[DESCRIPTION]

[Invention Title]

ELECTROCONDUCTIVE THERMOPLASTIC RESIN COMPOSITION AND PLASTIC ARTICLE

[Technical Field]

The present invention relates to an electrically conductive thermoplastic resin composition and a plastic article. More specifically, the present invention relates to an electrically conductive thermoplastic resin composition that enables realization of an electrically conductive thermoplastic resin with an improved electrical conductivity and superior physical properties (*e.g.*, impact resistance) and a plastic article.

[Background Art]

Thermoplastic resins are plastics that are softened and plasticized by heating and are hardened by cooling. Thermoplastic resins are divided into: common plastics such as polyethylene, polypropylene, acrylic resin, styrenic resin, and vinyl resins; and engineering plastics such as

polycarbonate, polyphenylene ether, polyamide, polyester, and polyimide resins.

Thermoplastic resins are widely used in applications including various household supplies, office automation equipment, and electric and electrical appliances owing to their superior processability and formability. There has been a continuous attempt to use a thermoplastic resin as a high value-added material by imparting specific properties as well as superior processability and formability to the thermoplastic resin, according to the kind and properties of products in which the thermoplastic resin is used. In particular, there have been various attempts to impart electrical conductivity to a thermoplastic resin and utilize the electrically conductive thermoplastic resin to obtain automobiles, electric apparatuses, electronic assemblies, and electrical cables with electromagnetic wave shielding performance.

The electrically conductive thermoplastic resin is commonly prepared from an electrically conductive thermoplastic resin composition obtained by mixing a thermoplastic resin with a conductive additive, such as carbon black, a carbon fiber, a metallic powder, a metal-coated inorganic powder and a metallic fiber. To ensure a desired level of electrical conductivity of the electrically

conductive thermoplastic resin, the conductive additive needs to be used in a considerably large amount. However, the use of the conductive additive in a considerably large amount causes deterioration of impact resistance, which is one of the basic mechanical properties of the thermoplastic resin.

Meanwhile, there is an attempt to impart superior electrical conductivity to a thermoplastic resin by using carbon nanotubes as the conductive additive.

However, when an electrically conductive thermoplastic resin is prepared by mixing a thermoplastic resin with carbon nanotubes and injecting the mixture in an injector, the carbon nanotubes show mobility and unexpected orientation due to shearing stress occurring during the injection. As a result, disconnection between the carbon nanotubes in the electrically conductive thermoplastic resin occurs, thus causing deterioration in electrical conductivity. Accordingly, in the case where carbon nanotubes are used, the carbon nanotubes need to be added in a considerably great amount to the thermoplastic resin in order to ensure the desired electrical conductivity. It is also inevitable that the use of the carbon nanotubes in a considerable amount causes deterioration of impact resistance, which is one of the basic mechanical properties of the electrically conductive thermoplastic resin.

[Technical Solution]

In accordance with one aspect of the present invention, there is provided an electrically conductive thermoplastic resin composition comprising: 80 to 99.9 parts by weight of a thermoplastic resin; 0.1 to 10 parts by weight of carbon nanotubes; 0.1 to 10 parts by weight of an impact modifier, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes; and 0.1 to 10 parts by weight of conductive metal oxide, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes.

Details of other aspects and exemplary embodiments of the present invention are encompassed in the following detailed description.

[Best Mode]

Now, the present invention will be described in more detail with reference to the following Examples, such that those skilled in the art easily practice the present invention. These examples are provided only for illustrating the present invention and should not be construed as limiting the scope and spirit of the present invention.

According to one embodiment of the present invention,

there may be provided an electrically conductive thermoplastic resin composition comprising: 80 to 99.9 parts by weight of a thermoplastic resin; 0.1 to 10 parts by weight of carbon nanotubes; 0.1 to 10 parts by weight of an impact modifier, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes; and 0.1 to 10 parts by weight of conductive metal oxide, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes.

As described above, the electrically conductive thermoplastic resin composition comprises carbon nanotubes and conductive metal oxide. Accordingly, during injection of the electrically conductive thermoplastic resin composition, the conductive metal oxide prevents the carbon nanotubes from being unexpectedly oriented or mobilized, thus avoiding the disconnection between carbon nanotubes. Thus, it is possible to obtain an electrically conductive thermoplastic resin with more improved electrical conductivity by employing the resin composition. The impact modifier contained in the resin composition prevents deterioration of basic mechanical properties (*e.g.*, impact resistance) of the electrically conductive thermoplastic resin, which results from the carbon nanotubes and conductive metal oxide used. Hence, it is possible to obtain an electrically conductive thermoplastic resin with superior impact resistance as well as more improved

electrical conductivity from the electrically conductive thermoplastic resin composition.

