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(54) Title: FLAME RETARDANT COMPOSITIONS

(57) Abstract: Organic polymeric substrates, for example polyolefins such as polypropylene, can be made flame retardant by the incorporation of a mixture of (i) at least one sterically hindered alkoxyamine stabiliser and (ii) at least one conventional flame retardant selected from the group consisting of the melamine based flame retardants. The compositions of the invention combine good flame retardant properties with light stability and good mechanical properties. Polyolefin molded articles are stabilised against light, heat and oxygen and made flame retardant with the incorporation of at least one sterically hindered alkoxyamine and at least one conventional flame retardant, while allowing normally high levels of flame-retardant fillers to be greatly reduced or eliminated.



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Flame retardant compositions

The instant invention pertains to a novel method of flame retarding a polymeric substrate by adding thereto an effective flame retarding amount of a mixture of at least one sterically hindered alkoxyamine and at least one conventional melamine based flame retardant.

- 5 The instant invention also pertains to polyolefin molded articles that are stabilised against light, heat and oxygen and made flame retardant with the incorporation therein of at least one sterically hindered alkoxyamine and at least one conventional flame retardant, while allowing normally high levels of flame-retardant fillers to be greatly reduced or eliminated.

10 *U.S. Pat. Specification No. 5,096,950* discloses the co-use of certain NOR (N-alkoxy) hindered amines with a brominated Sb_2O_3 -containing flame retardant in polypropylene.

U.S. Pat. Specification No. 5,393,812 discloses polyolefin compositions which are made flame retardant by a combination of a halogenated hydrocarbyl phosphate or phosphonate ester flame retardant in combination with a alkoxyamine functional hindered amine.

15 *U.S. Patent Specification No. 5,844,026* discloses polyolefin compositions comprising certain NOR hindered amines and certain traditional flame retardants.

U.S. Patent Specification No. 6,117,995 discloses that certain N-alkoxy hindered amines may be used as flame retardants for organic polymers.

U.S. Patent Specification No. 6,271,377 discloses polyolefin compositions that comprise N-hydroxyalkoxy hindered amines and a halogenated flame retardant.

20 *U.S. Patent Specification No. 6,309,987* and equivalent WO 99/54530 teach polyolefin non-woven flame retardant fabrics that comprise N-alkoxyamines.

25 *U.S. Patent Specification No. 6,262,161* discloses random interpolymers, for example polymers of ethylene and/or one or more α -olefin monomers with one or more vinyl aromatic monomers, with improved ignition resistance that comprises a filler and at least one other component which may be a hindered amine stabiliser.

R. Srinivasan et al. in A Revolutionary UV Stable Flame Retardant System for Polyolefins, Int. Conf. Addit. Polyolefins 1998, 69-83, teach polyolefins comprising certain NOR hindered amines with halogen and phosphorus containing traditional flame retardants.

30 *R. Srinivasan and B. Rotzinger in Advances in a Revolutionary Flame Retardant System for Polyolefins, Polyolefins 2000, Int. Conf. Polyolefins 2000*, 571-581, teach polyolefins comprising certain NOR hindered amines with brominated and phosphorus containing flame retardants.

N. Kaprinidis and *R. King*, in an abstract posted on the Society of Plastics Engineers website, posted Sep. 2001, discuss the use of NOR hindered amines as flame retardants in polyolefins. The abstract is for a paper submitted to the Polymer Modifiers and Additives Division subsection to be presented at the Polyolefins 2002 conference in Houston USA Feb. 24, 2002. The website is www.PMAD.org.

EP-A-0792911 A2, discloses polyolefin compositions that comprise alkoxyamine functional hindered amines and tris(trihalogenopentyl) phosphate flame retardants.

WO 99/00450 discloses the use of certain N-alkoxy hindered amines as flame retardants.

EP-A-1038912 discloses specific hydrocarbyloxy hindered amine compounds as flame retardants.

Research Disclosure, Sept. 2000, No. 437087, June 2000, No. 434095 and Dec. 2000, No. 440128 also disclose the efficacy of certain hydrocarbyloxy hindered amine compounds as flame retardants.

Flame retardants (FR) interfere with the combustion process by chemical and/or physical means. Mechanistically FR have been proposed to function during combustion of an article in either the gas phase, the condensed phase or both. Organohalogens are proposed to generate halide species (e.g. HX), which interfere in the gas phase with free radical organic "fuel" from the polymer substrate. Synergists are proposed to react with HX to form additional chemical species, which interfere with combustion in the gas phase, such as reaction of antimony oxide with HX to form antimony halide and water vapor. Antimony compounds, such as antimony trioxide, also act as a radical scavenger forming antimony halides.

Although antimony compounds are efficient in terms of cost performance, there is concern because of the toxicity of the by-products, which are formed during combustion in the presence of a halogenated flame retardant. Antimony oxides often contain trace amounts of arsenic compounds, which are suspected carcinogens. Because of these ecological concerns, the replacement of antimony trioxide in flame retardant applications is desirable.

Efficient FR additives prevent dripping during the application of the fire. Dripping during combustion is the process of the separation of parts of the polymer from the matrix in the shape of droplets. These are flaming and impose a tremendous danger for fire spread. It is a common measure to add fillers such as talc in large amounts to the polymer, with some negative consequences on the mechanical properties. Fillers sometimes used include calcium carbonate, magnesium carbonate, zinc borate, silicates, silicones, glass fibres, glass bulbs, asbestos, kaolin, mica, barium sulphate, calcium sulphate, metal oxides, hydrates and hydrox-

ides such as zinc oxide, magnesium hydroxide, alumina trihydrate, silica, calcium silicate and magnesium silicate.

It has been found that polymers with good flame retardant properties are prepared when a sterically hindered alkoxyamine is added thereto together with a conventional melamine based flame retardant. With this combination, flame-retardant fillers or conventional fillers may be largely reduced or replaced. As the instant alkoxyamine compounds are active as stabilisers, the polymer compositions of the invention are efficiently protected from the deleterious effects of light, oxygen and/or heat.

The instant invention pertains to a flame retardant composition, which comprises

10 (A) An organic polymer substrate and

(B) An effective flame retarding amount of a mixture of

(i) At least one sterically hindered alkoxyamine stabiliser and

(ii) At least one conventional flame retardant selected from the group consisting of melamine ammonium phosphate, melamine ammonium polyphosphate, melamine ammonium pyrophosphate, a condensation product of melamine, a reaction product of melamine with phosphoric acid and a reaction product of the condensation product of melamine with phosphoric acid or mixtures thereof.

In a preferred embodiment the instant invention pertains to a flame retardant composition, which comprises

20 (A) An organic polymer substrate and

(B) An effective flame retarding amount of a mixture of

(i) At least one sterically hindered alkoxyamine stabiliser and

(ii) At least one conventional flame retardant selected from the group consisting of a melamine phosphate, dimelamine phosphate, melamine pyrophosphate, melamine borate, melamine cyanurate, melam or melem phosphate, melam or melem polyphosphate, melamine ammonium phosphate, melamine ammonium pyrophosphate and a melamine ammonium polyphosphate or mixtures thereof.

A particularly preferred embodiment of the invention relates to a flame retardant composition, which comprises

30 (A) An organic polymer substrate and

(B) An effective flame retarding amount of a mixture of

- (i) At least one sterically hindered alkoxyamine stabiliser and
- (ii) At least one conventional flame retardant selected from the group consisting of a melamine phosphate, melamine borate, melamine cyanurate and a melamine phosphate.

5 The compositions of the present invention may contain minor amounts of flame-retardant fillers, e.g. less than about 3%, for instance less than about 1%, for example less than about 0.1% by weight of the polymer component A.

Flame-retardant fillers are known in the art and are selected from the group consisting of magnesium hydroxide, alumina trihydrate and zinc borate. Flame-retardant fillers are inorganic compounds employed for flame-retardant properties at sufficient levels to be considered as "fillers".

Conventional fillers, such as talc, calcium carbonate and the like, are normally employed for instance for flow properties in order to reduce the spread of flaming droplets. These fillers may also be reduced with the use of the present compositions. The present compositions may contain only minor amounts of conventional fillers, for example less than about 3%, for instance less than 1%, for example less than about 0.1% by weight of the polymer component A.

The polymeric substrate of component (A) is any of a wide variety of polymeric types including polyolefins, polystyrenics, and PVC. For example, the polymer substrate may be selected from the group consisting of resins consisting of the polyolefins, the thermoplastic olefins, styrenic polymers and copolymers, ABS and polymers which contain hetero atoms, double bonds or aromatic rings. Specific embodiments are where component (A) is polypropylene, polyethylene, thermoplastic olefin (TPO), ABS or high impact polystyrene.

For example, the polymer substrate is selected from the group of resins consisting of the polyolefins, the thermoplastic olefins, styrenic polymers and copolymers, and ABS.

Another embodiment of the present invention relates to a flame retardant composition, wherein the polymer substrate is selected from the group consisting of polypropylene, polyethylene, thermoplastic olefin (TPO), ABS and high impact polystyrene.

In this embodiment the polymer substrate is polypropylene, polyethylene or thermoplastic olefin (TPO). Organic polymers of component A are for example thermoplastic polymers such as polyolefins like polyethylene, polypropylene or copolymers thereof. The thermoplastic polymer is for example polypropylene.

Further examples for organic polymers (component A) are:

1. Polymers of monoolefins and diolefins, for example polypropylene, polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, polyvinylcyclohexane, 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).

The polyolefins, i.e. the polymers of monoolefins exemplified in the preceding paragraph, for example 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, VIb 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, ethylene/vinylcyclohexane copolymers, ethylene/cycloolefin copolymers (e.g. ethylene/norbornene like COC), ethylene/1-olefins copolymers, where the 1-olefin is generated in-situ; propylene/butadiene copolymers, isobutylene/isoprene copolymers, ethylene/vinylcyclohexene copolymers, ethylene/alkyl acrylate copolymers, ethylene/alkyl methacrylate copolymers, ethylene/vinyl acetate copolymers 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. Hydrocarbon resins (for example C₅-C₉) including hydrogenated modifications thereof (e.g. tackifiers) and mixtures of polyalkylenes and starch

Homopolymers and copolymers from 1.) - 4.) may have any stereostructure including syndiotactic, isotactic, hemi-isotactic or atactic; for example atactic polymers.

Stereoblock polymers are also included.

5. Polystyrene, poly(p-methylstyrene), poly(α -methylstyrene).
6. Aromatic homopolymers and copolymers derived from vinyl aromatic monomers including styrene, α -methylstyrene, all isomers of vinyl toluene, especially p-vinyltoluene, all isomers of ethyl styrene, propyl styrene, vinyl biphenyl, vinyl naphthalene, and vinyl anthracene, and mixtures thereof. Homopolymers and copolymers may have any stereostructure including syndiotactic, isotactic, hemi-isotactic or atactic; for example atactic polymers. Stereoblock polymers are also included

- a) Copolymers including aforementioned vinyl aromatic monomers and comonomers selected from ethylene, propylene, dienes, nitriles, acids, maleic anhydrides, maleimides, vinyl acetate and vinyl chloride or acrylic derivatives and mixtures thereof, for example styrene/butadiene, styrene/acrylonitrile, styrene/ethylene (interpolymers), styrene/alkyl methacrylate, styrene/butadiene/alkyl acrylate, styrene/butadiene/alkyl methacrylate, styrene/maleic anhydride, styrene/acrylonitrile/methyl acrylate; mixtures of high impact strength of styrene copolymers and another polymer, for exam-

ple a polyacrylate, a diene polymer or an ethylene/propylene/diene terpolymer; and block copolymers of styrene such as styrene/butadiene/styrene, styrene/isoprene/styrene, styrene/ethylene/butylene/styrene or styrene/ethylene/propylene/styrene.

- 5 b) Hydrogenated aromatic polymers derived from hydrogenation of polymers mentioned above, especially including polycyclohexylethylene (PCHE) prepared by hydrogenating atactic polystyrene, often referred to as polyvinylcyclohexane (PVCH)
- 10 c) Hydrogenated aromatic polymers derived from hydrogenation of polymers mentioned under 6 a).

Homopolymers and copolymers may have any stereostructure including syndiotactic, isotactic, hemi-isotactic or atactic; for example atactic polymers. Stereoblock polymers are also included.

- 15 7. Graft copolymers of vinyl aromatic monomers such as styrene or α -methylstyrene, for example styrene on polybutadiene, styrene on polybutadiene-styrene or polybutadiene-acrylonitrile copolymers; styrene and acrylonitrile (or methacrylonitrile) on polybutadiene; styrene, acrylonitrile and methyl methacrylate on polybutadiene; styrene and maleic anhydride on polybutadiene; styrene, acrylonitrile and maleic anhydride or maleimide on polybutadiene; styrene and maleimide on polybutadiene; styrene and alkyl acrylates or methacrylates on polybutadiene; styrene and acrylonitrile on ethylene/propylene/diene terpolymers; styrene and acrylonitrile on polyalkyl acrylates or polyalkyl methacrylates, styrene and acrylonitrile on acrylate/butadiene copolymers, as well as mixtures thereof with the copolymers listed under 6), for example the copolymer mixtures known as ABS, MBS, ASA or AES polymers.
- 20 8. Halogen-containing polymers such as polychloroprene, chlorinated rubbers, chlorinated and brominated copolymer of isobutylene-isoprene (halobutyl rubber), chlorinated or sulphochlorinated polyethylene, copolymers of ethylene and chlorinated ethylene, epichlorohydrin homo- and copolymers, especially polymers of halogen-containing vinyl compounds, for example polyvinyl chloride, polyvinylidene chloride, polyvinyl fluoride, polyvinylidene fluoride, as well as copolymers thereof such as vinyl chloride/vinylidene chloride, vinyl chloride/vinyl acetate or vinylidene chloride/vinyl acetate copolymers.
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9. Polymers derived from α,β -unsaturated acids and derivatives thereof such as polyacrylates and polymethacrylates; polymethyl methacrylates, polyacrylamides and polyacrylonitriles, impact-modified with butyl acrylate.
- 5 10. Copolymers of the monomers mentioned under 9) with each other or with other unsaturated monomers, for example acrylonitrile/ butadiene copolymers, acrylonitrile/alkyl acrylate copolymers, acrylonitrile/alkoxyalkyl acrylate or acrylonitrile/vinyl halide copolymers or acrylonitrile/ alkyl methacrylate/butadiene terpolymers.
- 10 11. Polymers derived from unsaturated alcohols and amines or the acyl derivatives or acetals thereof, for example polyvinyl alcohol, polyvinyl acetate, polyvinyl stearate, polyvinyl benzoate, polyvinyl maleate, polyvinyl butyral, polyallyl phthalate or polyallyl melamine; as well as their copolymers with olefins mentioned in 1) above.
12. Homopolymers and copolymers of cyclic ethers such as polyalkylene glycols, polyethylene oxide, polypropylene oxide or copolymers thereof with bisglycidyl ethers.
- 15 13. Polyacetals such as polyoxymethylene and those polyoxymethylenes which contain ethylene oxide as a comonomer; polyacetals modified with thermoplastic polyurethanes, acrylates or MBS.
14. Polyphenylene oxides and sulphides, and mixtures of polyphenylene oxides with styrene polymers or polyamides.
- 20 15. Polyurethanes derived from hydroxyl-terminated polyethers, polyesters or polybutadienes on the one hand and aliphatic or aromatic polyisocyanates on the other, as well as precursors thereof.
- 25 16. Polyamides and copolyamides derived from diamines and dicarboxylic acids and/or from aminocarboxylic acids or the corresponding lactams, for example polyamide 4, polyamide 6, polyamide 6/6, 6/10, 6/9, 6/12, 4/6, 12/12, polyamide 11, polyamide 12, aromatic polyamides starting from m-xylene diamine and adipic acid; polyamides prepared from hexamethylenediamine and isophthalic or/and terephthalic acid and with or without an elastomer as modifier, for example poly-2,4,4,-trimethylhexamethylene terephthalamide or poly-m-phenylene isophthalamide; and also block copolymers of the aforementioned polyamides with polyolefins, olefin copolymers, ionomers or
30 chemically bonded or grafted elastomers; or with polyethers, e.g. with polyethylene glycol, polypropylene glycol or polytetramethylene glycol; as well as polyamides or copolyamides modified with EPDM or ABS; and polyamides condensed during processing (RIM polyamide systems).

