

Improved Weatherability of Flame Retardant Polyolefin

The instant invention pertains to a thermoplastic organic polymer, especially a polyolefin such as thermoplastic polyolefin (TPO), stabilized against the deleterious effects of light, oxygen and heat and containing a certain flame retardant, which contains a sterically hindered amine of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class and optionally further stabilizers, to the use of these flame retardants and sterically hindered amines for imparting both light stabilization and flame retardant properties, and to a corresponding process for improving light stability and flame retardancy of a thermoplastic organic polymer.

United States Patent No. 5,393,812 does describe polyolefin compositions which are made flame retardant by addition of a halogenated hydrocarbyl phosphate or phosphonate ester flame retardant, and stabilized against weathering with a alkoxyamine functional hindered amine. EP-A-792911 proposes the use of a alkoxyamine functional hindered amine for improving the flame retardant properties of a polyolefin. The activity of alkoxyamine functional hindered amines alone as a flame retardant is disclosed in WO 99/00450.

There is still need to improve flame retardant polymer compositions in order to obtain good stability against weathering.

Now it has been found that optimum stabilization against UV light and weathering and good flame retardant properties, especially for outdoor applications, can be combined in a thermoplastic polymer, especially a polyolefin, polyolefin copolymer or blend thereof such as impact modified polyolefin or thermoplastic polyolefin (TPO), when certain hindered amine stabilizers are used in combination with a specific flame retardant. Thus, present invention pertains to the use of a combination of a flame retardant selected from

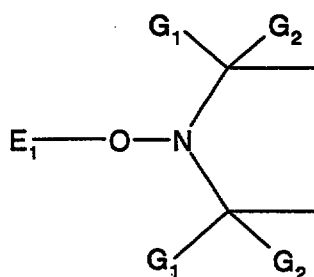
- b1) melamig based flame retardants and/or ammonium polyphosphate,
 - b2) bis-(hexachlorocyclopentadieno) cyclooctane,
 - b3) tris-(2,3-dibromopropyl)-isocyanurate,
 - b4) ethylene-bis-tetrabromophthalimide,
 - b5) 1,2,5,6,9,10-hexabromo-cyclo-dodecan,
 - b6) ethane-1,2-bis(pentabromophenyl);
- and

c) a sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class for imparting both weathering stability and flame retardancy to a thermoplastic polymer (a),
provided that the flame retardant is not (b4) if the sterically hindered amine is of the hydroxyhydrocarbyloxy class.

Detailed Disclosure

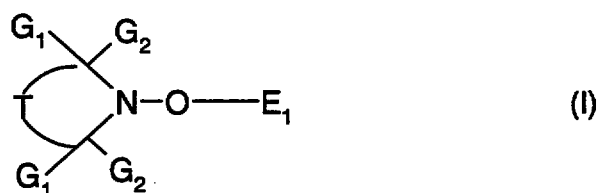
The sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class of component (c) is characterized by its substituent E₁-O- on the amino nitrogen atom (see formula below), wherein E₁ is preferably C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl or C₇-C₁₅aralkyl in the sterically hindered amine of the hydrocarbyloxyamine class; and E₁ is preferably C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl or C₇-C₁₅aralkyl each of which is substituted in the aliphatic part by 1-3 OH groups in the sterically hindered amine of the hydroxyhydrocarbyloxyamine class. The latter type of compound, containing a reactive OH group, may also be used in the form of its reaction product.

The sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class of component c usually is a compound containing a group of the formula



where G₁ and G₂ are independently alkyl of 1 to 4 carbon atoms or are together pentamethylene, and

E₁ is C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl or C₇-C₁₅aralkyl; or E₁ is C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl or C₇-C₁₅aralkyl each of which is substituted in the aliphatic part by 1-3 OH groups; or is a reaction product thereof. Preferred is a cyclic sterically hindered amine conforming to the formula



wherein

G_1 , G_2 and E_1 are as defined above;

T is a divalent organic radical required to complete formula I to form, together with the hindered amine nitrogen atom and the two quaternary carbon atoms substituted by G_1 and G_2 , a five- or six-membered aliphatic ring structure, especially a piperidine ring;

or is an oligomeric or polymeric hindered amine molecule made from the reaction of a dialkyl ester or isocyanate with a compound of the formula (I) wherein E_1 contains 1 OH group and T is $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-$;

or is a simple diester or urethane derivative of a compound of the formula (I) wherein E_1 contains 1 OH group and T is $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-$.

In general, effective stabilizing amounts of a compound of component c used are from 0.01 to 10 %, preferably from 0.05 to 5% by weight, especially from 0.1 to 2 % by weight, based on the polymer component (a), of the stabilizer of component (c).

Sterically hindered amines of present component (c) are largely known as light stabilizers (US-5004770; US-5096950; US-5204473; US-5096950; US-5300544; US-6117995; US-6271377).

Flame retardants of component (b) are commercial compounds. Most preferred is tris-(2,3-dibromopropyl)-isocyanurate (b3).

Halogen-free flame retardants b1 are usually employed in an amount from 1 to about 50 % by weight of the polymer (a), preferably in an amount from 5 to 50 % by weight of the polymer (a). The ratio b1 : c is most preferably in the range from 20 : 1 to 250 : 1.

Halogenated flame retardants b2, b3, b4, b5 and/or b6 are usually employed in a total amount from 0.5 to 40 % by weight of the polymer (a); more preferably 3 to 40%, most preferably 5 to 35% by weight of polymer (a).

Most preferred amounts of flame retardants (b) in the compositions of present invention are for

b1) the melamin based flame retardant and/or ammonium polyphosphate 20 - 50 %;

b2) bis-(hexachlorocyclopentadieno) cyclooctane 5 -20 %;

b3) tris-(2,3-dibromopropyl)-isocyanurate 2 -10 %;

b4) ethylene-bis-tetrabromophthalimide 10 - 40 %;

b5) 1,2,5,6,9,10-hexabromo-cyclo-dodecan 2 – 20 %;

b6) ethane-1,2-bis(pentabromophenyl) 2 – 20 %;

each amount denotes percent by weight, based on the weight of the polymer (a).

Also of importance in the context of present invention is the use of the flame retardant tris(3-bromo-2,2-(bromomethyl)propyl) phosphate (b7; see below), which is most preferably employed in an amount of 2 – 20, especially 2 – 10, percent by weight, based on the weight of the polymer (a).

The ratio of halogenated flame retardants b2, b3, b4, b5, b6 or b7 : c is most preferably in the range from 5 : 1 to 100 : 1.

Advantageously, halogenated flame retardants such as b2, b3, b4, b5, b6 and/or b7 may be used in combination with an appropriate synergist such as an antimon compound (often Sb_2O_3), which is commonly added in an amount of 0.5 to 20 % by weight of the polymer (a).

Component a is frequently selected from the following thermoplastic polymers:

1. Polymers of monoolefins and diolefins, for example polypropylene (PP), polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, polyisoprene or polybutadiene, as well as polymers of cycloolefins, for instance of cyclopentene or norbornene, polyethylene (which optionally can be crosslinked), for example high density polyethylene (HDPE), high density and high molecular weight polyethylene (HDPE-HMW), high density and ultrahigh molecular weight polyethylene (HDPE-UHMW), medium density polyethylene (MDPE), low density polyethylene (LDPE), linear low density polyethylene (LLDPE), (VLDPE) and (ULDPE).

Polyolefins, i.e. the polymers of monoolefins exemplified in the preceding paragraph, preferably polyethylene and polypropylene, can be prepared by different, and especially by the following, methods:

- a) radical polymerisation (normally under high pressure and at elevated temperature).
 - b) catalytic polymerisation using a catalyst that normally contains one or more than one metal of groups IVb, Vb, Vlb or VIII of the Periodic Table. These metals usually have one or more than one ligand, typically oxides, halides, alcoholates, esters, ethers, amines, alkyls, alkenyls and/or aryls that may be either π - or σ -coordinated. These metal complexes may be in the free form or fixed on substrates, typically on activated magnesium chloride, titanium(III) chloride, alumina or silicon oxide. These catalysts may be soluble or insoluble in the polymerisation medium. The catalysts can be used by themselves in the polymerisation or further activators may be used, typically metal alkyls, metal hydrides, metal alkyl halides, metal alkyl oxides or metal alkyloxanes, said metals being elements of groups Ia, IIa and/or IIIa of the Periodic Table. The activators may be modified conveniently with further ester, ether, amine or silyl ether groups. These catalyst systems are usually termed Phillips, Standard Oil Indiana, Ziegler (-Natta), TNZ (DuPont), metallocene or single site catalysts (SSC).
2. Mixtures of the polymers mentioned under 1), for example mixtures of polypropylene with polyisobutylene, polypropylene with polyethylene (for example PP/HDPE, PP/LDPE) and mixtures of different types of polyethylene (for example LDPE/HDPE).
 3. Copolymers of monoolefins and diolefins with each other or with other vinyl monomers, for example ethylene/propylene copolymers, linear low density polyethylene (LLDPE) and mixtures thereof with low density polyethylene (LDPE), propylene/but-1-ene copolymers, propylene/isobutylene copolymers, ethylene/but-1-ene copolymers, ethylene/hexene copolymers, ethylene/methylpentene copolymers, ethylene/heptene copolymers, ethylene/octene copolymers, propylene/butadiene copolymers, isobutylene/isoprene copolymers, ethylene/alkyl acrylate copolymers, ethylene/alkyl methacrylate copolymers, ethylene/vinyl acetate copolymers and their copolymers with carbon monoxide or ethylene/acrylic acid copolymers and their salts (ionomers) as well as terpolymers of ethylene with propylene and a diene such as hexadiene, dicyclopentadiene or ethylidene-norbornene; and mixtures of such

copolymers with one another and with polymers mentioned in 1) above, for example polypropylene/ethylene-propylene copolymers, LDPE/ethylene-vinyl acetate copolymers (EVA), LDPE/ethylene-acrylic acid copolymers (EAA), LLDPE/EVA, LLDPE/EAA and alternating or random polyalkylene/carbon monoxide copolymers and mixtures thereof with other polymers, for example polyamides.

4. Blends of the aforementioned polymers (polyblends), for example PP/EPDM.

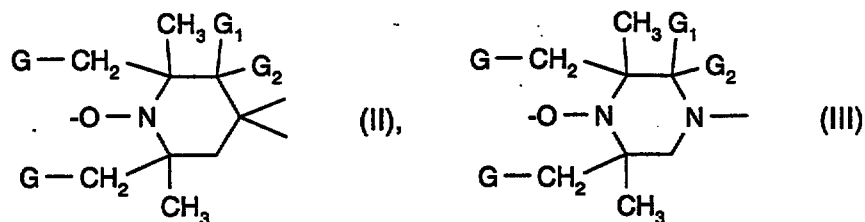
In the following, the term polyolefin will be used for pure polyolefin homopolymers as well as copolymers and blends thereof.

Preferably, the polyolefin or thermoplastic olefin or polyolefin (TPO) is the only organic polymer present in these compositions; mainly it is polyethylene (PE) or polypropylene (PP), especially LDPE, LLDPE or PP, or copolymers of PP and PE.

Especially preferred as component (a) are polymers known as thermoplastic (poly)olefines (TPO), e.g. polypropylene or polyethylene containing an impact modifier or elastomer component such as EPR etc., or heterophasic copolymers (see e.g. W. Neissl et al., Kunststoffe 83, No. 8, 1993).

Examples of polymer compositions in which the instant compounds are effective include flame retardant polyolefins where acidic residues from the decomposition of the halogenated flame retardants deactivate hindered amines not having the N-OR group, roofing membranes, greenhouse films and agricultural mulch films where acidic residues from pesticides interfere with the activity of "normal" hindered amine stabilizers, and in thermoplastic polyolefins where pigment interactions with basic hindered amine stabilizers interfere with painting the substrate surfaces.

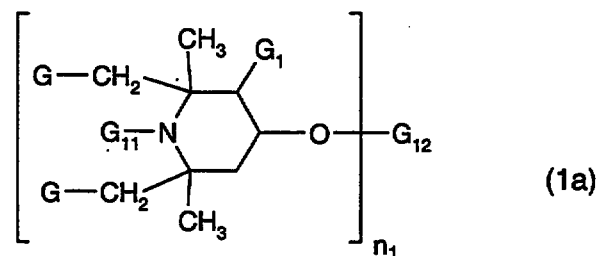
Preferably, the compound of present component c is a cyclic sterically hindered amine containing a group of formula (II) and/or (III)



in which G is hydrogen or methyl, and G₁ and G₂, independently of one another, are hydrogen, methyl or together are a substituent =O.

Examples of sterically hindered amines of present component c are described below under classes (a') to (m').

(a') A compound of the formula (1a)



in which n₁ is a number from 1 to 4, G and G₁, independently of one another, are hydrogen or methyl,

G₁₁ is O⁻, hydroxyl, C₁-C₁₈alkoxy, C₅-C₁₂cycloalkoxy, C₇-C₁₅phenylalkoxy; or G₁₁ is C₁-C₁₈alkoxy, C₅-C₁₂cycloalkoxy or C₇-C₁₅phenylalkoxy each of which is substituted in the aliphatic part by 1-3 OH groups; G₁₁ preferably being C₁-C₁₂alkoxy or cyclohexyloxy or C₂-C₈hydroxyalkoxy, especially octyloxy, cyclohexyloxy or 2-hydroxy-2-methylpropoxy, and G₁₂, if n₁ is 1, is hydrogen, C₁-C₁₈alkyl which is uninterrupted or interrupted by one or more oxygen atoms, COO and/or CONH groups, or is cyanoethyl, benzoyl, glycidyl, a monovalent radical of an aliphatic, cycloaliphatic, araliphatic, unsaturated or aromatic carboxylic acid, carbamic acid or phosphorus-containing acid or a monovalent silyl radical, preferably a radical of an aliphatic carboxylic acid having 2 to 18 carbon atoms, of a cycloaliphatic carboxylic acid having 7 to 15 carbon atoms, or an α,β-unsaturated carboxylic acid having 3 to 5 carbon atoms or of an aromatic carboxylic acid having 7 to 15 carbon atoms, where

each carboxylic acid can be substituted in the aliphatic, cycloaliphatic or aromatic moiety by 1 to 3 $-\text{COOZ}_{12}$ groups, in which Z_{12} is H, $\text{C}_1\text{-C}_{20}$ alkyl, $\text{C}_3\text{-C}_{12}$ alkenyl, $\text{C}_5\text{-C}_7$ cycloalkyl, phenyl or benzyl,

G_{12} , if n_1 is 2, is $\text{C}_2\text{-C}_{12}$ alkylene, $\text{C}_4\text{-C}_{12}$ alkenylene, xylylene, a divalent radical of an aliphatic, cycloaliphatic, araliphatic or aromatic dicarboxylic acid, dicarbamic acid or phosphorus-containing acid or a divalent silyl radical, preferably a radical of an aliphatic dicarboxylic acid having 2 to 36 carbon atoms, or a cycloaliphatic or aromatic dicarboxylic acid having 8-14 carbon atoms or of an aliphatic, cycloaliphatic or aromatic dicarbamic acid having 8-14 carbon atoms, where each dicarboxylic acid may be substituted in the aliphatic, cycloaliphatic or aromatic moiety by one or two $-\text{COOZ}_{12}$ groups,

G_{12} , if n_1 is 3, is a trivalent radical of an aliphatic, cycloaliphatic or aromatic tricarboxylic acid, which may be substituted in the aliphatic, cycloaliphatic or aromatic moiety by $-\text{COOZ}_{12}$, of an aromatic tricarbamic acid or of a phosphorus-containing acid, or is a trivalent silyl radical, preferred radicals including triacyl radicals of nitrilo triacetic acid of benzene tricarboxylic acid,

and G_{12} , if n_1 is 4, is a tetravalent radical of an aliphatic, cycloaliphatic or aromatic tetracarboxylic acid.

The carboxylic acid radicals mentioned above are in each case taken to mean radicals of the formula $(-\text{CO})_x\text{R}$, where x is as defined above for n_1 , and the meaning of R arises from the definition given above.

Alkyl with up to 20 carbon atoms is, for example, methyl, ethyl, n-propyl, n-butyl, sec-butyl, tert-butyl, n-hexyl, n-octyl, 2-ethylhexyl, n-nonyl, n-decyl, n-undecyl, n-dodecyl, n-tridecyl, n-tetradecyl, n-hexadecyl or n-octadecyl.

$\text{C}_1\text{-C}_{18}$ alkoxy G_{11} is, for example, methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, pentoxy, isopentoxy, hexoxy, heptoxy, octoxy, decyloxy, dodecyloxy, tetradecyloxy, hexadecyloxy and octadecyloxy. $\text{C}_6\text{-C}_{12}$ alkoxy, in particular heptoxy and octoxy, is preferred.

$\text{C}_5\text{-C}_{12}$ cycloalkoxy G_{11} is, for example, cyclopentoxy, cyclohexoxy, cycloheptoxy, cyclooctoxy, cyclodecyloxy and cyclododecyloxy. $\text{C}_5\text{-C}_8$ cycloalkoxy, in particular cyclopentoxy and cyclohexoxy, is preferred.

$\text{C}_7\text{-C}_9$ phenylalkoxy is, for example, benzyloxy.

G_{11} as C_1 - C_{18} alkoxy, C_5 - C_{12} cycloalkoxy or C_7 - C_{15} phenylalkoxy substituted in the aliphatic part by 1-3 OH groups is a radical formed by abstraction of an carbon-bonded hydrogen atom preferably from 2-methyl-2-propanol (tert.-butanol), 2-propanol, 2,2-dimethyl-1-propanol, 2-methyl-2-butanol, ethanol, 1-propanol, 1-butanol, 1-pentanol, 1-hexanol, 1-nonanol, 1-decanol, 1-dodecanol, 1-octadecanol, 2-butanol, 2-pentanol, 2-ethyl-1-hexanol, cyclohexanol, cyclooctanol, allyl alcohol, phenethyl alcohol or 1-phenyl-1-ethanol; 1,2-ethanediol, 1,2-propanediol, 1,3-propanediol, 1,2-butanediol, 1,3-butanediol, 1,4-butanediol, 2,2-dimethyl-1,3-propanediol, 1,2-cyclohexanediol, 1,3-cyclohexanediol or 1,4-cyclohexanediol; glycerol, 1,1,1-tris(hydroxymethyl)methane, 2-ethyl-2-(hydroxymethyl-1,3-propanediol, 1,2,4-butanetriol or 1,2,6-hexanetriol.

