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(54) **UNE COMPOSITION RETICULABLE DE POLYETHYLENE**
(54) **A POLYETHYLENE CROSSLINKABLE COMPOSITION**

(57) A composition comprising: (a) polyethylene; (b) as a scorch inhibitor, 1,1-diphenylethylene, substituted or unsubstituted; (c) optionally, a cure booster; and (d) an organic peroxide.

A POLYETHYLENE CROSSLINKABLE COMPOSITION

Abstract of the Disclosure

A composition comprising:

(a) polyethylene;

(b) as a scorch inhibitor, 1,1-diphenylethylene, substituted or unsubstituted;

(c) optionally, a cure booster; and

(d) an organic peroxide.

A POLYETHYLENE CROSSLINKABLE COMPOSITION

Technical Field

This invention relates to polyethylene compositions useful in the preparation of cable insulation, semiconducting shields, and jackets.

Background of the Invention

A typical electric power cable generally comprises one or more conductors in a cable core that is surrounded by several layers of polymeric materials including a first semiconducting shield layer (conductor or strand shield), an insulating layer, a second semiconducting shield layer (insulation shield), a metallic tape or wire shield, and a protective jacket. Additional layers within this construction such as moisture impervious materials are often incorporated. Other cable constructions such as plenum and riser cable omit the shield.

In many cases, crosslinking of the polymeric materials is essential to the particular cable application, and, in order to accomplish this, useful compositions generally include a polymer; a crosslinking agent, usually an organic peroxide; and antioxidants, and, optionally, various other additives such as a scorch inhibitor or retardant and a crosslinking booster. Crosslinking assists the polymer in meeting mechanical and physical requirements such as improved thermal aging and lower deformation under pressure.

The crosslinking of polymers with free radical initiators such as organic peroxides is well known. Generally, the organic peroxide is incorporated into the polymer by melt blending in a roll mill, a biaxial screw kneading extruder, or a Banbury™ or Brabender™ mixer at a temperature lower than the onset temperature for significant decomposition of the peroxide. Peroxides are judged for decomposition based on their half life temperatures as described in Plastic Additives Handbook, Gachter et al, 1985, pages 646 to 649. An alternative method for organic peroxide incorporation into a polymeric compound is to mix liquid peroxide and pellets of the polymer in a blending device, such as a Henschel™ mixer or a soaking device such as a simple drum tumbler, which are maintained at temperatures above the freeze point of the organic peroxide and below the decomposition temperature of the organic peroxide and the melt temperature of the polymer. Following the organic peroxide incorporation, the polymer/organic peroxide blend is then, for example, introduced into an extruder where it is extruded around an electrical conductor at a temperature lower than the decomposition temperature of the organic peroxide to form a cable. The cable is then exposed to higher temperatures at which the organic peroxide decomposes to provide free radicals, which lead to crosslinking of the polymer.

Polymers containing peroxides are vulnerable to scorch (premature crosslinking occurring during the extrusion process). Scorch causes the formation of discolored gel-like particles in the resin. Further, to achieve a high crosslink density, high levels of organic peroxide have been used. This leads to a problem known as sweat-out, which has a negative effect on the extrusion process and the cable product. Sweat-out dust may foul filters and can cause slippage and instability in the extrusion process. The cable product exposed to sweat-out may have surface irregularities such as lumps and pimples and voids may form in the insulation layer.

Industry is constantly seeking to find polyethylene crosslinkable compositions, which can be extruded at high temperatures (although limited by the decomposition temperature of the organic peroxide) and rates with a minimum of scorch and yet be crosslinked at a fast cure rate to a high crosslink density, all with essentially no sweat out., i.e., diffusion of the organic peroxide to the surface of the extrudate.

Disclosure of the Invention

An object of this invention, therefore, is to provide a polyethylene composition with an additive, which minimizes scorch and does not form crystals in the matrix which fail to melt blend on extrusion. Other objects and advantages will become apparent hereinafter.

According to the invention, such a composition has been discovered. The composition comprises:

(a) polyethylene;

(b) as a scorch inhibitor, 1,1-diphenylethylene, substituted or unsubstituted;

(c) optionally, a cure booster; and

(d) an organic peroxide.

