

ELECTROCONDUCTIVE RESIN SHEET



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FIELD OF THE INVENTION



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The present invention relates to an electroconductive
5 resin sheet suitable for use as a container or a packaging
material for containing or carrying a semiconductor or an
electronic component, and a formed or shaped article formed
with the sheet.

10 BACKGROUND OF THE INVENTION

A tray (injection molded tray, vacuum forming tray, etc.),
a magazine, a carrier tape (embossed carrier tape, etc.) and
the like are used as a packaging material for a semiconductor
or an electronic component, particularly for an integrated
15 circuit (IC) or an electronic component using an IC. Each of
the above packaging materials is composed of a thermoplastic
resin such as a polystyrene-series resin, an ABS resin, a
polyvinyl chloride-series resin, a polypropylene-series resin,
a polyester-series resin, a polyphenylene ether-series resin,
20 polycarbonate-series resin and the like. However, such
packaging materials are generally high in surface specific
resistivity and are readily charged.

Thus, it is necessary to impart an electroconductivity
of at least an antistatic level to the packaging materials in
25 order to avoid damage or destruction of the IC caused by static
charges. Examples of the electroconductivity imparting method
include a method of mixing conductants such as

electroconductive carbon black with a resin. Among the above thermoplastic resins comprising packaging materials, the polystyrenic resin is generally used since the resin is not remarkably reduced in flowability and formability even when
5 a relatively large amount of the carbon black is mixed therewith and moreover is low in costs.

For example, Japanese Patent Application Laid-open No. 152580/1979 (JP-54-152580A) discloses a resin composition comprising, relative to 100 parts by weight of a high impact
10 polystyrene, 10 to 70 parts by weight of a carbon black, and 15 to 80 parts by weight of a butadiene-series rubber and/or a rubber like olefinic copolymer which have good affinity for the above-mentioned both components. Japanese Patent Application Laid-open No. 230655/1989 (JP-1-230655A)
15 discloses an electroconductive resin composition prepared by mixing 100 parts by weight of a polystyrene component contained in a polystyrenic resin with 1 to 15 parts by weight of a mineral oil, 1 to 10 parts by weight of a butadiene rubber and 10 to 20 parts by weight of a carbon black having a DBP
20 (dibutylphthalate) oil absorption of 100 ml/100 g or more. The composition has a melt index (MI) of 5 g/10 min. or more. However, these resin compositions are not satisfactory in mechanical properties such as impact resistance, strength, etc., and, therefore, subject to a notch or a crack in postforming.
25 Moreover, since it is necessary for obtaining enough electroconductivity to increase a content of a conductant, it is difficult to strike a good balance between

electroconductivity and mechanical strength of the composition.

Japanese Patent Application Laid-open No. 76424/1997 (JP-9-76424A) discloses a electroconductive composite sheet in which a electroconductive resin composition comprising a polystyrenic resin, a carbon black and an olefinic resin is laminated on both sides of a sheet base comprising a polystyrenic resin, wherein the composition comprises 1 to 30 parts by weight of the olefinic resin relative to 100 parts by weight of the total amount of the polystyrenic resin and the carbon black. In the literature, a polyethylene-series resin and a polypropylene-series resin are exemplified as an olefinic resin, and in the Examples, 10 parts by weight of a polyethylene-series resin relative to 100 parts by weight of a polystyrenic resin is used. However, the sheet is not satisfactory in mechanical strength such as impact resistance and folding endurance. For example, the sheet is subject to a notch or a crack in postforming.

Moreover, Japanese Patent Application Laid-open No. 76423/1997 (JP-9-76423A) discloses an electroconductive composite sheet in which a styrene-butadiene-styrene block copolymer is blended to the above-mentioned electroconductive resin composition in order to improve the folding endurance. The sheet is improved in impact resistance, however, burrs and shavings occur in cutting and punching or processing it. For example, burrs and shavings may occur in perforating a carrier tape and may adhere to the IC or the like.

SUMMARY OF THE INVENTION

Therefore, an object of the present invention is to provide an electroconductive resin sheet and a formed or shaped article which are excellent in not only formability and external appearance but also mechanical properties such as impact resistance, strength and the like.

Another object of the present invention is to provide an electroconductive resin sheet and a formed or shaped article in which occurrences of burrs and shavings are suppressed during the cutting and punching process.

Still another object of the present invention is to provide an electroconductive resin sheet and a formed or shaped article that are suppressed in occurrences of notches and cracks in postforming.

