

Thermoplastic Polymer Compositions Containing Stabiliser Mixtures**Field of the Invention**

5 The present invention relates to thermoplastic polymer compositions, preferably of polyolefins, comprising stabiliser mixtures. The thermoplastic compositions can be processed, for instance when making shaped articles, such as fibres or films, especially under conditions that are known to induce oxidative, thermal or light induced degradation of thermoplastic polymers. The inventive thermoplastic polymer
10 compositions have been found to give effective processability with reduced degradation and/or provide a good reduction in colour formation of the thermoplastic polymer. The invention also relates to a method of producing such thermoplastic compositions and the use of stabiliser mixtures for this purpose. In addition, the invention also includes specific stabiliser mixtures.

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Background of the Invention

Various compounds have been used as processing stabilisers when processing thermoplastic polymers with the intention of mitigating the risk of inducing oxidative,
20 thermal or light induced degradation during processing.

The use of compounds of the benzofuran-2-one type as stabilisers for organic polymers is known, for example, from US Pat. Nos. 4325863; 4388244; 5175312; 5252643; 5216052; 5369159; 5488117; 5356966; 5367008; 5428162; 5428177; or
25 5516920.

Sterically hindered amines, including in particular compounds containing 2,2,6,6-tetramethyl piperidyl groups, are known as "hindered amine" light stabilisers (HALS).

30 Polyolefin fibres have been stabilised with sterically hindered phenols in combination with compounds from the group of organic phosphites or phosphonites and, in some cases, with additional use of light stabilisers.

- US Patent No 6521681 reports that the use of such stabiliser mixtures can have the disadvantageous effect of yellowing of the polyolefin fibres so produced, especially under the action of NO_x gas referred to in the art as gas fading. In many cases discolouration occurs even during processing, especially in the case of melt
- 5 extrusion. It is also known that compounds from the group of the sterically hindered amines, which may be added as light stabilisers, show an antagonistic effect together with the sterically hindered phenols, which adversely affects the long-term thermal stability.
- 10 US Patent No. 6521681 provides and describes a stabiliser mixture comprising at least one compound of the benzofuran-2-one type and at least one compound of the sterically hindered amine type and is reported as being particularly suitable as a stabiliser for organic materials which are sensitive to oxidative, thermal or light induced degradation. It is stated that these stabiliser systems suppress the
- 15 discolouring of the organic materials during processing, have an excellent action in respect of resistance to the effect of NO_x (no gas fading) and, moreover, exhibit improved long-term thermal stability relative to stabilisation systems which include phenolic antioxidants.
- 20 PCT Application No. WO 99/03915 A1 discloses blends of various lactones and phosphites provide better protection against polymer degradation during processing. This is said to be evidenced by changes in melt flow and may provide better resistance to yellowing. Example 2 compares trisnonylphenyl phosphite/lactone blends and as lactones nonyl-3-phenyl-3H-benzofuran-2-one and 5,7-di-*t*-butyl 3-
- 25 phenyl-3H-benzofuran-2-one, the structures of which are illustrated on page 11. Example 3 compares phosphite/lactone blends with and without Vitamin E. Specifically Blend #7 contained 75 wt% tris (nonylphenyl) phosphite and 15 wt% nonyl-3-phenyl-3H-benzofuran-2-one and 10 wt% Vitamin E and was used for processing a polypropylene at 1000 ppm.
- 30 US Patent Application No. 2006/0135792 A1 describes compounds and compositions and synthetic methods related to lactone antioxidant 3-arylbenzofuranones. The disclosure reveals that the compounds may be useful to prevent

yellowing and deterioration of organic materials preferably polymers, such as polyurethane foams as one example. The lactone antioxidants may be polymeric and may also be liquid or paste in physical form at room temperature. It is further indicated that the compositions may bear one or more reactive primary OH groups
5 on the polar chains.

PCT Application No. WO2015/121445 A1 and PCT Application No. WO2017/025431 A1 each describe compositions comprising an organic material to be stabilised and a specific group of 3-phenyl-benzofuran-2-one derivatives containing phosphorus as
10 stabiliser for the organic material. Such organic material is susceptible to oxidative, thermal or light induced degradation. It is stated that this may be for example a polymer, an oligohydroxy compound, a wax, a fat or a mineral oil.

PCT Application No. WO2016/020322 A1 and PCT Application No. WO2019/243267
15 A1 each define compositions comprising an organic material to be stabilised and a specific group of 3-phenyl-benzofuran-2-one diphosphite or 3-phenyl-benzofuran-2-one diphosphate derivatives as stabilisers. Such organic material is susceptible to oxidative, thermal or light induced degradation. It is stated that this may be for example a polymer, an oligohydroxy compound, a wax, a fat or a mineral oil.

20 PCT Application No. WO2019/010167 A1 describes polyolefin compositions comprising a polyolefin, one or more phosphorus-containing benzofuranone compounds and one or more hindered phenolic antioxidants which are said to provide excellent protection against discolouration and enhanced thermal stability during melting processing. Example 2 compares 7 different additive mixtures for
25 formulating with fibre grade Ziegler-Natta polypropylene homopolymer (zn-PP). Additive mixture #7 contains 375 ppm of Phos1 (organophosphorus stabiliser, tris (2,4-di-tert-butylphenyl) phosphite); 500 ppm AO7 (alpha-tocopherol); 125 ppm benzofuranone (109) (structural formula shown on page 20).

30 Chromanol compounds such as tocopherols have been employed in formulations for stabilising plastic materials.

US Patent No.4806580 describes stabiliser mixtures for stabilising plastics, for instance polypropylene, during processing. The stabiliser mixtures containing (a) a chroman derivative and (b) and organic phosphite or phosphonite in a weight ratio of a:b of 1:5 to 1:14.

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European Patent Application No.542108 A2 reveals a stabilising mixture for plastics containing polyethylene, comprising (a) a tocopherol compound and (b) a phosphorus or sulphur-containing secondary antioxidant in a weight ratio of a:b of 1:1.4 to 1:5. There is a corresponding disclosure in the article of S. F. Laermer and P.F. Zambetti published in the Journal of Plastic Film & Sheeting, volume 8, 1992, pages 228 to 248. This article further describes a mixture of alpha tocopherol and a phosphite in the weight ratio of 1:1:4 for the stabilisation of polypropylene.

An article of S. S. Young, S. F. Laermer and P. F. Zambetti published in the Journal of Plastic Film and Sheeting, volume 11, 1995, pages 126 to 142, demonstrates that alpha tocopherol formulations can replace phenols/phosphite combinations as the primary antioxidant system, or the alpha tocopherol formulations can actually replace the phosphite portion to achieve better performance.

N,N-dialkylhydroxylamines are known to be useful processing stabilisers for polyolefins such as polypropylene.

US Patent No. 4590231 describes a composition that is stabilised against degradation comprising (a) a saturated polyolefin or mixtures thereof; (b) a stabilising amount of a stabiliser or mixture of stabilisers selected from the group consisting of phenolic antioxidants, hindered amine light stabilisers, ultraviolet light absorbers, organic phosphorus compounds, alkaline metal salts of fatty acids, and thiosynergists; and (c) a stabilising amount of a hydroxylamine derivative, or mixture thereof.

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Chinese Patent Application Publication No 115819842A claims a hindered phenyl containing anti-colouring antioxidant composition for polymers, characterised in that it includes the following components: (1) primary antioxidant, (2) secondary

antioxidant, (3) carbon free base capture agent, (4) colour blocker, (5) catalyst.

Example 5 describes providing 100 parts of polypropylene powder, 0.5 parts of tetrakis [β -(3,5-di-tert-butyl-4-hydroxy phenyl) propionate] pentaerythritol ester, 0.3 parts of tris (2,4-di-tert-butylphenyl) Phosphate ester, 0.06 parts of N,N-bis

- 5 (octadecyl) hydroxylamine, 0.06 parts of 5, 7-di-tert-butyl-3-(3, 4-dimethyl)benzofuran-2(3H)-one, 0.1 parts of butane-1, 4-bis (3-(4-mercaptophenyl) propionate and 0.05 parts of tris(pentafluorophenyl)borane, mixed uniformly by high speed mixer, and then extruded by twin screw. The extruder is extruded at the temperature of each zone at 200~240°C, and then the pelletiser is used for traction
10 and pelletising to obtain modified polypropylene pellets.

Japanese Patent Application Publication No 2008230079 A addresses the problem of providing a laminate made of a non-halogen resin excellent in weatherability, heat resistance and discolouration resistance. The reference defines a solution of

- 15 providing a laminate made of a non-halogen resin which keeps the outermost surface overlaid with a sheet made of non-halogen resin that contains 0.05-3.0 parts by weight of a light stabiliser and 0.01-2.0 parts by weight of an antioxidant based on 100 parts by weight of the non-halogen resin. Table 2, sample 3 describes employing as a resin 80 parts of olefin type thermoplastic elastomer and 20 parts of
20 random polypropylene. The additives are included 0.07 parts of antioxidant hydroxylamine Irgastab FS 042, 0.07 parts of antioxidant lactone system HP-136, 0.05 parts of optical stabiliser N-hydrogen substituted hindered amine type system group optical stabiliser Chimassorb 944, and parts of filler calcium carbonate and 0.1 parts of lubricating agent zinc stearate.

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US Patent No 5834541 relates to a polymer composition comprising (i) an olefin polymer containing an acid neutralising agent other than a metallic salt of a saturated or unsaturated fatty acid, and (ii) a stabiliser system distributed throughout the polymer, the stabiliser system comprising (a) a phosphite selected from the group
30 consisting of 2,2',2''-nitriolo[triethyl-tris(3,3',5,5'-tetra-tert-butyl-1,1-di-phenyl-2,2'-diyl) phosphite] and tris (2,4-di-tert butylphenyl) phosphite; and (b) a N,N-dialkyl hydroxylamine, a benzofuranone or mixtures thereof. The patent reveals that smoke generation during fibre, film and sheet processing can be significantly reduced by

using (1) a combination of N,N-dialkylhydroxylamine and a specific phosphite stabiliser to melt stabilise a controlled rheology olefin polymer, and (2) an acid neutralising agent other than a metallic salt of a saturated or unsaturated fatty acid.

- 5 The article by S Al-Malaika et al. entitled, "Stabilisation of metallocene ethylene-1-octene copolymers during multiple extrusions", Polymer Degradation and Stability 93 (2008) 1619-1631 refers to the melt stabilising efficiency of antioxidants with different structures based on hindered phenols, phosphite esters, phosphonite and a lactone which was examined during multi-pass extrusions at 265°C in three metallocene
10 ethylene-1-octene copolymers (m-LLDPE) having different extent of short-chain branching (SCB) and one Ziegler copolymer (z-LLDPE) containing the same level of SCB corresponding to one of the m-LLDPE polymers. Table 4 illustrates antioxidant mixtures used in m-LLDPE and z-LLDPE polymers during compounding. One of the antioxidant mixtures described is Irganox E201: Ultrinox 626: HP 136 300 ppm: 600
15 ppm: 250 ppm respectively.

EP Patent Application No. 323409 A2 describes stabilising polyolefin compositions with long chain N,N-dialkylhydroxylamines. The two alkyl groups are said to be independently alkyl of 12 to 18 carbon atoms. The hydroxylamine derived from
20 di(hydrogenated tallow) amine is said to be particularly useful for this purpose. The polyolefin is said to be preferably a homopolymer of an alpha olefin. Saturated polyolefins include polymers derived from mono olefins, such as polyethylene, which can be cross-linked, polypropylene, polyisobutylene, polybutene-1, poly-3-methyl butene-1 and poly-4-methyl pentene-1.

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PCT Application No. WO00/12605 relates to high melt flow polypropylene compositions which provide for reduced malformation when extruded into fibres or films. The composition is said to comprise a high melt flow polypropylene resin, a stabilising amount of an N,N-dialkylhydroxylamines and a stabilising amount of an
30 organic phosphite or phosphonites and, optionally, other conventional additives such as antioxidants, acid acceptors, light stabilisers, ultraviolet light absorbers and the like.

US Patent No. 6872764 B2 describes a polyolefin article of improved strength and/or discolouration resistance being essentially phenol antioxidant free and having incorporated therein a stabiliser system sufficient to attenuate the deleterious effects of gamma irradiation. The stabiliser system comprises (a) one or more hindered
5 amine stabilisers, (b) one or more compounds selected from the group consisting of i) hydroxylamine stabilisers, ii) nitro stabilisers, iii) amine oxides stabilisers and iv) benzofuranone stabilisers; and optionally (c) one or more compounds selected from the group of organic phosphites and phosphonites. The article is said to be subjected to one or more doses of gamma irradiation.

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EP Patent Application No 867467 A1 concerns thermoplastic resin compositions comprising a thermoplastic resin or mixture thereof and a stabilising amount of a stabiliser or mixture of stabilisers. The stabiliser or mixture of stabilisers is selected from the group consisting of the phenolic antioxidants, the 3-aryl benzofuranones,
15 the hindered amine stabilisers, ultraviolet light absorbers, the organic phosphorus compounds, the alkaline metal salts of fatty acids, the alkaline metal salts of fatty acids, the hydroxylamines, and the thiosynergists, and stabilising amount of a tertiary amine oxide. The compositions are said to have improved stability against discolouration upon exposure to heating or to the combustion products of natural gas
20 by the concomitant presence of an effective amount of a tertiary amine oxide.

N,N-dialkylhydroxylamines are effective as both primary antioxidant (hydrogen donor) and secondary antioxidant (peroxide scavenger) and therefore can be used effectively in phenol free processing stabiliser systems. Processing stabiliser
25 systems containing N,N-dialkylhydroxylamines are very effective as processing stabilisers for a variety of thermoplastics, typically polyolefins. Nevertheless, hydroxylamines have been found to be not as effective at temperatures of at least 230°C, for instance greater than 250°C. This would be a drawback for processing of thermoplastics such as polypropylene fibre processing where temperatures of 230°C
30 or higher or greater than 250°C can be employed, for instance temperatures as high as 280 to 300°C which can be used for fibre spinning in order to achieve a high throughput.

It is an objective of the present invention to provide a stabiliser system for processing thermoplastics, such as polyolefins, for instance polypropylene, that can be employed in high temperature processing, for instance at temperatures of at least 230°C, and provide a good balance of performance properties. A further objective is to find a stabiliser system which achieves good colour stability and/or processing characteristics in processing thermoplastics. Furthermore, it would be desirable if such a stabiliser system were phenol free or had reduced phenol content. For the purposes of the present invention chromanol is not a phenol.

10 **Summary of the Invention**

It has been found that combinations of at least two of the components selected from (i) a hydroxylamine or amine oxide; (ii) specific benzofuran-2-ones, typically based on 3-aryl benzofuran-2-one derivatives; and (iii) a chromanol provide effective stabiliser mixtures for the processing of thermoplastics, such as polyolefins, can exhibit good processing characteristics and can provide reduced degradation and/or reduced colour yield of the thermoplastic polymer.

The first aspect of the present invention defines a composition comprising

20 a) a thermoplastic polymer, preferably a polyolefin; and

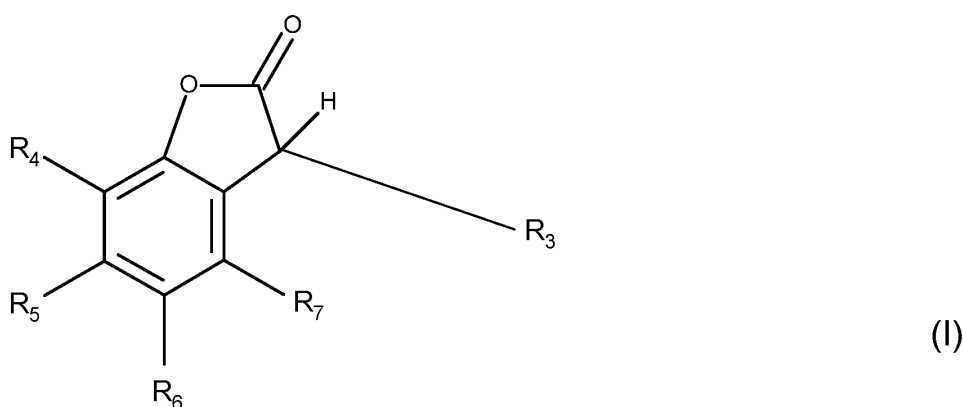
b) a stabiliser mixture comprising at least two of the components selected from (i), (ii) and (iii),

wherein

component (i) is a hydroxylamine or an amine oxide;

25 component (ii) is a benzofuran-2-one of formula (I); and

component (iii) is a chromanol,



wherein,

R_3 is a substituted carbocyclic or heterocyclic aromatic ring system,

- R_4 , R_5 , R_6 and R_7 are each independently of one another hydrogen or a substituent
 5 selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group,
 optionally containing at least one heteroatom; substituted or unsubstituted
 hydrocarbyloxy group, optionally containing at least one further heteroatom;
 substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least
 one heteroatom; or hydrocarbylthio, optionally containing at least one further
 10 heteroatom,

- wherein when the stabiliser mixture comprises components (i) and (ii) and/or (iii) it is
 present in the composition in an amount of below 500 ppm by the combined weight
 of components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the
 15 weight of the thermoplastic polymer,

- wherein when the stabiliser mixture comprises components (ii) and (iii) without (i) it is
 present in the composition in an amount of less than 300 ppm, desirably less than
 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably
 20 still up to 100 ppm, by weight of components (ii) and (iii) based on the weight of the
 thermoplastic polymer.

The second aspect of the present invention provides a method of preparing the said
 composition,

comprising the step of processing the thermoplastic polymer, preferably polyolefin, in the presence of a stabiliser mixture, wherein the stabiliser mixture is incorporated into or applied onto the thermoplastic polymer before or during the processing of the thermoplastic polymer,

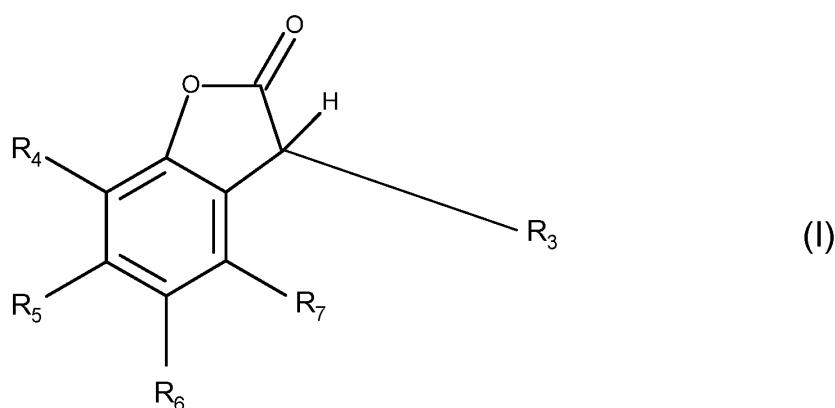
- 5 wherein the stabiliser mixture comprises at least two of the components selected from (i), (ii) and (iii),

wherein

component (i) is a hydroxylamine or amine oxide;

component (ii) is a benzofuran-2-one of formula (I); and

- 10 component (iii) is a chromanol,



wherein,

R₃ is a substituted carbocyclic or heterocyclic aromatic ring system,

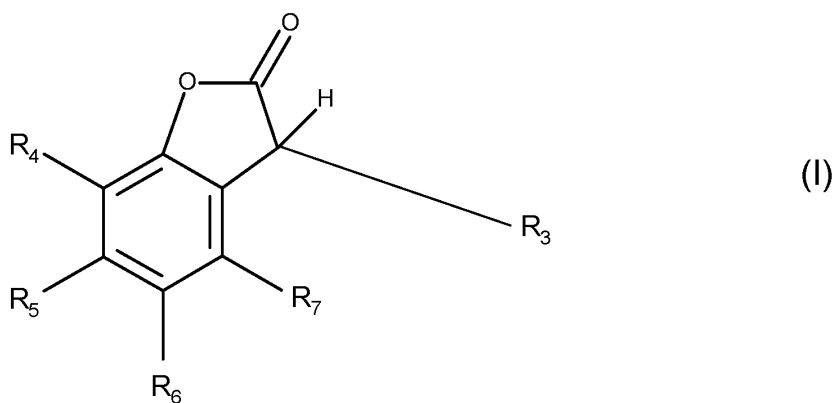
- R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent
 15 selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group, optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom; substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least one heteroatom; or hydrocarbylthio, optionally containing at least one further
 20 heteroatom,

wherein when the stabiliser mixture comprises components (i) and (ii) and/or (iii) it is present in the composition in an amount of below 500 ppm by the combined weight

of components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the weight of the thermoplastic polymer,

wherein when the stabiliser mixture comprises components (ii) and (iii) without (i) it is present in the composition in an amount of less than 300 ppm, desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by weight of components (ii) and (iii) based on the weight of the thermoplastic polymer.

- 10 The third aspect of the present invention provides a use of a stabiliser mixture for improving the processability and/or reduced colour formation when processing a thermoplastic polymer, preferably a polyolefin,
- wherein
- the stabiliser mixture comprises at least two of the components selected from (i), (ii)
- 15 and (iii),
- wherein
- component (i) is a hydroxylamine or amine oxide;
- component (ii) is a benzofuran-2-one of formula (I); and
- component (iii) is a chromanol,



- 20 wherein,
- R₃ is a substituted carbocyclic or heterocyclic aromatic ring system,
- R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group,
- 25 optionally containing at least one heteroatom; substituted or unsubstituted

hydrocarbyloxy group, optionally containing at least one further heteroatom;
substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least
one heteroatom; or hydrocarbylthio, optionally containing at least one further
heteroatom,

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wherein when the stabiliser mixture comprises components (i) and (ii) and/or (iii) it is
present in the composition in an amount of below 500 ppm by the combined weight
of components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the
weight of the thermoplastic polymer,

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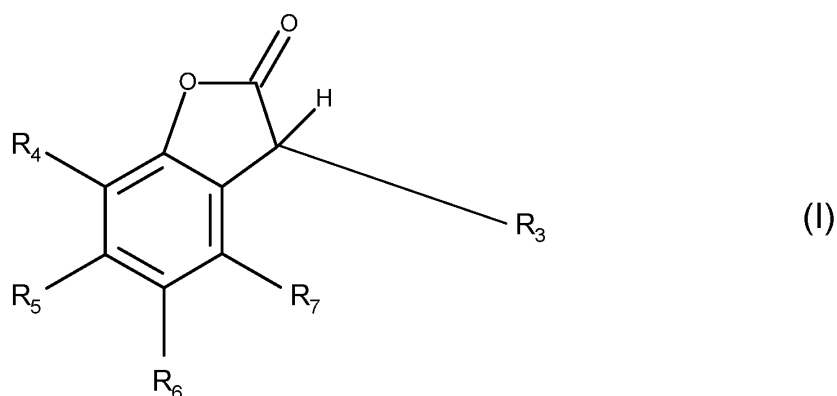
wherein when the stabiliser mixture comprises components (ii) and (iii) without (i) it is
used in an amount of less than 300 ppm, desirably less than 250 ppm, preferably up
to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by
weight of components (ii) and (iii) based on the weight of the thermoplastic polymer.

