ANTI-YELLOWING POLYCONDENSATION POLYMER COMPOSITIONS AND ARTICLES

CROSS REFERENCE TO PROVISIONAL APPLICATIONS

This application claims priority from U.S. provisional patent application Serial No. 60/418,184; filed October 15, 2002, the entire disclosure of which is incorporated herein by reference.

TECHNICAL FIELD

This invention is directed to polycondensation polymer compositions having an improved resistance to yellowing under heat aging, and articles formed from the polymer compositions, including reflectors, reflector cups, and scramblers for light emitting diodes.

BACKGROUND OF THE INVENTION

Light emitting diode (LED) components, such as reflectors, reflector cups, and scramblers are typically formed from polymer compositions. LED applications require polymer compositions with good opacity and reflective properties. Various useful polymer compositions for LED applications are known, these ones usually include polycondensation polymers, such as polyphthalamides. One problem noted with the prior art compositions used in LED applications is yellowing upon heat aging.

LED components are exposed to elevated temperatures during the manufacturing process. For example, during the fabricating steps the LED components are heated to about 180 °C to cure an epoxy potting compound. The LED components are also exposed to temperatures above 260 °C while soldering operations are performed. In addition, while in

use, LED components, such as automobile components, are routinely subjected to temperatures above 80 °C. This exposure to high temperatures causes yellowing of polymer compositions used for forming LED components.

Another polymer composition used for LED components comprises polycarbonate. Polycarbonate compositions, however, soften when exposed to the epoxy curing and soldering temperatures. LED components formed from polycarbonate compositions would not retain their shape at these temperatures.

Yellowing is a particularly acute problem for blue light LEDs. Yellow surfaces absorb blue light. Thus, yellow reflectors absorb blue light rather and are, therefore, inefficient reflectors.

SUMMARY OF THE INVENTION

There exists a need in the reflector art for polycondensation polymer compositions capable of withstanding long-term exposure to high temperatures. There exists a need in the reflector art for polycondensation polymer compositions that do not yellow upon heat aging. There exists a need in the reflector art for reflectors, reflector cups, and scramblers formed from polycondensation polymer compositions that resist yellowing upon heat aging while maintaining excellent opacity and reflective properties.

These and other needs are met by certain embodiments of the present invention that provide a polymer composition comprising at least 20 weight % based on the total weight of the polymer composition, of at least one polycondensation polymer having a heat deflection temperature of above 80 °C under a load of 1.82 Mpa when measured according to ASTM D648. The composition further comprises from 0 to 5 weight % based on the total weight of the polymer composition, of at least one polymer having a heat deflection temperature of at most

80°C under a load of 1.82 MPa when measured according to ASTM D648. In addition, the polymer composition comprises a white pigment in a concentration of at least 4 wt% based on the total weight of the composition, and a black pigment in a concentration of up to 0.02 weight % based on the total weight of the composition.

In certain embodiments of the present invention, the polycondensation polymer is selected from the group consisting of polyarylethersulfones, at least partially aromatic polyamides, polyamideimides, liquid crystalline polymers, polyimides, polyetherimides, polyaryletherketones, and polyphenylene sulfides.

These and other needs are further met by certain embodiments of the present invention that provide a shaped article formed from the polymer composition as above detailed.

These and other needs are additionally met by certain embodiments of the present invention wherein the shaped articles are a reflector for an LCD, reflector cup for a surface mount LED, or a scrambler for a seven-segment light LED.

In addition, these and other needs are met by a method of forming a shaped article comprising providing a polymer composition as above detailed.

Furthermore, these and other needs are met by using a black pigment to improve the heat-stability of a white-pigmented polycondensation polymer composition.

In certain embodiments of the present invention, the black pigment is a carbon black, the white pigment is titanium dioxide, and the polycondensation polymer is a polyphthalamide.

The present invention provides a new polymer composition that inhibits yellowing of high-temperature polycondensation polymers upon heat aging. The present invention provides reflectors, reflector cups, and scramblers with excellent opacity and reflective

properties.

The present invention provides use of a black pigment to improve the heat stability of a white-pigmented polycondensation polymer composition comprising at least 20 weight %, based on the total weight of the polymer composition, of at least one polycondensation polymer having a heat deflection temperature of above 80 °C under a load of 1.82 Mpa when measured according to ASTM D648, and from 0 to 5 weight %, based on the total weight of the polymer composition, of at least one polymer having a heat deflection temperature of at most 80 °C under a load of 1.82 Mpa when measured according to ASTM D648.

The present invention also provides a cost effective polycondensation polymer composition for use in reflectors, reflector cups, and scramblers. The present invention addresses the longstanding limitation of yellowing of polycondensation polymers upon heat aging.