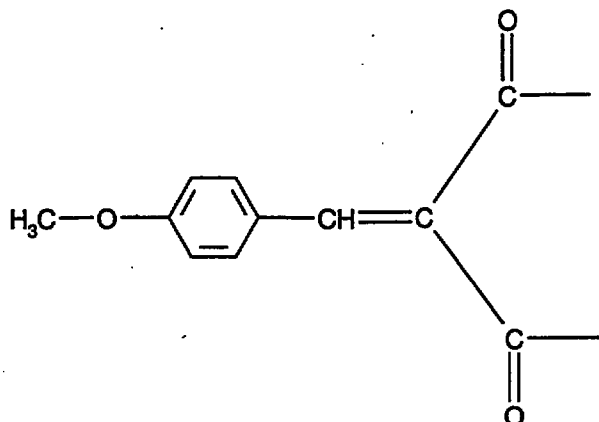
More preferably, G_{11} is are formed from 2-methyl-2-propanol or cyclohexanol, 1,4-butanediol, 2,2-dimethyl-1,3-propanediol, 1,2-cyclohexanediol, 1,3-cyclohexanediol or 1,4-cyclohexanediol. Most preferred hydroxy substituted G_{11} is 2-hydroxy-2-methylpropoxy.

Examples of several G_{12} radicals are given below.

If G_{12} is a monovalent radical of a carboxylic acid, it is, for example, an acetyl, caproyl, stearoyl, acryloyl, methacryloyl, benzoyl or β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionyl radical.

If G_{12} is a monovalent silyl radical, it is, for example, a radical of the formula $-(C_jH_{2j})-Si(Z')_2Z''$, in which j is an integer in the range from 2 to 5, and Z' and Z'' , independently of one another, are C_1 - C_4 alkyl or C_1 - C_4 alkoxy.

If G_{12} is a divalent radical of a dicarboxylic acid, it is, for example, a malonyl, succinyl, glutaryl, adipoyl, suberoyl, sebacoyl, maleoyl, itaconyl, phthaloyl, dibutylmalonyl, dibenzylmalonyl, butyl(3,5-di-tert-butyl-4-hydroxybenzyl)malonyl or bicycloheptenedicarbonyl radical or a group of the formula



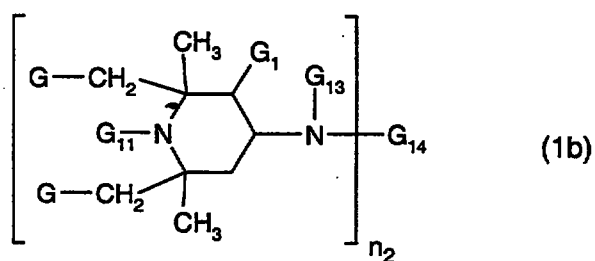
If G_{12} is a trivalent radical of a tricarboxylic acid, it is, for example, a trimellitoyl, citryl or nitrilotriacetyl radical.

If G_{12} is a tetravalent radical of a tetracarboxylic acid, it is, for example, the tetravalent radical of butane-1,2,3,4-tetracarboxylic acid or of pyromellitic acid.

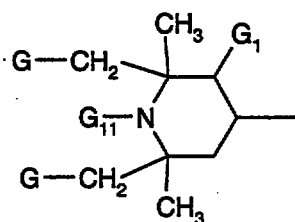
If G_{12} is a divalent radical of a dicarbamic acid, it is, for example, hexamethylenedicarbamoyl or 2,4-toluylenedicarbamoyl radical.

Preference is given to compounds of the formula (1a) in which G and G_1 are hydrogen, G_{11} is hydrogen or methyl, n_1 is 2 and G_{12} is the diacyl radical of an aliphatic dicarboxylic acid having 4-12 carbon atoms.

(b') A compound of the formula (1b)



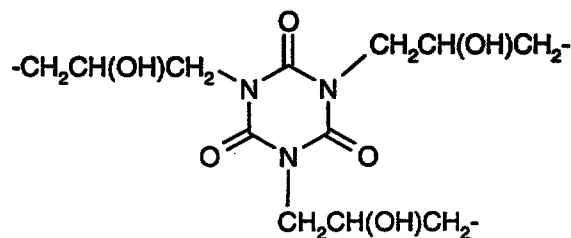
in which n_2 is the number 1, 2 or 3, and G, G_1 and G_{11} are as defined under (a'), G_{13} is hydrogen, C_1 - C_{12} alkyl, C_2 - C_5 hydroxyalkyl, C_5 - C_7 cycloalkyl, C_7 - C_8 aralkyl, C_1 - C_{18} alkanoyl, C_3 - C_5 alkenoyl, benzoyl or a group of the formula



and G_{14} , if n_2 is 1, is hydrogen, C_1 - C_{18} alkyl, C_3 - C_8 alkenyl, C_5 - C_7 cycloalkyl, C_1 - C_4 alkyl which is substituted by a hydroxyl, cyano, alkoxy carbonyl or carbamide group or group of the formula $-\text{CONH}-Z$, or G_{14} is glycidyl, a group of the formula $-\text{CH}_2-\text{CH}(\text{OH})-Z$ or of the formula $-\text{CONH}-Z$, in which Z is hydrogen, methyl or phenyl or $\text{CH}_2-\text{OZ}_{14}$ with Z_{14} being hydrogen or C_1 - C_{18} alkyl;

G_{14} , if n_2 is 2, is C_2 - C_{12} alkylene, C_6 - C_{12} arylene, xylylene, a $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2$ group or a $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-\text{O}-D-\text{O}-$ group, in which D is C_2 - C_{10} alkylene, C_6 - C_{15} arylene, C_6 - C_{12} cycloalkylene, or, provided that G_{13} is not alkanoyl, alkenoyl or benzoyl, G_{14} can alternatively be 1-oxo- C_2 - C_{12} alkylene, a divalent radical of an aliphatic, cycloaliphatic or aromatic dicarboxylic acid or dicarbamic acid or alternatively the group $-\text{CO}-$,

G_{14} , if n_2 is 3, is a group



or, if n_2 is 1, G_{13} and G_{14} together can be the divalent radical of an aliphatic, cycloaliphatic or aromatic 1,2- or 1,3-dicarboxylic acid.

Some examples for the radicals G_{13} , G_{14} and D are given below.

Any alkyl substituents are as defined above for (a').

Any C_5 - C_7 cycloalkyl substituents are, in particular, cyclohexyl.

C₇-C₈aralkyl G₁₃ is, in particular, phenylethyl or especially benzyl.

C₂-C₅hydroxyalkyl G₁₃ is, in particular, 2-hydroxyethyl or 2-hydroxypropyl.

C₁-C₁₈alkanoyl G₁₃ is, for example, formyl, acetyl, propionyl, butyryl, octanoyl, dodecanoyl, hexadecanoyl, octadecanoyl, but preferably acetyl, and C₃-C₅alkenoyl G₁₃ is, in particular, acryloyl.

C₂-C₈alkenyl G₁₄ is, for example, allyl, methallyl, 2-butenyl, 2-pentenyl, 2-hexenyl or 2-octenyl.

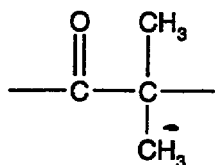
G₁₄ as a hydroxyl-, cyano-, alkoxycarbonyl- or carbamide-substituted C₁-C₄alkyl can be, for example, 2-hydroxyethyl, 2-hydroxypropyl, 2-cyanoethyl, methoxycarbonylmethyl, 2-ethoxycarbonyl ethyl, 2-aminocarbonylpropyl or 2-(dimethylaminocarbonyl)ethyl.

Any C₂-C₁₂alkylene radicals are, for example, ethylene, propylene, 2,2-dimethylpropylene, tetramethylene, hexamethylene, octamethylene, decamethylene or dodecamethylene.

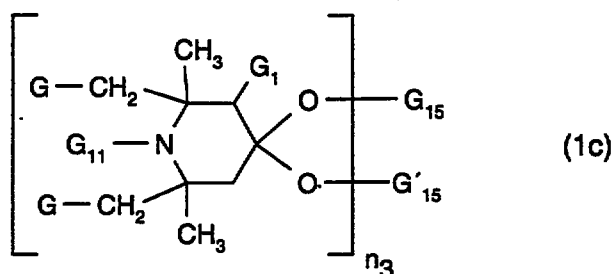
Any C₆-C₁₅arylene substituents are, for example, o-, m- or p-phenylene, 1,4-naphthylene or 4,4'-diphenylene.

C₆-C₁₂cycloalkylene is, in particular, cyclohexylene.

G₁₄ as 1-oxo-C₂-C₁₂alkylene is preferably a group



(c') A compound of the formula (1c)

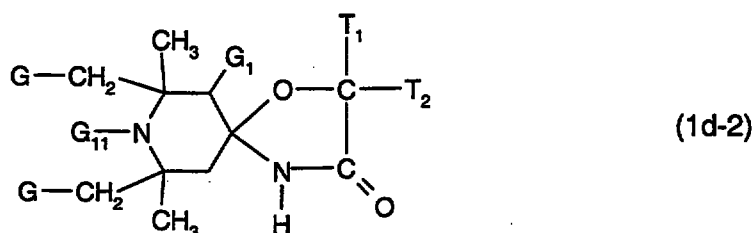
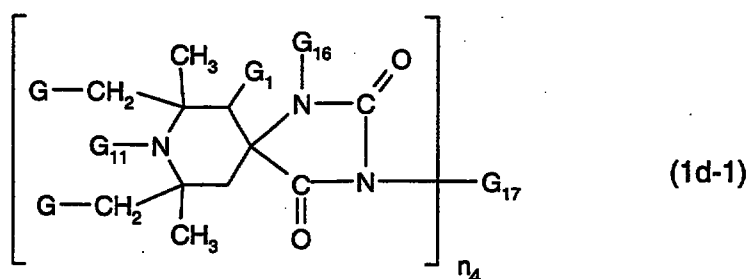


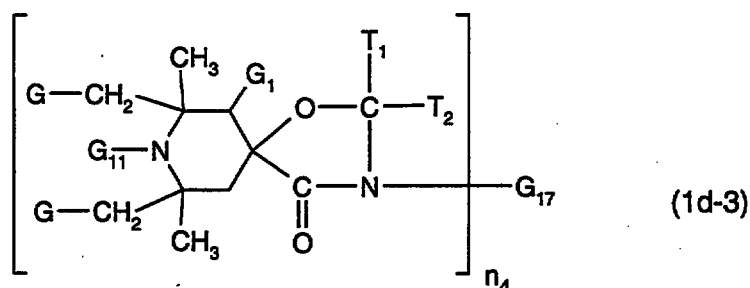
in which n_3 is the number 1 or 2, G, G_1 and G_{11} are as defined under (a'), and G_{15} and G'_{15} if n_3 is 1, are independently C_1 - C_{12} alkyl, C_2 - C_{12} alkenyl, C_7 - C_{12} aralkyl, or G_{15} is also hydrogen, or G_{15} and G'_{15} together are C_2 - C_8 alkylene, C_5 - C_{15} alkenylene, C_2 - C_8 hydroxyalkylene or C_4 - C_{22} acyloxyalkylene, and if n_3 is 2, G_{15} and G'_{15} together are the $(-\text{CH}_2)_2\text{C}(\text{CH}_2)_2$ group.

C_2 - C_8 alkylene or C_2 - C_8 hydroxyalkylene G_{15} and G'_{15} is, for example, ethylene, 1-methylethylene, propylene, 2-ethylpropylene or 2-ethyl-2-hydroxymethylpropylene.

C_4 - C_{22} acyloxyalkylene G_{15} and G'_{15} is, for example, 2-ethyl-2-acetoxymethylpropylene.

(d') A compound of the formula (1d-1), (1d-2) or (1d-3),





in which n_4 is the number 1 or 2, G, G_1 and G_{11} are as defined under (a'), G_{16} is hydrogen, C_1 - C_{12} alkyl, allyl, benzyl, glycidyl or C_2 - C_6 alkoxyalkyl, and G_{17} , if n_4 is 1, is hydrogen, C_1 - C_{12} alkyl, C_3 - C_5 alkenyl, C_7 - C_9 aralkyl, C_5 - C_7 cycloalkyl, C_2 - C_4 hydroxyalkyl, C_2 - C_6 alkoxyalkyl, C_6 - C_{10} aryl, glycidyl or a group of the formula $-(\text{CH}_2)_p\text{-COO-Q}$ or $-(\text{CH}_2)_p\text{-O-CO-Q}$, in which p is 1 or 2, and Q is C_1 - C_4 alkyl or phenyl, and G_{17} , if n_4 is 2, is C_2 - C_{12} alkylene, C_4 - C_{12} alkenylene, C_6 - C_{12} arylene, a group of the formula $-\text{CH}_2\text{-CH(OH)-CH}_2\text{-O-D'-O-CH}_2\text{-CH(OH)-CH}_2-$, in which D' is C_2 - C_{10} alkylene, C_6 - C_{15} arylene or C_6 - C_{12} cycloalkylene, or a group of the formula $-\text{CH}_2\text{CH(OD'')CH}_2\text{-(OCH}_2\text{-CH(OD'')CH}_2\text{)}_2-$, in which D'' is hydrogen, C_1 - C_{18} alkyl, allyl, benzyl, C_2 - C_{12} alkanoyl or benzoyl, T_1 and T_2 , independently of one another, are hydrogen, C_1 - C_{18} alkyl or unsubstituted or halogen- or C_1 - C_4 alkyl-substituted C_6 - C_{10} aryl or C_7 - C_9 aralkyl, or T_1 and T_2 together with the carbon atom bonding them form a C_5 - C_{14} cycloalkane ring.

Any C_1 - C_{12} alkyl substituents are, for example, methyl, ethyl, n-propyl, n-butyl, sec-butyl, tert-butyl, n-hexyl, n-octyl, 2-ethylhexyl, n-nonyl, n-decyl, n-undecyl or n-dodecyl.

Any C_1 - C_{18} alkyl substituents can be, for example, the abovementioned groups and in addition, for example, n-tridecyl, n-tetradecyl, n-hexadecyl or n-octadecyl.

Any C_2 - C_6 alkoxyalkyl substituents are, for example, methoxymethyl, ethoxymethyl, propoxymethyl, tert-butoxymethyl, ethoxyethyl, ethoxypropyl, n-butoxyethyl, tert-butoxyethyl, isopropoxyethyl or propoxypropyl.

C_3 - C_5 alkenyl G_{17} is, for example, 1-propenyl, allyl, methallyl, 2-butenyl or 2-pentenyl.

C₇-C₉aralkyl G₁₇, T₁ and T₂ are, in particular, phenethyl or especially benzyl. If T₁ and T₂ together with the carbon atom form a cycloalkane ring, this can be, for example, a cyclopentane, cyclohexane, cyclooctane or cyclododecane ring.

C₂-C₄hydroxyalkyl G₁₇ is, for example, 2-hydroxyethyl, 2-hydroxypropyl, 2-hydroxybutyl or 4-hydroxybutyl.

C₆-C₁₀aryl G₁₇, T₁ and T₂ are, in particular, phenyl or α- or β-naphthyl, which are unsubstituted or substituted by halogen or C₁-C₄alkyl.

C₂-C₁₂alkylene G₁₇ is, for example, ethylene, propylene, 2,2-dimethylpropylene, tetramethylene, hexamethylene, octamethylene, decamethylene or dodecamethylene.

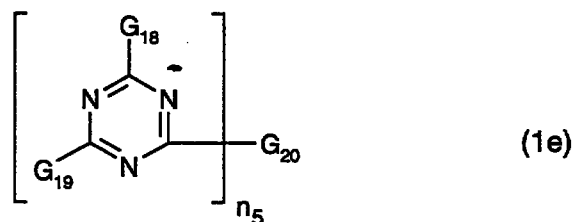
C₄-C₁₂alkenylene G₁₇ is, in particular, 2-butenylene, 2-pentenylene or 3-hexenylene.

C₆-C₁₂arylene G₁₇ is, for example, o-, m- or p-phenylene, 1,4-naphthylene or 4,4'-diphenylene.

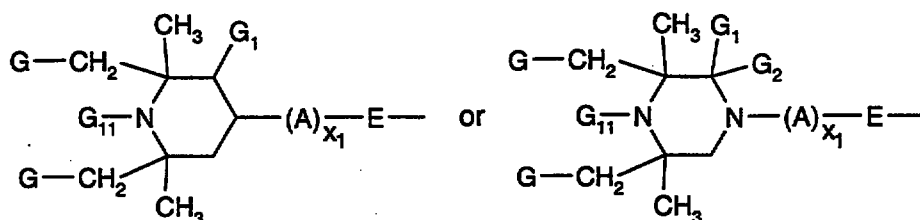
C₂-C₁₂alkanoyl D'' is, for example, propionyl, butyryl, octanoyl, dodecanoyl, but preferably acetyl.

C₂-C₁₀alkylene, C₆-C₁₅arylene or C₆-C₁₂cycloalkylene D' have, for example, one of the definitions given for D under (b').

(e') A compound of the formula (1e)



in which n₅ is the number 1 or 2, and G₁₈ is a group of the formula



in which G and G₁₁ are as defined under (a'), and G₁ and G₂ are hydrogen, methyl or, together, are a substituent =O,

E is -O- or -ND^{'''}-,

A is C₂-C₆alkylene or -(CH₂)₃-O- and

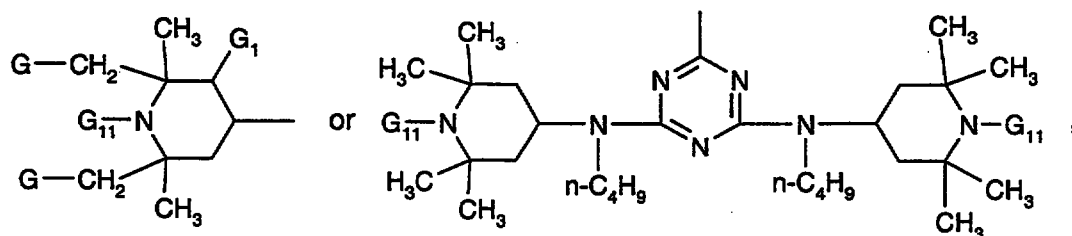
x₁ is the number 0 or 1,

D^{'''} is hydrogen, C₁-C₁₂alkyl, C₂-C₁₂alkylene-N(D^V)₂, C₂-C₅hydroxyalkyl or C₅-C₇cycloalkyl, where D^V, independently, is hydrogen or butyl,-

G₁₉ is identical to G₁₈ or is one of the groups -N(G₂₁)(G₂₂), -OG₂₃, -N(H)(CH₂OG₂₃) or -N(CH₂OG₂₃)₂,

G₂₀, if n₅ = 1, is identical to G₁₈ or G₁₉ and, if n₅ = 2, is an -E-D^{IV}-E- group, in which D^{IV} is C₂-C₈alkylene or C₂-C₈alkylene which is interrupted by 1 or 2 -NG₂₁- groups,

G₂₁ is hydrogen, C₁-C₁₂alkyl, cyclohexyl, benzyl or C₁-C₄-hydroxyalkyl or a group of the formula



G₂₂ is C₁-C₁₂alkyl, cyclohexyl, benzyl or C₁-C₄hydroxyalkyl, and

G₂₃ is hydrogen, C₁-C₁₂alkyl or phenyl, or G₂₁ and G₂₂ together are C₄-C₅alkylene or C₄-C₅oxaalkylene, for example -CH₂CH₂-O-CH₂CH₂-, or a group of the formula -CH₂CH₂-N(G₁₁)-CH₂CH₂-.

