SPECIFICATION

ELECTRO-CONDUCTIVE RESIN COMPOSITION, AND MOLDED ARTICLE OF THE SAME

[TECHNICAL FIELD]

[0001] The present invention relates to a novel electro-conductive resin composition, and more specifically to an electro-conductive polyphenylene ether resin composition containing a styrene-base resin (occasionally abbreviated as modified polyphenylene ether resin, hereinafter) reduced in odor possibly generated when the resin is kneaded under fusion or when the molded article is heated to high temperatures, and suppressed in adhesion of dust or particle, and a article molded by using the resin, such as containers and trays for storing and carrying electric/electronic components.

[BACKGROUND ART]

[0002] With recent advancement in down-sizing, weight reduction, higher integration, and sophistication of electric, electronic, and office-automation equipment, there are growing needs of suppressing adhesion of dust or particle to the electric/electronic components to the utmost. The electric/electronic components are intrinsically incompatible with adhesion of dust or particle, because adhesion of dust or particle to the electric/electronic components may raise problems of contact failure, read error and so forth. The needs have particularly been becoming more stringent, with recent

advancement in down-sizing, weight reduction, higher integration, further sophistication of electric, electronic of recent electric/electronic components. Most typical examples include wafer used for semiconductor manufacturing; IC chip; solid-state imagers such as CCD image sensor, CMOS image sensor and so forth; and internal components of hard disk used for computers. These electric/electronic components are manufactured and assembled generally in so-called clean room extremely reduced in dust and particle, where adhesion of dust and particle is avoidable. The electric/electronic components are, however, exposed to the open air during carriage, where a problem of adhesion of dust and particle may arise. To avoid this problem, molded articles for carrying and storing the electric/electronic components (tray, case, housing and so forth for IC and CCD) are requested to use a resin material having electro-conductivity.

[0003] On the other hand, processes such as manufacturing and injection-molding of the resin composition are carried out generally under high temperatures. For example, styrene resins come into melted state at as high as 200 to 280°C, polyphenylene ether at 260 to 360°C, and modified polyphenylene ether resin at 240 to 350°C.

In addition, also molded articles obtained by molding these resin compositions are often exposed to high temperatures in the process of use. For example, when the molded article is a tray used in the processes of

manufacturing and carrying IC or CCD, such tray is used while being loaded with IC or CCD, and put into a baking chamber set to 130°C or above, in order to degas or remove (bake) a trace amount of moisture and volatile impurities such as alkali ion, Br ion and Cl ion contained therein. A sufficient degree of heating is necessary in the baking, because moisture and gaseous components otherwise remained in IC or CCD may result in fatal defects in the accuracy of IC or CCD. Aiming at improved reliability of IC or CCD, recent trend is such as elevating the baking temperature to as high as 150°C or above.

[0004] In high-temperature processes such as kneading under fusion and molding of the resin composition, and baking of the molded articles, another problems which are (1) odor derived from a small amount of source materials remaining in the resin, (2) odor caused by thermal decomposition of the resin, and (3) odor caused by decomposition of vaporization of additives reside. These sorts of odor may undesirably degrade environments of the room for manufacturing the resin composition, the room for molding process, and the peripherals. The odor is also entrained with the molded articles, such as the tray carrying thereon IC or CCD, into the clean room where ventilation is only limitedly available, and may considerably offend workers at assembly lines of electric/electronic components. Accordingly, an electro-conductive resin composition producing less odor is required for the purpose of

composing the tray for carrying electric/electronic components.

[0005] In order to provide electro-conductivity to the modified polyphenylene ether resin, a method having widely been adopted is such as mixing an electro-conductive carbon black or metal fiber. The modified polyphenylene ether resin mixed with the electro-conductive carbon black may be exemplified by the resins disclosed in Patent Document 1 and 2, but with drawbacks described in the next. (1) Elimination of the carbon black may occur in the process of contact or friction with the molded articles (so-called "drop of carbon black"), and the eliminated carbon black adheres to IC and CCD chips, wafer, internal components of hard disk used for computers to induce wrong operation. (2) The resin composition and the molded article may produce odor when heated to high temperatures. (3) The molded article may be lowered in mechanical strength, reduced in moldability, and degraded in appearance due to exposure of carbon black. (4) The resin composition is obtainable only in black, so that the molded article cannot be obtained in various colors and it is impossible to differentiate the molded article by the color of the molded article.

When the resin is mixed with metal fibers longer than 1 mm, dispersion failure of the metal fiber tends to cause due to entanglement of the metal fiber, so that the resin may be causative of variation in the electro-conductivity, or obstruction of the gate.

One electro-conductive resin composition, successfully solved in the above-described problems ascribable to carbon black, or dispersion failure of the metal fiber, may be a composition having metal fibers of 1 mm or shorter mixed therein, such as disclosed in Patent Document 3. The metal fiber disclosed in Patent Document 3 may be still long enough to obstruct the gate, and has not yet been solved in the problem of odor, which is possibly produced when the resin composition and the molded article are heated to high temperatures.

[0006] For the purpose of solving the problems of odor, there is disclosed a resin composition obtained by mixing a modified polyphenylene ether resin with carbon black, and with a synthetic zeolite having a pore size of 0.8 nm or larger, and showing a moisture adsorptivity of 20 wt% or more under conditions including a temperature of 25°C, a relative humidity of 10% at normal pressure (Patent Document 4). The synthetic zeolite described in Patent Document 4 is, however, highlighted only in the moisture adsorptivity, but is not highlighted and expressly disclosed in the silica index or the amount of crystal water of the zeolite. Moreover, only Examples using hydrophilic zeolites having small silica indices are given.

[0007] Patent Document 5 discloses an additive for resin, containing an inorganic powder capable of eliminating odor possibly produced in the processes of kneading and molding of the resin composition as a major constituent, and a

technique of using, as the inorganic powder, an aluminosilicate containing silica, a metal oxide and alumina at a specific ratio. However, as for the resin composition added with the additive for resin specifically described, Patent Document 5 gives no description on appearance and mechanical strength of the molded article. Moreover, the inorganic powders adopted in Examples are those having only small silica indices.