The inventors of the present invention made intensive studies to achieve the above objects, and finally found that an electroconductive resin sheet in which an electroconductive layer is formed on a base layer becomes excellent in not only formability and external appearance but also mechanical properties such as impact resistance and strength by adjusting melt indexes (MI) of both layers to the specific range, wherein the base layer comprises a resin composition containing a styrenic resin, and the electroconductive layer comprises a resin composition composed of a styrenic resin containing a conductant in combination with a given amount of olefinic elastomer. The present invention was accomplished based on the

above findings.

That is, the electroconductive resin sheet of the present invention comprises a base layer and an electroconductive layer formed on the base layer, wherein the base layer comprises a resin composition (A) composed of a styrenic resin, and the electroconductive layer comprises a resin composition (B) composed of 5 to 50 parts by weight of a conductant (B2) and 30 to 100 parts by weight of an olefinic elastomer (B3) relative to 100 parts by weight of a styrenic resin (B1), and wherein the ratio of the melt index (MIA) of the resin composition (A) relative to the melt index (MIB) of the resin composition (B) (MIA/MIB) is 0.1 to 10. In the above-mentioned sheet, the olefinic elastomer (B3) may be at least one member selected from: a copolymer of an olefinic monomer with at least one polymerizable monomer selected from the group consisting of a (meth)acrylic monomer and a vinyl ester-series monomer; and a thermoplastic elastomer, in particular, an ethylene-C₁₋₄alkyl (meth)acrylate copolymer (a copolymer of ethylene and C₁₋₄alkyl (meth)acrylic acid). The styrenic resin (B1) may comprise about 3 to 40 weight % of a rubber like polymer. The conductant (B2) may be an electroconductive carbon black having an average specific surface area of 20 to 80 m²/g (in particular, 30 to 80 m²/g). The resin composition (B) may comprise 0.01 to 10 parts by weight of a lubricant relative to 100 parts by weight of the styrenic resin (B1). The surface specific resistivity of the sheet may be $1 \times 10^{11} \Omega/\square$ or less. The sheet may be formed an electroconductive layer on the both sides of a base

layer.

The invention also includes a formed or shaped article formed with the sheet. The formed or shaped article may sufficiently be used for containing and carrying an electronic
5 component or parts.

The invention also includes a method for producing a formed or shaped article, which comprises thermoforming the sheet into an article having a concaved or recesses.

10 DETAILED DESCRIPTION OF THE INVENTION

[Base Layer]

A base layer is mainly formed to improve mechanical strength such as rigidity and impact resistance of the sheet of the present invention. The base layer comprises a resin
15 composition (A) containing a styrenic resin (such as a polystyrenic resin and a rubber-reinforced styrenic resin). It is specially preferred that the resin composition (A) comprises the styrenic resin in an amount of not less than 50 wt.%, preferably not less than 70 wt.% and more preferably not
20 less than 90 wt.%.

The styrenic (or styrene-series) resin includes a polystyrenic resin and a rubber-modified (or rubber-containing) styrenic resin (a rubber-g-styrenic resin or a high impact polystyrene). Examples of an aromatic vinyl monomer for
25 forming the polystyrenic resin are styrene, an alkyl-substituted styrene (e.g. vinyltoluene, vinylxylene, p-ethylstyrene, p-isopropylstyrene, butylstyrene, p-t-

butylstyrene, etc.), a halogen-substituted styrene (e.g. chlorostyrene, bromostyrene, etc.), an α -alkyl-substituted styrene wherein an alkyl group is substituted at the α position (e.g. α -methylstyrene, etc.) and the like. The above aromatic
5 vinyl monomers are used alone or in combination thereof. Among the above monomers, generally, styrene, vinyltoluene, α -methylstyrene and the like are used and, in particular, styrene, is used.

The aromatic vinyl monomers may be used in combination
10 with a copolymerizable monomer. Examples of the copolymerizable monomer are a vinyl cyanide-series monomer (e.g. acrylonitrile, etc.), an unsaturated polycarboxylic acid or its acid anhydride (e.g. maleic acid, itaconic acid, citraconic acid or its acid anhydride, etc.), an imide-series monomer [e.g.
15 maleimide, N-alkylmaleimide (e.g. N-C₁₋₄ alkylmaleimide, etc.), N-cycloalkylmaleimide (e.g. N-cyclohexylmaleimide, etc.), N-arylmaleimide (e.g. N-phenylmaleimide, etc.)], an acrylic monomer [e.g. a C₁₋₂₀ alkyl esters of (meth)acrylic acid such as (meth)acrylic acid, methyl (meth)acrylic acid, ethyl
20 (meth)acrylic acid, butyl (meth)acrylic acid, hexyl (meth)acrylic acid, octyl (meth)acrylic acid, 2-ethylhexyl (meth)acrylic acid, etc., cyclohexyl (meth)acrylic acid, phenyl (meth)acrylic acid, benzyl (meth)acrylic acid, glycidyl (meth)acrylic acid, a C₂₋₄ alkyl esters of hydroxy (meth)acrylic
25 acid such as 2-hydroxyethyl (meth)acrylic acid, 2-hydroxypropyl (meth)acrylic acid, etc.] and so on. The above copolymerizable monomers may be used alone or in combination

thereof. The amount of the copolymerizable monomer to be used with respect to an amount of total monomers is usually in a range of about 1 to 50 wt.%, preferably in a range of about 5 to 40 wt.%, more preferably in a range of about 8 to 30 wt.%.