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The fourth aspect of the present invention provides a stabiliser mixture, for
processing of thermoplastic polymers, preferably polyolefins, the composition
comprising component (i) and component (iii) and optionally component (ii),
wherein

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component (i) is a hydroxylamine or amine oxide;
component (ii) is a benzofuran-2-one of formula (I); and
component (iii) is a chromanol.



wherein,

25

R₃ is a substituted carbocyclic or heterocyclic aromatic ring system,

- R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group, optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom;
- 5 substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least one heteroatom; or hydrocarbylthio, optionally containing at least one further heteroatom.

Detailed Description of the Invention

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In accordance with the various aspects of the present invention, the stabiliser mixture may be:

- I) a mixture of (i) a hydroxylamine or amine oxide and (ii) a benzofuran-2-one of formula (I);
- 15 II) a mixture of (i) a hydroxylamine or amine oxide and (iii) a chromanol;
- III) a mixture of (ii) a benzofuran-2-one of formula (I) and (iii) a chromanol; or
- IV) a mixture of (i) a hydroxylamine or amine oxide and (ii) a benzofuran-2-one of formula (I) and (iii) a chromanol.
- 20 Component (i) of the stabiliser mixture should suitably be a substituted hydroxylamine in which one or preferably two substituted or unsubstituted hydrocarbyl groups are bonded to the nitrogen of the hydroxylamine moiety. In one desirable embodiment component (i) is a hydroxylamine having the formula (II):

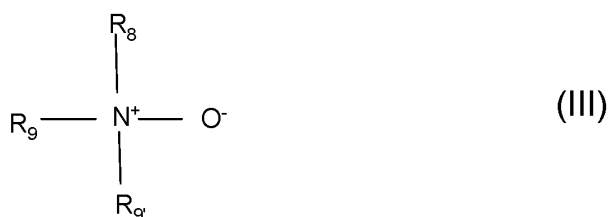


- 25 wherein R₁ and R₂ are each independently selected from alkyl, cycloalkyl, aryl, aralkyl, alkaryl groups which may be substituted. In one desirable embodiment R₁ and R₂ are each independently of one another C₁-C₃₀ alkyl, C₇-C₉ phenylalkyl, unsubstituted or C₁-C₄ alkyl substituted phenyl, unsubstituted or C₁-C₄ alkyl substituted C₅-C₈ cycloalkyl, C₁-C₁₈ alkoxy. In one preferred embodiment R₁ and R₂

are each independently selected from C₈ - C₃₀ alkyl groups, preferably C₁₂ - C₃₀ alkyl groups, more preferably C₁₆ - C₂₀ alkyl groups. More preferably still, R₁ and R₂ are independently alkyl of 16 to 18 carbon atoms or mixtures thereof. Hydroxylamines of particular interest include N,N-dioctadecyl hydroxylamine and N,N-dihexadecyl

5 hydroxylamine or a mixture thereof. In one especially preferred embodiment the hydroxylamine is bis (hydrogenated palm oil alkyl) hydroxy amines. In another particularly preferred embodiment the hydroxylamine is oxidised bis(hydrogenated tallow alkyl)amines.

- 10 In an alternative embodiment, component (i) of the stabiliser mixture may be a substituted amine oxide in which one, two or preferably three substituted or unsubstituted hydrocarbyl groups are bonded to the nitrogen of the amine oxide. Desirably the amine oxide is a tertiary amine oxide. In one desirable embodiment component (i) is an amine oxide of the formula (III):



- 15 wherein R₈, R₉ and R_{9'} are each independently selected from alkyl, cycloalkyl, aryl, aralkyl, alkaryl groups which may be substituted. In one desirable embodiment R₈ and R₉ are each independently of one another C₆-C₃₆ residue that may optionally contain at least one -O-, -S-, -SO-, -CO₂-, -CO-, or -CON- moiety; and wherein R_{9'} is
- 20 a C₁-C₃₆ residue that may optionally contain at least one -O-, -S-, -SO-, -CO₂-, -CO-, or -CON- moiety.

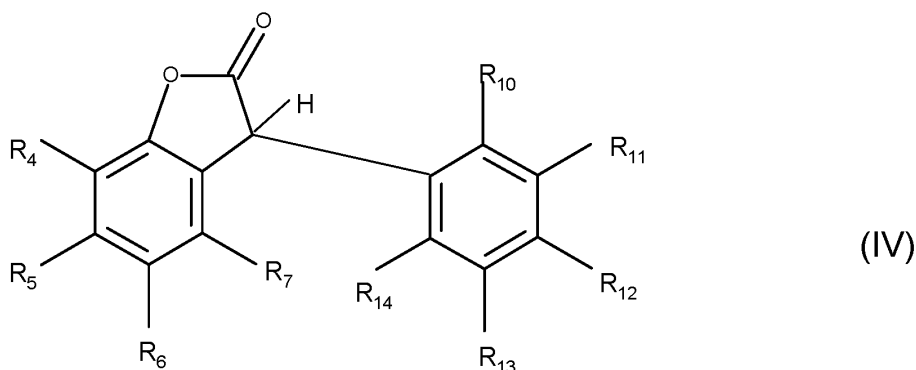
- In one preferred embodiment R₈ and R₉ are each independently selected from C₈ - C₃₀ alkyl groups, preferably C₁₂ - C₃₀ alkyl groups, more preferably C₁₂ - C₂₄ alkyl
- 25 groups and R_{9'} is a methyl group. More preferably still, R₈ and R₉ are each independently C₁₄ - C₂₄ alkyl groups and R_{9'} is a methyl group.

Suitable amine oxides are tertiary amine oxides selected from the group consisting of dioctyl methyl amine oxide, trioctyl amine oxide, di decyl methyl amine oxide, di

(coco alkyl) methyl amine oxide, tri (coco alkyl) amine oxide, di (tallow alkyl) methyl amine oxide, tri (tallow alkyl) amine oxide, tri (C₁₄-C₂₄) amine oxide, di (C₁₄-C₂₄ alkyl) methyl amine oxide, and mixtures containing any of the foregoing. Suitable amine oxides are available commercially, for instance Genox™ EP stabilizer, available from
 5 SI Group, and having the chemical name amines, bis (hydrogenated rape-oil alkyl)methyl, N-oxides.

Amine oxides are known to undergo pyrolytic elimination and the elevated temperatures, for instance from 150°C to 200°C. Under such conditions amine
 10 oxides can eliminate a hydroxylamine and result in an alkene. Thus, there is a relationship between amine oxides and hydroxylamine in that under the elevated conditions of thermoplastic polymer processing it is possible that such amine oxides would eliminate hydroxylamine in situ.

15 In a preferred embodiment component (ii) of the stabiliser mixture is a benzofuran-2-one of formula (IV):



wherein

20 R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group, optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom; substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least
 25 one heteroatom; or hydrocarbylthio, optionally containing at least one further

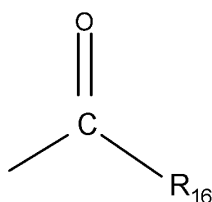
heteroatom, and preferably R_4 , R_5 , R_6 and R_7 are each independently of one another hydrogen, or C_1 - C_8 -alkyl;

R_{10} , R_{11} , R_{12} , R_{13} and R_{14} are each independently of one another hydrogen, hydroxy, C_1 - C_{12} -alkyl, $-OR_{15}$, $-NR_{34}R_{35}$ or a substituent carrying one or repeating alkylene

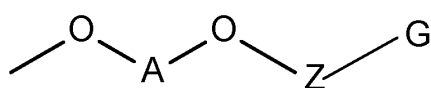
- 5 oxide units, in which at least one of R_{10} , R_{11} , R_{12} , R_{13} and R_{14} is not hydrogen and wherein no more than one of R_{10} , R_{11} , R_{12} , R_{13} and R_{14} is $-OR_{15}$ or $-NR_{34}R_{35}$, where R_{15} is a group of formula (V) or a group of formula (V-A) or a group of formula (VI) or a group of formula (VI-A),

R_{34} is a group of formula (VI-A),

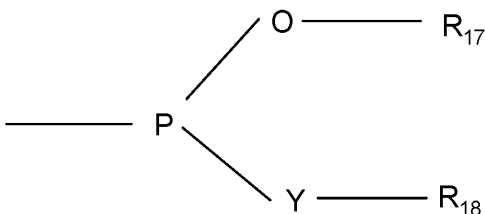
- 10 R_{35} is hydrogen or C_1 - C_8 alkyl,



(V)



(V-A)



(VI)

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A comprises a C_2 - C_{20} alkylene group or a divalent oligomeric oxyalkylene radical,

Z comprises a C_2 - C_{20} alkyl or a divalent oligomeric ester radical,

G is an end group and is selected from the group consisting of hydrogen, C_1 - C_{10}

- 20 alkyl, alkylcarbonyl and arylcarbonyl,

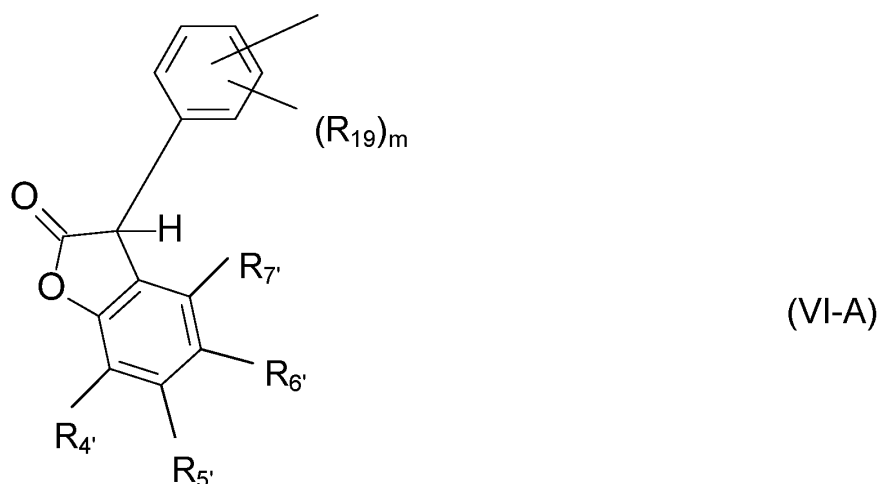
R_{16} is a substituted or unsubstituted C_1 - C_{12} alkyl group; substituted or unsubstituted C_4 - C_8 cycloalkyl group; substituted or unsubstituted C_5 - C_6 aryl group, preferably substituted or unsubstituted phenyl, preferably R_{16} is C_1 - C_{12} alkyl or a substituted

phenyl group, more preferably R_{16} is a C_1 - C_4 alkyl group or a substituted phenyl group carrying as substituents a hydroxyl group and one or two C_1 - C_4 alkyl groups;

Y is oxygen or a covalent bond;

when Y is oxygen,

- 5 R_{17} and R_{18} are each independently a radical of formula (VI-A):



Each R_{19} group or groups is/are independently of one another C_1 - C_8 -alkyl;

m is an integer from 0 to 4;

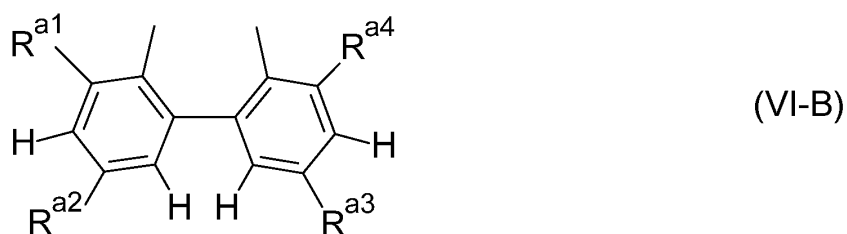
$R_{4'}$, $R_{5'}$, $R_{6'}$ and $R_{7'}$ each independently have the same meanings as R_4 , R_5 , R_6 and

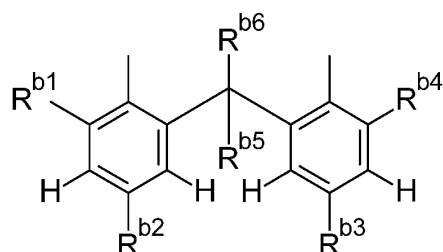
- 10 R_7 ; or

R_{17} and R_{18} are each independently of each other C_6 - C_{10} -aryl, which is unsubstituted or substituted by C_1 - C_8 -alkyl, C_1 - C_8 -alkoxy, halogen or one phenyl; C_1 - C_{18} alkyl; C_3 - C_{16} -cycloalkyl; C_7 - C_{13} -aralkyl; C_2 - C_{18} -alkenyl; C_2 - C_{30} -alkyl, which is interrupted by one or more oxygen atoms; or C_2 - C_{16} -alkyl, which is interrupted by one sulphur

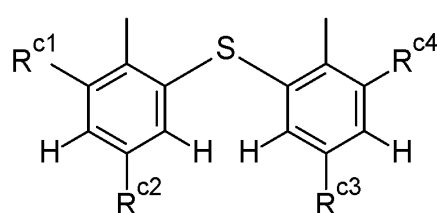
- 15 atom; or

R_{17} together with R_{18} form one of the structures of formulae (VI-B), (VI-C) or (VI-D):





(VI-C)



(VI-D)

5

R^{a1} , R^{a2} , R^{a3} and R^{a4} are independently from each other hydrogen or C₁-C₈-alkyl, R^{b1} , R^{b2} , R^{b3} , R^{b4} , R^{b5} and R^{b6} are independently from each other hydrogen or C₁-C₈-alkyl, and R^{c1} , R^{c2} , R^{c3} and R^{c4} are independently from each other hydrogen or C₁-C₈-alkyl,

10

when Y is a covalent bond,

R_{17} is formula (VI-A), or

R_{17} is C₆-C₁₀-aryl, which is unsubstituted or substituted by C₁-C₈ alkyl, C₁-C₈ alkoxy, halogen or one phenyl; C₁-C₁₈-alkyl; C₃-C₁₆-cycloalkyl; C₇-C₁₃-aralkyl; C₂-C₁₈-alkenyl;

15

C₂-C₃₀-alkyl, which is interrupted by one or more oxygen atoms; or C₂-C₁₆-alkyl, which is interrupted by one sulphur atom,

R_{18} is C₆-C₁₀-aryl, which is unsubstituted or substituted by C₁-C₈-alkyl, C₁-C₈-alkoxy, halogen or one phenyl, or halogen.

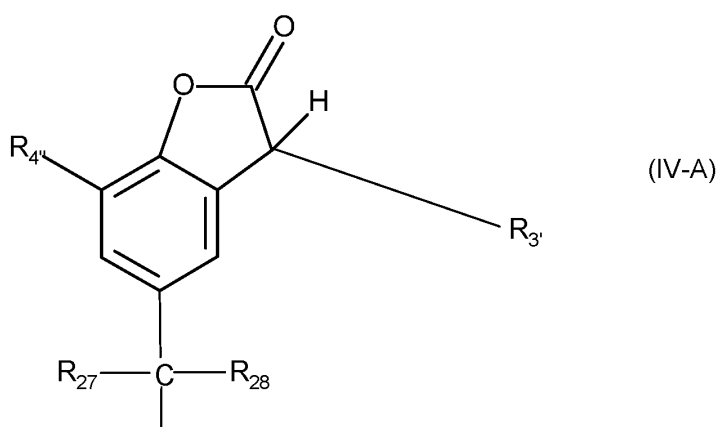
20

In one embodiment the benzofuran-2-one of formula IV, R_4 , R_5 , R_6 and R_7 are each independently of one another hydrogen, chloro, hydroxy, C₁-C₂₅ alkyl, C₇-C₉ phenyl alkyl, unsubstituted or C₁-C₄ alkyl substituted phenyl, unsubstituted or C₁-C₄ alkyl substituted C₅-C₈ cycloalkyl; C₁-C₁₈ alkoxy, C₁-C₁₈ alkylthio, C₁-C₄ alkyl amino, di-

(C₁-C₄ alkyl)amino, C₁-C₂₅ alkanoyloxy, C₁-C₂₅ alkanoylamino, C₃-C₂₅ alkenoyloxy, C₃-C₂₅ alkanoyloxy which is interrupted by oxygen, sulphur or >N-R₂₅;

R₄, R₅, R₆ and R₇ may also be C₆-C₉ cycloalkyl carbonyloxy, benzoyloxy or C₁-C₁₂ alkyl substituted benzoyloxy; or pair of substituents R₄ and R₅ or R₅ and R₆ or R₆ and

- 5 R₇, together with the linking carbon atoms, forms a benzene ring; or, if R₅ and R₇ are hydrogen, R₆ is additionally a radical formula (IV-A)



wherein

- 10 R₃' is an unsubstituted or C₁-C₄ alkyl- or hydroxy substituted phenylene or naphthalene; or is -R₂₉-X-R₃₀-,
 R₄'' is hydrogen, chloro, hydroxy, C₁-C₂₅ alkyl, C₆-C₁₀- aryl, phenyl, unsubstituted or C₁-C₄ alkyl substituted phenyl, unsubstituted or C₁-C₄ alkyl substituted C₅-C₈ cycloalkyl; C₁-C₁₈ alkoxy, C₁-C₁₈ alkylthio, C₁-C₄ alkylamino, di-(C₁-C₄ alkyl) amino,
 15 C₁-C₂₅ alkanoyloxy, C₁-C₂₅ alkanoyl amino, C₃-C₂₅ alkenoyloxy, C₃-C₂₅ alkanoyloxy which is interrupted by oxygen, sulphur or >N-R₃₁; C₆-C₉ cycloalkylcarbonyloxy, benzoyloxy or C₁-C₁₂ alkyl substituted benzoyloxy,
 R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ have the same definitions as above,
 R₂₅ is hydrogen or C₁-C₈ alkyl,
 20 R₂₇ and R₂₈ are each independently of the other hydrogen, CF₃, C₁-C₁₂ alkyl or phenyl, or R₂₇ and R₂₈, together with the linking carbon atom form a C₅-C₈ cycloalkyl ring which is unsubstituted or substituted by 1 to 3 C₁-C₄ alkyl groups,
 R₂₉ and R₃₀ are each independently of the other substituted or C₁-C₄ alkyl substituted phenylene or naphthalene,

R₃₁ is hydrogen or C₁-C₈ alkyl,

R₃₂ is hydrogen or C₁-C₈ alkyl,

X is a direct bond, oxygen, sulphur or NR₃₂.

- 5 C₁-C₈-alkyl is linear or branched and for example methyl, ethyl, n-propyl, 1-methyl-ethyl, n-butyl, 1-methyl-propyl, 2-methyl-propyl, 1,1-dimethyl-ethyl, n-pentyl, 1-methyl-butyl, 3-methyl-butyl, n-hexyl, 1-methyl-pentyl, 2-methyl-pentyl, 4-methyl-pentyl, 2-ethyl-butyl, n-heptyl, 1-methyl-hexyl, n-octyl, 1-methyl-heptyl, 2-ethyl-hexyl, 5,5-dimethyl-hexyl or 1,1,3,3-tetramethyl-butyl. Preferred is C₁-C₄-alkyl or C₈-alkyl, in
- 10 particular methyl, ethyl, 1-methyl-ethyl, 1-methyl-propyl 1,1-dimethyl-ethyl or 1,1,3,3-tetramethyl-butyl. Preferred is C₁-C₄-alkyl, in particular methyl, ethyl, 1-methyl-ethyl, 1-methyl-propyl 1,1-dimethyl-ethyl and very particular methyl, 1-methyl-propyl or 1,1-dimethyl-ethyl.
- 15 C₁-C₁₂-alkyl is linear or branched and for example methyl, ethyl, n-propyl, 1-methyl-ethyl, n-butyl, 1-methyl-propyl, 2-methyl-propyl, 1,1-dimethyl-ethyl, n-pentyl, 1-methyl-butyl, 3-methyl-butyl, n-hexyl, 1-methyl-pentyl, 2-methyl-pentyl, 4-methyl-pentyl, 2-ethyl-butyl, n-heptyl, 1-methyl-hexyl, n-octyl, 1-methyl-heptyl, 2-ethyl-hexyl, 5,5-dimethyl-hexyl, 1,1,3,3-tetramethyl-butyl, n-nonyl, 2-ethyl-heptyl, n-decyl,
- 20 undecyl, n-dodecyl,
- C₆-C₁₀-aryl, which is unsubstituted or substituted by C₁-C₈-alkyl, C₁-C₈-alkoxy, halogen or one phenyl, is for example phenyl, 2-methyl-phenyl, 3-methyl-phenyl, 4-methyl-phenyl, 2,4-dimethyl-phenyl, 3,5-dimethyl-phenyl, 4-(1,1-dimethylethyl)-
- 25 phenyl, 4-(1,1,3,3-tetramethylpentyl)-phenyl, naphthalen-1-yl, naphthalen-2-yl, 6-methyl-naphthalen-2-yl, 4-phenyl-phenyl, 2-methoxy-phenyl, 3-methoxy-phenyl, 4-methoxy-phenyl, 2-ethoxyphenyl, 3-ethoxy-phenyl, 3-(n-propoxy)-phenyl, 4-(1,1-dimethylethoxy)-phenyl, 2-chloro-phenyl, 3-chlorophenyl, 4-chlorophenyl, 2-chloro-4-methylphenyl. Preferred is C₆-C₁₀-aryl, which is unsubstituted or substituted by C₁-
- 30 C₈-alkyl or C₁-C₈-alkoxy. Especially preferred is phenyl, which is unsubstituted or substituted by C₁-C₈-alkyl. Particularly preferred is phenyl.

C₁-C₈-alkoxy is linear or branched and for example methoxy, ethoxy, n-propoxy, 1-methyl-ethoxy, n-butoxy, 1-methyl-propoxy, 1,1-dimethyl-ethoxy, n-pentoxo, 2-methyl-pentoxo, 2-ethyl-butoxy, 1-methyl-hexoxo, n-octoxo, 1-methyl-heptoxo, 2-ethyl-hexoxo, 1,1,3,3-tetramethyl-butoxy. Preferred is C₁-C₄-alkoxy and in particular methoxy.

Halogen is for example a fluorine atom (= fluoro), chlorine atom (= chloro), a bromine atom (= bromo) or a iodine atom (= iodo). Preferred is a chlorine atom or a fluorine atom, in particular a fluorine atom.