[0008] [Patent Document 1] Japanese Laid-Open Patent Publication No. H2-175754

[Patent Document 2] Japanese Laid-Open Patent Publication No. 2004-263016

[Patent Document 3] Japanese Laid-Open Patent Publication No. H2-178336

[Patent Document 4] Japanese Laid-Open Patent Publication No. H7-138466

[Patent Document 5] Japanese Laid-Open Patent Publication No. H11-293032

[DISCLOSURE OF THE INVENTION]

[SUBJECTS TO BE SOLVED BY THE INVENTION]

[0009] The present inventors further investigated into the above-described Patent Document 4, only to find that, when the synthetic zeolite having a moisture adsorptivity of 20 wt% or more described in Patent Document 4 was used, silver streak appeared, the molded article was poor in the appearance, and the problem of drop of carbon black remained unsolved.

The present inventors further investigated also into the resin composition of Patent Document 5, again only to find the problem of drop of inorganic powder remained unsolved.

It is therefore subjects of the present invention to provide an electro-conductive resin composition allowing coloration into colors other than black, capable of producing molded articles excellent in the appearance, and suppressed in odor possibly generated in the processes under heating at high temperatures, such as kneading under fusion and molding of resin, or in the process of heating of the resin molding at high temperatures, without impairing intrinsic characteristics of modified polyphenylene ether resin, and to provide a molded article obtained by molding the resin composition.

[MEANS FOR SOLVING THE SUBJECTS]

[0010] Aiming at solving the above-described subject, the present inventors finally found out, from our extensive investigation, that the above-described subject may be solved by using a metal fiber having a specific shape, in combination with a synthetic zeolite which is a highly-hydrophobic aluminosilicate having a large SiO_2/Al_2O_3 molar ratio.

More specifically, the present inventors found out that a resin composition obtained by mixing 100 parts by weight of resin component (C), which is composed of 50 to 92 wt% of polyphenylene ether (A) and 50 to 8 wt% of

styrene-base resin (B); 50 to 200 parts by weight of stainless-steel microfiber (D); and 0.1 to 5.0 parts by weight of synthetic zeolite (E) represented by the formula (1) below, may considerably be suppressed in generation of odor in the processes under heating at high temperatures, such as kneading under fusion and molding of resin, allowed for coloration into colors other than black, and excellent in the appearance of the molded article, without impairing inherent characteristics of the modified polyphenylene ether resin, and reached to propose the present invention.

[0011] $M_{2/n}O \cdot Al_2O_3 \cdot xSiO_2 \cdot yH_2O$ (1)

(in the formula, M represents a monovalent or divalent ion-exchangeable metal, n represents the number of valence of metal, x represents silica index (SiO_2/Al_2O_3 molar ratio) ranging from 10 to 500, and y represents the number of crystal water ranging from 0 to 7.)

[EFFECT OF THE INVENTION]

[0012] Since the low-odor, electro-conductive resin composition of the present invention allows coloration, suppressed in adhesion of dust and particle, and thereby expresses stable electro-conductivity, while keeping the intrinsic characteristics of modified polyphenylene ether resin, so that the resin composition is particularly preferable as a material for composing containers or trays, storing or carrying electric/electronic components. Since the resin composition and the molded article using the resin composition may produce in only an extremely

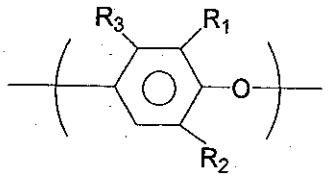
small amount of odor even under heating at high temperatures, so that a comfortable environment of working may be maintained even in a clean room where ventilation is only limitedly available. The resin composition is, therefore, suitable particularly for manufacturing molded articles such as trays for carrying electric/electronic components such as IC and CCD.

[BEST MODES FOR CARRYING OUT THE INVENTION]

[0013] Contents of the present invention will be detailed below. Note that a word "··· to ···" in this specification will be used to indicate a range including the lower and upper limits represented by the numerals given therebefore and thereafter, respectively. In this patent specification, any "group" such as alkyl group may have substituent(s) or may have no substituent, unless otherwise specifically noted.

In the present invention, the polyphenylene ether (A) means a polymer having an aromatic polyether structure, and is preferably a polymer having, in the principal chain thereof, a structural unit represented by the formula (2) below:

[0014] [Chemical Formula 1]



(2)

(where, R_1 represents a lower alkyl group having 1 to 3 carbon atom(s), each of R_2 and R_3 independently represents

a hydrogen atom or lower alkyl group having 1 to 3 carbon atom(s)), and may be a homopolymer or copolymer.

R_1 is preferably a methyl group or ethyl group.

When each of R_2 and R_3 represents a lower alkyl group having 1 to 3 carbon atom(s), each of them may preferably be a methyl group or ethyl group.

[0015] Examples of the polyphenylene ether (A) may include homopolymers such as poly(2,6-dimethyl-1,4-phenylene) ether, poly(2,6-diethyl-1,4-phenylene) ether, poly(2,6-dipropyl-1,4-phenylene) ether, poly(2-methyl-6-ethyl-1,4-phenylene) ether, and poly(2-methyl-6-propyl-1,4-phenylene) ether; and copolymers including various 2,6-dialkylphenol/2,3,6-trialkylphenol copolymers, wherein poly(2,6-dimethyl-1,4-phenylene) ether, and 2,6-dimethylphenol/2,3,6-trimethylphenol copolymer are particularly preferable. Also any polyphenylene ethers having molecular structural portions contributive to improvement in the characteristics of molecular weight, melt viscosity, impact strength and so forth may be adoptable.

[0016] The polyphenylene ether (A) used in the present invention preferably has an intrinsic viscosity of 0.2 to 0.8 dl/g, and more preferably 0.3 to 0.6 dl/g, measured in chloroform at 30°C. Adjustment of the intrinsic viscosity to 0.2 dl/g or larger may raise a tendency towards improvement in the mechanical strength, whereas adjustment to 0.8 dl/g or smaller may raise a tendency

towards improvement in the fluidity, and thereby facilitates the molding process.

[0017] The styrene-base resin (B) used in the present invention may be exemplified by polymer of styrene-base monomers, copolymer of styrene-base monomers with other co-polymerizable monomer(s), and styrene-base graft copolymer.

[0018] The styrene-base monomer may be exemplified by styrene, α-methylstyrene, and *p*-methylstyrene, among which styrene is preferable. The monomer co-polymerizable with the styrene-base monomer may be exemplified by vinyl cyanate monomers such as acrylonitrile and methacrylonitrile; alkyl (meth)acrylate ester monomers such as methyl acrylate, ethyl acrylate, propyl acrylate, methyl methacrylate, and ethyl methacrylate; maleimide; and N-phenylmaleimide, among which vinyl cyanate monomer and alkyl (meth)acrylate ester are preferable.