Description of the Preferred Embodiment(s)

Polyethylene, as that term is used herein, is a homopolymer of ethylene or a copolymer of ethylene and a minor proportion of one or more alpha-olefins having 3 to 12 carbon atoms, and preferably 4 to 8 carbon atoms, and, optionally, a diene, or a mixture or blend of such homopolymers and copolymers. The mixture can be a mechanical blend or an in situ blend. Examples of the alpha-olefins are propylene, 1-butene, 1-hexene, 4-methyl-1-pentene, and 1-octene. The polyethylene can also be a copolymer of ethylene and an unsaturated ester such as a vinyl ester, e.g., vinyl acetate or an acrylic or methacrylic acid ester.

The polyethylene can be homogeneous or heterogeneous. The homogeneous polyethylenes usually have a polydispersity (Mw/Mn) in the range of about 1.5 to about 3.5 and an essentially uniform comonomer distribution, and are characterized by single and relatively low DSC melting points. The heterogeneous polyethylenes, on the other hand, have a polydispersity (Mw/Mn) greater than 3.5 and do not have a uniform comonomer distribution. Mw is defined as weight average molecular weight and Mn is defined as number average molecular weight. The polyethylenes can have a density in the range of 0.860 to 0.950 gram per cubic centimeter, and preferably have a density in the range of 0.870 to about 0.930 gram per cubic centimeter. They also can have a melt index in the range of about 0.1 to about 50 grams per 10 minutes.

The polyethylenes can be produced by low or high pressure processes. They are preferably produced in the gas phase, but they can also be produced in the liquid phase in solutions or slurries by conventional techniques. Low pressure processes are typically run at pressures below 1000 psi whereas high pressure processes are typically run at pressures above 15,000 psi.

Typical catalyst systems, which can be used to prepare these polyethylenes, are magnesium/titanium based catalyst systems, which can be exemplified by the catalyst system described in United States patent 4,302,565 (heterogeneous polyethylenes); vanadium based catalyst systems such as those described in United States patents 4,508,842 (heterogeneous polyethylenes) and 5,332,793; 5,342,907; and 5,410,003 (homogeneous polyethylenes); a chromium based catalyst system such as that described in United States patent 4,101,445; a metallocene catalyst system such as those described in United States patents 4,937,299, 5,272,236, 5,278,272, and 5,317,036 (homogeneous polyethylenes); or other transition metal catalyst systems. Many of these catalyst systems are often referred to as Ziegler-Natta catalyst systems or Phillips catalyst systems. Catalyst systems, which use chromium or molybdenum oxides on silica-alumina supports, can be included here. Typical processes for preparing the polyethylenes are also described in the aforementioned patents. Typical in situ polyethylene blends and processes and catalyst systems for providing same are described in United States Patents 5,371,145 and 5,405,901. The various polyethylenes can include low density homopolymers of ethylene made by high pressure processes (HP-LDPEs), linear low density polyethylenes (LLDPEs), very low density polyethylenes (VLDPEs), medium density polyethylenes (MDPEs), high density polyethylene (HDPE) having a density greater than 0.940 gram per cubic centimeter and metallocene copolymers with densities less than 0.900 gram per cubic centimeter. The latter five polyethylenes are generally made by low pressure processes. A conventional high pressure process is described in Introduction to Polymer Chemistry, Stille, Wiley and Sons, New York, 1962, pages 149 to 151. The high pressure processes are typically free radical initiated polymerizations conducted in a tubular reactor or a stirred autoclave. In the stirred autoclave, the pressure is in the range of about 10,000 to 30,000 psi and the temperature is in the range of about 175 to about 250 degrees C, and in the tubular reactor, the pressure is in the range of about 25,000 to about 45,000 psi and the temperature is in the range of about 200 to about 350 degrees C. Blends of high pressure polyethylene and metallocene resins are particularly suited for use in the application, the former component for its excellent processability and the latter for its flexibility.