5 The rubber-modified styrenic resin is a copolymer prepared by copolymerization (graft polymerization, block polymerization) or the like wherein a rubber like polymer or elastomeric polymer (soft component) is dispersed in a matrix (rigid component) of the polystyrenic resin in the form of
10 particles and, generally, is a graft copolymer obtainable by polymerizing at least an aromatic vinyl monomer (e.g., the above aromatic vinyl monomers or a monomer composed of the above copolymerizable monomers and the above aromatic vinyl monomers) by a conventional method (bulk polymerization, bulk suspension
15 polymerization, solution polymerization, emulsion polymerization) in the presence of the rubber like polymer.

 Examples of the rubber (rubber like polymer or elastomeric polymer) of the rubber-modified styrenic resin are a diene-series rubber [polybutadiene (lower cis-type or higher
20 cis-type polybutadiene), polyisoprene, a styrene-butadiene copolymer, a styrene-isoprene copolymer, a butadiene-acrylonitrile copolymer, an isobutylene-isoprene copolymer, a styrene-isobutylene-butadiene-series copolymerized rubber, etc.], an ethylene-vinylacetate copolymer, an acrylic rubber
25 (a copolymerized elastomer containing C₂₋₈ alkylester of a polyacrylic acid as a major constituent, etc.), an ethylene- α -olefin-series copolymer [ethylene-propylene

rubber (EPR), etc.], an ethylene- α -olefin-polyene copolymer [ethylene-propylene-diene rubber (EPDM), etc.], an urethane rubber, a silicone rubber, a butyl rubber, a hydrogenated diene-series rubber (hydrogenated styrene-butadiene copolymer, 5 hydrogenated butadiene-series polymer, etc.) and the like. In addition, the copolymers may be random or block copolymers, and the block copolymers include copolymers having the structure of an AB type, an ABA type, a taper type, a radial teleblock type and the like. The rubber like polymers may be 10 used alone or in combination thereof. Preferred rubber like polymers are conjugated 1,3-diene or a polymer of its derivatives and, particularly, a diene-series rubber [polybutadiene (butadiene rubber), isoprene rubber, styrene-butadiene copolymer, etc.].

15 In the rubber-modified styrenic resin, a content of the rubber like polymer is, for example, about 2 to 80 wt.%, preferably about 3 to 50 wt.%, more preferably about 3 to 20 wt.% (e.g., about 5 to 10 wt.%).

 The form of the rubber (or rubber like polymer), dispersed 20 in the matrix composed of the polystyrenic resin, is not particularly limited and may be a core/shell structure, an onion structure, a salami structure or the like. The particle size of the rubber like polymer forming the dispersed phase can be selected from the range of the volumetric mean particle diameter, 25 for example, about 0.05 to 30 μm , preferably about 0.1 to 10 μm , more preferably about 0.2 to 7 μm (particularly about 0.5 to 5 μm). Further, in the rubber-modified styrenic resin, a

graft ratio is about 5 to 300 %, preferably about 10 to 250 %.

Among the styrenic resins, a polystyrene (GPPS), a styrene-acrylonitrile copolymer (AS resin), a styrene-methyl methacrylate copolymer, a styrene-maleic anhydride copolymer
5 (SMA resin), etc. are preferably used as the polystyrenic resin, while a high impact-resistant polystyrene (HIPS), a styrene-butadiene block copolymer, a styrene-acrylonitrile-butadiene copolymer (ABS resin), an α -methylstyrene-modified ABS resin, an imide-modified ABS resin,
10 an MBS resin and the like are preferably used as the rubber-modified styrenic resin.

Further, it is preferred that the styrenic resin is composed of at least the rubber-modified styrenic resin, and the rubber-modified styrenic resin and the polystyrenic resin
15 may be used in combination. The ratio (weight ratio) of the rubber-modified styrenic resin/the polystyrenic resin is about 100/0 to 50/50 (particularly about 100/0 to 60/40).

From the viewpoint of the balance of mechanical properties, a preferred content of the rubber like polymer (soft
20 component) in the styrenic resin is about 3 to 40 wt.%, and a range of about 5 to 20 wt.% is particularly preferable.