17. Polyureas, polyimides, polyamide-imides, polyetherimids, polyesterimids, polyhydantoins and polybenzimidazoles.

18. Polyesters derived from dicarboxylic acids and diols and/or from hydroxycarboxylic acids or the corresponding lactones, for example polyethylene terephthalate, polybutylene terephthalate, poly-1,4-dimethylolcyclohexane terephthalate, polyalkylenenaphthalate (PAN) and polyhydroxybenzoates, as well as block copolyether esters derived from hydroxyl-terminated polyethers; and also polyesters modified with polycarbonates or MBS.

19. Polycarbonates and polyester carbonates.

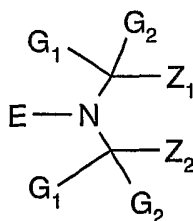
20. Polyketones.

21. Polysulphones, polyether sulphones and polyether ketones.

22. Blends of the aforementioned polymers (polyblends), for example PP/EPDM, Polyamide/EPDM or ABS, PVC/EVA, PVC/ABS, PVC/MBS, PC/ABS, PBTP/ABS, PC/ASA, PC/PBT, PVC/CPE, PVC/acrylates, POM/thermoplastic PUR, PC/thermoplastic PUR, POM/acrylate, POM/MBS, PPO/HIPS, PPO/PA 6.6 and copolymers, PA/HDPE, PA/PP, PA/PPO, PBT/PC/ABS or PBT/PET/PC.

Sterically Hindered Alkoxyamine Stabilisers of Component (i)

The so-called sterically hindered alkoxyamines are for example monomeric compounds or are oligomeric or polymeric compounds. The present sterically hindered stabilisers of components (i) are known in the art, and are, for example, represented by the formula



wherein

G₁ and G₂ are independently alkyl of 1 to 8 carbon atoms or are together pentamethylene;

Z₁ and Z₂ are each methyl, or Z₁ and Z₂ together form a linking moiety which may additionally be substituted by an ester, ether, amide, amino, carboxy or urethane group;

E is oxyl, hydroxyl, alkoxy, cycloalkoxy, aralkoxy, aryloxy, -O-CO-OZ₃, -O-Si(Z₄)₃, -O-PO(OZ₅)₂ or -O-CH₂-OZ₆ where Z₃, Z₄, Z₅ and Z₆ are selected from the group consisting of hydrogen, an aliphatic, araliphatic and aromatic moiety; or E is -O-T-(OH)_b;

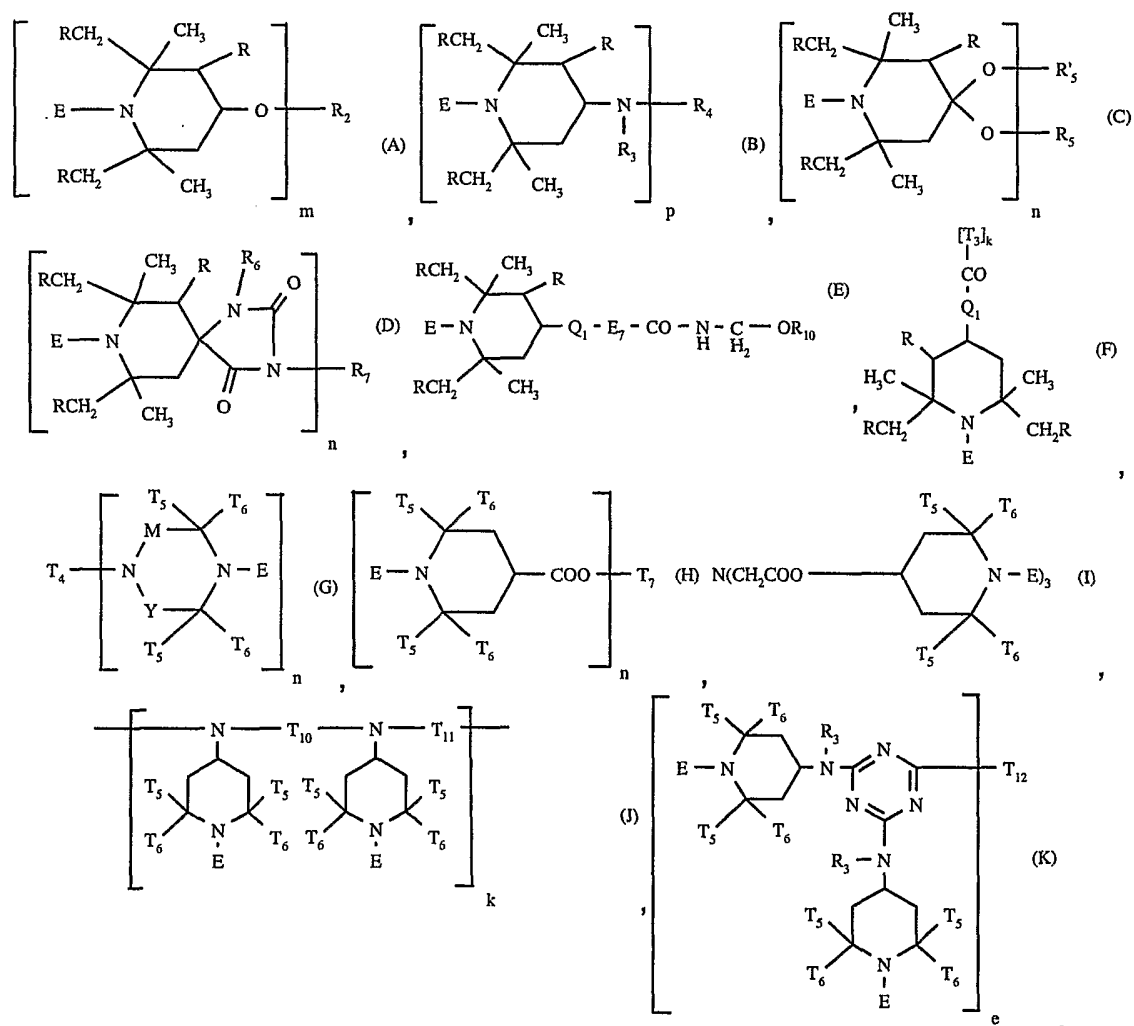
T is a straight or branched chain alkylene of 1 to 18 carbon atoms, cycloalkylene of 5 to 18 carbon atoms, cycloalkenylene of 5 to 18 carbon atoms, a straight or branched chain alkylene of 1 to 4 carbon atoms substituted by phenyl or by phenyl substituted by one or two alkyl groups of 1 to 4 carbon atoms;

- 5 b is 1, 2 or 3 with the proviso that b cannot exceed the number of carbon atoms in T, and when b is 2 or 3, each hydroxyl group is attached to a different carbon atoms of T;

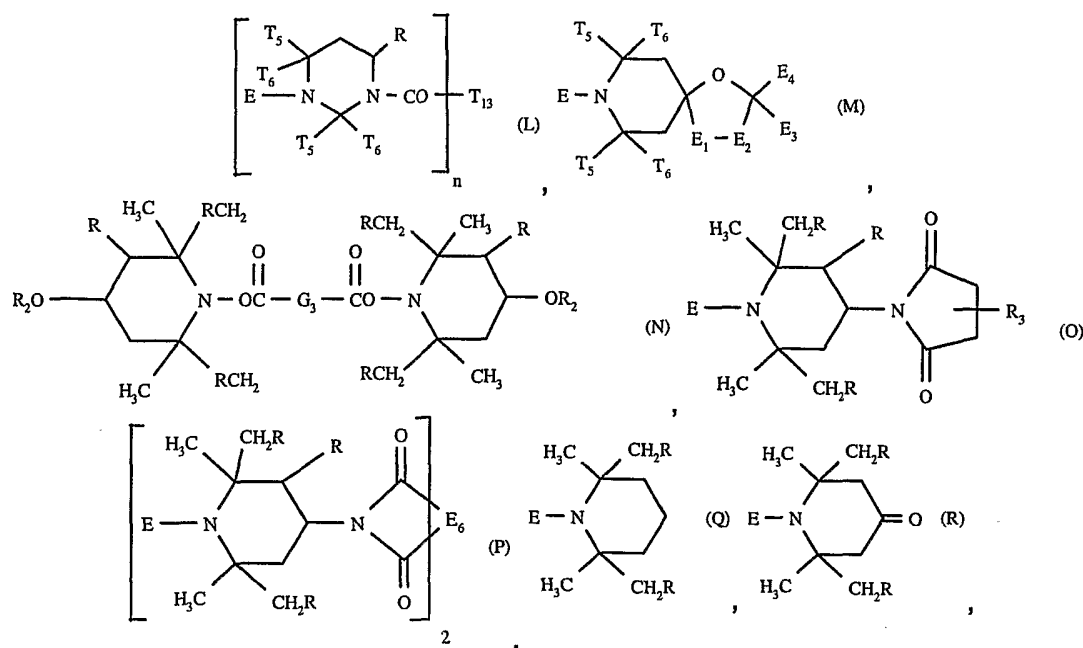
E is for example oxyl, hydroxyl, alkoxy, cycloalkoxy or aralkoxy. For instance, E is methoxy, propoxy, cyclohexyloxy or octyloxy.

Representative sterically hindered alkoxyamine of component (i) are for example of the formula A-R:

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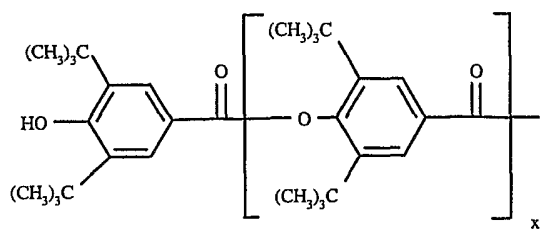
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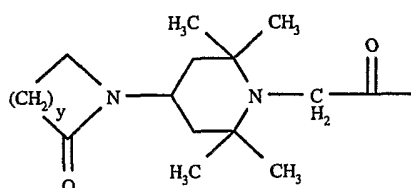
wherein

- 5 E is oxyl, hydroxyl, alkoxy of 1 to 18 carbon atoms, cycloalkoxy of 5 to 12 carbon atoms or aralkoxy of 7 to 15 carbon atoms, or E is -O-T-(OH)_b;
- T is a straight or branched chain alkylene of 1 to 18 carbon atoms, cycloalkylene of 5 to 18 carbon atoms, cycloalkenylene of 5 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
- 10 alkyl groups of 1 to 4 carbon atoms;
- b is 1, 2 or 3 with the proviso that b cannot exceed the number of carbon atoms in T, and when b is 2 or 3, each hydroxyl group is attached to a different carbon atoms of T;
- R is hydrogen or methyl;
- m is 1 to 4;
- 15 when m is 1;
- R₂ is hydrogen, C₁-C₁₈alkyl or said alkyl optionally interrupted by one or more oxygen atoms, C₂-C₁₂alkenyl, C₆-C₁₀aryl, C₇-C₁₈aralkyl, glycidyl, a monovalent acyl radical of an aliphatic, cycloaliphatic or aromatic carboxylic acid, or a carbamic acid, for example an acyl radical of an aliphatic carboxylic acid having 2-18 C atoms, of a cycloaliphatic carboxylic acid having 5-12 C atoms or of an aromatic carboxylic acid having 7-15 C atoms; or
- 20 represents groups of the formulae

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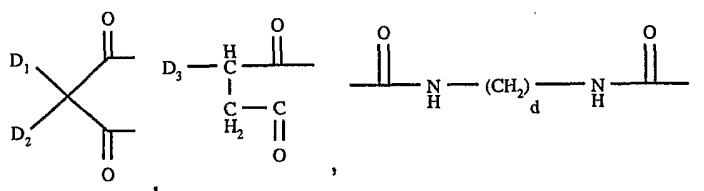
wherein x is 0 or 1;



wherein y is 2-4; and

5 when m is 2,

R_2 is C_1 - C_{12} alkylene, C_4 - C_{12} alkenylene, xylene, a divalent acyl radical of an aliphatic, cycloaliphatic, araliphatic or aromatic dicarboxylic acid or of a dicarbamic acid, for example 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, or of an aliphatic, cycloaliphatic or aromatic dicarbamic acid having 8-14 C atoms; or represents groups of the formulae



wherein

15 D_1 and D_2 are independently hydrogen, an alkyl radical containing up to 8 carbon atoms, an aryl or aralkyl radical including 3,5-di-*t*-butyl-4-hydroxybenzyl radical, D_3 is hydrogen, or an alkyl or alkenyl radical containing up to 18 carbon atoms, and d is 0-20;

when m is 3, R_2 is a trivalent acyl radical of an aliphatic, unsaturated aliphatic, cycloaliphatic, or aromatic tricarboxylic acid;

20 when m is 4, R_2 is a tetravalent acyl radical of a saturated or unsaturated aliphatic or aromatic tetracarboxylic acid including 1,2,3,4-butanetetracarboxylic acid, 1,2,3,4-but-2-ene-tetracarboxylic, and 1,2,3,5- and 1,2,4,5-pentanetetracarboxylic acid;

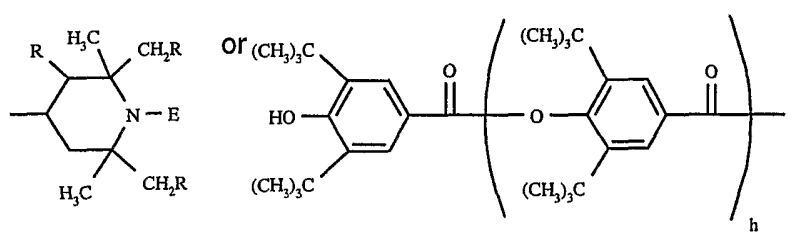
p is 1, 2 or 3,

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R_3 is hydrogen, C_1 - C_{12} alkyl, C_5 - C_7 cycloalkyl, C_7 - C_9 aralkyl, C_2 - C_{18} alkanoyl, C_3 - C_5 alkenoyl or benzoyl;

when p is 1,

5 R_4 is hydrogen, C_1 - C_{18} alkyl, C_5 - C_7 cycloalkyl, C_2 - C_8 alkenyl, unsubstituted or substituted by a cyano, carbonyl or carbamide group, aryl, aralkyl, or it is glycidyl, a group of the formula - CH_2 - $CH(OH)$ -Z or of the formula -CO-Z or -CONH-Z wherein Z is hydrogen, methyl or phenyl; or represents groups of the formulae