Each constituent component of the electrically conductive thermoplastic resin composition will be described in detail.

The electrically conductive thermoplastic resin composition comprises 80 to 99.9 parts by weight of the thermoplastic resin.

Any thermoplastic resin including common and engineering plastics may be used without any particular limitation so long as it can be applied to extrusion or injection molding.

Examples of the thermoplastic resin include polyacetal, acrylic resin, polycarbonate, styrenic resin, polyester, vinyl resin, polyphenylene ether, polyolefin, acrylonitrile-butadiene-styrene copolymer, polyarylate, polyamide, polyamide imide, polyarylsulfone, polyether imide, polyethersulfone, polyphenylene sulfide, fluorine, polyimide, polyetherketone, polybenzoxazole, polyoxadiazole, polybenzothiazole, polybenzimidazole, polypyridine, polytriazole, polypyrrolidine, polydibenzofuran, polysulfone, polyurea, polyphosphazene and liquid crystal polymer resins. In addition, the thermoplastic resin may be used as a copolymer or a mixture thereof.

In view of physical properties of the thermoplastic

resin or the type of product applied, preferred examples of the thermoplastic resin include, but are not limited to: polyolefin resins such as polyethylene, polypropylene, ethylene-vinyl acetate copolymer, ethylene-methyl methacrylate copolymer resins; styrene resins; and engineering plastics such as polyamide, polyester (*e.g.*, polyethylene terephthalate or polybutylene terephthalate) and polycarbonate resins.

Hereinafter, polycarbonate, polyester and polyolefin resins suitable as the thermoplastic resin will be described in detail.

First, the polyolefin resin may be used as the thermoplastic resin.

The polyolefin resin is prepared by radical polymerization or metal-catalyzed polymerization of an olefin monomer. In particular, preferred are polyolefin resins prepared by using Ziegler-Natta, metallocene or Phillips catalysts. There is no limitation as to the preparation method of the polyolefin resin. Accordingly, there may be used a polyolefin resin prepared by using any method well-known to those skilled in the art.

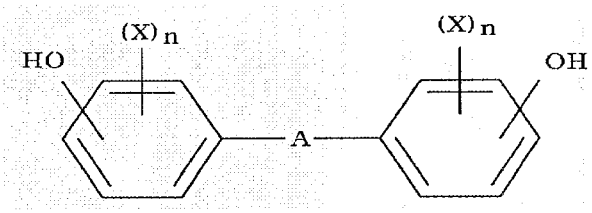
Second, the polyester resin may be used as the thermoplastic resin.

The polyester resin may contain an ester linkage in a polymer chain and be melted by heating. The polyester resin

is prepared by polycondensation of dicarboxylic acid and a dihydroxy compound. There is no limitation as to the preparation method of the polyester resin. Accordingly, there may be used a polyester resin prepared by using any method well-known to those skilled in the art. In addition, any polyester resin, such as a homopolyester or copolyester resin, may be used without any particular limitation.

Third, the polycarbonate resin may be used as the thermoplastic resin.

Examples of the polycarbonate resin may include an aromatic polycarbonate resin, which is prepared by reacting phosgene, halogen formate, or diester carbonate with a diphenol compound represented by Formula 1 below:



(1)

Wherein A is a single bond, C_1-C_5 alkylene, C_1-C_5 alkylidene, C_5-C_6 cycloalkylidene, -S- or $-SO_2-$; X is a halogen; and n is 0, 1 or 2.

Examples of the diphenol compound of Formula 1 include 4,4'-dihydroxydiphenyl, 2,2-bis-(4-hydroxyphenyl)-propane, 2,4-bis-(4-hydroxyphenyl)-2-methylbutane, 1,1-bis-(4-hydroxyphenyl)-cyclohexane, 2,2-bis-(3-chrolo-4-

hydroxyphenyl)-propane and 2,2-bis-(3,5-dichrolo-4-hydroxyphenyl)-propane. Preferred are 2,2-bis-(4-hydroxyphenyl)-propane, 2,2-bis-(3,5-dichrolo-4-hydroxyphenyl)-propane or 1,1-bis-(4-hydroxyphenyl)-cyclohexane. More preferred is 2,2-bis-(4-hydroxyphenyl)-propane, also called "bisphenol-A (BPA)".