10

C₁-C₁₈-alkyl is linear or branched and for example methyl, ethyl, n-propyl, 1-methyl-ethyl, n-butyl, 1-methyl-propyl, 2-methyl-propyl, 1,1-dimethyl-ethyl, n-pentyl, 1-methyl-butyl, 3-methyl-butyl, n-hexyl, 1-methyl-pentyl, 2-methyl-pentyl, 4-methyl-pentyl, 2-ethyl-butyl, n-heptyl, 1-methyl-hexyl, n-octyl, 1-methyl-heptyl, 2-ethyl-hexyl, 5,5-dimethyl-hexyl, 1,1,3,3-tetramethyl-butyl, n-nonyl, 2-ethyl-heptyl, n-decyl, undecyl, n-dodecyl, tridecyl, tetradecyl, pentadecyl, n-hexadecyl or n-octadecyl. Preferred is C₁-C₁₈-alkyl and in particular C₁-C₁₂-alkyl.

15

C₃-C₁₆-cycloalkyl is unsubstituted or substituted by C₁-C₄-alkyl and is for example cyclobutyl, cyclopentyl, 3,4-dimethyl-cyclopentyl, cyclohexyl, 4-methyl-cyclohexyl, 4-(1-methylethyl)-cyclohexyl, 4-(1,1-dimethylethyl)-cyclohexyl, 3,5-dimethyl-cyclohexyl, 5-methyl-2-(1-methyl-ethyl)-cyclohexyl, cycloheptyl, cyclooctyl or cyclododecyl. Preferred is C₅-C₇-cycloalkyl and in particular cyclohexyl.

20

C₇-C₁₃-aralkyl is for example benzyl, 4-methyl-benzyl, 2-phenyl-ethyl, 3,5-dimethylbenzyl, 1-phenyl-1,1-dimethyl-methyl, 3-phenyl-propyl, 3-phenyl-2-methyl-propyl, 3,5-di-tert-butyl-benzyl or 4-phenyl-phenyl-methyl. Preferred is benzyl.

25

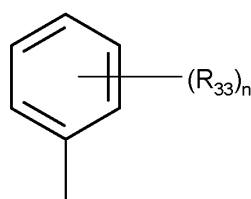
C₂-C₁₈-alkenyl is linear or branched and for example vinyl, allyl, Z- or E-but-2-ene-yl, Z- or E-but-3-ene-yl, Z- or E-pent-2-ene-yl, pent-4-ene-yl, Z- or E-2-methyl-but-2-ene-yl, Z- or E-3-methyl-but-3-ene-yl, Z- or E-hex-1-ene-yl, Z- or E-hexadec-9-ene-yl or Z- or E-octadec-9-ene-yl, (9Z,12Z)-octadeca-9,12-diene-yl or (9Z,12Z,15Z)-octadeca-9,12,15-triene-yl. Preferred is allyl.

30

C₂-C₃₀-alkyl, which is interrupted by one or more oxygen atoms, is linear or branched and for example methoxy-methyl, 2-methoxy-ethyl, 2-ethoxy-ethyl, 2-(2-methoxy-ethoxy)-ethyl, 2-n-butoxy-ethyl, 2-[2-(2-methoxy-ethoxy)-ethoxy]-ethyl, 2-[2-[2-(2-methoxy-ethoxy)-ethoxy]-ethoxy]-ethyl, 2-(2-methoxy-1-methyl-ethoxy)-1-methyl-ethyl, 3-(n-propoxy)-propyl, 2-[2-[2-(2-n-butoxy-ethoxy)-ethoxy]-ethoxy]-ethyl, 2-[2-(2-n-butoxy-2-methyl-ethoxy)-2-methyl-ethoxy]-2-methyl-ethyl or 2-[(2-n-lauryl)-ethoxy]-ethyl. Preferred is 2-methoxy-ethyl or 2-ethoxy-ethyl.

10 C₂-C₁₆-alkyl, which is interrupted by one sulfur atom, is linear or branched and for example 2-(methyl-sulfanyl)-ethyl, 3-thiaundecyl or 3-thiapentadecyl.

In a suitable embodiment, the benzofuran-2-one of formula (IV),
 R₄ is hydrogen or C₁-C₈ alkyl, preferably C₁-C₄ alkyl, more preferably tertiary butyl,
 15 R₅ and R₇ are both hydrogen,
 R₆ is the radical of formula (IV-A),
 R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen or C₁-C₈ alkyl, preferably hydrogen or C₁-C₄ alkyl, more preferably methyl, wherein at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is C₁-C₈ alkyl, preferably one or two of R₁₀, R₁₁,
 20 R₁₂, R₁₃ and R₁₄ being C₁-C₄ alkyl more preferably methyl,
 R₂₇ and R₂₈, together with the linking carbon atom, form a C₆ cycloalkyl ring, preferably a cyclohexyl ring,
 R_{3'} is a substituted phenyl group of formula (IV-B)



(IV-B)

25 wherein R₃₃ is a C₁-C₈ alkyl group, preferably C₁-C₄ alkyl group, more preferably methyl,
 n is an integer from 1 to 5, preferably 1 or 2, more preferably 2,
 R_{4''} is a C₁-C₈ alkyl group, preferably C₁-C₄ alkyl group, more preferably tertiary butyl.

In another embodiment the benzofuran-2-one of formula (IV), R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₈ alkyl;

R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen, hydroxy,

5 C₁-C₁₂-alkyl or -NR₃₄R₃₅,

in which at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is not hydrogen and wherein no more than one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -NR₃₄R₃₅,

where R₃₄ is a group of formula (VI-A),

R₃₅ is hydrogen or a C₁-C₈ alkyl,

10 Each R₁₉ group or groups is/are independently of one another C₁-C₈ alkyl;

m is an integer from 0 to 4;

R_{4'}, R_{5'}, R_{6'} and R_{7'} each independently have the same meanings as R₄, R₅, R₆ and R₇.

15 Desirably in the embodiment of benzofuran-2-one of formula (IV), R₄, R₅, R₆, R₇, R_{4'}, R_{5'}, R_{6'} and R_{7'} are each independently of one another hydrogen or C₁-C₄ alkyl, preferably hydrogen or tertiary butyl, more preferably R₄, R₆, R_{5'} and R_{7'} are tertiary butyl and R₅, R₇, R_{4'} and R_{6'} are hydrogen;

One of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -NR₃₄R₃₅ and the remainder of R₁₀, R₁₁, R₁₂, R₁₃

20 and R₁₄ are hydrogen or C₁-C₄ alkyl, preferably R₁₂ is -NR₃₄R₃₅ and R₁₀, or R₁₁, R₁₃ and R₁₄ are hydrogen;

R₃₄ is a group of formula (VI-A),

R₃₅ is hydrogen or a C₁-C₄ alkyl, preferably methyl,

m is 0,

25 preferably the bonding connections to the phenyl of the radical of formula (IV-A) is in the para position.

In a further embodiment the benzofuran-2-one of formula (IV), R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₈ alkyl;

30 R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen, hydroxy, C₁-C₁₂-alkyl or -OR₁₅,

in which at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is not hydrogen and wherein no more than one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅,

where R₁₅ is a group of formula (VI-A),

Each R₁₉ group or groups is/are independently of one another C₁-C₈ alkyl;

m is an integer from 0 to 4;

R_{4'}, R_{5'}, R_{6'} and R_{7'} each independently have the same meanings as R₄, R₅, R₆ and

5 R₇.

Desirably in the embodiment of benzofuran-2-one of formula (IV), R₄, R₅, R₆, R₇, R_{4'}, R_{5'}, R_{6'} and R_{7'} are each independently of one another hydrogen or C₁-C₄ alkyl, preferably hydrogen or tertiary butyl, more preferably R₄, R₆, R_{5'} and R_{7'} are tertiary butyl and R₅, R₇, R_{4'} and R_{6'} are hydrogen;

10 One of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ and the remainder of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are hydrogen or C₁-C₄ alkyl, preferably R₁₂ is -OR₁₅ and R₁₀, or R₁₁, R₁₃ and R₁₄ are hydrogen;

R₁₅ is a group of formula (VI-A),

m is 0,

15 preferably the bonding connections to the phenyl of the radical of formula (IV-A) is in the para position.

In one suitable embodiment of the benzofuran-2-one of formula (IV),

R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₈ alkyl,

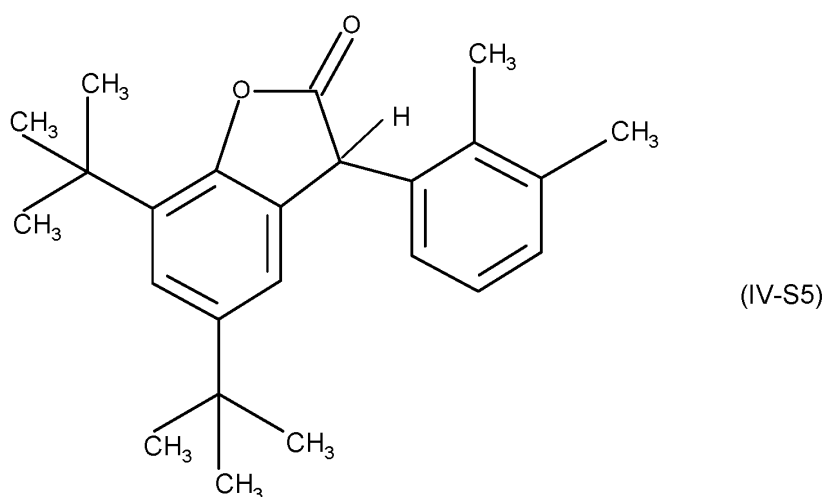
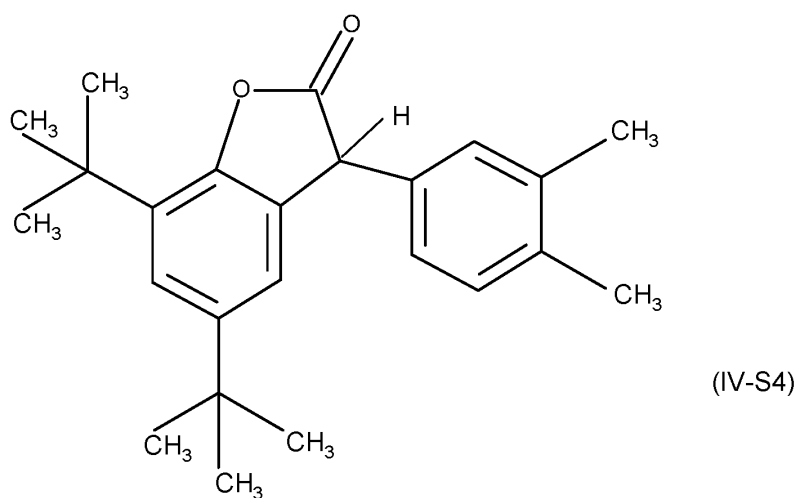
20 preferably hydrogen or C₁-C₄ alkyl,

at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is a C₁-C₈ alkyl and the remainder of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is/are hydrogen, preferably two of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are C₁-C₄ alkyl and the remainder of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is/are hydrogen.

25 It is suitable in this embodiment of the benzofuran-2-one of formula (IV), that R₄ and R₆ are C₁-C₄ alkyl, preferably tertiary butyl and R₅ and R₇ are hydrogen, R₁₁ and R₁₂ are C₁-C₄ alkyl, preferably methyl, and R₁₀, R₁₃ and R₁₄ are hydrogen or alternatively R₁₀ and R₁₁ are C₁-C₄ alkyl, preferably methyl, and R₁₂, R₁₃ and R₁₄ are hydrogen.

30

Suitable examples of this embodiment are represented by the benzofuran-2-one of structural formula (IV-S4) and structural formula (IV-S5).



- 5 Formula (IV-S4) corresponds to 5,7-di-tert-butyl-3-(3,4-dimethylphenyl)-3H-benzofuran-2-one and formula (IV-S5) corresponds to 5,7-di-tert-butyl-3-(2,3-dimethylphenyl)-3H-benzofuran-2-one.

10 In one suitable embodiment a mixture of compounds relating to formula (IV-S4) and formula (IV-S5) is employed in the present invention. It is more preferred that the isomer corresponding to formula (IV-S4) is used as the major component of the mixture. Thus, it is desirable that the ratio of compound of formula (IV-S4) to the

compound of formula (IV-S5) is from 51:49 to 99:1, suitably from 60:40 to 99:1, more suitably from 70:30 to 99:1, preferably from 80:20 to 99:1 and from 85:15 to 95:5.

In a particularly suitable embodiment of the benzofuran-2-one of formula (IV),

- 5 R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₁₂ alkyl, preferably hydrogen or C₁-C₈ alkyl, suitably hydrogen or C₁-C₄ alkyl, wherein at least one of R₄, R₅, R₆ and R₇ is not hydrogen, R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen or C₁-C₁₂ alkyl, preferably hydrogen or C₁-C₈ alkyl, suitably hydrogen or C₁-C₄ alkyl, or -OR₁₅,
10 and wherein one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ and R₁₅ is a radical of formula (V) or a radical of formula (VI), and at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is a C₁-C₁₂ alkyl, preferably C₁-C₈ alkyl, suitably C₁-C₄ alkyl, R₁₆ is C₁-C₇ alkyl or substituted phenyl
Y is oxygen,
15 R₁₇ together with R₁₈ form structure represented by formula (VI-C), R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6} are independently from each other hydrogen or C₁-C₈-alkyl, preferably R^{b1}, R^{b2}, R^{b3} and R^{b4} are C₁-C₄ alkyl and R^{b5} and R^{b6} are hydrogen, methyl or ethyl.
- 20 In a particularly preferred embodiment of the benzofuran-2-one of formula (IV), R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₁₂ alkyl, preferably hydrogen or C₁-C₈ alkyl, suitably hydrogen or C₁-C₄ alkyl, wherein at least one of R₄, R₅, R₆ and R₇ is not hydrogen, R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen or C₁-C₁₂
25 alkyl, preferably hydrogen or C₁-C₈ alkyl, suitably hydrogen or C₁-C₄ alkyl, -OR₁₅, wherein one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ and R₁₅ is a radical of formula (V), and at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is a C₁-C₁₂ alkyl, preferably C₁-C₈ alkyl, suitably C₁-C₄ alkyl,
R₁₆ is C₁-C₇ alkyl, preferably methyl, or R₁₆ is a phenyl group having at least one C₁-
30 C₄ alkyl group and at least one hydroxyl group.

In a further embodiment of the benzofuran-2-one of formula (IV),

R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₁₂ alkyl, preferably hydrogen or C₁-C₈ alkyl, wherein at least one of R₄, R₅, R₆ and R₇ is not hydrogen,

- 5 R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen or C₁-C₁₂ alkyl, preferably hydrogen or C₁-C₈ alkyl, or -OR₁₅, wherein one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ and R₁₅ is a radical of formula (V), and at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is a C₁-C₁₂ alkyl, preferably C₁-C₈ alkyl, R₁₆ is C₁-C₇ alkyl, preferably methyl.

10

Desirably in this embodiment of the benzofuran-2-one of formula (IV),

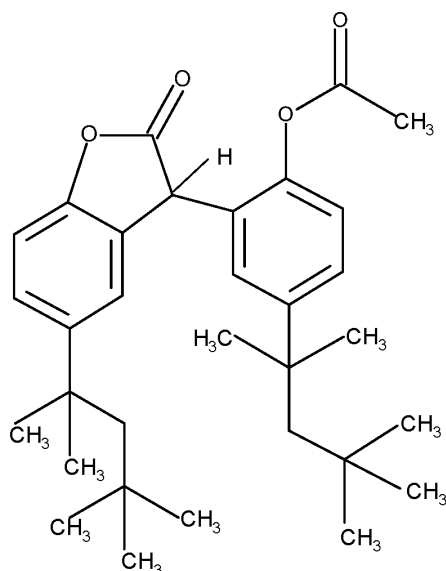
R₄ and R₁₁ are each independently of one another hydrogen or C₁-C₈ alkyl, preferably hydrogen,

R₅, R₇, R₁₂ and R₁₄ are hydrogen,

- 15 R₆ and R₁₃ are each independently of one another C₁-C₁₂ alkyl, R₁₀ is -OR₁₅ and R₁₅ is a radical of formula (V), R₁₆ is C₁-C₇ alkyl, preferably methyl.

A particularly suitable compound of this embodiment of benzofuranone of formula

- 20 (IV) is represented by the structure of formula (IV-S6)



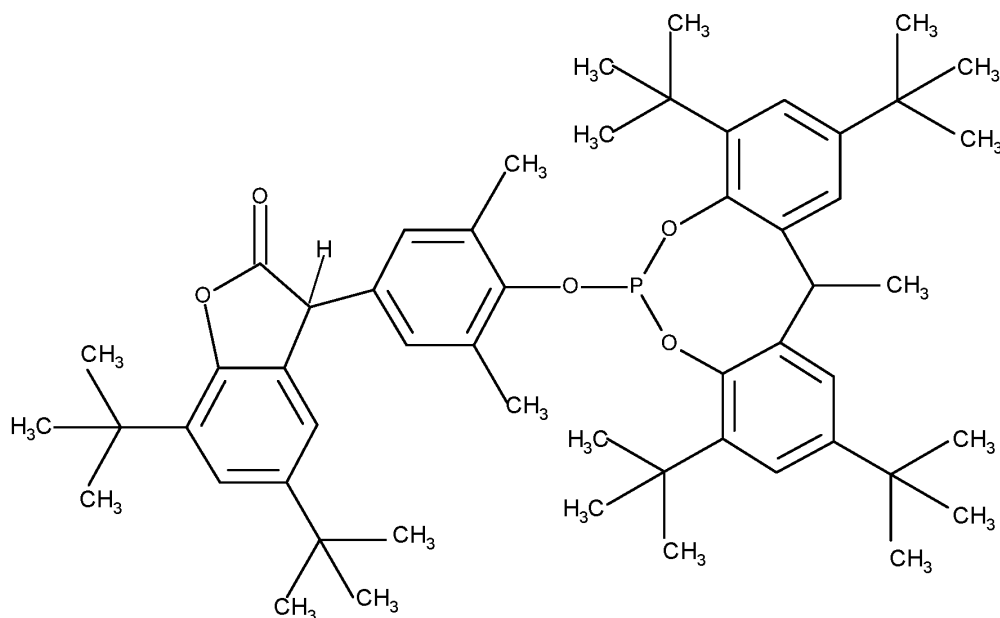
(IV-S6)

Formula (IV-S6) corresponds to 2(3H)-Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-tetramethylbutyl)-

- 5 In a particularly desirable further embodiment of the benzofuran-2-one of formula (IV),
R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₈ alkyl, preferably hydrogen or C₁-C₄ alkyl,
R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen or C₁-C₈
10 alkyl, preferably hydrogen or C₁-C₄ alkyl, or-OR₁₅, wherein one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ and R₁₅ is a radical of formula (VI), wherein at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is a C₁-C₈ alkyl, preferably C₁-C₄ alkyl,
Y is oxygen,
R₁₇ together with R₁₈ form structure represented by formula (VI-C),
15 R^{b1}, R^{b2}, R^{b3}, R^{b4}, R^{b5} and R^{b6} are independently from each other hydrogen or C₁-C₈-alkyl, preferably R^{b1}, R^{b2}, R^{b3} and R^{b4} are C₁-C₄ alkyl and R^{b5} and R^{b6} are hydrogen, methyl or ethyl.

- In a more desirable form of this further embodiment of the benzofuran-2-one of
20 formula (IV),
R₄ and R₆ are each independently of one another a C₁-C₄ alkyl, preferably both being tertiary butyl,
R₅ and R₇ are hydrogen,
R₁₀ and R₁₄ are hydrogen,
25 R₁₁ and R₁₃ are each independently of one another a C₁-C₄ alkyl, preferably both being methyl,
R₁₂ is -OR₁₅ and R₁₅ is a radical of formula (VI)
Y is oxygen,
R₁₇ together with R₁₈ form structure represented by formula (VI-C),
30 R^{b1}, R^{b2}, R^{b3} and R^{b4} are tertiary butyl,
R^{b5} is methyl or ethyl, preferably methyl,
R^{b6} is hydrogen.

A particularly desirable compound of this embodiment of benzofuranone of formula (IV) is represented by the structure of formula (IV-S7)



5

(IV-S7)

Formula (IV-S7) corresponds to 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl].

10

In another suitable embodiment of the benzofuran-2-one of formula (IV),

R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₈ alkyl, preferably hydrogen or C₁-C₄ alkyl,

R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen or C₁-C₈

15 alkyl, preferably hydrogen or C₁-C₄ alkyl, or -OR₁₅, wherein one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ and R₁₅ is a radical of formula (V), and at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is a C₁-C₈ alkyl, preferably C₁-C₄ alkyl,

R₁₆ is a phenyl group having at least one C₁-C₄ alkyl group and at least one hydroxyl group.

20

In the more suitable form of this embodiment of the benzofuran-2-one of formula (IV),

R₆ is a C₁-C₄ alkyl, more desirably tertiary butyl,

R₄, R₅ and R₇ are hydrogen,

5 R₁₁, R₁₂ and R₁₄ are hydrogen,

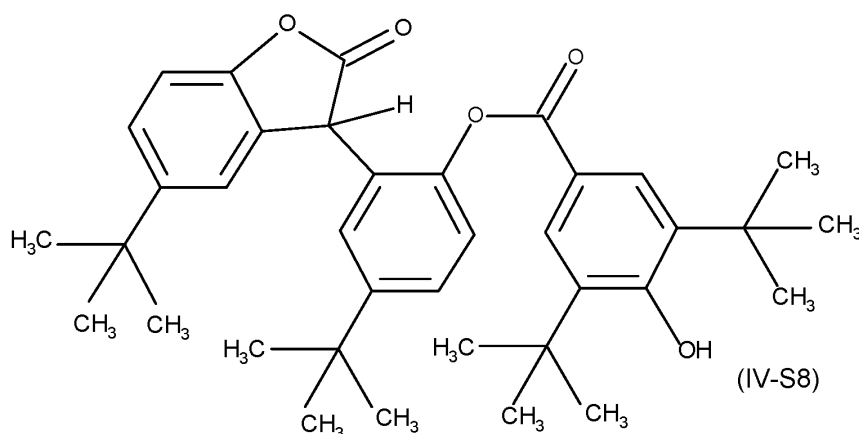
R₁₃ is a C₁-C₄ alkyl, more desirably tertiary butyl,

R₁₀ is -OR₁₅ and R₁₅ is a radical of formula (V),

R₁₆ is a phenyl group carrying C₁-C₄ alkyl, more desirably tertiary butyl, in the 3 and 5 positions and a hydroxyl group in the 4 position.

10

A particularly desirable compound of this embodiment of benzofuran-2-one of formula (IV) is represented by the structure of formula (IV-S8).



Formula (IV-S8) corresponds to [4-tert-butyl-2-(5-tert-butyl-2-oxo-3H-1-benzofuran-3-yl)phenyl] 3,5-di-tert-butyl-4-hydroxybenzoate.

