL, 1.21 mol) in
distilled water (600 mL) in ice-bath. Then, the reaction mixture was refluxed under N₂ for 6-
10 h. The completion of the reaction was confirmed by TLC. After cooling down the reaction
1725 mixture, solution phase was decantated and the precipitate was washed with water. The
precipitate dried under vacuum gave the target product as light yellow to brown powder. This

reaction was done using other solvents such as toluene and 1,2-dichloroethane. This reaction was also done using oxalic acid as a catalyst.

EXAMPLE 11

1730 The same method in Example 10 was used for the synthesis of o-cresol, o,m,p-cresol mixtures, 2-t-butyl-4-methoxyphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, and 4-t-butylphenol. It is also used others such as m-cresol, p-cresol, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, resorcinol, catechol, and phloroglucinol. This reaction was done using other solvents such as toluene and 1,2-
1735 dichloroethane. This reaction was done using oxalic acid as a catalyst.

EXAMPLE 12

Lauroyl chloride (152 mL, 0.639 mol) in 300 mL of THF was added slowly to the mixture of the product from Example 10 (100 g, 0.188 mol) and triethylamine (88.5 mL, 0.639 mol)
1740 dissolved in 600 mL of THF in ice-bath under a nitrogen atmosphere. The reaction mixture was stirred overnight at room temperature under nitrogen atmosphere. The completion of the reaction was confirmed by FTIR. The mixture was filtered to remove salt and then washed with THF. It was then concentrated under reduced pressure. The crude product was dissolved
1745 in EtOAc, extracted with saturated NaHCO₃ and brine. The organic phase was dried over anhydrous Na₂SO₄. Concentration in vacuo gave the target compounds as light yellow oil.

EXAMPLE 13

The same method in Example 12 was used with a linear alkyl chain of C₈, C₁₂, C₁₆ and a branched alkyl chain of C₈ atoms. It is also used with a linear alkyl chain of C₁₈ atoms.

EXAMPLE 14

1750 The same method in Example 5 is used with a linear alkyl chain of C₈, C₁₂, C₁₆ and C₁₈ atoms and a branched alkyl chain of C₈ atoms for Example 13.

EXAMPLE 15

The same method in Example 5 is used with a linear alkyl chain of C₈, C₁₂, C₁₆ and C₁₈ atoms and a branched alkyl chain of C₈ atoms for Example 13.

1755

EXAMPLE 16

The same method in Example 12 was used with a linear alkyl chain of C₈ for 4-t-butylphenol and 2-t-butyl-4-methoxyphenol used as starting material in Example 11. The same method in Example 5 is used with a linear alkyl chain of C₈, C₁₂, C₁₆ and C₁₈ atoms and a branched alkyl chain of C₈ atoms for the other compounds obtained in Example 11.

1760

EXAMPLE 17

The same method in Example 5 is used with a linear alkyl group of C₈, C₁₂, C₁₆ and C₁₈ atoms and a branched alkyl chain of C₈ atoms for Example 11.

EXAMPLE 18

1765 The same method in Example 7 is used with a linear alkyl chain of C₈, C₁₂, C₁₆ and C₁₈ atoms and a branched alkyl chain of C₈ atoms for Example 11.

EXAMPLE 19

Oxalyl chloride (3.7 mL, 42.56 mmol) was added slowly to the mixture of 2-methoxyphenol (4.49 g, 35.47 mmol) and oleic acid (10.02 g, 35.47 mmol) with a catalytic amount (a couple
1770 of drops) of DMF in ice-bath under a nitrogen atmosphere. The reaction mixture was stirred for 30 min at this temperature under nitrogen atmosphere. Then, the reaction mixture was stirred at 60 °C for 6-10 h. The completion of the reaction was confirmed by TLC and FTIR. After cooling, the crude product was extracted with saturated NaHCO₃ and brine. The organic phase was dried over anhydrous Na₂SO₄. It was then concentrated under reduced
1775 pressure. Concentration in vacuo gave the target compound yellow oil. This reaction was done using thionyl chloride.

EXAMPLE 20

The same method in Example 19 was used for phenol, o-cresol, resorcinol and catechol. It is also used others such as 2-t-butyl-4-methoxyphenol, m-cresol, p-cresol, o,m,p-cresol
1780 mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol and 4-t-butylphenol, and phloroglucinol. Dichloromethane was used as a solvent of substituted phenols which are solid at reaction temperature 60 °C.

EXAMPLE 21

1785 Example 19 was synthesized using thionyl chloride instead of oxalyl chloride.

EXAMPLE 22

Example 20 is synthesized using thionyl chloride instead of oxalyl chloride.

EXAMPLE 23

Oxalyl chloride (3.6 mL, 41.3 mmol) was added slowly to the mixture of the product in
1790 Example 10 (5 g, 9.39 mmol) and oleic acid (9 g, 31.9 mmol) in dichloromethane (25 mL)
with a catalytic amount (0.1 mL) of DMF in ice-bath under a nitrogen atmosphere. The
reaction mixture was stirred for 30 min at this temperature under nitrogen atmosphere. Then,
the reaction mixture was stirred at 60 °C for 6-10 h. The completion of the reaction was
confirmed FTIR. After cooling, the crude product was extracted with saturated NaHCO₃ and
1795 brine. The organic phase was dried over anhydrous Na₂SO₄. It was then concentrated under
reduced pressure. Concentration in vacuo gave the target compound as yellow oil. This
reaction was done using thionyl chloride. This reaction was also done as following: Thionyl
chloride was added slowly to the mixture of an oleic acid with a catalytic amount of DMF in
ice-bath by scrubbing gaseous products into aqueous sodium hydroxide solution. The reaction
1800 mixture was stirred at room temperature for 2-4 h. Excess thionyl chloride was distilled of. In
a separate flask, the product of Example 10 was dissolved in 1,2-dichloroethane by followed
by addition of triethylamine. Then, this mixture was added drop wise over a period of 30 min
into oleoyl chloride in ice-bath under a nitrogen atmosphere. The reaction mixture was stirred
at room temperature for 8-16 h. The completion of the reaction was confirmed FTIR. The salt
1805 formed in the reaction was filtered out and washed with the reaction solvent. The
concentration of filtrate in rotavapor gave the target compound as yellow oil. This was done
using other solvents such as ethyl acetate and toluene.

EXAMPLE 24

The compound in Example 23 was synthesized using thionyl chloride instead of oxalyl
1810 chloride.

EXAMPLE 25

The same method in Example 24 was used to attach oleic acid to the compounds obtained in Example 12 such as using o-cresol, o,m,p-cresol mixtures, resorcinol, and catechol. It is also
1815 used others such as using m-cresol, p-cresol, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, 2-t-butyl-4-methoxyphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol and 4-t-butylphenol and phloroglucinol.

EXAMPLE 26

1820 Example 25 is synthesized using thionyl chloride instead of oxalyl chloride.

EXAMPLE 27

Concentrated H₂SO₄ (1.9 mL, 0.036 mol) was added slowly to a reaction mixture of oleic acid (101 g, 0.36 mol) in MeOH (200 mL). Then, the mixture was refluxed for 2-4 h under nitrogen atmosphere. The completion of the reaction was confirmed by FTIR. After cooling
1825 down the reaction mixture, the crude product was concentrated in vacuo. It was then extracted with saturated NaHCO₃ and brine. The organic phase was dried over anhydrous Na₂SO₄. Concentration in vacuo gave the target product as light yellow oil.

EXAMPLE 28

The same method in Example 27 was used for the attachment of C₄ alkyl chain. It is also used
1830 for the attachment of C₂ and C₃ alkyl chains.

EXAMPLE 29

The mixture of oleic acid (7.51 g, 26.6 mmol), 1-octadecanol (7.19 g, 26.6 mmol), PTSA.H₂O (0.51 g, 2.7 mmol) and molecular sieves were stirred at 110 °C for 4h under a nitrogen atmosphere. The completion of the reaction was confirmed by FTIR. After cooling
1835 down the reaction mixture, molecular sieves were filtered and washed with EtOAc. The filtrate was then extracted with saturated NaHCO₃ and brine. The organic phase was dried over anhydrous Na₂SO₄. Concentration in vacuo gave the target product as a yellow wax.

EXAMPLE 30

1840 The same method in Example 29 is used for the attachment of a linear alkyl chain of C₈, C₁₂ and C₁₆ atoms and a branched alkyl chain of C₈ atoms.

EXAMPLE 31

Example 30 is synthesized using apparatus Dean-Stark instead of molecular sieves.