The polycarbonate resin may have a weight average molecular weight of 15,000 to 50,000 g/mol.

There is no limitation as to the type of the polycarbonate resin. More specifically, the polycarbonate resin may be a linear or branched polycarbonate resin, or a polyester-carbonate copolymer resin. The branched polycarbonate resins may be prepared by using 0.05 to 2 mol% of a tri- or more functional (*i.e.*, polyfunctional) compound, such as a tri- or more functional phenol compound, based on the total mole of the diphenol compound of Formula 1. The polyester-carbonate copolymer resins may be prepared by polymerizing polycarbonate in the presence of an ester precursor, such as dicarboxylic acid. The polyester-carbonate copolymer resins may be used singly, or as a mixture with a polycarbonate.

The polycarbonate resin may be homopolycarbonate or copolycarbonate resin, or a combination thereof.

As mentioned above, suitable examples of the

thermoplastic resin include, but are not limited to polycarbonate, polyester and polyolefin resins. The composition and preparation method of each thermoplastic resin are well-known to those skilled in the art.

Meanwhile, the electrically conductive thermoplastic resin composition may further comprise carbon nanotubes. The inclusion of the carbon nanotubes enables the thermoplastic resin to exhibit superior electrical conductivity.

The carbon nanotubes have a superior mechanical strength, a high initial Young's modulus and a large aspect ratio. In addition, the carbon nanotubes have superior electrical conductivity and thermal stability. Accordingly, the carbon nanotubes are mixed with the thermoplastic resin, thereby imparting superior electrical conductivity to the thermoplastic resin.

Carbon nanotubes are synthesized by arc-discharge, pyrolysis, laser ablation, plasma enhanced chemical vapor deposition (PECVD), thermal chemical vapor deposition, electrolysis or flame synthesis. However, there is no limitation as to the synthesis method of the carbon nanotubes. Accordingly, carbon nanotubes synthesized by employing any method may be used for the electrically conductive thermoplastic resin composition without any particular limitation.

Carbon nanotubes are divided into single-walled carbon nanotubes, double-walled carbon nanotubes and multi-walled carbon nanotubes, based on the wall number thereof. These carbon nanotubes may be used for the electrically conductive thermoplastic resin composition without any particular limitation.

Carbon nanotubes may have a thickness of 1 to 50 nm, preferably, 2 to 10 nm, and a length of 0.01 to 10 ㎛, preferably, 1 to 10 ㎛. Based on the thickness and length, the carbon nanotubes may have an aspect ratio (L/D) of 100 or more, preferably, 100 to 1,000. As a result, the carbon nanotubes are uniformly distributed in the thermoplastic resin, thereby realizing the electrically conductive thermoplastic resin with superior electrical conductivity.

The carbon nanotubes are used in an amount of 0.1 to 10 parts by weight for the electrically conductive thermoplastic resin composition. Preferably, the carbon nanotubes are used in an amount of 1 to 5 parts by weight. The content of carbon nanotubes less than 0.1 parts by weight makes it difficult to adjust the electrical conductivity of the prepared electrically conductive thermoplastic resin to the desired level. The content of carbon nanotubes exceeding 10 parts by weight causes deterioration in mechanical and physical properties of the electrically conductive thermoplastic resin.

The electrically conductive thermoplastic resin composition may further comprise an impact modifier. The impact modifier may be a rubber impact modifier selected from the group consisting of a core-shell graft copolymer, a silicone polymer, an olefin polymer, and a mixture thereof.

When such an impact modifier is contained in the electrically conductive thermoplastic resin composition, rubbery particles are distributed therein, thus enabling an improvement in the physical properties (*e.g.*, impact resistance) thereof. That is to say, the impact modifier offsets deterioration in physical properties of the electrically conductive thermoplastic resin due to the carbon nanotubes or the following conductive metal oxide, which are used to impart electrical conductivity to the electrically conductive thermoplastic resin, thereby obtaining the electrically conductive thermoplastic resin with improved physical properties.

The core-shell graft copolymer is prepared by polymerizing a rubber monomer and grafting a given unsaturated compound on a rubber core of the resulting polymer. The core-shell graft copolymer has a core-shell structure in which the unsaturated compound is grafted on the rubber core in the form of a hard shell.