Additional advantages and aspects of the present invention will become readily apparent to those skilled in the art from the following detailed description, wherein embodiments of the present invention are shown and described, by way of illustration of the best mode contemplated for practicing the present invention. As will be described, the present invention is capable of other and different embodiments, and its several details are susceptible to modification in various obvious respects, all without departing from the spirit of the present invention. Accordingly, the description is to be regarded as illustrative in nature, and not as limitative.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 schematically illustrates a LED reflector cup according to an embodiment of the instant invention.

FIG. 2 illustrates a seven segment scrambler for an LED according to an embodiment of the instant invention.

FIG. 3 is a plot of reflectivity versus wavelength for polycondensation polymer compositions according to embodiments of the present invention.

FIG. 4 is a plot of heat aged reflectivity versus wavelength of light for polycondensation polymer compositions according to embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In many applications polymers that are capable of withstanding elevated temperatures, and that have good strength, and tolerance to a host of chemical environments are required.

Polymers that are suitable for use in the present invention are polycondensation engineering polymers. Polycondensation polymers are polymers that are formed from a repeating condensation reaction. Engineering polymers are thermoplastics that advantageously maintain dimensional stability and most mechanical properties above 80 °C and below 0 °C. Engineering polymers can be advantageously formed into functional parts that can bear loads and withstand abuse in temperature environments commonly experienced by traditional engineering materials, such as wood, metals, glass, and ceramics.

Aromatic polycondensation polymers, in particular, provide high temperature service, high strength, and chemical resistance. Aromatic polycondensation polymers are polymers formed by the condensation reaction of two compounds, wherein at least one of the compounds comprises at least one aromatic group. Aromatic polycondensation polymers are well suited for forming LED components.

Polycondensation polymers that are suitable for certain embodiments of the present invention are high temperature polycondensation polymers. High temperature polycondensation polymers are defined as polycondensation polymers that have a heat deflection temperature (HDT) of above 80 °C under a load of 1.82 MPa when measured according to ASTM D648. Typical heat deflection temperatures of certain polycondensation polymers are listed in Table 1.

Table 1 – High Temperature Polycondensation Polymers

Polycondensation Polymer	**Heat Deflection Temp. (°C)**
Polysulfone	174
Polyethersulfone	203
Polyphenylsulfone	204
Polyphthalamide	120
Polyamideimide	278
Liquid crystalline polymers (LCP) (there are several different conventional LCPs)	180 – 310
Polyimide	360
Polyetherimide	200
Polyetheretherketone (low flow)	160
Polyetheretherketone (high flow)	171
Polyphenylene sulfide	135
Polycarbonate	132

Heat deflection temperatures of polymers and polymer compositions are determined according to ASTM D648, Method A, using a span of 4 inches. The polymer is injection molded into plaques that are 5 inches long, 1/2 inch wide, and 1/8 inch thick. The plaques are immersed in a suitable liquid heat-transfer medium, such as an oil, during the HDT test. Dow Corning 710 silicone oil, for example, is used for polyphthalamide polymers and compositions. For polycondensation polymers and compositions, such as polyphthalamides and polyphthalamide compositions, the HDT test is performed on unannealed specimens.

In the present invention, the addition of a black pigment to a polycondensation polymer composition unexpectedly provides resistance to heat aging induced yellowing of

articles formed from the composition, such as LED components. Polymer compositions according to the present invention comprise a polycondensation polymer, a white pigment, and a black pigment.

In certain embodiments of the present invention, the polycondensation polymer is present in the polymer composition in a concentration of at least about 55 weight %. In certain other embodiments of the present invention, the polycondensation polymer is present in the polymer composition in a concentration of at least about 43 weight %. In certain other embodiments of the present invention, the polycondensation polymer is present in the polymer composition in a concentration of at least about 40 weight %. In certain embodiments of the present invention, the polycondensation polymer is present in the polymer composition in a concentration of up to about 90 weight %. In certain other embodiments of the present invention, the polycondensation polymer is present in the polymer composition in a concentration of up to about 75 weight %. The concentration of polymer in the polymer composition is based on the total weight of the polymer composition.

Suitable polycondensation engineering polymers for use in certain embodiments of the present invention include polyarylethersulfones, at least partially aromatic polyamides, polyamideimides, liquid crystalline polymers, polyimides, polyetherimides, polyaryletherketones, and polyphenylene sulfides.

