

Stabilisation of polyamide, polyester and polyacetal

The present invention relates to compositions comprising a polyamide, polyester or polyketone, to a specific phenolic antioxidant, to the use thereof for stabilising polyamides, polyesters or polyacetals against oxidative, thermal and/or light-induced degradation as well as to a process for stabilising these plastic materials.

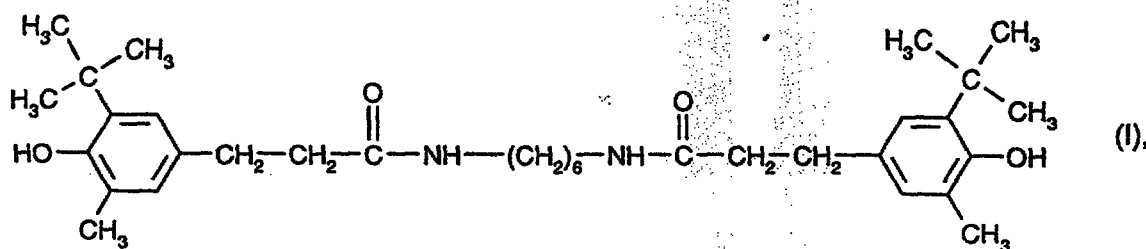
It is known from US patent specifications 3,691,131 and 3,860,558 that polyamides may be stabilised with phenolic antioxidants in the presence of metal hypophosphites, such as potassium hypophosphite or sodium hypophosphite, and of copper salts of organic acids.

In polyamides, polyesters or polyacetals, these known stabiliser mixtures cannot meet all the demands made on them. It is known that such stabiliser mixtures reduce the starting colour as well as the colour development of the polyamide during oven ageing and that they furthermore reduce the impairment of the mechanical properties of the polyamide to during oven ageing and exposure to light.

It has now been found that a specific phenolic antioxidant, which is selected from US patent specifications 3,691,131 and 3,860,558, is particularly suitable as stabiliser for polyamides, polyesters or polyacetals in the absence of metal hypophosphites and copper salts of organic acids. The polyamides, polyesters or polyacetals stabilised in this manner have improved properties with regard to oxidative, thermal or/und light-induced degradation.

Accordingly, this invention relates to compositions comprising

- a) a polyamide, polyester or polyacetal which is subject to oxidative, thermal or light-induced degradation, and
- b) the compound of formula I



with the proviso that, if component (a) is a polyamide, then the composition contains no metal hypophosphite and no copper salt of an organic acid.

Component (b) of the novel composition, or the compound of formula I, is known and bears the Chemical Abstracts registry number [37042-77-6]. The preparation of the compound of formula I is disclosed in GB-A-1 251 840, Example 1, page 5.

Polyamides will be understood to mean aliphatic and aromatic polyamides or copolyamides which are derived from diamines and dicarboxylic acids and/or from aminocarboxylic acids or their corresponding lactams. Suitable polyamides are for example: PA 6, PA 11, PA 12, PA 46, PA 6.6, PA 4.6, PA 6.9, PA 6.10 or PA 6.12, PA 10.12, PA 12.12 and also amorphous polyamides of the type Trogamid PA 6-3-T and Grilamid TR 55. Polyamides of the cited type are commonly known and are commercially available.

Interesting compositions are those wherein component (a) is polyamide 6, polyamide 6.6, polyamide 4.6, polyamide 11 or polyamide 12 or copolymers thereof, in particular polyamide 6 or polyamide 6.6 or elastomer-modified polyamide 6 or polyamide 6.6 blended with polypropylene.

The polyesters used may be homo- or copolyesters which are composed of aliphatic, cycloaliphatic or aromatic dicarboxylic acids and diols or hydroxycarboxylic acids.

The aliphatic dicarboxylic acids may contain 2 to 40 carbon atoms, the cycloaliphatic dicarboxylic acids 6 to 10 carbon atoms, the aromatic dicarboxylic acids 8 to 14 carbon atoms, the aliphatic hydroxycarboxylic acids 2 to 12 carbon atoms and the aromatic, e.g. cycloaliphatic, hydroxycarboxylic acids 7 to 14 carbon atoms.

The aliphatic diols may contain 2 to 12 carbon atoms, the cycloaliphatic diols 5 to 8 carbon atoms and the aromatic diols 6 to 16 carbon atoms.

Aromatic diols are those wherein two hydroxyl groups are bound to one or to different aromatic hydrocarbon radicals.



The polyesters may also be branched with small amounts, e.g. 0.1 to 3 mol%, based on the dicarboxylic acids present, of more than difunctional monomers (e.g. pentaerythritol, trimellitic acid, 1,3,5-tri(hydroxyphenyl)benzene, 2,4-dihydroxybenzoic acid or 2-(4-hydroxyphenyl)-2-(2,4-dihydroxyphenyl)propane).

Polyesters consisting of at least 2 monomers may be randomly distributed or they may be block copolymers.

Suitable dicarboxylic acids are linear and branched saturated aliphatic dicarboxylic acids, aromatic dicarboxylic acids and cycloaliphatic dicarboxylic acids.

Suitable aliphatic dicarboxylic acids are those containing 2 to 40 carbon atoms, for example oxalic acid, malonic acid, dimethylmalonic acid, succinic acid, pimelic acid, adipic acid, trimethyladipic acid, sebacic acid, azelaic acid and dimeric acids (dimerisation products of unsaturated aliphatic carboxylic acids such as oleic acid), alkylated malonic and succinic acids such as octadecylsuccinic acid.

Suitable cycloaliphatic dicarboxylic acids are: 1,3-cyclobutanedicarboxylic acid, 1,3-cyclopentanedicarboxylic acid, 1,3- and 1,4-cyclohexanedicarboxylic acid, 1,3- and 1,4-(dicarboxylmethyl)cyclohexane, 4,4'-dicyclohexyldicarboxylic acid.

Suitable aromatic dicarboxylic acids are: in particular terephthalic acid, isophthalic acid, o-phthalic acid, and also 1,3-, 1,4-, 2,6- or 2,7-naphthalenedicarboxylic acid, 4,4'-diphenyldicarboxylic acid, 4,4'-diphenylsulfonedicarboxylic acid, 4,4'-benzophenonedicarboxylic acid, 1,1,3-trimethyl-5-carboxyl-3-(p-carboxylphenyl)indane, 4,4'-diphenyl ether dicarboxylic acid, bis-p-(carboxylphenyl)methane or bis-p-(carboxylphenyl)ethane.

The aromatic dicarboxylic acids are preferred, and among those in particular terephthalic acid, isophthalic acid and 2,6-naphthalenedicarboxylic acid.

Other suitable dicarboxylic acids are those containing -CO-NH groups; they are described in DE-A-2 414 349. Dicarboxylic acids containing N-heterocyclic rings are also suitable, for example those which are derived from carboxylalkylated, carboxylphenylated or carboxybenzylated monoamine-s-triazinedicarboxylic acids (cf. DE-A-2 121 184 and 2 533 675), mono-

or bishydantoins, optionally halogenated benzimidazoles or parabanic acid. In this context, the carboxyalkyl groups may contain 3 to 20 carbon atoms.