The melt index (MI) of the styrenic resin when melted at a temperature of 200°C and with a load of 49N (5.0 kgf) can be selected from the range of about 1 to 15 g/10 min., preferably
25 about 1 to 10 g/10 min., and more preferably about 1 to 5 g/10 min.. Incidentally, the melt index (MIA) of the resin composition (A) can be also selected within the same range as

MI of the styrenic resin.

A weight average molecular weight of the styrenic resin (in the graft copolymer, the styrenic resin structuring a matrix) is about 50,000 to 1,000,000, preferably about 100,000
5 to 500,000, more preferably about 150,000 to 400,000.

There may be added to the resin composition if necessary a coloring agent, a dispersant, a stabilizer (such as an antioxidant, an ultraviolet rays absorbent and a thermostabilizer), a flame retardant, a lubricant, a filler,
10 an antifoaming agent, a coatability improving agent, a thickner, and the like. Among the above additives, it is preferred to use about 0.01 to 10 parts by weight, preferably about 0.05 to 5 parts by weight and more preferably about 0.05 to 4 parts by weight of the lubricant (e.g. waxes or a C₈₋₂₄ higher aliphatic
15 ester or amide, etc.) with respect to 100 parts by weight of the styrenic resin (A).

[Electroconductive Layer]

An electroconductive layer is formed to mainly improve mechanical properties such as folding endurance and impact
20 resistance as well as antistatic ability. The electroconductive layer comprises a resin composition (B) containing a styrenic resin (B1), a conductant (B2) and an olefinic elastomer (B3).

Styrenic Resin (B1)

25 The styrenic resin (B1) is used to strengthen hardness of the electroconductive layer and to improve rigidity thereof. As the styrenic resin (B1), the same styrenic resin as one

constituting the base layer may be used.

Further, it is preferred that the styrenic resin (B1) is also composed of at least the rubber-modified styrenic resin, and the rubber-modified styrenic resin and the polystyrenic resin may be used in combination. Ratio (weight ratio) of the rubber-modified styrenic resin/the polystyrenic resin is about 100/0 to 50/50 (particularly about 100/0 to 60/40).

From the viewpoint of the balance of mechanical properties, a preferred content of the rubber like polymer (soft component) in the styrenic resin (B1) is about 3 to 40 wt.%, and a range of about 5 to 20 wt.% is particularly preferable.

The melt index (MI) of the styrenic resin (B1) when melted at a temperature of 200°C and with a load of 49N (5.0 kgf) can be selected from the range of about 3 to 30 g/10 min., preferably about 5 to 25 g/10 min., and more preferably about 10 to 20 g/10 min.. In the electroconductive layer, the fluidity of the resin is decreased or lowered by blending a conductant. Therefore, it is preferred that MI of the styrenic resin (B1) is higher than MI of a styrenic resin constituting a base layer in order to narrow the gap between the fluidity of the electroconductive layer and that of the base layer. The fluidity of the styrenic resin may be adjusted by controlling a molecular weight thereof and/or by adding a lubricant.

A weight average molecular weight of the styrenic resin (B1) (in the graft copolymer, the styrenic resin structuring a matrix) is about 10,000 to 500,000, preferably about 50,000 to 300,000, more preferably about 100,000 to 250,000.

Conductant (B2)

It is possible to use a carbon powder (an artificial graphite powder, swelling graphite powder, natural graphite powder, a coke breeze or powder, an electroconductive carbon black, etc., that are used conventionally), a carbon fiber, a metal powder and the like are used as the conductant (B2). Among these conductants, the electroconductive carbon black is preferably used. The above conductants can be used alone or in combination thereof.

10 Examples of the electroconductive carbon black include a furnace black, a channel black, a gas black, an acetylene black, an arc black and the like. Among these electroconductive carbon blacks, a preferred carbon black has a DBP oil absorption of about 100 ml/100 g or more, preferably about 110 to 200 ml/100g, and preferred examples thereof are the furnace black, Ketchen black and acetylene black having excellent electroconductivity, wherein the furnace black is particularly preferred. Further, an electroconductive composite carbon black prepared by combining the electroconductive carbon blacks may be used. An average specific surface area of the electroconductive carbon black is about 20 to 300 m²/g, preferably about 20 to 100 m²/g (for example, 20 to 80 m²/g), and more preferably about 30 to 80 m²/g (particularly, about 30 to 50 m²/g).

25 There may be used commercially available electroconductive carbon blacks such as "#3050B", "#3150B", "#3750B" and "#3950B" manufactured by Mitsubishi Chemical Corporation (JP), "VULCAN XC72", "VULCAN P", "BLACK PEARLS

3500" and "BLACK PEARLS 3700" manufactured by Cabot Specialty Chemicals Inc., U.S.A., "Acetylene Black" manufactured by Denki Kagaku Kogyo Kabushiki Kaisha (JP) and the like.