In certain embodiments of the present invention, suitable at least partially aromatic polyamides are polyphthalamides. Suitable polyphthalamides for certain embodiments of the present invention are formed by a polycondensation reaction between at least one aromatic dicarboxylic acid and a diamine. In certain embodiments, the aromatic dicarboxylic acid is terephthalic acid. In certain other embodiments of the present invention, the polyphthalamide further comprises isophthalic acid residues. In other certain embodiments of the present

invention, the polyphthalamide is further formed from an aliphatic dicarboxylic acid, such as adipic acid. In certain other embodiments of the present invention, the diamine is an aliphatic diamine. Suitable aliphatic diamines for certain embodiments of the present invention comprise 4 to 12 carbon atoms, such as hexamethylene diamine (HMDA), nonane diamine, 2-methyl-1,5 pentadiamine, and 1,4-diaminobutane. Suitable polyphthalamides for certain embodiments of the present invention are disclosed in U.S. Patent Nos. 5,436,294; 5,447,980; and Re34,447; the entire disclosures of which are incorporated herein by reference. In certain embodiments of the present invention, the molar amount of dicarboxylic acid used in the polyphthalamide is from about 50% to about 75% terephthalic acid, from about 0 % to about 45 % adipic acid, and from about 0 % to about 35 % isophthalic acid.

In certain embodiments of the instant invention, the dicarboxylic acid component of the polyphthalamide comprises from about 55 mole % to about 75 mole % terephthalic acid and from 25 mole % adipic acid to about 45 mole %, and the diamine component comprises about 100 mole % hexamethylene diamine. In a certain embodiment of the instant invention, the dicarboxylic acid component of the polyphthalamide comprises about 65 mole % terephthalic acid and 35 mole % adipic acid, and the diamine component comprises about 100% hexamethylene diamine.

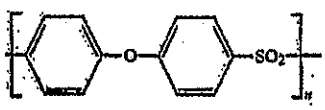
In certain embodiments of the present invention, the dicarboxylic acid used in forming the polyphthalamide comprises a mole ratio of aromatic dicarboxylic acid groups in the range from at least about 50 mole % aromatic groups to about 100% aromatic groups. In certain embodiments of the present invention, the polyphthalamide polymer comprises from about 50 mole % to about 95 mole % hexamethylene terephthalamide units, from about 25 mole % to about 0 mole % hexamethylene isophthalamide units, and from about 50 mole % to about 5 mole % hexamethylene adipamide units. Suitable polyphthalamides for use in the

present invention are available as AMODEL® polyphthalamides from Solvay Advanced Polymers, L.L.C.

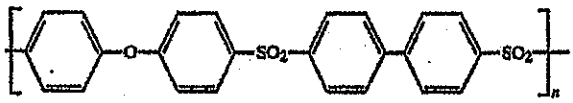
Other at least partially aromatic polyamides suitable for use in the present invention include polyamides formed from the reaction of an aliphatic dicarboxylic with an aromatic diamine. Suitable partially aromatic polyamides formed from aromatic diamine include the reaction product of adipic acid and m-xylene diamine. Such partially aromatic polyamides are available as IXEF® polyarylamide from Solvay Advanced Polymer, L.L.C.

Partially aromatic polyamides suitable for use in the polymer compositions according to the present invention include polyamides formed from dicarboxylic acids and diamines, wherein up to 100 mole % of the dicarboxylic acids are aromatic dicarboxylic acids and up to 100 mole % of the diamines are aromatic diamines.

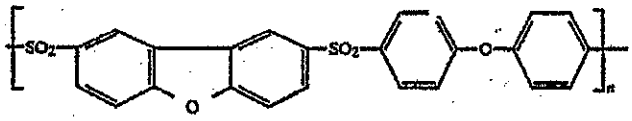
Other aromatic polycondensation polymers suitable for use in the polymer compositions according to the present invention include polyarylethersulfones. The polyarylethersulfone polymers used in this invention are defined as polyarylene compounds in which arylene units exist irregularly or regularly together with ether and sulfone linkages. Examples of sulfone polymers within the scope of the present invention polymers comprise the following structural formulae (1) to (16) where n is an integer of at least 10. Generally, the average number of repeat units n is greater than 30 and more typically greater than about 40 to ensure sufficiently high molecular weight for robust physical and mechanical integrity of the polymers when fabricated into structural components.