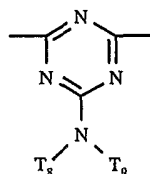
wherein h is 0 or 1,

10 R_3 and R_4 together, when p is 1, can be alkylene of 4 to 6 carbon atoms or 2-oxo-polyalkylene the cyclic acyl radical of an aliphatic or aromatic 1,2- or 1,3-dicarboxylic acid,

when p is 2,

R_4 is a direct bond or is C_1 - C_{12} alkylene, C_6 - C_{12} arylene, xylylene, a - $CH_2CH(OH)CH_2$ group or a group - $CH_2CH(OH)CH_2O-X-OCH_2CH(OH)CH_2$ - wherein X is C_2 - C_{10} alkylene, C_6 -
15 C_{15} arylene or C_6 - C_{12} cycloalkylene; or, provided that R_3 is not alkanoyl, alkenoyl or benzoyl, R_4 can also be a divalent acyl radical of an aliphatic, cycloaliphatic or aromatic dicarboxylic acid or dicarbamic acid, or can be the group -CO-; or

R_4 represents a group of the formula



20 wherein T_8 and T_9 are independently hydrogen, alkyl of 1 to 18 carbon atoms, or T_8 and T_9 together are alkylene of 4 to 6 carbon atoms or 3-oxapentamethylene, for instance T_8 and T_9 together are 3-oxapentamethylene;

when p is 3;

R_4 is 2,4,6-triazinyl;

25 n is 1 or 2;

- 14 -

when n is 1;

R₅ and R'₅ are independently C₁-C₁₂ alkyl, C₂-C₁₂ alkenyl, C₇-C₁₂ aralkyl, or R₅ is also hydrogen, or R₅ and R'₅ together are C₂-C₈alkylene or hydroxyalkylene or C₄-C₂₂acyloxyalkylene;

5 when n is 2;

R₅ and R'₅ together are $(-\text{CH}_2)_2\text{C}(\text{CH}_2-)_2$;

R₆ is hydrogen, C₁-C₁₂alkyl, allyl, benzyl, glycidyl or C₂-C₆alkoxyalkyl;

when n is 1;

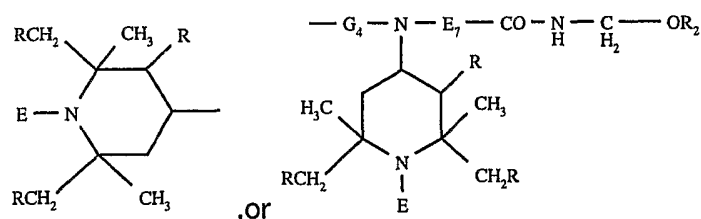
10 R₇ is hydrogen, C₁-C₁₂alkyl, C₃-C₅alkenyl, C₇-C₉aralkyl, C₅-C₇cycloalkyl, C₂-C₄hydroxyalkyl, C₂-C₆alkoxyalkyl, C₆-C₁₀ aryl, glycidyl, a group of the formula $-(\text{CH}_2)_t\text{-COO-Q}$ or of the formula $-(\text{CH}_2)_t\text{-O-CO-Q}$ wherein t is 1 or 2, and Q is C₁-C₄alkyl or phenyl; or

when n is 2;

15 R₇ is C₂-C₁₂alkylene, C₆-C₁₂arylene, a group $-\text{CH}_2\text{CH}(\text{OH})-\text{CH}_2\text{-O-X-O-CH}_2\text{-CH}(\text{OH})-\text{CH}_2-$ wherein X is C₂-C₁₀alkylene, C₆-C₁₅arylene or C₆-C₁₂cycloalkylene, or a group $-\text{CH}_2\text{CH}(\text{OZ}')\text{CH}_2-(\text{OCH}_2\text{-CH}(\text{OZ}')\text{CH}_2)_2-$ wherein Z' is hydrogen, C₁-C₁₈alkyl, allyl, benzyl, C₂-C₁₂alkanoyl or benzoyl;

Q₁ is $-\text{N}(\text{R}_8)-$ or $-\text{O}-$; E₇ is C₁-C₃ alkylene, the group $-\text{CH}_2\text{-CH}(\text{R}_9)\text{-O-}$ wherein R₉ is hydrogen, methyl or phenyl, the group $-(\text{CH}_2)_3\text{-NH-}$ or a direct bond;

20 R₁₀ is hydrogen or C₁-C₁₈ alkyl, R₈ is hydrogen, C₁-C₁₈alkyl, C₅-C₇cycloalkyl, C₇-C₁₂aralkyl, cyanoethyl, C₆-C₁₀aryl, the group $-\text{CH}_2\text{-CH}(\text{R}_9)\text{-OH}$ wherein R₉ has the meaning defined above; or represents a group of the formulae



wherein G₄ is C₂-C₆alkylene or C₆-C₁₂arylene; or R₈ is a group $-\text{E}_7\text{-CO-NH-CH}_2\text{-OR}_{10}$;

25 Formula F denotes a recurring structural unit of a polymer where T₃ is ethylene or 1,2-propylene, is the repeating structural unit derived from an alpha-olefin copolymer with an alkyl acrylate or methacrylate; for example a copolymer of ethylene and ethyl acrylate, and where k is 2 to 100;

T₄ has the same meaning as R₄ when p is 1 or 2,

- 15 -

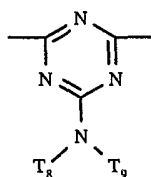
T₅ is methyl,

T₆ is methyl or ethyl, or T₅ and T₆ together are tetramethylene or pentamethylene, for instance T₅ and T₆ are each methyl,

M and Y are independently methylene or carbonyl, and T₄ is ethylene where n is 2;

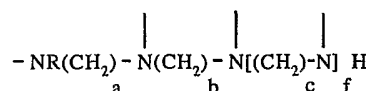
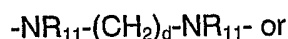
5 T₇ is the same as R₇, and T₇ is for example octamethylene where n is 2,

T₁₀ and T₁₁ are independently alkylene of 2 to 12 carbon atoms; or T₁₁ represents a group of the formula

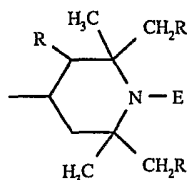


T₁₂ is piperazinyll; or represents a group of the formulae

10



where R₁₁ is as defined as R₃ or represents a group of the formula



a, b and c are independently 2 or 3, and f is 0 or 1, for instance a and c are each 3, b is 2 and f is 1; and

15 -e is 2, 3 or 4, for example 4;

T₁₃ is the same as R₂ with the proviso that T₁₃ cannot be hydrogen when n is 1;

E₁ and E₂, being different, each are -CO- or -N(E₅)- where E₅ is hydrogen, C₁-C₁₂ alkyl or C₄-C₂₂ alkoxy carbonylalkyl, for instance E₁ is -CO- and E₂ is -N(E₅)-;

20 E₃ is hydrogen, alkyl of 1 to 30 carbon atoms, phenyl, naphthyl, said phenyl or said naphthyl substituted by chlorine or by alkyl of 1 to 4 carbon atoms, or phenylalkyl of 7 to 12 carbon atoms, or said phenylalkyl substituted by alkyl of 1 to 4 carbon atoms,

E₄ is hydrogen, alkyl of 1 to 30 carbon atoms, phenyl, naphthyl or phenylalkyl of 7 to 12 carbon atoms; or

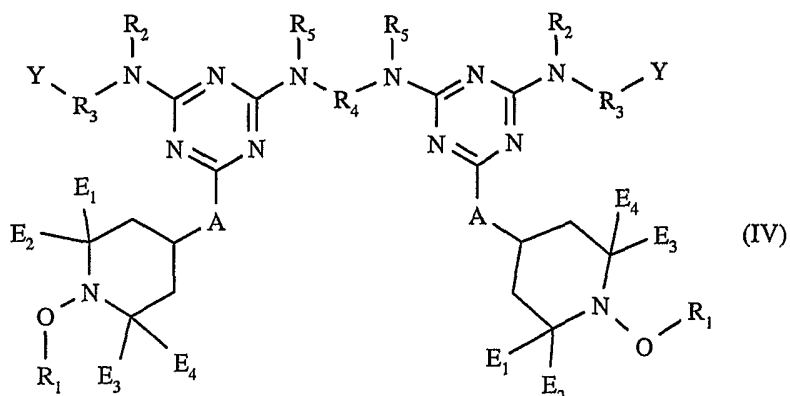
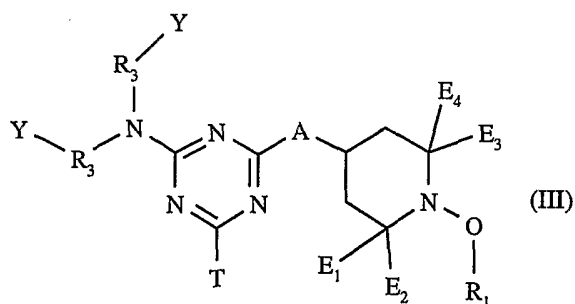
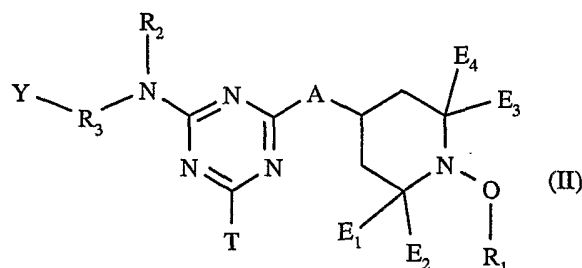
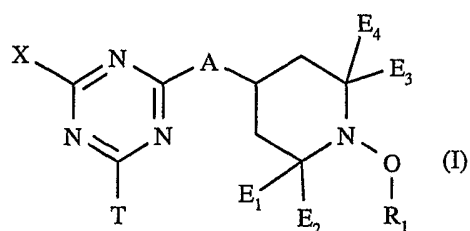
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E₃ and E₄ together are polymethylene of 4 to 17 carbon atoms, or said polymethylene substituted by up to four alkyl groups of 1 to 4 carbon atoms, for example methyl;

E₆ is an aliphatic or aromatic tetravalent radical;

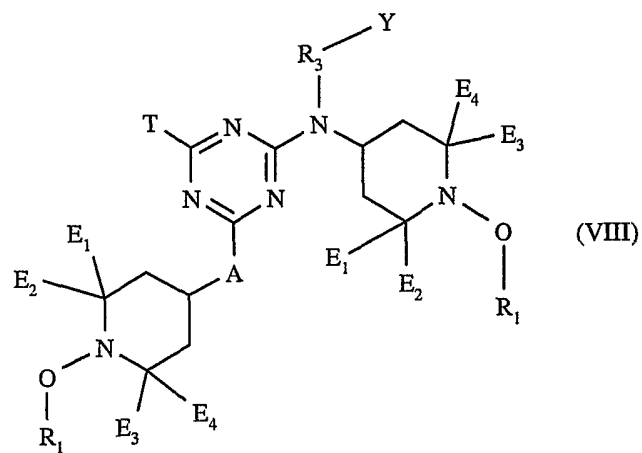
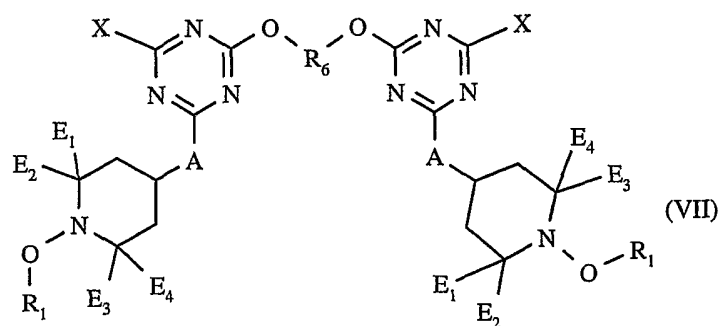
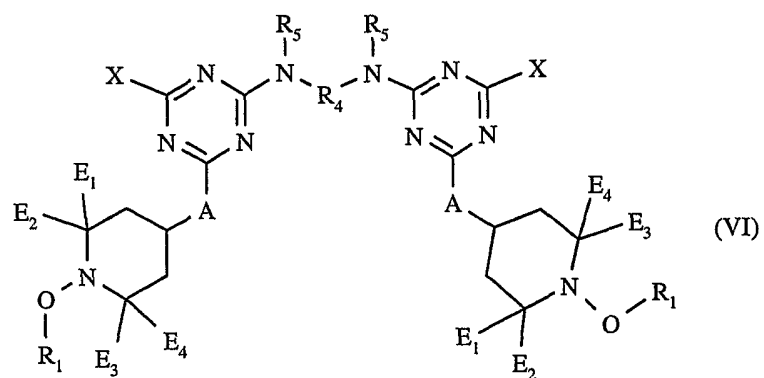
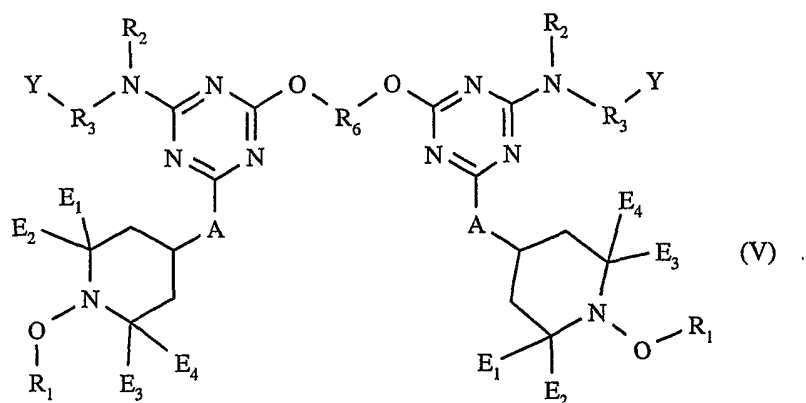
R₂ of formula (N) is a previously defined when m is 1;

- 5 G₁ a direct bond, C₁-C₁₂ alkylene, phenylene or -NH-G'-NH wherein G' is C₁-C₁₂ alkylene; or wherein the hindered amine compound is a compound of the formula I, II, III, IV, V, VI, VII, VIII, IX, X or XI

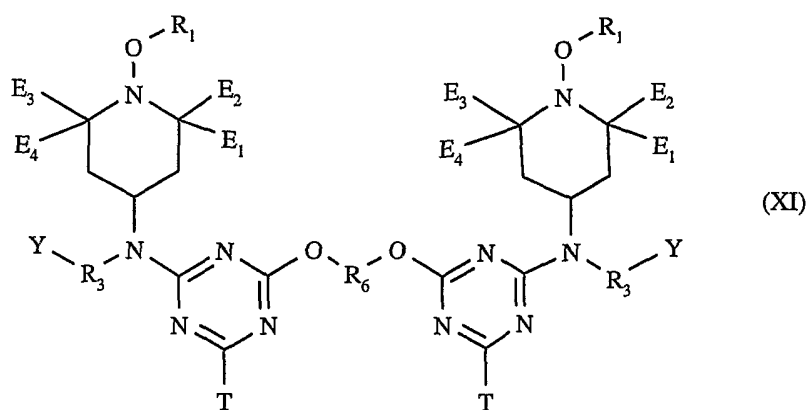
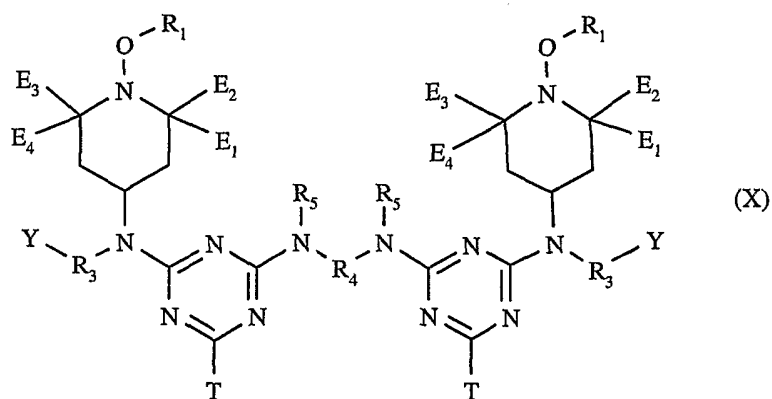
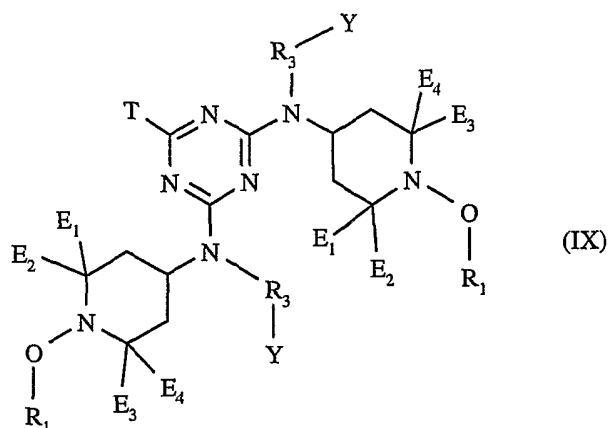