Suitable aliphatic diols are the linear and branched aliphatic glycols, in particular those containing 2 to 12, preferably 2 to 6 carbon atoms in the molecule, for example: ethylene glycol, 1,2- and 1,3-propylene glycol, 1,2-, 1,3-, 2,3- or 1,4-butanediol, pentyl glycol, neopentyl glycol, 1,6-hexanediol, 1,12-dodecanediol. A suitable cycloaliphatic diol is e.g. 1,4-dihydroxycyclohexane. Other suitable aliphatic diols are, for example, 1,4-bis(hydroxymethyl)cyclohexane, aromatic-aliphatic diols such as p-xylylene glycol or 2,5-dichloro-p-xylylene glycol, 2,2-(β -hydroxyethoxyphenyl)propane and polyoxyalkylene glycols, such as ethylene glycol, triethylene glycol, polyethylene glycol or polypropylene glycol. The alkylenediols are preferably linear and preferably contain 2 to 4 carbon atoms.

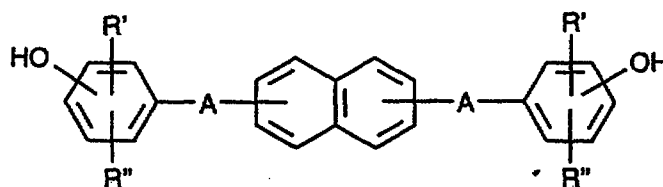
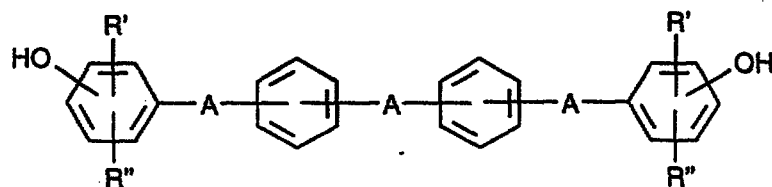
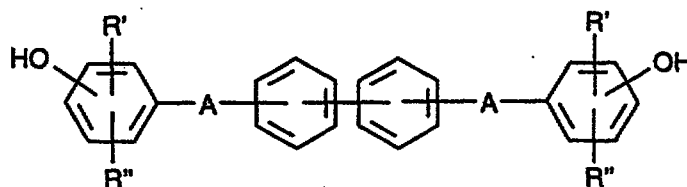
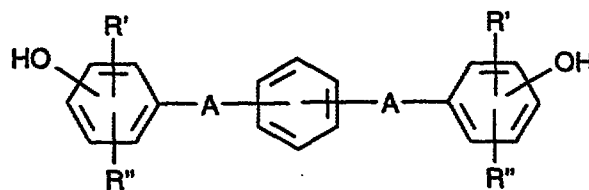
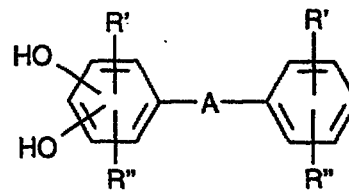
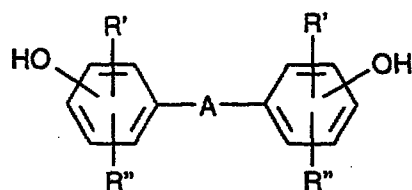
Preferred diols are the alkylenediols, 1,4-dihydroxycyclohexane and 1,4-bis(hydroxymethyl)cyclohexane. Ethylene glycol, 1,4-butanediol and 1,2- and 1,3-propylene glycol are particularly preferred.

Other suitable aliphatic diols are the β -hydroxyalkylated, in particular β -hydroxyethylated bisphenols, such as 2,2-bis[4'-(β -hydroxyethoxy)phenyl]propane. Other bisphenols are cited hereinafter.

Another group of suitable aliphatic diols is that of the heterocyclic diols described in DE-A-1 812 003, DE-A-2 342 432, DE-A-2 342 372 and DE-A-2 453 326. Examples are: N,N'-bis(β -hydroxyethyl)-5,5-dimethylhydantoin, N,N'-bis(β -hydroxypropyl)-5,5-dimethylhydantoin, methylene-bis-[N-(β -hydroxyethyl)-5-methyl-5-ethylhydantoin], methylene-bis-[N-(β -hydroxyethyl)-5,5-dimethylhydantoin], N,N'-bis(β -hydroxyethyl)benzimidazolone, N,N'-bis(β -hydroxyethyl)-(tetrachloro)benzimidazolone or N,N'-bis(β -hydroxyethyl)-(tetrabromo)benzimidazolone.

Suitable aromatic diols are mononuclear diphenols and, in particular, dinuclear diphenols carrying a hydroxyl group at each aromatic nucleus. The term aromatic is understood as referring preferably to hydrocarbon-aromatic radicals, for example phenylene or naphthylene. In addition to e.g. hydroquinone, resorcinol or 1,5-, 2,6- and 2,7-dihydroxynaphthalene, men-

tion is to be made in particular of the bisphenols which may be represented by the following formulae:



The hydroxyl groups may be in m-position and, in particular, in p-position. R' and R'' in these formulae may mean alkyl containing 1 to 6 carbon atoms, halogen, such as chloro or bromo and, preferably, hydrogen atoms. A may be a direct bond, or oxygen, sulfur, -SO-, -SO₂-,

>C=O , $-\text{P}(\text{O})(\text{C}_1\text{-C}_{20}\text{alkyl})-$, unsubstituted or substituted alkylidene, cycloalkylidene or alkylene.

Examples of unsubstituted or substituted alkylidene are: ethylidene, 1,1- or 2,2-propylidene, 2,2-butylidene, 1,1-isobutylidene, pentylidene, hexylidene, heptylidene, octylidene, dichloroethylidene, trichloroethylidene.

Examples of unsubstituted or substituted alkylene are methylene, ethylene, phenylmethylene, diphenylmethylene, methylphenylmethylene. Examples of cycloalkylidene are cyclopentylidene, cyclohexylidene, cycloheptylidene and cyclooctylidene.

Examples of bisphenols are: bis(p-hydroxyphenyl) ether or bis(p-hydroxyphenyl) thioether, bis(p-hydroxyphenyl)sulfone, bis(p-hydroxyphenyl)methane, bis(4-hydroxyphenyl)-2,2'-biphenyl, phenylhydroquinone, 1,2-bis(p-hydroxyphenyl)ethane, 1-phenyl-bis(p-hydroxyphenyl)methane, diphenyl-bis(p-hydroxyphenyl)methane, diphenyl-bis(p-hydroxyphenyl)ethane, bis(3,5-dimethyl-4-hydroxyphenyl)sulfone, bis(3,5-dimethyl-4-hydroxyphenyl)-p-diisopropylbenzene, bis(3,5-dimethyl-4-hydroxyphenyl)-m-diisopropylbenzene, 2,2-bis(3',5'-dimethyl-4'-hydroxyphenyl)propane, 1,1- or 2,2-bis(p-hydroxyphenyl)butane, 2,2-bis(p-hydroxyphenyl)-hexafluoropropane, 1,1-dichloro- or 1,1,1-trichloro-2,2-bis(p-hydroxyphenyl)ethane, 1,1-bis(p-hydroxyphenyl)cyclopentane and, in particular, 2,2-bis(p-hydroxyphenyl)propane (bisphenol A) and 1,1-bis(p-hydroxyphenyl)cyclohexane (bisphenol C).

Suitable polyesters of hydroxycarboxylic acids are, for example, polycaprolactone, polypivalolactone or the polyesters of 4-hydroxycyclohexanecarboxylic acid or 4-hydroxybenzoic acid.

Also suitable are polymers which may predominantly contain ester bonds but also other bonds, for example polyester amides or polyester imides.

Polyester containing aromatic dicarboxylic acids have become most important, in particular the polyalkylene terephthalates. Accordingly, those inventive moulding compositions are preferred in which the polyester is composed of at least 30 mol%, preferably of at least 40 mol%, of aromatic dicarboxylic acids and of at least 30 mol%, preferably of at least

40 mol%, of alkylenediols containing preferably 2 to 12 carbon atoms, based on the polyester.