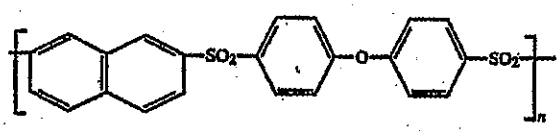
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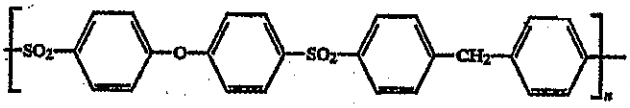
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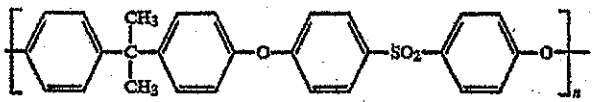
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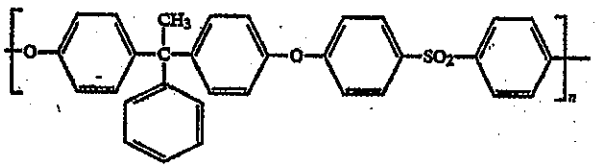
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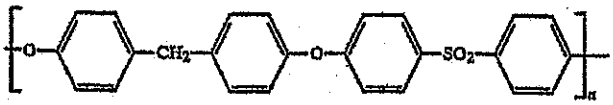
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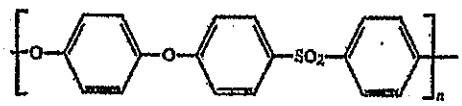
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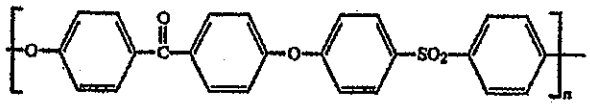
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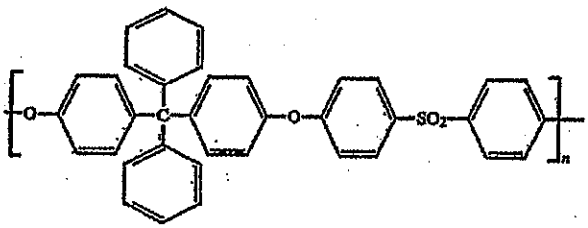
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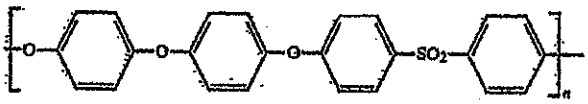
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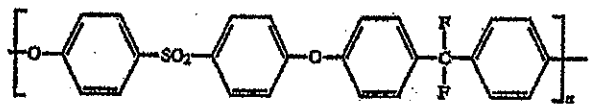
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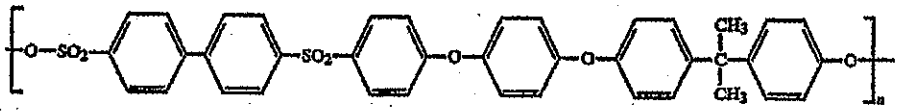
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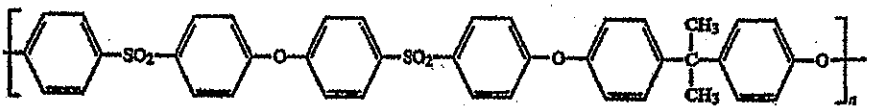
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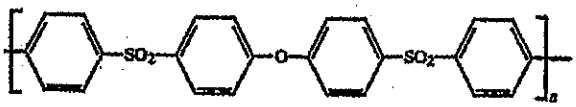
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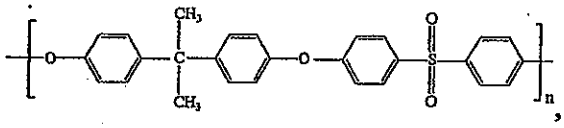


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In certain embodiments of the present invention, the aromatic polycondensation polymer may preferably comprise polysulfone, polyphenylsulfone, polyethersulfone,

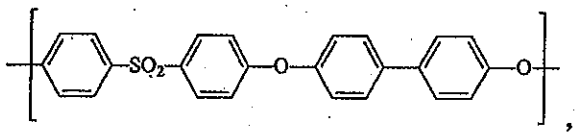
polyetherethersulfone, and blends and copolymers thereof. The structural repeat units of polyphenylsulfone, polysulfone, polyethersulfone, and polyetherethersulfone are listed below:

polysulfone



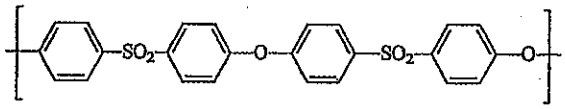
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polyphenylsulfone



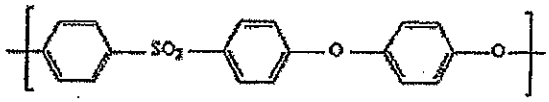
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polyethersulfone



, and (III)

polyetherethersulfone

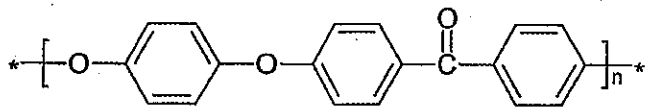


(IV)

Preparation of polyarylethersulfones is described in U.S. Patent Nos. 4,108,837; 4,175,175; and Canadian Patent No. 847,963 which are incorporated herein by reference in their entireties. Polysulfone is commercially available as UDEL® polysulfone from Solvay Advanced Polymers, L.L.C. Polyethersulfone and polyphenylsulfone are commercially available as RADEL® A and RADEL® R, respectively, from Solvay Advanced Polymers, L.L.C.