15

In another embodiment of the benzofuran-2-one of formula (IV),

R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or C₁-C₈ alkyl, preferably hydrogen or C₁-C₄ alkyl,

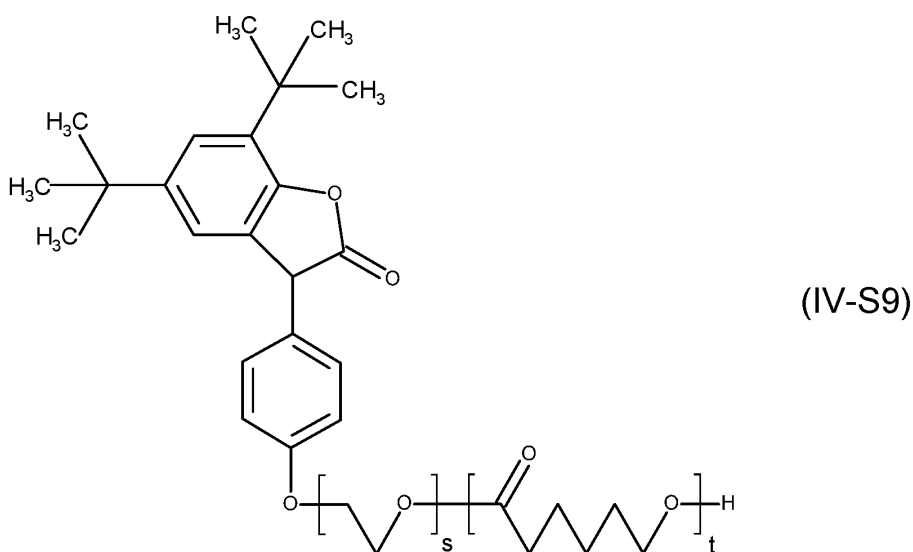
20 R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen or C₁-C₈ alkyl, preferably hydrogen or C₁-C₄ alkyl, wherein one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ and where R₁₅ is a group of formula (V-A), wherein

A comprises a C₂-C₂₀ alkylene group or a divalent oligomeric oxyalkylene radical,

Z comprises a C₂-C₂₀ alkyl or a divalent oligomeric ester radical,

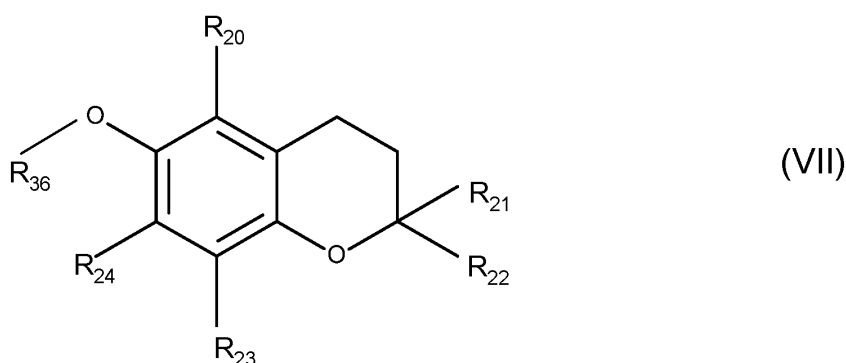
G is an end group and is selected from the group consisting of hydrogen, C₁-C₁₀ alkyl, alkylcarbonyl and arylcarbonyl.

- In a more specific form of this embodiment R₄ and R₆ are C₁-C₄ alkyl, preferably tertiary butyl and R₅ and R₇ are hydrogen. Further, R₁₀, R₁₁, R₁₃ and R₁₄ are all hydrogen and R₁₂ is -OR₁₅ and where R₁₅ is a group of formula (V-A), wherein A, Z and G are defined above, and more preferably A comprises a divalent oxyalkylene radical, comprising between 1 and 50, preferably between 1 and 20, oxyalkylene repeating units in which each oxyalkylene unit consists of between 2 and 4 carbon atoms, more preferably Z which is optionally present and being a divalent ester radical, comprising between 0 and 50, preferably between 0 and 20, ester repeating units in which each ester unit consists of between 2 and 8, preferably between 2 and 6, carbon atoms, more preferably G being hydrogen or a C₁-C₁₀ alkyl group.
- One such example of this benzofuran-2-one of formula (IV) is illustrated in Formula (IV-S9).



wherein s is an integer between 1 and 20, and t is an integer between 0 and 20, and wherein s+t it is equal to or greater than 3.

In a preferred embodiment component (iii) of the stabiliser mixture is a chromanol of formula (VII):



5 wherein

R_{20} is selected from hydrogen, or an aliphatic radical having 1 to 6 carbon atoms;

R_{21} is an organic radical have been 1 to 30 carbon atoms;

R_{22} , R_{23} , R_{24} are selected from, independently of one another, hydrogen or C_1 - C_4 alkyl; and

10 R_{36} is hydrogen or a carbonyl radical, preferably acetyl.

In an embodiment, the aliphatic radical having 1 to 6 carbon atoms mentioned for R_{20} in the compound of formula (VII) can have 1, 2, 3, 4, 5 or 6 carbon atoms, for example 1 to 4, 1 to 3, 1 to 2 carbon atoms. In an embodiment, the aliphatic radical
 15 having 1 to 6 carbon atoms mentioned for R_{20} can be selected from alkyl, wherein the above alkyl can optionally be interrupted by one or more non-adjacent sulfur/oxygen atoms, and/or one or more non-adjacent carbon atoms in the above alkyl can optionally be replaced with $-(CO)-O-$.

20 In the compound of formula (VII), R_{20} can be selected from hydrogen or C_1 - C_6 -alkyl, wherein the above C_1 - C_6 -alkyl can optionally be interrupted by one or more non-adjacent sulfur/oxygen atoms, and/or one or more non-adjacent carbon atoms in the above alkyl can optionally be replaced with $-(CO)-O-$.

25 In the compound of formula (VII), R_{20} can be selected from hydrogen or C_1 - C_4 -alkyl (for example methyl, ethyl, propyl or butyl), wherein the above C_1 - C_4 -alkyl can

optionally be interrupted by one or more non-adjacent sulfur/oxygen atoms, and/or one or more non-adjacent carbon atoms in the above alkyl can optionally be replaced with $-(CO)-O-$.

- 5 Examples of suitable C_1-C_6 alkyl, which embraces C_1-C_4 alkyl, include methyl, ethyl, propyl, 1-methylethyl, butyl, 1-methylpropyl, 2-methylpropyl, 1,1-dimethylethyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 2,2-dimethylpropyl, 1-ethylpropyl, hexyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 1,1-dimethylbutyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 10 2,2-dimethylbutyl, 2,3-dimethylbutyl, 3,3-dimethylbutyl, 1-ethylbutyl, 2-ethylbutyl, 1,1,2-trimethylpropyl, 1,2,2-trimethylpropyl, 1-ethyl-1-methylpropyl, 1-ethyl-2-methylpropyl, ethenyl, 1-propenyl, 2-propenyl (allyl), 1-methylethenyl, 1-butenyl, 2-butenyl, 3-butenyl, 1-methyl-1-propenyl, 2-methyl-1-propenyl, 1-methyl-2-propenyl, 2-methyl-2-propenyl, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and their 15 isomers.

In an embodiment, the organic radical having 1 to 30 carbon atoms mentioned for R_{21} in the compound of formula (VII) can have 2 to 30 (for example 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28 and 30), 6 to 30, 8 to 30, 8 to 22, 10 to 22 carbon 20 atoms. In an embodiment, the R_2 is a hydrocarbyl. In an embodiment, R_{21} is a linear or branched hydrocarbyl.

In an embodiment, wherein R_{21} is selected from C_1-C_{30} -alkyl, or C_2-C_{30} -alkenyl; more preferably R_2 is selected from C_8-C_{30} -alkyl, or C_8-C_{30} -alkenyl. In an embodiment, R_{21} 25 is selected from C_8-C_{22} -alkyl, or C_8-C_{22} -alkenyl. In an embodiment, R_{21} is selected from $C_{10}-C_{22}$ -alkyl, or $C_{10}-C_{22}$ -alkenyl. In an embodiment, the alkenyl mentioned for R_{21} can have 1 to 3 double bonds, for example 1, 2 or 3 double bonds. The above alkyl (C_1-C_{30} -alkyl and C_8-C_{30} -alkyl) can optionally be interrupted by one or more non-adjacent sulfur/oxygen atoms, and/or one or more non adjacent carbon atoms in 30 the above alkyl can optionally be replaced with $-(CO)-O-$.

In the compound of formula (VII), R_{22} , R_{23} , R_{24} are selected from, independently of one another, hydrogen or C_1-C_4 -alkyl. In a preferred embodiment, R_{22} , R_{23} , R_{24} are

selected from, independently of one another, hydrogen, methyl or ethyl, preferably hydrogen or methyl.

In an embodiment, the variables in the compound of formula (VII) have the following meanings:

R₂₀ is selected from hydrogen or C₁-C₆-alkyl;

R₂₁ is selected from C₁-C₃₀-alkyl, or C₂-C₃₀-alkenyl; and

R₂₂, R₂₃, R₂₄ are selected from, independently of one another, hydrogen or C₁-C₄-alkyl;

wherein the above alkyl (C₁-C₆-alkyl and C₁-C₃₀-alkyl) can optionally be interrupted by one or more non-adjacent sulfur/oxygen atoms, and/or one or more non-adjacent carbon atoms in the above alkyl can optionally be replaced with -(CO)-O-.

In an embodiment, the variables in the compound of formula (VII) have the following meanings:

R₂₀ is selected from hydrogen or C₁-C₃-alkyl;

R₂₁ is selected from C₈-C₃₀-alkyl, or C₈-C₃₀-alkenyl; and

R₂₂, R₂₃, R₂₄ are selected from, independently of one another, hydrogen, methyl or ethyl;

wherein the above alkyl (C₁-C₃-alkyl and C₈-C₃₀-alkyl) can optionally be interrupted by one or more non-adjacent sulfur/oxygen atoms, and/or one or more non-adjacent carbon atoms in the above alkyl can optionally be replaced with -(CO)-O-.

In an embodiment, the variables in the compound of formula (VII) have the following meanings:

R₂₀ is selected from hydrogen or C₁-C₂-alkyl;

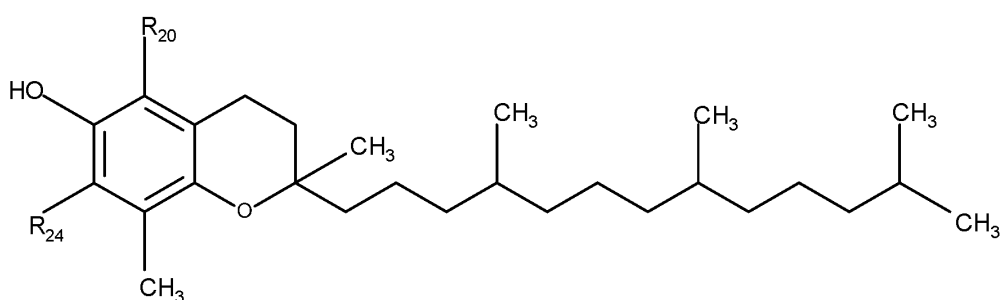
R₂₁ is selected from C₈-C₂₂-alkyl, or C₈-C₂₂-alkenyl; and

R₂₂, R₂₃, R₂₄ are selected from, independently of one another, hydrogen or methyl;

wherein the above alkyl (C₈-C₂₂-alkyl) can optionally be interrupted by one or more non-adjacent sulfur/oxygen atoms, and/or one or more non adjacent carbon atoms in the above alkyl can optionally be replaced with -(CO)-O-.

In an embodiment, at least one (i.e., one or two) of R_{20} and R_{24} is not hydrogen. In an embodiment, at least one (i.e., one or two) of R_1 and R_5 is methyl. In an embodiment, both R_{20} and R_{24} are methyl.

- 5 In an embodiment, the compound of formula (VII) comprises a compound of formula (VII-A):



(VII-A)

wherein

- 10 R_{20} and R_{24} are independently of each other H or C_1 -alkyl (desirably methyl).

In an embodiment, R_{20} and R_{24} in formula (VII-A) are C_1 -alkyl (i.e., methyl).

- The compound of formula (VII-A) possesses three asymmetric carbon atoms at positions 2, 4' and 8' in its chemical structure. All combinations of *R* and *S* configurations at the single asymmetric carbon atoms are covered, including also mixtures of enantiomers and diastereomers, for example racemic mixtures. A compound of formula (VII-A) is for example α -tocopherol, i.e. R_{20} is C_1 -alkyl, R_{24} is C_1 -alkyl and the configuration 2*R*, 4'*R* and 8'*R*, β -tocopherol, i.e. R_{20} is C_1 -alkyl, R_{24} is hydrogen and the configuration 2*R*, 4'*R* and 8'*R*, γ -tocopherol, i.e. R_{20} is hydrogen, R_{24} is C_1 -alkyl and the configuration 2*R*, 4'*R* and 8'*R*, or δ -tocopherol, i.e. R_{20} is hydrogen, R_{24} is hydrogen and the configuration 2*R*, 4'*R* and 8'*R*. Mixtures of compound of formula (VII-A) are also suitable, for example, natural vitamin E or industrially synthesized vitamin E contains compounds of formula (VII-A). Preferably, at least one of R_{20} and R_{24} is C_1 -alkyl. In particular, R_{20} and R_{24} are C_1 -alkyl.

In an embodiment, the compound of formula (VIII) (component (iii)) is selected from tocopherols, tocotrienols, and mixtures thereof. Tocopherols can include for example α -, β -, γ - and δ -tocopherols. Tocotrienols can include for example α -, β -, γ - and δ -tocotrienols.

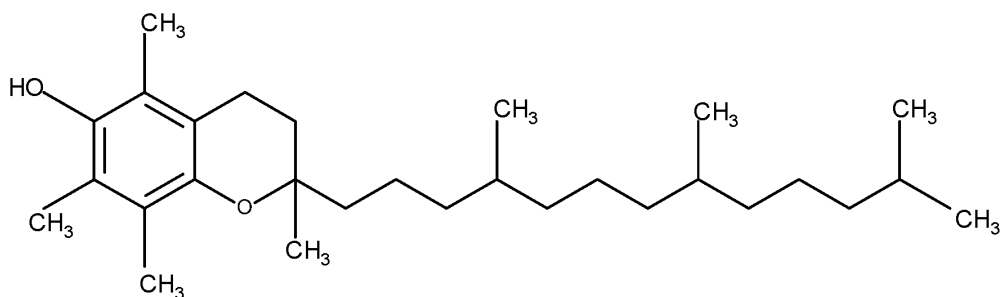
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In an embodiment, component (iii) comprises α -, β -, γ -, δ -tocopherols or α -, β -, γ -, δ -tocotrienols, or mixture thereof.

In an embodiment, the compound of formula (VII) (component (iii)) is Vitamin E.

10 Vitamin E contains natural source Vitamin E and synthetic source Vitamin E. In an embodiment, the Vitamin E is synthesized and is a mixture of stereoisomers.

In an embodiment, the compound of formula (VII) (component (iii)) is a compound of formula (VII-B):



15

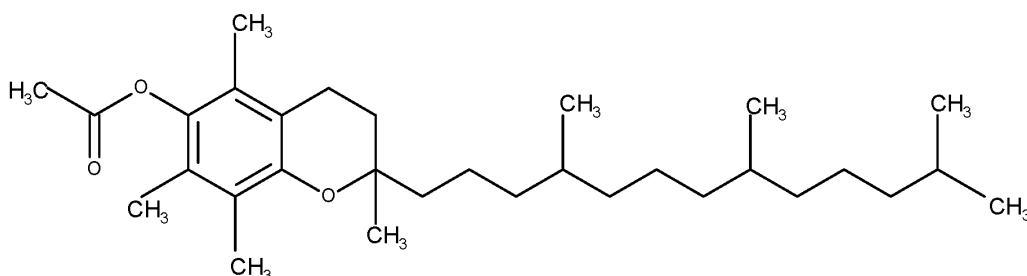
(VII-B).

The compound relating to Formula (VII-B) is 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol.

20

In an embodiment, the compound of formula (VII) (component (iii)) is a compound of formula (VII-C):

37



The compound relating to Formula (VII-C) is 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-yl acetate.

5

The compounds of formulae (VII-B) and (VII-C) each contain three asymmetric carbon atoms at positions 2, 4' and 8' in their respective chemical structures. All combinations of *R* and *S* configurations at the single asymmetric carbon atoms are covered, including also mixtures of enantiomers and diastereomers, for example racemic mixtures. In an embodiment, component (iii) is a racemic mixture of stereoisomers of formula (VII-B) and/or of formula (VII-C).

10

The stabiliser mixture developed in the present invention has been found to be effective for processing thermoplastics, such as polyolefins.

15

The components of the stabiliser mixture may be used in any suitable weight ratio sufficient to give the desired performance. Stabiliser mixtures comprising two of the three components (i) hydroxylamine or amine oxide; (ii) benzofuran-2-one according to formula (I); and (iii) chromanol, specifically (i) to (ii); (i) to (iii) in each case may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. Stabiliser mixtures comprising the three components (i) hydroxylamine or amine oxide; (ii) benzofuran-2-one according to formula (I); and (iii) chromanol (i) to (ii) to (iii) may range from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1.

20

25

In a particularly desirable embodiment, the stabiliser mixture comprises the combination of bis (hydrogenated palm oil alkyl) hydroxy amines and 2(3H)-Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-

tetramethylbutyl)- (Formula (IV-S6)). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance

5 phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In a particularly desirable embodiment, the stabiliser mixture comprises the combination of N,N-di(hydrogenated tallow) hydroxylamine and 2(3H)-

10 Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-tetramethylbutyl)- (Formula (IV-S6)). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance

15 phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In a particularly desirable embodiment, the stabiliser mixture comprises the combination of bis (hydrogenated palm oil alkyl) hydroxy amines and [4-tert-butyl-2-

20 (5-tert-butyl-2-oxo-3H-1-benzofuran-3-yl)phenyl] 3,5-di-tert-butyl-4-hydroxybenzoate (Formula IV-S8). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance

25 phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In a particularly desirable embodiment, the stabiliser mixture comprises the combination of N,N-di(hydrogenated tallow) hydroxylamine and [4-tert-butyl-2-(5-tert-

30 butyl-2-oxo-3H-1-benzofuran-3-yl)phenyl] 3,5-di-tert-butyl-4-hydroxybenzoate (Formula IV-S8). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in

stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

- 5 In another particularly desirable embodiment, the stabiliser mixture comprises a combination of bis (hydrogenated palm oil alkyl) hydroxy amines and 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl] (Formula (IV-S7)). The weight ratio of the two components may range from 9:1 to
- 10 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.
- 15 In another particularly desirable embodiment, the stabiliser mixture comprises a combination of N,N-di(hydrogenated tallow) hydroxylamine and 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl] (Formula (IV-S7)). The weight ratio of the two components may range from 9:1 to
- 20 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.
- In a further particularly desirable embodiment, the stabiliser mixture comprises a
- 25 combination of bis (hydrogenated palm oil alkyl) hydroxy amines and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used
- 30 for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

- In a further particularly desirable embodiment, the stabiliser mixture comprises a combination of N,N-di(hydrogenated tallow) hydroxylamine and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.
- 10 In a yet further particularly desirable embodiment, the stabiliser mixture comprises a combination of 2(3H)-Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-tetramethylbutyl)- (Formula (IV-S6)) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.
- 20 In a yet further particularly desirable embodiment, the stabiliser mixture comprises a combination of [4-tert-butyl-2-(5-tert-butyl-2-oxo-3H-1-benzofuran-3-yl)phenyl] 3,5-di-tert-butyl-4-hydroxybenzoate (Formula IV-S8) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.
- 25 In a still further particularly desirable embodiment, the stabiliser mixture comprises a combination of 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl] (Formula (IV-S7)) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol)
- 30

(Formula VII-B). The weight ratio of the two components may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In another particularly desirable embodiment, the stabiliser mixture comprises the combination of bis (hydrogenated palm oil alkyl) hydroxy amines and 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl] (Formula (IV-S7)) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the three components may range from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In another particularly desirable embodiment, the stabiliser mixture comprises the combination of N,N-di(hydrogenated tallow) hydroxylamine and 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl] (Formula (IV-S7)) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the three components may range from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In another particularly desirable embodiment, the stabiliser mixture comprises the combination of bis (hydrogenated palm oil alkyl) hydroxy amines and 2(3H)-Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-tetramethylbutyl)- (Formula (IV-S6)) and 2,5,7,8-tetramethyl-2-(4,8,12-

trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the three components may range from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In another particularly desirable embodiment, the stabiliser mixture comprises the combination of N,N-di(hydrogenated tallow) hydroxylamine and 2(3H)-Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-tetramethylbutyl)- (Formula (IV-S6)) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the three components may range from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In another particularly desirable embodiment, the stabiliser mixture comprises the combination of bis (hydrogenated palm oil alkyl) hydroxylamines and [4-tert-butyl-2-(5-tert-butyl-2-oxo-3H-1-benzofuran-3-yl)phenyl] 3,5-di-tert-butyl-4-hydroxybenzoate (Formula IV-S8) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the three components may range from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In another particularly desirable embodiment, the stabiliser mixture comprises the combination of N,N-di(hydrogenated tallow) hydroxylamine and [4-tert-butyl-2-(5-tert-butyl-2-oxo-3H-1-benzofuran-3-yl)phenyl] 3,5-di-tert-butyl-4-hydroxybenzoate (Formula IV-S8) and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B). The weight ratio of the three components may range from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In a suitable embodiment, the stabiliser mixture comprises the combination of bis(hydrogenated palm oil alkyl) hydroxy amines and 5,7-di-tert-butyl-3-(3,4-dimethylphenyl)-3H-benzofuran-2-one (Formula (IV-S4) and/or 5,7-di-tert-butyl-3-(2,3-dimethylphenyl)-3H-benzofuran-2-one (Formula IV-S5), particularly as the 90:10 weight ratio of these two benzofuranones. The weight ratio of the hydroxylamine to benzofuranone may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

In a suitable embodiment, the stabiliser mixture comprises the combination of N,N-di(hydrogenated tallow) hydroxylamine and 5,7-di-tert-butyl-3-(3,4-dimethylphenyl)-3H-benzofuran-2-one (Formula (IV-S4) and/or 5,7-di-tert-butyl-3-(2,3-dimethylphenyl)-3H-benzofuran-2-one (Formula IV-S5), particularly as the 90:10 weight ratio of these two benzofuranones. The weight ratio of the hydroxylamine to benzofuranone may range from 9:1 to 1:9, preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2. The stabiliser mixture may additionally comprise other additives commonly used in stabiliser mixtures used for processing thermoplastic polymers, for instance phosphites e.g. tris(2,4-di-tert-butylphenyl) phosphite; light stabilisers; and acid scavengers.