Some examples of the several variables in the formula (1e) are given below.

Any C₁-C₁₂alkyl substituents are, for example, methyl, ethyl, n-propyl, n-butyl, sec-butyl, tert-butyl, n-hexyl, n-octyl, 2-ethylhexyl, n-nonyl, n-decyl, n-undecyl or n-dodecyl.

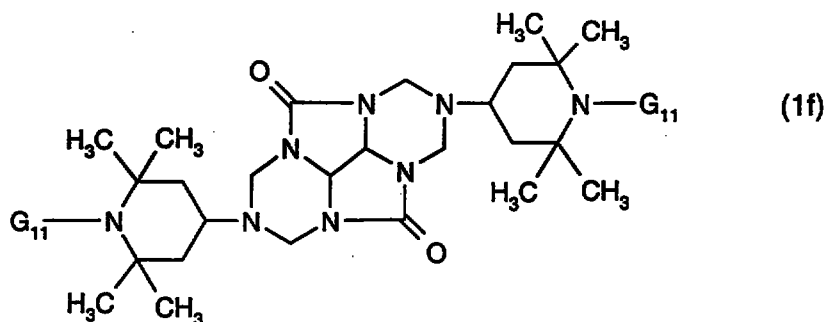
Any hydroxyalkyl substituents are, for example, 2-hydroxyethyl, 2-hydroxypropyl, 3-hydroxypropyl, 2-hydroxybutyl or 4-hydroxybutyl.

Any C₅-C₇cycloalkyl substituents are, for example, cyclopentyl, cyclohexyl or cycloheptyl. Cyclohexyl is preferred.

C₂-C₆alkylene A is, for example, ethylene, propylene, 2,2-dimethylpropylene, tetramethylene or hexamethylene.

If G₂₁ and G₂₂ together are C₄-C₅alkylene or oxaalkylene, they are, for example, tetramethylene, pentamethylene or 3-oxapentamethylene.

(f') A compound of the formula (1f)



wherein G₁₁ is as defined under (a').

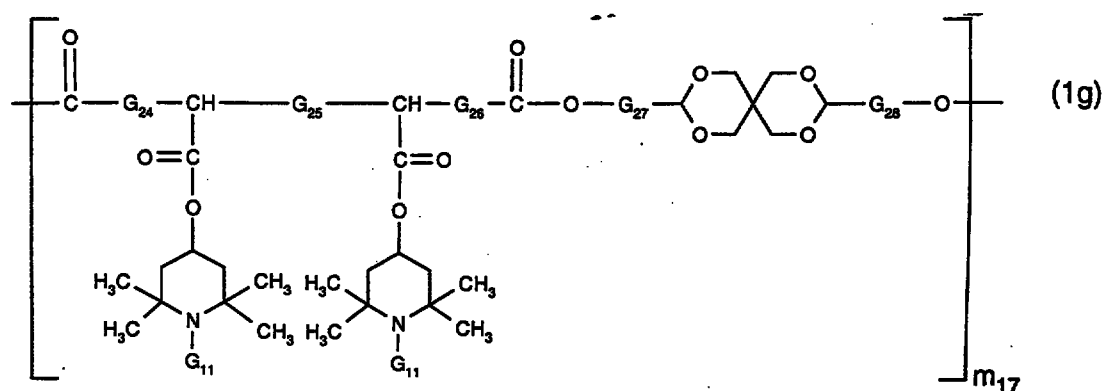
(g') Oligomeric or polymeric compounds whose recurring structural unit contains a 2,2,6,6-tetraalkylpiperidiny radical, in particular polyesters, polyethers, polyamides, polyamines, polyurethanes, polyureas, polyaminotriazines, poly(meth)acrylates, poly(meth)acrylamides and copolymers thereof which contain such radicals.

Examples of 2,2,6,6-polyalkylpiperidine compounds from this class are the compounds of the following formulae. m_1 to m_{14} is a number from 2 to about 200, preferably 2 to 100, for example 2 to 50, 2 to 40, 3 to 40 or 4 to 10.

The meanings of the end groups which saturate the free valences in the oligomeric or polymeric compounds listed below depend on the processes used for the preparation of said compounds. The end groups can also in addition be modified after the synthesis of the compounds.

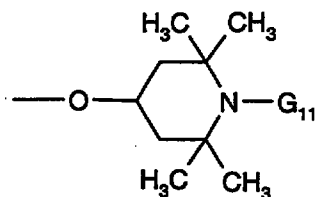
Examples for polymeric compounds are:

1) A compound of the formula (1g)

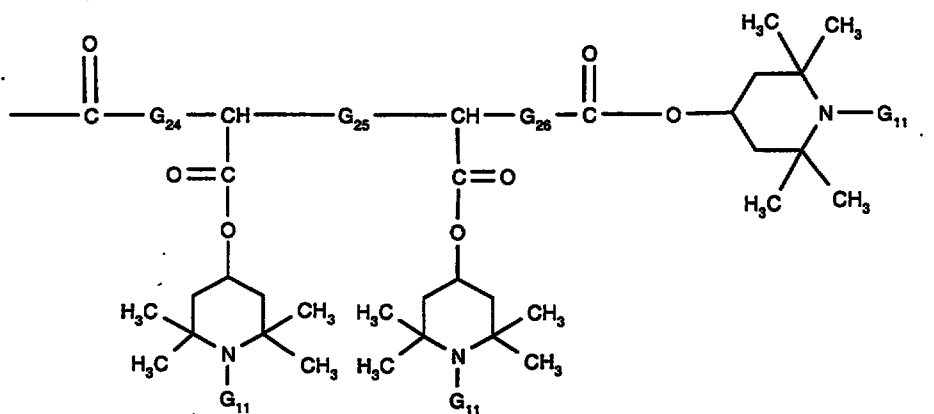


wherein G_{24} , G_{25} , G_{26} , G_{27} and G_{28} , independently of one another, are a direct bond or C_1 - C_{10} alkylene, G_{11} is as defined under (a') and m_{17} is a number from 1 to 50.

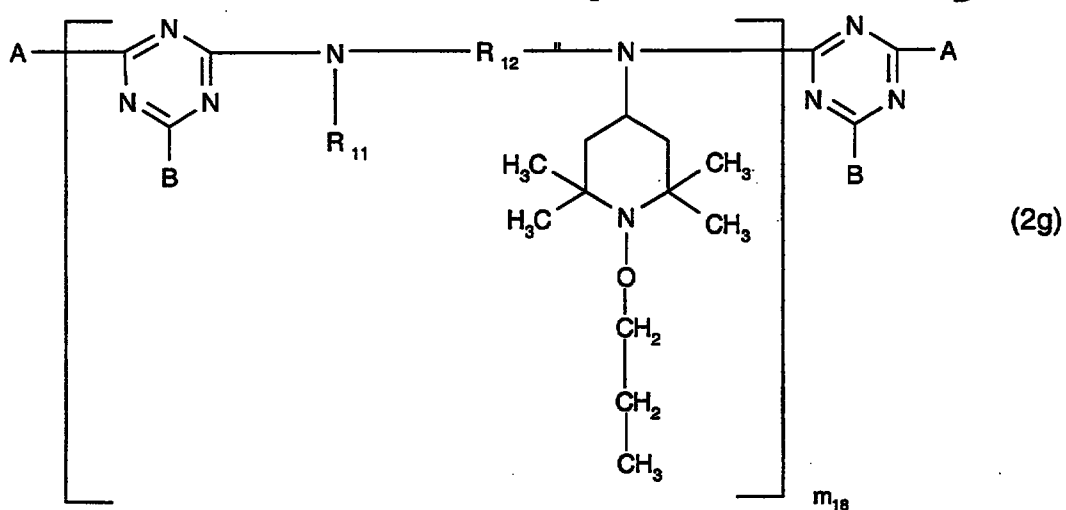
In the compound of the formula (1g), the end group bonded to the $>C=O$ group can be, for example,



and the end group bonded to the oxygen can be, for example

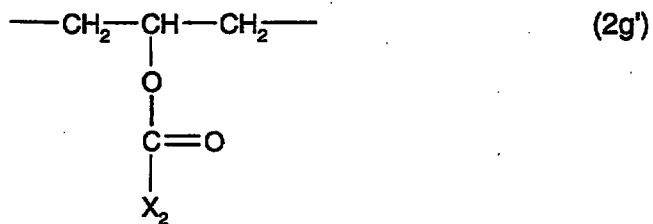


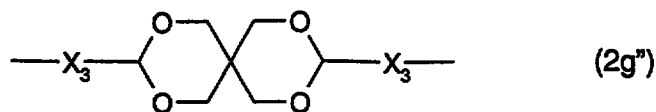
2) Compound of the formula (2g)



in which the index m_{18} ranges from 1 to 15;

R₁₂ is C₂-C₁₂alkylene, C₄-C₁₂alkenylene, C₅-C₇cycloalkylene, C₅-C₇cycloalkylene-di(C₁-C₄alkylene), C₁-C₄alkylenedi(C₅-C₇cycloalkylene), phenylenedi(C₁-C₄alkylene) or C₄-C₁₂alkylene interrupted by 1,4-piperazinediyl, -O- or >N-X₁ with X₁ being C₁-C₁₂acyl or (C₁-C₁₂alkoxy)carbonyl or having one of the definitions of R₁₄ given below except hydrogen; or R₁₂ is a group of the formula (2g') or (2g'');

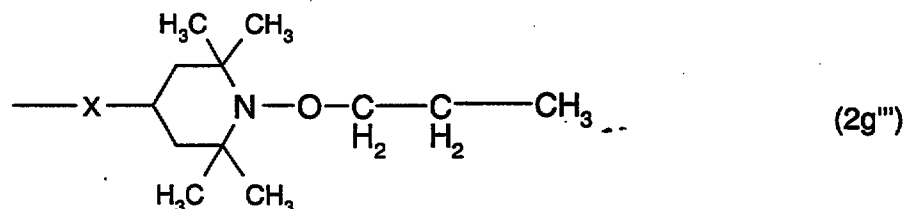




X₂ being C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl which is unsubstituted or substituted by 1, 2 or 3 C₁-C₄alkyl; phenyl which is unsubstituted or substituted by 1, 2 or 3 C₁-C₄alkyl or C₁-C₄alkoxy; C₇-C₉phenylalkyl which is unsubstituted or substituted on the phenyl by 1, 2 or 3 C₁-C₄alkyl; and

the radicals X₃ being independently of one another C₂-C₁₂alkylene;

the radicals A are independently of one another -OR₁₃, -N(R₁₄)(R₁₅) or a group of the formula (2g''');



R₁₃, R₁₄ and R₁₅, which are identical or different, are hydrogen, C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl which is unsubstituted or substituted by 1, 2 or 3 C₁-C₄alkyl; C₃-C₁₈alkenyl, phenyl which is unsubstituted or substituted by 1, 2 or 3 C₁-C₄alkyl or C₁-C₄alkoxy; C₇-C₉phenylalkyl which is unsubstituted or substituted on the phenyl by 1, 2 or 3 C₁-C₄alkyl; tetrahydrofurfuryl or C₂-C₄alkyl which is substituted in the 2, 3 or 4 position by -OH, C₁-C₈alkoxy, di(C₁-C₄alkyl)amino or a group of the formula (2g^{IV});

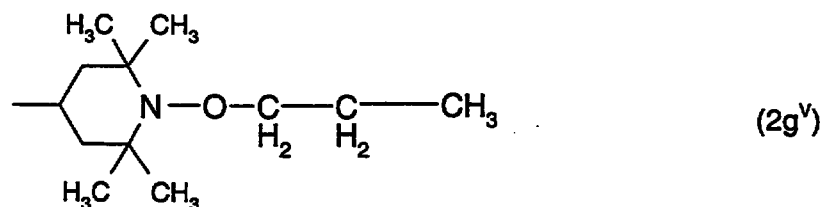


with Y being -O-, -CH₂-, -CH₂CH₂- or >N-CH₃,

or -N(R₁₄)(R₁₅) is additionally a group of the formula (2g^{IV});

X is -O- or >N-R₁₆;

R₁₆ is hydrogen, C₁-C₁₈alkyl, C₃-C₁₈alkenyl, C₅-C₁₂cycloalkyl which is unsubstituted or substituted by 1, 2 or 3 C₁-C₄alkyl; C₇-C₉phenylalkyl which is unsubstituted or substituted on the phenyl by 1, 2 or 3 C₁-C₄alkyl; tetrahydrofurfuryl, a group of the formula (2g^V),

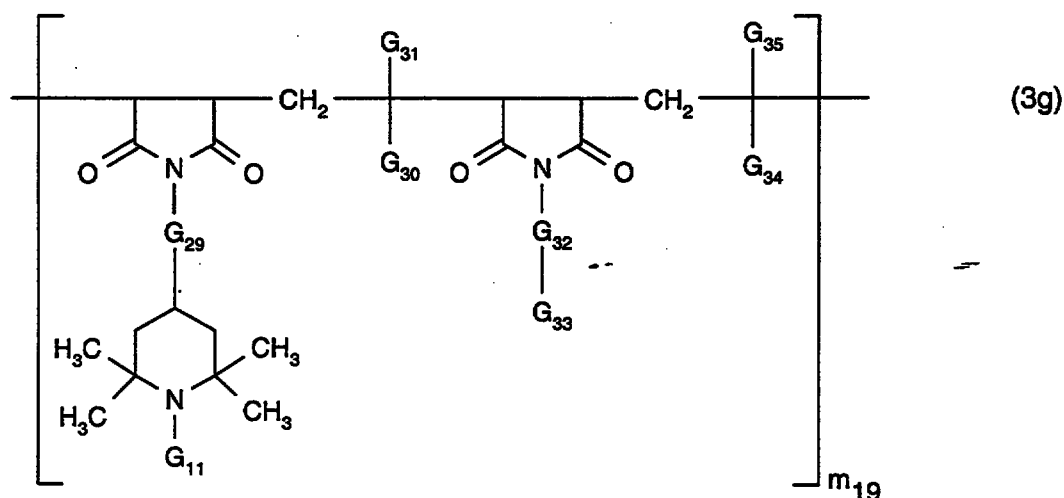


or C₂-C₄alkyl which is substituted in the 2, 3 or 4 position by -OH, C₁-C₈alkoxy, di(C₁-C₄alkyl)amino or a group of the formula (2g^{IV});

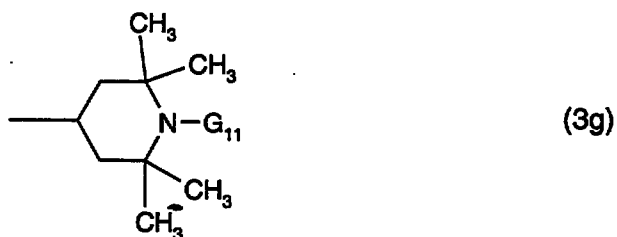
R₁₁ has one of the definitions given for R₁₆; and

the radicals B have independently of one another one of the definitions given for A.

3) A compound of the formula (3g)

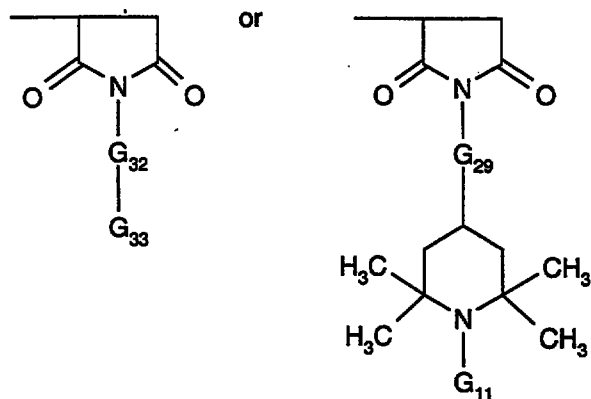


in which G₁₁ is as defined under (a'), G₂₉ and G₃₂, independently of one another, are a direct bond or a -N(X₁)-CO-X₂-CO-N(X₃)- group, where X₁ and X₃, independently of one another, are hydrogen, C₁-C₈alkyl, C₅-C₁₂cycloalkyl, phenyl, C₇-C₉phenylalkyl or a group of the formula

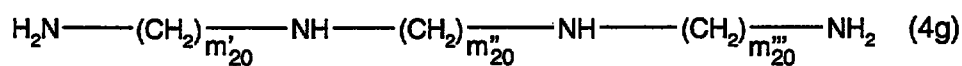


and X₂ is a direct bond or C₁-C₄alkylene, G₃₀, G₃₁, G₃₄ and G₃₅, independently of one another, are hydrogen, C₁-C₃₀alkyl, C₅-C₁₂cycloalkyl or phenyl, G₃₃ is hydrogen, C₁-C₃₀alkyl, C₅-C₁₂cycloalkyl, C₇-C₉phenylalkyl, phenyl or a group of the formula (3g), and m₁₉ is a number from 1 to 50.