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- 18 -



wherein

- 5 E₁, E₂, E₃ and E₄ are independently alkyl of 1 to 4 carbon atoms, or E₁ and E₂ are independently alkyl of 1 to 4 carbon atoms and E₃ and E₄ taken together are pentamethylene, or E₁ and E₂; and E₃ and E₄ each taken together are pentamethylene;

R₁ is alkyl of 1 to 18 carbon atoms, cycloalkyl of 5 to 12 carbon atoms, a bicyclic or tricyclic hydrocarbon radical of 7 to 12 carbon atoms, phenylalkyl of 7 to 15 carbon atoms, aryl of 6 to 10 carbon atoms or said aryl substituted by one to three alkyl of 1 to 8 carbon atoms;

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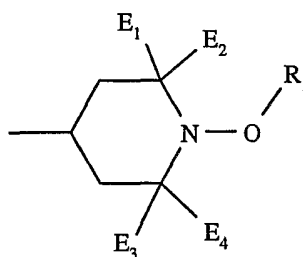
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R_2 is hydrogen or a linear or branched chain alkyl of 1 to 12 carbon atoms;

R_3 is alkylene of 1 to 8 carbon atoms, or R_3 is $-\text{CO}-$, $-\text{CO}-R_4-$, $-\text{CONR}_2-$, or $-\text{CO}-\text{NR}_2-R_4-$;

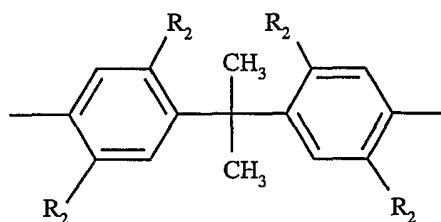
R_4 is alkylene of 1 to 8 carbon atoms;

R_5 is hydrogen, a linear or branched chain alkyl of 1 to 12 carbon atoms; or represents a group of the formula



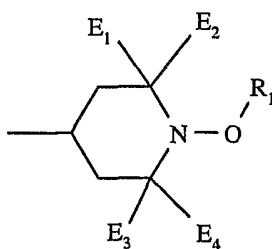
or when R_4 is ethylene, two R_5 methyl substituents can be linked by a direct bond so that the triazine bridging group $-\text{N}(\text{R}_5)-R_4-\text{N}(\text{R}_5)-$ is a piperazin-1,4-diyl moiety;

R_6 is alkylene of 2 to 8 carbon atoms; or represents a group of the formula



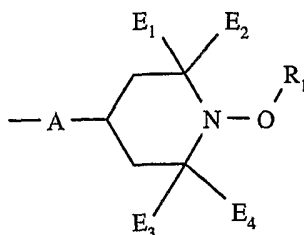
with the proviso that Y is not $-\text{OH}$ when R_6 is the structure depicted above;

A is $-\text{O}-$ or $-\text{NR}_7-$, wherein R_7 is hydrogen, a straight or branched chain alkyl of 1 to 12 carbon atoms; or R_7 represents a group of the formula



T is phenoxy, phenoxy substituted by one or two alkyl groups of 1 to 4 carbon atoms, alkoxy of 1 to 8 carbon atoms or $-\text{N}(\text{R}_2)_2$ with the stipulation that R_2 is not hydrogen, or T represents a group of the formula

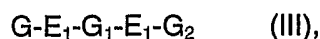
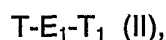
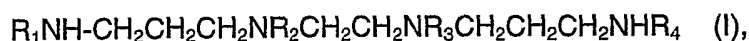
- 20 -



X is -NH₂, -NCO, -OH, -O-glycidyl, or -NHNH₂; and

Y is -OH, -NH₂, -NHR₂ where R₂ is not hydrogen; or Y is -NCO, -COOH, oxiranyl, -O-glycidyl, or -Si(OR₂)₃; or the combination R₃-Y- is -CH₂CH(OH)R₂ where R₂ is alkyl or said alkyl interrupted by one to four oxygen atoms, or R₃-Y- is -CH₂OR₂; or,

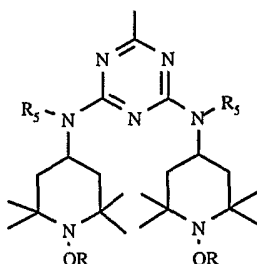
Wherein the hindered amine compound is a mixture of N,N',N''-tris{2,4-bis[(1-hydrocarbyloxy-2,2,6,6-tetramethylpiperidin-4-yl)alkylamino]-s-triazin-6-yl}-3,3'-ethylenediiminodipropylamine; N,N',N''-tris{2,4-bis[(1-hydrocarbyloxy-2,2,6,6-tetramethylpiperidin-4-yl)alkylamino]-s-triazin-6-yl}-3,3'-ethylenediiminodipropylamine, and bridged derivatives as described by formulae I, II, IIA and III:



where in the tetraamine of formula I,

R₁ and R₂ are the s-triazine moiety E; and one of R₃ and R₄ is the s-triazine moiety E with the other of R₃ or R₄ being hydrogen,

E is a group of the formula



wherein R is methyl, propyl, cyclohexyl or octyl, for instance cyclohexyl;

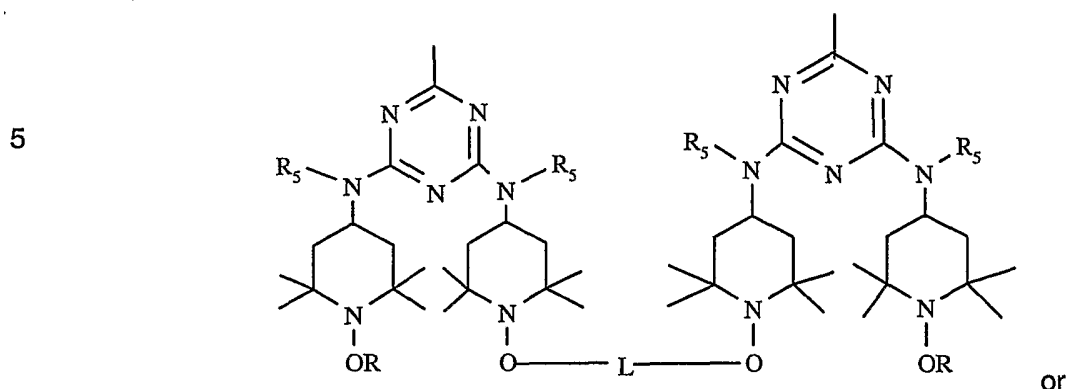
R₅ is alkyl of 1 to 12 carbon atoms, for example n-butyl;

wherein in the compound of formula II or IIA when R is propyl, cyclohexyl or octyl;

T and T₁ are each a tetraamine substituted by R₁-R₄ as is defined for formula I, wherein

- (1) one of the s-triazine moieties E in each tetraamine is replaced by the group E₁ which forms a bridge between two tetraamines T and T₁;

E₁ is



- (2) the group E₁ can have both termini in the same tetraamine T as in formula IIA where two of the E moieties of the tetraamine are replaced by one E₁ group, or

- (3) all three s-triazine substituents of tetraamine T can be E₁ such that one E₁ links T and T₁ and a second E₁ has both termini in tetraamine T;

10 L is propanediyl, cyclohexanediyl or octanediyl;

wherein in the compound of formula III

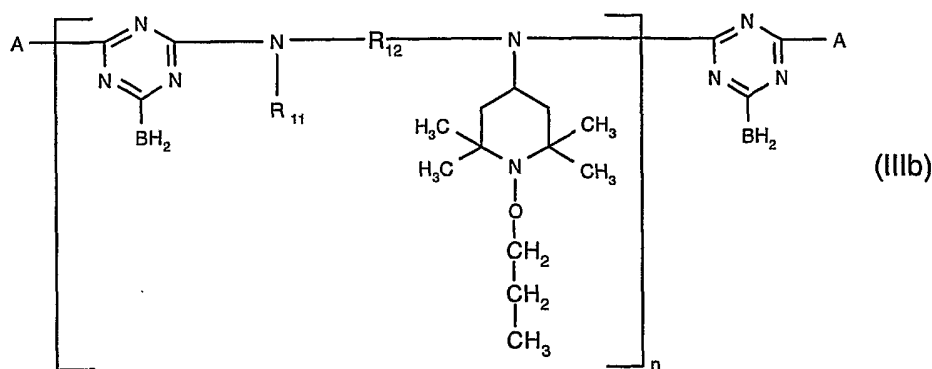
G, G₁ and G₂ are each tetraamines substituted by R₁-R₄ as defined for formula I, except that G and G₂ each have one of the s-triazine moieties E replaced by E₁, and G₁ has two of the triazine moieties E replaced by E₁, so that there is a bridge between G and G₁ and a second bridge between G₁ and G₂;

15

which mixture is prepared by reacting two to four equivalents of 2,4-bis[(1-hydrocarbyloxy-2,2,6,6-piperidin-4-yl)butylamino]-6-chloro-s-triazine with one equivalent of N,N'-bis(3-aminopropyl)ethylenediamine;

or the hindered amine is a compound of the formula IIIb

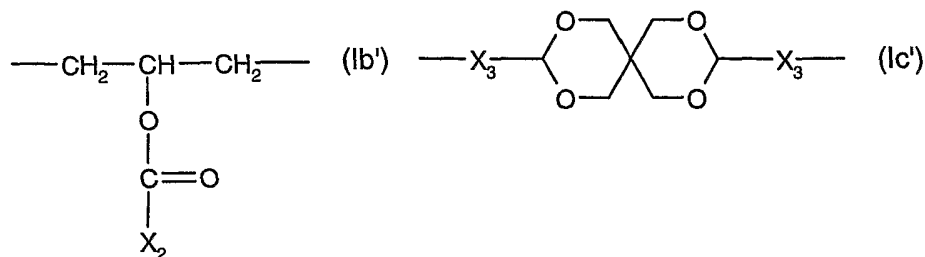
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in which the index n ranges from 1 to 15;

R_{12} is C_2 - C_{12} alkylene, C_4 - C_{12} alkenylene, C_5 - C_7 cycloalkylene, C_5 - C_7 cycloalkylene-, di(C_1 - C_4 alkylene), C_1 - C_4 alkylenedi(C_5 - C_7 cycloalkylene), phenylenedi(C_1 - C_4 alkylene) or C_4 -

- 5 C_{12} alkylene interrupted by 1,4-piperazinediyl, -O- or $>N-X_1$ with X_1 being C_1 - C_{12} acyl or (C_1 - C_{12} alkoxy)carbonyl or having one of the definitions of R_{14} given below except hydrogen; or R_{12} is a group of the formulae (Ib') or (Ic');



with m being 2 or 3;

- 10 X_2 being C_1 - C_{18} alkyl, C_5 - C_{12} cycloalkyl which is unsubstituted or substituted by 1, 2 or 3, C_1 - C_4 alkyl; phenyl which is unsubstituted or substituted by 1, 2 or 3 C_1 - C_4 alkyl or C_1 - C_4 alkoxy; C_7 - C_9 phenylalkyl which is unsubstituted or substituted on the phenyl by 1, 2 or 3 C_1 - C_4 alkyl; and

The radicals X_3 being independently of one another C_2 - C_{12} alkylene;

- 15 R_{13} , R_{14} and R_{15} , which are identical or different, are hydrogen, C_1 - C_{18} alkyl, C_5 - C_{12} cycloalkyl which is unsubstituted or substituted by 1, 2 or 3 C_1 - C_4 alkyl; C_3 - C_{18} alkenyl, phenyl which is unsubstituted or substituted by 1, 2 or 3 C_1 - C_4 alkyl or C_1 - C_4 alkoxy; C_7 - C_9 phenylalkyl

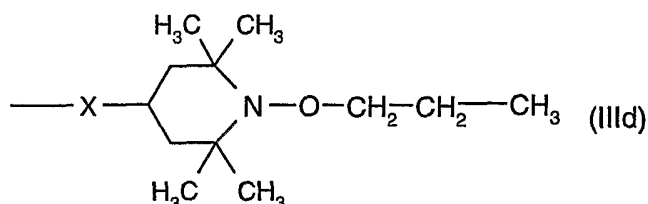
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which is unsubstituted or substituted on the phenyl by 1, 2 or 3 C₁-C₄alkyl; tetrahydrofurfuryl or C₂-C₄alkyl which is substituted in the 2, 3 or 4 position by -OH, C₁-C₈alkoxy, di(C₁-C₄alkyl)amino or represents a group of the formula (Ie');



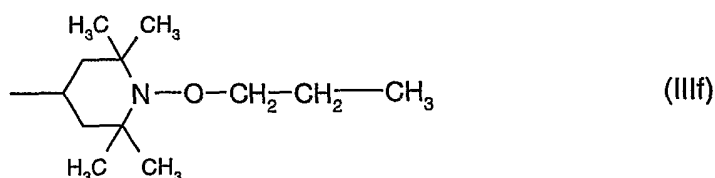
- 5 with Y being -O-, -CH₂-, -CH₂CH₂- or >N-CH₃, or -N(R₁₄)(R₁₅) is additionally a group of the formula (Ie'); or

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



- 10 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 (III f),



- 15 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 (Ie');

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.

The following general definitions of the substituents mentioned above apply:

- 20 Alkyl is straight or branched and 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.

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Cycloalkyl groups include cyclopentyl and cyclohexyl; typical cycloalkenyl groups include cyclohexenyl; while typical aralkyl groups include benzyl, alpha-methyl-benzyl, alpha,alpha-dimethylbenzyl or phenethyl.

If R_2 is a monovalent acyl radical of a carboxylic acid, it is for example an acyl radical of acetic acid, stearic acid, salicylic acid, benzoic acid or β -(3,5-di-tert-butyl-4-hydroxyphenyl) propionic acid.

If R_2 is a divalent acyl radical of a dicarboxylic acid, it is for example an acyl radical of oxalic acid, adipic acid, succinic acid, suberic acid, sebacic acid, phthalic acid dibutylmalonic acid, dibenzylmalonic acid or butyl-(3,5-di-tert-butyl-4-hydroxybenzyl)-malonic acid, or bicycloheptenedicarboxylic acid, with succinates, sebacates, phthalates and isophthalates being specific examples.

If R_2 is a divalent acyl radical of a dicarbamic acid, it is for example an acyl radical of hexamethylenedicarbamic acid or of 2,4-toluylenedicarbamic acid.