Other aromatic polycondensation polymers included in the polymer compositions within the scope of this invention include: polyamideimides, liquid crystalline polymers, polyimides, polyetherimides, polyaryletherketones, and polyphenylene sulfides. An example

of a polyaryletherketone included within the scope of this invention is polyetheretherketone (PEEK). PEEK comprises polymers formed the following structural unit:



(V)

PEEK is commercially available as VICTREX® from Victrex, LTD. ULTEM® polyetherimide is commercially available from General Electric. Liquid crystalline polymers and polyamideimide are available from Solvay Advanced Polymers, LLC, as XYDAR® and TORLON®, respectively.

In certain embodiments of the present invention, the polycondensation polymer has a HDT of above 100 °C under a load of 1.82 MPa when measured according to ASTM D648. In certain other embodiments of the present invention, the polycondensation polymer has a HDT of above 110 °C under a load of 1.82 MPa when measured according to ASTM D648. In certain other embodiments of the present invention, the polycondensation polymer has a heat deflection temperature HDT of below 250 °C under a load of 1.82 MPa when measured according to ASTM D648. In certain other embodiments of the present invention, the polycondensation polymer has a heat deflection temperature HDT of below 200 °C under a load of 1.82 MPa when measured according to ASTM D648. In certain other embodiments of the present invention, the polycondensation polymer has a heat deflection temperature HDT of below 170 °C under a load of 1.82 MPa when measured according to ASTM D648. In certain other embodiments of the present invention, the polycondensation polymer has a heat deflection temperature HDT of below 155 °C under a load of 1.82 MPa when measured according to ASTM D648.

Polymers usually having an HDT of at most 80 °C under a load of 1.82 MPa when

measured according to ASTM D648, include polyamide 6, polyamide 66, polyamide 12, polyethylene terephthalate, and polybutylene terephthalate.

In certain embodiments of the present invention, the amount of polymer having an HDT of at most 80 °C under a load of 1.82 MPa when measured according to ASTM D648 in the polymer composition is at most 2.5 weight %, based on the total weight of the polymer composition. In certain other embodiments of the present invention, the polymer composition is substantially free of polymer having an HDT of at most 80 °C under a load of 1.82 MPa when measured according to ASTM D648.

In certain embodiments of the present invention, the polymer composition is free of polycarbonate.

Suitable white pigments for certain embodiments of the present invention include titanium dioxide, zinc sulfide, zinc oxide, barium sulfate, and potassium titanate, and mixtures thereof. In certain embodiments of the present invention, the white pigment is present in the polymer composition in a concentration of at least about 12 weight %. In certain other embodiments of the present invention, the white pigment is present in a concentration of from at least about 4 weight %. In certain other embodiments of the present invention, the white pigment is present in a concentration of up to about 30 weight %. In certain other embodiments of the present invention, the white pigment is present in a concentration of up to about 25 weight %. The concentration of white pigment is based on the total weight of the polymer composition. In certain embodiments of the present invention, the white pigment is titanium dioxide.

A suitable zinc oxide is KADOX® 911, available from Zinc Corporation of America. Suitable titanium dioxide for the present invention include rutile titania, such as Kronos 2230.

In certain embodiments of the present invention, the black pigment is present in the

polymer composition in a concentration of at least about 0.0001 weight %. In certain other embodiments of the present invention, the black pigment is present in a concentration of at least about 0.0005 weight %. In certain other embodiments of the present invention, the black pigment is present in a concentration of at least about 0.0008 weight %. In certain other embodiments of the present invention, the black pigment is present in a concentration of up to about 0.02 weight %. In certain other embodiments of the present invention, the black pigment is present in a concentration of up to about 0.01 weight %. In certain other embodiments of the present invention, the black pigment is present in a concentration of up to 0.005 weight %. In certain other embodiments of the present invention, the black pigment is present in a concentration of up to 0.002 weight %. In certain other embodiments of the present invention, a black pigment concentration of about 0.0012 weight % is well suited. In certain other embodiments of the present invention, a concentration of about 0.0016 weight % black pigment is well suited.