The copolymer of styrene-base monomers with other co-polymerizable monomer(s) may be exemplified by styrene-acrylonitrile resin (AS resin), and the styrene-base graft copolymer may be exemplified by high-impact polystyrene (HIPS resin), acrylonitrile/butadiene/styrene resin (ABS resin), AES resin having butadiene in the above-described ABS resin substituted with ethylene-propylene-base rubber, and acrylonitrile/acrylate/styrene resin (AAS resin). Methods of manufacturing the styrene-base copolymers may

be exemplified by publicly-known methods including emulsion polymerization, solution polymerization, suspension polymerization and bulk polymerization.

The styrene-base resin (B) may preferably be polystyrene or high-impact polystyrene, from the viewpoint of compatibility with polyphenylene ether. For the case of special need of impact strength, high-impact polystyrene is more preferable.

[0019] The resin component (C) in the present invention contains 50 to 92 wt% of polyphenylene ether (A), and 50 to 8 wt% of styrene-base resin (B). The resin component (C) may more preferably contain 60 to 90 wt% of polyphenylene ether (A), and 40 to 10 wt% of styrene-base resin (B), and may still more preferably contain 70 to 90 wt% of polyphenylene ether (A), and 30 to 10 wt% of styrene-base resin (B). The content of polyphenylene ether (A) less than 50 wt% may raise a tendency towards lowering of the Deflection temperature under load and mechanical strength, whereas the content exceeding 92 wt% may undesirably raise a tendency towards lowering of the fluidity, and consequently complicating the molding process.

[0020] The resin component (C) in the present invention may preferably be mixed with an additional styrene-base elastomer, aiming at improving the impact strength. The styrene-base elastomer preferably mixed in the present invention may be exemplified by block copolymers having the hard segment configured by styrene polymer and having

the soft segment configured by at least one polymer selected from the group consisting of polybutadiene, polyisoprene and hydrogen-added products of them. More specifically, SBS (styrene/butadiene/styrene block copolymer), SIS (styrene/isoprene/styrene block copolymer), SEBS (styrene/ethylene/butylene/styrene block copolymer: hydrogen-added product of SBS), SEPS (styrene/ethylene/propylene/styrene block copolymer: hydrogen-added product of SIS) and so forth may be exemplified, among which SEBS is particularly preferable.

Compositional ratio of the hard segment and the soft segment of the styrene-base elastomer may appropriately be selectable in the range from 10:90 to 90:10 (molar ratio), and more preferably from 10:90 to 50:50. Modes of bonding of the hard segment block and the soft segment block may be either of the diblock-type and triblock-type.

The number-average molecular weight of the styrene-base elastomer may preferably 20,000 to 180,000, more preferably 30,000 to 160,000, and still more preferably 35,000 to 140,000. By adjusting the number-average molecular weight to 20,000 or larger, the impact strength and dimensional stability of the finally-obtainable resin composition may be improved, and also the appearance of the molded article obtainable from the resin composition may be improved. On the other hand, by adjusting the number-average molecular weight to 180,000 or smaller, the fluidity of the finally-obtainable

resin composition may be improved, and thereby the molding process may be facilitated.

[0021] The amount of mixing the styrene-base elastomer may be 1 to 25 wt%, preferably 3 to 20 wt%, and more preferably 5 to 15 wt% in the resin component (C). The amount of mixing of the styrene-base elastomer adjusted to 1 wt% or more raises a tendency towards improvement of the mechanical strength. The amount of mixing of the styrene-base elastomer adjusted to 25 wt% or less may raises a desirable tendency towards improvement in the rigidity and Deflection temperature under load of the resin composition.

The resin component (C) used in the present invention may contain other resin component(s), without departing from the spirit of the present invention. The content(s) of other resin component(s) in this case may generally be 50 wt% or less of the resin component (C).

[0022] In the present invention, the stainless steel microfiber (D) is mixed, mainly for the purpose of imparting electro-conductivity to the resin composition. Species of stainless steel which serves as a source material of the stainless-steel microfiber (D) used in the present invention is not specifically limited, wherein SUS304, SUS316 and SUS403, specified by JIS, and mixtures of them may be preferable.

The mean fiber length of the stainless-steel microfiber (D) is preferably 50 to 500 μm, and more preferably 100 to 300 μm. The mean fiber length adjusted

to 50 μm or longer raises a tendency towards improvement in the electro-conductivity, whereas the mean fiber length adjusted to 500 μm or shorter may be more likely to suppress entanglement and consequent dispersion failure of the fiber, to suppress variation in the electro-conductivity, to avoid obstruction of the gate in the process of molding, and to elevate the mechanical strength of the article.

The average fiber diameter of the stainless-steel microfiber (D) is preferably 1 to 50 μm, more preferably 10 to 30 μm, and particularly preferably 10 to 20 μm. The average fiber diameter adjusted to 1 μm or larger makes the fiber less likely to fracture, and the diameter adjusted to 50 μm or smaller raises tendencies towards improvement in the electro-conductivity and appearance. Note that the mean fiber length and the average fiber diameter of the stainless-steel microfiber in the context of the present invention are defined as number-average values of the length and diameter of 2000 pieces of stainless-steel microfiber, obtained by scattering the stainless-steel microfiber as a source material onto a slide glass, observing and photographing them under a microscope, and analyzing the obtained photograph using an image analyzing software ("Image-Pro Plus" from Planetron, Inc.).

The density of the stainless-steel microfiber (D) is preferably 7.7 to 8.0.

The stainless-steel microfiber (D) used in the present invention may also be treated with a surface

modifier such as coupling agent generally used as a surface modifier for glass fiber.

The stainless-steel microfiber (D) used in the present invention is less causative of bleeding-out up to the surface of molded article, as compared with electro-conductive carbon black having conventionally been used for the purpose of providing electro-conductivity, and thereby ensures desirable appearance while causing only a small amount of dropping. By virtue of its small ratio of volume relative to the amount of mixing, the stainless-steel microfiber (D) ensures desirable dispersion in the resin composition, without causing variation in the electro-conductivity, color unevenness, and reduction in the mechanical strength due to dispersion failure. In the present invention, the above-described effects may more effectively be expressed, particularly by using the stainless-steel microfiber (D) having an mean fiber length of as short as 100 to 300 μm or around.