In this case the alkylenediol is preferably linear and contains 2 to 6 carbon atoms, such as ethylene-, tri-, tetra- or hexamethylene glycol, and aromatic dicarboxylic acid denotes terephthalic and/or isophthalic acid.

Particularly suitable polyesters are PET, PETG (glycol-modified polyethylene terephthalate) or PBT (polybutylene terephthalate) and corresponding copolymers, PET and its copolymers being especially preferred.

Polyacetals are, for example, homopolymers or copolymers of paraformaldehyde, such as in particular polyoxymethylene (POM), and those polyoxymethylenes which contain comonomers, such as ethylene oxide, and polyacetals which are modified by thermoplastic polyurethanes, acrylates or MBS.

Useful compositions are those, as described above, wherein component (b) is present in an amount of 0.01 to 1 %, preferably of 0.02 to 0.8 %, for example of 0.03 to 0.6 %, based on the weight of component (a).

Besides the components (a) and (b), the novel compositions can contain additional additives or costabilisers, such as the following:

1. Antioxidants

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

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

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

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

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

1.6. Alkylidenebisphenols, for example 2,2'-methylenebis(6-tert-butyl-4-methylphenol), 2,2'-methylenebis(6-tert-butyl-4-ethylphenol), 2,2'-methylenebis[4-methyl-6-(α -methylcyclohexyl)phenol], 2,2'-methylenebis(4-methyl-6-cyclohexylphenol), 2,2'-methylenebis(6-nonyl-4-methylphenol), 2,2'-methylenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(4,6-di-tert-butylphenol), 2,2'-ethylidenebis(6-tert-butyl-4-isobutylphenol), 2,2'-methylenebis[6-(α -methylbenzyl)-4-nonylphenol], 2,2'-methylenebis[6-(α,α -dimethylbenzyl)-4-nonylphenol], 4,4'-methylenebis(2,6-di-tert-butylphenol), 4,4'-methylenebis(6-tert-butyl-2-methylphenol), 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 2,6-bis(3-tert-butyl-5-methyl-2-hydroxybenzyl)-4-methylphenol, 1,1,3-tris(5-tert-butyl-4-hydroxy-2-methylphenyl)butane, 1,1-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-3-n-dodecylmercaptobutane, ethylene glycol bis[3,3-bis(3'-tert-butyl-4'-hydroxyphenyl)butyrate], bis(3-tert-butyl-4-hydroxy-5-methylphenyl)dicyclopentadiene, bis[2-(3'-tert-butyl-2'-hydroxy-5'-methylbenzyl)-6-tert-butyl-4-methylphenyl]terephthalate, 1,1-bis(3,5-dimethyl-2-hydroxyphenyl)butane, 2,2-bis(3,5-di-tert-butyl-4-hydroxyphenyl)propane, 2,2-bis(5-tert-butyl-4-hydroxy-2-methylphenyl)-4-n-dodecylmercaptobutane, 1,1,5,5-tetra-(5-tert-butyl-4-hydroxy-2-methylphenyl)pentane.

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

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

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

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

1.11. Benzylphosphonates, for example dimethyl-2,5-di-tert-butyl-4-hydroxybenzylphosphonate, diethyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl-3,5-di-tert-butyl-4-hydroxybenzylphosphonate, dioctadecyl-5-tert-butyl-4-hydroxy-3-methylbenzylphosphonate, the calcium salt of the monoethyl ester of 3,5-di-tert-butyl-4-hydroxybenzylphosphonic acid.

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

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

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

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

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

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

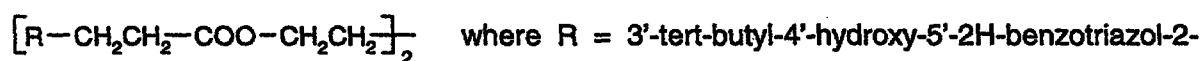
1.18. Ascorbic acid (vitamin C)

1.19. Aminic antioxidants, for example N,N'-di-isopropyl-p-phenylenediamine, N,N'-di-sec-butyl-p-phenylenediamine, N,N'-bis(1,4-dimethylpentyl)-p-phenylenediamine, N,N'-bis(1-ethyl-3-methylpentyl)-p-phenylenediamine, N,N'-bis(1-methylheptyl)-p-phenylenediamine, N,N'-dicyclohexyl-p-phenylenediamine, N,N'-diphenyl-p-phenylenediamine, N,N'-bis(2-naphthyl)-p-phenylenediamine, N-isopropyl-N'-phenyl-p-phenylenediamine, N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine, N-(1-methylheptyl)-N'-phenyl-p-phenylenediamine, N-cyclohexyl-N'-phenyl-p-phenylenediamine, 4-(p-toluenesulfamoyl)diphenylamine, N,N'-dimethyl-N,N'-di-sec-butyl-p-phenylenediamine, diphenylamine, N-allyldiphenylamine, 4-isopropoxydiphenylamine, N-phenyl-1-naphthylamine, N-(4-tert-octylphenyl)-1-naphthylamine, N-phenyl-2-naphthylamine, octylated diphenylamine, for example p,p'-di-tert-octyldiphenylamine, 4-n-butylaminophenol, 4-butyrylaminophenol, 4-nonanoylaminophenol, 4-dodecanoylaminophenol, 4-octadecanoylaminophenol, bis(4-methoxyphenyl)amine, 2,6-di-tert-butyl-4-dimethylaminomethylphenol, 2,4'-diaminodiphenylmethane, 4,4'-diaminodiphenylmethane, N,N,N',N'-tetramethyl-4,4'-diaminodiphenylmethane, 1,2-bis[(2-methylphenyl)amino]ethane, 1,2-bis(phenylamino)propane, (o-tolyl)biguanide, bis[4-(1',3'-dimethylbutyl)phenyl]amine, tert-octylated N-phenyl-1-naphthylamine, a mixture of mono- and dialkylated tert-butyl/tert-octyldiphenylamines, a mixture of mono- and dialkylated nonyldiphenylamines, a mixture of mono- and dialkylated dodecyldiphenylamines, a mixture of mono- and dialkylated isopropyl/isohexyldiphenylamines, a mixture of mono- und dialkylated tert-butyl/tert-octyldiphenylamines, 2,3-dihydro-3,3-dimethyl-4H-1,4-benzothiazine, phenothiazine, a mixture of mono- und dialkylated tert-butyl/tert-octylphenothiazines, a mixture of mono- und dialkylated tert-octyl-phenothiazines, N-allylphenothiazin, N,N,N',N'-tetraphenyl-1,4-diaminobut-2-ene, N,N-bis(2,2,6,6-tetramethylpiperid-4-yl)-hexamethylenediamine, bis(2,2,6,6-tetramethylpiperid-4-yl)sebacate, 2,2,6,6-tetramethylpiperidin-4-one, 2,2,6,6-tetramethylpiperidin-4-ol.