Other suitable embodiments of stabiliser mixtures include the combination of primary stabiliser components:

- 5,7-di-tert-butyl-3-(3,4-dimethylphenyl)-3H-benzofuran-2-one (Formula (IV-S4) and/or 5,7-di-tert-butyl-3-(2,3-dimethylphenyl)-3H-benzofuran-2-one (Formula IV-S5), particularly as the 90:10 weight ratio of these two benzofuranones with 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B).
- bis (hydrogenated palm oil alkyl) hydroxy amines and 5,7-di-tert-butyl-3-(3,4-dimethylphenyl)-3H-benzofuran-2-one (Formula (IV-S4) and/or 5,7-di-tert-butyl-3-(2,3-dimethylphenyl)-3H-benzofuran-2-one (Formula IV-S5), particularly as the 90:10 weight ratio of these two benzofuranones, and 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B).

Other suitable embodiments of stabiliser mixtures include the combination of primary stabiliser components:

- tertiary amine oxides selected from the group consisting of dioctylmethyl amine oxide, trioctyl amine oxide, didecyl methyl amine oxide, di(coco alkyl)methyl amine oxide, tri(coco alkyl) amine oxide, di(tallow alkyl)methyl amine oxide, tri(tallow alkyl) amine oxide, tri(C₁₄-C₂₄) amine oxide, di(C₁₄-C₂₄ alkyl)methyl amine oxide, and mixtures containing any of the foregoing, preferably amines, bis (hydrogenated rape-oil alkyl)methyl, N-oxides, in combination with 5,7-di-tert-butyl-3-(3,4-dimethylphenyl)-3H-benzofuran-2-one (Formula (IV-S4) and/or 5,7-di-tert-butyl-3-(2,3-dimethylphenyl)-3H-benzofuran-2-one (Formula IV-S5), particularly as the 90:10 weight ratio of these two benzofuranones.
- tertiary amine oxides selected from the group consisting of dioctylmethyl amine oxide, trioctyl amine oxide, didecyl methyl amine oxide, di(coco alkyl)methyl amine oxide, tri(coco alkyl) amine oxide, di(tallow alkyl)methyl amine oxide, tri(tallow alkyl) amine oxide, tri(C₁₄-C₂₄) amine oxide, di(C₁₄-C₂₄ alkyl)methyl amine oxide, and mixtures containing any of the foregoing, preferably amines, bis (hydrogenated rape-oil alkyl)methyl, N-oxides, in

combination with 2(3H)-Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-tetramethylbutyl)- (Formula (IV-S6)).

- tertiary amine oxides selected from the group consisting of dioctylmethyl amine oxide, trioctyl amine oxide, didecylmethyl amine oxide, di(coco alkyl)methyl amine oxide, tri(coco alkyl) amine oxide, di(tallow alkyl)methyl amine oxide, tri(tallow alkyl) amine oxide, tri(C₁₄-C₂₄) amine oxide, di(C₁₄-C₂₄ alkyl)methyl amine oxide, and mixtures containing any of the foregoing, preferably amines, bis (hydrogenated rape-oil alkyl)methyl, N-oxides, in combination with 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl] (Formula (IV-S7)).
- Tertiary amine oxides selected from the group consisting of dioctylmethyl amine oxide, trioctyl amine oxide, didecylmethyl amine oxide, di(coco alkyl)methyl amine oxide, tri(coco alkyl) amine oxide, di(tallow alkyl)methyl amine oxide, tri(tallow alkyl) amine oxide, tri(C₁₄-C₂₄) amine oxide, di(C₁₄-C₂₄ alkyl)methyl amine oxide, and mixtures containing any of the foregoing in combination, preferably amines, bis (hydrogenated rape-oil alkyl)methyl, N-oxides, with [4-tert-butyl-2-(5-tert-butyl-2-oxo-3H-1-benzofuran-3-yl)phenyl] 3,5-di-tert-butyl-4-hydroxybenzoate (Formula IV-S8).
- Tertiary amine oxides selected from the group consisting of dioctylmethyl amine oxide, trioctyl amine oxide, didecylmethyl amine oxide, di(coco alkyl)methyl amine oxide, tri(coco alkyl) amine oxide, di(tallow alkyl)methyl amine oxide, tri(tallow alkyl) amine oxide, tri(C₁₄-C₂₄) amine oxide, di(C₁₄-C₂₄ alkyl)methyl amine oxide, and mixtures containing any of the foregoing, preferably amines, bis (hydrogenated rape-oil alkyl)methyl, N-oxides, in combination with 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (alpha-tocopherol) (Formula VII-B).

In one form of the invention the stabiliser mixture comprises the components (i) i.e. a hydroxylamine (including any of the more specific embodiments described herein) or an amine oxide (including any of the more specific embodiments described herein); and (ii) benzofuran-2-one according to formula (I) (including any of the more specific embodiments described herein) and/or (iii) chromanol (including any of the more

specific embodiments described herein). In a more desired form, the stabiliser mixture is employed in an amount of below 500 ppm by the combined weights of the components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the weight of the thermoplastic polymer. Desirably still the amount employed based on the components (i) and (ii) and/or (iii) should be less than 300 ppm, more desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm.

Thus, in this form of the invention, the stabiliser mixture comprises at least two of the components selected from (i), (ii) and (iii), any of the more respective specific embodiments described herein for each of the components and the stabiliser mixture is present in the thermoplastic polymer composition or employed in the method or use for producing the thermoplastic polymer composition in an amount of below 500 ppm, desirably less than 300 ppm, more desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by weight of the components (i), (ii) and (iii) present in the stabiliser mixture, based on the weight of the thermoplastic polymer.

Generally, the stabiliser mixture may be present in the thermoplastic polymer composition or employed in the method or use for producing the thermoplastic polymer composition in an amount of at least 40 ppm by the combined weight of the components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the weight of the thermoplastic polymer. Suitable amounts of the stabiliser mixture employed may lie in the range of from 40 ppm to below 500 ppm, for instance from 50 ppm to below 300 ppm, from 50 ppm to below 250 ppm, from 50 ppm to 200 ppm, from 60 ppm to 150 ppm, from 60 ppm to 100 ppm, by the combined weight of the components (i), (ii) and (iii) present in the stabiliser mixture, based on the weight of the thermoplastic polymer.

In one particularly preferable embodiment of the present invention, the stabiliser mixture comprises the components (A) (i) a hydroxylamine or amine oxide and (iii) a chromanol; or (B) (ii) a benzofuran-2-one of formula (I) and (iii) a chromanol; or (C) (i) a hydroxylamine or amine oxide and (ii) a benzofuran-2-one of formula (I) and (iii)

a chromanol. Thus, in this embodiment a (iii) chromanol must be present in the stabiliser mixture. This particularly preferable embodiment applies to the various aspects (composition, method of preparing the composition, and use of the stabiliser mixture) wherein the composition comprises (a) a thermoplastic polymer, preferably
5 a polyolefin; and (b) a stabiliser mixture. In accordance with the definitions of the present invention, in regard to (A) the components (i) and (iii) are present in the composition; and (C) the components (i) and (ii) and (iii) respectively are present in the composition in an amount below 500 ppm by the combined weight of the respect of components present in the stabiliser system based on the weight of the
10 thermoplastic polymer; and in regard to (B) the components (ii) and (iii) are present in the composition in an amount of less than 300 ppm, desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by weight of the respective components based on the weight of the thermoplastic polymer.

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The components (i) and (ii) and/or (iii) present in the stabiliser mixture of the invention may be regarded as primary antioxidants. These primary antioxidants can scavenge and/or trap C-centered radicals which are typically formed during the degradation of thermoplastic polymers.

20

In a desirable form of the invention, the stabiliser mixture may also contain a secondary antioxidant. More desirably the secondary antioxidant is a phosphite or phosphonite, preferably a phosphite. Examples of suitable phosphites or phosphonites are Trisalkyl (C₁₂-C₁₅) phosphite, Triisodecyl phosphite, Triisotridecyl
25 phosphite, Dioleoyl Hydrogen phosphite, Triisooctyl Phosphite, Heptakis (dipropyleneglycol) Triphosphite, Trilauryl Trithio Phosphite, Tris (Dipropyleneglycol) Phosphite, Dimethyl hydrogen phosphite, Dibutyl hydrogen phosphite, Dilauryl hydrogen phosphite, Tri-C₁₂-C₁₄-phosphite or Bis(2-ethylhexyl) hydrogen phosphite. Other phosphites and phosphonates, which are for instance liquid ones such as Di-
30 n-octyl hydrogen phosphite or Di-iso-octyl hydrogen phosphite, or for example triphenyl phosphite, tris(nonylphenyl) phosphite, Phenyl-diisodecyl phosphite, Diphenylisodecyl phosphite, [Triphenyl phosphite, polymer with 1,4-cyclohexanedimethanol and polypropylene glycol, C₁₀-C₁₆ alkyl esters]. Further

optional phosphites or phosphonates additives are for instance Alkyl (C₁₂-C₁₅) bisphenol A phosphite, Alkyl (C₁₀) bisphenol A phosphite, Poly (dipropyleneglycol) phenyl phosphite, Tris (tridecyl) phosphite, Diphenyl phosphite, Dodecyl nonylphenol phosphite blend, Phenyl Neopentylene Glycol Phosphite, Poly 4,4'

- 5 Isopropylidenediphenol - C₁₀ Alcohol Phosphite, Poly 4,4' Isopropylidenediphenol - C₁₂₋₁₅ Alcohol Phosphite, diphenylalkyl phosphites, phenyldialkyl phosphites, C₁₂-C₁₈ alkyl bis[4-(1-methyl-1-phenyl-ethyl)phenyl] phosphite, C₁₂-C₁₈ alkenyl bis[4-(1-methyl-1-phenyl-ethyl)phenyl] phosphite, bis[4-(1-methyl-1-phenyl-ethyl)phenyl] [(E)-octadec-9-enyl] phosphite, decyl bis[4-(1-methyl-1-phenyl-ethyl)phenyl] phosphite,
- 10 didecyl [4-(1-methyl-1-phenyl-ethyl)phenyl] phosphite, [4-(1-methyl-1-phenyl-ethyl)phenyl] bis[(E)-octadec-9-enyl] phosphite, trilauryl phosphite, trioctadecyl phosphite, distearyl pentaerythritol diphosphite, tris(2,4-di-tert-butylphenyl) phosphite, diisodecyl pentaerythritol diphosphite, bis(2,4-di-tert-butylphenyl) pentaerythritol diphosphite, bis(2,4-di-cumylphenyl) pentaerythritol diphosphite, bis(2,6-di-tert-butyl-
- 15 4-methylphenyl) pentaerythritol diphosphite, diisodecyloxypentaerythritol diphosphite, bis(2,4-di-tert-butyl-6-methylphenyl) pentaerythritol diphosphite, bis(2,4,6-tris(tert-butylphenyl) pentaerythritol diphosphite, [2-tert-butyl-4-[1-[5-tert-butyl-4-di(tridecoxy)phosphanyloxy-2-methyl-phenyl]butyl]-5-methyl-phenyl] ditridecyl phosphite, tristearyl sorbitol triphosphite, a mixture of at least two different tris(mono-
- 20 C₁-C₈-alkyl)phenyl phosphites such as for example mentioned in US 7468410 B2 as products of examples 1 and 2, a mixture of phosphites comprising at least two different tris(arylphenyl) phosphites such as for example mentioned in US 8008383 B2 as mixtures 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25 and 26, a mixture of a least four different phosphites comprising tris[4-(1,1-dimethylpropyl)phenyl]
- 25 phosphite, [2,4-bis(1,1-dimethylpropyl)phenyl] bis[4-(1,1-dimethylpropyl)phenyl] phosphite, bis[2,4-bis(1,1-dimethylpropyl)phenyl] [4-(1,1-dimethylpropyl)phenyl] phosphite and tris[2,4-bis(1,1-dimethylpropyl)phenyl] phosphite, a mixture of phosphites comprising at least two different tris(butylphenyl) phosphites such as for example mentioned in US 8008383 B2 as mixtures 34, 35, 36, 37, 38, 39 and 40, an
- 30 oxyalkylene-bridged bis-(di-C₆-aryl) diphosphite or an oligomeric phosphite obtainable by condensation under removal of hydrogen chloride of (i) a trichlorophosphane, with (ii) a dihydroxyalkane interrupted by one or more oxygen atoms and with (iii) a mono-hydroxy-C₆-arene such as for example mentioned in US

8304477 B2 as products of examples 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17, a polymeric phosphite obtainable by transesterification under removal of phenol of (i) triphenyl phosphite with (ii) a dihydroxyalkane optionally interrupted by one or more oxygen atoms and/or a bis(hydroxyalkyl)(alkyl)amine and with (iii) a

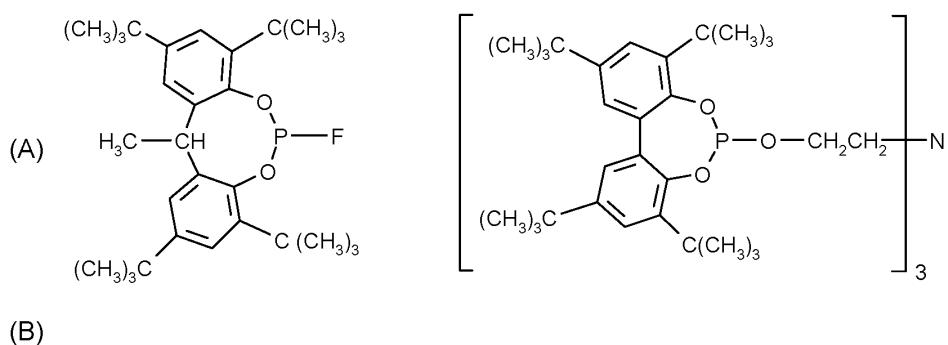
5 mono-hydroxyalkane optionally interrupted by one or more oxygen atoms such as for example mentioned in US 8563637 B2 as products of examples 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11, tetrakis(2,4-di-tert-butylphenyl) 4,4'-biphenylene diphosponite, 6-isooctyloxy-2,4,8,10-tetra-tert-butyl-12H-dibenz[d,g]-1,3,2-dioxaphosphocine, bis(2,4-di-tert-butyl-6-methylphenyl)methylbis(2,4-di-tert-butyl-6-methylphenyl)methyl

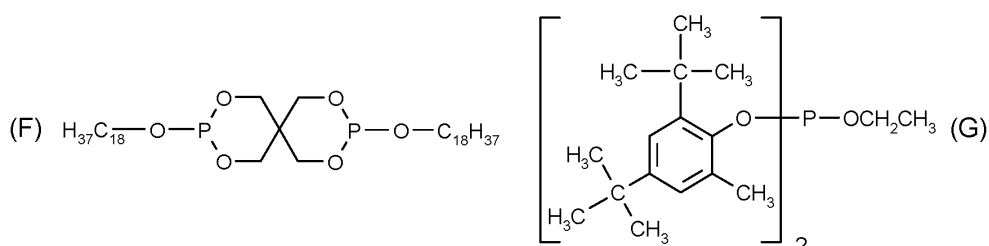
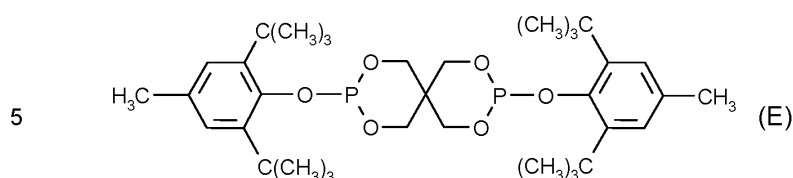
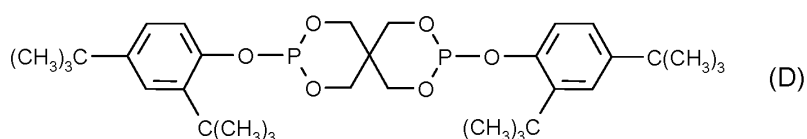
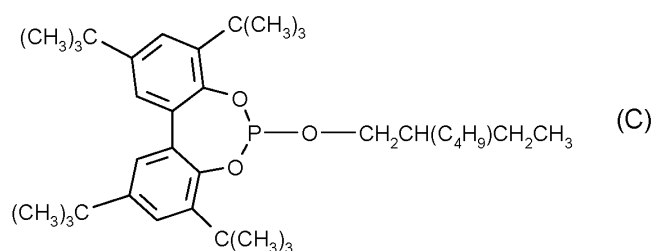
10 phosphite, bis(2,4-di-tert-butyl-6-methylphenyl)ethyl phosphite, 6-fluoro-2,4,8,10-tetra-tert-butyl-12-methyl-dibenz[d,g]-1,3,2-dioxaphosphocine, 1,3,7,9-tetra-tert-butyl-11-octoxy-5H-benzo[d][1,3,2]benzodioxaphosphocine, 2,2',2''-nitrilo[triethyltris(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite], phosphorous acid, triphenyl ester, polymer with α -hydro- ω -hydroxypoly[oxy(methyl-

15 1,2-ethanediyl)], C10-16-alkyl esters, 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, phosphorous acid, mixed 2,4-bis(1,1-dimethylpropyl)phenyl and 4-(1,1-dimethylpropyl)phenyl triesters.

20 The following phosphites are especially preferred:

Tris(2,4-di-tert-butylphenyl) phosphite (BASF), tris(nonylphenyl) phosphite,





The phosphites or phosphonites may be used in an amount of up to 2 wt.% by weight of the thermoplastic polymer, for instance from 0.01 wt.% to 2 wt.%, for instance from 0.025 wt.% to 1 wt.%.

10

The stabiliser mixture may also contain additional antioxidants. Typical additional antioxidants that may be included into the stabiliser mixture can be selected from the following list.

- 15 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,
 5 2,4-dimethyl-6-(1'-methylundec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methylheptadec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methyltridec-1'-yl)phenol, 2,4-dimethyl-6-(1'-methyl-1'-tetradecyl-methyl)-phenol and mixtures thereof.

2. Alkylthiomethylphenols, for example 2,4-dioctylthiomethyl-6-tert-butylphenol, 2,4-dioctylthiomethyl-6-methylphenol, 2,4-dioctylthiomethyl-6-ethylphenol, 2,6-didodecylthiomethyl-4-nonylphenol.
 10

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.
 15

4. Hydroxylated thiodiphenyl ethers, for example 2,2'-thiobis(6-tert-butyl-4-methylphenol), 2,2'-thiobis(4-octylphenol), 4,4'-thiobis(6-tert-butyl-3-methylphenol), 4,4'-thiobis(6-tert-butyl-2-methylphenol), 4,4'-thiobis(3,6-di-sec-amylphenol), 4,4'-bis(2,6-dimethyl-4-hydroxyphenyl)disulfide.
 20

5. 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-($\square$ -methylcyclohexyl)phenol], 2,2'-methylenebis(4-methyl-6-cyclohexylphenol), 2,2'-methylenebis(6-nonyl-4-methylphenol), 2,2'-methylenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol), 2,2'-methylenebis[6-(α -methylbenzyl)-4-nonylphenol], 2,2'-methylenebis[6-(α,α -dimethylbenzyl)-4-nonylphenol], 4,4'-methylenebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-2-methylphenol), 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-
 25
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- butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis(3'-tert-butyl-4'-hydroxyphenyl)butyrate], bis(3-tert-butyl-4-hydroxy-5-methyl-phenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate, 1,1-bis-(3,5-dimethyl-2-
- 5 hydroxyphenyl)butane, 2,2-bis(3,5-di-tert-butyl-4-hydroxyphenyl)propane, 2,2-bis-(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1,1,5,5-tetra(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.
6. O-, N- and S-benzyl compounds, for example 3,5,3',5'-tetra-tert-butyl-4,4'-di-
- 10 hydroxydibenzyl ether, octadecyl-4-hydroxy-3,5-dimethylbenzylmercaptoacetate, tridecyl-4-hydroxy-3,5-di-tert-butylbenzylmercaptoacetate, tris(3,5-di-tert-butyl-4-hydroxybenzyl)amine, bis(4-tert-butyl-3-hydroxy-2,6-dimethylbenzyl)dithioterephthalate, bis(3,5-di-tert-butyl-4-hydroxybenzyl)sulfide, isooctyl-3,5-di-tert-butyl-4-hydroxybenzylmercaptoacetate.
- 15 7. 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-
- 20 butyl-4-hydroxybenzyl)malonate.
8. 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.
- 25 9. 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-
- 30 (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.

10. 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.
11. Acylaminophenols, for example 4-hydroxylauranilide, 4-hydroxystearanilide, octyl N-(3,5-di-tert-butyl-4-hydroxyphenyl)carbamate.
12. Esters of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, for example with methanol, ethanol, n-octanol, i-octanol, a mixture of linear and branched C₇-C₉-alkanol, octadecanol, a mixture of linear and branched C₁₃-C₁₅-alkanol, 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.
13. Esters of β -(5-tert-butyl-4-hydroxy-3-methylphenyl)propionic acid with mono- or polyhydric alcohols, for example with methanol, ethanol, n-octanol, i-octanol, octadecanol, 1,6-hexanediol, 1,9-nonanediol, ethylene glycol, 1,2-propanediol, neopentyl glycol, thiodiethylene glycol, diethylene glycol, triethylene glycol, pentaerythritol, tris(hydroxyethyl)isocyanurate, N,N'-bis(hydroxyethyl)oxamide, 3-thiaundecanol, 3-thiapentadecanol, trimethylhexanediol, trimethylolpropane, 4-hydroxymethyl-1-phospha-2,6,7-trioxabicyclo[2.2.2]octane; 3,9-bis[2-{3-(3-tert-butyl-4-hydroxy-5-methylphenyl)propionyloxy}-1,1-dimethylethyl]-2,4,8,10-tetraoxaspiro[5.5]undecane.
14. Esters of β -(3,5-dicyclohexyl-4-hydroxyphenyl)propionic acid with mono- or polyhydric alcohols, for example 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.

- 5 15. Esters of 3,5-di-tert-butyl-4-hydroxyphenyl acetic acid with mono- or polyhydric alcohols, for example 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.

16. Amides of β -(3,5-di-tert-butyl-4-hydroxyphenyl)propionic acid, for example 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 (RTM), supplied by Uniroyal).