[0023] The amount of mixing of the stainless-steel microfiber (D) is preferably 50 to 200 parts by weight per 100 parts by weight of the resin component (C), more preferably 60 to 150 parts by weight, and still more preferably 60 to 120 parts by weight. The amount of mixing adjusted to 50 parts by weight or more raises tendencies towards considerable lowering in the surface resistivity, and improvement in the electro-conductive effect. On the other hand, the amount of mixing adjusted to 200 parts by

weight or less raises tendencies towards lowering in the specific gravity, and improvement in the mechanical strength.

[0024] In the present invention, the synthetic zeolite (E) is mixed, mainly for the purpose of reducing odor possibly generated from the resin composition heated at high temperatures, caused by residual source materials, thermal decomposition of the resin, thermal decomposition or vaporization of the additives, and so forth. The synthetic zeolite (E) used in the present invention is aluminosilicate generally composed of a three-dimensional skeletal structure, represented by the formula (1) below:

[0025] $M_{2/n}O \cdot Al_2O_3 \cdot xSiO_2 \cdot yH_2O$ (1)

(where, M represents an ion-exchangeable monovalent or divalent metal, n represents valence of metal, x represents silica index (SiO_2/Al_2O_3, molar ratio) ranging from 10 to 500, y represents the number of crystal water, ranging from 0 to 7.)

[0026] Zeolite may be classified into natural zeolite and synthetic zeolite, and the synthetic zeolite may further be classified into hydrophilic zeolite having a small (smaller than 10) silica index (for example, A-type zeolite, X-type zeolite, Y-type zeolite), and hydrophobic zeolite having a large (10 or larger) silica index (for example, MFI-type zeolite). The above-described synthetic zeolite (E) used in the present invention is preferably the hydrophobic zeolite, in view of the

commercial availability, and more preferably MFI-type synthetic zeolite. The hydrophobic MFI-type synthetic zeolite has a three-dimensional network structure composed of linear pores, opening of each of them being composed of a ten-membered oxygen ring, and zigzag pores cross normal to the linear pores, preferably given as an elliptic shape having an effective pore size of 5 to 6Å, a pore volume of 0.15 to 0.25 mL/g, and a specific surface area of 300 to 550 m^2/g, and more preferably given as an elliptic shape having an effective pore size of 5 to 6Å, a pore volume of 0.15 to 0.25 mL/g, and a specific surface area of 300 to 450 m^2/g.

[0027] The synthetic zeolite (E) used in the present invention needs be represented by the formula (1) shown in the above, more preferably has a silica index x of 20 to 60, and still more preferably 30 to 60. M in the formula (1) may more preferably be sodium, potassium or calcium, and still more preferably sodium. The lower value of y in the formula (1) is the better.

The synthetic zeolite (E) used in the present invention is preferably a synthetic zeolite having a moisture adsorptivity of smaller than 20 wt% under conditions of temperature=25°C/relative humidity=10%/normal pressure, and more preferably smaller than 15 wt%, and still more preferably smaller than 10 wt%. In particular, the synthetic zeolite represented by the formula (1), having a silica index x of 20 to 60,

and a moisture adsorptivity of smaller than 10 wt%, under conditions of temperature=25°C/relative humidity=10%/ normal pressure, is excellent in the heat resistance and hydrophobicity. The molded article obtained from the low-odor resin composition mixed with such synthetic zeolite may be characterized also by its excellent appearance, without showing silver streak.

The mean primary particle size of the synthetic zeolite (E) relevant to the present invention is preferably 0.1 to 20 μm, more preferably 0.2 to 10 μm, and still more preferably 0.5 to 5 μm. The mean primary particle size of the synthetic zeolite (E) adjusted to 0.1 μm or larger raises a tendency towards reduction in the melt viscosity of the resin composition, whereas the mean primary particle size adjusted to 20 μm or larger raises a tendency towards improved appearance, while making surface roughening less visible.

[0028] The amount of addition of the synthetic zeolite (E) is preferably 0.1 to 5.0 parts by weight, and more preferably 0.2 to 3.0 parts by weight, per 100 parts by weight of the resin component (C). The amount of addition less than 0.1 parts by weight may reduce the odor only to a limited degree, whereas the amount of addition exceeding 5.0 parts by weight may be no more effective in further reduction in the odor, and may raise a problem of degradation in the mechanical strength.

[0029] The low-odor, electro-conductive resin composition of the present invention may be added with additives

besides the above-described components, which are exemplified by colorants such as pigment and dye, mold-release agents such as aliphatic carboxylic acid, aliphatic carboxylate ester, polyolefin-base wax, and silicone oil, stabilizers such as hindered phenol compounds, phosphorus-containing compounds and zinc oxide, flame retarders such as phosphate ester and condensed phosphate ester, ultraviolet absorber such as compounds of hindered amine-base, benzotriazole-base, benzophenone-base, and epoxy-base, antioxidant, lubricant, plasticizer, antistatic agent, sliding agent, and compatibilizer; fluorine-containing resins expressing an action of preventing melt dropping during combustion of the resin, such as difluoroethylene polymer, tetrafluoroethylene polymer, tetrafluoroethylene-hexafluoropropylene copolymer, and copolymer of tetrafluoroethylene and fluorine-free, ethylene-base monomer; reinforcing fillers such as glass fiber, glass flake, carbon fiber, and metal fiber other than stainless-steel microfiber; and inorganic fillers such as whisker of potassium titanate, aluminum borate and calcium silicate, mica, talc and clay, depending on needs. These additives may appropriately be mixed by any of publicly-known methods allowing full expression of their properties.

[0030] In the present invention, a colorant (F) may be added. In many cases, the conventional electro-conductive resin compositions have been obtained only in black, because

carbon black has been adopted in order to impart electro-conductivity. In contrast, in the present invention, the resin composition may freely be colored because the electro-conductivity may be imparted without using the electro-conductive carbon black.

The colorant (F) used in the present invention may be exemplified by dye, inorganic pigment, and organic pigment generally adopted to thermoplastic resins.

The dye may be exemplified by azo dye, anthraquinone dye, phthalocyanine dye, indigo dye, diphenylmethane dye, acridine dye, cyanine dye, nitro dye, and nigrosine. The inorganic pigment may be exemplified by oxide pigments such as titanium oxide, red iron oxide and cobalt blue; hydroxide pigments such as alumina white; sulfate pigments such as zinc sulfate and cadmium yellow; silicate pigments such as white carbon and talc; and carbon black. The organic pigment may be exemplified by nitro pigment, azo pigment, phthalocyanine pigment, and condensed polycyclic pigment. Among these, the inorganic pigment is preferable because it may be less likely to bleed out on the surface of the molded article. For the purpose of improving handlability in extrusion, the colorant may be included in a master batch together with a thermoplastic resin such as polyphenylene ether resin, polystyrene-base resin, polycarbonate-base resin and acrylic resin.