2. UV absorbers and light stabilisers

2.1. 2-(2'-Hydroxyphenyl)benzotriazoles, for example 2-(2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-5'-(1,1,3,3-tetramethylbutyl)phenyl)benzotriazole, 2-(3',5'-di-tert-butyl-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-methylphe-

nyl)-5-chloro-benzotriazole, 2-(3'-sec-butyl-5'-tert-butyl-2'-hydroxyphenyl)benzotriazole, 2-(2'-hydroxy-4'-octyloxyphenyl)benzotriazole, 2-(3',5'-di-tert-amyl-2'-hydroxyphenyl)benzotriazole, 2-(3',5'-bis(α,α -dimethylbenzyl)-2'-hydroxyphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)-5-chloro-benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-methoxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-octyloxycarbonylethyl)phenyl)benzotriazole, 2-(3'-tert-butyl-5'-[2-(2-ethylhexyloxy)carbonylethyl]-2'-hydroxyphenyl)benzotriazole, 2-(3'-dodecyl-2'-hydroxy-5'-methylphenyl)benzotriazole, 2-(3'-tert-butyl-2'-hydroxy-5'-(2-isooctyloxycarbonylethyl)phenyl)benzotriazole, 2,2'-methylene-bis[4-(1,1,3,3-tetramethylbutyl)-6-benzotriazole-2-ylphenol]; the transesterification product of 2-[3'-tert-butyl-5'-(2-methoxycarbonylethyl)-2'-hydroxyphenyl]-2H-benzotriazole with polyethylene glycol 300;



2-[2'-hydroxy-3'-(α,α -dimethylbenzyl)-5'-(1,1,3,3-tetramethylbutyl)phenyl]benzotriazole; 2-[2'-hydroxy-3'-(1,1,3,3-tetramethylbutyl)-5'-(α,α -dimethylbenzyl)phenyl]benzotriazole.

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

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

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

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

2.6. Sterically hindered amines, for example bis(2,2,6,6-tetramethyl-4-piperidyl)sebacate, bis(2,2,6,6-tetramethyl-4-piperidyl)succinate, bis(1,2,2,6,6-pentamethyl-4-piperidyl)sebacate, bis(1-octyloxy-2,2,6,6-tetramethyl-4-piperidyl)sebacate, bis(1,2,2,6,6-pentamethyl-4-piperidyl), n-butyl-3,5-di-tert-butyl-4-hydroxybenzylmalonate, the condensate of 1-(2-hydroxyethyl)-2,2,6,6-tetramethyl-4-hydroxypiperidine and succinic acid, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-tert-octylamino-2,6-dichloro-1,3,5-triazine, tris(2,2,6,6-tetramethyl-4-piperidyl)nitrilotriacetate, tetrakis(2,2,6,6-tetramethyl-4-piperidyl)-1,2,3,4-butane-tetracarboxylate, 1,1'-(1,2-ethanediyl)-bis(3,3,5,5-tetramethylpiperazinone), 4-benzoyl-2,2,6,6-tetramethylpiperidine, 4-stearyloxy-2,2,6,6-tetramethylpiperidine, bis(1,2,2,6,6-pentamethylpiperidyl)-2-n-butyl-2-(2-hydroxy-3,5-di-tert-butylbenzyl)malonate, 3-n-octyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decan-2,4-dione, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)sebacate, bis(1-octyloxy-2,2,6,6-tetramethylpiperidyl)succinate, linear or cyclic condensates of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-morpholino-2,6-dichloro-1,3,5-triazine, the condensate of 2-chloro-4,6-bis(4-n-butylamino-2,2,6,6-tetramethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, the condensate of 2-chloro-4,6-di-(4-n-butylamino-1,2,2,6,6-pentamethylpiperidyl)-1,3,5-triazine and 1,2-bis(3-aminopropylamino)ethane, 8-acetyl-3-dodecyl-7,7,9,9-tetramethyl-1,3,8-triazaspiro[4.5]decane-2,4-dione, 3-dodecyl-1-(2,2,6,6-tetramethyl-4-piperidyl)pyrrolidin-2,5-dione, 3-dodecyl-1-(1,2,2,6,6-pentamethyl-4-piperidyl)pyrrolidine-2,5-dione, a mixture of 4-hexadecyloxy- and 4-stearyloxy-2,2,6,6-tetramethylpiperidine, a condensation product of N,N'-bis(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine and 4-cyclohexylamino-2,6-dichloro-1,3,5-triazine, a condensation product of 1,2-bis(3-aminopropylamino)ethane and 2,4,6-trichloro-1,3,5-triazine as well as 4-butylamino-2,2,6,6-tetramethylpiperidine (CAS Reg. No. [136504-96-6]); N-(2,2,6,6-tetramethyl-4-piperidyl)-n-dodecylsuccinimid, N-(1,2,2,6,6-pentamethyl-4-piperidyl)-n-dodecylsuccinimid, 2-undecyl-7,7,9,9-tetramethyl-1-oxa-3,8-diaza-4-oxo-spiro[4.5]decane, a reaction product of 7,7,9,9-tetramethyl-2-

cycloundecyl-1-oxa-3,8-diaza-4-oxospiro [4,5]decane und epichlorohydrin, 1,1-bis(1,2,2,6,6-pentamethyl-4-piperidyloxycarbonyl)-2-(4-methoxyphenyl)ethene, N,N'-bis-formyl-N,N'-bis-(2,2,6,6-tetramethyl-4-piperidyl)hexamethylenediamine, diester of 4-methoxy-methylene-malonic acid with 1,2,2,6,6-pentamethyl-4-hydroxypiperidine, poly[methylpropyl-3-oxy-4-(2,2,6,6-tetramethyl-4-piperidyl)]siloxane, reaction product of maleic acid anhydride- α -olefin-copolymer with 2,2,6,6-tetramethyl-4-aminopiperidine or 1,2,2,6,6-pentamethyl-4-aminopiperidine.

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

2.8. 2-(2-Hydroxyphenyl)-1,3,5-triazines, for example 2,4,6-tris(2-hydroxy-4-octyloxyphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2,4-dihydroxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2,4-bis(2-hydroxy-4-propyloxyphenyl)-6-(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-octyloxyphenyl)-4,6-bis(4-methylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-dodecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-tridecyloxyphenyl)-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-butyloxy-propoxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-octyloxy-propyloxy)phenyl]-4,6-bis(2,4-dimethyl)-1,3,5-triazine, 2-[4-(dodecyloxy/tridecyloxy-2-hydroxypropoxy)-2-hydroxy-phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-[2-hydroxy-4-(2-hydroxy-3-dodecyloxy-propoxy)phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine, 2-(2-hydroxy-4-hexyloxy)phenyl-4,6-diphenyl-1,3,5-triazine, 2-(2-hydroxy-4-methoxyphenyl)-4,6-diphenyl-1,3,5-triazine, 2,4,6-tris[2-hydroxy-4-(3-butoxy-2-hydroxy-propoxy)phenyl]-1,3,5-triazine, 2-(2-hydroxyphenyl)-4-(4-methoxyphenyl)-6-phenyl-1,3,5-triazine, 2-[2-hydroxy-4-[3-(2-ethylhexyl-1-oxy)-2-hydroxypropyloxy]phenyl]-4,6-bis(2,4-dimethylphenyl)-1,3,5-triazine.