For example, the core-shell graft copolymer has a core-

shell structure in which an unsaturated compound, such as methyl methacrylate, styrene or acrylonitrile, is grafted on a rubber polymer core polymerized from at least one monomer selected from the group consisting of C_4-C_6 diene, acrylic and silicone rubber monomers.

Preferably, the core-shell graft copolymer comprises 20 to 90% by weight of the rubber core and 10 to 80% by weight of the shell grafted on the rubber core. As a result, the mechanical properties (*e.g.*, impact resistance) of the electrically conductive thermoplastic resin can be efficiently offset.

Examples of the diene rubber monomers that may be used to prepare the core-shell graft copolymer include butadiene, acrylic, ethylene-propylene, styrene-butadiene, acrylonitrile-butadiene, isoprene and ethylene-propylene-diene copolymer (EPDM) rubbers. Examples of the acrylic rubber monomers include methyl acrylate, ethyl acrylate, n-propyl acrylate, n-butyl acrylate, 2-ethylhexyl acrylate, hexyl methacrylate and 2-ethylhexyl methacrylate. As a hardener to polymerize the rubber monomer, there may be used ethylene glycol dimethacrylate, propylene glycol dimethacrylate, 1,3-butylene glycol dimethacrylate, 1,4-butylene glycol dimethacrylate, allyl methacrylate and triallyl cyanurate.

Examples of the silicone rubber monomer include

hexamethyl cyclotrisiloxane, octamethyl cyclotetrasiloxane, decamethyl cyclopentasiloxane, dodecamethyl cyclohexasiloxane, trimethyl triphenyl cyclotrisiloxane, tetramethyl tetraphenyl cyclotetrasiloxane and octaphenyl cyclotetrasiloxane. As a hardener to polymerize the silicone rubber monomer, there may be used trimethoxy methylsilane, triethoxy phenylsilane, tetramethoxysilane and tetraethoxysilane.

Examples of the rubber monomer that may be used to prepare the core-shell graft copolymer include, but are not limited to, diene, acrylic and silicone rubber monomers. In addition, any diene, acrylic and silicone rubber monomer may be used without any particular limitation.

As described above, a silicone polymer or an olefin polymer is also used as the impact modifier.

The silicone polymer may include a polymer of at least one silicone rubber monomer selected from the group consisting of hexamethyl cyclotrisiloxane, octamethyl cyclotetrasiloxane, decamethyl cyclopentasiloxane, dodecamethyl cyclohexasiloxane, trimethyl triphenyl cyclotrisiloxane, tetramethyl tetraphenyl cyclotetrasiloxane and octaphenyl cyclotetrasiloxane, and a mixture thereof. As a hardener to polymerize the silicone rubber monomer, there may be used trimethoxy methylsilane, triethoxyphenylsilane, tetramethoxysilane, tetraethoxysilane, etc.

The olefin polymer may include a polymer of at least one monomer selected from the group consisting of ethylene, propylene, isopropylene, butylene and isobutylene monomers, and a mixture thereof. The olefin polymer may be prepared by using various olefin polymerization catalysts, *e.g.*, a Ziegler-Natta catalyst. Alternatively, to prepare an olefin polymer having a selective structure, metallocene catalysts may be used. To improve dispersion of the polymer with the thermoplastic resin, a functional group, *e.g.*, maleic anhydride, may be grafted on the olefin polymer.

Suitable examples of the silicone and olefin polymers as the impact modifier have been mentioned. Any silicone or olefin polymer may be used without any particular limitation so long as it is well-known to those skilled in the art as a modifier capable of improving mechanical properties (*e.g.*, impact resistance) of a thermoplastic resin.

The impact modifier is used in an amount of 0.1 to 10 parts by weight, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes. The inclusion of the impact modifier in this amount causes considerable improvement in physical properties such as impact resistance, tensile strength, flexural strength and flexural modulus of the electrically conductive thermoplastic resin, and prevents mobility and orientation of the carbon nanotubes,

thereby imparting high electrical conductivity to the electrically conductive thermoplastic resin.

The electrically conductive thermoplastic resin composition further comprises conductive metal oxide. The conductive metal oxide prevents the carbon nanotubes from being oriented or mobilized during injection of the electrically conductive thermoplastic resin composition, thus avoiding disconnection between the carbon nanotubes. Thus, it is possible to obtain the electrically conductive thermoplastic resin with more improved electrical conductivity.