[0031] The amount of mixing of the colorant (F) is preferably 0.01 to 20 parts by weight, and more preferably 0.1 to 15 parts by weight, per 100 parts by weight of the

resin component (C). The inorganic pigment such as titanium oxide may occasionally be used for the purpose other than coloration (for example, provision of light blocking), wherein the amount of addition in this case may generally be 5 to 20 parts by weight, and preferably 5 to 15 parts by weight, per 100 parts by weight of the resin component (C). Two or more species of these colorants may be used in combination.

[0032] The stabilizer used in the present invention may be exemplified by hindered phenol compounds, phosphorus-containing compounds and zinc oxide.

Specific examples of the hindered phenol compounds include, *n*-octadecyl-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl) propionate, 1,6-hexanediol-bis[3-(3,5-di-*tert*-butyl-4-hydroxyphenyl) propionate], pentaerythritol-tetrakis[3-(3,5-di-*tert*-butyl-4-hydroxyphenyl) propionate], 2,6-di-*tert*-butyl-4-methylphenol, 3,9-bis[1,1-dimethyl-2-{β-(3-*tert*-butyl-4-hydroxy-5-methylphenyl)propionyloxy}ethyl]-2,4,8,10-tetraoxaspiro[5,5]undecane, triethylene glycol-bis[3-(3-tert-butyl-5-methyl-4-hydroxyphenyl) propionate], 3,5-di-*tert*-butyl-4-hydroxybenzyl phosphonate-diethyl ester, 1,3,5-trimethyl-2,4,6-tris (3,5-di-*tert*-butyl-4-hydroxybenzyl)benzene, 2,2-thio-diethylene-bis[3-(3,5-di-*tert*-butyl-4-hydroxyphenyl) propionate], tris(3,5-di-*tert*-butyl-4-hydroxybenzyl) -isocyanulate, and N,N′-hexamethylene-bis(3,5-di-*tert*-

butyl-4-hydroxy-hydrocinnamide). Among these, *n*-octadecyl-3-(3,5-di-*tert*-butyl-4-hydroxyphenyl) propionate, 1,6-hexanediol-bis[3-(3,5-*tert*-butyl-4-hydroxyphenyl) propionate], 2,6-di-*tert*-butyl-4-methylphenol, and 3,9-bis[1,1-dimethyl-2-{β-(3-*tert*-butyl-4-hydroxy-5-methylphenyl)propionyloxy}ethyl]-2,4,8,10-tetraoxaspiro[5,5]undecane are preferable.

[0033] As the phosphorus-containing compound, phosphonite compound and phosphite compound may preferably be used.

The phosphonite compound may be exemplified by tetrakis(2,4-di-*tert*-butylphenyl)-4,4'-biphenylene diphosphonite, tetrakis(2,5-di-*tert*-butylphenyl) -4,4'-biphenylene diphosphonite, tetrakis(2,3,4-trimethylphenyl)-4,4'-biphenylene diphosphonite, tetrakis(2,3-dimethyl-5-ethylphenyl)-4,4'-biphenylene diphosphonite, tetrakis(2,6-di-*tert*-butyl-5-ethylphenyl)-4,4'-biphenylene diphosphonite, tetrakis(2,3,4-tributylphenyl)-4,4'-biphenylene diphosphonite, and tetrakis(2,4,6-tri-*tert*-butylphenyl) -4,4'-biphenylene diphosphonite. Among these, tetrakis (2,4-di-*tert*-butylphenyl)-4,4'-biphenylene diphosphonite is preferable.

The phosphite compound may be exemplified by tris(2,4-di-*tert*-butylphenyl) phosphite, bis(2,4-di-*tert*-butylphenyl)pentaerythritol diphosphite, bis(2,6-di-*tert*-butyl-4-methylphenyl)pentaerythritol diphosphite, 2,2-methylene-bis(4,6-di-*tert*-butylphenyl)octyl phosphite, 4,4'-butylidene-bis(3-

methyl-6-*tert*-butylphenylditridecyl) phosphite, 1,1,3-tris(2-methyl-4-ditridecylphosphite-5-*tert*-butyl-phenyl)butane, tris(nonylphenyl) phosphite, and 4,4'-isopropylidene-bis(phenyldialkylphosphite). Preferable examples include tris(2,4-di-*tert*-butylphenyl) phosphite, 2,2-methylene-bis(4,6-di-*tert*-butylphenyl) octylphosphite, and bis(2,6-di-*tert*-butyl-4-methylphenyl)pentaerythritol diphosphite.

[0034] As the zinc oxide, those having a mean particle size of 0.02 to 1 μm are preferable, and those having a mean particle size of 0.08 to 0.8 μm are more preferable.

Among these stabilizers, zinc oxide is preferable because it is less likely to produce mold deposit, and to induce color change.

[0035] The amount of addition of the stabilizer is preferably 0.01 to 5 parts by weight, and more preferably 0.05 to 3 parts by weight, per 100 parts by weight of the resin component (C). The amount of addition adjusted to 0.01 parts by weight or more allows the stabilizer to sufficiently express its effect, and the amount of addition adjusted to 5 parts by weight or less suppresses degradation of the mechanical strength, and production of mold deposit in the process of molding. Two or more species of these stabilizers may be used in combination.

[0036] The mold-release agent used in the present invention may be exemplified by aliphatic carboxylic acid, aliphatic carboxylate ester, polyolefin-base wax, and silicone oil.

The aliphatic carboxylic acid may be exemplified by saturated or unsaturated aliphatic monocarboxylic acid, dicarboxylic acid or tricarboxylic acid. The aliphatic carboxylic acid herein includes also alicyclic carboxylic acid. Among these, preferable aliphatic carboxylic acid is a mono- or dicarboxylic acid having 6 to 36 carbon atoms, wherein aliphatic saturated monocarboxylic acid having 6 to 36 carbon atoms is more preferable. Specific examples of the aliphatic carboxylic acid may be exemplified by palmitic acid, stearic acid, valeric acid, caproic acid, capric acid, lauric acid, arachic acid, behenic acid, lignoceric acid, cerotic acid, melissic acid, tetratriacontanic acid, montanic acid, glutaric acid, adipic acid, and azelaic acid.