- 20 17. Ascorbic acid (vitamin C)

18. Aminic antioxidants, for example N,N'-di-isopropyl-p-phenylenediamine, N,N'-di-sec-butyl-p-phenylenediamine, N,N'-bis(1,4-dimethylpentyl)-p-phenylenediamine, N,N'-bis(1-ethyl-3-methylpentyl)-p-phenylenediamine, N,N'-bis(1-methylheptyl)-p-phenylenediamine, N,N'-dicyclohexyl-p-phenylenediamine, N,N'-diphenyl-p-phenylenediamine, N,N'-bis(2-naphthyl)-p-phenylenediamine, N-isopropyl-N'-phenyl-p-phenylenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine, N-(1-methylheptyl)-N'-phenyl-p-phenylenediamine, N-cyclohexyl-N'-phenyl-p-phenylenediamine, 4-(p-toluenesulfamoyl)diphenylamine, N,N'-dimethyl-N,N'-di-sec-butyl-p-phenylenediamine, diphenylamine, N-allyldiphenylamine, 4-isopropoxydiphenylamine, N-phenyl-1-naphthylamine, N-(4-tert-octylphenyl)-1-naphthylamine, N-phenyl-2-naphthylamine, octylated diphenylamine, for example p,p'-di-tert-octyldiphenylamine, 4-n-butylaminophenol, 4-butyrylamino-phenol, 4-

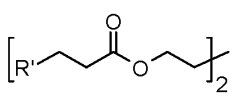
- nonanoylaminophenol, 4-dodecanoylaminophenol, 4-octadecanoylaminophenol, bis(4-methoxyphenyl)amine, 2,6-di-tert-butyl-4-dimethylaminomethylphenol, 2,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylmethane, N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane, 1,2-bis[(2-methylphenyl)amino]ethane, 1,2-
- 5 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
- 10 mono- and dialkylated tert-butyldiphenylamines, 2,3-dihydro-3,3-dimethyl-4H-1,4-benzothiazine, phenothiazine, a mixture of mono- and dialkylated tert-butyl/tert-octylphenothiazines, a mixture of mono- and dialkylated tert-octylphenothiazines, N-allylphenothiazine, N,N,N',N'-tetraphenyl-1,4-diaminobut-2-ene, N,N-bis(2,2,6,6-tetramethylpiperid-4-yl-hexamethylenediamine, bis(2,2,6,6-tetramethylpiperid-4-
- 15 yl)sebacate, 2,2,6,6-tetramethylpiperidin-4-one, 2,2,6,6-tetramethylpiperidin-4-ol.

The stabiliser mixtures of the present invention may also include UV absorbers and light stabilisers. Typical examples of UV absorbers and light stabilisers are shown in the list below.

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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-
- 25 chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphenyl)-5-chlorobenzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octyloxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)benzotriazole, 2-(3',5'-bis(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)-
- 30 5-chlorobenzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)-5-chlorobenzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-5-chlorobenzotriazole, 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-yl]phenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonylethyl)-2'-hydroxyphenyl]-2H-benzotriazole with

polyethylene glycol 300; , 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.

- 10 dimethylbenzyl)phenyl]benzotriazole.

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.

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3. Esters of substituted and unsubstituted benzoic acids, for example 4-tert-butylphenyl salicylate, phenyl salicylate, octylphenyl salicylate, dibenzoyl resorcinol, bis(4-tert-butylbenzoyl)resorcinol, benzoyl resorcinol, 2,4-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate, hexadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, 20 octadecyl 3,5-di-tert-butyl-4-hydroxybenzoate, 2-methyl-4,6-di-tert-butylphenyl 3,5-di-tert-butyl-4-hydroxybenzoate.

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

5. Nickel compounds, for example nickel complexes of 2,2'-thiobis[4-(1,1,3,3-tetramethylbutyl)phenol], such as the 1:1 or 1:2 complex, with or without additional ligands such as n-butylamine, triethanolamine or N-cyclohexyldiethanolamine, nickel

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dibutyldithiocarbamate, nickel salts of the monoalkyl esters, e.g. the methyl or ethyl ester, of 4-hydroxy-3,5-di-tert-butylbenzylphosphonic acid, nickel complexes of ketoximes, e.g. of 2-hydroxy-4-methylphenylundecylketoxime, nickel complexes of 1-phenyl-4-lauroyl-5-hydroxypyrazole, with or without additional ligands.

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6. Sterically Hindered Amine Light Stabilisers (HALS), for example bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate, bis(2,2,6,6-tetramethyl-4-piperidyl)succinate, bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacate, bis(1,2,2,6,6-pentamethyl-4-piperidyl) n-butyl-3,5-di-tert-butyl-4-hydroxybenzylmalonate, the condensate of 1-(2-hydroxyethyl)-2,2,6,6-tetramethyl-4-hydroxypiperidine and succinic acid, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-tert-octylamino-2,6-dichloro-1,3,5-triazine, tris(2,2,6,6-tetramethyl-4-piperidyl)nitrilotriacetate, tetrakis(2,2,6,6-tetramethyl-4-piperidyl)-1,2,3,4-butanetetracarboxylate, 1,1'-(1,2-ethanediyl)-bis(3,3,5,5-tetramethylpiperazinone), 4-benzoyl-2,2,6,6-tetramethylpiperidine, 4-stearyloxy-2,2,6,6-tetramethylpiperidine, bis(1,2,2,6,6-pentamethylpiperidyl)-2-n-butyl-2-(2-hydroxy-3,5-di-tert-butylbenzyl)malonate, 3-n-octyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, bis(1-octyloxy-2,2,6,6-tetramethylpiperid-4-yl)sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperid-4-yl)succinate, bis-[2,2,6,6-tetramethyl-1-(undecyloxy)-piperidin-4-yl] carbonate, 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-aminopropyl-amino)ethane, 8-acetyl-3-dodecyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, 3-dodecyl-1-(2,2,6,6-tetramethyl-4-piperidyl)pyrrolidine-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione, a mixture of 4-hexadecyloxy- and 4-stearyloxy-2,2,6,6-tetramethylpiperidine, a condensate of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-cyclohexylamino-2,6-dichloro-1,3,5-triazine, a condensate of 1,2-bis(3-aminopropylamino)ethane and 2,4,6-trichloro-1,3,5-triazine as well as 4-butylamino-2,2,6,6-tetramethylpiperidine ; a condensate of 1,6-hexanediamine and 2,4,6-trichloro-1,3,5-triazine as well as N,N-dibutylamine and 4-

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- butylamino-2,2,6,6-tetramethylpiperidine ; N-(2,2,6,6-tetramethyl-4-piperidyl)-n-dodecylsuccinimide, N-(1,2,2,6,6-pentamethyl-4-piperidyl)-n-dodecylsuccinimide, 2-undecyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxo-spiro[4,5]decane, a reaction product of 7,7,9,9-tetramethyl-2-cycloundecyl-1-oxa-3,8-diaza-4-oxospiro-
- 5 [4,5]decane and epichlorohydrin, 1,1-bis(1,2,2,6,6-pentamethyl-4-piperidyloxycarbonyl)-2-(4-methoxyphenyl)-ethene, N,N'-bis-formyl-N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine, a diester of 4-methoxymethylenemalononic acid with 1,2,2,6,6-pentamethyl-4-hydroxy-piperidine, poly[methylpropyl-3-oxy-4-(2,2,6,6-tetramethyl-4-piperidyl)]siloxane, a reaction
- 10 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, a mixture of oligomeric compounds which are the formal condensation products of N,N'-bis-(2,2,6,6-tetramethyl-1-propoxy-piperidin-4-yl)-hexane-1,6-diamine and 2,4-dichloro-6-{n-butyl-(2,2,6,6-tetramethyl-1-propoxy-piperidin-4-yl)-amino}-[1,3,5]triazine end-capped
- 15 with 2-chloro-4,6-bis-(di-n-butylamino)-[1,3,5]triazine, a mixture of oligomeric compounds which are the formal condensation products of N,N'-bis-(2,2,6,6-tetramethyl-piperidin-4-yl)-hexane-1,6-diamine and 2,4-dichloro-6-{n-butyl-(2,2,6,6-tetramethyl-piperidin-4-yl)-amino}-[1,3,5]triazine end-capped with 2-chloro-4,6-bis-(di-n-butylamino)-[1,3,5]triazine, 2,4-bis[N-(1-cyclohexyloxy-2,2,6,6-
- 20 tetramethylpiperidine-4-yl)-N-butylamino]-6-(2-hydroxyethyl)amino-1,3,5-triazine, 1-(2-hydroxy-2-methylpropoxy)-4-octadecanoyloxy-2,2,6,6-tetramethylpiperidine, 5-(2-ethylhexanoyl)oxymethyl-3,3,5-trimethyl-2-morpholinone, Sanduvor (Clariant), 5-(2-ethylhexanoyl)-oxymethyl-3,3,5-trimethyl-2-morpholinone, the reaction product of 2,4-bis-[(1-cyclo-hexyloxy-2,2,6,6-piperidine-4-yl)butylamino]-6-chloro-s-triazine with
- 25 N,N'-bis-(3-amino-propyl)ethylenediamine), 1,3,5-tris(N-cyclohexyl-N-(2,2,6,6-tetramethyl-piperazine-3-one-4-yl)amino)-s-triazine, 1,3,5-tris(N-cyclohexyl-N-(1,2,2,6,6-pentamethylpiperazine-3-one-4-yl)-amino)-s-triazine.
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,
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mixtures of o- and p-methoxy-disubstituted oxanilides and mixtures of o- and p-ethoxy-disubstituted oxanilides.

8. 2-(2-Hydroxyphenyl)-1,3,5-triazines, for example 2,4,6-tris(2-hydroxy-4-octyloxyphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2,4-dihydroxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-tridecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-butyloxypropoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxypropyloxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[4-(dodecyloxy/tridecyloxy-2-hydroxypropoxy)-2-hydroxyphenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-dodecyloxypropoxy)phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-hexyloxy)phenyl-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-methoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2,4,6-tris[2-hydroxy-4-(3-butoxy-2-hydroxypropoxy)phenyl]-1,3,5-triazine, 2-(2-hydroxyphenyl)-4-(4-methoxyphenyl)-6-phenyl-1,3,5-triazine, 2-{2-hydroxy-4-[3-(2-ethylhexyl-1-oxy)-2-hydroxypropyloxy]phenyl}-4,6-bis-(2,4-dimethylphenyl)-1,3,5-triazine.

Other additives which may be included in the stabiliser mixtures are as follows:

- 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-hydroxyphenyl-propionyl)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.

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Nitrones, for example N-benzyl-alpha-phenylnitron, N-ethyl-alpha-methylnitron, N-octyl-alpha-heptylnitron, N-lauryl-alpha-undecylnitron, N-tetradecyl-alpha-tridecyl-nitron, N-hexadecyl-alpha-pentadecylnitron, N-octadecyl-alpha-heptadecylnitron,

N-hexadecyl- α -heptadecylnitrone, N-octadecyl- α -pentadecylnitrone, N-heptadecyl- α -heptadecylnitrone, N-octadecyl- α -hexadecylnitrone, nitrone derived from N,N-dialkylhydroxylamine derived from hydrogenated tallow amine.

- 5 Thiosynergists, for example dilauryl thiodipropionate, dimistyl thiodipropionate, distearyl thiodipropionate and pentaerythritol tetrakis-[3-(n-lauryl)-propionic acid ester].

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

- 15 Polyamide stabilizers, for example copper salts in combination with iodides and/or phosphorus compounds and salts of divalent manganese.

- 20 Acid scavengers, 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 and zinc pyrocatecholate.

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

- 30 Other additives, include for example plasticisers, lubricants, rheology additives, catalysts, flow-control agents, optical brighteners, flameproofing agents, antistatic agents and blowing agents. Additional other additives which are useful to add include antiagglomerants (such as glycerol monostearate, calcium stearate, etc.),

antiblocking agents, slip agents/processing aids (such as spinning oils), wetting aids, nucleator and clarifier additives, pigments and delustrants (such as TiO_2).

The thermoplastic polymer component in the present invention possesses
5 thermoplastic properties meaning that generally it can be shaped into a new form at an elevated temperature, for example in the range from 135°C to 350°C, especially from 150°C to 340°C.

The thermoplastic polymer can be natural, semi-synthetic or synthetic. A natural
10 polymer is isolated from a natural source without further synthetic modifications. A synthetic polymer does not contain a polymer part isolated from a natural source. A semi-synthetic polymer contains at least one natural polymer part, wherein the natural polymer part can be synthetically modified and / or reacted with monomers to form the semi-synthetic polymer.

15 The thermoplastic polymer may be a homopolymer, based essentially on one monomer that has been homopolymerised i.e. in the absence of a different monomer, or a copolymer based on at least two different monomers that have been copolymerised.

20 Examples of suitable thermoplastic polymer are:

1. Polymers of monoolefins and diolefins, for example polypropylene, polyisobutylene, polybut-1-ene, poly-4-methylpent-1-ene, polyvinylcyclohexane,
25 polyisoprene or polybutadiene, as well as polymers of cycloolefins, for instance of cyclopentene or nor-bornene, 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
30 polyethylene (LDPE), linear low density polyethylene (LLDPE), (VLDPE) and (ULDPE).

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

- a) radical polymerisation (normally under high pressure and at elevated temperature).
- b) catalytic polymerisation using a catalyst that normally contains one or more than one metal of groups IVb, Vb, VIb (for example chromium) 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.
- A special copolymer of two monoolefins is a pipe grade polypropylene random copolymer, which is obtainable from the polymerization of more than 90% by weight of propylene and of less than 10% by weight, typically between 2 and 6% by weight, of ethylene.
4. Hydrocarbon resins (for example C₅-C₉) including hydrogenated modifications there-of (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; where isotactic polymers are preferred. 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-vinyl-toluene, 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; where atactic polymers are preferred. Stereoblock polymers are also included.

6a. Copolymers including aforementioned vinyl aromatic monomers and
5 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,
10 styrene/acrylonitrile/methyl acrylate; mixtures of high impact strength of styrene copolymers and another polymer, for example 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.

15

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

20

6c. Hydrogenated aromatic polymers derived from hydrogenation of polymers mentioned under 6a.).

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

7. Graft copolymers of vinyl aromatic monomers such as styrene or α -methylstyrene, for example styrene on polybutadiene, styrene on polybutadiene-
30 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
- 5 copolymers listed under 6), for example the copolymer mixtures known as ABS, MBS, ASA or AES polymers.
8. Halogen-containing polymers such as polychloroprene, chlorinated rubbers, chlorinated and brominated copolymer of isobutylene-isoprene (halobutyl rubber),
- 10 chlorinated or sulfochlorinated 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
- 15 acetate copolymers.
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.
- 20
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
- 25 terpolymers.
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
- 30 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.

5 13. Polyacetals such as polyoxymethylene and those polyoxymethylenes which contain ethylene oxide as a comonomer; polyacetals modified with thermoplastic polyurethanes, acrylates or MBS.

10 14. Polyphenylene oxides and sulfides, and mixtures of polyphenylene oxides with styrene polymers or polyamides.

15 15. Polyurethanes, for example polyurethanes synthesized from a polyol and an aliphatic or aromatic polyisocyanate such as 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.

Hydroxyl-terminated polyethers are known and are prepared, for example, by polymerizing epoxides such as ethylene oxide, propylene oxide, butylene oxide, tetrahydrofuran, styrene oxide or epichlorohydrin with themselves, for example in the presence of BF_3 , or by addition reaction of these epoxides, alone or as a mixture or in succession, with starting components containing reactive hydrogen atoms, such as water, alcohols, ammonia or amines, for example ethylene glycol, propylene 1,3- and 1,2-glycol, trimethylolpropane, 4,4'-dihydroxydiphenylpropane, aniline, ethanolamine or ethylenediamine. Sucrose polyethers are also suitable in accordance with the invention. In many cases preference is given to those polyethers which predominantly (up to 90% by weight, based on all the OH groups present in the polyether) contain primary OH groups. Furthermore, polyethers modified by vinyl polymers, as are formed, for example, by polymerizing styrene and acrylonitrile in the presence of polyethers, are suitable, as are polybutadienes containing OH groups.

In particular, a polyol compound has a molecular weight of 400-10000, especially 800 to 10000, and is a compound containing several hydroxyl groups, especially containing from 2 to 8 hydroxyl groups, especially from 2 to 4.

Suitable polyisocyanates are aliphatic or aromatic, for example ethylene

- 5 diisocyanate, 1,4-tetramethylene diisocyanate, 1,6-hexamethylene diisocyanate, 1,12-dodecane diisocyanate, cyclobutane 1,3-diisocyanate, cyclohexane 1,3- and -1,4-diisocyanate and also any desired mixtures of these isomers, 1-isocyanato-3,3,5-trimethyl-5-isocyanatomethylcyclohexane, 2,4- and 2,6-hexahydrotolylene diisocyanate and also any desired mixtures of these isomers, hexahydro-1,3-
10 and/or -1,4-phenylene diisocyanate, perhydro-2,4'- and/or -4,4'-diphenylmethanediisocyanate, 1,3- and 1,4-phenylene diisocyanate, 2,4- and 2,6-tolylene diisocyanate, and also any desired mixtures of these isomers, diphenylmethane 2,4'- and/or -4,4'-diisocyanate, naphthylene 1,5-diisocyanate, triphenylmethane 4,4',4''-triisocyanate, polyphenyl-polymethylene polyisocyanates as
15 are obtained by aniline-formaldehyde condensation followed by phosgenization, m- and p-isocyanatophenylsulfonyl isocyanates, perchlorinated aryl polyisocyanates, polyisocyanates containing carbodiimide groups, polyisocyanates containing allophanate groups, polyisocyanates containing isocyanurate groups, polyisocyanates containing urethane groups, polyisocyanates containing acylated
20 urea groups, polyisocyanates containing biuret groups, polyisocyanates containing ester groups, reaction products of the abovementioned isocyanates with acetals, and polyisocyanates containing polymeric fatty acid radicals.

- It is also possible to employ the isocyanate group-containing distillation residues, as
25 they are or dissolved in one or more of the abovementioned polyisocyanates, which are obtained in the course of the industrial preparation of isocyanates. It is additionally possible to use any desired mixtures of the abovementioned polyisocyanates.

- 30 Preferred are 2,4- or 2,6-tolylene diisocyanate and any desired mixtures of these isomers ("TDI"), polyphenyl-polymethylene-polyisocyanates as prepared by aniline-formaldehyde condensation followed by phosgenization ("crude MDI") or

polyisocyanates containing carbodiimide, urethane, allophanate, isocyanurate, urea or biuret groups ("modified polyisocyanates").

The polyurethanes can be homogeneous polyurethanes or cellular.

5

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; 10 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 chemically bonded or grafted elastomers; or with 15 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, polyetherimides, polyesterimides, 20 polyhydantoins and polybenzimidazoles.

18. Polyesters derived from dicarboxylic acids and diols and/or from hydroxycarboxylic acids or the corresponding lactones or lactides, for example polyethylene terephthalate, polybutylene terephthalate, poly-1,4- 25 dimethylolcyclohexane terephthalate, polyalkylene naphthalate and polyhydroxybenzoates as well as copolyether esters derived from hydroxyl-terminated polyethers, and also polyesters modified with polycarbonates or MBS. Copolyesters may comprise, for example - but are not limited to - polybutylenesuccinate/terephthalate, polybutyleneadipate/terephthalate, 30 polytetramethyleneadipate/terephthalate, polybutylensuccinate/adipate, polybutylensuccinate/carbonate, poly-3-hydroxybutyrate/octanoate copolymer, poly-3-hydroxybutyrate/hexanoate/decanoate terpolymer. Furthermore, aliphatic polyesters may comprise, for example - but are not limited to - the class of

poly(hydroxyalkanoates), in particular, poly(propiolactone), poly(butylolactone),
poly(pivalolactone), poly(valerolactone) and poly(caprolactone),
polyethylenesuccinate, polypropylenesuccinate, polybutylenesuccinate,
polyhexamethylenesuccinate, polyethyleneadipate, polypropyleneadipate,
5 polybutyleneadipate, polyhexamethyleneadipate, polyethyleneoxalate,
polypropyleneoxalate, polybutyleneoxalate, polyhexamethyleneoxalate,
polyethylenesebacate, polypropylenesebacate, polybutylenesebacate and polylactic
acid (PLA) as well as corresponding polyesters modified with polycarbonates or
MBS. The term "polylactic acid (PLA)" designates a homo-polymer of preferably
10 poly-L-lactide and any of its blends or alloys with other polymers; a co-polymer of
lactic acid or lactide with other monomers, such as hydroxy-carboxylic acids, like for
example glycolic acid, 3-hydroxy-butyric acid, 4-hydroxy-butyric acid, 4-hydroxy-
valeric acid, 5-hydroxy-valeric acid, 6-hydroxy-caproic acid and cyclic forms thereof;
the terms "lactic acid" or "lactide" include L-lactic acid, D-lactic acid, mixtures and
15 dimers thereof, i.e. L-lactide, D-lactide, meso-lactide and any mixtures thereof.

19. Polycarbonates and polyester carbonates.

20. Polyketones.

20

21. Polysulfones, polyether sulfones and polyether ketones.

22. Crosslinked polymers derived from aldehydes on the one hand and phenols,
ureas and melamines on the other hand, such as phenol/formaldehyde resins,
25 urea/formal-dehyde resins and melamine/formaldehyde resins.

23. Drying and non-drying alkyd resins.

24. Unsaturated polyester resins derived from copolyesters of saturated and
30 unsaturated dicarboxylic acids with polyhydric alcohols and vinyl compounds as
crosslinking agents, and also halogen-containing modifications thereof of low
flammability.

25. Crosslinkable acrylic resins derived from substituted acrylates, for example epoxy acrylates, urethane acrylates or polyester acrylates.
26. Alkyd resins, polyester resins and acrylate resins crosslinked with melamine
5 resins, urea resins, isocyanates, isocyanurates, polyisocyanates or epoxy resins.
27. Crosslinked epoxy resins derived from aliphatic, cycloaliphatic, heterocyclic or aromatic glycidyl compounds, e.g. products of diglycidyl ethers of bisphenol A and bisphenol F, which are crosslinked with customary hardeners such as anhydrides or
10 amines, with or without accelerators.
28. Natural polymers such as cellulose, rubber, gelatin and chemically modified homologous derivatives thereof, for example cellulose acetates, cellulose propionates and cellulose butyrates, or the cellulose ethers such as methyl cellulose;
15 as well as rosins and their derivatives.
29. 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,
20 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.
30. Naturally occurring and synthetic organic materials which are pure monomeric compounds or mixtures of such compounds, for example mineral oils, animal and
25 vegetable fats, oil and waxes, or oils, fats and waxes based on synthetic esters (e.g. phthalates, adipates, phosphates or trimellitates) and also mixtures of synthetic esters with mineral oils in any weight ratios, typically those used as spinning compositions, as well as aqueous emulsions of such materials.
- 30 31. Aqueous emulsions of natural or synthetic rubber, e.g. natural latex or latices of carboxylated styrene/butadiene copolymers.

At least a portion of the thermoplastic polymer may include recycled thermoplastic polymer, often referred to as recyclates.

Preferably the thermoplastic polymer is a polyolefin, more preferably a polyethylene or polypropylene, including any of the polyethylene or polypropylene polymers and copolymers described in sections 1-3 and 29 of the above list of thermoplastic polymers.

The method of producing the thermoplastic polymer composition, the stabiliser mixture is incorporated into the thermoplastic polymer before or during the processing of the thermoplastic polymer.

The incorporation or application of stabiliser mixture can be carried out in a processing apparatus, in particular a heatable container equipped with a stirrer, which can preferably be closed. A heatable container equipped with a stirrer is for example a kneader, extruder, mixer or stirred vessel. Specific examples thereof are a single-screw extruder, contrarotating and corotating twin-screw extruder, planetary-gear extruder, ring extruder or co-kneader. It is also possible to use a processing apparatus, which contains at least one gas removal compartment to which a vacuum can be applied and / or which can be set under an atmosphere, wherein the oxygen content is low or oxygen is absent, for example under a nitrogen atmosphere. The stabiliser mixture can be added directly into the processing apparatus.