In the compounds of the formula (3g), the end group bonded to the 2,5-dioxopyrrolidine ring can be, for example, hydrogen, and the end group bonded to the $-C(G_{34})(G_{35})-$ radical can be, for example,

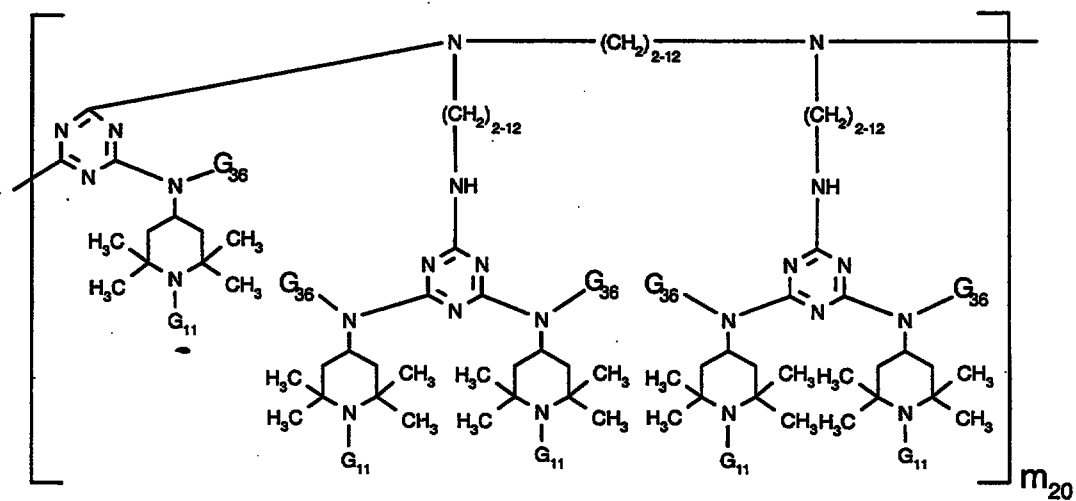
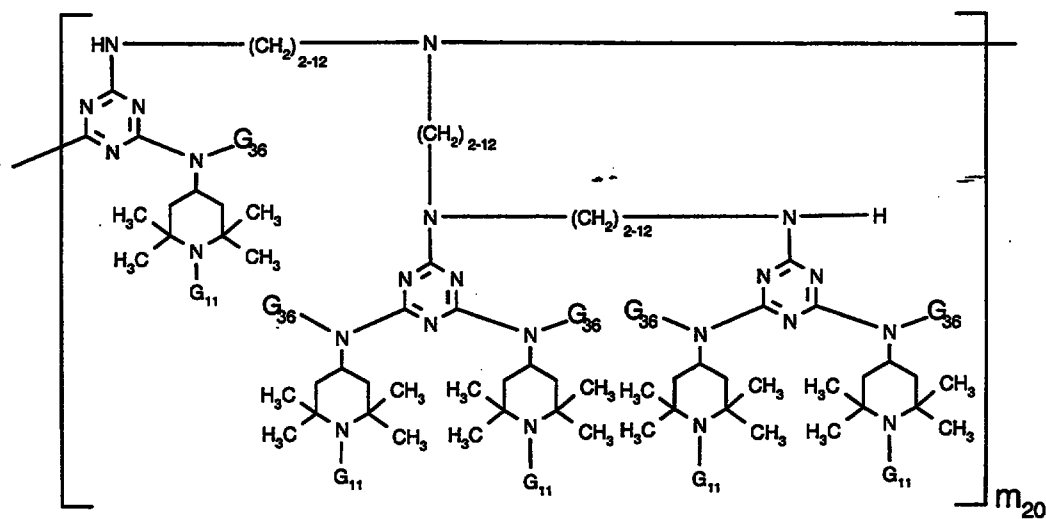
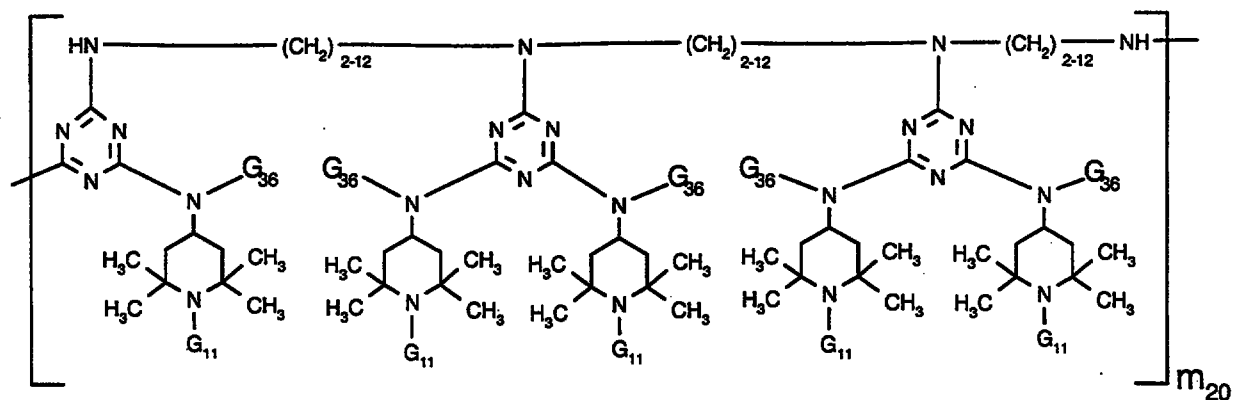


4) A product obtainable by reacting an intermediate product, obtained by reaction of a polyamine of the formula (4g) with cyanuric chloride, with a compound of the formula (4g')

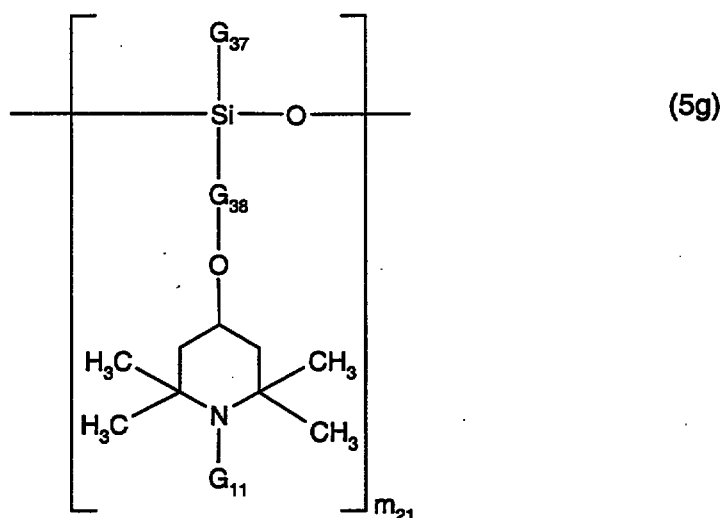


in which m'_{20} , m''_{20} and m'''_{20} , independently of one another, are a number from 2 to 12, G_{36} is hydrogen, C_1 - C_{12} alkyl, C_5 - C_{12} cycloalkyl, phenyl or C_7 - C_9 phenylalkyl, and G_{11} is as defined under (a').

In general, the above reaction product can be represented for example by a compound of the following 3 formulae. It can also be in the form of a mixture of these three compounds:



5) A compound of the formula (5g)

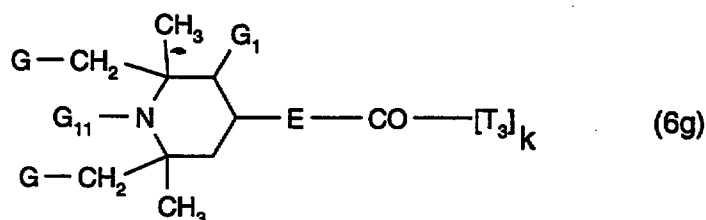


in which G_{11} is as defined under (a'), G_{37} is C_1 - $\bar{C}_{10}$ alkyl, C_5 - C_{12} cycloalkyl, C_1 - C_4 alkyl-substituted C_5 - C_{12} cycloalkyl, phenyl or C_1 - C_{10} alkyl-substituted phenyl, G_{38} is C_3 - C_{10} alkylene and m_{21} is a number from 1 to 50.

In the compounds of the formula (5g), the terminal group bonded to the silicon atom can be, for example, $(G_{37})_3Si-O-$, and the terminal group bonded to the oxygen can be, for example, $-Si(G_{37})_3$.

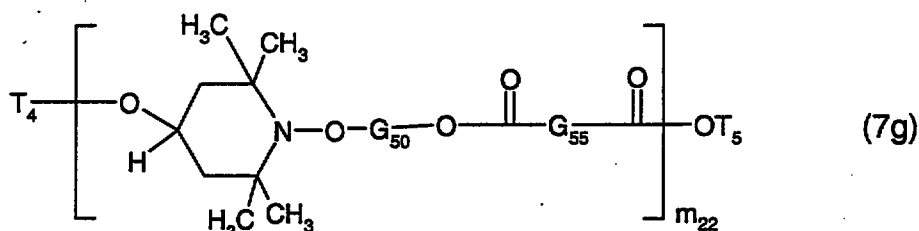
The compounds of the formula (5g) can also be in the form of cyclic compounds if m_{21} is a number from 3 to 10, i.e. the free valences shown in the structural formula then form a direct bond.

6) A compound of the formula (6g)



where E is -O- or -ND'''- as defined under (e'), T₃ is ethylene or 1,2-propylene, is the repeating structural unit derived from an alpha-olefin copolymer with an alkyl acrylate or methacrylate; preferably a copolymer of ethylene and ethyl acrylate, and where k is 2 to 100.

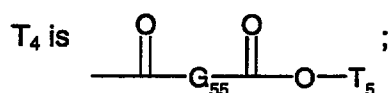
7) A compound of the formula (7g)



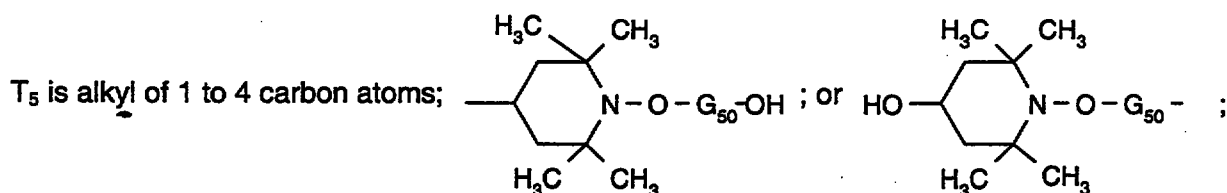
wherein m is 1 to 100;

G₅₀ is straight or branched chain alkylene of 1 to 18 carbon atoms, cycloalkylene of 5 to 8 carbon atoms, cycloalkenylene of 5 to 8 carbon atoms, alkenylene of 3 to 18 carbon atoms, a straight or branched chain alkylene of 1 to 4 carbon atoms substituted by phenyl or by phenyl substituted by one or two alkyl of 1 to 4 carbon atoms, with the proviso that in formula (7g) successive hindered amine moieties can be oriented in either a head to head or head to tail fashion;

T₄ is hydrogen or



G₅₅ is a straight or branched chain alkylene of 1 to 18 carbon atoms, cycloalkylene or cycloalkenylene of 5 to 8 carbon atoms, phenylene or -NH-alkylene-NH- of 2 to 18 carbon atoms including 5-amino-1-aminomethyl-1,3,3-trimethylcyclohexane and -NH-xylylene-NH-;

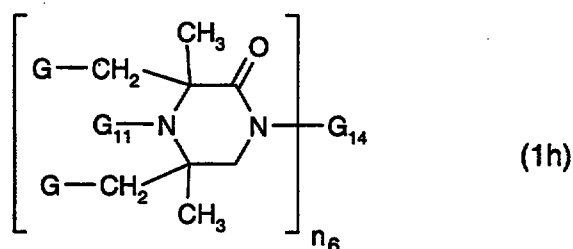


In the above shown oligomeric and polymeric compounds,

examples of alkyl are methyl, ethyl, propyl, isopropyl, n-butyl, sec-butyl, isobutyl, tert-butyl, 2-ethylbutyl, n-pentyl, isopentyl, 1-methylpentyl, 1,3-dimethylbutyl, n-hexyl, 1-methylhexyl, n-

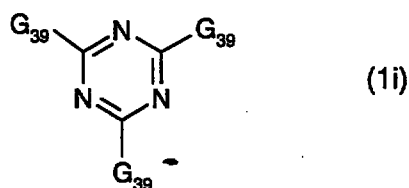
heptyl, isoheptyl, 1,1,3,3-tetramethylbutyl, 1-methylheptyl, 3-methylheptyl, n-octyl, 2-ethylhexyl, 1,1,3-trimethylhexyl, 1,1,3,3-tetramethylpentyl, nonyl, decyl, undecyl, 1-methylundecyl, dodecyl, 1,1,3,3,5,5-hexamethylhexyl, tridecyl, tetradecyl, pentadecyl, hexadecyl, heptadecyl, octadecyl, eicosyl and docosyl;
 examples of cycloalkyl are cyclopentyl, cyclohexyl, cycloheptyl and cyclooctyl;
 an example of C₇-C₉phenylalkyl is benzyl; and
 examples of alkylene are ethylene, propylene, trimethylene, tetramethylene, pentamethylene, 2,2-dimethyltrimethylene, hexamethylene, trimethylhexamethylene, octamethylene and decamethylene.

(h') A compound of the formula (1h)

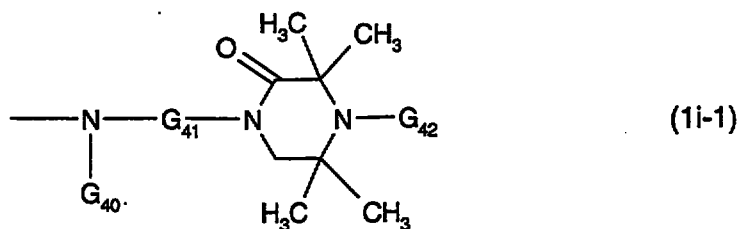


in which n_6 is the number 1 or 2, G and G_{11} are as defined under (a'), and G_{14} is as defined under (b'), but G_{14} cannot be -CONH-Z and -CH₂-CH(OH)-CH₂-O-D-O-.

(i') A compound of the formula (1i)



wherein the radicals G_{39} , independently of one another, are a group of the formula (1i-1)



in which G_{40} is C_1 - C_{12} alkyl or C_5 - C_{12} cycloalkyl, G_{41} is C_2 - C_{12} alkylene and G_{42} is as defined for G_{11} above.

Alkyl is for example C_1 - C_4 alkyl, in particular methyl, ethyl, propyl or butyl.

Cycloalkyl is preferably cyclohexyl.

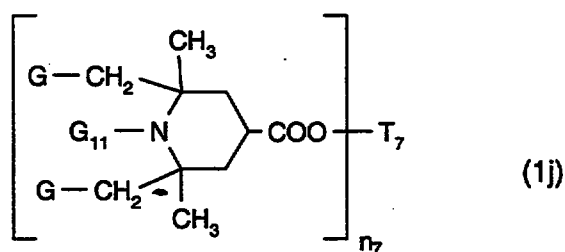
Alkylene is for example ethylene, propylene, trimethylene, tetramethylene, pentamethylene, 2,2-dimethyltrimethylene or hexamethylene.

Alkenyl is preferably allyl.

Phenylalkyl is preferably benzyl.

Acyl is preferably acetyl.

(j') A compound of the formula (1j)

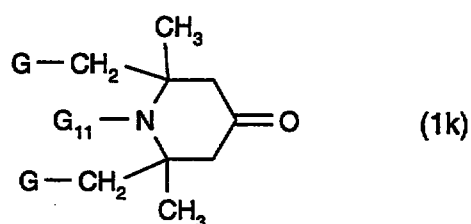


wherein G , G_{11} are as defined above and

when n_7 is 1, T_7 is hydrogen, C_1 - C_{12} alkyl, C_3 - C_5 alkenyl, C_7 - C_9 aralkyl, C_5 - C_7 cycloalkyl, C_2 - C_4 hydroxyalkyl, C_2 - C_6 alkoxyalkyl, C_6 - C_{10} aryl, glycidyl, a group of the formula $-(CH_2)_t-COO-Q$ or of the formula $-(CH_2)_t-O-CO-Q$ wherein t is 1 or 2, and Q is C_1 - C_4 alkyl or phenyl; or

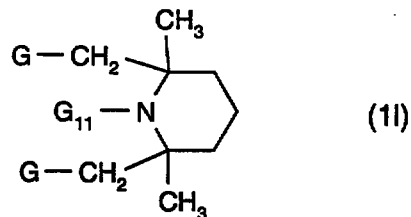
when n_7 is 2, T_7 is C_2 - C_{12} alkylene, C_6 - C_{12} arylene, a group $-CH_2CH(OH)-CH_2-O-X-O-CH_2-CH(OH)-CH_2-$ wherein X is C_2 - C_{10} alkylene, C_6 - C_{15} arylene or C_6 - C_{12} cycloalkylene, or a group $-CH_2CH(OZ')CH_2-(OCH_2-CH(OZ')CH_2)_2-$ wherein Z' is hydrogen, C_1 - C_{18} alkyl, allyl, benzyl, C_2 - C_{12} alkanoyl or benzoyl.

(k') A compound of the formula (1k)



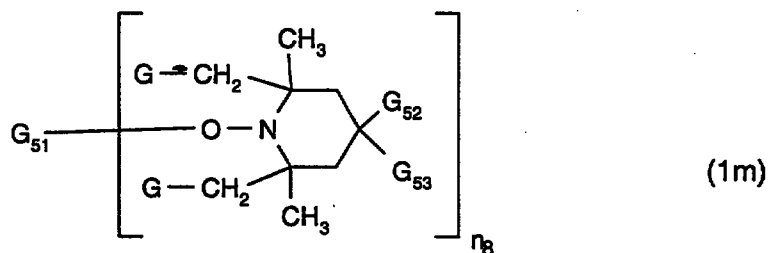
wherein G , G_{11} are as defined above.

(l') A compound of the formula (1l)



wherein G , G_{11} are as defined above.