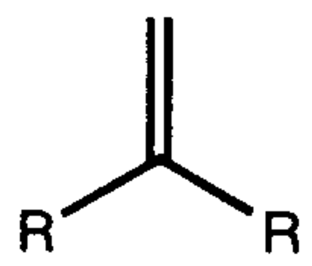
Copolymers comprised of ethylene and unsaturated esters are well known, and can be prepared by the conventional high pressure techniques described above. The unsaturated esters can be alkyl acrylates, alkyl methacrylates, and vinyl carboxylates. The alkyl group can have 1 to 8 carbon atoms and preferably has 1 to 4 carbon atoms. The carboxylate group can have 2 to 8 carbon atoms and preferably has 2 to 5 carbon atoms, The portion of the copolymer attributed to the ester comonomer can be in the range of about 5 to about 50 percent by weight based on the weight of the copolymer, and is preferably in the range of about 15 to about 40 percent by weight. Examples of the acrylates and methacrylates are ethyl acrylate, methyl acrylate, methyl methacrylate, t-butyl acrylate, n-butyl acrylate, n-butyl methacrylate, and 2-ethylhexyl acrylate. Examples of the vinyl carboxylates are vinyl acetate, vinyl propionate, and vinyl butanoate. The melt index of the ethylene/unsaturated ester copolymers can be in the range of about 0.5 to about 50 grams per 10 minutes, and is preferably in the range of about 2 to about 25 grams per 10 minutes. One process for the preparation of a copolymer of ethylene and an unsaturated ester is described in United States Patent 3,334,081.

The VLDPE can be a copolymer of ethylene and one or more alpha-olefins having 3 to 12 carbon atoms and preferably 3 to 8 carbon atoms. The density of the VLDPE can be in the range of 0.870 to 0.915 gram per cubic centimeter. It can be produced, for example, in the presence of (i) a catalyst containing chromium and titanium, (ii) a catalyst containing magnesium, titanium, a halogen, and an electron donor; or (iii) a catalyst containing vanadium, an electron donor, an alkyl aluminum halide modifier, and a halocarbon promoter. Catalysts and processes for making the VLDPE are described, respectively, in United States patents 4,101,445; 4,302,565; and 4,508,842. The melt index of the VLDPE can be in the range of about 0.1 to about 20 grams per 10 minutes and is preferably in the range of about 0.3 to about 5 grams per 10 minutes. The portion of the VLDPE attributed to the comonomer(s), other than ethylene, can be in the range of about 1 to about 49 percent by weight based on the weight of the copolymer and is preferably in the range of about 15 to about 40 percent by weight. A third comonomer can be included, e.g., another alpha-olefin or a diene such as ethylidene norbornene, butadiene, 1,4-hexadiene, or a dicyclopentadiene. Ethylene/propylene copolymers and ethylene/propylene/diene terpolymers are generally referred to as EPRs and the terpolymer is generally referred to as an EPDM. The third comonomer can be present in an amount of about 1 to 15 percent by weight based on the weight of the copolymer and is preferably present in an amount of about 1 to about 10 percent by weight. It is preferred that the copolymer contain two or three comonomers inclusive of ethylene.

The LLDPE can include the VLDPE and MDPE, which are also linear, but, generally, has a density in the range of 0.916 to 0.925 gram per cubic centimeter. It can be a copolymer of ethylene and one or more alpha-olefins having 3 to 12 carbon atoms, and preferably 3 to 8 carbon atoms. The melt index can be in the range of about 1 to about 20 grams per 10 minutes, and is preferably in the range of about 3 to about 8 grams per 10 minutes. The alpha-olefins can be the same as those mentioned above, and the catalysts and processes are also the same subject to variations necessary to obtain the desired densities and melt indices.

As noted, included in the definition of polyethylene are homopolymers of ethylene made by a conventional high pressure process. The homopolymer preferably has a density in the range of 0.910 to 0.930 gram per cubic centimeter. The homopolymer can also have a melt index in the range of about 0.5 to about 5 grams per 10 minutes, and preferably has a melt index in the range of about 0.75 to about 3 grams per 10 minutes. Melt index is determined under ASTM D-1238, Condition E. It is measured at 190 degrees C and 2160 grams.

The scorch inhibitor is 1,1-diphenylethylene, substituted or unsubstituted. 1,1,-diphenylethylenes have the following structure



wherein each R can be independently phenyl or substituted phenyl. In the case where there are no substituents on the R groups other than hydrogen, the structure is the unsubstituted 1,1-diphenylethylene. In the case of the substituted 1,1-diphenylethylene, the substituents can contain up to 20 carbon atoms, and can be alkyl, alkoxy, amino, alkyl amino, dialkyl amino, thio, thioalkyl, or hydroxyl. Each R group can contain up to five such substituents. The unsubstituted 1,1-diphenylethylene is preferred.