EXAMPLE 32

1845 The same method in Example 31 is used to make Example 30.

EXAMPLE 33

To a 50 ml two-neck round bottom flask equipped thermocouple-temperature controller was added methyl oleate obtained in Example 28 (25.22 g, 85.08 mmol) and maleic anhydride (8.34 g, 85.08 mmol) in dimethyl succinate (6 mL, 0.2 eq. by wt). The reaction mixture was
1850 stirred at 175 °C under a nitrogen atmosphere for 4-6 h. The completion of the reaction was confirmed by FTIR and TLC. The reaction product was used in next step without further purification.

EXAMPLE 34

The same method in Example 33 was used for the compounds obtained in Example 19.

1855

EXAMPLE 35

The same method in Example 33 was used for the compounds obtained in Example 20 such as using phenol, o-cresol, resorcinol, and catechol. It is also used others such as 2-t-butyl-4-methoxyphenol, m-cresol, p-cresol, o,m,p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-
1860 methoxyphenol and 4-t-butylphenol, and phloroglucinol.

EXAMPLE 36

The same method in Example 33 was used for the compounds obtained in Example 23.

EXAMPLE 37

1865 The same method in Example 33 was used for the compounds obtained in Example 25 such as using o-cresol, o,m,p-cresol mixtures, resorcinol, and catechol. It is also used others such as using m-cresol, p-cresol, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, 2-t-butyl-4-methoxyphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol and 4-t-butylphenol and phloroglucinol.

1870

EXAMPLE 38

The same method in Example 33 was used for the compound obtained in Example 28. It is also used for the attachment of C₂ and C₃ alkyl chains.

EXAMPLE 39

1875 The same method in Example 33 was used for the compound obtained in Example 29.

EXAMPLE 40

The same method in Example 33 is used for the compounds obtained in Example 30.

EXAMPLE 41

1880 Propylene oxide (4.45 mL, 63.76 mmol) was added slowly to a reaction mixture of phenol (5 g, 53.13 mmol) dissolved in aqueous NaOH (4.25g, 106.2 mmol) in 15mL water. Then, the temperature was raised to 75 °C for 16 h under nitrogen atmosphere. The completion of the reaction was confirmed by TLC and FTIR. After cooling down the reaction mixture, the crude product was acidified with 1M HCl. It was diluted with EtOAc and then extracted with saturated NaHCO₃, 1M NaOH (aq) and brine. The organic phase was dried over anhydrous
1885 Na₂SO₄. Concentration in vacuo gave the target product as a colorless liquid.

EXAMPLE 42

1890 The same method in Example 41 is used for the substituted phenols such as 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol and phloroglucinol.

EXAMPLE 43

The same method in Example 41 is used for the compound obtained in Example 10.

EXAMPLE 44

The same method in Example 41 is used for the compounds obtained in Example 11.

1895

EXAMPLE 45

Octadecyl oleate succinic anhydride obtained in Example 36 (2.03 g, 2.57 mmol) was stirred with 1-octadecanol (0.69 g, 2.57 mmol) and dimethyl succinate (0.2 eq by weight) at 130 °C for 2-4 h under nitrogen atmosphere. The completion of the reaction was confirmed by FTIR. No work-up was required. The product appeared as yellow wax upon cooling.

1900

EXAMPLE 46

The same method in Example 45 is used for the compound obtained in Example 33 with a linear alkyl alcohol of C₈, C₁₂ and C₁₆ atoms and a branched alkyl alcohol of C₈ atoms, ethylene glycol, hexanediol, neopentyl glycol, 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, diethanolamine, trimethylolpropane, glycerol, triethanolamine, pentaerythritol and di-pentaerythritol .

1905

EXAMPLE 47

The same method in Example 45 is used for the compound obtained in Example 34 with the reaction of C₁-C₂₄ mono alkyl alcohols, ethylene glycol, 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, hexanediol, neopentyl glycol, diethanolamine, trimethylolpropane, glycerol, triethanolamine, pentaerythritol, and di-pentaerythritol.

1910

EXAMPLE 48

The same method in Example 45 was used for the compound obtained in Example 35 with a linear alkyl alcohol of C₈, C₁₂ and C₁₆ atoms and a branched alkyl alcohol of C₈ atoms, 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, ethylene glycol, hexanediol, neopentyl glycol, diethanolamine, trimethylolpropane, glycerol, triethanolamine, pentaerythritol and di-pentaerythritol.

1915

EXAMPLE 49

1920 The same method in Example 45 was used for the compound obtained in Example 36 with a linear alkyl alcohol of C₈, C₁₂ and C₁₆ atoms and a branched alkyl alcohol of C₈ atoms.

EXAMPLE 50

The same method in Example 45 was used for the compound obtained in Example 37 with a linear alkyl alcohol of C₈, C₁₂ and C₁₆ atoms and a branched alkyl alcohol of C₈ atoms.

EXAMPLE 51

1925 The same method in Example 45 was used for the compound obtained in Example 39 with a linear alkyl alcohol of C₈, C₁₂ and C₁₆ atoms and a branched alkyl alcohol of C₈ atoms, 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, ethylene glycol, hexanediol, neopentyl glycol, diethanolamine, trimethylolpropane, glycerol, triethanolamine, pentaerythritol and di-pentaerythritol.

1930

EXAMPLE 52

The same method in Example 45 is used for the compound obtained in Example 40 with a linear alkyl alcohol of C₈, C₁₂ and C₁₆ atoms and a branched alkyl alcohol of C₈ atoms, 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, ethylene glycol, hexanediol, neopentyl glycol, diethanolamine, trimethylolpropane, glycerol, triethanolamine, 1935 pentaerythritol and di-pentaerythritol.

EXAMPLE 53

The same method in Example 45 is used the compound obtained in Example 10 to react with succinic anhydrides such as a DDSA, ODSA, OSA, and PIBSA.

EXAMPLE 54

1940 The same method in Example 45 is used the compound obtained in Example 11 to react with succinic anhydrides such as DDSA, ODSA, OSA, and PIBSA.

EXAMPLE 55

1945 The same method in Example 45 is used substituted phenols such as 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol and phloroglucinol to react with succinic anhydrides such as a linear alkyl and a branched alkyl of octenyl succinic anhydride, tetradecenylsuccinic anhydride, hexadecenylsuccinic anhydride and polyisobutylene succinic
1950 anhydride.

EXAMPLE 56

1955 The same method in Example 45 is used substituted phenols such as 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol, and phloroglucinol to react with the compound obtained in Example 33.

EXAMPLE 57

1960 The same method in Example 45 is used substituted phenols such as 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol, and phloroglucinol to react with the compound obtained in Example 38.

EXAMPLE 58

1965 The same method in Example 45 is used substituted phenols such as 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol, and phloroglucinol to react with the compound obtained in Example 39.

1970

EXAMPLE 59

The same method in Example 45 is used substituted phenols such as 2-methoxyphenol, o-cresol, m-cresol, p-cresol and o,m,p-cresol mixtures, 2-sec-butylphenol, 2-tert-amylphenol, 2-tert-butylphenol, 2-isopropyl-5-methylphenol, eugenol, isoeugenol, 4-ethyl-2-methoxyphenol, 4-t-butylphenol, resorcinol, catechol, and phloroglucinol to react with the compound obtained in Example 40.

1975

EXAMPLE 60

The same method in Example 45 was used the compound obtained in Example 41 to react with an octadecenylsuccinic anhydride.

EXAMPLE 61

1980 The same method in Example 45 is used the compound obtained in Example 41 to react with other succinic anhydrides such as DDSA, ODSA, OSA, and PIBSA.

EXAMPLE 62

The same method in Example 45 is used the compound obtained in Example 41 to react with the compounds obtained in Example 33.

1985

EXAMPLE 63

The same method in Example 45 is used the compound obtained in Example 41 to react with the compounds obtained in Example 34.

EXAMPLE 64

1990 The same method in Example 45 is used the compound obtained in Example 41 to react with the compounds obtained in Example 35.

EXAMPLE 65

The same method in Example 45 is used the compound obtained in Example 41 to react with the compounds obtained in Example 36.

EXAMPLE 66

1995 The same method in Example 45 is used the compound obtained in Example 41 to react with
the compounds obtained in Example 37.

EXAMPLE 67

2000 The same method in Example 45 is used the compound obtained in Example 41 to react with
the compounds obtained in Example 38.

EXAMPLE 64

The same method in Example 45 is used the compound obtained in Example 41 to react with
the compounds obtained in Example 39.

EXAMPLE 68

2005 The same method in Example 45 is used the compound obtained in Example 41 to react with
the compounds obtained in Example 40.