The hindered alkoxyamine stabilisers of components (i) are well known in the art, also known as N-alkoxy hindered amines and NOR hindered amines or NOR hindered amine light stabilisers or NOR HALS.

They are disclosed for example in *U.S. Patent Specification Nos. 5,004,770, 5,204,473, 5,096,950, 5,300,544, 5,112,890, 5,124,378, 5,145,893, 5,216,156, 5,844,026, 6,117,995, 6,271,377*. The relevant disclosures of these patents and applications are hereby incorporated by reference.

U.S. Patent Specification No. 6,271,377, disclose hindered hydroxyalkoxyamine stabilisers. For the purposes of this invention, the hindered hydroxyalkoxyamine stabilisers are considered a subset of the hindered alkoxyamine stabilisers and are part of present component (i). Hindered hydroxyalkoxyamine stabilisers are also known as N-hydroxyalkoxy hindered amines, or NORol HALS.

Suitable hindered amines of component (i) include for example:

NOR 1: cyclohexyloxy-2,2,6,6-tetramethyl-4-octadecylaminopiperidine;

NOR 2: bis(1-octyloxy-2,2,6,6-tetramethylpiperidin-4-yl) sebacate;

NOR 3: 2,4-bis[(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidin-4-yl)butylamino]-6-(2-hydroxyethylamino-s-triazine);

NOR 3: bis(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidin-4-yl) adipate;

NOR 4: 2,4-bis[(1-cyclohexyloxy-2,2,6,6-piperidin-4-yl)butylamino]-6-chloro-s-triazine;

NOR 5: 1-(2-hydroxy-2-methylpropoxy)-4-hydroxy-2,2,6,6-tetramethylpiperidine;

NOR 6: 1-(2-hydroxy-2-methylpropoxy)-4-oxo-2,2,6,6-tetramethylpiperidine;

NOR 7: 1-(2-hydroxy-2-methylpropoxy)-4-octadecanoyloxy-2,2,6,6-tetramethylpiperidine;

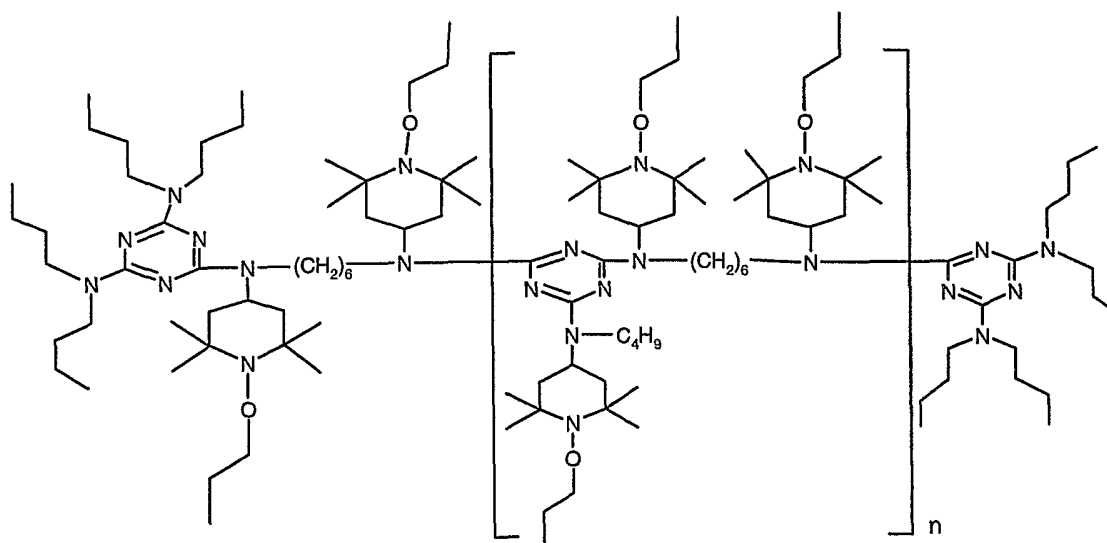
NOR 8: bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) sebacate;

5 NOR 9: bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) adipate;

NOR 10: 2,4-bis[N-[1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl]-N-butylamino]-6-(2-hydroxyethylamino)-s-triazine;

NOR 11: The reaction product of 2,4-bis[(1-cyclohexyloxy-2,2,6,6-piperidin-4-yl)butylamino]-6-chloro-s-triazine with N,N'-bis(3-aminopropyl)ethylenediamine) [CAS Reg. No. 191680-81-6]; and

NOR 12: The compound of formula:



in which n is from 1 to 15.

Compound NOR 12 is disclosed in example 2 of *U.S. Patent Specification No. 6,117,995*.

15 The stabilisers of component (i) are advantageously contained in the composition of the invention in an amount from about 0.05 to about 20% by weight based on the polymer substrate (A); for example from about 0.1 to about 10% by weight; for example from about 0.2 to about 8% by weight; for instance from about 0.5 to about 3% by weight.

Conventional Flame Retardants of Component (ii)

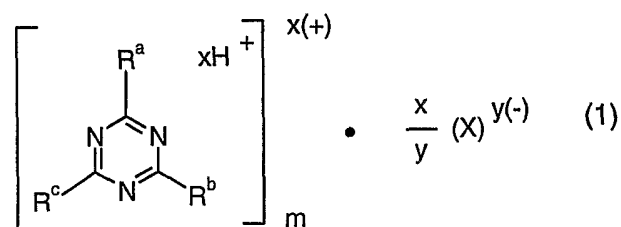
20 The melamine based flame retardants useful as component (ii) in compositions of present invention are known in the art and are commercially available. They are for example selected

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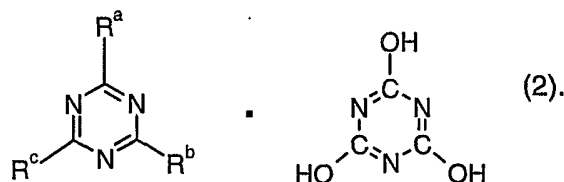
from the group consisting of melamine ammonium phosphate, melamine ammonium polyphosphate, melamine ammonium pyrophosphate, a condensation product of melamine, a reaction product of melamine with phosphoric acid and a reaction product of the condensation product of melamine with phosphoric acid or mixtures thereof.

- 5 In a preferred embodiment of the invention the melamine based flame retardants are selected from the group consisting of a melamine phosphate, dimelamine phosphate, melamine pyrophosphate, melamine borate, melamine cyanurate, melam or melem phosphate, melam or melem polyphosphate, melamine ammonium phosphate, melamine ammonium pyrophosphate and a melamine ammonium polyphosphate.

- 10 The melamine borate is, e.g. represented by the formula



and the melamine cyanurate is, e.g. represented by the formula



In the formulae (1) and (2) of above

- 15 R^a , R^b and R^c independently of one another represent hydrogen, C_1 - C_8 -alkyl, C_5 - C_6 -cycloalkyl or C_1 - C_4 -alkyl- C_5 - C_6 -cycloalkyl, each unsubstituted or substituted with hydroxy or C_1 - C_4 -hydroxylkyl, C_2 - C_8 -alkenyl, C_1 - C_8 -alkoxy, C_1 - C_8 -acyl, C_1 - C_8 acyloxy, C_6 - C_{12} -aryl, $-\text{O}-\text{R}^d$ or $-\text{N}(\text{R}^d)\text{R}^e$, wherein

- R^d and R^e represent hydrogen, C_1 - C_4 -alkyl, C_5 - C_6 -cycloalkyl, C_2 - C_8 -alkenyl, C_1 - C_4 -hydroxylkyl oder C_6 - C_{12} -aryl;

with the proviso that all of R^a , R^b and R^c do not represent hydrogen;

with the additional proviso that in the formula VII at least one group is present capable of adding a proton;

X represents the anion of a proton donating acid;

- 25 x represents the number of protons donated by the acid to the triazine moiety; and

y represents the number of protons abstracted from the proton donating acid;

The symbol X in the formula (1) represents e.g. the anion of phosphoric acid, polyphosphoric acid, pyrophosphoric acid, Phosphinic acid, phosphonic acid and boric acid.

In a preferred embodiment of the invention R^a , R^b and R^c independently of one another represent hydrogen, C₁-C₄-alkyl, cyclopentyl, cyclohexyl, methylcyclohexyl, C₁-C₄-hydroxyalkyl, C₂-C₆-alkenyl, C₁-C₄-alkoxy, phenyl, phenyl substituted with 1-3 substituents selected from the group consisting of methyl, methoxy and halogen;

Or represent $-OR^d$ or $-NR^dR^e$, wherein R^d and R^e independently of one another represent, C₁-C₄-alkyl, C₁-C₄-hydroxyalkyl, cycloalkyl, methylcyclohexyl, phenyl or phenyl substituted with 1-3 substituents selected from the group consisting of methyl, methoxy and halogen.

According to particularly preferred embodiments of the invention melamine based flame retardants are selected from the group consisting of a melamine phosphate, dimelamine phosphate, melamine pyrophosphate, melamine borate, melamine cyanurate, melamine ammonium phosphate, melamine ammonium pyrophosphate and melamine ammonium polyphosphate.

According to other particularly preferred embodiments of the invention melamine based flame retardants are condensation products of melamine selected from the group consisting of melem, melam, melon and higher condensation products of melamine.

According to other particularly preferred embodiments of the invention melamine based flame retardants are reaction products selected from the group consisting of melamine with phosphoric acid, condensation products of melamine with phosphoric acid and mixtures thereof.

According to other particularly preferred embodiments of the invention melamine based flame retardants are reaction products of melamine with phosphoric acid selected from the group consisting of dimelamine pyrophosphate, melem polyphosphate, melam polyphosphate and mixed poly salts thereof.

Component (ii) is advantageously contained in the composition of the invention in an amount from about 0.5% to about 45% by weight of the polymeric substrate (A); for instance about 3% to about 40%; for example about 5% to about 35% by weight of component (A). For example, component (ii) is employed from about 0.5% to about 10% by weight, from about 1% to about 10%, from about 3% to about 10% or from about 5% to about 10% by weight, based on the weight of the polymeric substrate. For example, component (ii) is employed from

about 0.5% to about 8%, from about 0.5% to about 6%, from about 0.5% to about 5%, or from about 0.5% to about 3% by weight, based on the weight of the polymeric substrate.

The ratio (parts by weight) of component (i) to component (ii) is for example between about 1:5 to about 1:200, for instance from about 1:50 to about 1:100, or about 1:10 to about 1:25.

5 For example the ratio of component (i) to component (ii) is from about 1:10 to about 1:200, from about 1:25 to about 1:200, from about 1:50 to about 1:200 or from about 1:100 to about 1:200. For example, the weight ratio of component (i) to component (ii) is from about 1:5 to about 1:100, from about 1:5 to about 1:50, from about 1:5 to about 1:25, or from about 1:5 to about 1:10.

10 The amount of component (ii) used also depends on the effectiveness of the specific compound(s), the polymer and the specific application type.

The compositions of the present invention are useful for many applications, for example outdoor applications, including the following:

15 Thermoplastic olefins, paintable thermoplastic olefins, polypropylene molded articles, polyethylene films, thermoplastic elastomers with other costabilisers, 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 films, pre-formed films for lamination to plastic substrates, electronic appliances, containers, boxes, bins for storage and transportation, automotive applications, e.g. dashboardso back boards, furniture e.g. stadium seats or public seats, roofing sheets, roofing membranes, flooring materials, liners, profiles, for example window and door profiles, geomembranes, awning fabrics, banner films, upholstery, drapery, carpeting, tents, tarpaulins, 20 Surgical gowns, caps and other hospital applications, fabrics, ropes, nets, tire cords or parachutes.

The compositions of the present invention are useful in textile laminates and as coatings of substrates as described in *U.S. Patent Specification Nos. 6,235,658 and 6,251,995*, the relevant disclosures of which are hereby incorporated by reference.

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

The resulting stabilised compositions of the invention may optionally also contain various conventional additives, for example in amounts from about 0.01 to about 10%, for instance

from about 0.025 to about 4%, for example from about 0.1 to about 2% by weight of component (A), such as the materials listed below, or mixtures thereof.

1. Antioxidants

5 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, 10 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

15 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

20 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)disulphide

25 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], 30 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-methyl-

phenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methyl-phenyl)-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-hydroxy-phenyl)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)sulphide, 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, 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

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)oxamide, 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 (Naugard®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-toluenesulphamoyl)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-butyrylaminophenol, 4-nonanoylaminophenol, 4-dodecanoylaminophenol, 4-octadecanoylaminophenol, 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- und dialkylated tert-butyldiphenylamines, 2,3-dihydro-3,3-dimethyl-4H-1,4-benzothiazine, phenothiazine, a mixture of mono- und dialkylated tert-butyl/tert-octylphenothiazines, a mixture of mono- und dialkylated tert-octyl-phenothiazines, N-allylphenothiazin, 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-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chloro-benzotriazole, 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)ethyl)phenyl)-5-

chloro-benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)-carbonylethyl]-2'-hydroxy-phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonylethyl)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-methoxycarbonylethyl)-2'-hydroxyphenyl]-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, as for example 4-tertbutyl-phenyl 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-hydroxybenzoate, 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-methoxy-cinnamate, butyl α -cyano- β -methyl-p-methoxy-cinnamate, methyl α -carbomethoxy-p-methoxycinnamate and N-(β -carbomethoxy- β -cyanovinyl)-2-methylindoline

2.5 Nickel compounds, for example nickel complexes of 2,2'-thio-bis-[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-methylphenyl undecylketoxime, nickel complexes of 1-phenyl-4-lauroyl-5-hydroxypyrazole, with or without additional ligands

2.6 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-octyloxy-2,2,6,6-tetramethyl-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-butane-tetracarboxylate, 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]decan-2,4-dione, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)succinate, 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)pyrrolidin-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione, a mixture of 4-hexadecyloxy- and 4-stearyloxy-2,2,6,6-tetramethylpiperidine, a condensation product of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-cyclohexylamino-2,6-dichloro-1,3,5-triazine, a condensation product 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]); N-(2,2,6,6-tetramethyl-4-piperidyl)-n-dodecylsuccinimid, N-(1,2,2,6,6-pentamethyl-4-piperidyl)-n-dodecylsuccinimid, 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 und epichlorohydrin, 1,1-bis(1,2,2,6,6-pentamethyl-4-piperidylloxycarbonyl)-2-(4-methoxyphenyl)ethene, N,N'-bis-formyl-N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine, diester of 4-methoxy-methylene-malonic acid with 1,2,2,6,6-pentamethyl-4-hydroxypiperidine, poly[methylpropyl-3-oxy-4-(2,2,6,6-tetramethyl-4-piperidyl)]siloxane, 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-butyloxy-propoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxy-propyloxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[4-(dodecyloxy/tridecyloxy-2-hydroxypropoxy)-2-hydroxy-phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-dodecyloxy-propoxy)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-hydroxy-propoxy)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.