The optional cure (crosslinking) booster can be any one, or a mixture, of a broad selection of boosters. For example, it can be an ester, ether, or ketone containing at least 2 , and preferably 3, unsaturated groups such as a cyanurate, an isocyanurate, a phosphate, an ortho formate, an aliphatic or aromatic ether, or an allyl ester of benzene tricarboxylic acid. The number of carbon atoms in the ester, ether, or ketone can be in the range of 9 to 40 or more, and is preferably 9 to 20. Preferred esters, ethers, and ketones are essentially non-volatile at storage temperatures, and the unsaturated groups are preferably allyl groups. Specific examples are triallyl cyanurate (TAC); triallyl-1,3,5-triazine-2,4,6(1H,3H,5H)-trione also known as triallyl isocyanurate (TAIC); triallyl phosphate; triallyl ortho formate; tetra-allyloxy-ethane; triallyl benzene-1,3,5-tricarboxylate; diallyl pthalate; zinc dimethacrylate; ethoxylated bisphenol A dimethacrylate; methacrylate terminated monomer with average chain lenght of C_{14} or C_{15}; pentaerythritol tetraacrylate; dipentaerythritol pentaacrylate; pentaerythritol triacrylate; dimethylolpropane tetraacrylate; ethoxylated trimethylolpropane triacrylate; trimethylolpropane triacrylate; and 2,4,6-triallyl-1,3,5-trione. Also see United States patent 4,018,852.

A preferred booster is triallyl trimellitate (TATM). Other preferred cure boosters are 3,9-divinyl-2,4,8,10-tetra-oxaspiro[5.5]undecane (DVS); triallylcyanurate; and triallyl isocyanurate.

The organic peroxide preferably has a decomposition temperature of 100 to 220 degrees C for a 10 minute half-life and can be exemplified by the following compounds [the numbers set off by the parentheses are their decomposition temperatures (in degrees C)]: succinic acid peroxide (110), benzoyl peroxide (110), t-butyl peroxy-2-ethyl hexanoate (113), p-chlorobenzoyl peroxide (115), t-butyl peroxy isobutylate (115), t-butyl peroxy isopropyl carbonate (135), t-butyl peroxy laurate (140), 2,5-dimethyl-2,5-di(benzoyl peroxy)hexane (140), t-butyl peroxy acetate (140), di-t-butyl diperoxy phthalate (140), t-butyl peroxy maleic acid (140), cyclohexanone peroxide (145), t-butyl peroxy benzoate (145), dicumyl peroxide (150), 2,5-dimethyl-2,5-di(t-butyl-peroxy)hexane (155), t-butyl cumyl peroxide (155), t-butyl hydroperoxide (158), di-t-butyl peroxide (160), 2,5-dimethyl-2,5-di(t-butyl peroxy)hexane-3 (170), alpha, alpha'-bis-t-butylperoxy-1,4-diisopropylbenzene (160), and alpha, alpha'-bis-t-butylperoxy-1,3-diisopropylbenzene. Alpha, alpha'-bis-t-butylperoxy-1,4-diisopropylbenzene is preferred because of its high decomposition temperature although dicumyl peroxide is more commonly used. Alpha, alpha'-bis-t-butylperoxy-1,4-diisopropylbenzene, which is the para isomer, is often used in combination with the meta isomer.

The scorch inhibitor, the cure booster (if used), and the organic peroxide are, respectively, present in sufficient amounts to effectively inhibit scorch, boost the cure, and cure the resin.

Based on 100 parts by weight of polyethylene, the proportions of the compounds can be about as follows (in parts by weight):

Component	Broad Range	Preferred Range
(b) scorch inhibitor	0.03 to 1	0.05 to 0.5
(c) cure booster	0.1 to 1	0.25 to 0.75
(d) organic peroxide	0.4 to 3	0.6 to 2

It should be understood that these proportions can vary outside of the stated ranges depending on the desired properties. For example, to achieve a low dissipation factor in wire and cable applications, the amount of cure booster can be lowered and the amount of peroxide raised. Variations can also be considered for other properties such as heat aging characteristics and tensile properties. In the event it is desired to use a cure booster, the weight ratio of scorch inhibitor to cure booster can be in the range of about 0.03:1 to about 5:1, and is preferably in the range of about 0.07:1 to about 1.2:1.