The performance of corrosion inhibitor can be evaluated using ASTM D130 and
ASTM D665 test methods for fluids like lubricants and fuels. ASTM D130 test method is
2010 suited to test the performance corrosion inhibitors for copper metals whereas ASTM D665 is
of steel materials. The Copper Strip Tarnish Test assesses the relative degree of corrosivity
of petroleum products, including aviation fuels, automotive gasoline, natural gasoline,
solvents, kerosene, diesel fuel, distillate fuel oil, lubricating oil and other products. A
polished copper strip is immersed in 30mL of the sample at elevated temperature. After the
2015 test period, the strip is examined for evidence of corrosion and a classification number from
1-4 is assigned based on a comparison with the ASTM Copper Strip Corrosion Standards.
The most typical test run is for 3 hours @ 100°C. However, time and temperature can vary
according to product type and specification. Results are reported as a number followed by a
letter according to the ASTM chart, a rating of 1a and 1b being an excellent corrosion
2020 inhibitor and a rating of 4 is a poor performer.

The efficacy of the corrosion inhibitor of representative samples of the present invention was
tested by adding 500 ppm in canola oil, Group II oil and polyolester (synthetic oil, Group
IV). The results are summarized in Table 1.

Corrosion Inhibitor	CORROSION INHIBITION (ASTM D130)				RUST INHIBITION (ASTM D665-2)				DEMULSIFICATION (ASTM D1401-12)	
	Treat Level	Canola Oil	Group II Oil	Polyol Ester	Treat Level	Canola Oil	Treat Level	Group II Oil	Canola Oil	Group II Oil
Example 49	0.05%	1A	1B	1A	0.5%	Pass	0.05%	Pass	40-40-0 (30)	40-40-0 (30)

2025

In a similar way, corrosion inhibitors of this invention were also tested using ASTM D665 protocol. In this method, 300 ml of fluid treated with corrosion inhibitor and 30 ml of standard synthetic sea water are mixed thoroughly at 60 °C and a standard polished, cylindrical steel rod are immersed in the fluid for 4 hours. The rod will be examined for a pass or fail the test. If there is no sign of rust on the surface of the steel rod, a rating of Pass is given to the product. The products of this invention show no rust corrosion for steel rods in canola oil if they are treated with 0.4-0.5 weight % of the oil.

2030

The ASTM D 1401 test method was used to study water separability of the present invention. In this method is a known amount of water and oil treated with the demulsifier, 40 ml were poured in to a graduated jar of a specified diameter. The sample was kept at a constant temperature (40 °C). Both oil and water were stirred using a motorized stirrer at a specified specific rotation speed of 1500 rpm. The time taken for the two separate was measured in minutes, the faster the separation better is the demulsibility. The results are quoted as ml-ml-emulsion (time, min). For example, 40-40-0 (30) means it took 30 minutes to separate the two with no emulsion. The sample of the present invention treated at the same level for corrosion inhibitor. For example, canola was treated at 0.5% with the sample of the present invention whereas Group II oil was tested at 0.05%.

2035

2040

While this invention has been particularly shown and described with references to preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the scope of the invention encompassed by the appended claims.

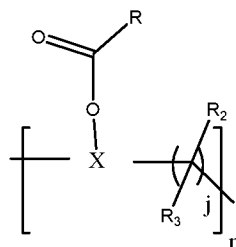
2045

CLAIMS

2050 What is claimed is:

1. A compound having Structural Formula I:

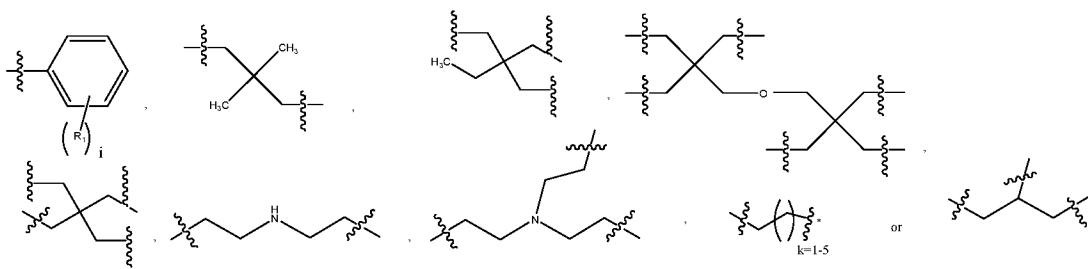
Structural Formula I



2055

wherein:

X is:



2060

each R_1 is H, independently an optionally substituted C_1 - C_{20} alkyl group, an optionally substituted C_1 - C_{10} alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, an optionally- $CH(R''')(R''')COOH$ wherein each R''' independently C_1 - C_{10} linear or branched alkyl chain, $-OH$, $-SH$ or $-NH_2$ or an optionally substituted carbocyclic or heterocyclic non- aromatic ring;

2065

$i = 0, 1, 2, 3$;

$j = 0$ or 1 ;

2070

n is an integer from 1 to 1000, or an integer from 1 to 100, or an integer from 1 to 50, or an integer from 1 to 25, or an integer from 1 to 15, or preferably an integer from 1 to 10;

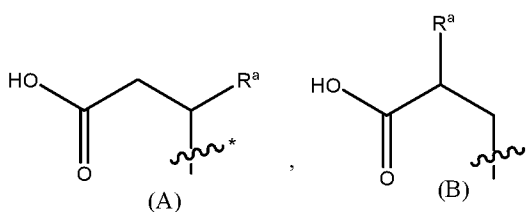
when $n = 1$, then $j = 0$;

when $n > 1$ then $j = 1$;

2075 each R_2 and R_3 is independently H, a C₁-C₈ linear or branched or cyclic alkyl chain, an optionally substituted C₁-C₂₀ alkyl group, an optionally substituted C₁-C₁₀ alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, or -CH(R''')(R''')COOH);

2080

R is a C₁-C₂₄ linear or branched alkyl chain, alkenyl chain, or an isomerized structure or a mixture of isomerized (A) and (B):



2085 wherein R^a is a C₁-C₂₄ alkenyl linear or branched chain.

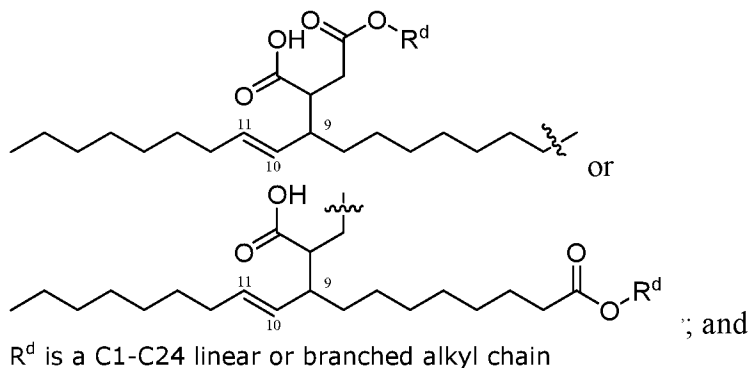
2. The compound of Claim 1, wherein:

$n = 1$;

$j = 0$;

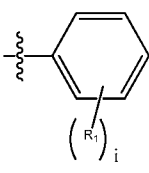
R is a mixture of isomerized structures of

2090

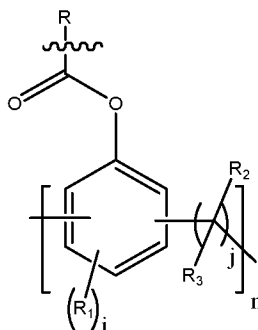


3. The compound of Claim 1, wherein:

2095

[X] is , and the compound is represented by structural Formula II:

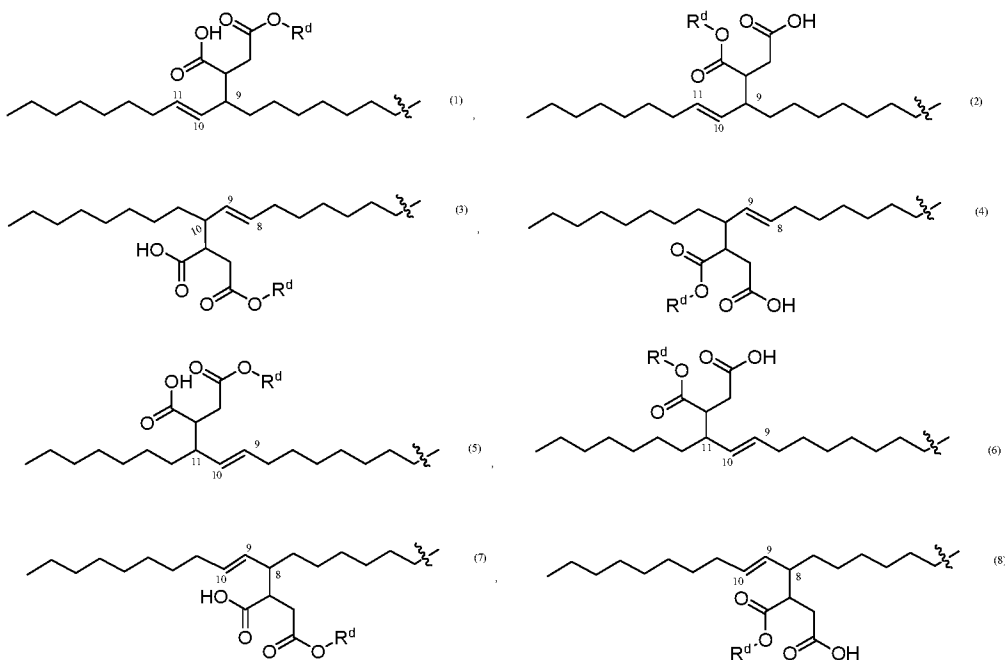
Structural Formula II



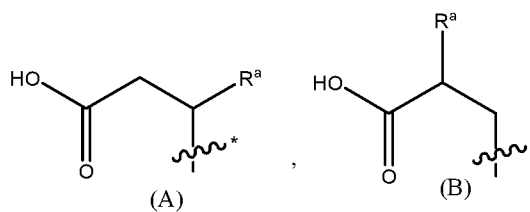
2100 wherein:

 each R_2 , R_3 independently is H, methyl, or a C_1 - C_8 linear or branched or cyclic alkyl chain,

R is a C_1 - C_{24} linear or branched alkyl chain, an isomerized alkenyl chain or a
2105 mixture of isomerized alkenyl chains represented by:



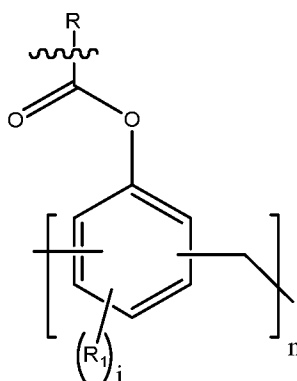
2110 wherein R^d is a linear or branched C_1 - C_{24} alkyl chain; or
 an isomerized structure or a mixture of isomerized (A) and (B)



2115 wherein R^a is a C₁-C₂₄ linear or branched alkenyl chain, an alkenyl chain portion of octenyl succinic anhydride (OSA); dodecenyl succinic anhydride (DDSA); octadecenyl succinic anhydride (ODSA); or polyisobutylene succinic anhydride (PIBSA) having a molecular weight between 300 and 1500.

2120 4. The compound of Claim 3, wherein each R₂, R₃ is H and j=1, wherein the compound structure is represented by Structural formula III:

Structural Formula III

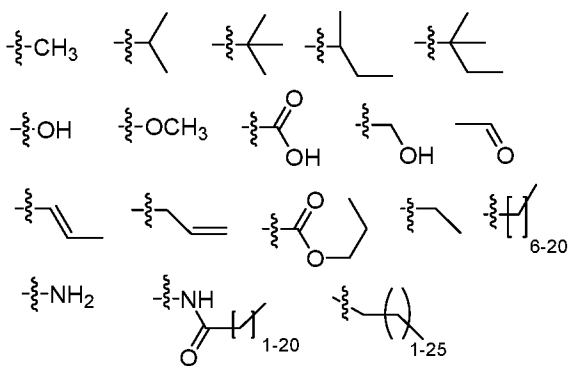


2125

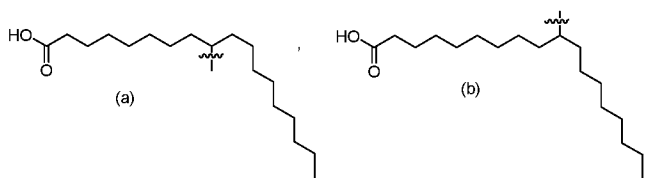
wherein,

R₁ is selected from the group consisting of

2130

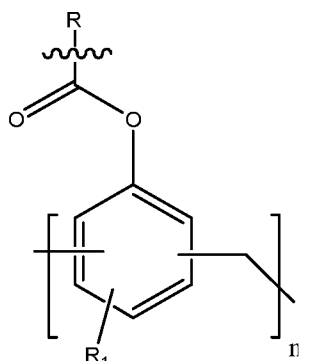


an isomerized alkyl acid chain or a mixture of isomerized alkyl acid chains as shown below



- 2135 5. The compound of Claim 4, wherein i is 1 and compound is represented by Structural Formula IV

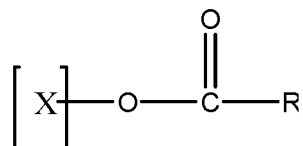
Structural Formula IV



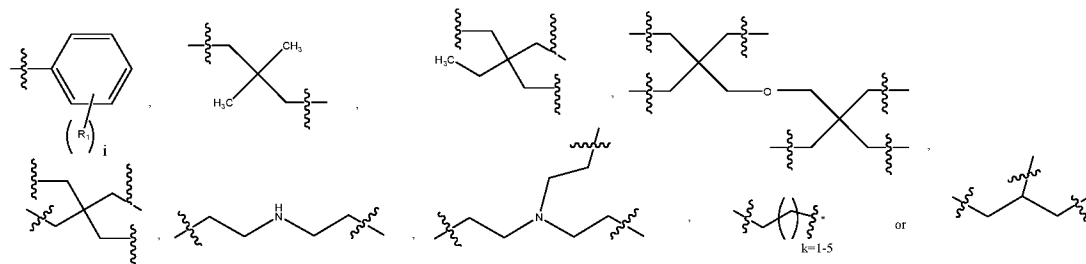
2140

6. The compound of Claim 5, wherein R₁ is H, CH₃, OCH₃, or a linear or branched C₁-C₉ alkyl chain.
7. The compound of Claim 1 wherein, wherein n = 1, j = 0, is represented by the structural formula:

2145

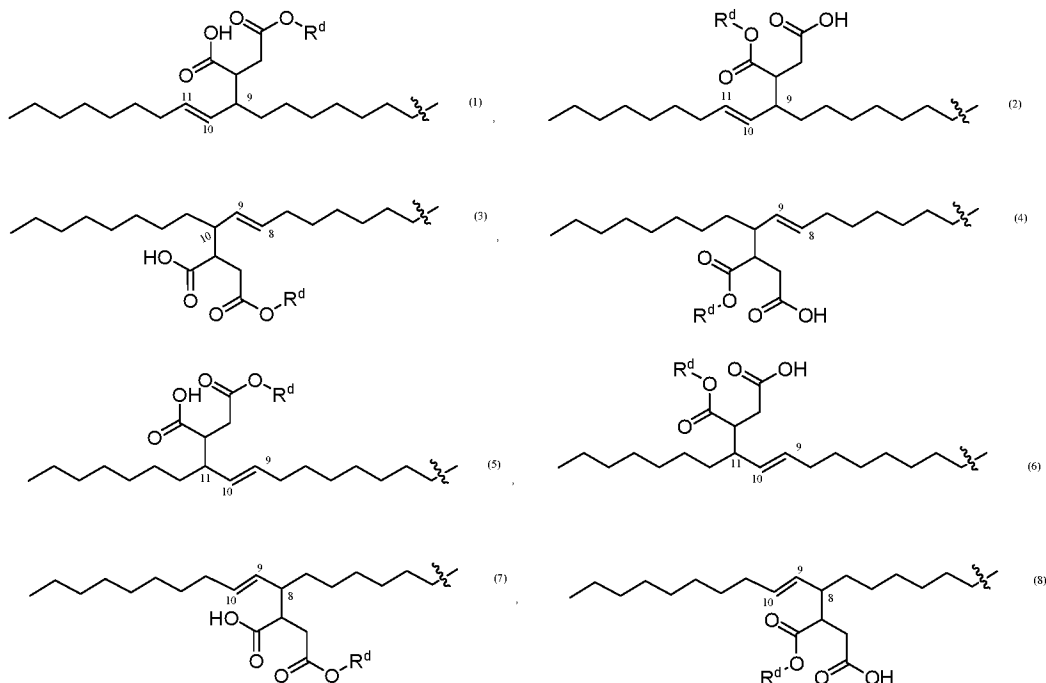


wherein [X] is



2150

R is an isomerized alkenyl chain represented by

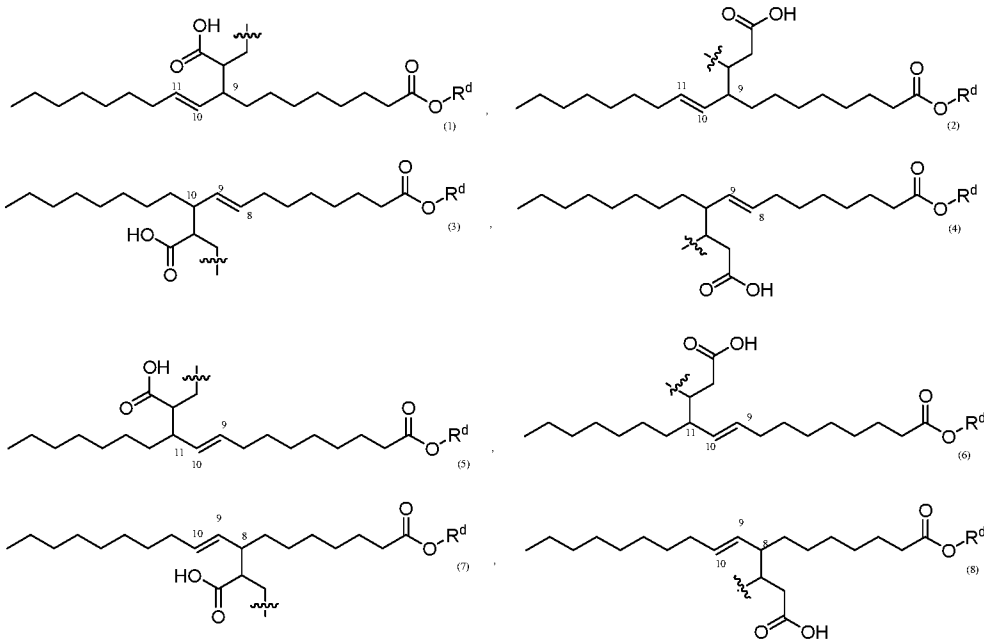


, or mixtures thereof; and

2155

each R^d is a linear or branched C₁-C₂₄ alkyl chain.

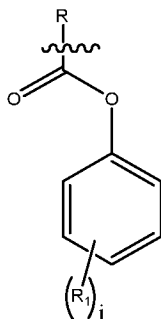
8. The compound of Claim 7, wherein, R is isomerized alkenyl chain represented by



2160

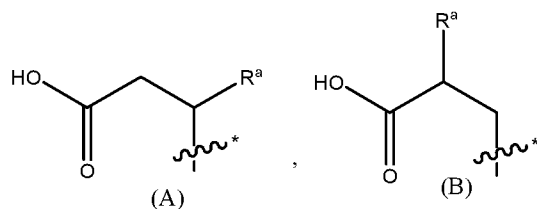
or their isomer mixtures (1)-(8); and each R^d is a C₁-C₂₄ alkyl chain.

2165 9. The compound of Claim 7 wherein n = 1, j = 0, and the compound is represented by:



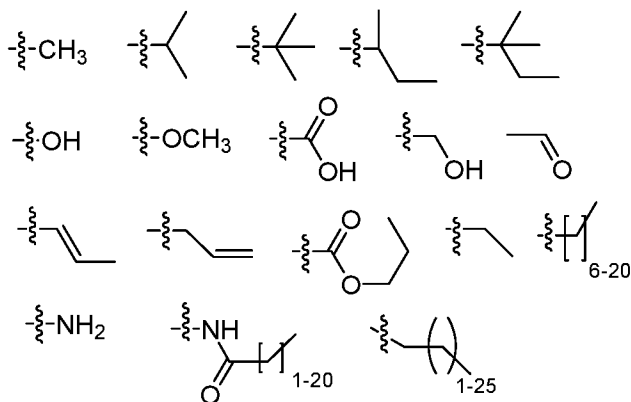
2170

wherein R^d is a linear or branched C₁-C₂₄ alkyl chain; an isomerized structure or a mixture of isomerized (A) and (B)

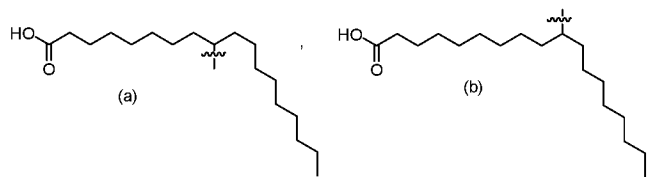


2175 wherein R^a is a C₁-C₂₄ linear or branched alkenyl chain, an alkenyl chain portion of octenyl succinic anhydride (OSA); dodecenyl succinic anhydride (DDSA); octadecenyl succinic anhydride (ODSA); or polyisobutylene succinic anhydride (PIBSA) having a molecular weight from 300 to 1500; and

2180 R₁ is selected from the group consisting of



an isomerized alkyl acid chain or a mixture of isomerized alkyl acid chains as shown below:



2185 and

wherein the substituted phenol is not phenol, 2,4-dimethyl phenol or resorcinol if R^a is an alkenyl chain portion of OSA, DDSA, ODSA, or PIBSA.

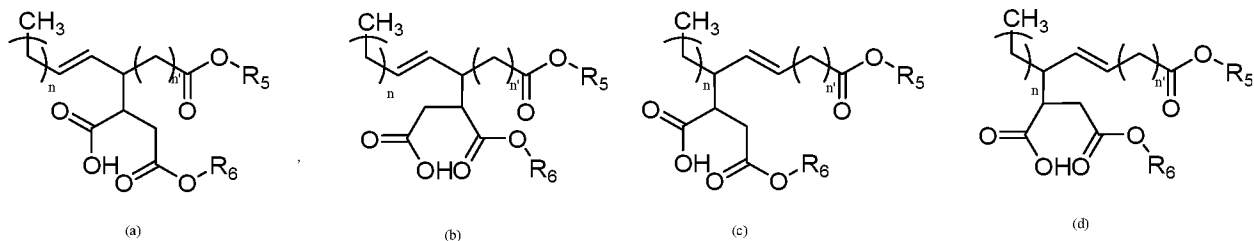
2190 10. The compound of Claim 9, wherein

i=1; and

R₁ is H, CH₃, OCH₃, or a linear or branched C₁-C₁₂ alkyl chain.

11. A mixture of a compound represented by following structural formulas:

2195



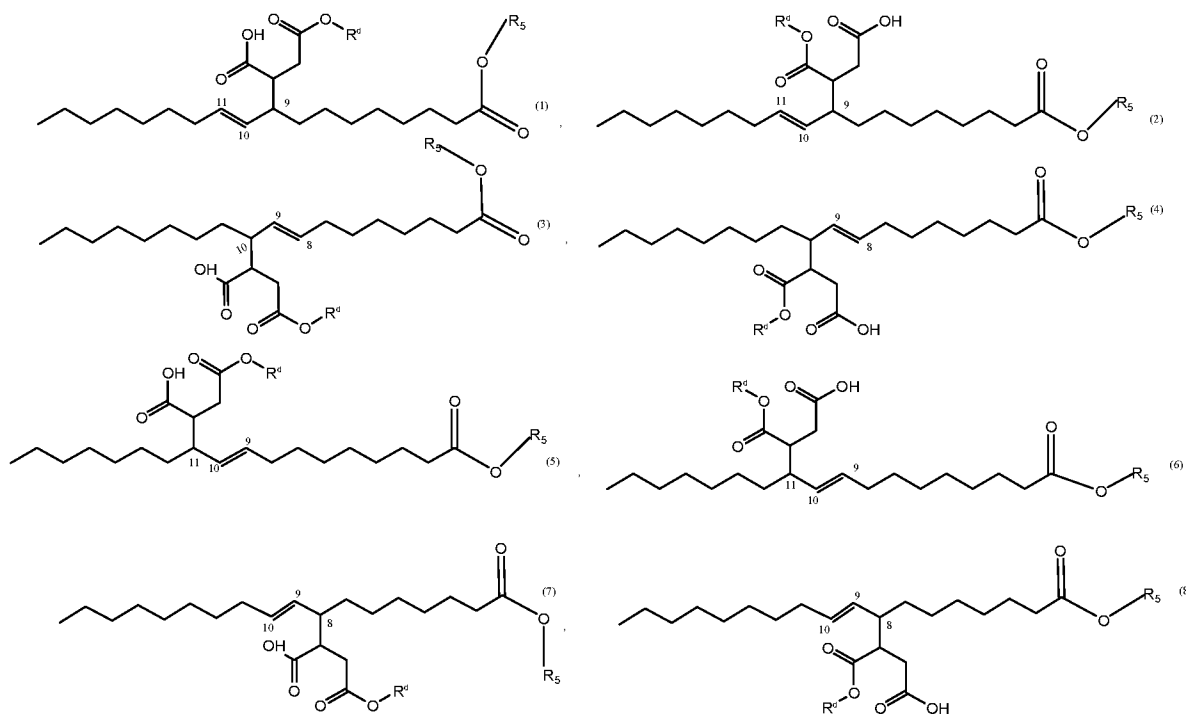
wherein

each R_5 and R_6 is independently a H, methyl, or a C_1 - C_{24} linear or branched or cyclic alkyl chain;

2200

Each n and n' is independently 1 to 15, preferably 4 to 10;

in particular, a compound containing the following isomer structures:



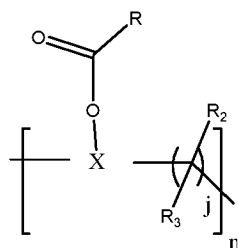
2205

wherein each R_5 , R^d independently is a linear or branched C_1 - C_{24} alkyl chain.