(m') A compound of the formula (1m)



wherein G is as defined above, n_8 is 1, 2 or 3,

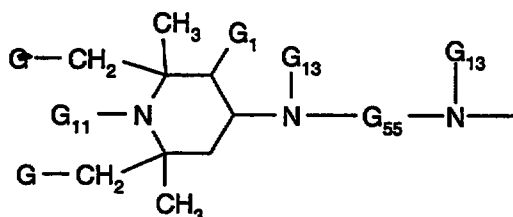
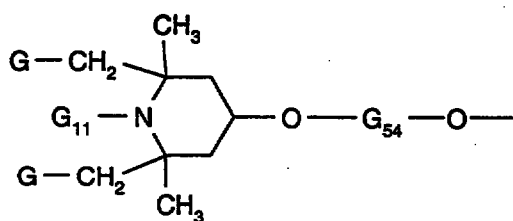
if n_8 is 1, G_{51} is $-G_{50}-O-CO-G_{56}$; G_{52} is $-O-CO-G_{56}$; and G_{53} is hydrogen; where G_{56} is alkyl or $-NH$ -alkyl of 1 to 18 carbon atoms or $-NH$ -cycloalkyl of 5 to 8 carbon atoms;

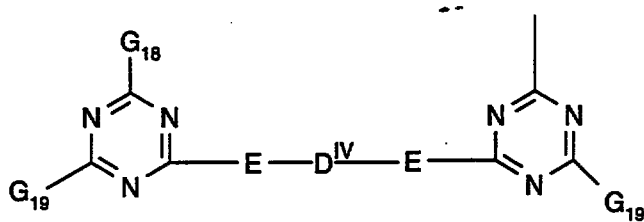
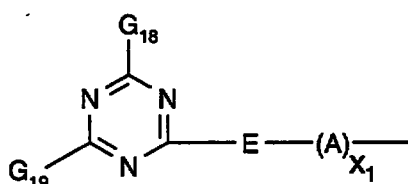
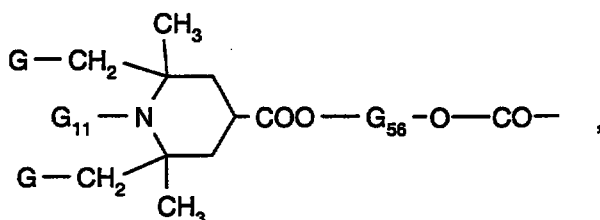
if n_8 is 2, G_{51} is alkylene of 1 to 18 carbon atoms, hydroxyalkylene of 3 to 18 carbon atoms, cycloalkylene of 5 to 8 carbon atoms, cycloalkenylene or hydroxycycloalkylene of 5 to 8 carbon atoms, alkenylene of 3 to 18 carbon atoms, or a straight or branched chain alkylene of 1 to 4 carbon atoms or hydroxyalkylene of 2 to 4 carbon atoms substituted by phenyl or by phenyl substituted by one or two alkyl of 1 to 4 carbon atoms; or G_{51} is a divalent acyl radical of an aliphatic, cycloaliphatic, araliphatic or aromatic dicarboxylic acid or of a dicarbamic acid, preferably an acyl radical of an aliphatic dicarboxylic acid having 2-18 C atoms, of a cycloaliphatic or aromatic dicarboxylic acid having 8-14 C atoms,

if n_8 is 3, G_{51} is alkanetriyl of 1 to 18 carbon atoms, hydroxyalkanetriyl of 3 to 18 carbon atoms, cycloalkanetriyl of 5 to 8 carbon atoms, cycloalkenetriyl of 5 to 8 carbon atoms, alkenetriyl of 3 to 18 carbon atoms, a straight or branched chain alkanetriyl of 1 to 4 carbon atoms substituted by phenyl or by phenyl substituted by one or two alkyl of 1 to 4 carbon atoms;

if n_8 is 2 or 3,

G_{52} is $-O-G_{12}$; $-N(G_{13})G_{14}$; $-O-G_{15}$; $-COO-T_7$; or is a group of one of the formulae

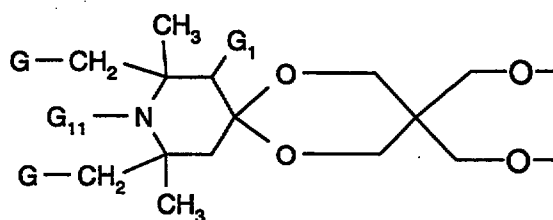




and

G_{53} is hydrogen or, if G_{52} is $-O-G_{15}$, is $O-G'_{15}$;

or G_{52} and G_{53} together are $=O$; or a group of the formula



where G_{11} and G_{12} are as defined above under (a') if n_1 is 1; G_{13} and G_{14} are as defined above under (b') if n_2 is 1; G_{15} and G'_{15} are as defined above under (c') if n_3 is 1; G_{18} , G_{19} , A , E , D^{IV} , x_1 are as defined above under (e'); T_7 is as defined above under (j') if n_7 is 1; G_{54} is as defined for G_{12} under (a') if n_1 is 2; G_{55} is as defined for G_{14} under (b') if n_2 is 2; G_{56} is as defined for T_7 under (j') if n_7 is 2.

Of special technical importance is a sterically hindered amine light stabilizer of the hydroxyhydrocarbyloxyamine class, wherein E_1 is preferably C_1 - C_{18} alkyl, C_5 - C_{12} cycloalkyl or C_7 - C_{15} aralkyl each of which is substituted in the aliphatic part by 1-

3 OH groups, especially 1 OH group.

Thus, present invention also pertains to a flame retardant composition stabilized against deleterious effects of light and weathering comprising

- a) a polyolefin, and
- b) a flame retardant selected from
 - b1) melamin based flame retardants and/or ammonium polyphosphate,
 - b2) bis-(hexachlorocyclopentadieno) cyclooctane,
 - b3) tris-(2,3-dibromopropyl)-isocyanurate,
 - b4) ethylene-bis-tetrabromophthalimide;and
- c) a sterically hindered amine light stabilizer of the hydroxyhydrocarbyloxyamine class.

Further, the instant invention pertains to a process for imparting light stability and flame retardancy to a thermoplastic polymer, which process comprises adding to said polymer a combination of the flame retardant tris-(2,3-dibromopropyl)-isocyanurate and a sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class. A flame retardant and light stabilized composition comprising

- a) a polyolefin,
 - b) tris-(2,3-dibromopropyl)-isocyanurate as a flame retardant
- and
- c) a sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class
- is another preferred object of present invention.

Preferred components a and c and amounts thereof in the novel process and novel compositions are as described above.

Components b and c of the instant invention and optional further components may readily be incorporated into the polymer by conventional techniques, at any convenient stage prior to the manufacture of shaped articles therefrom. For example, the additives may be mixed with the polymer in dry powder form, or a suspension or emulsion of the stabilizer may be mixed with a solution, suspension, or emulsion of the polymer. The additives may be added to component (a), individually or mixed with one another. If desired, the individual components can be mixed with one another in the melt (melt blending) before incorporation

into the material to be stabilized. Components b and/or c and optional further additives may be incorporated, for example, before or after molding or also by applying the dissolved or dispersed stabilizer mixture to the material to be stabilized, with or without subsequent evaporation of the solvent. The additives of component b and/or c as well as further additives can also be added to the material to be stabilized in the form of a masterbatch which contains these components in a concentration of, for example, about 2.5 % to about 25 % by weight; in such operations, the polymer can be used in the form of powder, granules, solutions, suspensions or in the form of latices.

Incorporation can take place prior to or during the shaping operation, or by applying the dissolved or dispersed compound to the polymer, with or without subsequent evaporation of the solvent. In the case of elastomers, these can also be stabilized as latices. A further possibility for incorporating the stabilizers of the invention into polymers is to add them before, during or directly after the polymerization of the corresponding monomers. In the case of addition prior to or during the polymerization, the stabilizers of the invention can also act as a regulator of the chain length of the polymers (chain terminator).

Components b and c of the invention can judiciously be incorporated by the following methods:

- as emulsion or dispersion (e.g. to latices or emulsion polymers),
- as a dry mixture during the mixing in of additional components or polymer mixtures,
- by direct introduction into the processing apparatus (e.g. extruders, internal mixers, etc),
- as solution or melt.

The additive combination of present components b and c is useful for many applications, especially outdoor applications, including the following:

Thermoplastic olefins (TPO), e.g. paintable thermoplastic olefins

Polypropylene molded articles

Polyethylene film

Molded polypropylene with brominated flame retardants

Molded thermoplastic olefin with brominated flame retardants

Polyethylene film with brominated flame retardants
Thermoplastic elastomers with other costabilizers
Grease-filled wire and cable insulation
Coatings over plastic substrates
Polyolefin tanks or containers containing chemicals
Polyolefin films with an antifog agent
Polyolefin films with IR thermal fillers such as hydrotalcites, e.g. DHT4A
Polyolefin films with an antistatic agent
Flame-resistant molded polypropylene articles
Flame-resistant molded thermoplastic olefins
Flame-resistant polyethylene film
Pre-formed films for lamination to plastic substrates
Electronic appliance
Containers, boxes, bins for storage and transportation
Automotive applications e.g. dashboard, back board
Furniture e.g. stadium seats, public seats
Roofing sheets
Roofing membranes
Flooring materials
Liners
Profiles, especially window and door profiles
Geomembranes.

The materials containing the stabilizers described herein can be used for the production of moldings, extruded articles, rotomolded articles, injection molded articles, blow molded articles, mono- and multilayer films, extruded profiles, surface coatings and the like.

The resulting stabilized compositions of the invention may optionally also contain various conventional additives, preferably in amounts from 0.01 to 10%, more preferably from about 0.025 to about 2%, and especially from about 0.1 to about 1% by weight of component (a), such as the materials listed below, or mixtures thereof.

1. Antioxidants

1.1. Alkylated monophenols, for example 2,6-di-tert-butyl-4-methylphenol, 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-dicyclopentyl-4-methylphenol, 2-(α -methylcyclohexyl)-4,6-dimethylphenol, 2,6-dioctadecyl-4-methylphenol, 2,4,6-tricyclohexylphenol, 2,6-di-tert-butyl-4-methoxymethylphenol, nonylphenols which are linear or branched in the side chains, for example 2,6-di-nonyl-4-methylphenol, 2,4-dimethyl-6-(1'-methylundec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methylheptadec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methyltridec-1'-yl)phenol and mixtures thereof.

1.2. Alkylthiomethylphenols, for example 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol, 2,6-di-dodecylthiomethyl-4-nonylphenol.

1.3. Hydroquinones and alkylated hydroquinones, for example 2,6-di-tert-butyl-4-methoxyphenol, 2,5-di-tert-butylhydroquinone, 2,5-di-tert-amylhydroquinone, 2,6-diphenyl-4-octadecyloxyphenol, 2,6-di-tert-butylhydroquinone, 2,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyanisole, 3,5-di-tert-butyl-4-hydroxyphenyl stearate, bis(3,5-di-tert-butyl-4-hydroxyphenyl) adipate.

1.4. Tocopherols, for example α -tocopherol, β -tocopherol, γ -tocopherol, δ -tocopherol and mixtures thereof (vitamin E).

1.5. 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), 4,4'-thiobis(3,6-di-sec-amylphenol), 4,4'-bis(2,6-dimethyl-4-hydroxyphenyl)-disulfide.

1.6. 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(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-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis(3'-tert-butyl-4'-hydroxyphenyl)butyrate], bis(3-tert-butyl-4-hydroxy-5-methyl-phenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate, 1,1-bis-(3,5-dimethyl-2-hydroxyphenyl)butane, 2,2-bis(3,5-di-tert-butyl-4-hydroxyphenyl)propane, 2,2-bis-(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1,1,5,5-tetra(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.

1.7. O-, N- and S-benzyl compounds, for example 3,5,3',5'-tetra-tert-butyl-4,4'-dihydroxydibenzyl ether, octadecyl-4-hydroxy-3,5-dimethylbenzylmercaptoacetate, tridecyl-4-hydroxy-3,5-di-tert-butylbenzylmercaptoacetate, tris(3,5-di-tert-butyl-4-hydroxybenzyl)amine, bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithioterephthalate, bis(3,5-di-tert-butyl-4-hydroxybenzyl)sulfide, isooctyl-3,5-di-tert-butyl-4-hydroxybenzylmercaptoacetate.

1.8. Hydroxybenzylated malonates, for example dioctadecyl-2,2-bis(3,5-di-tert-butyl-2-hydroxybenzyl)malonate, di-octadecyl-2-(3-tert-butyl-4-hydroxy-5-methylbenzyl)malonate, di-dodecylmercaptoethyl-2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate, bis[4-(1,1,3,3-tetramethylbutyl)phenyl]-2,2-bis(3,5-di-tert-butyl-4-hydroxybenzyl)malonate.

1.9. Aromatic hydroxybenzyl compounds, for example 1,3,5-tris(3,5-di-tert-butyl-4-hydroxybenzyl)-2,4,6-trimethylbenzene, 1,4-bis(3,5-di-tert-butyl-4-hydroxybenzyl)-2,3,5,6-tetramethylbenzene, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxybenzyl)phenol.

1.10. Triazine compounds, for example 2,4-bis(octylmercapto)-6-(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyanilino)-1,3,5-triazine, 2-octylmercapto-4,6-bis(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,3,5-triazine, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenoxy)-1,2,3-triazine, 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, 2,4,6-tris(3,5-di-tert-butyl-4-hydroxyphenylethyl)-1,3,5-triazine, 1,3,5-tris(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)-hexahydro-1,3,5-triazine, 1,3,5-tris(3,5-dicyclohexyl-4-hydroxybenzyl)isocyanurate.

1.11. Benzylphosphonates, for example dimethyl-2,5-di-tert-butyl-4-hydroxybenzylphosphonate, diethyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate.

droxybenzylphosphonate, dioctadecyl-5-tert-butyl-4-hydroxy-3-methylbenzylphosphonate, the calcium salt of the monoethyl ester of 3,5-di-tert-butyl-4-hydroxybenzylphosphonic acid.

1.12. Acylaminophenols, for example 4-hydroxylauranilide, 4-hydroxystearanilide, octyl N-(3,5-di-tert-butyl-4-hydroxyphenyl)carbamate.

1.13. Esters of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, n-octanol, i-octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

1.14. Esters of β -(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, n-octanol, i-octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane; 3,9-bis[2-{3-(3-tert-butyl-4-hydroxy-5-methylphenyl)propionyloxy}-1,1-dimethylethyl]-2,4,8,10-tetraoxaspiro[5.5]undecane.

1.15. Esters of β -(3,5-dicyclohexyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

1.16. Esters of 3,5-di-tert-butyl-4-hydroxyphenyl acetic acid with mono- or polyhydric alcohols, e.g. with methanol, ethanol, octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)ox-

amide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane.

1.17. Amides of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid e.g. N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hexamethylenediamide, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)trimethylenediamide, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazide, N,N'-bis[2-(3-[3,5-di-tert-butyl-4-hydroxyphenyl]propionyloxy)ethyl]oxamide (Nau-gard®XL-1, supplied by Uniroyal).

1.18. Ascorbic acid (vitamin C)

1.19. Aminic antioxidants, for example N,N'-di-isopropyl-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'-dicyclohexyl-p-phenylenediamine, N,N'-diphenyl-p-phenylenediamine, N,N'-bis(2-naphthyl)-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, 4-(p-toluenesulfamoyl)diphenylamine, N,N'-dimethyl-N,N'-di-sec-butyl-p-phenylenediamine, diphenylamine, N-allyldiphenylamine, 4-isopropoxydiphenylamine, N-phenyl-1-naphthylamine, N-(4-tert-octylphenyl)-1-naphthylamine, N-phenyl-2-naphthylamine, octylated diphenylamine, for example p,p'-di-tert-octyldiphenylamine, 4-n-butylaminophenol, 4-butyrylamino-phenol, 4-nonanoylamino-phenol, 4-dodecanoylamino-phenol, 4-octadecanoylamino-phenol, bis(4-methoxyphenyl)amine, 2,6-di-tert-butyl-4-dimethylaminomethylphenol, 2,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylmethane, N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane, 1,2-bis[(2-methylphenyl)amino]ethane, 1,2-bis(phenylamino)propane, (o-tolyl)biguanide, bis[4-(1',3'-dimethylbutyl)phenyl]amine, tert-octylated N-phenyl-1-naphthylamine, a mixture of mono- and dialkylated tert-butyl/tert-octyldiphenylamines, a mixture of mono- and dialkylated nonyldiphenylamines, a mixture of mono- and dialkylated dodecyldiphenylamines, a mixture of mono- and dialkylated isopropyl/isohexyldiphenylamines, a mixture of mono- and dialkylated tert-butyl/diphenylamines, 2,3-dihydro-3,3-dimethyl-4H-1,4-benzothiazine, phenothiazine, a mixture of mono- and dialkylated tert-butyl/tert-octylphenothiazines, a mixture of mono- and dialkylated tert-octylphenothiazines, N-allylphenothiazine, N,N,N',N'-tetraphenyl-1,4-diaminobut-2-ene, N,N-bis-

(2,2,6,6-tetramethyl-piperid-4-yl-hexamethylenediamine, bis(2,2,6,6-tetramethylpiperid-4-yl)-sebacate, 2,2,6,6-tetramethylpiperidin-4-one, 2,2,6,6-tetramethylpiperidin-4-ol.

2. UV absorbers and light stabilisers

2.1. 2-(2'-Hydroxyphenyl)benzotriazoles, for example 2-(2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)phenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chlorobenzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octyloxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)benzotriazole, 2-(3',5'-bis(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonyl]phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl)phenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonyl]phenyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonyl)phenyl)benzotriazole, 2,2'-methylenebis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazole-2-ylphenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonyl)phenyl]-2H-benzotriazole with polyethylene glycol 300; $\left[\text{R}-\text{CH}_2\text{CH}_2-\text{COO}-\text{CH}_2\text{CH}_2 \right]_2$, where R = 3'-tert-butyl-4'-hydroxy-5'-2H-benzotriazol-2-ylphenyl, 2-[2'-hydroxy-3'-(α,α -dimethylbenzyl)-5'-(1,1,3,3-tetramethylbutyl)phenyl]benzotriazole; 2-[2'-hydroxy-3'-(1,1,3,3-tetramethylbutyl)-5'-(α,α -dimethylbenzyl)phenyl]benzotriazole.

2.2. 2-Hydroxybenzophenones, for example the 4-hydroxy, 4-methoxy, 4-octyloxy, 4-decyloxy, 4-dodecyloxy, 4-benzyloxy, 4,2',4'-trihydroxy and 2'-hydroxy-4,4'-dimethoxy derivatives.

2.3. Esters of substituted and unsubstituted benzoic acids, for example 4-tert-butylphenyl salicylate, phenyl salicylate, octylphenyl salicylate, dibenzoyl resorcinol, bis(4-tert-butylbenzoyl)resorcinol, benzoyl resorcinol, 2,4-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzo-

ate, hexadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, octadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, 2-methyl-4,6-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate.

2.4. Acrylates, for example ethyl α -cyano- β,β -diphenylacrylate, isooctyl α -cyano- β,β -diphenylacrylate, methyl α -carbomethoxycinnamate, methyl α -cyano- β -methyl-p-methoxycinnamate, butyl α -cyano- β -methyl-p-methoxycinnamate, methyl α -carbomethoxy-p-methoxycinnamate and N-(β -carbomethoxy- β -cyanovinyl)-2-methylindoline.

2.5. Nickel compounds, for example nickel complexes of 2,2'-thiobis[4-(1,1,3,3-tetramethylbutyl)phenol], such as the 1:1 or 1:2 complex, with or without additional ligands such as n-butylamine, triethanolamine or N-cyclohexyldiethanolamine, nickel dibutyldithiocarbamate, nickel salts of the monoalkyl esters, e.g. the methyl or ethyl ester, of 4-hydroxy-3,5-di-tert-butylbenzylphosphonic acid, nickel complexes of ketoximes, e.g. of 2-hydroxy-4-methylphenylundecylketoxime, nickel complexes of 1-phenyl-4-lauroyl-5-hydroxypyrazole, with or without additional ligands.