[0037] As the aliphatic carboxylic acid component composing the aliphatic carboxylate ester, those similar to the above-described aliphatic carboxylic acid may be adoptable. On the other hand, the alcoholic component composing the aliphatic carboxylate ester may be exemplified by saturated or unsaturated monohydric alcohol, and saturated or unsaturated polyhydric alcohol. These alcohol may have a substituent such as a fluorine atom, and aryl group. Among these alcohols, monohydric or polyhydric saturated alcohol having 30 or smaller number of carbon atoms may be preferable, and aliphatic saturated monohydric alcohol or polyhydric alcohol having 30 or smaller number of carbon atoms may be more

preferable. The aliphatic alcohol herein includes also alicyclic alcohol.

[0038] These alcohols may specifically be exemplified by octanol, decanol, dodecanol, stearyl alcohol, behenyl alcohol, ethylene glycol, diethylene glycol, glycerin, pentaerythritol, 2,2-dihydroxy perfluoropropanol, neopentylene glycol, ditrimethylolpropane, and dipentaerythritol. These aliphatic carboxylate ester may contain, as an impurity, aliphatic carboxylic acid and/or alcohol, or may be mixtures of a plurality of compounds.

[0039] The aliphatic carboxylate ester may specifically be exemplified by bees wax (mixture containing myristyl palmitate as a major constituent), stearyl stearate, behenyl behenate, octyldodecyl behenate, glycerin monopalmitate, glycerin monostearate, glycerin distearate, glycerin tristearate, pentaerythritol monopalmitate, pentaerythritol monostearate, pentaerythritol distearate, pentaerythritol tristearate, and pentaerythritol tetrastearate.

[0040] The polyolefin-base wax may be exemplified by homopolymer and copolymer of olefin. The homopolymer of olefin may be exemplified by polyethylene wax, polypropylenewax, and partially oxidized products or mixtures of them. The copolymer of olefin may be exemplified by copolymers of α-olefins such as ethylene, propylene, 1-butene, 1-hexene, 1-decene, 2-methylbutene-1,3-methylbutene-1,3-methylpentene-1,4-

methylpentene-1; and copolymers of these olefins and monomers co-polymerizable therewith, which are polymerizable monomers exemplified by unsaturated carboxylic acid or its acid anhydride [maleic anhydride, (meth)acrylic acid, for example], and (meth)acrylate ester [C_{1-6} alkyl esters of (meth)acrylic acid such as methyl (meth)acrylate and ethyl (meth)acrylate]. These copolymer include random copolymer, block copolymer, or graft copolymer. The olefin copolymer is generally a copolymer of ethylene, polymerized with at least one species of monomer selected from other olefins and polymerizable monomers. Among these polyolefin waxes, polyethylene wax is most preferable. The polyolefin wax may have either structure of linear or branched structure.

[0041] The silicone oil may be exemplified by those composed of poly(dimethyl siloxane); silicone oil having a part or all of methyl groups of poly(dimethyl siloxane) substituted by phenyl group, hydrogen atom, alkyl group having two or more carbon atoms, halogenated phenyl group or fluoroester group; epoxy-modified silicone oil having epoxy groups; amino-modified silicone oil having amino groups; alcohol-modified silicone oil having alcoholic hydroxyl groups; and polyether-modified silicone oil having polyether structure. Two or more species of silicone oil may be used in combination.

[0042] The amount of mixing of the mold-release agent is preferably 0.01 to 10 parts by weight, more preferably 0.1 to 6 parts by weight, and still more preferably 0.1 to 3

parts by weight, per 100 parts by weight of the resin component (C). The amount of mixing adjusted to 0.01 parts by weight or more allows the mold-releasing effect to express more effectively, and the amount of mixing adjusted to 10 parts by weight or less desirably suppress makes problems in heat resistance, pollution of mold and plasticization failure less likely to occur.

[0043] Methods of obtaining the electro-conductive resin composition of the present invention include (1) a method of kneading en bloc the above-described components and optionally-added additives under fusion, using various types of kneader such as single-screw and multi-screw kneaders, Banbury mixer, roll mixer, and Brabender plastograph, (2) a method of preliminarily kneading the above-descried components and a part of optionally-added additives, and followed by further kneading with other component(s) (including a method of using master batch), and (3) a method of mixing optionally-added additives, preliminarily dissolved or dispersed in an appropriate solvent such as hydrocarbon, which is exemplified by hexane, heptane, benzene, toluene, xylene, and their derivatives, with the resin component (C). The methods (1) and the melt kneading method (2) may be preferable from the viewpoint of industrial cost, but may not be limited thereto. A single-screw or double-screw extruder may preferably be used in melt kneading.

[0044] Injection-molding method is often used as a method of molding using the electro-conductive resin composition

of the present invention, for example, as a method of molding containers and trays for storing and carrying electric/electronic components, in view of its excellence in productivity. The method is, however, not specifically limited thereto, and allows adoption of those generally used for molding thermoplastic resins, such as blow molding, extrusion molding, heat molding using sheet-form molded article, and rotational molding.

The molded article molded by using the electro-conductive resin composition of the present invention may be exemplified by trays for IC and CCD; containers such as case and housing for storing electric/electronic components; and trays for carrying. The electro-conductive resin composition of the present invention is particularly preferable for trays for carrying IC and CCD, used at high temperatures in the process of baking or the like.

[0045] The Charpy impact strength of the resin composition of the present invention is preferably 20 kJ/m^2 or larger, when measured according to the method described later. The Deflection temperature under load of the resin composition of the present invention is preferably 155°C or higher, when measured according to the method described later.

[Examples]

[0046] The present invention will further be detailed referring to Examples. Note that the present invention

will not be limited by Examples below, without departing from the spirit thereof. Evaluation of the resin composition and the molded article in Examples and Comparative Examples were carried out as described below.

[0047] (1) Odor A: In the process of melt kneading of the resin composition carried out under the conditions for manufacturing described later, odor was sensed by five judges at a position 50 cm away from the dies of a double-screw extruder (with a 30-mm-diameter screw), and rated according to the criteria below. The total score of all judges was adopted as an evaluation score.

Odor B: An ISO test piece for Charpy impact test, obtained under the molding conditions described later, was placed in a 300-mL stoppered Erlenmeyer flask, and heated at 140°C for 3 hours. The odor was sensed by five judges, and rated according to the criteria below. The total score was adopted as an evaluation score.