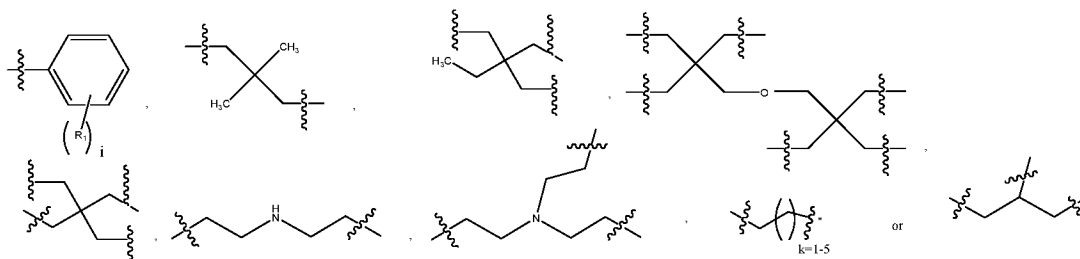
12. A method of producing a compound having Structural Formula I:

2210

Structural Formula I



2215 wherein
X is



2220 each R₁ is H, independently an optionally substituted C₁-C₂₀ alkyl group, an optionally substituted C₁-C₁₀ alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, an optionally-CH(R''')(R''')COOH wherein each R''' independently C₁-C₁₀ linear or branched alkyl chain, -OH, -SH or -NH₂ or an optionally substituted carbocyclic or heterocyclic non- aromatic ring.

I = 0, 1, 2, 3;

j = 0 or 1;

n is an integer from 1 to 1000 or 1 to 100, 1 to 50 or 1 to 25, 1 to 15, or preferably 1 to 10,

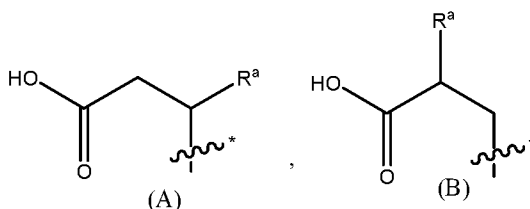
2230 when n = 1, then j = 0;

when n > 1 then j = 1;

2235 each R₂ and R₃ is independently H, a C₁-C₈ linear or branched or cyclic alkyl chain, an optionally substituted C₁-C₂₀ alkyl group, an optionally substituted C₁-C₁₀ alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, or -CH(R''')(R''')COOH

R is a C₁-C₂₄ linear or branched alkyl chain, alkenyl chain, or an isomerized structure or a mixture of isomerized (A) and (B):

2240



wherein R^a is a C₁-C₂₄ alkenyl linear or branched chain,
the method comprising:

(a) reacting X in a solvent with an aldehyde selected from the group of
2245 formaldehyde, acetaldehyde, valeraldehyde, butyraldehyde, isovalrealdehyde, 2-
methyl butanal, benzaldehyde, cyclohexanecarbaldehyde, 3-
methylcyclohexanecarbaldehyde, glyceraldehyde, glucose aldehyde,

(b) Reacting the product in (a) with an alkyl acyl chloride, an oleoyl
chloride, or alkenyl succinic anhydride selected from the group of octenyl succinic
2250 anhydride (OSA), dodecanyl succinic anhydride (DDSA); octadecanyl succinic
anhydride (ODSA); polyisobutylene succinic anhydride (PIBSA) having a molecular
weight from 300 to 1500;

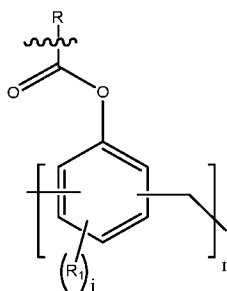
(c) Reacting the product of (b) with maleic anhydride if the reactant used
in (b) is an oleoyl chloride, and then finally,

(d) Reacting the succinic anhydride group of product in (c) is reacting with
2255 a C₁-C₂₄ linear or branched or cyclic alcohol.

13. The method of Claim 12, wherein the compound is represented by

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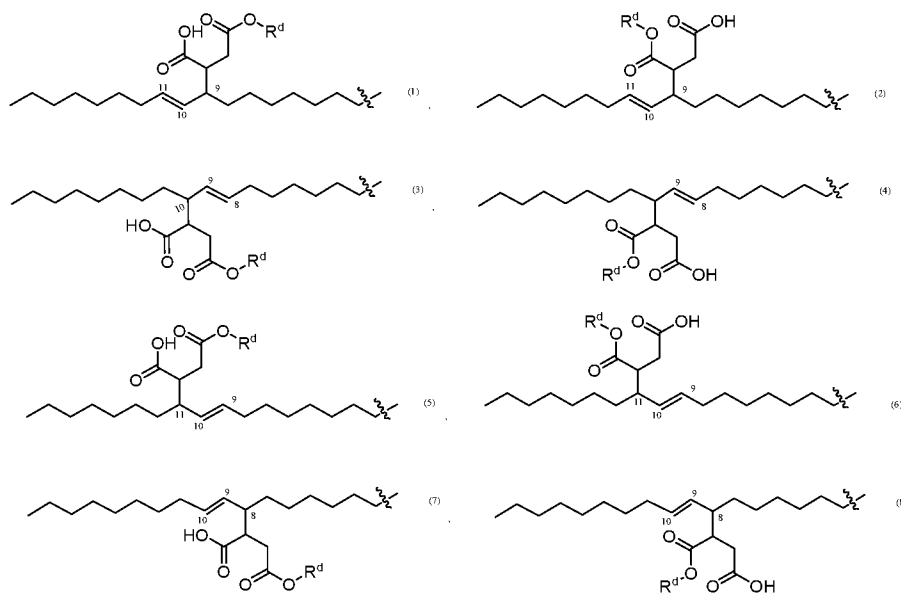
Structural Formula III



wherein,

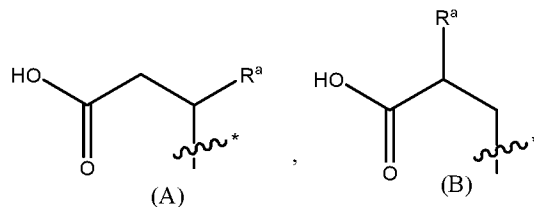
2265

R is a C₁-C₂₄ linear or branched alkyl chain, an isomerized alkenyl chain or a mixture of isomerized alkenyl chains represented by



wherein R^d is a linear or branched C₁-C₂₄ alkyl chain; or an isomerized structure or a mixture of isomerized (A) and (B)

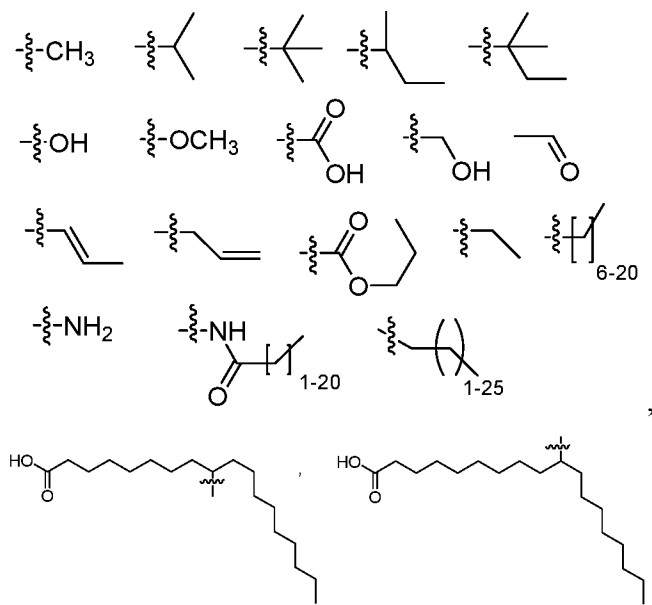
2270



wherein R^a is a C₁-C₂₄ linear or branched alkenyl chain, an alkenyl chain portion of OSA, octenyl succinic anhydride; DDSA, dodecyl succinic anhydride; ODSA, octadecenyl succinic anhydride; PIBSA, polyisobutylene succinic anhydride (low molecular weight, 300 - 1500 molecular weight, and