The 1,1-diphenylethylene scorch inhibitor can be used together with other scorch inhibitors. Examples of such scorch inhibitors are as follows: 4,4'-thiobis(2-methyl-6-t-butylphenol); 2,2'-thiobis(6-t-butyl-4-methylphenol); 4,4'-thiobis(2-t-butyl-5-

methylphenol); 1,4 hydroquinone; a substituted hydroquinone, preferably substituted at the 2 position with a tertiary alkyl group or at the 2 and 5 positions with the same or different tertiary alkyl groups (examples of tertiary alkyl groups are tertiary butyl and tertiary amyl; the alkyl group can have 1 to 18 carbon atoms; 2,4-diphenyl-4-methyl-1-pentene; and conventional scorch inhibitors.

The composition of the invention can be processed in various types of extruders, e.g., single or twin screw types. A description of a conventional extruder can be found in United States patent 4,857,600. A typical extruder has a hopper at its upstream end and a die at its downstream end. The hopper feeds into a barrel, which contains a screw. At the downstream end, between the end of the screw and the die, is a screen pack and a breaker plate. The screw portion of the extruder is considered to be divided up into three sections, the feed section, the compression section, and the metering section, and two zones, the back heat zone and the front heat zone, the sections and zones running from upstream to downstream. In the alternative, there can be multiple heating zones (more than two) along the axis running from upstream to downstream. If it has more than one barrel, the barrels are connected in series. The length to diameter ratio of each barrel is in the range of about 15:1 to about 30:1. For the purposes of this specification, it will be understood that the term "extruder" includes, in addition to conventional extruders, the combination of an extruder, crosshead, die, and a heating or cooling zone where a further forming of the material can be accomplished. The heating or cooling follows the die and may be, for example, an oven. In wire coating, where the material is crosslinked after extrusion, the die of the crosshead feeds directly into a heating zone, and this zone can be maintained at a temperature in the range of about 130 to about 260 degrees C, and preferably in the range of about 170 to about 220 degrees C.

The extrudate is then crosslinked by exposing it to a temperature greater than the decomposition temperature of the organic peroxide. Preferably, the peroxide employed is decomposed through four or more half-lives. The crosslinking can be accomplished in, for example, an oven or a continuous vulcanizable (CV) tube. With steam CV equipment, a pressure rated vulcanizing tube is mechanically coupled to the extruder crosshead such that the polymer melt exits the crosshead/die assembly into a vulcanizing pipe running perpendicular to the extruder. In a typical CV operation, compositions incorporating peroxides are extrusion fabricated into insulation and cable jacketing at low melt extrusion temperatures to avoid premature crosslinking in the extruder. The fabricated melt shape exits the shaping die into the steam vulcanizing tube where post extrusion peroxide initiated crosslinking occurs. The steam tube is filled with saturated steam which continues to heat the polyolefin melt to the increased temperatures needed for crosslinking. Most of the CV tube is filled with saturated steam to maximize dwell time for crosslinking to occur. The final length before exiting the tube is filled with water to cool the now crosslinked insulation/jacketing. At the end of the CV tube, the insulated wire or cable passes through an end seal incorporating close fitting gaskets, which minimize the cooling water leakage. Steam regulators, water pumps, and valvings maintain equilibrium of the steam and water and the respective fill lengths within the steam CV tube. Alternatively, a hot nitrogen gas CV tube may be used to cure the cable construction.

Conventional additives can be added to the polymer either before or during processing. The amount of additive is usually in the range of about 0.01 to about 50 percent by weight based on the weight of the resin. Useful additives are antioxidants, ultraviolet absorbers, antistatic agents, pigments, carbon black, dyes, fillers, slip agents, fire retardants, plasticizers, processing aids, lubricants, stabilizers, smoke inhibitors, halogen scavengers, flow aids, lubricants, water tree inhibitors such as polyethylene glycol, and viscosity control agents.

In order to provide a semiconducting shield it is necessary to incorporate conductive particles into the composition. These conductive particles are generally provided by particulate carbon black. Useful carbon blacks can have a surface area of about 50 to about 1000 square meters per gram. The surface area is determined under ASTM D 4820-93a (Multipoint B.E.T. Nitrogen Adsorption). The carbon black is used in the semiconducting shield composition in an amount of about 20 to about 60 percent by weight based on the weight of the composition, and is preferably used in an amount of about 25 to about 45 percent by weight. Examples of conductive carbon blacks are the grades described by ASTM N550, N472, N351, and N110, and acetylene black.