2.6. Conventional sterically hindered amines, for example bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate, bis(2,2,6,6-tetramethyl-4-piperidyl)succinate, bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacate, bis(1,2,2,6,6-pentamethyl-4-piperidyl) n-butyl-3,5-di-tert-butyl-4-hydroxybenzylmalonate, the condensate of 1-(2-hydroxyethyl)-2,2,6,6-tetramethyl-4-hydroxypiperidine and succinic acid, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-tert-octylamino-2,6-dichloro-1,3,5-triazine, tris(2,2,6,6-tetramethyl-4-piperidyl)nitrilotriacetate, tetrakis(2,2,6,6-tetramethyl-4-piperidyl)-1,2,3,4-butanetetracarboxylate, 1,1'-(1,2-ethanediyl)-bis(3,3,5,5-tetramethylpiperazinone), 4-benzoyl-2,2,6,6-tetramethylpiperidine, 4-stearyloxy-2,2,6,6-tetramethylpiperidine, bis(1,2,2,6,6-pentamethylpiperidyl)-2-n-butyl-2-(2-hydroxy-3,5-di-tert-butylbenzyl)malonate, 3-n-octyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-morpholino-2,6-dichloro-1,3,5-triazine, the condensate of 2-chloro-4,6-bis(4-n-butylamino-2,2,6,6-tetramethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, the condensate of 2-chloro-4,6-di-(4-n-butylamino-1,2,2,6,6-pentamethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, 8-acetyl-3-dodecyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, 3-dodecyl-1-(2,2,6,6-tetramethyl-4-piperidyl)pyrrolidine-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione, 5-(2-

ethylhexanoyl)-oxymethyl-3,3,5-trimethyl-2-morpholinone, 1,3,5-tris(N-cyclohexyl-N-(2,2,6,6-tetramethylpiperazin-3-on-4-yl)amino)-s-triazine, 1,3,5-tris(N-cyclohexyl-N-(1,2,2,6,6-pentamethylpiperazin-3-on-4-yl)amino)-s-triazine, a mixture of 4-hexadecyloxy- and 4-stearyloxy-2,2,6,6-tetramethylpiperidine, a condensate of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-cyclohexylamino-2,6-dichloro-1,3,5-triazine, a condensate of 1,2-bis(3-aminopropylamino)ethane and 2,4,6-trichloro-1,3,5-triazine as well as 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [136504-96-6]); a condensate of 1,6-hexanediamine and 2,4,6-trichloro-1,3,5-triazine as well as N,N-dibutylamine and 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [192268-64-7]); N-(2,2,6,6-tetramethyl-4-piperidyl)-n-dodecylsuccinimide, N-(1,2,2,6,6-pentamethyl-4-piperidyl)-n-dodecylsuccinimide, 2-undecyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxo-spiro[4,5]decane, a reaction product of 7,7,9,9-tetramethyl-2-cycloundecyl-1-oxa-3,8-diaza-4-oxospiro[4,5]decane and epichlorohydrin, 1,1-bis(1,2,2,6,6-pentamethyl-4-piperidyl)oxycarbonyl-2-(4-methoxyphenyl)ethene, N,N'-bis-formyl-N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)-hexamethylenediamine, a diester of 4-methoxymethylenemalonic acid with 1,2,2,6,6-pentamethyl-4-hydroxypiperidine, poly[methylpropyl-3-oxy-4-(2,2,6,6-tetramethyl-4-piperidyl)]siloxane, a reaction product of maleic acid anhydride- α -olefin copolymer with 2,2,6,6-tetramethyl-4-aminopiperidine or 1,2,2,6,6-pentamethyl-4-aminopiperidine.

2.7. Oxamides, for example 4,4'-dioctyloxyoxanilide, 2,2'-diethoxyoxanilide, 2,2'-dioctyloxy-5,5'-di-tert-butoxanilide, 2,2'-didodecyloxy-5,5'-di-tert-butoxanilide, 2-ethoxy-2'-ethyloxanilide, N,N'-bis(3-dimethylaminopropyl)oxamide, 2-ethoxy-5-tert-butyl-2'-ethoxanilide and its mixture with 2-ethoxy-2'-ethyl-5,4'-di-tert-butoxanilide, mixtures of o- and p-methoxy-disubstituted oxanilides and mixtures of o- and p-ethoxy-disubstituted oxanilides.

2.8. 2-(2-Hydroxyphenyl)-1,3,5-triazines, for example 2,4,6-tris(2-hydroxy-4-octyloxyphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2,4-dihydroxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-tridecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-butyloxypropoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxypropyloxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[4-(dodecyloxy/tridecyloxy-2-hydroxypropoxy)-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-dodecyloxypropoxy)phenyl]-4,6-

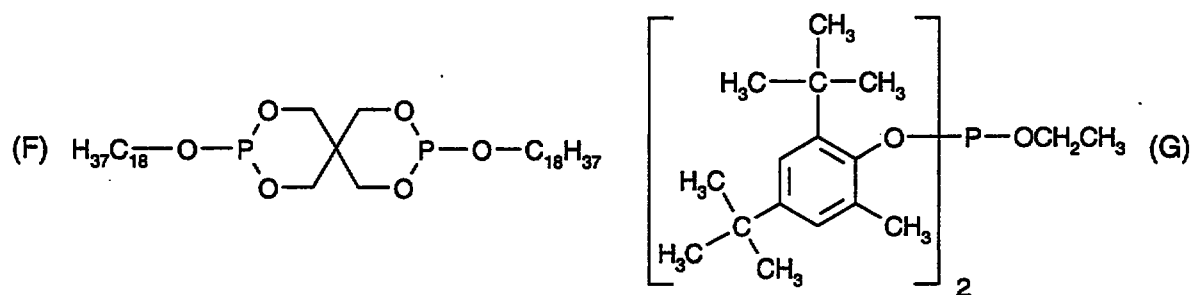
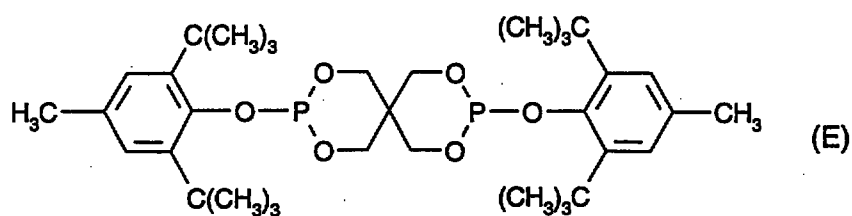
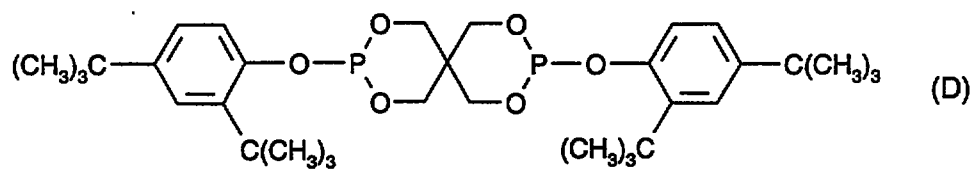
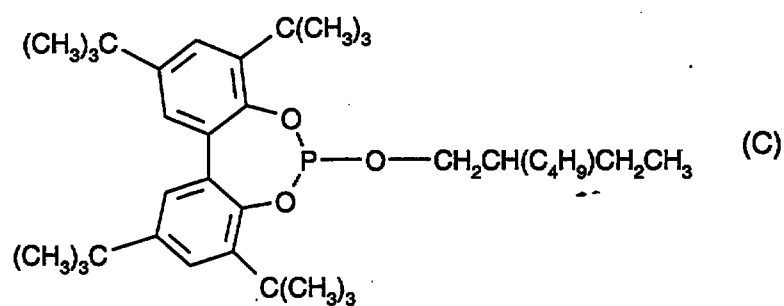
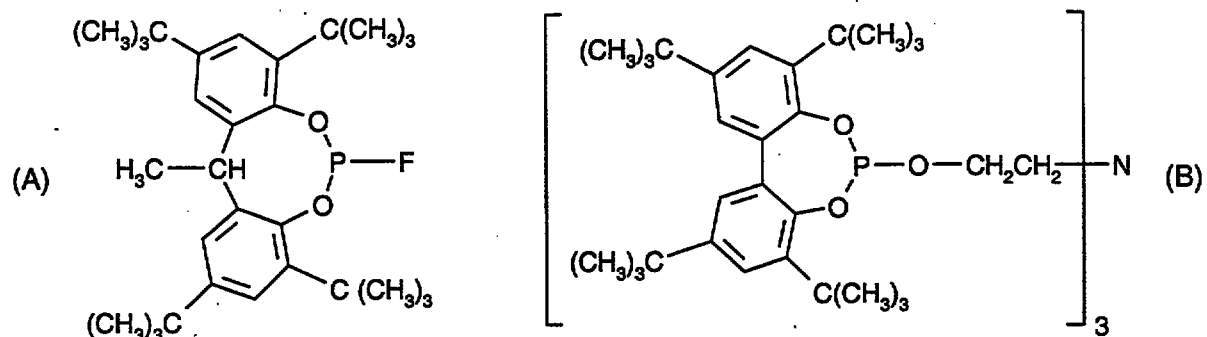
bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-hexyloxy)phenyl-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-methoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2,4,6-tris[2-hydroxy-4-(3-butoxy-2-hydroxypropoxy)phenyl]-1,3,5-triazine, 2-(2-hydroxyphenyl)-4-(4-methoxyphenyl)-6-phenyl-1,3,5-triazine, 2-{2-hydroxy-4-[3-(2-ethylhexyl-1-oxy)-2-hydroxypropyloxy]phenyl}-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine.

3. Metal deactivators, for example N,N'-diphenyloxamide, N-salicylal-N'-salicyloyl hydrazine, N,N'-bis(salicyloyl)hydrazine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl)hydrazine, 3-salicyloylamino-1,2,4-triazole, bis(benzylidene)oxalyl dihydrazide, oxanilide, isophthaloyl dihydrazide, sebacoyl bisphenylhydrazide, N,N'-diacetyl adipoyl dihydrazide, N,N'-bis(salicyloyl)oxalyl dihydrazide, N,N'-bis(salicyloyl)thiopropionyl dihydrazide.

4. Phosphites and phosphonites, for example triphenyl phosphite, diphenylalkyl phosphites, phenyldialkyl phosphites, tris(nonylphenyl) phosphite, trilauryl phosphite, trioctadecyl phosphite, distearyl pentaerythritol diphosphite, tris(2,4-di-tert-butylphenyl) phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl) pentaerythritol diphosphite, bis(2,4-di-cumylphenyl) pentaerythritol diphosphite, bis(2,6-di-tert-butyl-4-methylphenyl) pentaerythritol diphosphite, diisodecyl oxypentaerythritol diphosphite, bis(2,4-di-tert-butyl-6-methylphenyl) pentaerythritol diphosphite, bis(2,4,6-tris(tert-butylphenyl) pentaerythritol diphosphite, tristearyl sorbitol triphosphite, tetrakis(2,4-di-tert-butylphenyl) 4,4'-biphenylene diphosphonite, 6-isooctyloxy-2,4,8,10-tetra-tert-butyl-12H-dibenz[d,g]-1,3,2-dioxaphosphocin, bis(2,4-di-tert-butyl-6-methylphenyl)methyl phosphite, bis(2,4-di-tert-butyl-6-methylphenyl)ethyl phosphite, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenz[d,g]-1,3,2-dioxaphosphocin, 2,2',2''-nitriolo-[triethyltris(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite], 2-ethylhexyl(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite, 5-butyl-5-ethyl-2-(2,4,6-tri-tert-butylphenoxy)-1,3,2-dioxaphosphirane.

The following phosphites are especially preferred:

Tris(2,4-di-tert-butylphenyl) phosphite (Irgafos®168, Ciba-Geigy), tris(nonylphenyl) phosphite,



5. Hydroxylamines, for example N,N-dibenzylhydroxylamine, N,N-diethylhydroxylamine, N,N-dioctylhydroxylamine, N,N-dilaurylhydroxylamine, N,N-ditetradecylhydroxylamine, N,N-dihexadecylhydroxylamine, N,N-dioctadecylhydroxylamine, N-hexadecyl-N-octadecylhydroxylamine, N-heptadecyl-N-octadecylhydroxylamine, N,N-dialkylhydroxylamine derived from hydrogenated tallow amine.

6. Nitrones, for example N-benzyl-alpha-phenylnitron, N-ethyl-alpha-methylnitron, N-octyl-alpha-heptylnitron, N-lauryl-alpha-undecylnitron, N-tetradecyl-alpha-tridecylnitron, N-hexadecyl-alpha-pentadecylnitron, N-octadecyl-alpha-heptadecylnitron, N-hexadecyl-alpha-heptadecylnitron, N-octadecyl-alpha-pentadecylnitron, N-heptadecyl-alpha-heptadecylnitron, N-octadecyl-alpha-hexadecylnitron, nitron derived from N,N-dialkylhydroxylamine derived from hydrogenated tallow amine.

7. Thiosynergists, for example dilauryl thiodipropionate or distearyl thiodipropionate.

8. Peroxide scavengers, for example esters of β -thiodipropionic acid, for example the lauryl, stearyl, myristyl or tridecyl esters, mercaptobenzimidazole or the zinc salt of 2-mercaptobenzimidazole, zinc dibutyldithiocarbamate, dioctadecyl disulfide, pentaerythritol tetrakis(β -dodecylmercapto)propionate.

9. Polyamide stabilisers, for example copper salts in combination with iodides and/or phosphorus compounds and salts of divalent manganese.

10. Basic co-stabilisers, for example melamine, polyvinylpyrrolidone, dicyandiamide, triallyl cyanurate, urea derivatives, hydrazine derivatives, amines, polyamides, polyurethanes, alkali metal salts and alkaline earth metal salts of higher fatty acids, for example calcium stearate, zinc stearate, magnesium behenate, magnesium stearate, sodium ricinoleate and potassium palmitate, antimony pyrocatecholate or zinc pyrocatecholate.

11. Nucleating agents, for example inorganic substances, such as talcum, metal oxides, such as titanium dioxide or magnesium oxide, phosphates, carbonates or sulfates of, preferably, alkaline earth metals; organic compounds, such as mono- or polycarboxylic acids and the salts thereof, e.g. 4-tert-butylbenzoic acid, adipic acid, diphenylacetic acid, sodium succinate

or sodium benzoate; polymeric compounds, such as ionic copolymers (ionomers). Especially preferred are 1,3:2,4-bis(3',4'-dimethylbenzylidene)sorbitol, 1,3:2,4-di(paramethyldibenzylidene)sorbitol, and 1,3:2,4-di(benzylidene)sorbitol.

12. Fillers and reinforcing agents, for example calcium carbonate, silicates, glass fibres, glass beads, asbestos, talc, kaolin, mica, barium sulfate, metal oxides and hydroxides, carbon black, graphite, wood flour and flours or fibers of other natural products, synthetic fibers.

13. Other additives, for example plasticisers, lubricants, emulsifiers, pigments, rheology additives, catalysts, flow-control agents, optical brighteners, flameproofing agents, antistatic agents and blowing agents.

14. Benzofuranones and indolinones, for example those disclosed in U.S. 4,325,863; U.S. 4,338,244; U.S. 5,175,312; U.S. 5,216,052; U.S. 5,252,643; DE-A-4316611; DE-A-4316622; DE-A-4316876; EP-A-0589839 or EP-A-0591102 or 3-[4-(2-acetoxyethoxy)-phenyl]-5,7-di-tert-butyl-benzofuran-2-one, 5,7-di-tert-butyl-3-[4-(2-stearoyloxyethoxy)phenyl]benzofuran-2-one, 3,3'-bis[5,7-di-tert-butyl-3-(4-[2-hydroxyethoxy]phenyl)benzofuran-2-one], 5,7-di-tert-butyl-3-(4-ethoxyphenyl)benzofuran-2-one, 3-(4-acetoxy-3,5-dimethylphenyl)-5,7-di-tert-butyl-benzofuran-2-one, 3-(3,5-dimethyl-4-pivaloyloxyphenyl)-5,7-di-tert-butyl-benzofuran-2-one, 3-(3,4-dimethylphenyl)-5,7-di-tert-butyl-benzofuran-2-one, 3-(2,3-dimethylphenyl)-5,7-di-tert-butyl-benzofuran-2-one.

15. Amine oxides, for example amine oxide derivatives as disclosed in U.S. Patent Nos. 5,844,029 and 5,880,191, didecyl methyl amine oxide, tridecyl amine oxide, tridodecyl amine oxide and trihexadecyl amine oxide. U.S. Patent Nos. 5,844,029 and 5,880,191 disclose the use of saturated hydrocarbon amine oxides towards the stabilization of thermoplastic resins. It is disclosed that the thermoplastic compositions may further contain a stabilizer or mixture of stabilizers selected from phenolic antioxidants, hindered amine light stabilizers, ultraviolet light absorbers, organic phosphorus compounds, alkaline metal salts of fatty acids and thiosynergists. The co-use of amine oxides with other stabilizers towards stabilizing polyolefins is not exemplified.

Further preferred compositions comprise, in addition to components (b) and (c) further additives, in particular phenolic antioxidants, light stabilizers or processing stabilizers.

Particularly preferred additives are phenolic antioxidants (item 1 of the list), further sterically hindered amines (item 2.6 of the list), light stabilizers of the benzotriazole and/or o-hydroxyphenyltriazine class (items 2.1 and 2.8 of the list), phosphites and phosphonites (item 4 of the list) and peroxide-destroying compounds (item 5.) of the list.

Additional additives (stabilizers) which are also particularly preferred are benzofuran-2-ones, such as described, for example, in US-A-4,325,863, US-A-4,338,244 or US-A-5,175,312.

The instant composition can additionally contain another UV absorber selected from the group consisting of the s-triazines, the oxanilides, the hydroxybenzophenones, benzoates and the α -cyanoacrylates. Particularly, the instant composition may additionally contain an effective stabilizing amount of at least one other 2-hydroxyphenyl-2H-benzotriazole; another tris-aryl-s-triazine; or hindered amine or mixtures thereof. Preferred are additional components selected from pigments, dyes, plasticizers, antioxidants, thixotropic agents, levelling assistants, basic costabilizers, further light stabilizers like UV absorbers and/or sterically hindered amines, metal passivators, metal oxides, organophosphorus compounds, hydroxylamines, and mixtures thereof, especially pigments, phenolic antioxidants, calcium stearate, zinc stearate, UV absorbers of the 2-(2'-hydroxyphenyl)benzotriazole and 2-(2-Hydroxyphenyl)-1,3,5-triazine classes, and sterically hindered amines.

It is one of the findings of present invention that an especially improved performance, both in light stability and flame retardancy, may be obtained if the thermoplastic polymer contains, besides the flame retardant, a combination of a conventional sterically hindered amine of high molecular weight with a low molecular weight sterically hindered amine of the hydroxyhydrocarbyloxyamine class. Thus, present invention also pertains to a flame retardant composition stabilized against deleterious effects of light and weathering comprising

- A) a thermoplastic polymer,
- B) a flame retardant selected from ammonium polyphosphate, halogenated and/or melamin based flame retardants, and
- C) a combination of sterically hindered amine light stabilizers comprising
 - C1) a low molecular weight sterically hindered amine of the hydroxyhydrocarbyloxyamine class, and

C2) a conventional high molecular weight sterically hindered amine.

Preferred polymers (A) in these compositions are as initially explained (a).