Score	Judgment Criteria
1	very slight odor;
2	slight odor;
3	readily sensible odor;
4	strong odor; and
5	very strong odor.

[0048] (2) Gate Obstruction Tendency: Using a mold having a gate diameter of 0.7 mm and a gate land of 2.0 mm, at the center of a 1.0-mm thick, 50-mm-diameter circular plate, a 500-shot continuous injection-molding was carried out under conditions of a cylinder set temperature of 290 to

330°C, a mold temperature of 120°C, and a molding cycle of 30 seconds. The number of shots at which gate obstruction was observed first, was checked. Those causing no obstruction even in the 500-th shot were denoted as ">500" in Table 1.

[0049] (3) Appearance of Molded Article: Occurrence of silver streak, flow mark and so forth on each 50 mm×90 mm×3.2mm(t) rectangular plate molded article, obtained according to the conditions of molding described later, was visually observed, and the molded articles were rated according to three steps of ○, △ and × as shown below, in the order of excellence of appearance thereof.

○: Appearance defect such as silver streak and flow mark not observed;

△: appearance defect such as silver streak and flow mark slightly observed; and

×: appearance defect such as silver streak and flow mark frequently observed.

[0050] (4) Charpy Impact Strength: Five ISO test pieces for Charpy impact test, obtained according to the conditions of molding described later, were used for every measurement at 23°C conforming to ISO527. The Charpy impact strength (simply denoted as impact strength, hereinafter) was expressed by an average value from five pieces.

[0051] (5) Deflection Temperature under Load: Deflection temperature under load (abbreviated as DTUL, hereinafter) of each ISO test piece for Deflection temperature under load test, obtained according to the conditions of molding

described later, was measured under 1.82-MPa load, conforming to ISO75.

[0052] (6) Surface Resistivity: Surface resistivity was measured at three arbitrary points on each 50 mm×90 mm×3.2 mm(t) rectangular plate molded article obtained under the conditions of molding described later, using Rolesta or Hiresta (manufactured by Mitsubishi Chemical Corporation). Hiresta was used for the molded articles having a surface resistivity of 10^4 Ω or larger, whereas Rolesta was used for the molded articles showing smaller surface resistivity.

[0053] (7) Anti-Peeling-Off Property against Tape: "Cellotape" (registered trade name) CT405A-18" from Nichiban Co., Ltd. was placed on the surface of each 50 mm×90 mm×3.2 mm(t) rectangular plate article obtained under the conditions of molding described later, and then peeled off. The state of the surface of peeled molded articles was visually observed, and rated according to three steps of ○, △ and × as shown below. It may be judged that the smaller degree of the peeling, the smaller amount of dropping of the stainless-steel microfiber and carbon black is.

○: No peeling observed on the surface of article, even after placing Cellotape, rubbing it under pressure, and peeling it off:

△: peeling observed on the surface of article, after placing Cellotape, rubbing it under pressure, and peeling it off; and

×: peeling observed on the surface of article, only after placing Cellotape, and rubbing it softly.

[0054] [Source Materials]

The source materials listed below were used.

(1) Poly(2,6-dimethyl-1,4-phenylene) ether resin: trade name "PX100F" from Mitsubishi Engineering-Plastics Corporation, intrinsic viscosity=0.38 dl/g (measured in chloroform at 30°C) (abbreviated as "PPE", hereinafter)

(2) Styrene-base resin: high-impact polystyrene: trade name "H485", from Toyo Styrene Co., Ltd., weight-average molecular weight=200,000, MFR=3.2 g/10 min. (abbreviated as "HIPS", hereinafter)

[0055] (3-1) Stainless-steel microfiber: trade name "SMF-708AE", from JFE Techno-Research Corporation, mean fiber length =150 μm, mean fiber diameter=15 μm, specific gravity=7.9 (abbreviated as "SMF", hereinafter)

(3-2) (for Comparative Examples) Stainless-steel fiber: master pellet of stainless-steel fiber, trade name "Lioconduct", from Toyo Ink MFG. Co., Ltd., obtained by compositizing 8-μm-diameter, stainless-steel fiber with polyester and by cutting into 4-mm-long pellets, stainless-steel content=75 wt% (abbreviated as "SUS", hereinafter)

(3-3) Carbon black: trade name "Ketjen Black EC" from Ketjen Black International Company, mean particle size=30 μm (abbreviated as "CB", herein after)

[0056] (4-1) MFI-type synthetic high-silica zeolite: trade name "Mizukasieves EX-122" from Mizusawa Industrial Chemicals, Ltd., M in the above formula (1) is sodium, n=1, silica index x=33, the number of crystal water y=0 to 7, having an elliptic shape with effective pore size=5 to 6Å, pore volume=0.15 to 0.25 mL/g, specific surface area=300 to 450 m^2/g, mean primary particle size=2.0 μm, moisture adsorptivity=7 wt%, measured under conditions of temperature 25°C/relative humidity=10%/normal pressure (abbreviated as "M-zeolite", hereinafter)

(4-2) (For Comparative Examples) X-type zeolite: trade name "Zeostar NX-110P" from Nippon Chemical Industrial Co., Ltd., silica index x=2.6, effective pore size=9 Å, mean primary particle size=3 μm, moisture adsorptivity=25 wt%, measured under conditions of temperature 25°C/relative humidity=10%/normal pressure (abbreviated as "X-zeolite", hereinafter)

[0057] (5) Mold-release agent: polyethylene wax, trade name "Sanwax 151P" from Sanyo Chemical Industries, Ltd., density=0.93g/ mL, weight-average molecular weight=2,000 (abbreviated as "mold-release agent", hereinafter)

(6) Stabilizer: zinc oxide (first-grade reagent), from the Honjo Chemical Corporation (abbreviated as "stabilizer", hereinafter)

(7) Colorant: Red inorganic pigment, trade name "140ED" from Toda Kogyo Corporation

[0058] [Method of Manufacturing Resin Composition]

Each composition prepared according to the ratio of mixing shown in Table 1 was kneaded under fusion, using "VS-40" (vent-type single-screw extruder having a screw diameter of 40 mm) from Tanabe Plastics Machinery Co., Ltd., at a cylinder set temperature of 270 to 320°C, and a speed of rotation of screw of 50 rpm, to thereby manufacture an electro-conductive resin composition in a pellet form.