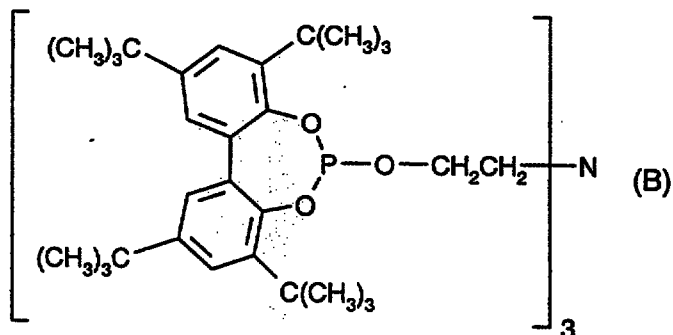
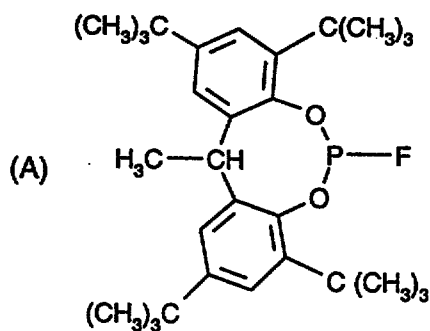
3. Metal deactivators, for example N,N'-diphenyloxamide, N-salicylal-N'-salicyloyl hydrazine, N,N'-bis(salicyloyl) hydrazine, N,N'-bis(3,5-di-tert-butyl-4-hydroxyphenylpropionyl) hydrazine, 3-salicyloylamino-1,2,4-triazole, bis(benzylidene)oxalyl dihydrazide, oxanilide, isophthaloyl

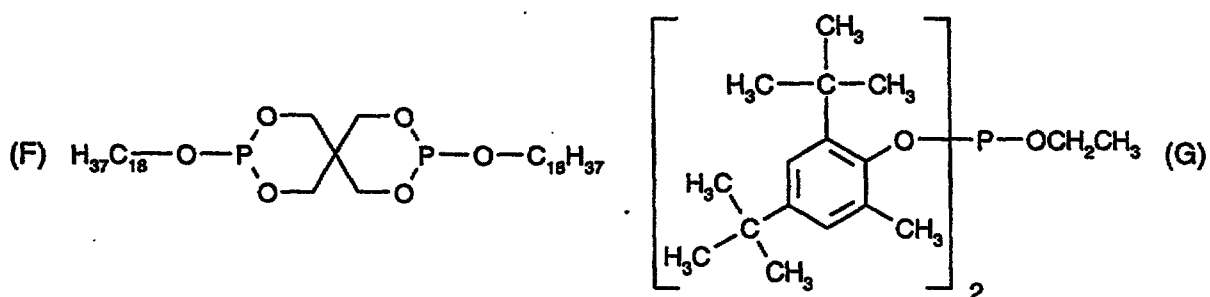
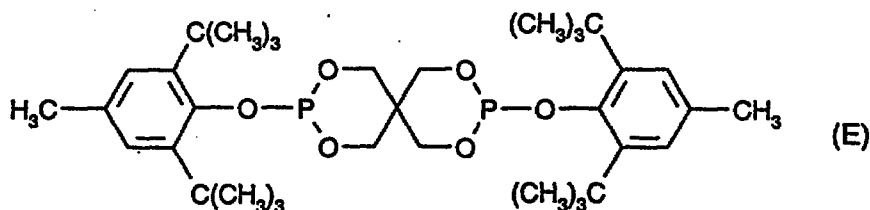
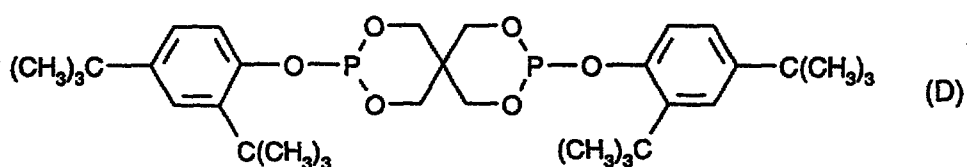
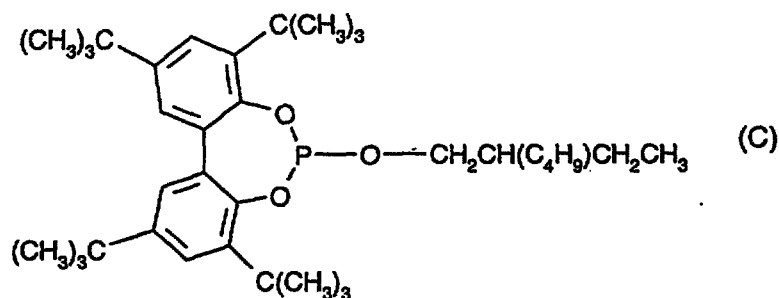
dihydrazide, sebacoyl bisphenylhydrazide, N,N'-diacetyladi-poyl dihydrazide, N,N'-bis(salicyloyl)oxalyl dihydrazide, N,N'-bis(salicyloyl)thiopropionyl dihydrazide.

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

Especially preferred are the following phosphites:

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





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

6. Nitrones, for example N-benzyl-alpha-phenyl-nitrone, N-ethyl-alpha-methyl-nitrone, N-octyl-alpha-heptyl-nitrone, N-lauryl-alpha-undecyl-nitrone, N-tetradecyl-alpha-tridcyl-nitrone, N-

hexadecyl-alpha-pentadecyl-nitrone, N-octadecyl-alpha-heptadecyl-nitrone, N-hexadecyl-alpha-heptadecyl-nitrone, N-octadecyl-alpha-pentadecyl-nitrone, N-heptadecyl-alpha-heptadecyl-nitrone, N-octadecyl-alpha-hexadecyl-nitrone, nitrone derived from N,N-dialkylhydroxylamine derived from hydrogenated tallow amine.

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

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

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

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

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

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

13. Benzofuranones and indolinones, for example those disclosed in U.S. 4,325,863; U.S. 4,338,244; U.S. 5,175,312; U.S. 5,216,052; U.S. 5,252,643; DE-A-4316611;

DE-A-4316622; DE-A-4316876; EP-A-0589839 or EP-A-0591102 or 3-[4-(2-acetoxyethoxy)-phenyl]-5,7-di-tert-butyl-benzofuran-2-one, 5,7-di-tert-butyl-3-[4-(2-stearoyloxyethoxy)phenyl]benzofuran-2-one, 3,3'-bis[5,7-di-tert-butyl-3-(4-[2-hydroxyethoxy]phenyl)benzofuran-2-one], 5,7-di-tert-butyl-3-(4-ethoxyphenyl)benzofuran-2-one, 3-(4-acetoxy-3,5-dimethylphenyl)-5,7-di-tert-butyl-benzofuran-2-one, 3-(3,5-dimethyl-4-pivaloyloxyphenyl)-5,7-di-tert-butyl-benzofuran-2-one, 3-(3,4-dimethylphenyl)-5,7-di-tert-butyl-benzofuran-2-one, 3-(2,3-dimethylphenyl)-5,7-di-tert-butyl-benzofuran-2-one.

The costabilisers, with the exception of the benzofuranones listed under item 13, are added in concentrations of, for example, 0.01 to 10 %, based on the total weight of the polyamide, polyester or polyacetal to be stabilised.

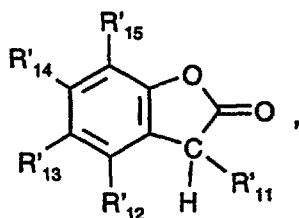
Other preferred compositions comprise further additives in addition to components (a) and (b), in particular phenolic antioxidants, light stabilisers or/and processing stabilisers.

Particularly preferred additives are phenolic antioxidants (item 1 of the list), sterically hindered amines (item 2.6 of the list), phosphites and phosphonites (item 4 of the list) and peroxide scavengers (item 8 of the list).

Particularly interesting compositions are those comprising in addition to components (a) and (b) as further additive at least one compound of the type of the organic phosphites or phosphonites (item 4 of the list).

Other preferred additional additives (stabilisers) are benzofuran-2-ones, such as those described, inter alia, in U.S. 4,325,863; U.S. 4,338,244; U.S. 5,175,312; U.S. 5,216,052; U.S. 5,252,643; DE-A-4 316 611, DE-A-4 316 622, DE-A-4 316 876, EP-A-0 589 839 or EP-A-0 591 102.