The halogenated flame retardants useful as component (B) in compositions of present invention may be selected from organic aromatic halogenated compounds such as halogenated benzenes, biphenyls, phenols, ethers or esters thereof, bisphenols, diphenyloxides, aromatic carboxylic acids or polyacids, anhydrides, amides or imides thereof; organic cycloaliphatic or polycycloaliphatic halogenated compounds; and organic aliphatic halogenated compounds such as halogenated paraffins, oligo- or polymers, alkylphosphates or alkylisocyanurates. These components are largely known in the art, see e.g. US patents Nos. 4,579,906 (e.g. col. 3, lines 30-41), 5,393,812; see also *Plastics Additives Handbook*, Ed. by H. Zweifel, 5th Ed., Hanser Publ., Munich 2001, pp. 681-698.

The halogenated flame retardant may be, for example, a chlorinated or brominated compound, e.g. selected from the following compounds:

Chloroalkyl phosphate esters (ANTIBLAZE[®] AB-100, Albright & Wilson; FYROL[®] FR-2, Akzo Nobel),

polybrominated diphenyl oxide (DE-60F, Great Lakes Corp.),

decabromodiphenyl oxide (DBDPO; SAYTEX[®] 102E),

tris[3-bromo-2,2-bis(bromomethyl)propyl] phosphate (PB 370[®], FMC Corp.),

bis(2,3-dibromopropyl ether) of bisphenol A (PE68),

brominated epoxy resin,

ethylene-bis(tetrabromophthalimide) (SAYTEX[®] BT-93),

bis(hexachlorocyclopentadieno)cyclooctane (DECLORANE PLUS[®]),

chlorinated paraffins,

1,2-bis(tribromophenoxy)ethane (FF680),

tetrabromo-bisphenol A (SAYTEX[®] RB100),

ethylene bis-(dibromo-norbornanedicarboximide) (SAYTEX[®] BN-451),

bis-(hexachlorocyclopentadieno) cyclooctane,

tris-(2,3-dibromopropyl)-isocyanurate,

ethylene-bis-tetrabromophthalimide.

Preferred as component (B) are brominated flame retardants.

Most preferred flame retardants (B) in these compositions of the invention are

- B1) melamin based flame retardants and/or ammonium polyphosphate,
- B2) bis-(hexachlorocyclopentadieno) cyclooctane,
- B3) tris-(2,3-dibromopropyl)-isocyanurate,
- B4) ethylene-bis-tetrabromophthalimide,
- B5) 1,2,5,6,9,10-hexabromo-cyclo-dodecan,
- B6) ethane-1,2-bis(pentabromophenyl),
- B7) tris(3-bromo-2,2-(bromomethyl)propyl) phosphate.

Especially preferred flame retardants (B) in these compositions of the invention are as initially explained for component (b).

The flame retardant (B) is often contained in an amount from 0.5 to 50 % by weight of the polymeric substrate (A); more preferred dosages for the most preferred flame retardants (B) are as initially explained for component (b).

The ratio (B) : (C) in these compositions is preferably in the range from 20 : 1 to 250 : 1.

The ratio (C1) : (C2) in these compositions is often in the range from 1 : 5 to 5 : 1. In case that the polymeric substrate (A) is a polyolefin, the low molecular weight component (C1) is preferably used in about the same or in a larger amount than (C2), e.g. 40 – 95 parts by weight of (C1) on 100 total parts by weight of component (C) consisting of (C1) and (C2).

In a polyolefin with main component polyethylene, the low molecular weight part (C1) often will amount about half of the total amount of component (C), e.g. from 40 to about 70, more specifically from 45 to about 55 % by weight of total component (C).

In a polyolefin with main component polypropylene, the low molecular weight part (C1) often will amount rather more than half of the total amount of component (C), e.g. from 50 to about 90, more specifically from 60 to about 85 % by weight of total component (C).

Under such conditions in a polyolefin, the low molecular weight component (C1) may also be of the hydrocarbyloxyamine class. Thus, another object of the invention pertains to a composition comprising

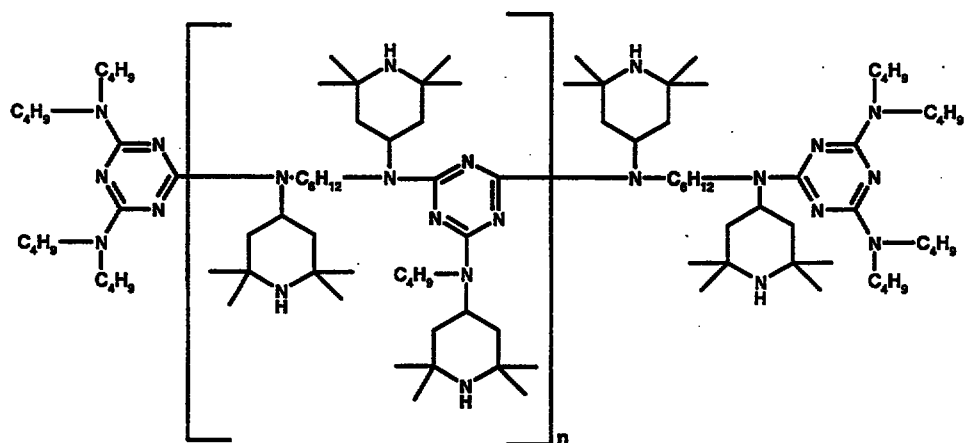
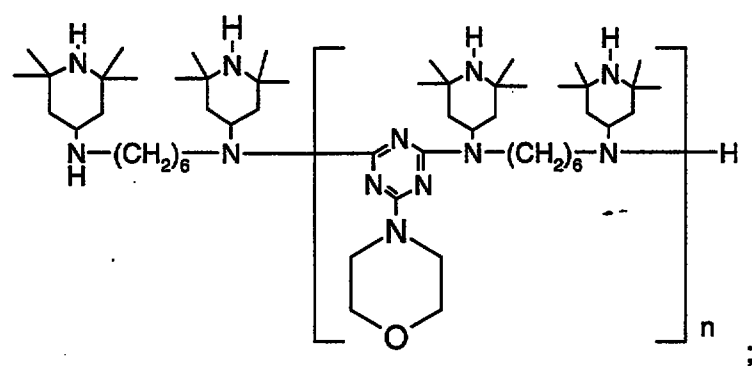
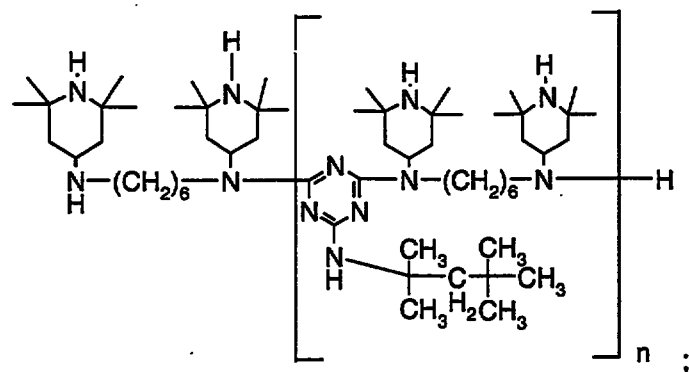
- A) a polyolefin,
- B) a flame retardant selected from ammonium polyphosphate, halogenated and/or melamin based flame retardants, and
- C) a combination of sterically hindered amine light stabilizers comprising, on 100 parts by weight of total component (C),
 - C1) 40 to 95 parts by weight a low molecular weight sterically hindered amine of the hydrocarbyloxyamine class; and
 - C2) 5 to 60 parts by weight of a conventional high molecular weight sterically hindered amine.

The low molecular weight sterically hindered amine of the hydroxyhydrocarbyloxyamine or, where appropriate, hydrocarbyloxyamine class (C1) usually is from the molecular weight range 200 to 1000 g/mol, especially 300 to 800 g/mol. It may be one compound or a mixture of compounds, each fulfilling the molecular weight condition. Especially preferred are, for example,

- 1-cyclohexyloxy-2,2,6,6-tetramethyl-4-octadecylaminopiperidine;
- bis(1-octyloxy-2,2,6,6-tetramethylpiperidin-4-yl) sebacate;
- bis(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidin-4-yl) adipate;
- 1-(2-hydroxy-2-methylpropoxy)-4-octadecanoyloxy-2,2,6,6-tetramethylpiperidine.

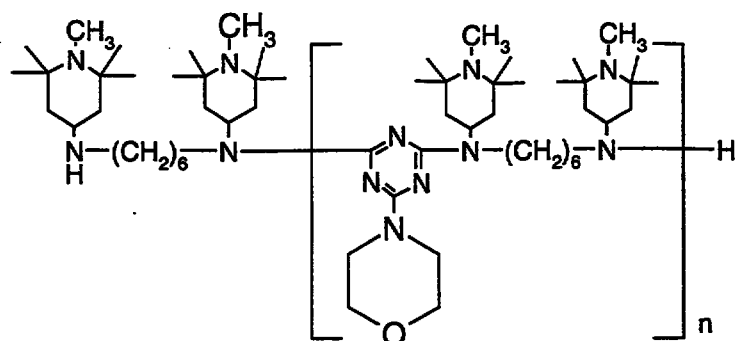
The high molecular weight sterically hindered amine (C2) is of the conventional type containing 2,2,6,6-tetramethyl-4-piperidyl moieties whose nitrogen atoms are unsubstituted (secondary sterically hindered amine) or substituted by alkyl, especially methyl (alkylated tertiary sterically hindered amine) or are part of a polymeric backbone (polymeric tertiary sterically hindered amine). It usually is from the molecular weight range 1200 to 10000 g/mol, especially 1500 to 5000 g/mol. Examples for such compounds useful in the composition of the invention can be found among those listed under item 2.6 above, e.g. the following compounds:

Examples for secondary sterically hindered amines of high molecular weight



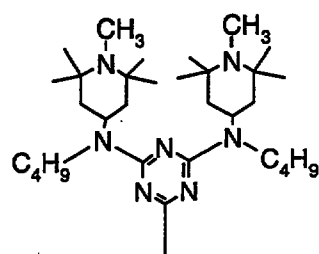
where n is mainly from the range 3-5.

Examples for methylated tertiary sterically hindered amines of high molecular weight



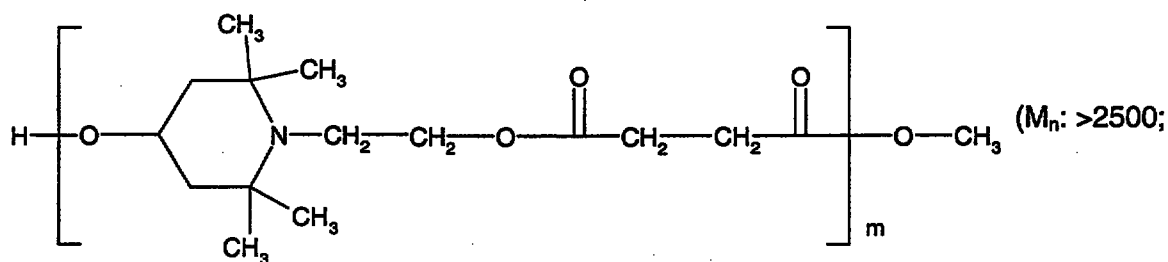
with n as defined above;

$R-NH-(CH_2)_3-N(R)-(CH_2)_2-N(R)-(CH_2)_3-NH-R$, wherein R is



(CAS-No. 106990-43-6).

Example for polymeric tertiary sterically hindered amine of high molecular weight



CAS-No. 65447-77-0).

Especially preferred compounds of component (C2) are those containing 2,2,6,6-tetramethyl-4-piperidyl moieties whose nitrogen atoms are unsubstituted or alkyl, especially methyl substituted. Especially preferred compounds of component (C2) are also containing triazine moieties as structural backbones.

In general, component (C) is contained in an amount from 0.01 to 10 %, preferably from 0.05 to 5% by weight, especially from 0.1 to 3 % by weight, based on the polymer component (A). The weight ratio (C1) : (C2) preferably ranges from 1 : 10 to 10 : 1; most preferably from 1 : 1 to 10 : 1.

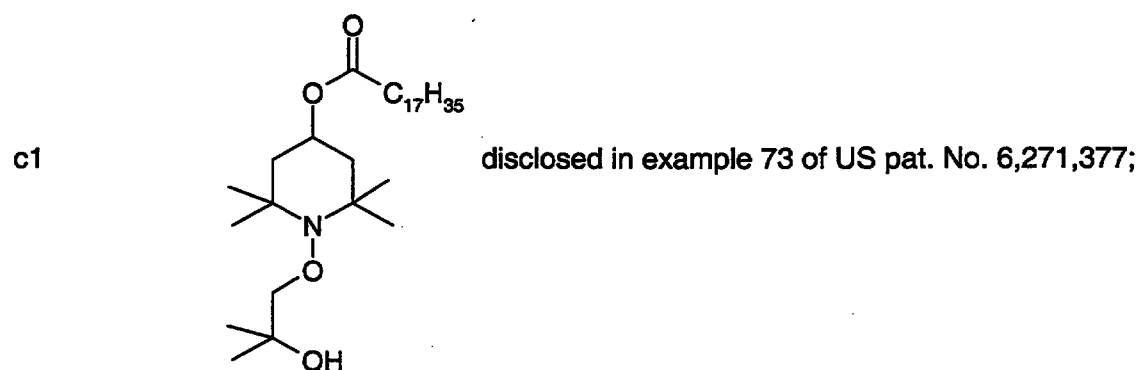
Further components optionally to be used in these compositions of the invention, and methods of using them, are as initially explained.

The following examples are for illustrative purposes only and are not to be construed to limit the instant invention in any manner whatsoever. Room temperature depicts a temperature in the range 20-25°C. Percentages are by weight unless otherwise indicated.

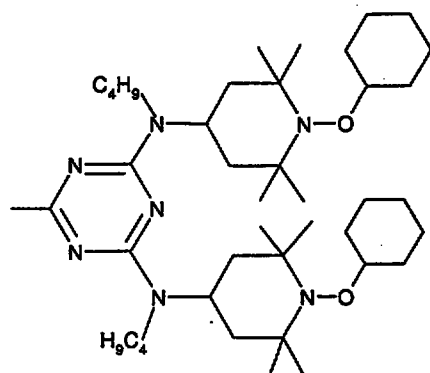
Abbreviations:

v	parts by volume
w	parts by weight
$^1\text{Hnmr}$	nuclear magnetic resonance (NMR) of ^1H
m/z	mass spectrometry (atomic units)
amu	molecular weight in g/mol (= atomic units)
M_n	number average of molecular weight (usually determined by GPC)
PP	polypropylene
PE	polyethylene
PE-LD	low density polyethylene (LDPE)

Sterically hindered amines of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class (present component c) for use in the examples are the compounds



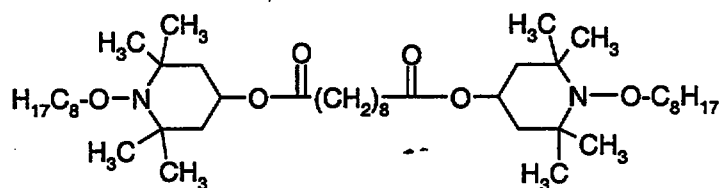
c2 mixture of compounds with main component of the formula
 $R_1\text{NH-CH}_2\text{CH}_2\text{CH}_2\text{NR}_2\text{CH}_2\text{CH}_2\text{NR}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NHR}_4$
wherein 3 of R_1 , R_2 , R_3 and R_4 are residues of formula



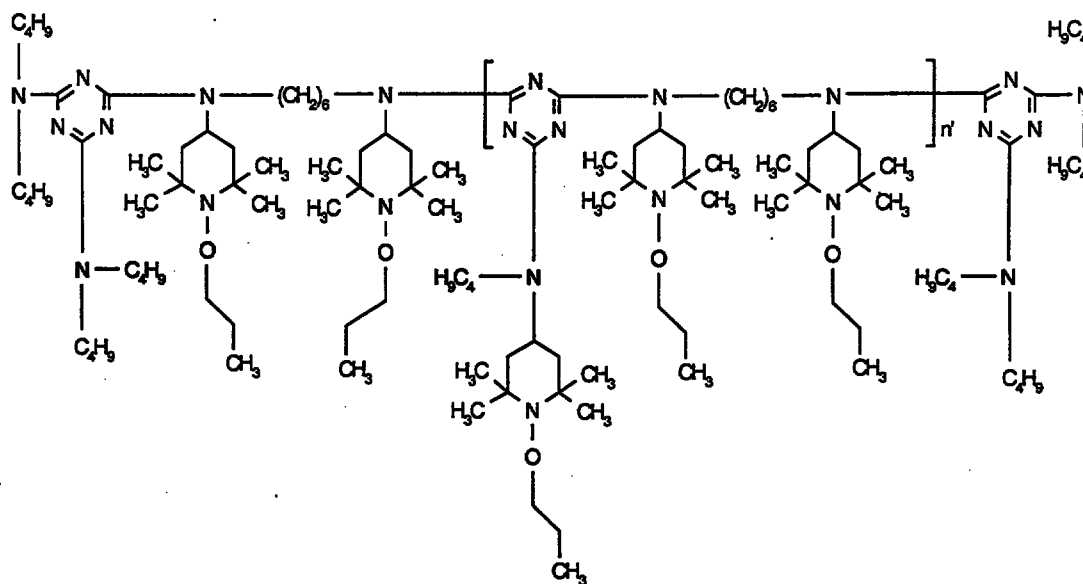
and 1 of R₁, R₂, R₃ and R₄ is hydrogen

(c2 is disclosed in example 3 of US-5844026)

c3



c4

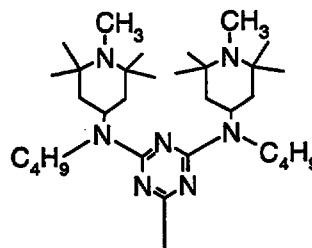


(example 2 of US-6117995).