Carbon blacks are suitable black pigments for certain embodiments of the present invention. Suitable carbon blacks include lamp blacks, furnace blacks, channel blacks, oil blacks, and acetylene blacks. Suitable carbon blacks for the present invention include RAVEN® carbon black, available from Columbian Chemicals Company; SHAWINIGAN BLACK®, available from Chevron Phillips Chemical Company; BLACK PEARLS®, MONARCH®, and REGAL® carbon blacks, all available from Cabot Corporation, and MPC Channel Black.

Certain embodiments of the present invention, further comprise from about 5 weight % glass fiber. Certain other embodiments of the instant invention further comprise up to about 25 weight % glass fiber. Certain embodiments of the present invention comprise from about 0.1 weight % antioxidant. Certain other embodiments of the present invention

comprise up to about 2 weight % antioxidant. The weight percents are based on the total weight of the polymer composition.

Glass fibers are commercially available in continuous filament, chopped, and milled forms. Any of these forms of glass fiber can be used in the practice of this invention. A suitable glass fiber for embodiments of this invention is CERTAINTEED® 910 fiberglass, available from Vetrotex CertainTeed Corp. Another suitable glass fiber is fiberglass 1/8" 3/16" available from Saint Gobain. Suitable antioxidants include IRGANOX® 1098, available from Ciba Specialty Chemicals.

The compositions of the present invention, may optionally include reinforcing filler, additives, and like. Representative fibers which may serve as reinforcing media include graphitic carbon fibers, amorphous carbon fibers, synthetic polymeric fibers, aluminum fibers, aluminum silicate fibers, oxide of metals such as aluminum fibers, titanium fibers, magnesium fibers, wollastonite, rock wool fibers, steel fibers, tungsten fibers, silicon carbide fibers, alumina fibers, boron fibers, etc. Representative filler and other materials include glass, calcium silicate, silica, clays, such as kaolin, chalk, mica, talc, and other mineral fillers and other additives such as, wollastonite, graphite, alumina trihydrate, sodium aluminum carbonate, barium ferrite, etc. Suitable polymeric fibers include fibers formed from engineering polymers such as, for example, poly(benzothiazole), poly(benzimidazole), polyarylates, poly(benzoxazole), polyaryl ethers, aromatic polyamide fibers such as the fibers sold by the DuPont Company under the trade name KEVLAR®, and the like, and may include mixtures comprising two or more such fibers. The compositions of this invention may further include additional additives commonly employed in the art, such as thermal stabilizers, ultraviolet light stabilizers, oxidative stabilizers, plasticizers, lubricants, and mold release agents. Certain polymer compositions according to the present invention further

comprise an external lubricant, such as PTFE or low density polyethylene (LDPE), to facilitate extrusion. Suitable powdered PTFE for certain embodiments of the present invention include POLYMIST® F5A available from Solvay Solexis. The levels of such additives will be determined for the particular use envisioned, with up to about 50 weight %, based on total composition, of such additional additives considered to be within the range of ordinary practice in the polymer compounding art.

A certain embodiment of the instant invention comprises 59.5 weight % polyphthalamide, 25 weight % titanium dioxide, 15 weight % fiberglass, 0.5 weight % antioxidant, and 0.0016 weight % carbon black.

Additional embodiments of the present invention include shaped articles made from any of the polymer compositions described herein. The composition of the present invention can be molded, such as by melt fabricating, injection molding, extruding, and blow molding, to form a variety of shaped articles. Articles within the scope of this invention include LED components such as reflector cups for surface mount LEDs, scramblers (covers) for seven-segment LEDs, and reflectors for any type of LED. Such reflectors, reflector cups, and scramblers feature improved anti-yellowing properties during heat aging, and have excellent opacity and reflectivity properties. A reflector cup 1 according to the present invention is illustrated in FIG. 1, with an LED element 2 positioned inside the cup 1. The shape of reflector cup 1, can be varied to optimize light reflection. Other common shapes of reflector cups include parabaloidal, conical, and hemispherical. A seven segment scrambler 3 for an LED according to the present invention is illustrated in FIG. 2.

An additional embodiment of the present invention is the use of a black pigment to improve the heat stability of a white-pigmented polycondensation polymer composition. The polymer composition comprises at least 20 weight % of at least one polycondensation

polymer having a heat deflection temperature of above 80 °C under a load of 1.82 MPa when measured according to ASTM D648, and from 0 to 5 weight % of at least one polymer having a heat deflection temperature of at most 80 °C under a load of 1.82 MPa when measured according to ASTM D648.

Another additional embodiment of the present invention is a polymer composition comprising at least 20 weight % of at least one polycondensation polymer having a heat deflection temperature of above 80 °C under a load of 1.82 MPa when measured according to ASTM D648. The composition further comprises from 0 to 5 weight % of at least one polymer having a heat deflection temperature of at most 80 °C under a load of 1.82 MPa when measured according to ASTM D648, and a white pigment. After 3 hours of heat aging at 170 °C the polymer composition has a reflectivity of greater than 65 % at a wavelength of 420 nm.