The conductive metal oxide may be any metal oxide with conductivity. Examples of the conductive metal oxide include titanium oxide, zinc oxide, indium oxide, tin oxide, indium tin oxide, antimony oxide, zirconium oxide, aluminum oxide, magnesium oxide, barium oxide, calcium oxide, strontium oxide, chromium oxide and iron oxide. The conductive metal oxide may be used alone or as a mixture thereof. In addition, to further improve the conductivity of the conductive metal oxide, the conductive metal oxide may be doped with a metal selected from the group consisting of aluminum, gallium, germanium, indium and tin, be coated with the metal, or be mixed with the metal. Alternatively, other physical or chemical techniques may be used in combination of the metal

with metal oxide. There is no limitation as to the shape of the conductive metal oxide. More specifically, the conductive metal oxide may be particle, fiber, flat or amorphous shape.

Conductive zinc oxide is preferred. The conductive zinc oxide may be prepared from various zinc oxides. The conductive zinc oxide may be composed of basic constituent particles (so-called primary particles), or aggregate particles (so-called secondary particles) in which the basic constituent particles are fused and bound together. Aggregate particles are preferred.

The conductive zinc oxide has an average diameter of 300 nm or less, preferably, 200 nm or less.

The conductive zinc oxide has a structure in which zinc oxide is combined with one metal selected from the group consisting of aluminum, gallium, germanium, indium and tin. The combination is carried out by doping, coating, mixing or other physical/chemical bonding techniques.

The conductive metal oxide may be used in an amount of 0.1 to 10 parts by weight, preferably, 0.5 to 5 parts by weight, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes. The content of the conductive metal oxide less than 0.1 parts by weight makes it impossible to prevent the carbon nanotubes from being unexpectedly oriented or mobilized. As a result, the carbon

nanotubes cannot be efficiently prevented from being disconnected, and thus, the electrically conductive thermoplastic resin may not have sufficient electrical conductivity. Meanwhile, the content of the conductive metal oxide exceeding 10 parts by weight causes deterioration in mechanical properties (*e.g.*, impact resistance) of the electrically conductive thermoplastic resin.

The electrically conductive thermoplastic resin composition may further comprise an additive suitable for the use intended. Examples of additives include vinyl copolymers, lubricants, release agents, plasticizers, nucleating agents, stabilizers, flame retardants, dyes, pigments, modifiers and inorganic additives. The additive is added in an amount equal to or less than 30 parts by weight to the electrically conductive thermoplastic resin composition.

The preparation of an electrically conductive thermoplastic resin is carried out by general methods comprising: mixing each constituent component to prepare an electrically conductive thermoplastic resin composition; and melt-extruding the resin composition in an extruder. A plastic article is prepared from the electrically conductive thermoplastic resin.

According to another embodiment of the present invention, there is provided a plastic article prepared from

the electrically conductive thermoplastic resin composition. For example, the plastic article may comprise a thermoplastic resin matrix, carbon nanotubes dispersed in the thermoplastic resin matrix, an impact modifier dispersed in the thermoplastic resin matrix, and conductive metal oxide dispersed in the thermoplastic resin matrix.

The plastic article exhibits more enhanced electrical conductivity owing to an interaction between the carbon nanotubes and the conductive metal oxide, which prevents orientation and mobility of the carbon nanotubes dispersed in the thermoplastic resin. In addition, the impact modifier dispersed in the thermoplastic resin offsets deterioration in mechanical properties (*e.g.*, impact resistance) of the plastic article due to the inclusion of the carbon nanotubes and conductive metal oxide, thereby ensuring superior mechanical properties of the plastic article.

Accordingly, since the plastic article imparts electrical conductivity to automobiles, electric apparatuses, electronic assemblies and electrical cables, they may be widely and preferably applied to a variety of uses, *e.g.*, antistatic or electrostatic discharge.

[Mode for Invention]

The present invention will be better understood from the following examples. However, these examples are not to be construed as limiting the scope of the invention.

The further details for (A) a thermoplastic resin (polycarbonate resin), (B) carbon nanotubes, (C) an impact modifier and (D) conductive metal oxide used in the following examples and comparative examples are as follows:

(A) Thermoplastic resin (polycarbonate resin)

Bisphenol-A polycarbonate (weight average molecular weight (Mw): 25,000 g/mol) was used as a polycarbonate resin selected from thermoplastic resins.