Examples of antioxidants are: hindered phenols such as tetrakis[methylene(3,5-di-tert- butyl-4-hydroxyhydro-cinnamate)]methane, bis[(beta-(3,5-ditert-butyl-4-hydroxybenzyl)-methylcarboxyethyl)]sulphide, and thiodiethylene bis(3,5-di-tert-butyl-4-hydroxy hydrocinnamate); phosphites and phosphonites such as tris(2,4-di-tert-butylphenyl)phosphite and di-tert-butylphenyl-phosphonite; thio compounds such as dilaurylthiodipropionate, dimyristylthiodipropionate, and distearylthiodipropionate (DSTDP); various siloxanes; and various amines such as polymerized 2,2,4-trimethyl-1,2-dihydroquinoline, 4,4'-bis(alpha,alpha-dimethylbenzyl)diphenylamine, and alkylated diphenylamines. Antioxidants can be used in amounts of about 0.1 to about 5 percent by weight based on the weight of the composition. Generally, lower amounts can be used because the scorch inhibitors, which are in the composition of the invention, are excellent process and heat stabilizers.

Advantages of the invention are low scorch, higher allowable extrusion temperatures, high crosslink density, less molecular weight degradation of copolymer, and, under suitable circumstances, higher throughput of wire or cable through the continuous vulcanizing oven. A key advantage is the relatively good compatibility of the scorch inhibitor with the resin and its low melting point resulting in extrusion melt blending with no contaminating crystals in the product. It should be noted that 1,1-diphenylethylene requires a higher level of peroxide than alpha-methyl styrene dimer (AMSD), a commercial scorch inhibitor. This high level of peroxide could lead to greater sweatout. The combination of 1,1-diphenylethylene; peroxide; and cure boosters is recommended to resolve this problem.

At least three methods exist for quantifying the degree of crosslinking of the resin: (i) by "hot-set"(IEC 502/540). This is accomplished by attaching a weight to the crosslinked composition in plaque form at 200 degrees C. If the elongation is no greater than 100 percent, the crosslink density is sufficient for industrial purposes. (ii) by decalin extractables (ASTM D 2765). The uncrosslinked polymer dissolves in the hot decalin solvent and the value is reported in percent by weight decalin extractables. A value below 30 percent and preferably less than 20 percent is judged to be acceptable. (iii) by rheometer, which checks the viscosity. The rheometer test procedure is described in United States Patent 3,954,907. The first two methods are industry standards. The third method is a diagnostic tool particularly suitable for accurate screening and laboratory study.

The higher the extrusion temperature, the hotter the resin composition going into the CV tube to be crosslinked and, thus, the faster the cure rate, simply because the resin composition doesn't have to be heated up as much for the cure step. The maximum extrusion temperature relates to the decomposition temperature of the organic peroxide, i.e., the extrusion temperature cannot be as high as the temperature at which significant decomposition of the peroxide takes place. Thus, it is advantageous to be able to use an organic peroxide having a higher decomposition temperature if the other components of the composition of the invention will tolerate a higher extrusion temperature.

The term "surrounded" as it applies to a substrate being surrounded by an insulating composition, jacketing material, or other cable layer is considered to include extruding around the substrate; coating the substrate; or wrapping around the substrate as is well known by those skilled in the art. The substrate can include, for example, a core including a conductor or a bundle of conductors, or various underlying cable layers as noted above.

All molecular weights mentioned in this specification are weight average molecular weights unless otherwise designated.

The patents, patent application, and publication mentioned in this specification are incorporated by reference herein.

The invention is illustrated by the following examples.

Examples 1 and 2

1,1-Diphenylethylene (DPE) is added to a pelleted LDPE (a homopolymer of ethylene having a density of 0.92 gram per cubic centimeter and a melt index of 1.9 grams per 10 minutes prepared by a high pressure process) composition that has already been premixed with 0.15 to 0.2 part by weight of thiodiethylene bis(3,5-di-tert-butyl-4-hydroxy hydrocinnamate) and 0.15 to 0.2 part by weight of distearylthiodipropionate (DSTDP) by tumble coating the diphenylethylene onto 70 to 80 degree C pelleted resin, allowing the diphenylethylene to absorb into the pellets overnight at 70 to 80 degrees C. The organic peroxide is then added to the pelleted material following the same procedure. The data is in Table I. Parts by weight are based on 100 parts by weight of LDPE.