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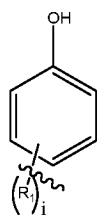
R₁ is selected from the group consisting of



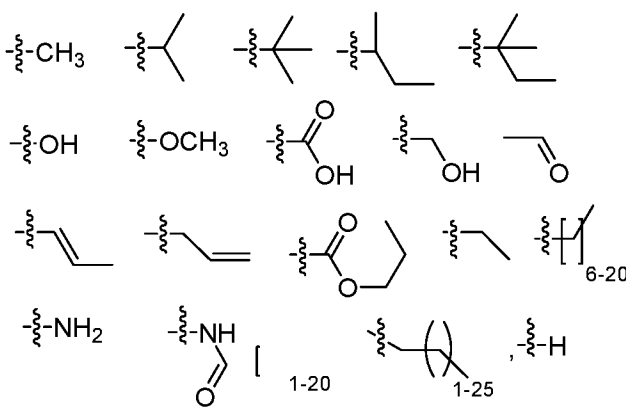
2280 n is an integer from 1 to 1000 or 1 to 100, 1 to 50 or 1 to 25, 1 to 15, or preferably 1 to 10,

a method comprising:

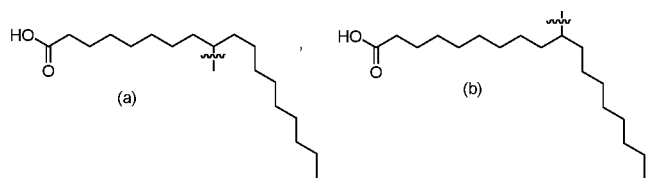
(a) Reacting in a solvent at reflux a phenol having the following formula:



2285 wherein R₁ is selected from the group consisting of



an isomerized alkyl acid chain or a mixture of isomerized alkyl acid chains as shown below



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with
formaldehyde,

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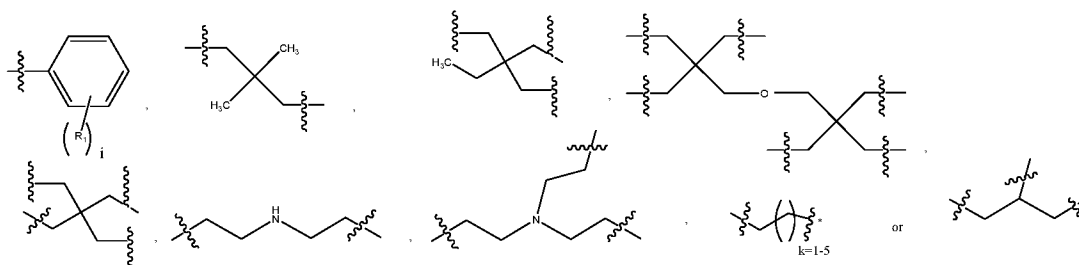
(b) The product in (a) is reacting with an oleoyl chloride or alkyl acyl chloride at ice temperature to room temperature for 1 hour to 24 hours, or an alkenyl succinic anhydride is selected from the group of OSA, octenyl succinic anhydride; DDSA, dodecenyl succinic anhydride; ODSA, octadecenyl succinic anhydride; PIBSA, polyisobutylene succinic anhydride (low molecular weight, 300 - 1500 molecular weight) at 80 °C to 150 °C for 1 to 24 hours ,

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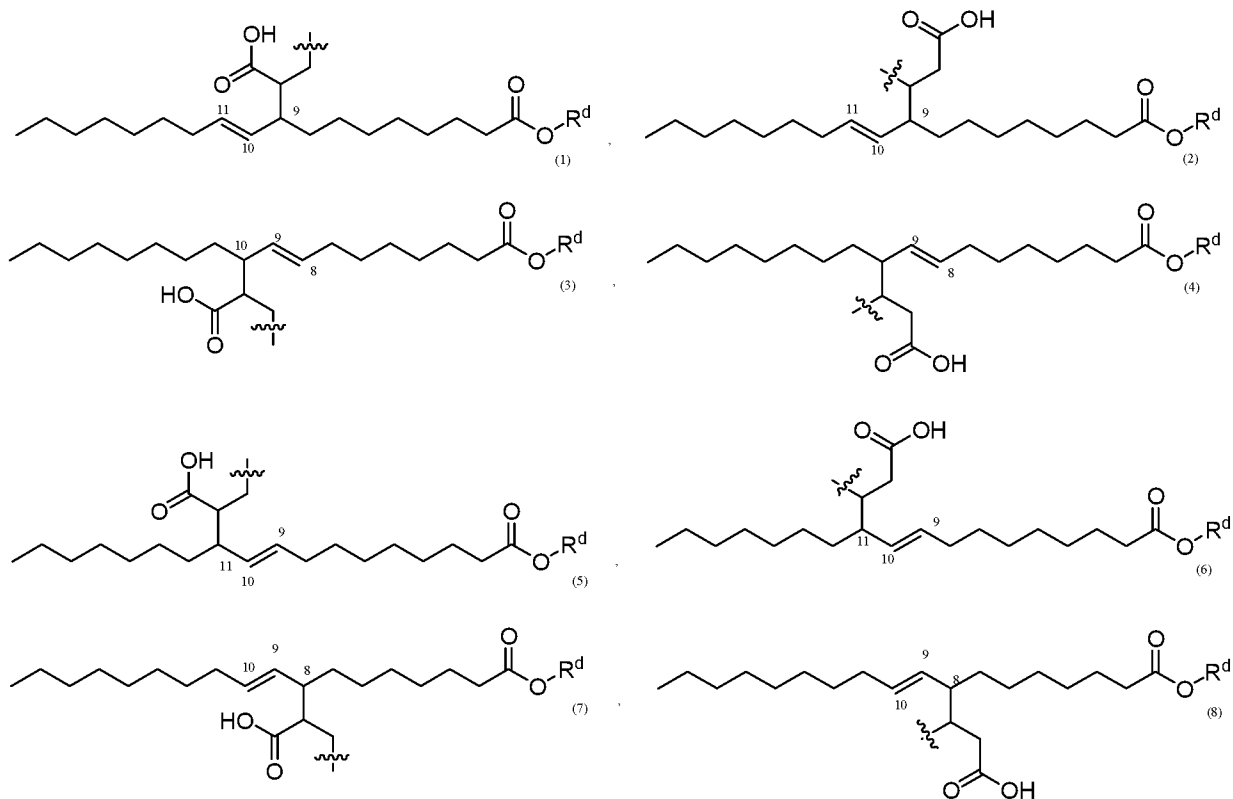
(c) The product in (b) is reacting with maleic anhydride at 170 °C-210 °C for 1 hour to 24 hours if the reactant used in (b) is an oleoyl chloride, and then finally
(d) The succinic anhydride group of product in (c) is reacting with a C₁-C₂₄ linear or branched or cyclic alcohol at 80 °C to 150 °C, if the reactant used in (b) is an oleoyl chloride.