(B) Carbon nanotubes

Multi-walled carbon nanotubes (C-tube 100® available from CNT Co., LTD., thickness: 10-50 nm, length: 1-25 ㎛) were used as carbon nanotubes.

(C) Impact modifier

An ethyl acrylate-butadien-styrene copolymer (C-223A® available from Mitsubishi Chemical Corp., average particle size: 100 nm to 1 ㎛) were used as an impact modifier.

(D) Conductive metal oxide

Conductive zinc oxide (23-K® available from Hakushi Tech) was used as conductive metal oxide.

EXAMPLES 1 TO 5 AND COMPARATIVE EXAMPLES 1 TO 4

The content of each constituent component used in the following examples 1 to 5 and comparative examples 1 to 4 is shown in Tables 1 and 2. Respective components were mixed in accordance with the composition shown in Tables 1 and 2 to prepare an electrically conductive thermoplastic resin composition. The composition was extruded in a double-screw extruder (L/D=36, Φ=45 mm) and the resulting extrudate was pelletized. The pellet was injected in an injection machine (10 oz) at 270℃ to prepare a sample of 10 cm x 10 cm for measurement of physical properties and electrical conductivity.

First, the electrical conductivity (surface resistance) of each sample was measured with a surface resistance meter (electrical conductivity evaluation).

The notched IZOD impact strength (1/8″) of the sample was measured in accordance with ASTM D256, which is an American standard test method for determining an IZOD impact strength of plastics with a pendulum having a uniform weight (impact resistance evaluation).

The measurement results of the electrical conductivity and impact resistance are shown in Tables 1 and 2 below.

Table 1

	Examples				
	1	2	3	4	5
(A) thermoplastic resin (wt. parts)	97	97	97	98	99
(B) carbon nanotubes (wt. parts)	3	3	3	2	1
(C) impact modifier (wt. parts)	1	3	3	3	3
(D) conductive metal oxide (wt. parts)	1	1	3	3	3
IZOD impact strength (1/8") (23℃, kgf · cm/cm)	16	19	17	18	19
Surface resistance (Ω/sq.)	10^8	10^7	10^5	10^9	10^{11}

Table 2

	Comparative Examples			
	1	2	3	4
(A) thermoplastic resin (wt. parts)	97	97	100	100
(B) carbon nanotubes (wt. parts)	3	3	-	-
(C) impact modifier (wt. parts)	-	-	-	3
(D) conductive metal oxide (wt. parts)	-	1	3	3

IZOD impact strength (1/8") (23℃, kgf · cm/cm)	4	N · A*	N · A*	20
Surface resistance (Ω/sq.)	10^{15}	10^{9}	10^{15}	10^{15}

N · A* (Not Available): IZOD impact strength cannot be measured due to excessively high brittleness of sample.

As can be seen from the data in Tables 1 and 2, samples of Examples 1 to 5 comprising all constituent components of carbon nanotubes, an impact modifier and conductive metal oxide exhibited improved electrical conductivity, as compared to those of Comparative Examples 1, 3 and 4, which consist of any one or two of these components. In addition, the samples of Examples 1 to 5 exhibited improved impact resistance, as compared to that of Comparative Example 2, which comprises no impact modifier.

Accordingly, it can be confirmed that samples of Examples 1 to 5 exhibited both high electrical conductivity and impact resistance, when compared to those of Comparative Examples 1 to 4.

[CLAIMS]

[Claim 1]

An electrically conductive thermoplastic resin composition comprising:

80 to 99.9 parts by weight of a thermoplastic resin;

0.1 to 10 parts by weight of carbon nanotubes;

0.1 to 10 parts by weight of an impact modifier, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes; and

0.1 to 10 parts by weight of conductive metal oxide, based on a total of 100 parts by weight of the thermoplastic resin and the carbon nanotubes.