The invention will be further described by examples. The examples are illustrative of the present invention and do not limit the scope of the claimed invention.

Examples:

Example 1

44.625 pounds of an AMODEL® polyphthalamide comprising, as the dicarboxylic acid component, about 65 mole % terephthalic acid and 35 mole % adipic acid, and, as the diamine component, about 100 mole % hexamethylene diamine, having a HDT measured according to ASTM D648 under a load of 1.82 MPa of 120°C, was blended with 11.25 pounds of Saint Gobain fiberglass 1/8" 3/16", 18.75 pounds Kronos® 2230 titanium dioxide, 0.0012 pounds MPC channel black, and 0.375 pounds of IRGANOX® 1098 to form a polyphthalamide composition with excellent anti-yellowing, opacity, and reflectivity properties.

The properties of the polymer composition of Example 1 are listed in Table 2.

Table 2 - Example 1 Properties

TEST	VALUES
Tensile Strength (psi)	13,850
Tensile Elongation (%)	1.2
Tensile Modulus (kpsi)	1260
Flex Strength (psi)	24,820
Flex Strain (%)	2.39
Flex Modulus (kpsi)	1094
Notched Izod (ft-lb/in)	0.46
HDT @ 1.82 MPa (264 psi) (°C)	290.6
Ash (%)	40.24
Pellet IV (dl/gr)	0.98
Moisture (ppm)	570
Pellet Density (kg/m^3)	1.56

Table 3 lists the carbon black content of Control C1 and Examples 2, 3, and 4. MPC Channel Black was used in each of the Examples. The carbon black was added to 75 pounds of polyphthalamide composition. The compositions C1, 2, 3, and 4 are substantially similar to Example 1, except the amount of carbon black in each composition is different from each other, as shown in Table 3.

Table 3 – Carbon black content of polyphthalamide compositions.

Examples	C1	2	3	4
Carbon Black Content (%)	0	0.0012	0.0009	0.0016

The reflectivity data of the molded compositions according to the instant invention before and after heat aging are listed in Tables 4 and 5, and plotted in FIG. 3 and 4. Heat aging is performed for three hours at 170 °C in a forced air oven at ambient humidity. Reflectivity of plaques formed from the polymer compositions is measured using a colorimeter. Light from a xenon arc source impinge on the plaques at an oblique angle and light reflected from the surface of the plaque is collected by the colorimeter through an adjustable wavelength filter. Thus, reflectivity is measured at a number of different wavelengths. The reflectance of the plaques is compared to the reflectance of a known standard. The decreased reflectivity of the compositions after heat-aging is a result of the yellowing of the composition. As shown in FIG. 4, after heat aging, the compositions of the present invention, have improved reflectivity in the shorter visible wavelengths (blue end of visible spectrum), hence there is less yellowing than the control composition.

Table 4 - Reflectivity Before Heat Aging

Wavelength (nm)	Reflectivity (%)			
	Examples			
	C1	2	3	4
400	46	45	45	45
420	81	82	84	84
440	86	85	88	87
460	87	85	88	87
480	88	85	88	87
500	89	86	88	87
520	90	86	88	87
540	90	86	89	87
560	90	86	88	87
580	90	85	88	87
600	90	85	88	87
620	90	85	88	87
640	90	85	88	87
660	90	85	88	86
680	90	85	88	86
700	90	85	88	86

Table 5 - Heat Aged Reflectivity

Wavelength (nm)	Reflectivity (%)			
	Examples			
	C1	2	3	4
400	41	43	43	44
420	62	70	70	71
440	67	73	74	75
460	70	76	76	77
480	73	77	78	79
500	76	79	80	81
520	79	80	82	82
540	81	81	83	83
560	84	83	85	84
580	85	83	85	85
600	86	83	86	85
620	87	84	86	85
640	88	84	87	86
660	89	84	87	86
680	89	84	87	86
700	89	84	87	86

The embodiments illustrated in the instant disclosure are for illustrative purposes. They should not be construed to limit the scope of the claims. As is clear to one of ordinary skill in this art, the instant disclosure encompasses a wide variety of embodiments not specifically illustrated herein.

CLAIMS

1. Polymer composition comprising:

at least 20 weight % of at least one polycondensation polymer having a heat deflection temperature of above 80 °C under a load of 1.82 MPa when measured according to ASTM D648;

from 0 to 5 weight % of at least one polymer having a heat deflection temperature of at most 80 °C under a load of 1.82 MPa when measured according to ASTM D648;

a white pigment; and

a black pigment.