An average particle size of the conductant (B2)
5 (particularly of the electroconductive carbon black) is closely related to the ratio of the styrenic resin (B1), and cannot be flatly defined, however, the average particle size is typically about 1 nm to 1 μ m, preferably about 10 to 100 nm, and more preferably about 20 to 80 nm (particularly, about 40
10 to 60 nm).

The amount of the conductant (B2) relative to 100 parts by weight of the styrenic resin (B1) is about 5 to 50 parts by weight, preferably about 10 to 40 parts by weight (for example, about 20 to 40 parts by weight), and more preferably about 25
15 to 40 parts by weight (particularly about 30 to 40 parts by weight). When the amount of the conductant is too small, the electroconductivity of the sheet is not enough. On the other hand, when the amount of the conductant is too large, the mechanical properties of the sheet are deteriorated.

20 Olefinic Elastomer (B3)

Examples of the olefinic elastomer (B3) are a copolymer of an olefinic monomer and at least one monomer selected from the group consisting of (meth)acrylic monomers and vinyl-
ester-series monomers, a thermoplastic elastomer
25 (elastomer wherein its rigid segment comprising polyethylene or polypropylene and its soft segment comprising an ethylene-propylene rubber or an ethylene-propylene-diene

rubber), an ethylene- α -olefin-series copolymer [ethylene-propylene rubber (EPR), etc.], an ethylene- α -olefin-diene copolymer [ethylene-propylene-diene rubber (EPDM), etc.], a diene-series rubber [polybutadiene (lower cis-type or higher
5 cis-type polybutadiene), polyisoprene, a butadiene-acrylonitrile copolymer, an isobutylene-isoprene copolymer, etc.] and the like. Among the above olefinic elastomers, the copolymer of the olefinic monomer and the (meth)acrylic monomer as well as the copolymer of olefin and the vinylester-series
10 monomer (particularly, the copolymer of the olefinic monomer and the (meth)acrylic monomer) are preferred.

Examples of the olefinic monomer are a C_{2-10} olefin such as ethylene, propylene, butene, hexene, octene and the like, preferably a C_{2-4} olefin (particularly ethylene). Examples of
15 the acrylic monomer are (meth)acrylic acid, a C_{1-10} alkyl ester of (meth)acrylic acid such as methyl (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate and the like, preferably C_{1-4} alkyl ester of (meth)acrylic acid such as ethyl (meth)acrylate and the like.
20 Examples of the vinylester-series monomer are aliphatic vinylester such as vinyl acetate, vinyl propionate and the like. Specifically, it may be preferred to use an ethylene-ethyl acrylate copolymer, ethylene-vinyl acetate copolymer and the like, and it may be particularly preferred to use ethylene- C_{1-4}
25 alkyl ester of (meth)acrylic acid such as ethylene-ethyl acrylate copolymer.

The ratio (weight ratio) of the olefinic monomer to the

acrylic monomer and/or the vinylester-series monomer is about 97/3 to 50/50, preferably about 95/5 to 60/40, and more preferably about 90/10 to 60/40.

The molecular structure of each of the above elastomers
5 (B3) is not limited and may be a random copolymer, diblock copolymer, triblock copolymer, an asterisk block copolymer, a multiblock copolymer, a graft copolymer or the like.

These elastomers (B3) may be used alone or in combination thereof.

10 The rate of the elastomer (B3) relative to 100 parts by weight of the styrenic resin (B1) is about 30 to 100 parts by weight, preferably about 30 to 60 parts by weight, and more preferably about 30 to 40 parts by weight. In the case where
15 the proportion of the component (B3) is less than 30 parts by weight, mechanical properties such as folding endurance and impact resistance are deteriorated. On the other hand, in the case where the proportion of the component (B3) is more than 100 parts by weight, the dispersibility of the styrenic resin is deteriorated, and the external appearance of the sheet is
20 adversely affected.

There may be added to the resin composition (B) if necessary an antistatic agent (a surfactant having a weight average molecular weight of 3,000 or less, etc.), a coloring agent, a dispersant, a release agent, a stabilizer (such as
25 an antioxidant, an ultraviolet rays absorbent and a thermostabilizer), a flame retardant, an antiblocking agent, a lubricant, a filler, an antifoaming agent, a coatability

improving agent, a thickner and the like. Among the above additives, it is preferred to use about 0.01 to 10 parts by weight, preferably about 0.05 to 10 parts by weight and more preferably about 0.05 to 6 parts by weight, of the lubricant
5 (e.g. waxes or a C₈₋₂₄ higher aliphatic ester or amide, etc.) with respect to 100 parts by weight of the styrenic resin (B1). The use of the lubricant enables to not only control the fluidity of the resin composition but also inhibit occurrence of burrs in the resin composition.