[Claim 2]

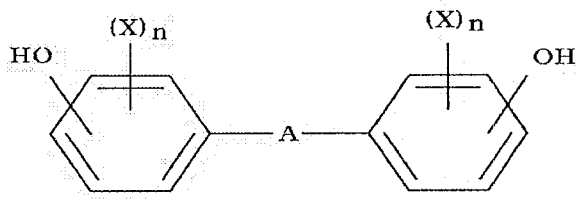
The electrically conductive thermoplastic resin composition according to claim 1, wherein the thermoplastic resin is selected from the group consisting of polyacetal, acrylic resin, polycarbonate, styrenic resin, polyester, vinyl resin, polyphenylene ether, polyolefin, acrylonitrile-butadiene-styrene copolymer, polyarylate, polyamide, polyamide imide, polyarylsulfone, polyether imide, polyethersulfone, polyphenylene sulfide, fluorine, polyimide, polyetherketone, polybenzoxazole, polyoxadiazole, polybenzothiazole,

polybenzimidazole, polypyridine, polytriazole, polypyrrolidine, polydibenzofuran, polysulfone, polyurea, polyphosphazene and liquid crystal polymer resins, and a copolymer or mixture thereof.

[Claim 3]

The electrically conductive thermoplastic resin composition according to claim 2, wherein the thermoplastic resin includes a polycarbonate resin, and

wherein the polycarbonate resin includes an aromatic polycarbonate resin, which is prepared by reacting phosgene, halogen formate or diester carbonate with a diphenol compound by represented by Formula 1 below:



(1)

Wherein A is a single bond, C_1-C_5 alkylene, C_1-C_5 alkylidene, C_5-C_6 cycloalkylidene, -S- or $-SO_2-$; X is a halogen; and n is 0, 1 or 2.

[Claim 4]

The electrically conductive thermoplastic resin composition according to claim 2, wherein the thermoplastic

resin includes a polycarbonate resin having a weight average molecular weight of 15,000 to 50,000 g/mol.

[Claim 5]

The electrically conductive thermoplastic resin composition according to claim 1, wherein the carbon nanotubes are single-walled carbon nanotubes or multi-walled carbon nanotubes.

[Claim 6]

The electrically conductive thermoplastic resin composition according to claim 1, wherein the carbon nanotubes have a thickness of 1 to 50 nm and a length of 0.01 to 10 ㎛.

[Claim 7]

The electrically conductive thermoplastic resin composition according to claim 1, wherein the carbon nanotubes have an aspect ratio of 100 to 1,000.

[Claim 8]

The electrically conductive thermoplastic resin composition according to claim 1, wherein the impact modifier is selected from the group consisting of a core-shell graft copolymer, a silicone polymer, an olefin polymer, and a

mixture thereof.

[Claim 9]

The electrically conductive thermoplastic resin composition according to claim 8, wherein the core-shell graft copolymer has a core-shell structure in which at least one unsaturated compound selected from the group consisting of methyl methacrylate, styrene and acrylonitrile is grafted on a rubber core polymerized from at least one selected from the group consisting of C_4-C_6 diene, acrylic and silicone rubber monomers.

[Claim 10]

The electrically conductive thermoplastic resin composition according to claim 8, wherein the silicone polymer includes a polymer of at least one selected from the group consisting of hexamethyl cyclotrisiloxane, octamethyl cyclotetrasiloxane, decamethyl cyclopentasiloxane, dodecamethyl cyclohexasiloxane, trimethyl triphenyl cyclotrisiloxane, tetramethyl tetraphenyl cyclotetrasiloxane and octaphenyl cyclotetrasiloxane monomers.

[Claim 11]

The electrically conductive thermoplastic resin

composition according to claim 8, wherein the olefin polymer includes a polymer of at least one selected from the group consisting of ethylene, propylene, isopropylene, butylene and isobutylene monomers.

[Claim 12]

The electrically conductive thermoplastic resin composition according to claim 1, wherein the conductive metal oxide includes at least one selected from the group consisting of titanium oxide, zinc oxide, indium oxide, tin oxide, indium tin oxide, antimony oxide, zirconium oxide, aluminum oxide, magnesium oxide, barium oxide, calcium oxide, strontium oxide, chromium oxide, iron oxide, and a mixture thereof.

[Claim 13]

The electrically conductive thermoplastic resin composition according to claim 12, wherein the conductive metal oxide includes zinc oxide combined with a metal selected from the group consisting of aluminum, gallium, germanium, indium and tin.

[Claim 14]

A plastic article prepared from the electrically conductive thermoplastic resin composition according to any

one of claims 1 to 13.

[Claim 15]

A plastic article comprising:

a thermoplastic resin matrix;

carbon nanotubes dispersed in the thermoplastic resin matrix;

an impact modifier dispersed in the thermoplastic resin matrix; and

conductive metal oxide dispersed in the thermoplastic resin matrix.