The stabiliser mixture can be incorporated or applied to at any stage of processing of the thermoplastic polymer. This is in particular prior to or during a shaping operation of the thermoplastic polymer in the processing apparatus.

The stabiliser mixture can be incorporated or applied in the form of a dry powder, in the form of a melt, in encapsulated form such as encapsulation in a wax or an auxiliary polymer or in the form of a wet mixture such as a solution, a dispersion or a suspension for example in an inert solvent, water or oil. A dispersing or suspension agent can be present in the case of a wet mixture of the stabiliser mixture. A further

form for incorporation is a granule, for example obtained by compacting a powder of stabiliser mixture.

The stabiliser mixture can also be incorporated or applied by spraying onto the
5 thermoplastic polymer.

A further possibility for incorporation or application of the stabiliser mixture to the thermoplastic polymer is addition before, during or directly after the polymerization of the corresponding starting materials, e.g. monomers, of the thermoplastic polymer.

10 For example, spraying during the deactivation of the polymerization catalysts is particularly advantageous. If crosslinking takes place during formation of the thermoplastic polymer, incorporation or application prior to crosslinking is preferred.

The process of incorporation or application is preferably a molding process, in
15 particular an injection-molding, blow-molding, compression-molding, roto-molding, slush-molding or extrusion-molding.

Preferred is a process which comprises the steps of

- providing the thermoplastic polymer, and
20 - incorporating the stabiliser mixture into the thermoplastic polymer and wherein a part or the complete incorporation takes place at a temperature in the range from 135 to 350°C, preferably from 150°C to 340°C, in particular from 180°C to 330°C and very especially from 190°C to 320°C.

25 Preferred is a process, wherein the stabiliser mixture is incorporated or applied to in an extruder during processing of the thermoplastic polymer, which is a polymer.

In case of one or more further additives are employed, the stabiliser mixture and the further additives can be incorporated into or applied onto the thermoplastic polymer
30 individually or mixed with one another. If desired, the individual components can be mixed with one another before incorporation into the thermoplastic polymer for example by dry blending, compaction, melting, encapsulation by a wax or by an

auxiliary polymer or as wet mixture in the form of solutions, dispersions or suspensions for example in an inert solvent, water or oil.

In a preferred embodiment the stabiliser mixture is provided as a masterbatch. The stabiliser mixture and any one or more further additive can also be added to the thermoplastic polymer in the form of a masterbatch ('concentrate'), which contains the stabiliser mixture, one or more further additive and a masterbatch polymer as an auxiliary polymer. The stabiliser mixture and any further additive can be incorporated into the masterbatch in a concentration of, for example, from 1% to 40% and preferably 2% to 20% by weight of the masterbatch. The masterbatch polymer content is the difference towards 100% by weight of the masterbatch. The masterbatch polymer must not be necessarily the same polymer as the thermoplastic polymer.

The article, which is advantageously made from a composition comprising the thermoplastic polymer the stabiliser mixture, can be a shaped article. Examples for a shaped article are:

I-1) Floating devices, marine applications, pontoons, buoys, plastic lumber for decks, piers, boats, kayaks, oars, and beach reinforcements.

I-2) Automotive applications, in particular bumpers, dashboards, battery, rear and front linings, moldings parts under the hood, hat shelf, trunk linings, interior linings, air bag covers, electronic moldings for fittings (lights), panes for dashboards, headlamp glass, instrument panel, exterior linings, upholstery, automotive lights, head lights, parking lights, rear lights, stop lights, interior and exterior trims; door panels; gas tank; glazing front side; rear windows; seat backing, exterior panels, wire insulation, profile extrusion for sealing, cladding, pillar covers, chassis parts, exhaust systems, fuel filter / filler, fuel pumps, fuel tank, body side mouldings, convertible tops, exterior mirrors, exterior trim, fasteners / fixings, front end module, glass, hinges, lock systems, luggage / roof racks, pressed/stamped parts, seals, side impact protection, sound deadener / insulator and sunroof.

I-3) Road traffic devices, in particular sign postings, posts for road marking, car accessories, warning triangles, medical cases, helmets, tires.

I-4) Devices for plane, railway, motor car (car, motorbike, trucks) including
5 furnishings.

I-5) Devices for space applications, in particular rockets and satellites, e.g. reentry shields.

10 I-6) Devices for architecture and design, mining applications, acoustic quietized systems, street refuges, and shelters.

II-1) Appliances, cases and coverings in general and electric/electronic devices (personal computer, telephone, portable phone, printer, television-sets, audio and
15 video devices), flower pots, satellite TV bowl, and panel devices.

II-2) Jacketing for other materials such as steel or textiles.

II-3) Devices for the electronic industry, in particular insulation for plugs, especially
20 computer plugs, cases for electric and electronic parts, printed boards, and materials for electronic data storage such as chips, check cards or credit cards.

II-4) Electric appliances, in particular washing machines, tumblers, ovens (microwave oven), dish-washers, mixers, and irons.

25

II-5) Covers for lights (e.g. street-lights, lamp-shades).

II-6) Applications in wire and cable (semi-conductor, insulation and cable-jacketing).

30 II-7) Foils for condensers, refrigerators, heating devices, air conditioners, encapsulating of electronics, semi-conductors, coffee machines, and vacuum cleaners.

III-1) Technical articles such as cogwheel (gear), slide fittings, spacers, screws, bolts, handles, and knobs.

5 III-2) Rotor blades, ventilators and windmill vanes, solar devices, swimming pools, swimming pool covers, pool liners, pond liners, closets, wardrobes, dividing walls, slat walls, folding walls, roofs, shutters (e.g. roller shutters), fittings, connections between pipes, sleeves, and conveyor belts.

10 III-3) Sanitary articles, in particular shower cubicles, lavatory seats, covers, and sinks.

15 III-4) Hygienic articles, in particular diapers (babies, adult incontinence), feminine hygiene articles, shower curtains, brushes, mats, tubs, mobile toilets, tooth brushes, and bed pans.

III-5) Pipes (cross-linked or not) for water, waste water and chemicals, pipes for wire and cable protection, pipes for gas, oil and sewage, guttering, down pipes, and drainage systems.

20 III-6) Profiles of any geometry (window panes) and siding.

III-7) Glass substitutes, in particular extruded or co-extruded plates, glazing for buildings (monolithic, twin or multiwall), aircraft, schools, extruded sheets, window film for architectural glazing, train, transportation, sanitary articles, and greenhouse.

25

III-8) Plates (walls, cutting board), extrusion-coating (photographic paper, tetrapack and pipe coating), silos, wood substitute, plastic lumber, wood composites, walls, surfaces, furniture, decorative foil, floor coverings (interior and exterior applications), flooring, duck boards, and tiles.

30

III-9) Intake and outlet manifolds.

III-10) Cement-, concrete-, composite-applications and covers, siding and cladding, hand rails, banisters, kitchen work tops, roofing, roofing sheets, tiles, and tarpaulins.

- IV-1) Plates (walls and cutting board), trays, artificial grass, synthetic (such as AstroTurf (RTM)), artificial covering for stadium rings (athletics), artificial floor for stadium rings (athletics), and tapes.

- IV-2) Woven fabrics continuous and staple, fibers (carpets / hygienic articles / geotextiles / monofilaments; filters; wipes / curtains (shades) / medical applications), bulk fibers (applications such as gown / protection clothes), nets, ropes, cables, strings, cords, threads, safety seat-belts, clothes, underwear, gloves; boots; rubber boots, intimate apparel, garments, swimwear, sportswear, umbrellas (parasol, sunshade), parachutes, paraglides, sails, "balloon-silk", camping articles, tents, airbeds, sun beds, bulk bags, and bags. Non-woven fabrics such as medical fabrics and related apparel, industrial apparel, outdoor fabrics, in-home furnishing and construction fabrics.

- IV-3) Membranes, insulation, covers and seals for roofs, tunnels, dumps, ponds, dumps, walls roofing membranes, geomembranes, swimming pools, curtains (shades) / sun-shields, awnings, canopies, wallpaper, food packing and wrapping (flexible and solid), medical packaging (flexible & solid), airbags/safety belts, arm- and head rests, carpets, centre console, dashboard, cockpits, door, overhead console module, door trim, headliners, interior lighting, interior mirrors, parcel shelf, rear luggage cover, seats, steering column, steering wheel, textiles, and trunk trim.

V) Films (packaging, dump, laminating, agriculture and horticulture, greenhouse, mulch, tunnel, silage), bale wrap, swimming pools, waste bags, wallpaper, stretch film, raffia, desalination film, batteries, and connectors.

- VI-1) Food packing and wrapping (flexible and solid), bottles.

VI-2) Storage systems such as boxes (crates), luggage, chest, household boxes, pallets, shelves, tracks, screw boxes, packs, and cans.

- VI-3) Cartridges, syringes, medical applications, containers for any transportation, waste baskets and waste bins, waste bags, bins, dust bins, bin liners, wheely bins, container in general, tanks for water / used water / chemistry / gas / oil / gasoline / diesel; tank liners, boxes, crates, battery cases, troughs, medical devices such as piston, ophthalmic applications, diagnostic devices, and packing for pharmaceuticals blister.
- 5
- VII-1) Extrusion coating (photo paper, tetrapack, pipe coating), household articles of any kind (e.g. appliances, thermos bottle / clothes hanger), fastening systems such as plugs, wire and cable clamps, zippers, closures, locks, and snap-closures.
- 10
- VII-2) Support devices, articles for the leisure time such as sports and fitness devices, gymnastics mats, ski-boots, inline-skates, skis, big foot, athletic surfaces (e.g. tennis grounds); screw tops, tops and stoppers for bottles, and cans.
- 15
- VII-3) Furniture in general, foamed articles (cushions, impact absorbers), foams, sponges, dish clothes, mats, garden chairs, stadium seats, tables, couches, toys, building kits (boards / figures / balls), playhouses, slides, and play vehicles.
- 20
- VII-4) Materials for optical and magnetic data storage.
- VII-5) Kitchen ware (eating, drinking, cooking, storing).
- 25
- VII-6) Boxes for CD's, cassettes and video tapes; DVD electronic articles, office supplies of any kind (ball-point pens, stamps and ink-pads, mouse, shelves, tracks), bottles of any volume and content (drinks, detergents, cosmetics including perfumes), and adhesive tapes.
- 30
- VII-7) Footwear (shoes / shoe-soles), insoles, spats, adhesives, structural adhesives, food boxes (fruit, vegetables, meat, fish), synthetic paper, labels for bottles, couches, artificial joints (human), printing plates (flexographic), printed circuit boards, and display technologies.

VII-8) Devices of filled polymers (talc, chalk, china clay (kaolin), wollastonite, pigments, carbon black, TiO₂, mica, nanocomposites, dolomite, silicates, glass, asbestos).

5

Preferred is an article, which is a shaped article, which is a film, pipe, profile, bottle, tank, container or fiber. More preferred shaped articles include fabrics (fibre-based applications: continuous filaments, spunbond and meltblown fibres, including bio component fibres of any geometry (side-by-side, core-sheath, islands in the sea),

10 with nonwovens and wovens-made articles ranging from medical clothing, geotextiles, diapers, filters, roofing etc.), films (mainly BOPP-films); injection molded, blow molded, thermoformed extruded sheets, cables etc.. Particularly preferred shaped articles include those items which are either films or fibres.

15 Preferred is a shaped article, which is molded. In particular, the molding is effected by injection, blow, compression, roto-molding, slush-molding or extrusion.

The following examples illustrate further the invention without limiting it. Percentage values are percentage by weight if not stated differently.

20

Examples

Additives used in Examples

25 Unless otherwise indicated, all parts and percentages are by weight. Weight percent (wt%), if not otherwise indicated, is based on an entire composition free of any volatiles.

The primary and secondary antioxidant ingredients are:

30

<u>Compound 1:</u>	Amines, bis(hydrogenated palm-oil alkyl)hydroxy
<u>Compound 2:</u>	2(3H)-Benzofuranone, 3-[2-(acetyloxy)-5-(1,1,3,3-tetramethylbutyl)phenyl]-5-(1,1,3,3-tetramethylbutyl)-

- [Formula IV-S6]
- Compound 3: 2(3H)-Benzofuranone, 5,7-bis(1,1-dimethylethyl)-3-[3,5-dimethyl-4-[[2,4,8,10-tetrakis(1,1-dimethylethyl)-12-methyl-12H-dibenzo[d,g][1,3,2]dioxaphosphocin-6-yl]oxy]phenyl]
- 5 [Formula IV-S7]
- Compound 4: 2,5,7,8-tetramethyl-2-(4,8,12-trimethyltridecyl)-3,4-dihydrochromen-6-ol (DL-ALPHA-Tocopherol) [Formula VII-B]
- Compound 5: Mixture of 90 wt.% 5,7-di-tert-butyl-3-(3,4-dimethylphenyl)-3H-benzofuran-2-one corresponding to Formula (IV-S4) and 10
- 10 wt.% 5,7-di-tert-butyl-3-(2,3-dimethylphenyl)-3H-benzofuran-2-one corresponding to Formula (IV-S5)
- Compound 6: tris(2,4-di-tert-butylphenyl) phosphite
- Compound 7: pentaerythritol tetrakis [3-[3,5-di-tert-butyl-4-hydroxyphenyl] propionate
- 15
- Example 1

Production of compounds and multiple pass extrusion:

- 20 Polypropylene HB 12XF (Polymer 1) (nominal MFI 11, manufacturer Polychim (F)) was used with a base additives package comprising 0.084% of tris(2,4-di-tert-butylphenyl) phosphite + 0.028% of poly(4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol-, 1,4-butanedioic acid) + 0.15% of reaction product of 1,6-hexanediamine, N,N'-bis (2,2,6,6-tetramethyl-4-piperidine-yl),2,4,6-trichloro-1, 3,5-
- 25 triazine, + 0.03% of magnesium/aluminium-hydrotalcite.

- Formulations were prepared via a powder blending in a Mixaco Lab CM 12 high-speed mixer. Production of the compounds was done at 230 °C under nitrogen blanket with a Collin 25X42D twin-screw extruder. The compounds were furthermore
- 30 3 times extruded at 280 °C in a Göttfert ES 30 L/D 25 single screw extruder.

The Melt Flow Index (MFI) was determined at 230 °C with 2.16kg in a Göttfert MI Robo (Göttfert Werkstoff Prüfmaschinen GmbH (D)) in accordance with EN ISO

1133. An increase in the Melt Flow Index indicates reduction of the melt viscosity of the polymer, in the case of Polymer 1 it correlates to chains degradation, reduction of the molecular weight of the Polymer 1 the MFI measurements serve to indicate the efficiency of the additives to stabilize the polymer.

5

Table 1: Combinations of primary antioxidants – MFI properties after 3rd extrusion

Test No.	Primary antioxidants	MFI (g/10min)
Comparative Test 1	0.008% Compound 1	14.6
Comparative Test 2	0.008% Compound 2	12.9
Comparative Test 3	0.008% Compound 3	13.5
Inventive Test 1	0.004% Compound 1 + 0.004% Compound 2	13.0
Inventive Test 2	0.004% Compound 1 + 0.004% Compound 3	12.8
Comparative Test 4	0.008% Compound 4	12.5
Inventive Test 3	0.004% Compound 1 + 0.004% Compound 4	11.8
Inventive Test 4	0.004% Compound 2 + 0.004% Compound 4	11.5
Inventive Test 5	0.004% Compound 3 + 0.004% Compound 4	11.2

The results show that the inventive Tests 1 to 5 with inventive stabiliser mixtures containing at least two of components (i), (ii) and (iii) as primary antioxidants provide surprisingly better overall MFI control compared to the Comparative Examples with the corresponding compounds alone. Inventive Tests 2, 3, 4 and 5 all show improved MFI results over the corresponding MFI results for the respective single components used alone. Inventive Test 1 illustrates a marked improvement MFI result over the individual use of Compound 1 and a comparable MFI result over Compound 2 used alone.

Example 2

Production of extruded fiber yarn material:

Polymer 1 was used with a base additive package comprising 0.084% of tris(2,4-di-
tert-butylphenyl) phosphite + 0.028% of poly(4-hydroxy-2,2,6,6-tetramethyl-1-
5 piperidineethanol-, 1,4-butanedioic acid) + 0.15% of reaction product of 1,6-
hexanediamine, N,N'-bis (2,2,6,6-tetramethyl-4-piperidine-yl),2,4,6-trichloro-1, 3,5-
triazine + 0.03% of magnesium/aluminium-hydrotalcite.

Formulations were prepared via a powder blending in an MTI / M35 high-speed
10 mixer.

Production of the compounds was done at 230 °C under nitrogen blanket with a
Collin 25X42D twin-screw extruder. The compounds were used to spin fibers on a
Busschaert Spinboy II at 240 °C. The fiber yarn material for testing MFI was taken
15 before drawing and without applying spin finish.

The Melt Flow Index (MFI) was determined at 230 C with 2.16kg in a Göttfert MI
Robo (Göttfert Werkstoff Prüfmaschinen GmbH (D)) in accordance to EN ISO 1133.
An increase in the Melt Flow Index indicates reduction of the melt viscosity of the
20 polymer, in the case of Polymer 1 it correlates to chains degradation, reduction of the
molecular weight of the Polymer 1 the MFI measurements serve to indicate the
efficiency of the additives to stabilize the polymer.

Table 2: Combinations of primary antioxidants – stabiliser mixtures containing at
25 least two of components (i), (ii) and (iii) according to the present invention (– MFI
properties after fiber extrusion)

	Primary antioxidants	MFI (g/10min)
Comparative Test 5	0.008% Compound 1	19.3
Inventive Test 6	0.004% Compound 1 + 0.004% Compound 4	13.0
Inventive Test 7	0.004% Compound 1 + 0.002% Compound 3 +	13.8

	0.002% Compound 4 +	
Inventive Test 8	0.004% Compound 1+ 0.004% Compound 3	14.6

The results showed that the inventive Tests 6 to 8 with stabiliser mixture in the present invention comprising at least two of components (i), (ii) and (iii) primary antioxidants provide an unexpected increased MFI control compared to the

5 Comparative Test 5 with the single Compound 1.

Example 3

Production of compounds and multiple pass extrusion:

10 Polypropylene A10TB (Polymer 2) (nominal MFI 3, manufacturer Polychim (F)) was used with a base additive package comprising 0.04% of tris(2,4-di-tert-butylphenyl) phosphite + 0.03% of poly(4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol-, 1,4-butanedioic acid)+ 0.05% of Calcium Stearate.

15 Formulations were prepared via a powder blending in a high-speed mixer. Production of the compounds was done at 250 °C under nitrogen blanket as the first step with a single-screw extruder. The compounds were 4 times re-extruded at 250 °C as steps 2 to 5.

20 The Melt Flow Index (MFI) was determined at 230 C with 2.16kg in a Göttfert MI Robo (Göttfert Werkstoff Prüfmaschinen GmbH (D)) in accordance with EN ISO 1133.

25 An increase in the Melt Flow Index indicates reduction of the melt viscosity of the polymer, in the case of Polymer 2 it correlates to chains degradation, reduction of the molecular weight of the Polymer 2 the MFI measurements serve to indicate the efficiency of the additives to stabilize the polymer.

30 Table 3: Combinations of primary antioxidants– MFI properties after 5th extrusion

	Primary antioxidants Secondary antioxidant	MFI (g/10min) after 5th step
Comparative Test 6	0.02% Compound 6	18.1
Comparative Test 7	0.02% Compound 1	8.0
Inventive Test 9	0.01% Compound 1 + 0.01% Compound 5	6.4
Comparative Test 8	0.02% Compound 5	6.9

The results show that the inventive Test 9 with the stabiliser mixtures containing at least two of the components (i), (ii) and (iii) used according to the present invention as primary antioxidants provide surprisingly improved MFI control when compared to

5 Comparative Tests 7 and 8 with the single compounds alone and compared to Comparative Test 6 with only a secondary antioxidant.

Example 4

10 Production of compounds and multiple pass extrusion:

Polymer 1 was used with a base additive package comprising 0.084% of tris(2,4-di-tert-butylphenyl) phosphite + 0.028% of poly(4-hydroxy-2,2,6,6-tetramethyl-1-piperidineethanol-, 1,4-butanedioic acid) + 0.15% of reaction product of 1,6-

15 hexanediamine, N,N'-bis (2,2,6,6-tetramethyl-4-piperidine-yl),2,4,6-trichloro-1, 3,5-triazine, + 0.03% of magnesium/aluminium-hydrotalcite.

Formulations were prepared via a powder blending in a Mixaco Lab CM 12 high-speed mixer. Production of the compounds was done at 230 °C under nitrogen

20 blanket with a Collin 25X42D twin-screw extruder. The compounds were furthermore 3 times extruded at 280 °C in a Göttfert ES 30 L/D25 single screw extruder. 2mm plaques were compression molded at 230 °C with a compression molding time of 3min.

Measurement of color:

Measurement of color was done after compression molding and after exposure to NOx Gases for 24 hours with parameters set according to AATCC 164.

Color was determined with a Datacolor 800 from Datacolor AG Europe in

- 5
- Switzerland in accordance with DIN 6167. Yellowness Index (YI) (without unit) was measured for the initial color of the plaques and Delta E, measured in CIELAB units, taken as the square root of the squares of the differences in the L*, a* and b* CIELAB color coordinates at the time of recall minus time zero, as defined in ISO 11664-4, was providing information on the change in color during 24 hours of gas exposure in reference to the initial value.
- 10

Table 4: Combinations of primary antioxidants Yellowness Index [-] & deltaE [CIELAB units] over exposure according to NOx Gases for 24 hours with parameters set according to AATCC 164.

	Primary antioxidants	YI initial (measured)	Delta E after 24 hours of gas fading (measured)
Comparative Test 9	0.008% Compound 1	2.9	0.22
Comparative Test 10	0.008% Compound 2	6.7	0.88
Comparative Test 11	0.008% Compound 3	3.1	0.26
Comparative Test 12	0.008% Compound 4	4.2	0.34
Inventive Test 10	0.004% Compound 1 + 0.004% Compound 2	4.5	0.4

	Primary antioxidants	YI initial (measured)	Delta E after 24 hours of gas fading (measured)
Inventive Test 11	0.004% Compound 1 + 0.004% Compound 3	2.7	0.26
Inventive Test 12	0.004% Compound 1 + 0.004% Compound 4	3.2	0.12

The results demonstrate that the inventive Tests 10, 11 & 12 with the stabiliser mixtures containing at least two of the components (i), (ii) and (iii) used according to the present invention as primary antioxidants give better YI values than the YI values
5 that would have been expected by combining the respective components.