10 The melt index (MIB) of the resin composition (B) at a temperature of 200°C and with a load of 49N (5.0 kgf) is about 0.1 to 10 g/10 min., preferably about 0.3 to 5 g/10 min. and more preferably about 0.5 to 3 g/10 min..

[Electroconductive Resin Sheet]

15 The sheet of the present invention may be a laminated sheet comprising the electroconductive layer to/on at least one side of a base layer. Usually, it is preferred to laminate the electroconductive layer to both sides of the base layer, although the laminated sheet prepared by laminating the
20 electroconductive layer to only one side of the base layer is sufficiently used on some occasions.

In the electroconductive resin sheet, the ratio of the MIA to the MIB (MIA/MIB) is about 0.1 to 10 (for example, about 0.2 to 8), preferably about 0.5 to 5 (for example, about 1 to
25 5) and more preferably about 1.5 to 5 (particularly, about 2 to 4). If the ratio MIA/MIB is too large, the electroconductive layer is not formed uniformly and, as a result, an irregularity

occurs on the surface of the sheet. Particularly, with respect to the cross section of the sheet, the thickness of the base layer becomes larger in both side parts of the sheet, and electroconductivities of such parts are adversely affected.

- 5 On the other hand, the MIA/MIB is too small, the thickness of the base layer becomes smaller in both side parts of the sheet.

The electroconductive resin sheet has a surface specific resistivity of about $1 \times 10^{11} \Omega/\square$ or less (for example, about 1×10^0 to $1 \times 10^{11} \Omega/\square$), preferably about 1×10^1 to 1×10^8
10 $\Omega/\square$, more preferably about 1×10^2 to $1 \times 10^6 \Omega/\square$, and thus is excellent in electroconductivity.

Thickness of the electroconductive resin sheet is about 0.01 to 5 mm, preferably about 0.05 to 3 mm, more preferably about 0.1 to 1 mm. Thickness of the base layer is about 10 to
15 5,000 μm , preferably about 50 to 1,000 μm , more preferably about 100 to 500 μm . Thickness of each of the electroconductive layers is about 1 to 500 μm , preferably about 5 to 100 μm , more preferably about 10 to 50 μm . The thickness ratio of the base layer/the each electroconductive layers is about 30/1 to 1/1,
20 preferably about 20/1 to 5/1, more preferably about 15/1 to 10/1.

The electroconductive resin sheet, for example, can be produced by mixing components of each layer to prepare a resin composition, and then forming or molding the composition into
25 a sheet form by a conventional method. The resin composition may be a mixture of powders of components or may be prepared by kneading components. It is possible to employ a conventional

method for kneading and, for example, the components are dry-blended using a Henschel mixer or a ribbon mixer and then the mixture is fed to a conventional melt mixer such as a uniaxial or biaxial extruder, Banbury mixer, a kneader, a mixing roller
5 or the like to be melt-kneaded. The resin composition may be in the form of pellets. Moreover, the order of mixing each component in the kneading step is not limited and for example, in the case of the electroconductive layer, all components may be melt-kneaded simultaneously, or a pellet obtained by
10 melt-kneading a styrenic resin (B1) and a conductant (B2) may be blended with a pellet of an elastomer (B3).

The method for forming or shaping into a sheet form includes extrusion methods such as a die (e.g., flat die, T-shaped die, circular die) method and an inflation method,
15 stretch methods by a tenter manner, a tube manner, an inflation manner, and others. The resin sheet may be stretched (via uniaxial stretching, biaxial stretching) or may be non-stretched. The resin sheet may be prepared by subjecting obtained sheets each to a heat lamination method, a dry
20 lamination method, etc., but it is preferable to prepare the resin sheet by a coextrusion of resin compositions constituting each layer with use of a general-purpose die equipped with a feed block or a multi-manifold die, and others. The coextrusion method enables to obtain a thin surface layer and to mass-
25 produce the sheet. Incidentally, in the lamination method, an adhesive is not essentially required.

[Postformed Article]

The sheet thus obtained can be postformed by, for example, a conventional thermoforming method such as a blowing, a vacuum forming, a folding process, a compressed-air forming, a matched mold forming, a hot plate forming, etc., and the like. The sheet
5 may be foamed when so required. Examples of postformed articles are containers for food, containers for medicine, trays, embossed tapes, magazines and the like.