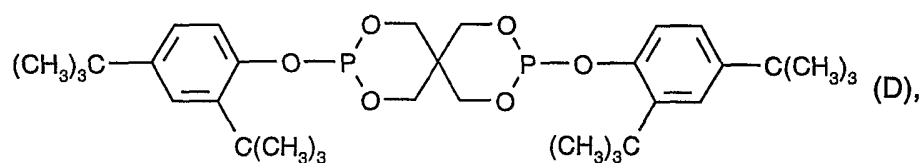
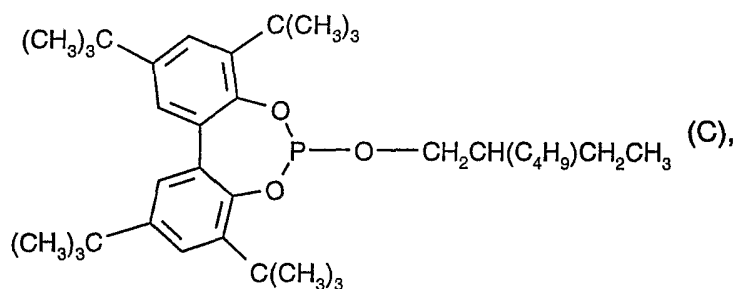
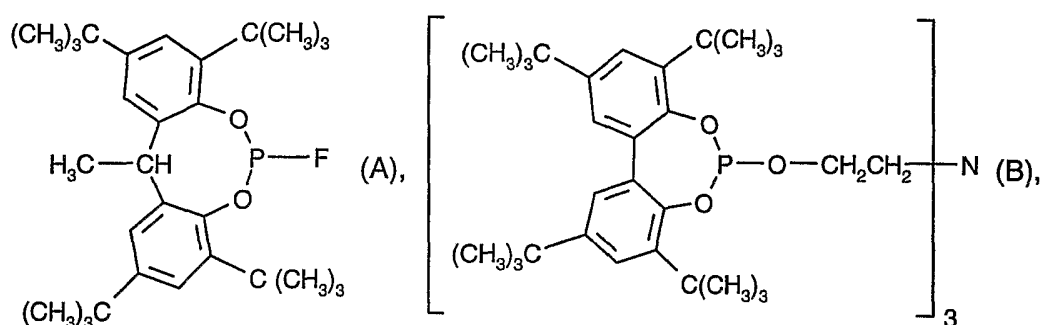
3. Metal deactivators, for example N,N'-diphenyloxamide, N-salicylal-N'-salicyloyl hydrazine, N,N'-bis(salicyloyl) hydrazine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl) hydrazine, 3-salicyloylamino-1,2,4-triazole, bis(benzylidene)oxalyl dihydrazide, oxanilide, isophthaloyl dihydrazide, sebacoyl 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, diphenyl alkyl phosphites, phenyl dialkyl 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(2,6-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-

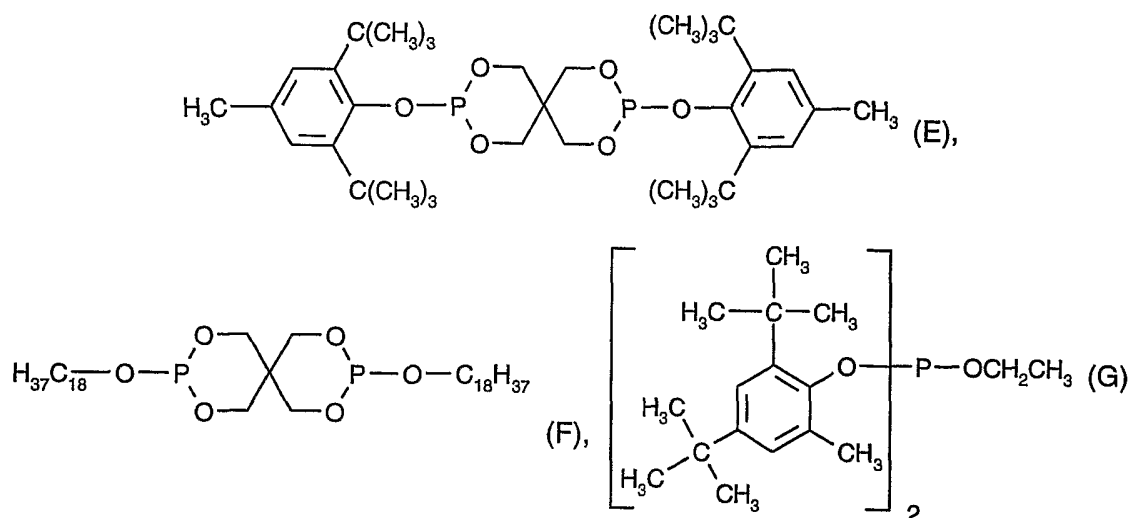
6-methylphenyl) methyl phosphite, bis(2,4-di-tert-butyl-6-methylphenyl) ethyl phosphite, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenz[d,g]-1,3,2-dioxaphosphocin, 2,2',2''-nitriolo[triethyltris(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite], 2-ethylhexyl(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite, 5-butyl-5-ethyl-2-(2,4,6-tri-tert-butylphenoxy)-1,3,2-dioxaphosphirane;

Specific examples are the following phosphites:

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



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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-phenyl-nitrone, N-ethyl-alpha-methyl-nitrone, N-octyl-alpha-heptyl-nitrone, N-lauryl-alpha-undecyl-nitrone, N-tetradecyl-alpha-tridcyl-nitrone, N-hexadecyl-alpha-pentadecyl-nitrone, N-octadecyl-alpha-heptadecyl-nitrone, N-hexadecyl-alpha-heptadecyl-nitrone, N-ocatadecyl-alpha-pentadecyl-nitrone, N-heptadecyl-alpha-heptadecyl-nitrone, N-octadecyl-alpha-hexadecyl-nitrone, nitrone 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 disulphide, 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 zink pyrocatecholate.

11. Nucleating agents, for example, inorganic substances such as talcum, metal oxides such as titanium dioxide or magnesium oxide, phosphates, carbonates or sulphates of, for example, 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). Specific examples are 1,3:2,4-bis(3',4'-dimethylbenzylidene)sorbitol, 1,3:2,4-di(paramethyldibenzylidene)sorbitol, und 1,3:2,4-di(benzylidene)sorbitol.

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

13. Benzofuranones and indolinones, for example those disclosed in *U.S. Patent Specification Nos. 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.*

14. Amine oxides, for example amine oxide derivatives as disclosed in *U.S. Patent Specification 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 Specification Nos. 5,844,029 and 5,880,191* disclose the use of saturated hydrocarbon amine oxides towards the stabilisation of thermoplastic resins. Specific examples of additives are phenolic antioxidants (item 1 of the list), further sterically hindered amines (item 2.6 of the list), light stabilisers 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-de-destroying compounds (item 5.) of the list.

The instant composition can additionally contain further UV absorber molecules 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 stabilising amount of at least one other 2-hydroxyphenyl-2H-benzotriazole; another tris-aryl-s-triazine; or hindered amine or mixtures thereof. For example, additional components are selected from pigments, dyes, plasticisers, antioxidants, thixotropic agents, levelling assistants, basic costabilisers, further light stabilisers 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.

5 The additives of the invention and optional further components may be added to the polymer material individually or mixed with one another. If desired, the individual components can be mixed with one another before incorporation into the polymer for example by dry blending, compaction or in the melt. Subject of the invention therefore is also a flame retardant additive combination comprising

- 10 (i) At least one sterically hindered alkoxyamine stabiliser; and
- (ii) At least one conventional flame retardant selected from the group consisting of the melamine based flame retardants as specified above, e.g. a flame retardant selected from the group consisting of melamine ammonium phosphate, melamine ammonium polyphosphate, melamine ammonium pyrophosphate, a condensation product of
- 15 melamine, a reaction product of melamine with phosphoric acid and a reaction product of the condensation product of melamine with phosphoric acid or mixtures thereof.

A preferred embodiment of the invention relates to a flame retardant additive combination comprising

- (i) At least one sterically hindered alkoxyamine stabiliser; and
- 20 (ii) At least one conventional flame retardant selected from the group consisting of a melamine phosphate, dimelamine phosphate, melamine pyrophosphate, melamine borate, melamine cyanurate, melam or melem phosphate, melam or melem polyphosphate, melamine ammonium phosphate, melamine ammonium pyrophosphate and a melamine ammonium polyphosphate or mixtures thereof.

25 The additives of above components (i) and (ii) and possibly further additives as described above may be dry blended and then extruded, for instance in a twin screw extruder at 180-220°C, with or without nitrogen atmosphere. The material thus obtained may be further processed according to known methods. The surface of the articles formed do not show any loss of gloss or any kind of roughness.

30 Further, the instant invention pertains to a process for imparting light stability and flame retardancy to an organic polymeric substrate, which process comprises adding to said polymeric substrate an effective flame retarding amount of a mixture of

- (i) At least one sterically hindered alkoxyamine stabiliser;

(ii) At least one conventional flame retardant as specified above.

The incorporation of the additives of the invention and optional further components into the polymer is carried out by known methods such as dry blending in the form of a powder, or wet mixing in the form of solutions, dispersions or suspensions for example in an inert solvent, water or oil. The additives of the invention and optional further additives may be incorporated, for example, before or after molding or also by applying the dissolved or dispersed additive or additive mixture to the polymer material, with or without subsequent evaporation of the solvent or the suspension/dispersion agent. They may be added directly into the processing apparatus (e.g. extruders, internal mixers, etc), e.g. as a dry mixture or powder or as solution or dispersion or suspension or melt.

The incorporation can be carried out in any heatable container equipped with a stirrer, e.g. in a closed apparatus such as a kneader, mixer or stirred vessel. The incorporation is for example carried out in an extruder or in a kneader. It is immaterial whether processing takes place in an inert atmosphere or in the presence of oxygen.

The addition of the additive or additive blend to the polymer can be carried out in all customary mixing machines in which the polymer is melted and mixed with the additives. Suitable machines are known to those skilled in the art. They are predominantly mixers, kneaders and extruders. The process is for instance carried out in an extruder by introducing the additive during processing.

Specific examples of suitable processing machines are single-screw extruders, contrarotating and corotating twin-screw extruders, planetary-gear extruders, ring extruders or cokneaders. It is also possible to use processing machines provided with at least one gas removal compartment to which a vacuum can be applied.

Suitable extruders and kneaders are described, for example, in *Handbuch der Kunststoffextrusion, Vol. 1 Grundlagen, Editors F. Hensen, W. Knappe, H. Potente, 1989, pp. 3-7, ISBN:3-446-14339-4 (Vol. 2 Extrusionsanlagen 1986, ISBN 3-446-14329-7).*

For example, the screw length is 1-60 screw diameters, for example 35-48 screw diameters. The rotational speed of the screw is for instance 10-600 rotations per minute (rpm), for example 25-300 rpm.

The maximum throughput is dependent on the screw diameter, the rotational speed and the driving force. The process of the present invention can also be carried out at a level lower than maximum throughput by varying the parameters mentioned or employing weighing machines delivering dosage amounts. If a plurality of components are added, these can be premixed or added individually.

The additives of the invention and optional further additives can also be sprayed onto the polymer material. They are able to dilute other additives, for example the conventional additives indicated above, or their melts so that they can be sprayed also together with these additives onto the material. Addition by spraying during the deactivation of the polymerisation catalysts is particularly advantageous; in this case, the steam evolved may be used for deactivation of the catalyst. In the case of spherically polymerised polyolefins it may, for example, be advantageous to apply the additives of the invention, optionally together with other additives, by spraying.

The additives of the invention and optional further additives can also be added to the polymer in the form of a masterbatch ("concentrate") which contains the components in a concentration of, for example, about 1% to about 40%, for example about 2% to about 20 % by weight incorporated in a polymer. The polymer must not be necessarily of identical structure than the polymer where the additives are added finally. 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. The materials containing the additives of the invention described herein are for example used for the production of molded articles, for example rotomolded articles, injection molded articles, profiles and the like. The molded polymer article made flame retardant by the incorporation of

(i) At least one sterically hindered alkoxyamine stabiliser; and

(ii) At least one conventional flame retardant as defined above

is another object of the invention.

According to another embodiment PTFE (= polytetrafluoroethylene, for example Teflon® 6C; E. I. Du Pont), may be advantageously added to the present compositions as an additional flame retardant, as disclosed in published *U.S. application 60/312,517*, filed Aug. 15, 2001.

It has further unexpectedly been found that polymer molded articles, which normally comprise large amounts of flame-retardant filler in order to maintain flame retardant properties, may be stabilised against light, heat and oxygen and made flame retardant, by the incorporation therein of a present hindered alkoxyamine in combination with a conventional melamine based flame retardant, and the amount of flame-retardant filler necessary is greatly reduced or even totally eliminated. The polymer molded articles are for example polyolefin molded articles, for example thin-section articles. The flame-retardant filler is typically magnesium hydroxide.

The thin-section polyolefin molded articles advantageously comprise present components (i) and (ii). The polyolefin molded articles of this invention, with reduced levels of flame-retar-

dant filler or no flame-retardant filler, maintain flame retardancy and have improved physical properties.

The polyolefin molded articles of this invention may be used for example as roofing membranes, siding, window profiles and moldings. Such molded articles are for example about 5 mil to about 100 mil thick, for example about 20 mil to about 100 mil thick, for instance about 10 mil to about 80 mil, for example about 40 mil to about 100 mil thick. The polyolefin is in particular thermoplastic polyolefin (TPO). The molded articles of this invention exhibit better physical properties than the state of the art formulations, as exhibited by mechanical properties such as tensile strength, elongation resistance and crack resistance.

- 10 The effective flame retarding amount of component (B) is that needed to show flame retarding efficacy as measured by one of the standard methods used to assess flame retardancy. These include the *NFPA 701 Standard Methods of Fire Tests for Flame-Resistant Textiles and Films, 1989 and 1996 Editions*; *UL 94 Test for Flammability of Plastic Materials for Parts in Devices and Appliances, 5th Edition, October 29, 1996*; *Limiting Oxygen Index (LOI)*,
 15 *ASTM D-2863*; and *Cone Calorimetry, ASTM E-1354*. Ratings according to the UL 94 V test are as compiled in the following table:

Rating	Afterflame time	Burning drips	Burn to Clamp
V-0	< 10 s	no	no
V-1	< 30 s	no	no
V-2	< 30 s	yes	no
Fail	< 30 s		yes
Fail	> 30 s		no

Coadditives found particularly useful for use with the instant combination of components (i) and (ii) in flame retardant compositions are as follows:

UV absorbers:

- 20 2-(2-hydroxy-3,5-di- α -cumylphenyl)-2H-benzotriazole, (TINUVIN[®] 234, Ciba Specialty Chemicals Corp.);
- 2-(2-hydroxy-5-methylphenyl)-2H-benzotriazole, (TINUVIN[®] P, Ciba Specialty Chemicals Corp.);

5-chloro-2-(2-hydroxy-3,5-di-tert-butylphenyl)-2H-benzotriazole, (TINUVIN[®] 327, Ciba Specialty Chemicals Corp.);

2-(2-hydroxy-3,5-di-tert-amylphenyl)-2H-benzotriazole, (TINUVIN[®] 328, Ciba Specialty Chemicals Corp.);

5 2-(2-hydroxy-3- α -cumyl-5-tert-octylphenyl)-2H-benzotriazole, (TINUVIN[®] 928, Ciba Specialty Chemicals Corp.);

2,4-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate, (TINUVIN[®] 120, Ciba Specialty Chemicals Corp.);

10 2-hydroxy-4-n-octyloxybenzophenone, (CHIMASSORB[®] 81, Ciba Specialty Chemicals Corp.);

2,4-bis(2,4-dimethylphenyl)-6-(2-hydroxy-4-octyloxyphenyl)-s-triazine, (CYASORB[®] 1164, Cytec).

The following examples are meant for illustrative purposes only and are not to be construed to limit the scope of this invention in any manner whatsoever. Where given, room temperature depicts a temperature in the range 20-25°C. Percentages are by weight of the polymer substrate unless otherwise indicated.