Further stabilizers used in the examples are compounds of formulae

A $R-NH-(CH_2)_3-N(R)-(CH_2)_2-N(R)-(CH_2)_3-NH-R$ (CAS Registry No. 106990-43-6)

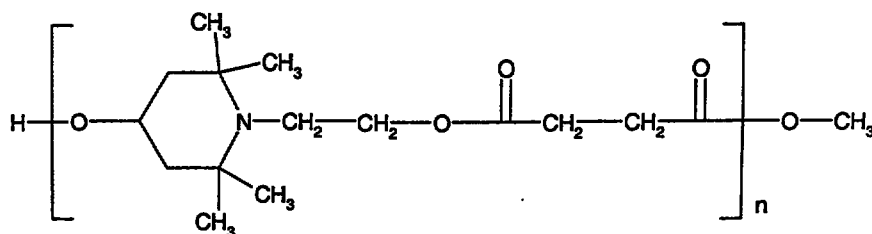
where R is the group



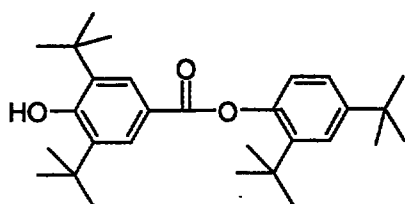
B poly [[6-[(1,1,3,3-tetramethyl butyl) amino]-1,3,5-triazine-2,4-diyl]][(2,2,6,6-tetramethyl-4-piperidyl) imino] hexamethylene [(2,2,6,6-tetramethyl-4-piperidyl) imino]] (CAS-No. 70624-18-9)

C bis(2,2,6,6-tetramethylpiperidin-4-yl)-sebacate (CAS-No. 52829-07-9)

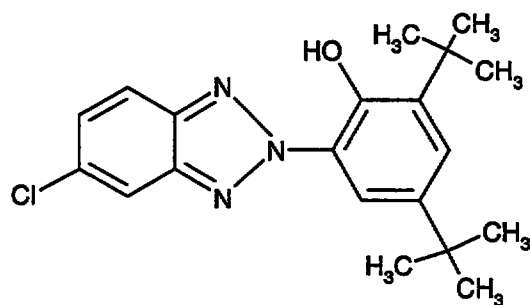
D oligomer (CAS-No. 65447-77-0) of the formula



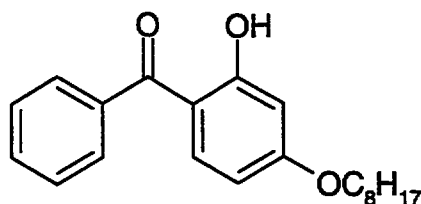
E



F



G



Compounds c2, c3 and A-G are commercial stabilizers available from Ciba Specialty Chemicals.

Example 1

Sample preparation: Polymer powder and stabilizers are pre-mixed (Henschel mixer, 800 rpm, room temperature), pigment powder and flame retardant are added as-concentrate in PP and homogenized in a drum mixer. Further homogenization and granulation is achieved by extrusion (Collin® twin screw extruder, max 200°C, 100 rpm).

Subsequently, the mixture is processed into a flat film by means of a single screw extruder (max 200°C, 70 rpm) equipped with a corresponding nozzle (sample dimension 2mm thickness, 10 cm width).

Weathering: Punched samples are exposed to accelerated weathering (Atlas® WOM Ci 65, 0.35W/m² (at 340nm), 102 min dry, 18 min water spray, 63°C black panel temperature. The effect of weathering on the surface is assessed in the following manner:

Visual inspection of chalking (chalking indicates decomposition on the surface).

Gloss: Minolta; degradation of surface reduces the reflection of polarized light (60° gloss as defined in DIN 67530).

Δ E: Colour change (according to DIN 6174).

Formulation:

- 84 parts by weight of polypropylene-ethylene copolymer (Novolen® PPG 1022),
- 15 parts by weight of a PE-based flame retardant masterbatch containing 51% by weight of ethylene-bis-tetrabromophthalimide (b4) and 17 % by weight of Sb₂O₃,
- 1 part by weight of TiO₂ and
- 0.2 parts by weight of blue pigment (Cromophtal blue 4GNP)

and stabilizers as shown in the following table (amounts given in % by weight of the total formulation).

The results are shown in the following table.

Table: Surface assessment after weathering for 2000 h

Exp. #	Stabilizers	Visual	Gloss	ΔE
a*	none	chalking	3	5.9
b	0.3% c1 0.1% B 0.2% F	unchanged	53	1.5
c*	0.3% C 0.1% B 0.2% F	chalking	8	4.6
d	0.3% c1 0.1% B 0.2% E	unchanged	51	2.8
e *	0.3% C 0.1% B 0.2% E	chalking	8	5.9

* comparative example

Samples containing the combination of flame retardant and sterically hindered amine of present invention show no chalking, better gloss and distinctly less colour change than samples wherein present component c has been replaced by another sterically hindered amine.

Example 2

Samples are prepared and subjected to accelerated weathering as described in example 1.

Formulation:

89 parts by weight of polypropylene-ethylene copolymer (Novolen® PPG 1022),
 10 parts by weight of a PE based flame retardant masterbatch containing 30% by weight of tris-(2,3-dibromopropyl)-isocyanurate (b3) and 15 % Sb₂O₃,
 1 part by weight of TiO₂ and
 0.2 parts by weight of blue pigment (Cromophtal blue 4GNP)
 and stabilizers as shown in the following table (amounts given in % by weight of the total formulation). The results are shown in the following table.

Table: Surface assessment after weathering for 2000 h

Exp. #	Stabilizers	Visual	Gloss	ΔE
a*	none	chalking	8	7.5
b	0.3% c1 0.1% B 0.2% F	unchanged	58	1.7
c *	0.3% C 0.1% B 0.2% F	chalking	12	6.4
d	0.3% c3 0.1% B 0.2% E	unchanged	57	3
e	0.3% c1 0.1% B 0.2% E	unchanged	63	2.3
f *	0.3% C 0.1% B 0.2% E	chalking	14	7.1

* comparative example

Replacing compound c3 in the above example by the same amount of c2 or c4 also leads to superior properties.

Example 3

Sample preparation: Polymer powder, flame retardant and stabilizers are pre-mixed (Henschel mixer, 800 rpm, room temperature), pigment is added as concentrate in PE-LD and homogenized in a drum mixer. Further homogenization and granulation is achieved by extrusion (Berstorff® twin screw extruder (max 220°C, 100 rpm).

Test samples (44 x 68 x 2 mm) are obtained by compression moulding (Engel) at a plastification temperature of max 200°C and a forming temperature of 50°C.

Accelerated weathering and assessment of the samples is done as described in example 1.

Formulation:

73 parts by weight of polypropylene-ethylene copolymer (Appryl ® 3060),
25 parts by weight of melamin polyphosphate (flame retardant b1, Melapur® P 46),
2 parts by weight of blue pigment masterbatch (10% Cromophtal blue 4GNP in PE-LD)
0.15 parts by weight of a commercial phenolic antioxidant (1 : 1 mixture of tris(2,4-di-t-butylphenyl)phosphite and pentaerythritol tetrakis[3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate], available from Ciba Specialty Chemicals)
and stabilizers as shown in the following table (amounts given in % by weight of the total formulation). The results are shown in the following table.

Table: Surface assessment after weathering for 1000 h

Exp. #	Stabilizers	Visual	Gloss	Δ E
a*	0.2% A 0.2% D	chalking	5	23.9
b	0.133% A 0.266% c1	unchanged	19	3.9

* comparative example

Example 4

Sample preparation, accelerated weathering and assessment of the samples is done as described in example 3.

Formulation:

82 parts by weight of polypropylene-ethylene copolymer (Appryl ® 3060),
12 parts by weight of bis-(hexachlorocyclopentadieno) cyclooctane (flame retardant b2, Dechloran Plus ®),
4 parts by weight of Sb₂O₃
2 parts by weight of blue pigment masterbatch (10% Cromophtal blue 4GNP in PE-LD)
0.15 parts by weight of a commercial phenolic antioxidant (1 : 1 mixture of tris(2,4-di-t-butylphenyl)phosphite and pentaerythritol tetrakis[3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate], available from Ciba Specialty Chemicals)
and stabilizers as shown in the following table (amounts given in % by weight of the total formulation). The results are shown in the following table.

Table: Surface assessment after weathering for 1000 h

Exp. #	Stabilizers	Visual	Gloss	ΔE
a*	0.2% B 0.2% C	chalking	7	5.1
b	0.2% A 0.2% c1	unchanged	35	0.7

* comparative example

Example 5

Sample preparation, accelerated weathering and assessment of the samples is done as described in example 3. Formulation is identical with the one of example 3 except that the melamin polyphosphate flame retardant is replaced by the same amount of ammonium polyphosphate (flame retardant b1; Exolith ® AP 752). Results are shown in the following table.

Table: Surface assessment after weathering for 1500 h

Exp. #	Stabilizers	Visual	Gloss	ΔE
a*	0.2% A 0.2% D	chalking	5	21.4
b	0.2% A 0.2% c1	unchanged	28	3.1

* comparative example

Example 6

Sample preparation, accelerated weathering and assessment of the samples is done as described in example 3.

Formulation:

- 92 parts by weight of polypropylene-ethylene copolymer (Appryl ® 3060),
- 4 parts by weight of tris(3-bromo-2,2-(bromomethyl)propyl) phosphat (flame retardant, FR 372 from Dead Sea Bromine),
- 2 parts by weight of Sb_2O_3
- 2 parts by weight of blue pigment masterbatch (10% Cromophtal blue 4GNP in PE-LD)
- 0.15 parts by weight of a commercial phenolic antioxidant (1 : 1 mixture of tris(2,4-di-t-butylphenyl)phosphite and pentaerythritol tetrakis[3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate], available from Ciba Specialty Chemicals)

and stabilizers as shown in the following table (amounts given in % by weight of the total formulation). The results are shown in the following table.

Table: Surface assessment after weathering for 1500 h

Exp. #	Stabilizers	Visual	Gloss	ΔE
a*	0.2% B 0.2% C	chalking	6	7.6
b	0.2% A 0.2% c1	unchalking	56	0.4
c	0.4% c1	unchalking	56	0.3

* comparative example

Example 7

Sample preparation, accelerated weathering and assessment of the samples is done as described in example 3.

Formulation:

- 88 parts by weight of polypropylene-ethylene copolymer (Appryl ® 3060),

8 parts by weight of ethane-1,2-bis(pentabromophenyl) (flame retardant b6, Saytex® 8010),

4 parts by weight of Sb_2O_3

2 parts by weight of blue pigment masterbatch (10% Cromophtal blue 4GNP in PE-LD)

0.15 parts by weight of a commercial phenolic antioxidant (1 : 1 mixture of tris(2,4-di-t-butylphenyl)phosphite and pentaerythritol tetrakis[3-(3,5-di-t-butyl-4-hydroxyphenyl)propionate], available from Ciba Specialty Chemicals)

and stabilizers as shown in the following table (amounts given in % by weight of the total formulation). The results are shown in the following table.

Table: Surface assessment after weathering for 750 h

Exp. #	Stabilizers	Visual	Gloss	ΔE
a*	0.2% B 0.2% C 0.1% G	Chalking	10	6.5
b	0.13% A 0.27% c1 0.1% G	Unchanged	38	5.3

* comparative example

WHAT IS CLAIMED IS:

1. A combination of

(b) one or more flame retardants selected from

- b1) melamin based flame retardants and/or ammonium polyphosphate,
- b2) bis-(hexachlorocyclopentadieno) cyclooctane,
- b3) tris-(2,3-dibromopropyl)-isocyanurate,
- b4) ethylene-bis-tetrabromophthalimide,
- b5) 1,2,5,6,9,10-hexabromo-cyclo-dodecan,
- b6) ethane-1,2-bis(pentabromophenyl); and

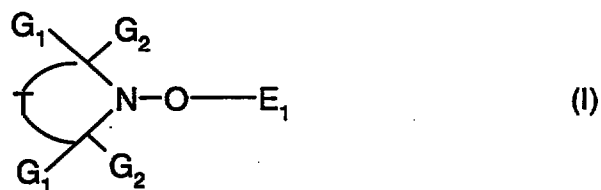


c) a sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class

for use of imparting both weathering stability and flame retardancy to a thermoplastic polymer (a), provided that the flame retardant is not (b4) if the sterically hindered amine is of the hydroxyhydrocarbyloxy class.

2. Combination of claim 1 for use of imparting outdoor weathering stability and flame retardancy to a polyolefin.

3. Combination of claim 1, wherein the sterically hindered amine light stabilizer of component c is a cyclic sterically hindered amine conforming to the formula



wherein

G₁ and G₂ are independently alkyl of 1 to 4 carbon atoms or are together pentamethylene, and

E₁ is C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl or C₇-C₁₅aralkyl; or E₁ is C₁-C₁₈alkyl, C₅-C₁₂ cyclo-alkyl or C₇-C₁₅aralkyl each of which is substituted in the aliphatic part by 1-3 OH groups;

T is a divalent organic radical required to complete formula (I) to form, together with the hindered amine nitrogen atom and the two quaternary carbon atoms substituted by G₁ and G₂, a five- or six-membered aliphatic ring structure, especially a piperidine ring;

or is an oligomeric or polymeric hindered amine molecule made from the reaction of a dialkyl ester or isocyanate with a compound of the formula (I) wherein E_1 contains 1 OH group and T is $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-$;
or is a simple diester or urethane derivative of a compound of the formula (I) wherein E_1 contains 1 OH group and T is $-\text{CH}_2-\text{CH}(\text{OH})-\text{CH}_2-$.

4. Combination of claim 1 comprising 0.01 to 10 % by weight of component c, based on the weight of the polymer (a).

5. Combination of claim 1 comprising component b1 an amount from 1 to 50 % by weight, or one or more of components b2, b3, b4, b5, b6 in a total amount from 0.5 to 20 % by weight, each based on the weight of the polymer (a) according to claim 1.

6. Combination of claim 1 for use of imparting both weathering stability and flame retardancy to a polyethylene, polypropylene, or copolymer or blend thereof.

7. Combination of claim 1 comprising one or more further components selected from pigments, dyes, plasticizers, antioxidants, thixotropic agents, levelling assistants, basic costabilizers, further light stabilizers, metal passivators, metal oxides, organophosphorus compounds, hydroxylamines, and mixtures thereof, especially pigments, phenolic antioxidants, calcium stearate, zinc stearate, sterically hindered amines, UV absorbers, like those of the 2-(2'-hydroxyphenyl)benzotriazole and 2-(2-hydroxyphenyl)-1,3,5-triazine classes.

8. A process for imparting light stability and flame retardancy to a thermoplastic polymer, which process comprises adding to said polymer a combination of the flame retardant tris-(2,3-dibromopropyl)-isocyanurate and a sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class.

9. A flame retardant and light stabilized composition comprising
a) a polyolefin,
b) tris-(2,3-dibromopropyl)-isocyanurate as a flame retardant
and



c) a sterically hindered amine light stabilizer of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class.

10. A flame retardant and light stabilized composition comprising

a) a polyolefin, and

b) a flame retardant selected from

b1) melamin based flame retardants and/or ammonium polyphosphate,

b2) bis-(hexachlorocyclopentadieno) cyclooctane,

b3) tris-(2,3-dibromopropyl)-isocyanurate,

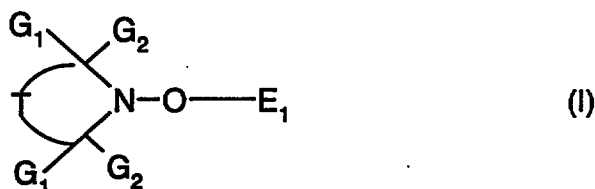
b5) 1,2,5,6,9,10-hexabromo-cyclo-dodecan,

b6) ethane-1,2-bis(pentabromophenyl); and

c) a sterically hindered amine light stabilizer of the hydroxyhydrocarbyloxyamine class.



11. A flame retardant and light stabilized composition according to claim 10 wherein component c is a compound of the formula



wherein

G₁ and G₂ are independently alkyl of 1 to 4 carbon atoms or are together pentamethylene, and

E₁ C₁-C₁₈alkyl, C₅-C₁₂cycloalkyl or C₇-C₁₅aralkyl each of which is substituted in the aliphatic part by 1-3 OH groups, especially 1 OH group;

T is a divalent organic radical required to complete formula (I) to form, together with the hindered amine nitrogen atom and the two quaternary carbon atoms substituted by G₁ and G₂, a five- or six-membered aliphatic ring structure, especially a piperidine ring;

or is an oligomeric or polymeric hindered amine molecule made from the reaction of a dialkyl ester or isocyanate with a compound of the formula (I) wherein E₁ contains 1 OH group and T is -CH₂-CH(OH)-CH₂-;

or is a simple diester or urethane derivative of a compound of the formula (I) wherein E₁ contains 1 OH group and T is -CH₂-CH(OH)-CH₂-.

12. A flame retardant composition stabilized against deleterious effects of light and weathering comprising

- a) a thermoplastic polymer,
- b) a flame retardant selected from ammonium polyphosphate, halogenated and/or melamin based flame retardants, and
- c) a combination of sterically hindered amine light stabilizers comprising
 - c1) a low molecular weight sterically hindered amine of the hydroxyhydrocarbyloxyamine class, and
 - c2) a high molecular weight secondary or alkylated or polymeric tertiary sterically hindered amine.

13. Composition according to claim 12, wherein component (a) is a polyolefin.

14. A flame retardant composition stabilized against deleterious effects of light and weathering comprising

- a) a polyolefin,
- b) a flame retardant selected from ammonium polyphosphate, halogenated and/or melamin based flame retardants, and
- c) a combination of sterically hindered amine light stabilizers comprising, on 100 parts by weight of total component (c),
 - c1) 40 to 95 parts by weight a low molecular weight sterically hindered amine of the hydroxyhydrocarbyloxyamine or hydrocarbyloxyamine class, and
 - c2) 5 to 60 parts by weight of a high molecular weight secondary or alkylated or polymeric tertiary sterically hindered amine.

15. Composition according to claim 12 or 14, wherein component (b) is selected from

- b1) melamin based flame retardants and/or ammonium polyphosphate,
- b2) bis-(hexachlorocyclopentadieno) cyclooctane,
- b3) tris-(2,3-dibromopropyl)-isocyanurate,
- b4) ethylene-bis-tetrabromophthalimide,
- b5) 1,2,5,6,9,10-hexabromo-cyclo-dodecane,



b6) ethane-1,2-bis(pentabromophenyl),

b7) tris(3-bromo-2,2-(bromomethyl)propyl) phosphate.



16. Composition according to claims 12 or 14, wherein the low molecular weight sterically hindered amine of the hydrocarbyloxyamine or hydroxyhydrocarbyloxyamine class (c1) is from the molecular weight range 200 to 1000 g/mol, and the high molecular weight sterically hindered amine (c2) is from the molecular weight range 1200 to 10000 g/mol.

17. Composition according to claims 9 or 10 or 12 or 14 containing component (b) in an amount from 0.5 to 50 % by weight, and component (c) in an amount of 0.01 to 10 % by weight, each based on the weight of component (a).

18. Composition according to claims 9 or 10 or 12 or 14 additionally containing one or more further components selected from pigments, dyes, plasticizers, antioxidants, thixotropic agents, levelling assistants, basic costabilizers, metal passivators, metal oxides, organophosphorus compounds, hydroxylamines, further light stabilizers and mixtures thereof, especially pigments, phenolic antioxidants, calcium stearate, zinc stearate, sterically hindered amines, UV absorbers of the 2-hydroxy-benzophenone, 2-(2'-hydroxyphenyl)benzotriazole and/or 2-(2-hydroxyphenyl)-1,3,5-triazine classes.

19. Molded or extruded article comprising a composition according to claims 9 or 10 or 12 or 14.