[Method of Manufacturing Test Pieces for Evaluation]

The electro-conductive resin composition, obtained in a pellet form by the method described in the above, was dried at 110°C for 4 hours using a hot air drier, and molded by injection-molding using an injection-molding machine Model IS150 from Toshiba Machine Co., Ltd., so as to produce 50 mm×90 mm×3.2mm(t) rectangular plate articles to be evaluated in the appearance, surface resistivity and anti-peeling-off property against tape, at a cylinder set temperature of 300 to 330°C, and at a mold temperature of 100 to 120°C for production of the molded articles to be evaluated in the appearance and surface resistivity, varied depending on the composition, and at a mold temperature of 140°C for production of the articles to be evaluated in the anti-peeling-off property against tape. The ISO test pieces to be subjected to Charpy impact test and Deflection temperature under load test were molded using an injection-molding machine Model J50 from The Japan Steel Works, Ltd., according to the same temperature

conditions under which the above-described rectangular plate articles were injection-molded.

[0059] [Examples 1 to 3, Comparative Examples 1 to 4]

Results of the evaluation according to the above-described methods were shown in Table 1.

The resin compositions of Examples 1 to 3 of the present invention were found to be low in odor, caused no obstruction of the gate during the injection-molding, excellent in all of the appearance of molded article, impact strength, DTUL, surface resistivity, and anti-peeling-off property against tape. On the contrary, the resin composition of Comparative Example 1, obtained without using zeolite, was found to be very strong in odor, and poor in the impact strength. The resin composition of Comparative Example 2, having the composition same as that in Example 1, except that X zeolite, having been used in the previous literature, was found to be slight odorous, undesirable in the appearance of article, and poor also in the impact strength and anti-peeling-off property against tape. The resin composition of Comparative Example 3, having the composition same as that in Example 2 except that the master pellet of stainless-steel fiber was used in place of the stainless-steel microfiber (D), was found to be slightly poor in the odor, disabled the gate due to obstruction at the 135-th shot after the start of the molding operation, degraded in the appearance of article and anti-peeling-off property of against tape, and largely degraded in the impact strength. The resin

composition of Comparative Example 4 obtained by using carbon black in place of stainless-steel microfiber (D) was found to be slightly odorous, degraded in the appearance of article and DTUL, and also largely degraded in the impact strength and anti-peeling-off property against tape.

[0060] [Table 1]

		Units	Examples			Comparative Examples			
			1	2	3	1	2	3	4
Ratios of mixing	PPE	parts by weight	83	87	83	83	83	87	83
	HIPS	parts by weight	17	13	17	17	17	13	17
	SMF	parts by weight	105	60	105	105	105	—	—
	SUS	parts by weight	—	—	—	—	—	60	—
	CB	parts by weight	—	—	—	—	—	—	12
	M-zeolite	parts by weight	1.0	0.8	1.0	—	—	0.8	1.0
	X-zeolite	parts by weight	—	—	—	—	1.0	—	—
	Mold-release agent	parts by weight	1.3	1.0	1.3	1.3	1.3	1.0	1.3
	Stabilizer	parts by weight	0.8	0.6	0.8	0.8	0.8	0.6	0.8
	Colorant	parts by weight	—	—	2.0	—	—	—	—
Results of evaluation	Odor A	points	9	9	9	22	13	10	14
	Odor B	points	7	6	7	16	10	8	11
	Gate obstruction tendency	number of shots	>500	>500	>500	>500	>500	135	>500
	Appearance of molded article	—	○	○	○	○	×	△	△
	Impact strength	kJ/m^2	23.7	22.8	21.8	20.3	20.3	10.5	13.0
	DTUL	°C	168	162	167	166	166	160	160
	Surface resistivity	Ω	1.0×10^5	4.2×10^7	1.5×10^5	8.3×10^4	7.4×10^4	9.6×10^6	2.0×10^5
	Anti-peeling-off property against tape	—	○	○	○	○	△	△	×

CLAIM

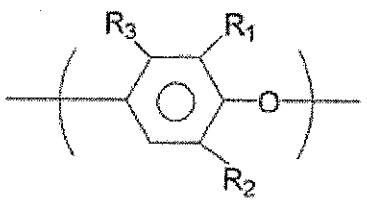
[1] An electro—conductive resin composition, comprising 100 parts by weight of resin component (C), the resin component comprising 50 to 92 wt% of polyphenylene ether (A) and 50 to 8 wt% of styrene-base resin (B); 50 to 200 parts by weight of stainless-steel microfiber (D); and 0.1 to 5.0 parts by weight of synthetic zeolite (E) represented by the following formula (1);

Formula (1)

$M_{2/n}O \cdot Al_2O_3 \cdot xSiO_2 \cdot yH_2O$ (1)

wherein, M represents a monovalent or divalent ion-exchangeable metal, n represents the number of valence of metal, x represents silica index (SiO_2/Al_2O_3 molar ratio) ranging from 20 to 60, and y represents the number of crystal water ranging from 0 to 7.

[2] The electro—conductive composition according to Claim 1, wherein the polyphenylene ether is a polymer, having, in the main chain thereof, a structural unit represented by the formula (2);



(2)

(where, R_1 represents a lower alkyl group having 1 to 3 carbon atom(s), each of R_2 and R_3

independently represents a hydrogen atom or lower alkyl group having 1 to 3 carbon atom(s)).

[3] The electro-conductive composition according to Claim 1 or 2, wherein the styrene-base resin (B) is a polystyrene or a high-impact polystyrene.

[4] The electro-conductive composition according to any one of Claims 1 to 3, wherein the resin component (C) comprises 60 to 90 wt% of polyphenylene ether (A), and 40 to 10 wt% of styrene-base resin (B).

[5] The electro-conductive composition according to any one of Claims 1 to 4, wherein M in the formula (1) is sodium.

[6] The electro-conductive composition according to any one of Claims 1 to 5, wherein the synthetic zeolite (E) is MFI-type zeolite.

[7] The electro-conductive composition according to any one of Claims 1 to 6, wherein the stainless-steel microfiber (D) has a mean fiber length of 50 to 500 μm and has an average fiber diameter of 1 to 50 μm.

[8] The electro-conductive composition according to any one of Claims 1 to 7, further comprising 0.01 to 20 parts by weight of a colorant (F), per 100 parts by weight of the resin component (C).

[9] An molded article obtained by molding the electro-conductive composition according to any one of Claims 1 to 8.

[10] The molded article according to Claim 9, wherein the molded article is used for a tray for a carrying electric/electronic component.