Examples of such benzofuran-2-ones are compounds of formula



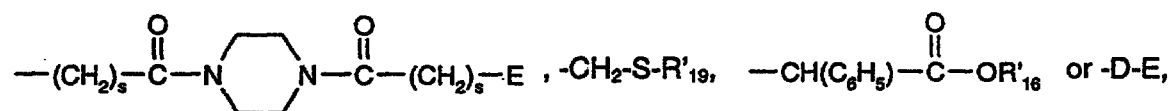
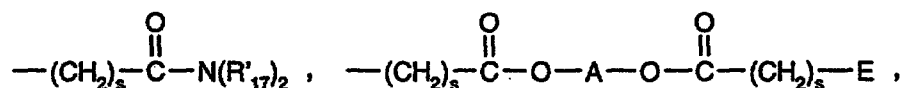
wherein

R'₁₁ is an unsubstituted or substituted carbocyclic or heterocyclic aromatic ring system;

R'₁₂ is hydrogen;

R'₁₄ is hydrogen, alkyl of 1 to 12 carbon atoms, cyclopentyl, cyclohexyl or chloro;

R'₁₃ has the meaning of R'₁₂ or R'₁₄ or is a radical of formula $-(CH_2)_s-\overset{\overset{O}{\parallel}}{C}-OR'_{16}$,

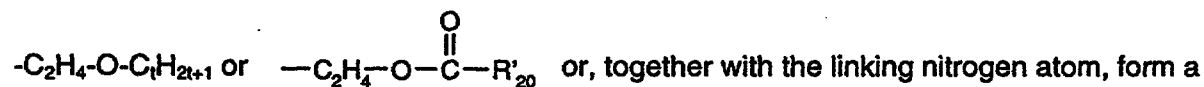


wherein

R'₁₆ is hydrogen, alkyl of 1 to 18 carbon atoms; alkyl of 2 to 18 carbon atoms which is interrupted by oxygen or sulfur, dialkylaminoalkyl containing a total of 3 to 16 carbon atoms, cyclopentyl, cyclohexyl, phenyl, or phenyl which is substituted by 1 to 3 alkyl radicals containing together no more than 18 carbon atoms;

s is 0, 1 or 2;

the substituents R'₁₇ are each independently of one another hydrogen, alkyl of 1 to 18 carbon atoms, cyclopentyl, cyclohexyl, phenyl, phenyl which is substituted by 1 or 2 alkyl radicals containing together no more than 16 carbon atoms, a radical of formula -C₂H₄OH,



piperidine radical or morpholine radical;

t is 1 to 18;

R'₂₀ is hydrogen, alkyl of 1 to 22 carbon atoms or cycloalkyl of 5 to 12 carbon atoms;

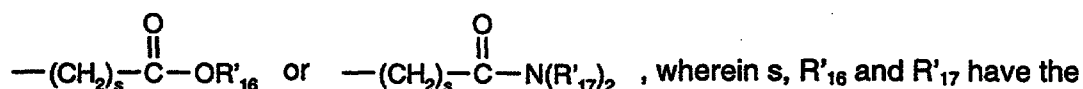
A is alkylene of 2 to 22 carbon atoms which may be interrupted by nitrogen, oxygen or sulfur;

R'₁₈ is hydrogen, alkyl of 1 to 18 carbon atoms, cyclopentyl, cyclohexyl, phenyl; phenyl or benzyl which is substituted by 1 or 2 alkyl radical containing together no more than 16 carbon atoms;

R'₁₉ is alkyl of 1 to 18 carbon atoms;

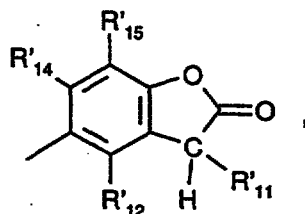
D is -O-, -S-, -SO-, -SO₂- or -C(R'₂₁)₂-;

the substituents R'₂₁ are each independently of the other hydrogen or C₁-C₁₆alkyl, the two R'₂₁ containing together 1 to 16 carbon atoms, R'₂₁ also being phenyl or a radical of formula



meanings cited above;

E is a radical of formula



wherein R'₁₁, R'₁₂ and R'₁₄ have the meanings cited above; and

R'₁₅ is hydrogen, alkyl of 1 to 20 carbon atoms, cyclopentyl, cyclohexyl, chloro or a radical of

formula $-\text{CH}_2-\overset{\overset{O}{\parallel}}{C}-OR'_{16}$ or $-\text{CH}_2-\overset{\overset{O}{\parallel}}{C}-N(R'_{17})_2$, wherein R'₁₆ and R'₁₇ have the meanings cited above, or R'₁₅, together with R'₁₄, is a tetramethylene radical.

Those benzofuran-2-ones are preferred, wherein R'₁₃ is hydrogen, alkyl of 1 to 12 carbon

atoms, cyclopentyl, cyclohexyl, chloro or a radical of formula $-(CH_2)_s-\overset{\overset{O}{\parallel}}{C}-OR'_{16}$,

$-(CH_2)_s-\overset{\overset{O}{\parallel}}{C}-N(R'_{17})_2$ or -D-E, wherein s, R'₁₆, R'₁₇, D and E have the meanings given

above, R'_{16} preferably being hydrogen, alkyl of 1 to 18 carbon atoms, cyclopentyl or cyclohexyl.

Other preferred benzofuran-2-ones are those, wherein R'_{11} is phenyl, or phenyl which is substituted by 1 or 2 alkyl radicals containing together no more than 12 carbon atoms; R'_{12} is hydrogen; R'_{14} is hydrogen or alkyl of 1 to 12 carbon atoms;

R'_{13} is hydrogen, alkyl of 1 to 12 carbon atoms, $-(CH_2)_s-\overset{\overset{O}{\parallel}}{C}-OR'_{16}$,

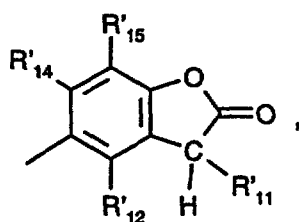
$-(CH_2)_s-\overset{\overset{O}{\parallel}}{C}-N(R'_{17})_2$ or -D-E; R'_{15} is hydrogen, alkyl of 1 to 20 carbon atoms,

$-\overset{\overset{O}{\parallel}}{C}-OR'_{16}$ or $-\overset{\overset{O}{\parallel}}{C}-N(R'_{17})_2$, or R'_{15} , together with R'_{14} , is a

tetramethylene radical, s, R'_{16} , R'_{17} , D and E having the meanings stated at the outset.

Particularly interesting benzofuran-2-ones are also those, wherein R'_{13} is hydrogen, alkyl of 1 to 12 carbon atoms or -D-E; R'_{12} and R'_{14} are each independently of the other hydrogen or alkyl of 1 to 4 carbon atoms; and R'_{15} is alkyl of 1 to 20 carbon atoms, D and E having the meanings stated at the outset.

Of special interest are, finally, also those benzofuran-2-ones, wherein R'_{13} is alkyl of 1 to 4 carbon atoms or -D-E; R'_{12} and R'_{14} are hydrogen; and R'_{15} is alkyl of 1 to 4 carbon atoms, cyclopentyl or cyclohexyl, D being a group $-C(R'_{21})_2-$ and E a radical of formula



the substituents R'_{21} are identical or different and are each alkyl of 1 to 4 carbon atoms, and R'_{11} , R'_{12} , R'_{14} and R'_{15} have the given meanings.

The amount of additionally added benzofuran-2-ones can vary within wide limits and they may be present in the compositions of this invention in amounts of, for example, 0.0001 to 5 % by weight, preferably of 0.001 to 2 % by weight, more preferably of 0.01 to 2 % by weight.