The surface of the sheet or the postformed article may be subjected to a surface treatment (e.g. discharge treatment
10 using corona discharge, glow discharge, etc., acid treatment, flame treatment and the like). For the purpose of imparting antistatic properties, the surface of the sheet or the postformed article may be subjected to electroconductive treatment or an antistatic treatment (e.g. by applying thereon
15 or mixing therewith an antistatic agent, an electroconductiveness imparting agent such as metal oxide, etc.). Instead, an electroconductive coating or an antistatic layer (e.g. a coating with an electroconductive ink) may be formed on the surface of the sheet or the postformed article.

20 Since the sheet of the present invention is excellent in antistatic properties as well as in formability and mechanical properties, the sheet is useful for forming a carrier article having a concaved area or recesses for containing a semiconductor or an electronic component, particularly an IC
25 or an electronic component using the IC [e.g. an electronic component carrying tray (an injection molded tray, a vacuum forming tray, etc.), a magazine, a carrier tape (an embossed

carrier tape, etc.) and the like] among the above-described postformed articles.

According to the present invention, it is possible to obtain an electroconductive resin sheet excellent in not only
5 formability and external appearance but also mechanical properties such as impact resistance, strength and the like. The electroconductive resin sheet is suppressed or inhibited occurrences of notches and cracks in postforming step as well as occurrences of burrs and shavings in cutting and punching
10 steps. Therefore, the electroconductive resin sheet is suitable for use as a container or a packaging material for containing or carrying the semiconductor, electronic component and the like.

15

EXAMPLES

The present invention will be described in detail based on examples; however, the invention is not limited by the examples. The method of the evaluation of evaluation items and components used in the examples are as follows.

20

[Melt Index]

The MI of strand cut pellets was measured by using "Melt Indexer L244" (Manufactured by Takara Kogyo Kabushiki Kaisha). A load of 49N (5 kgf) was applied to the pellets at a temperature of 200°C, and then the weight of the resin discharged from a
25 nozzle having an inner diameter of 2 mm in a predetermined period of time was measured. Then, the measured value was converted into the weight of the resin discharged in 10 minutes to detect

the MI value.

[Surface Specific Resistivity]

Measurements at an arbitrary 10 points (right side part, central part and left side part) of the obtained sample were
5 conducted by using a "Rolester Surface Resistivity Meter"
(manufactured by Mitsubishi Chemical Corporation) and a ring electrode with an inner circle having an outer diameter of 6 mm and an outer circle having an inner diameter of 11 mm, and a logarithmic mean value of the measured values was taken as
10 the surface specific resistivity.

[Folding Endurance]

A carrier tape subjected to an embossing process was folded by 180° by hand with convexes of the emboss being at the outer lateral side and then restored. The bending and restoring
15 operation was repeated, and the number of operations was counted until a crack occurred.

[Du Pont Impact Strength]

The impact strength of the sheet was measured at 500 g of a scale weight and 1.27 cm (1/2 inch) of punch diameter
20 according to JIS K 7211.

[Frequency in Occurrence of Burrs]

100 holes were selected arbitrarily among those made at a flange portion, and the number of burrs each having a width of 100 µm or more was counted by observing with a
25 microscope.

[External Appearance of the Sheet]

The external appearance of the sheet surface was observed

visually and evaluated based on the following criteria.

I: The surface of the sheet is uniform.

II: The surface of the sheet is uniform with ununiformity of gloss and striped patterns.

5 III: The surface of the sheet has thickness variance.

[Abbreviation and Details of Each Component]

HIPS-1: high-impact polystyrene ("Toyo Styrol E640" manufactured by Toyo Styrene Co., Ltd., MI=3.1 g/10 min.).

10 HIPS-2: high-impact polystyrene ("Toyo Styrol H610" manufactured by Toyo Styrene Co., Ltd., MI=17 g/10 min.).

CB: carbon black ("#3030B" manufactured by Mitsubishi Chemical Corporation).

EEA-1: ethylene-ethylacrylate copolymer ("NUC-6170" manufactured by Nippon Unicar Co., Ltd.).

15 EEA-2: ethylene-ethylacrylate copolymer ("DPDJ9169" manufactured by Nippon Unicar Co., Ltd.).

SBS: styrene-butadiene block copolymer ("Tufprene 126" manufactured by Asahi Kasei Corporation).

20 SEBS: styrene-ethylene-butylene copolymer ("Tuftec H1051" manufactured by Asahi Kasei Corporation).

Stabilizer: antioxidant ("Irganox 1010" manufactured by Ciba Geigy Co., Ltd.)

Lubricant: stearyl stearate ("Rikemal SL-800, manufactured by Riken Vitamin Co., Ltd.).