2. Polymer composition accordingly to claim 1, characterized in that the polycondensation polymer is selected from the group consisting of at least partially aromatic polyamides, polyamideimides, liquid crystalline polymers, polyimides, polyetherimides, polyaryletherketones, and polyphenylene sulfides.

3. Polymer composition accordingly to claim 1, characterized in that the polycondensation polymer is an at least partially aromatic polyamide.

4. Polymer composition accordingly to claim 3, characterized in that the at least partially aromatic polyamide is a polyphthalamide formed from terephthalic acid and an aliphatic diamine, and optionally, in addition, isophthalic acid/or an aliphatic dicarboxylic acid.

5. Polymer composition accordingly to claim 3, characterized in that the at least partially aromatic polyphthalamide is formed from an aliphatic dicarboxylic acid and an aromatic diamine.

6. Polymer composition according to any of claims 1 to 5, characterized in that the white pigment is titanium dioxide.

7. Polymer composition according to any of claims 1 to 6, characterized in that the black pigment is a carbon black..

8. Polymer composition according to any of claims 1 to 7, characterized in that the polycondensation polymer is present in a concentration of at least about 40 weight %, based on the total weight of the composition.

9. Polymer composition according to any of claims 1 to 8, characterized in that the polycondensation polymer is present in a concentration of up to about 90 weight %, based on the total weight of the composition.

10. Polymer composition according to any of claims 1 to 9, characterized in that the white pigment is present in a concentration of at least about 4 weight %, based on the total weight of the composition.

11. Polymer composition according to any of claims 1 to 10, characterized in that the white pigment is present in a concentration of up to 30 weight %, based on the total weight of the composition.

12. Polymer composition according to any of claims 1 to 11, characterized in that the black pigment is present in a concentration of at least 0.0001 weight %, based on the total weight of the composition.

13. Polymer composition according to any of claims 1 to 12, characterized in that the black pigment is present in a concentration of up to 0.02 weight % based on the total weight of the composition.

14. Shaped article formed from the composition according to any of claims 1 to 13.

15. Shaped article according to claim 14, characterized in that it is selected from the group consisting of a reflector for an LED, a reflector cup for a surface mount LED, and a scrambler for a seven-segment LED.

16. Use of a black pigment to improve the heat stability of a white-pigmented polycondensation polymer composition comprising at least 20 weight %, based on the total weight of the polymer composition, of at least one polycondensation polymer having a heat deflection temperature of above 80 °C under a load of 1.82 Mpa when measured according to ASTM D648, and from 0 to 5 weight %, based on the total weight of the polymer composition, of at least one polymer having a heat deflection temperature of at most 80 °C under a load of 1.82 Mpa when measured according to ASTM D648.

17. Use according to claim 16, characterized in that the polycondensation polymer is selected from the group consisting of polyarylethersulfones, at least partially aromatic polyamides, polyamideimides, liquid crystalline polymers, polyimides, polyetherimides, polyaryletherketones, and polyphenylene sulfides.

18. Use according to claim 16, characterized in that the polycondensation polymer is a polyphthalamide formed from terephthalic acid and an aliphatic diamine, and optionally, in addition, isophthalic acid and/or an aliphatic dicarboxylic acid.

19. Polymer composition comprising at least 20 weight %, based on the total weight of the polymer composition, of at least one polycondensation polymer having a heat deflection temperature of above 80 °C under a load of 1.82 Mpa when measured according to ASTM D648, from 0 to 5 weight %, based on the total weight of the polymer composition, of at least one polymer having a heat deflection temperature of at most 80 °C under a load of 1.82 Mpa when measured according to ASTM D648, and a white pigment, which after 3 hours of heat aging at 170° C has a reflectivity of greater than 65% at a wavelength of 420 nm.

20. Polymer composition according to claim 19, characterized in that the polycondensation polymer is a polyphthalamide formed from terephthalic acid and an aliphatic diamine, and optionally, in addition, isophthalic acid and/or an aliphatic dicarboxylic acid.

21 - Polymer composition according to claim 11, characterized in that the white pigment is present in a concentration of up to 25 weight %, based on the total weight of the composition.

22 - Polymer composition according to claim 12, characterized in that the black pigment is present in a concentration of at least 0.0005 weight %, based on the total weight of the composition.

23 - Polymer composition according to claim 12, characterized in that the black pigment is present in a concentration of at least 0.0008 weight %, based on the total weight of the composition.

24 - Polymer composition according to claim 13, characterized in that the black pigment is present in a concentration of up to 0.005 weight %, based on the total weight of the composition.

25 - Polymer composition according to claim 13, characterized in that the black pigment is present in a concentration of up to 0.002 weight %, based on the total weight of the composition.