The incorporation of component (b) and optional further additives into component (a) [polyamide, polyester or polyacetal] is carried out by known methods, for example before or after moulding or also by applying the dissolved or dispersed component (b) to component (a), with or without subsequent evaporation of the solvent. Component (b) can also be added to the materials to be stabilised [component (a)] in the form of a masterbatch which contains these components in a concentration of, for example, 2.5 to 25 %.

Component (b) can also be added before or during polymerisation or before crosslinking.

Component (b) can be incorporated into the component (a) to be stabilised in pure form or encapsulated in waxes, oils, or polymers.

Component (b) can also be sprayed onto the component (a) to be stabilised. It is able to dilute other additives (e.g. the conventional additives indicated above) or their melts so that they can be sprayed also together with these additives onto the component (a) to be stabilised. Addition by spraying during the deactivation of the polymerisation catalysts is particularly advantageous, it being possible to carry out spraying using, for example, the steam used for deactivation.

The polyamides, polyesters or polyacetals thus stabilised can be used in a very wide range of forms, typically including films, fibres, filaments, moulded articles, profiles, or as binders for paint systems, in particular powder coating compositions, adhesives or putties.

Component (b) is particularly suitable for use as processing stabiliser (heat stabiliser). For this purpose, it is usefully added to component (a) before or during processing.

Accordingly, a preferred embodiment of this invention is the use of component (b) as stabiliser, in particular as processing stabiliser (heat stabiliser), for stabilising polyamides, polyesters or polyacetals against oxidative, thermal and/or light-induced degradation.



Component (b) is distinguished by its advantageous colour behaviour, i.e. little discoloration of the polyamides, polyesters and polyacetals, during processing.

Accordingly, this invention also relates to a process for stabilising a polyamide, polyester or polyacetal against oxidative, thermal and/or light-induced degradation, which process comprises incorporating in, or applying to, said material at least one component (b).

The following Examples illustrate the invention in greater detail. Parts and percentages are by weight.

Example 1: Stabilisation of polyamide 12.

100 parts of unstabilised polyamide 12 granules (Grilamid®L 20 G, of EMS, Switzerland) are powdered by cryogenic grinding and charged with the stabilisers listed in Table 1. This mixture is mixed in a Henschel mixer for 2 minutes at 70°C. The powder so obtained is then dried at 80°C for 6 hours and is then extruded in a twin-screw extruder (type Berstorff) at a maximum of 210°C and then granulated. The granules obtained are injection moulded in an injection moulding apparatus (type Engel) at a maximum of 220°C to dumbbells 1.0 mm thick and 67 mm long. The yellowness index (YI) of these dumbbells is determined in accordance with ASTM D 1925-70. Low YI values denote little discoloration, high YI values strong discoloration of the samples. The less discoloration, the more effective the stabiliser or the stabiliser mixture. The results are compiled in Table 1.



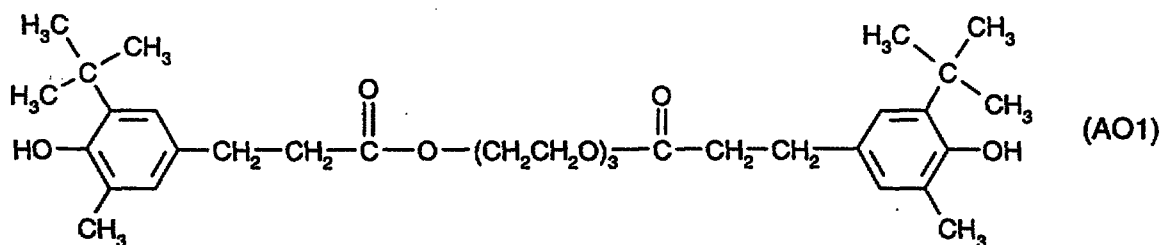
Table 1:

Example	Stabilisers	Yellowness index (dumbbells)
1a ^{a)}	—	6.7
1b ^{a)}	0.25 % Irganox®245 ^{c)}	8.9
1c ^{a)}	0.50 % Irganox®245 ^{c)}	9.6
1d ^{a)}	0.25 % Irganox®1098 ^{d)}	9.2
1e ^{a)}	0.50 % Irganox®1098 ^{d)}	10.7
1f ^{b)}	0.25 % component (b) ^{e)}	6.3
1g ^{b)}	0.50 % component (b) ^{e)}	6.4
1h ^{a)}	0.25 % Irganox®245 ^{c)} 0.25 % Irgafos®168 ^{f)}	6.8
1i ^{a)}	0.25 % Irganox®1098 ^{d)} 0.25 % Irgafos®168 ^{f)}	7.6
1j ^{b)}	0.25 % component (b) ^{e)} 0.25 % Irgafos®168 ^{f)}	5.7
1k ^{a)}	0.25 % Irganox®245 ^{c)} 0.25 % Irgafos®12 ^{g)}	5.3
1l ^{a)}	0.25 % Irganox®1098 ^{d)} 0.25 % Irgafos®12 ^{g)}	6.0
1m ^{b)}	0.25 % component (b) ^{e)} 0.25 % Irgafos®12 ^{g)}	3.4

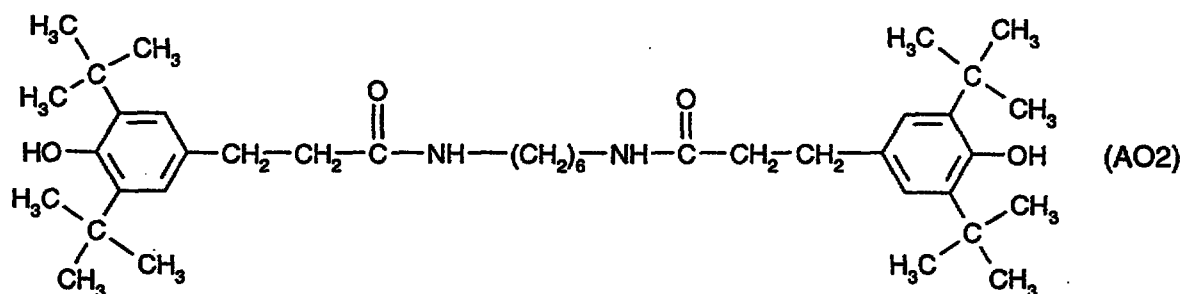
a) Comparison Example.

b) Example of this invention.

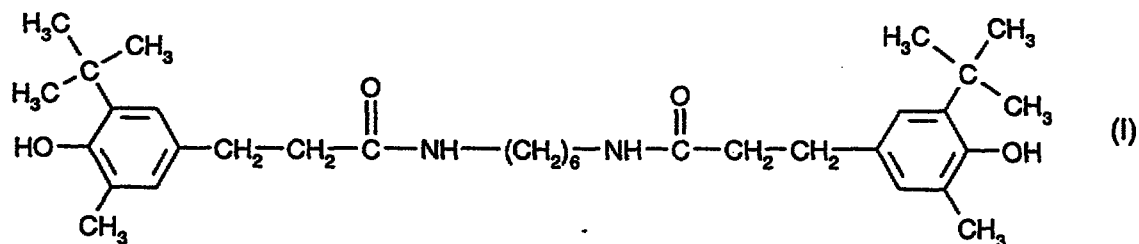
c) Irganox®245 (Ciba Spezialitätenchemie AG) denotes a compound of formula AO-1



d) Irganox[®]1098 (Ciba Spezialitätenchemie AG) denotes a compound of formula AO2

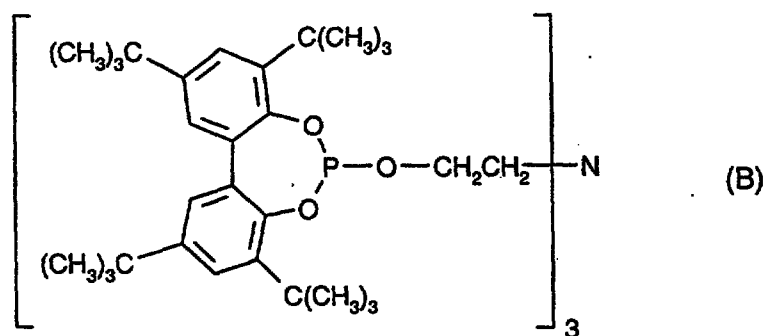


e) Component (b) denotes the compound of formula I



f) Irgafos[®]168 (Ciba Spezialitätenchemie AG) denotes tris(2,4-di-tert-butylphenyl)phosphite.

g) Irgafos[®]12 (Ciba Spezialitätenchemie AG) denotes 2,2',2''-nitrilo[triethyl-tris(3,3',5,5'-tetra-tert-butyl-1,1'-biphenyl-2,2'-diyl)phosphite]; Chemical Abstract registry number: 80410-33-9, and represents the compound of formula B.