The results also show that the inventive Test 10, employing the combination of Compound 1 and Compound 2, and Test 12, employing the combination of Compound 1 and Compound 4, gave significantly better Delta E values after 24
10 hours of gas fading, when compared to what would have been expected from the respective combinations of these components.

Inventive Test 11, employing a combination of Compound 1 and Compound 3, gave a comparable Delta E value after 24 hours of gas fading compared to the
15 corresponding use of the Compound 1 and Compound 3 when used individually. The test work contained herein also demonstrates that the combination of Compound 1 and Compound 3 as a stabiliser mixture at the same dose as this test brings about an unexpectedly improved YI value and significantly improved MFI control value.
Thus, the combinations of Compounds 1 and 3 are shown to provide an overall
20 improved performance.

Example 5

Production of compounds and multiple pass extrusion:

- 5 Polypropylene HA 10XT (Polymer 3) (nominal MFI 3, manufacturer Polychim (F)) was used with a base additives package comprising 0.06% of tris(2,4-di-tert-butylphenyl) phosphite + 0.03% of CalciumStearate.

10 Formulations were prepared via a powder blending in a Mixaco Lab CM 12 high-speed mixer. Production of the compounds was done at 230 °C under nitrogen blanket with a Berstorff ZE25Ax47D twin-screw extruder. The compounds were furthermore 3 times extruded at 280 °C in a Collin E30 P 25D single screw extruder.

15 The Melt Flow Index (MFI) was determined at 230 °C with 2.16kg in a Göttfert MI Robo (Göttfert Werkstoff Prüfmaschinen GmbH (D)) in accordance with EN ISO 1133. An increase in the Melt Flow Index indicates reduction of the melt viscosity of the polymer, in the case of Polymer 3 it correlates to chains degradation, reduction of the molecular weight of the Polymer 3 the MFI measurements serve to indicate the efficiency of the additives to stabilize the polymer.

20

Table 5: Combinations of primary antioxidants – MFI properties after 3rd extrusion

Test No.	Primary antioxidants	MFI (g/10min)
Comparative Test 13	0.015% Compound 1	9.9
Comparative Test 14	0.015% Compound 5	8.9
Comparative Test 15	0.015% Compound 4	5.7
Comparative Test 16	0.015% Compound 7*	12.3
Inventive Test 13	0.0075% Compound 1 + 0.0075% Compound 5	6.9
Inventive Test 14	0.0075% Compound 1 + 0.0075% Compound 4	5.9
Inventive Test 15	0.0075% Compound 5 + 0.0075% Compound 4	5.1

*Compound 7 is a stabiliser compound which is typically used in thermoplastic polymer compositions with phenol.

The results show that the inventive Tests 13 to 15 with inventive stabiliser mixtures containing at least two of components (i), (ii) and (iii) as primary antioxidants provide surprisingly improved behavior in MFI control compared to the Comparative Examples with the corresponding compounds alone. Inventive Tests 13 and 15 show improved MFI results over the corresponding MFI results for the respective single components used alone. Inventive Test 14 illustrates a marked improvement MFI result over the individual use of Compound 1 and a comparable MFI result over Compound 4 used alone.

Example 6

15 Production of compounds and multiple pass extrusion:

Polyethylene MG 9641 (Polymer 4) (nominal MFI 8, manufacturer Borealis) was used with a base additives package comprising 0.05% of tris(2,4-di-tert-butylphenyl) phosphite + 0.03% of CalciumStearate.

20

Formulations were prepared via a powder blending in a Mixaco Lab CM 12 high-speed mixer. Production of the compounds was done at 220 °C under nitrogen blanket with a Berstorff ZE25Ax47D twin-screw extruder. The compounds were furthermore 3 times extruded at 260 °C in a Collin E30 P 25D single screw extruder.

25

The Melt Flow Index (MFI) was determined at 190 °C with 2.16kg in a Göttfert MI Robo (Göttfert Werkstoff Prüfmaschinen GmbH (D)) in accordance with EN ISO 1133. A decrease in the Melt Flow Index indicates increase of the melt viscosity of the polymer, in the case of Polymer 4 it correlates to a typical crosslinking, increase of the molecular weight of the Polymer 4. the MFI measurements serve to indicate the efficiency of the additives to stabilize the polymer. In this case it is important to prevent or reduce cross-linking of the polyethylene Polymer 4 and hence the

30

improvement in the avoidance of cross-linking will be indicated by an increase in the MFI value.

Table 6: Combinations of primary antioxidants – MFI properties after 3rd extrusion

Test No.	Primary antioxidants	MFI (g/10min)
Comparative Test 17	0.01% Compound 1	7.9
Comparative Test 18	0.01% Compound 4	8.4
Comparative Test 19	0.01% Compound 7*	7.1
Inventive Test 16	0.005% Compound 1 + 0.005% Compound 4	8.6

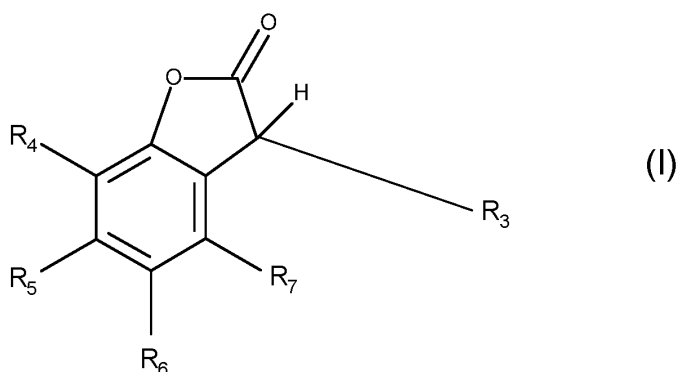
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The results show that the inventive Tests 16 with stabiliser mixtures containing components (i) and (iii) as primary antioxidants provide surprisingly improved behavior in MFI control compared to the Comparative Examples with the corresponding compounds alone.

10

Claims

1. A composition comprising
- a) a thermoplastic polymer, preferably a polyolefin; and
- 5 b) a stabiliser mixture comprising at least two of the components selected from (i), (ii) and (iii),
- wherein
- component (i) is a hydroxylamine or amine oxide;
- component (ii) is a benzofuran-2-one of formula (I); and
- 10 component (iii) is a chromanol,



- wherein,
- R₃ is a substituted carbocyclic or heterocyclic aromatic ring system,
- R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent
- 15 selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group, optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom; substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least one heteroatom; or hydrocarbylthio, optionally containing at least one further
- 20 heteroatom,

- wherein when the stabiliser mixture comprises components (i) and (ii) and/or (iii) it is present in the composition in an amount of below 500 ppm by the combined weight of components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the
- 25 weight of the thermoplastic polymer,

wherein when the stabiliser mixture comprises components (ii) and (iii) without (i) it is present in the composition in an amount of less than 300 ppm, desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by weight of components (ii) and (iii) based on the weight of the thermoplastic polymer.

2. The composition according to claim 1, wherein component (i) is a hydroxylamine having the formula (II):

10



wherein R₁ and R₂ are each independently selected from C₈ - C₃₀ alkyl groups, preferably C₁₂ - C₃₀ alkyl groups, more preferably C₁₆ - C₂₀ alkyl groups.

15

3. The composition according to claim 1, wherein component (i) is an amine oxide the formula (III):

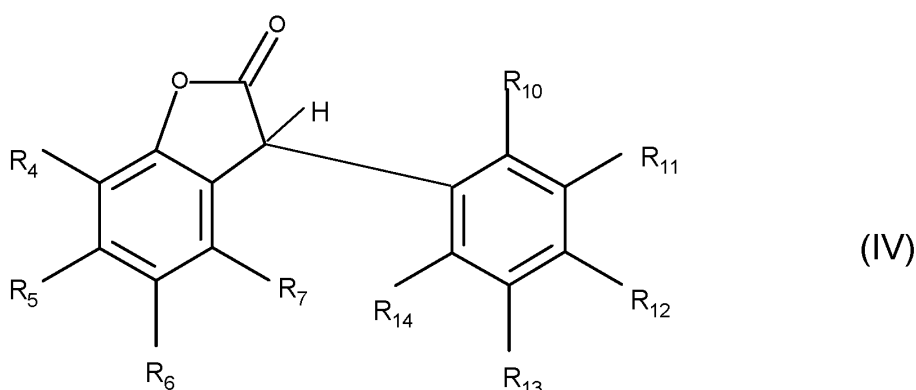


20 wherein R₈ and R₉ are each independently selected from C₈ - C₃₀ alkyl groups, preferably C₁₂ - C₃₀ alkyl groups, more preferably C₁₄ - C₂₄ alkyl groups.

4. The composition according to any preceding claim, wherein component (ii) is a benzofuran-2-one of formula (IV):

25

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wherein

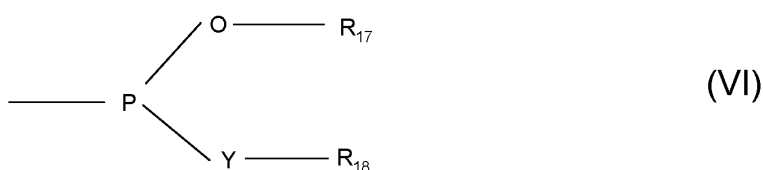
- R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent
 5 selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group, optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom; substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least one heteroatom; or hydrocarbylthio, optionally containing at least one further
 10 heteroatom, and preferably R₄, R₅, R₆ and R₇ are each independently of one another hydrogen, or C₁-C₈-alkyl;
 R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ are each independently of one another hydrogen, hydroxy, C₁-C₁₂-alkyl, -OR₁₅, -NR₃₄R₃₅ or a substituent carrying one or repeating alkylene oxide units, in which at least one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is not hydrogen and
 15 wherein no more than one of R₁₀, R₁₁, R₁₂, R₁₃ and R₁₄ is -OR₁₅ or -NR₃₄R₃₅, where R₁₅ is a group of formula (V) or a group of formula (V-A) or a group of formula (VI) or a group of formula (VI-A),
 R₃₄ is a group of formula (VI-A),
 R₃₅ is hydrogen or C₁-C₈ alkyl,

20





5



A comprises a C₂-C₂₀ alkylene group or a divalent oligomeric oxyalkylene radical,

Z comprises a C₂-C₂₀ alkyl or a divalent oligomeric ester radical,

10 G is an end group and is selected from the group consisting of hydrogen, C₁-C₁₀ alkyl, alkylcarbonyl and arylcarbonyl,

R₁₆ is a substituted or unsubstituted C₁-C₁₂ alkyl group; substituted or unsubstituted

C₄-C₈ cycloalkyl groups substituted or unsubstituted C₅-C₆ aryl group, preferably

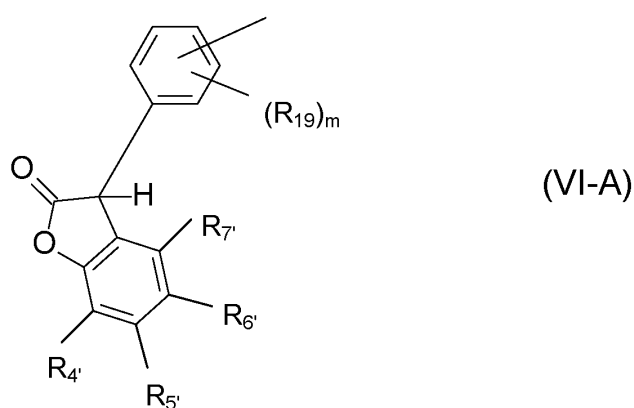
substituted or unsubstituted phenyl, preferably R₁₆ is C₁-C₁₂-alkyl or a substituted

15 phenyl group;

Y is oxygen or a covalent bond;

when Y is oxygen,

R₁₇ and R₁₈ are each independently a radical of formula (VI-A):



20

Each R₁₉ group or groups is/are independently of one another C₁-C₈-alkyl;

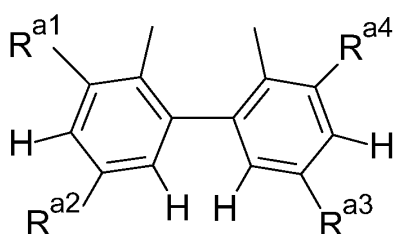
m is an integer from 0 to 4;

R₄, R₅, R₆ and R₇ each independently have the same meanings as R₄, R₅, R₆ and R₇; or

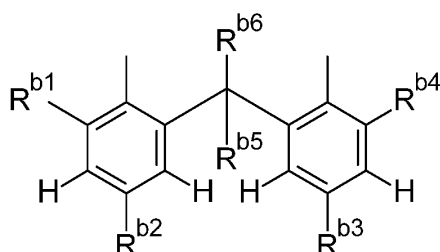
- 5 R₁₇ and R₁₈ are each independently of each other C₆-C₁₀-aryl, which is unsubstituted or substituted by C₁-C₈-alkyl, C₁-C₈-alkoxy, halogen or one phenyl; C₁-C₁₈ alkyl; C₃-C₁₆-cycloalkyl; C₇-C₁₃-aralkyl; C₂-C₁₈-alkenyl; C₂-C₃₀-alkyl, which is interrupted by one or more oxygen atoms; or C₂-C₁₆-alkyl, which is interrupted by one sulphur atom; or

R₁₇ together with R₁₈ form one of the structures of formulae (VI-B), (VI-C) or (VI-D):

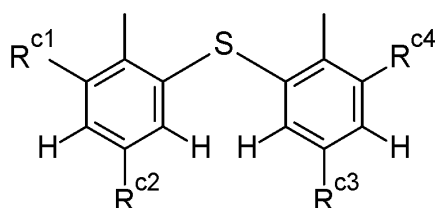
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(VI-B)



(VI-C)



(VI-D)

15

R^{a1}, R^{a2}, R^{a3} and R^{a4} are independently from each other hydrogen or C₁-C₈-alkyl,

R^{b1} , R^{b2} , R^{b3} , R^{b4} , R^{b5} and R^{b6} are independently from each other hydrogen or C₁-C₈-alkyl, and R^{c1} , R^{c2} , R^{c3} and R^{c4} are independently from each other hydrogen or C₁-C₈-alkyl,

5 when Y is a covalent bond,

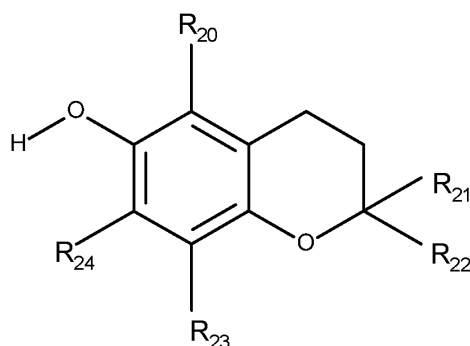
R_{17} is formula (VI-A), or

R_{17} is C₆-C₁₀-aryl, which is unsubstituted or substituted by C₁-C₈ alkyl, C₁-C₈ alkoxy, halogen or one phenyl; C₁-C₁₈-alkyl; C₃-C₁₆-cycloalkyl; C₇-C₁₃-aralkyl; C₂-C₁₈-alkenyl; C₂-C₃₀-alkyl, which is interrupted by one or more oxygen atoms; or C₂-C₁₆-alkyl,

10 which is interrupted by one sulphur atom,

R_{18} is C₆-C₁₀-aryl, which is unsubstituted or substituted by C₁-C₈-alkyl, C₁-C₈-alkoxy, halogen or one phenyl, or halogen.

5. The composition according to any preceding claim, wherein component (iii) is
15 a chromanol of formula (VII):



(VII)

wherein

R_{20} is selected from hydrogen, or an aliphatic radical having 1 to 6 carbon atoms;

20 R_{21} is an organic radical have been 1 to 30 carbon atoms; and

R_{22} , R_{23} , R_{24} are selected from, independently of one another, hydrogen or C₁-C₄ alkyl.

6. The composition according to any preceding claim in which the weight ratio of
25 (i) to (ii); (i) to (iii); or (ii) to (iii), in the stabiliser mixture, when the stabilisers mixture comprises only two of the three components (i), (ii) and (iii), is from 9:1 to 1:9,

preferably from 5:1 to 1:5, more preferably from 2:1 to 1:2; and the weight ratio of (i) to (ii) to (iii), in the stabilisers mixture, when the stabilisers mixture comprises all three of the components (i), (ii) and (iii), is from 9:0.5:0.5 to 4.5:4.5:1, preferably from 5:0.5:0.5 to 1:2.5:2.5, more preferably from 3:1:1 to 1:1:1

5

7. The composition according to any preceding claim, wherein the stabiliser mixture comprises components (i) and (ii) and/or (iii) and is present in the composition in an amount of less than 300 ppm, desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by the combined weight of components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the weight of the thermoplastic polymer.

8. The composition according to any preceding claim, wherein the stabiliser mixture further comprises a secondary antioxidant containing a phosphite.

15

9. The composition according to any preceding claim, wherein the stabilisers mixture further comprises at least one of the additives selected from the group consisting of light stabilisers, such as hindered amine light stabiliser (HALS), and acid scavengers.

20

10. The composition according to any preceding claim, wherein the composition is processed into a shaped article.

11. The composition according to any preceding claim, wherein the polyolefin is a polypropylene or a polyethylene.

25

12. A method of preparing the composition according to any of claims 1 to 11, comprising the step of processing the thermoplastic polymer, preferably polyolefin, in the presence of a stabiliser mixture, wherein the stabiliser mixture is incorporated into or applied onto the thermoplastic polymer before or during the processing of the thermoplastic polymer, wherein the stabiliser mixture comprises at least two of the components selected from (i), (ii) and (iii),

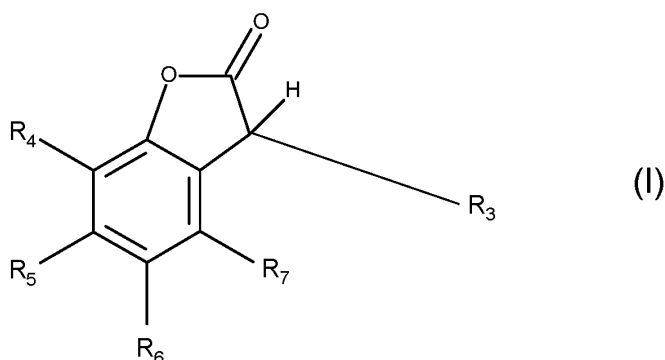
30

wherein

component (i) is a hydroxylamine or amine oxide;

component (ii) is a benzofuran-2-one of formula (I); and

component (iii) is a chromanol,



wherein,

R₃ is a substituted carbocyclic or heterocyclic aromatic ring system,

R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group,

optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom; substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least one heteroatom or hydrocarbylthio, optionally containing at least one further heteroatom,

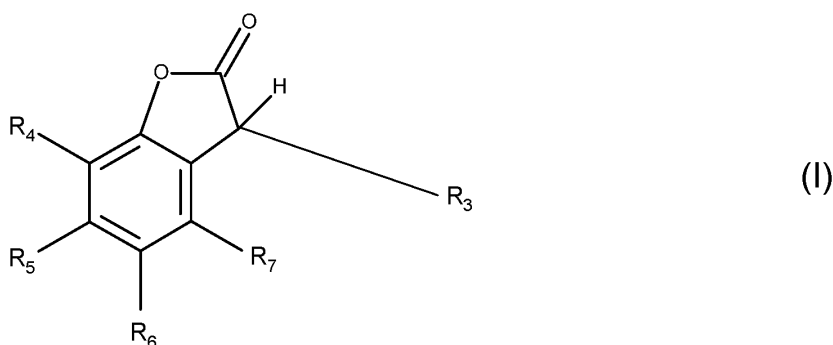
wherein when the stabiliser mixture comprises components (i) and (ii) and/or (iii) it is present in the composition in an amount of below 500 ppm by the combined weight of components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the weight of the thermoplastic polymer,

wherein when the stabiliser mixture comprises components (ii) and (iii) without (i) it is present in the composition in an amount of less than 300 ppm, desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by weight of components (ii) and (iii) based on the weight of the thermoplastic polymer.

13. The method according to claim 12 which includes any of the features defined in claims 2 to 11.

5 14. The method according to claim 12 or claim 13 in which the stabiliser mixture is provided as a masterbatch.

15. Use of a stabiliser mixture for improving the processability and/or reduced colour formation when processing a thermoplastic polymer, preferably a polyolefin,
 10 wherein
 the stabiliser mixture comprises at least two of the components selected from (i), (ii) and (iii),
 wherein
 component (i) is a hydroxylamine or amine oxide;
 15 component (ii) is a benzofuran-2-one of formula (I); and
 component (iii) is a chromanol,



wherein,

R₃ is a substituted carbocyclic or heterocyclic aromatic ring system,

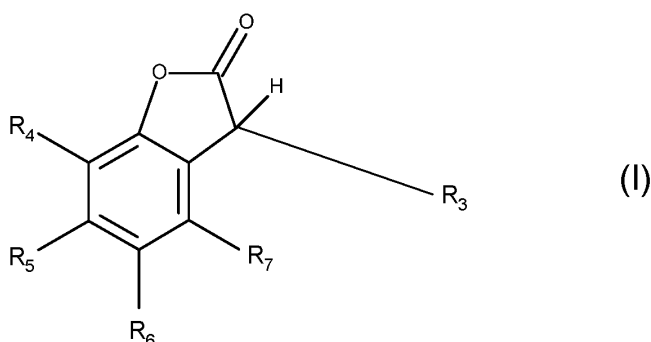
20 R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group, optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom; substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least
 25 one heteroatom; or hydrocarbylthio, optionally containing at least one further heteroatom,

wherein when the stabiliser mixture comprises components (i) and (ii) and/or (iii) it is present in the composition in an amount of below 500 ppm by the combined weight of components (i) and (ii) and/or (iii) present in the stabiliser mixture based on the weight of the thermoplastic polymer,

wherein when the stabiliser mixture comprises components (ii) and (iii) without (i) it is used in an amount of less than 300 ppm, desirably less than 250 ppm, preferably up to 200 ppm, more preferably up to 150 ppm, more preferably still up to 100 ppm, by weight of components (ii) and (iii) based on the weight of the thermoplastic polymer.

16. The use according to claim 15 which includes any of the features defined in claims 2 to 11 or claim 14.

17. A stabiliser mixture, for processing of thermoplastic polymers, preferably polyolefins, the composition comprising component (i) and component (iii) and optionally component (ii), wherein
 component (i) is a hydroxylamine or amine oxide;
 component (ii) is a benzofuran-2-one of formula (I); and
 component (iii) is a chromanol.



wherein,

R₃ is a substituted carbocyclic or heterocyclic aromatic ring system,

R₄, R₅, R₆ and R₇ are each independently of one another hydrogen or a substituent selected from chloro; hydroxy; a substituted or unsubstituted hydrocarbyl group,

- optionally containing at least one heteroatom; substituted or unsubstituted hydrocarbyloxy group, optionally containing at least one further heteroatom; substituted or unsubstituted cyclohydrocarbyl group, optionally containing at least one heteroatom; or hydrocarbylthio, optionally containing at least one further
- 5 heteroatom.