Abbreviations

v: parts by volume; w: parts by weight, ¹H-NMR: nuclear magnetic resonance (NMR) of ¹H;

20 m/z: mass spectrometry (atomic mass units divided by charge); amu: molecular weight in g/mol (= atomic units)

PP polypropylene

PE polyethylene

PE-LD low density polyethylene (LDPE)

Test Methods

25

NFPA 701 Standard Methods of Fire Tests for Flame-Resistant Textiles and Films, 1989 and 1996 editions;

UL 94 Test for Flammability of Plastic Materials for Parts in Devices and Appliances, 5th Edition, October 29, 1996;

30 Limiting Oxygen Index (LOI), ASTM D-2863;

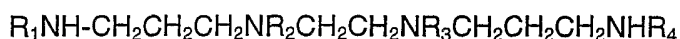
Cone Calorimetry, ASTM E-1 or ASTM E 1354;

ASTM D 2633-82, burn test.

Test compounds

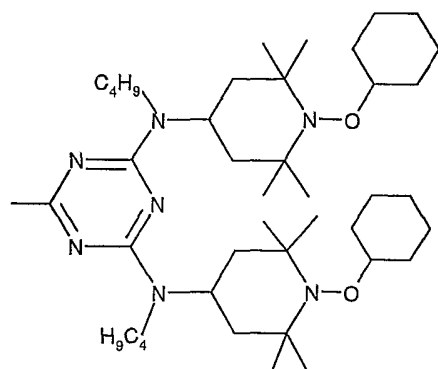
Hindered alkoxyamines of present component (i):

- 5 NOR 1: 1-cyclohexyloxy-2,2,6,6-tetramethyl-4-octadecylaminopiperidine;
 NOR 2: bis(1-octyloxy-2,2,6,6-tetramethylpiperidin-4-yl) sebacate;
 NOR 3: 2,4-bis[(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidin-4-yl)butylamino]-6-(2-hydroxyethylamino)-s-triazine;
 NOR 4: bis(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidin-4-yl) adipate;
- 10 NOR 5: 2,4-bis[(1-cyclohexyloxy-2,2,6,6-piperidin-4-yl)butylamino]-6-chloro-s-triazine;
 NOR 6 : 1-(2-hydroxy-2-methylpropoxy)-4-hydroxy-2,2,6,6-tetramethylpiperidine;
 NOR 7: 1-(2-hydroxy-2-methylpropoxy)-4-oxo-2,2,6,6-tetramethylpiperidine;
 NOR 8: 1-(2-hydroxy-2-methylpropoxy)-4-octadecanoyloxy-2,2,6,6-tetramethylpiperidine;
- 15 NOR 9: bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) sebacate;
 NOR 10: bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) adipate;
 NOR 11: 2,4-bis{N-[1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl]-N-butylamino}-6-(2-hydroxyethylamino)-s-triazine;
- 20 NOR 12: the reaction product of 2,4-bis[(1-cyclohexyloxy-2,2,6,6-piperidin-4-yl)butylamino]-6-chloro-s-triazine with N,N'-bis(3-aminopropyl)ethylenediamine [CAS Reg. No. 191680-81-6];
- (NOR 12 is represented as a mixture of compounds with main component of the formula:
- 25



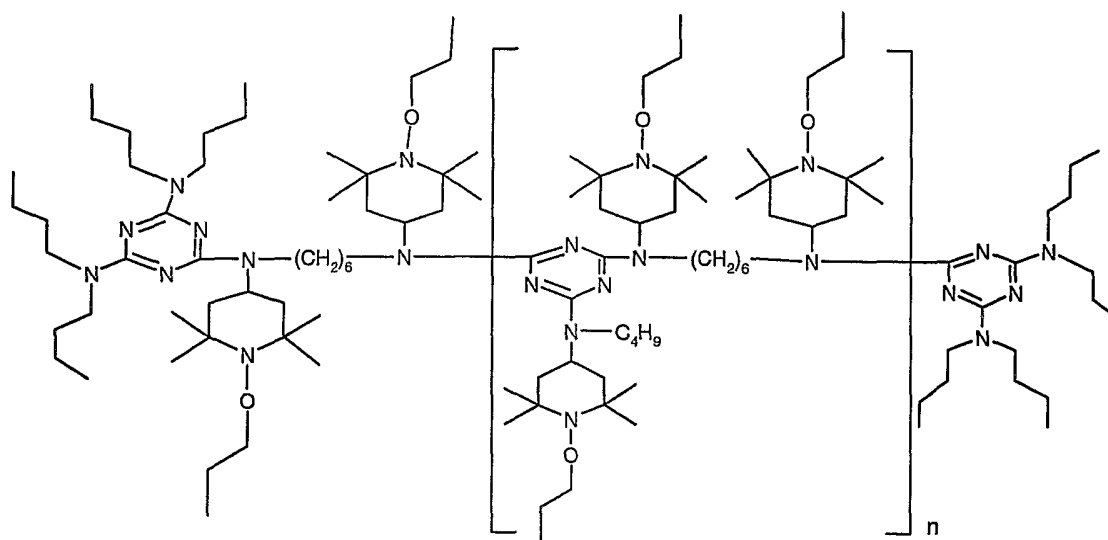
wherein 3 of R_1 , R_2 , R_3 and R_4 are residues of formula

- 45 -

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

NOR12 is a high molecular weight compound disclosed in example 3 of *U.S. Patent Specification. No. 5,844,026*); and

NOR13: the compound of formula



5

in which n is from 1 to 15.

Conventional flame retardants of component (ii):

FR 1: melamine cyanurate, MELAPUR[®] MC,

FR 2: melamine borate,

10 FR 3: melamine polyphosphate MELAPUR[®] 200 and

FR 4: melamine pyrophosphate.

Samples containing the combination of flame retardant and sterically hindered amines of the present invention show no chalking, better gloss and distinctly less color change than samples with non-alkoxy sterically hindered amines

The Compounds NOR 2, NOR 6, NOR10, NOR11 are commercial stabilisers available from Ciba Specialty Chemicals. MELAPUR products are available from DSM- Corporation.

Example 1

- 5 Sample preparation: Polymer powder and stabilisers are pre-mixed (Henschel mixer, 800 rpm, room temperature), pigment powder and flame retardant are added as concentrate in PP and homogenised in a drum mixer. Further homogenisation and granulation is achieved by extrusion (Collin® twin screw extruder, max 200°C, 100 rpm). Subsequently, the mixture
10 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).

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

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

Formulation:

- 84.0 parts by weight of polypropylene-ethylene copolymer (Novolen® PPG 1022),
20 15.0 parts by weight of a PE-based flame retardant masterbatch containing 51% by weight of FR1,
1.0 part by weight of TiO₂ and
0.2 part by weight of blue pigment (Cromophtal blue 4GNP)
0.4 part of an NOR selected from NOR1-NOR13.

25 **Example 2**

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

Formulation:

- 89.0 parts by weight of polypropylene-ethylene copolymer (Novolen® PPG 1022),
10.0 parts by weight of a PE based flame retardant masterbatch containing 30% by weight of
30 FR 1,

1.0 part by weight of TiO_2 and

0.2 part by weight of blue pigment (Cromophtal blue 4GNP)

0.4 part by weight an NOR stabiliser selected from NOR1-NOR13.

Example 3

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

Formulation:

94.0 parts by weight of polypropylene-ethylene copolymer (Novolen® PPG 1022),

4.0 parts by weight of FR 1,

0.2 part by weight of blue pigment (Cromophtal® Blue 4GNP)

10 0.4 part of an NOR selected from NOR1-NOR12,

Example 4

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

Formulation:

87.5 parts by weight of polypropylene-ethylene copolymer (Novolen® PPG 1022),

15 8.0 parts by weight of a PE based flame retardant masterbatch containing 40 % by weight of
FR 1

1.0 part by weight of TiO_2 and

0.2 part by weight of blue pigment (Cromophtal blue 4GNP)

0.4 part of an NOR selected from NOR1-NOR13

Example 5

Examples 1-4 are repeated, replacing FR1 with a conventional flame retardant selected from FR 2-FR 4.

Example 6 TPO Roofing Membranes

25 This example illustrates that by employing the present stabilising and flame retarding system of components (i) and (ii), that flame-retardant filler (typically magnesium hydroxide) may be replaced in polyolefin molded articles. The polyolefin molded articles of this invention maintain flame retardancy and have improved physical properties.

The polyolefin molded articles of this invention may be used for example as roofing membranes, siding, window profiles and moldings. Such molded articles are for example about

5 mil to about 100 mil thick. The polyolefin is in particular thermoplastic polyolefin (TPO). The molded articles of this invention exhibit better physical properties than the state of the art formulations, as exhibited by mechanical properties such as tensile strength, elongation resistance and crack resistance.

5 A typical state of the art formulation for such applications is for example:

	<u>Parts</u>
Polypropylene copolymer	100
TiO ₂ or carbon black	3
CaCO ₃	5
10 Magnesium hydroxide	35
UV stabiliser	1
Lubricant or other	1

The state of the art formulation requires that either TiO₂ or carbon black are present and that magnesium hydroxide is present. In the formulations of the present invention, magnesium

15 hydroxide is replaced with a sterically hindered alkoxyamine compound selected from NOR1-NOR12, and a traditional flame retardant selected from FR 1-FR 4.

The formulation of the present invention is for example:

	<u>parts</u>
Polypropylene copolymer	100
20 TiO ₂ or carbon black	3
CaCO ₃	0-5
Magnesium hydroxide	0
NOR8	1
FR1	4
25 UV stabiliser	1
Lubricant or other	1

NOR 8 may be replaced for example with another hindered amine selected from NOR1-NOR12. FR 1 may be replaced with a flame retardant selected from FR 2-FR 4. The molded

articles of the present invention exhibit excellent flame retardancy and improved physical properties as compared to state of the art molded articles.

Example 7

5 Molding grade polypropylene (Profax® 6501) is dry blended with test additives selected from components (i) and (ii) and then melt compounded in a twin screw extruder at 220°C. Base stabilisation is 500 ppm N,N-di(alkyl)hydroxylamine produced by the direct oxidation of N,N-di(hydrogenated tallow)amine (Irgastab® FS-042) and 500 ppm calcium stearate. Plaques (125 mil) containing an alkoxyamine selected from NOR 1-NOR 12 are prepared by injection molding from the formulations using a Boy Injection Molder at 475°F (246°C). The specimen
10 are tested for flame retardancy according to the UL-94 vertical burn test specifications.

Example 8

Polyethylene fibers are prepared from fiber grade polyethylene by dry blending with test additives and melt compounding at 400°F. Fibers are extruded from this formulation using a Hills laboratory scale fiber extruder. Socks are knitted from the fibers and are tested for flame
15 retardancy according to NFPA 701 vertical burn method. Polyethylene fibers contain 0.5%, 1% or 2% by weight, total, of an additive selected from NOR1-NOR13, and further with 10% by weight of a classic melamine based flame retardant. These formulated fibers are tested for flame retardancy according to NFPA 701.

Example 9

20 Molding grade polypropylene (Profax® 6501) is dry blended with an alkoxyamine selected from NOR1-NOR12 and 10% of FR 1, and then melt compounded in a twin screw extruder at 200°C under nitrogen. Base stabilisation is 500 ppm N,N-di(alkyl)hydroxylamine produced by the direct oxidation of N,N-di(hydrogenated tallow)amine (Irgastab® FS-042) and 500 ppm calcium stearate. Plaques (125 mil) are prepared by injection molding from the formulations
25 using a Boy Injection Molder at 475°F (246°C). The specimen are tested for flame retardancy according to the UL-94 vertical burn test specifications. The plaques are tested for flame retardancy by the UL 94V thick section test. The ratings achievable are V-0 (best rating), V-1, and V-2.

Example 10

30 Foam grade polyethylene is dry blended with test additives and then melt compounded into pellets. The pelletised fully formulated resin is then blown into foam. The polyethylene foam prepared contains an instant additive selected from NOR1- NOR13, and a classic melamine

based flame retardant FR 1-FR 4. The formulated foam is tested for flame retardancy according to the UL-94 burn test method.

Example 11

5 Wire & cable grade polyethylene is dry blended with test additives and then melt compounded into pellets. The pelletised fully formulated resin is then extruded onto wire. Test specimen are tested for flame retardancy using the ASTM D 2633-82 burn test conditions. The formulations contain a compound selected from NOR 1-NOR 13, and a melamine based flame retardant selected from FR 1-FR 4.

Example 12

10 Fiber grade polyethylene is dry-blended with test additives. Non-woven fabrics are produced from the polymer blend formulations by a spun-bonded or melt-blown process. The non-woven fabrics made thereby are tested for flame retardancy according to the NFPA 701 vertical burn test specifications. The fabrics contain a compound selected from NOR 1-NOR 12, and a melamine based flame retardant selected from FR 1-FR 4.

Example 13

15 Fiber grade polypropylene is dry-blended with test additives. Non-woven fabrics are produced from the polymer blend formulations by a spun-bonded or melt-blown process. The non-woven fabrics made thereby are tested for flame retardancy according to the NFPA 701 vertical burn test specifications. The fabrics contain an additive selected from NOR 1-NOR 12, and a melamine based flame retardant selected from FR 1-FR 4.

Example 14

20 Molding grade polystyrene is dry-blended with test additives and then melt compounded. Specimen are injection molded from these test formulations. The specimen are tested for flame retardancy according to the UL-94 burn test specifications. The molded specimen contain a compound selected from NOR 1-NOR 13, and a melamine based flame retardant selected from FR 1-FR 4.

Example 15

30 Foam grade polystyrene is dry-blended with test additives and then melt compounded. Foam polystyrene specimen are prepared from these test formulations. The specimen are tested for flame retardancy according to the UL-94 burn test specifications. The foam specimen contain the a compound selected from NOR1-NOR 13, and a melamine based flame retardant selected from FR 1-FR 4.

Example 16

Molding grade ABS is dry blended with test additives and then melt compounded at 425°F (218°C). Specimen 125 mil (1/8") thick are then injection molded from this formulation using a Boy Injection Molder at 450°F (232°C). The specimen are tested for flame retardancy according to the UL-94 vertical burn test specifications. The specimen contain a compound selected from NOR 1-NOR 13 and a melamine based flame retardant selected from FR 1-FR 4.

Example 17

Fiber grade polypropylene is dry blended with test additives and then melt compounded at 234°C into pellets. The pelletised fully formulated resin is then spun at 246°C into fiber using a Hills laboratory model fiber extruder. The spun tow of 41 filaments is stretched at a ratio of 1:3.2 to give a final denier of 615/41.

Socks are knitted from the stabilised polypropylene fiber on a Lawson-Hemphill Analysis Knitter and tested under NFPA 701 vertical burn procedure. The time in seconds for the knitted sock to extinguish after the insult flame is removed is reported as "After Flame". Both the maximum time for any one replicate and the total time for ten replicates are measured. Efficacy as a flame retardant is demonstrated when low After Flame times are observed relative to a blank sample containing no flame retardant. The specimen contain a compound selected from NOR 1-NOR 13 and melamine based flame retardants selected from FR 1-FR 4.

Example 18

Film grade polyethylene is dry blended with test additives and then melt compounded into pellets. The pelletised fully formulated resin is then blown at 205°C using a MPM Superior Blown film extruder. The films are tested for flame retardancy under NFPA 701 test conditions. The specimen contain a compound selected from NOR 1-NOR 13 and melamine based flame retardants selected from FR 1-FR 4. Film grade polypropylene is handled in a similar fashion and polypropylene films containing the present additive combinations also show excellent flame retardancy.