Example 2: Stabilisation of polyamide 6.

100 parts of unstabilised polyamide 6 granules (Ultramid®B3S, of BASF) are powdered by cryogenic grinding and are charged with the stabilisers listed in Table 2. This mixture is then mixed in a Henschel mixer for 2 minutes at 70°C. The powder to obtained is then dried at 80°C for 6 hours and extruded in a twin-screw extruder (type Berstorff) at a maximum of 240°C and then granulated. The granules obtained are injection moulded in an injection moulding apparatus at a maximum of 240°C to little rods 4 x 6 mm thick and 50 mm long. These rods are aged in a circulating air oven at 150°C. The time it takes for the impact strength of the rods to fall to 80 KJ/m² is measured in hours. The longer the time, the better the stabilisation. The results are compiled in Table 2.

Table 2: Impact strength in oven ageing test at 150°C

Example	Stabiliser	Time in hours at 150°C until reaching an impact strength of 80 KJ/m ²
2a ^{a)}	—	2
2b ^{a)}	0.25 % Irganox®245 ^{c)}	28
2c ^{a)}	0.25 % Irganox®1098 ^{d)}	30
2d ^{b)}	0.25 % component (b) ^{e)}	38

See end of Table 1 for the explanation on footnotes a) to e).

Example 3: Stabilisation of polyoxymethylene copolymer (POM)

100 parts of unstabilised POM copolymer (Hostaform[®]C, Hoechst) are mixed with 0.3 % of calcium stearate and with the stabilisers listed in Tables 3, 4 and 5. The powder is then extruded at a maximum of 190°C. One part of these granules is injection moulded in an injection moulding apparatus at a maximum of 200°C to platelets 2 mm thick, 40 mm wide and 60 mm long. The other part of the granules is injection moulded in an injection moulding apparatus at a maximum of 200°C to little rods 4 x 6 mm thick and 50 mm long.

Thermogravimetical measurement is carried out isothermally on part of these platelets under a stream of air at 220°C. The time until the platelets lose 3 %, 6 % and 10 % of their weight is measured in minutes. The longer the time, the better the stabilisation. The results are compiled in Table 3.

Table 3: Thermogravimetical measurement at 220°C

Example	Stabiliser	Time in minutes until reaching a weight loss of		
		3 %	6 %	10 %
3a ^{a)}	0.30 % Irganox [®] 245 ^{c)}	53	70	88
3b ^{a)}	0.30 % Irganox [®] 1098 ^{d)}	78	103	127
3c ^{b)}	0.30 % component (b) ^{e)}	82	114	157

See end of Table 1 for the explanation on footnotes a) to e).

An oven ageing test is carried out on another part of the platelets at 140°C. The platelets are aged in a circulating air oven at 140°C, and the time until the platelets lose 2 % of their weight is measured in hours. The longer the time, the better the stabilisation. The results are compiled in Table 4.

Table 4: Weight loss in oven ageing test at 140°C

Example	Stabiliser	Time in hours until reaching a weight loss of 2 %
3d ^{a)}	0.30 % Irganox®245 ^{c)}	1300
3e ^{a)}	0.30 % Irganox®1098 ^{d)}	2150
3f ^{b)}	0.30 % component (b) ^{e)}	2700

See end of Table 1 for the explanation on footnotes a) to e).

The 4 x 6 mm thick and 50 mm long rods are also subjected to an oven ageing test in a circulating air oven at 140°C, measuring the time in hours until the impact strength of the rods has fallen from the original 110 KJ/m² to 90 KJ/m². The longer the time, the better the stabilisation. The results are compiled in Table 5.

Table 5: Impact strength in oven ageing test at 140°C

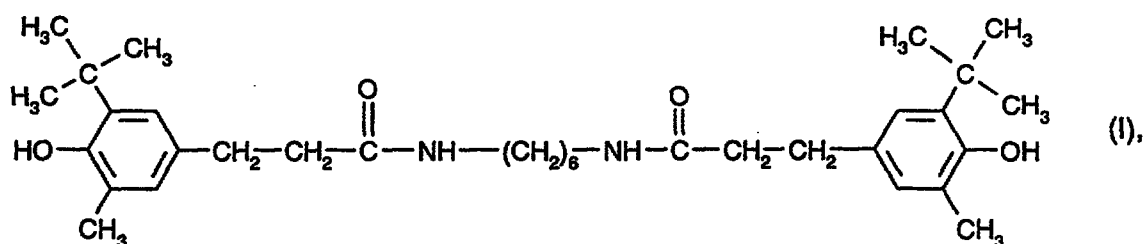
Example	Stabiliser	Time in hours at 140°C until reaching an impact strength of 90 KJ/m ²
2g ^{a)}	0.30 % Irganox®245 ^{c)}	770
2h ^{a)}	0.30 % Irganox®1098 ^{d)}	800
2i ^{b)}	0.30 % component (b) ^{e)}	1250

See end of Table 1 for the explanation on footnotes a) to e).



What is claimed is:

1. A composition, which comprises
 - a) a polyamide, polyester or polyacetal which is subject to oxidative, thermal or light-induced degradation, and
 - b) the compound of formula I



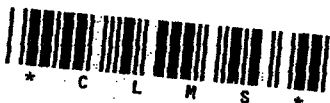
with the proviso that, if component (a) is a polyamide, then the composition contains no metal hypophosphite and no copper salt of an organic acid.

2. A composition according to claim 1, wherein the polyamide is polyamide 6, polyamide 6.6, polyamide 4.6, polyamide 11 or polyamide 12, or a copolymer thereof.
3. A composition according to claim 1, wherein the polyester is PET, PETG or PBT, or a copolymer thereof.
4. A composition according to claim 1, wherein the polyacetal is a homopolymer or a copolymer.
5. A composition according to claim 1, wherein component (b) is present in an amount of 0.01 to 1 %, based on the weight of component (a).
6. A composition according to claim 1, which additionally comprises further additives besides components (a) and (b).
7. A composition according to claim 6, wherein the further additives are phenolic antioxidants, light stabilisers or/and processing stabilisers.

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8. A composition according to claim 6, wherein the further additive is at least one compound of the type of the organic phosphite or phosphonite.
9. A composition according to claim 6, wherein the further additive is at least one compound of the type of the benzofuran-2-ones.
10. A process for stabilising a polyamide, polyester or polyacetal against oxidative, thermal and/or light-induced degradation, which comprises incorporating in, or applying to, said materials at least one component (b) according to claim 1.
11. Use of component (b) according to claim 1 as stabiliser for protecting polyamides, polyesters or polyacetals against oxidative, thermal and/or light-induced degradation.

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