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14. The method of Claim 13 wherein a substituted phenol is selected from the group of



R is an isomerized alkenyl chain represented by

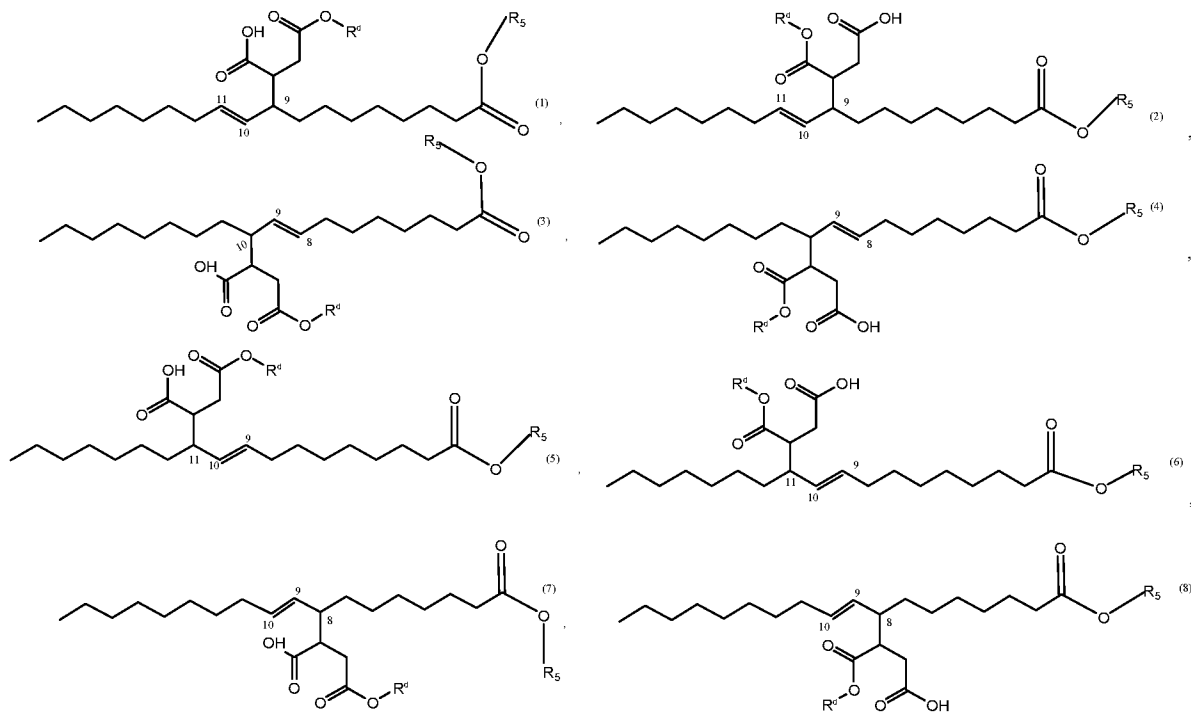


2325 wherein R^d independently is a linear or branched C₁-C₂₄ alkyl chain, the method comprising:

- a) reacting in a solvent or in bulk an oleic acid with a C₁-C₂₄ linear or branched or cyclic alcohol,
- b) the product in (a) is reacting with a maleic anhydride at 170 °C-210 °C for 1 hour to 24 hours, and finally
- c) the succinic anhydride group of product in (b) is reacting with an X-OH selected from a group of a substituted phenol, ethylene glycol, hexanediol, neopentyl glycol, diethanolamine, trimethylolpropane, glycerol, triethanolamine, pentaerythritol, di-pentaerythritol at 80°C to 150°C..

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18. The method of Claim 17 having the following a mixture of isomeric structures:



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wherein each R_5 , R^d independently is a linear or branched C_1 - C_{24} alkyl chain, the method comprising:

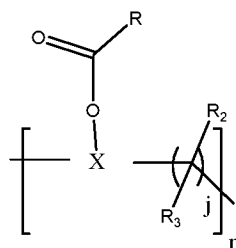
- a) reacting in a solvent or in bulk an oleic acid with a C_1 - C_{24} linear or branched or cyclic alcohol using an acidic catalyst selected from sulfuric acid, para-toluene sulfonic acid, solid phase catalysts, and phosphoric acid.
- b) the product in (a) is reacting with a maleic anhydride at 170 °C-210 °C for 1 hour to 24 hours, and finally
- c) the succinic anhydride group of product in (b) is reacting with a C_1 - C_{24} linear or branched or cyclic alcohol at 80 °C to 150 °C for 1 to 24 hours.

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19. A method of preventing corrosion in a corrodible material, comprising combining the corrodible material with a compound represented by the following structural formula:

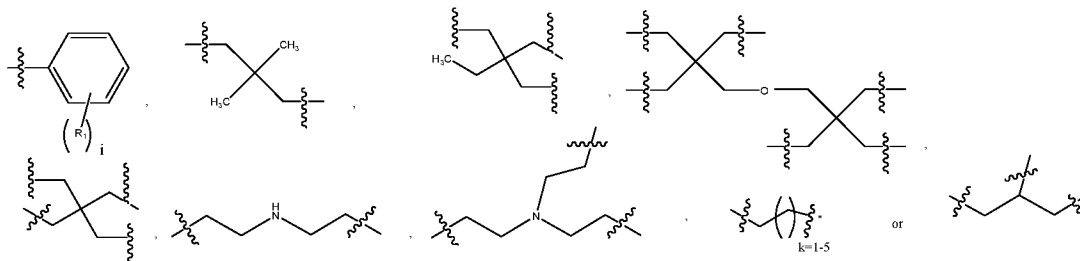
Structural Formula I

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wherein

X is



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Each R₁ is H, independently an optionally substituted C₁-C₂₀ alkyl group, an optionally substituted C₁-C₁₀ alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, an optionally-CH(R''')(R''')COOH) wherein each R''' independently C₁-C₁₀ linear or branched alkyl chain, -OH, -SH or -NH₂ or an optionally substituted carbocyclic or heterocyclic non-aromatic ring.

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i= 0 or 1 or 2 or 3;

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j=0 or 1;

n is an integer from 1 to 1000 or 1 to 100, 1 to 50 or 1 to 25, 1 to 15, or preferably 1 to 10,

when n=1, then j=0;

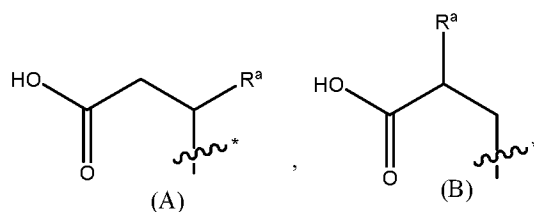
when n>1 then j=1;

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Each R₂, R₃, is H, independently a C₁-C₈ linear or branched or cyclic alkyl chain, independently an optionally substituted C₁-C₂₀ alkyl group, an optionally substituted C₁-C₁₀ alkyl group, a tertiary carbon group, a methyl group, a methoxy group, an optionally substituted aryl group, and optionally substituted alkoxy group, an optionally substituted carbonyl group, an optionally substituted alkoxy carbonyl group, an optionally-CH(R''')(R''')COOH)

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R is a C₁-C₂₄ linear or branched alkyl chain, alkenyl chain, or an isomerized structure or a mixture of isomerized (A) and (B):



wherein R^a is a C₁-C₂₄ alkenyl linear or branched chain.

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20. The method of Claim 19 wherein the corrodible material is a bio-oil or modified bio-oil, vegetable oil and/or animal fat, polyolesters, synthetic or bio poly alpha olefins (PAO), polyalkylene glycols (PAG), biobased esters like polyol esters and estolides, petroleum based Group I, II, III, IV, and V oil, or mixture thereof; lubricants, biolubricants, biobased lubricants, gasoline, kerosene, diesel, grease, and biodiesel oil, hydraulic oil, turbine oil, transformer oil, elevator oil, 2-stroke engine oil, engine oil, , and water based paints, cements, metal surfaces of, iron, steel, copper, aluminum, and alloys; plastics, bioplastics, polyolefins, nylons, polyamides, elastomers, thermoplastic elastomers, natural and synthetic polymers and copolymers.

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21. A composition comprising:
- a compound according to Claim 1; and
 - a bio-oil or modified bio-oil, a vegetable oil and/or animal fat, a polyolester, a synthetic or bio poly alpha olefin (PAO), a polyalkylene glycols (PAG), a biobased ester like polyol ester and estolides , a petroleum based Group I, II, III, IV, and V oil, or mixture thereof; and
 - one or more of an antioxidant, a metal deactivator, rust inhibitor, copper corrosion inhibitor, viscosity index modifier, pour point depressant, a dispersing agent , a detergent, an extreme-pressure, a dye, a seal swell agent, a demulsifier, or an anti-foaming additive.

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22. The composition of Claim 21, wherein the composition is an additive package comprising additives one or more of an antioxidant, a metal deactivator, rust inhibitor, copper corrosion inhibitor, viscosity index modifier, pour point depressant, dispersing agent , detergent, an extreme-pressure, a dye, a seal swell agent, a demulsifier, and an anti-foaming additive; each additive present is mixed into a carrier oil selected from a

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- 2415 group of petroleum, bio-based, bio-oil to formulate a fluid including gasoline, diesel, biodiesel, a base stock oil selected from the group of a bio-oil, a biobased oil, petroleum oil, Group I, Group II, Group III, Group IV oil, Group V or mixture thereof or to a already formulated lubricating oil for enhancing further the fluid or lubricant performance.
- 2420 23. A process for the inhibition of the metal corrosion due to contact with the fluid which comprises incorporating into the fluid an effective corrosion inhibiting amount of a compound of Structure (I) of Claim 1.