Example 19

Molded test specimen are prepared by injection molding thermoplastic olefin (TPO) pellets containing a present additive combination. The TPO formulations may also contain a pigment, a phosphite, a phenolic antioxidant or hydroxylamine, a metal stearate, a UV absorber or a hindered amine stabiliser or a mixture of hindered amine and UV absorber. Pigmented TPO formulation composed of polypropylene blended with a rubber modifier where the rubber modifier is an in-situ reacted copolymer or blended product containing copolymers of

propylene and ethylene with or without a ternary component such as ethylidene norbornene are stabilised with a base stabilisation system consisting of an N,N-dialkylhydroxylamine or a mixture of hindered phenolic antioxidant and an organophosphorus compound. The TPO plaques are tested for flame retardancy using the UL-94 Vertical Burn conditions. A minimum of three replicates are tested. Efficacy as a flame retardant is measured relative to a blank sample containing no flame retardant. The specimen contain a compound selected from NOR 1-NOR 13 and a melamine based flame retardant selected from FR 1-FR 4.

Example 20

Film grade ethylene/vinyl acetate (EVA) copolymers containing 20 weight percent or less of vinyl acetate are dry blended with test additives and then melt compounded into pellets. The pelletised fully formulated resin is then blown into a film at 205°C using a MPM Superior Blown-film extruder. The films are tested for flame retardancy under NFPA 701 test conditions. The films contain a compound selected from NOR1-NOR 13 and melamine based flame retardant selected from FR 1-FR 4. Film grade low density polyethylene (LDPE) which contains some linear low density polyethylene (LLDPE) and/or ethylene/vinyl acetate (EVA) are dry blended with test additives and blown into film as described above for EVA copolymer resin. The films are tested for flame retardancy under NFPA 701 test conditions.

Example 21

High impact polystyrene (HIPS) polymer (STYRON® 484C, Dow Chemical Co.) is compounded with test additives, pelletised and then injection or compression molded into plaques. These plaques are tested for flame retardant efficacy using cone calorimetry, LOI or UL-94 test method. The plaques contain a compound selected from NOR1-NOR 13, and a melamine based flame retardant selected from FR 1-FR 4. Flame retardant HIPS polymers find application in housings for business machines.

Example 22

This Example shows the efficacy of the present compound combinations in PVC formulations. Such formulations are useful in flexible or rigid PVC and in wire and cable applications. Typical formulations are seen below:

Component	Parts			
PVC resin	100	100	100	100
Tin mercaptide	1.5	--	2.0	--
Tin carboxylate	--	2.5	--	2.0
Process aid	1.5	1.5	2.0	2.0
Impact mod.	6.0	6.0	7.0	7.0
Paraffin wax	1.0	0.3	1.0	1.0
Polyethyl. Wax	0.1	0.1	0.2	0.2
Ca stearate	1.0	--	0.8	--
Pigment	1.0	0.9	5.0	5.0

5

Fully formulated PVC containing a compound selected from NOR1-NOR 13, and a melamine based flame retardant selected from FR 1-FR 4 is pelletised and then injection molded into test plaques for examination of flame retardancy using the UL-94 or LOI test method.

Example 23

- 10 Fiber grade poly(ethylene terephthalate) (PET) is dry blended with test additives, melt compounded at 550°F and pelletised. The polyester pellets are dried at 175°F for 24 hours under vacuum. The dried pellets are extruded into fibers using a Hills laboratory scale fiber extruder at 550°F. Socks are knitted from these fibers and tested for flame retardancy according to NFPA 701 test method. The fibers contain a compound selected from NOR 1 - NOR 13, and
- 15 a melamine based flame retardant selected from FR 1-FR 4.

Example 24

- Thermoplastic resins including polypropylene, polyethylene homopolymer, polyolefin copolymer or thermoplastic olefins (TPO), high impact polystyrene (HIPS) and ABS are dry blended with test additives and melt compounded into pellets. The pelletised fully formulated
- 20 resin is processed into a useful article such as extrusion into fiber; blown or cast extrusion

into film; blow molded into bottles; injection molded into molded articles, thermoformed into molded articles, extruded into wire and cable housing or rotation molded into hollow articles. The articles containing a compound selected from NOR1-NOR 13, and a melamine based flame retardant selected from FR 1-FR 4 are tested by a known standard test method. Polyethylene wire and cable applications are tested for flame retardancy according to ASTM D-2633-82 burn test method. The materials contain a compound selected from NOR 1-NOR 13, and a melamine based flame retardant selected from FR 1-FR 4.

Example 25

Articles prepared according to Example 24 which additionally contain an organophosphorus stabiliser selected from the group consisting of tris(2,4-di-tert-butylphenyl) phosphite, bis(2,4-di-tert-butyl-6-methylphenyl) ethyl phosphite, 2,2',2''-nitrido[triethyl-tris-(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl) phosphite], tetrakis(2,4-di-butylphenyl) 4,4'-biphenylenediphosphonite, tris(nonylphenyl) phosphite, bis(2,4-di-tert-butylphenyl) pentaerythrityl diphosphite, 2,2'-ethylidenebis(2,4-di-tert-butylphenyl) fluorophosphite and 2-butyl-2-ethylpropan-1,3-diyl 2,4,6-tri-tert-butylphenyl phosphite exhibit good flame retardancy properties.

Example 26

Articles prepared according to Example 24 which additionally contain a o-hydroxyphenyl-2H-benzotriazole, a hydroxyphenyl benzophenone or a o-hydroxyphenyl-s-triazine UV absorber selected from the group consisting of 2-(2-hydroxy-3,5-di- α -cumylphenyl)-2H-benzotriazole, 2-(2-hydroxy-5-methylphenyl)-2H-benzotriazole, 5-chloro-2-(2-hydroxy-3,5-di-tert-butylphenyl)-2H-benzotriazole, 2-(2-hydroxy-3,5-di-tert-amylphenyl)-2H-benzotriazole, 2-(2-hydroxy-3- α -cumyl-5-tert-octylphenyl)-2H-benzotriazole, 2,4-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate, 2-hydroxy-4-n-octyloxybenzophenone and 2,4-bis(2,4-dimethoxyphenyl)-6-(2-hydroxy-4-octyloxyphenyl)-s-triazine exhibit good flame retardancy.

Claims

1. A flame retardant composition, which comprises

(A) An organic polymer substrate and

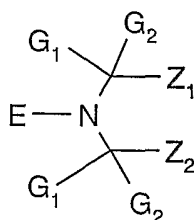
(B) An effective flame retarding amount of a mixture of

5 (i) At least one sterically hindered alkoxyamine stabiliser and

(ii) At least one conventional flame retardant selected from the group consisting of melamine ammonium phosphate, melamine ammonium polyphosphate, melamine ammonium pyrophosphate, a condensation product of melamine, a reaction product of melamine with phosphoric acid and a reaction product of the condensation product of melamine with phosphoric acid or mixtures thereof.

2. A composition according to claim 1 in which the polymer component (A) is selected from the group of resins consisting of the polyolefins, the thermoplastic olefins, styrenic polymers and copolymers, ABS and polymers which contain hetero atoms, double bonds or aromatic rings.

15 3. A composition according to claim 1 in which the stabilisers of component (i) are represented by the formula



wherein

G_1 and G_2 are independently alkyl of 1 to 8 carbon atoms or are together pentamethylene;

20 Z_1 and Z_2 are each methyl, or Z_1 and Z_2 together form a linking moiety which may additionally be substituted by an ester, ether, amide, amino, carboxy or urethane group;

E is oxyl, hydroxyl, alkoxy, cycloalkoxy, aralkoxy, aryloxy, $-\text{O}-\text{CO}-\text{OZ}_3$, $-\text{O}-\text{Si}(\text{Z}_4)_3$, $-\text{O}-\text{PO}(\text{OZ}_5)_2$ or $-\text{O}-\text{CH}_2-\text{OZ}_6$ where Z_3 , Z_4 , Z_5 and Z_6 are selected from the group consisting of hydrogen, an aliphatic, araliphatic and aromatic moiety; or E is $-\text{O}-\text{T}-(\text{OH})_b$;

25 T is a straight or branched chain alkylene of 1 to 18 carbon atoms, cycloalkylene of 5 to 18 carbon atoms, cycloalkenylene of 5 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 groups of 1 to 4 carbon atoms;

b is 1, 2 or 3 with the proviso that b cannot exceed the number of carbon atoms in T, and when b is 2 or 3, each hydroxyl group is attached to a different carbon atoms of T;

5 E is for example oxyl, hydroxyl, alkoxy, cycloalkoxy or aralkoxy.

4. A composition according to claim 3, wherein the stabiliser of component (i) is selected from the group consisting of

1-cyclohexyloxy-2,2,6,6-tetramethyl-4-octadecylaminopiperidine;

bis(1-octyloxy-2,2,6,6-tetramethylpiperidin-4-yl) sebacate;

10 2,4-bis[(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidin-4-yl)butylamino]-6-(2-hydroxyethylamino-s-triazine;

bis(1-cyclohexyloxy-2,2,6,6-tetramethylpiperidin-4-yl) adipate;

2,4-bis[(1-cyclohexyloxy-2,2,6,6-piperidin-4-yl)butylamino]-6-chloro-s-triazine;

1-(2-hydroxy-2-methylpropoxy)-4-hydroxy-2,2,6,6-tetramethylpiperidine;

15 1-(2-hydroxy-2-methylpropoxy)-4-oxo-2,2,6,6-tetramethylpiperidine;

1-(2-hydroxy-2-methylpropoxy)-4-octadecanoyloxy-2,2,6,6-tetramethylpiperidine;

bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) sebacate;

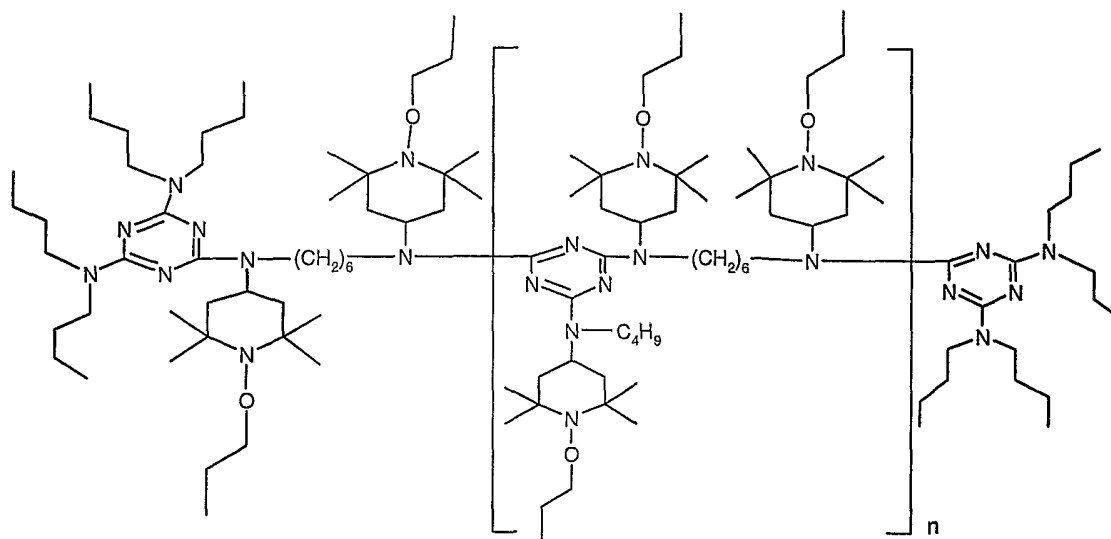
bis(1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl) adipate;

20 2,4-bis[N-[1-(2-hydroxy-2-methylpropoxy)-2,2,6,6-tetramethylpiperidin-4-yl]-N-butylamino]-6-(2-hydroxyethylamino)-s-triazine;

The reaction product of 2,4-bis[(1-cyclohexyloxy-2,2,6,6-piperidin-4-yl)butylamino]-6-chloro-s-triazine with N,N'-bis(3-aminopropyl)ethylenediamine) and

The compound of formula

- 57 -



in which n is from 1 to 15.

5. A composition according to claim 1, which comprises

(A) An organic polymer substrate and

5 (B) An effective flame retarding amount of a mixture of

(i) At least one sterically hindered alkoxyamine stabiliser and

(ii) At least one conventional flame retardant selected from the group consisting of a melamine phosphate, dimelamine phosphate, melamine pyrophosphate, melamine borate, melamine cyanurate, melam or melem phosphate, melam or melem polyphosphate, melamine ammonium phosphate, melamine ammonium pyrophosphate and a melamine ammonium polyphosphate or mixtures thereof.

10

6. A composition according to claim 1, which comprises

(A) An organic polymer substrate and

(B) An effective flame retarding amount of a mixture of

(i) At least one sterically hindered alkoxyamine stabiliser and

(ii) At least one conventional flame retardant selected from the group consisting of a melamine phosphate, melamine borate, melamine cyanurate and a melamine phosphate.

15

7. A composition according to claim 1, which comprises an additional component selected from the group consisting of pigments, dyes, plasticisers, phenolic antioxidants,

20

thixotropic agents, levelling assistants, basic costabilisers, nitron stabilisers, amine oxide stabilisers, benzofuranone stabilisers, UV absorbers, sterically hindered amines, metal passivators, metal oxides, organophosphorus compounds, hydroxylamines, and mixtures thereof.

- 5 8. A composition according to claim 1, in which the additional component is selected from the group consisting of phenolic antioxidants, calcium stearate, zinc stearate, phosphite and phosphonite stabilisers, benzofuranone stabilisers, UV absorbers of the 2-(2'-hydroxyphenyl)benzotriazole and 2-(2-hydroxyphenyl)-1,3,5-triazine classes, and sterically hindered amines.
- 10 9. A process for imparting light stability and flame retardancy to an organic polymer substrate, which process comprises adding to said polymer substrate a flame retardant composition according to claim 1.

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 03/10664

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C08K5/34 //(C08K5/34,5:3435,5:3492)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C08K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99 00450 A (CIBA GEIGY AG ;DYAS DARRELL DAVID JR (US); PUGLISI JOSEPH STEVEN () 7 January 1999 (1999-01-07) claims 1-5,9,10 examples ---	1-9
X	WO 02 074847 A (CIBA SC HOLDING AG ;KING ROSWELL EASTON (US); RAVICHANDRAN RAMANAT) 26 September 2002 (2002-09-26) claims 1-3,5,8-12 page 38 page 50; figure 13; example 24 ---	1-3,5-9
X	US 2002/120041 A1 (LINK JURGEN ET AL) 29 August 2002 (2002-08-29) claims 1-4,6-9,11-13 paragraph '0408!; example 3 paragraph '0346! - paragraph '0349! ---	1-9
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☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

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

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

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

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

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Date of the actual completion of the international search

2 December 2003

Date of mailing of the international search report

12/12/2003

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INTERNATIONAL SEARCH REPORT

International Application No.

PCT/EP 03/10664

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 03 016388 A (CIBA SC HOLDING AG ;HORSEY DOUGLAS WAYNE (US); KAPRINIDIS NIKOLAS) 27 February 2003 (2003-02-27) claims 1,5-8,14	1-9
A	----- SRINIVASAN R ET AL: "ADVANCES IN A REVOLUTIONARY FLAME RETARDANT SYSTEM FOR POLYEFINS" , INTERNATIONAL CONFERENCE ON POLYOLEFINS, XX, XX, PAGE(S) 571-581 XP001147529 page 577; table 7 page 581; figures NOR-1 page 581; figures FR-2 -----	1-9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/EP 03/10664

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