Table I

Examples		1	2
DPE		-----	0.3 part by weight
Dicumyl peroxide		1.6	1.65 part by weight
MDR at 182 degrees C:			
	TS1	1.22	1.39
	MH	3.12	3.35
MDR at 140 degrees C:			
	TS1	41.4	68.5

Examples 3 to 9

An advantage of the 1,1-diphenylethylene (DPE) over other scorch inhibitors is that its effectiveness does not appear to have a concentration limitation, i.e., as the DPE concentration is increased, the TS1 time keeps increasing while other scorch inhibitors tend to reach an asymptotic scorch retardance property. In these examples, this advantage is demonstrated over AMSD (alpha-methyl styrene dimer). AMSD is a scorch inhibitor described in United States patent 5,298,564. The concentration of the dicumyl peroxide is adjusted to maintain the torque difference between the minimum and maximum torque on the MDR at 5 pound-inches when operated with one degree rotation at 360 degrees F. The scorch reduction is indicated by the MDR TS2 when measured at 300 degrees F. See Table II.

Table II

(components are in parts by weight based on 100 parts by weight of LDPE)

Example	3	4	5	6	7	8	9
AMSD	0.33	0.60	0.80	-----	-----	-----	-----
DPE	-----	-----	-----	0.20	0.40	0.61	0.87
peroxide	1.34	1.46	1.55	1.52	1.62	1.80	2.00
TS2	28.1	31.4	32.4	25.6	33 .1	37.8	43.5

Notes to Tables:

1. TS1 represents the time, in minutes, 0.1 unit rise in the torque over the minimum torque; representative of the material's propensity for scorch.

2. TS2 = the time, in minutes, 0.1 unit rise in the torque over the minimum torque for a two unit rise.
3. MDR at 182 degrees C = moving die rheometer manufactured by Alpha Technologies using a 0.5 degree rotation arc and operated at 182 degrees C.
4. MDR at 140 degrees C = moving die rheometer manufactured by Alpha Technologies using a 0.5 degree rotation arc and operated at 140 degrees C.
5. MH (in-lbs) = maximum torque.
6. peroxide = dicumyl peroxide (note increased peroxide requirement in example 9).

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A composition comprising:
   (a) polyethylene;
   (b) as a scorch inhibitor, 1,1-diphenylethylene, substituted or unsubstituted;
   (c) optionally, a cure booster; and
   (d) an organic peroxide.

2. The composition defined in claim 1 wherein the scorch inhibitor is present in an amount of about 0.03 to about 1 part by weight based on 100 parts by weight of polyethylene.

3. The composition defined in claim 2 wherein the scorch inhibitor is present in an amount of about 0.05 to about 0.5 part by weight based on 100 parts by weight of polyethylene.

4. The composition defined in claim 1 wherein the cure booster is present in an amount of about 0.1 to about 1 part by weight based on 100 parts by weight of polyethylene.

5. The composition defined in claim 1 wherein the organic peroxide is present in an amount of about 0.4 to about 3 parts by weight based on 100 parts by weight of polyethylene.

6. The composition defined in claim 4 wherein the weight ratio of scorch inhibitor to cure booster is in the range of about 0.03:1 to about 5:1.

7. The composition defined in claim 1 wherein, for each 100 parts by weight of polyethylene, the other components are present as follows:

(b) about 0.05 to about 0.5 part by weight of scorch inhibitor;
(c) if used, about 0.25 to about 0.75 part by weight of cure booster; and
(d) about 0.6 to about 2 parts by weight of organic peroxide.

8. A cable comprising one or more electrical conductors or a core of electrical conductors, each conductor or core being surrounded by a cured composition comprising:

(a) polyethylene;
(b) as a scorch inhibitor, 1,1-diphenylethylene, substituted or unsubstituted; and
(c) optionally, a cure booster.

9. A process for extrusion comprising extruding around on or more electrical conductors or a core of electrical conductors, at a temperature below the decomposition temperature of the organic peroxide, a composition comprising:

(a) polyethylene;
(b) as a scorch inhibitor, 1,1-diphenylethylene, substituted or unsubstituted;
(c) optionally, a cure booster; and
(d) an organic peroxide,
and curing the extrudate.

10. The composition defined in claim 1 wherein the cure booster is triallyl trimellitate; 3,9-divinyl-2,4,8,10-tetra-

oxaspiro[5.5]undecane (DVS); triallylcyanurate; or triallyl isocyanurate.

11. The composition defined in claim 1 wherein the 1,1-diphenylethylene is unsubstituted.

12. The cable defined in claim 8 wherein the 1,1-diphenylethylene is unsubstituted.