25 Examples 1 to 4 and Comparative Examples 1 to 6

HIPS and CB shown in Table 1, and 0.1 part by weight of a stabilizer and 0.1 part by weight of a lubricant relative

to 100 parts by weight of HIPS were dry-blended using a tumbler, and then melt-kneaded at a cylindrical temperature of 210°C by using a biaxial extruder (inside diameter of 30 mm, L/D = 32), followed by pelletizing by the strand cut method. The resultant
5 pellet and a pellet of EEA, SBS or SEBS shown Table 1 were blended in the proportion shown Table 1 to obtain an electroconductive resin composition.

A multi-layer extruder (equipped with three dies each having two passages) was used in the following process.

10 100 parts by weight of HIPS and 2 parts by weight of black master batch (TSM01184 BLACK FD manufactured by Toyo Ink Mfg. Co., Ltd.) constituting the base layer was fed to a uniaxial extruder (inside diameter of 65 mm, L/D = 32) at a cylindrical temperature of 210°C, and the electroconductive resin
15 composition was fed to another uniaxial extruder (inside diameter of 50 mm, L/D = 28) at a cylindrical temperature of 210°C. Then, the electroconductive layer was converged on each side of the base layer to laminate both sides of the base layer, and then extruded by the T die-cast method at a die temperature
20 of 210°C to obtain a sheet-shaped extrusion. The sheet-shaped extrusion was cooled by using a cooling roller to thereby obtain a laminated sheet having a total thickness of 300 µm (thickness ratio: electroconductive layer/base layer/electroconductive layer = 20 µm/260 µm/20 µm). The laminated sheet was slit into
25 sections each having a width of 24 mm, subjected to embossing process with heat-pressure molding, and then one side thereof was provided with a flange portion having a width of 4 mm and

the other side thereof was provided with a flange portion having a width of 1 mm and with a concavity portion of a vertical length of 11 mm, a width of 19 mm and a depth of 3 mm to obtain a carrier tape. The flange portion having a width of 4mm was provided
5 with perforations (sprocket hole) each having a diameter of 1.5 mm at a constant interval wherein a distance from a center of a perforation to a center of a neighboring perforation was 4 mm. Intervals between the concavity portions were set at 5 mm. Evaluation results of the laminated sheet and the carrier
10 tape were shown in Table 1.

Table 1

		Examples				Comparative examples					
		1	2	3	4	1	2	3	4	5	6
Base Layer (parts by weight)	HIPS-1	100	100	100	100	100	100	100	100	100	-
	HIPS-2	-	-	-	-	-	-	-	-	-	100
Base Layer MIA (g/10min.)		3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	17
Electroconductive Layer (parts by weight)	HIPS-1	-	-	-	-	-	-	-	-	-	60
	HIPS-2	73	73	69	69	79	79	69	69	60	-
	CB	27	27	31	31	21	21	31	31	40	40
	EEA-1	35	-	40	-	5	-	-	-	100	20
	EEA-2	-	35	-	35	-	5	-	-	-	-
	SBS	-	-	-	-	-	-	40	-	-	-
	SEBS	-	-	-	-	-	-	-	40	-	-
Electroconductive Layer MIB (g/10 min.)		0.9	1	1.4	0.9	0.4	0.4	2.5	2.2	6	0.2
MIA/MIB		3.4	3.1	2.2	3.4	7.8	7.8	1.2	1.1	0.52	85
Surface Specific Resistivity (right) ($\Omega/\square$)		-	5×10^5	9×10^4	4×10^4	6×10^5	4×10^6	4×10^6	6×10^6	5×10^5	6×10^9
Surface Specific Resistivity (center) ($\Omega/\square$)		-	1×10^5	4×10^4	1×10^4	2×10^5	2×10^6	4×10^6	3×10^6	6×10^5	1×10^4
Surface Specific Resistivity (left) ($\Omega/\square$)		2×10^5	4×10^5	1×10^5	2×10^4	2×10^5	8×10^6	4×10^6	8×10^6	9×10^5	4×10^9
Folding Endurance (number of times of operation)		>20	>20	>20	>20	0	1	>20	>20	>20	>20
impact strength(kg·cm)		11.4	10.6	13	9.6	1.2	1.1	>20	>20	>20	>20
Burr's Occurrence Frequency (%)		2	4	3	3	8	5	75	80	12	12
External of Appearance		I	I	I	I	I	I	II	I	II	III

From the results of Table 1, it is apparent that the samples of the Examples are excellent in electroconductivity, high in strength and suppressed in occurrence of burrs. In turn, the samples of Comparative Examples 1 and 2 are low in strength
5 because the ratio of ethylene-ethyl acrylate resin is small. The samples of Comparative Examples 3 and 4 are improved in strength owing to blending of SBS or hydrogenated SBS, while the occurrence of burrs are increased. Particularly, in Comparative Example 3, the external appearance of the sheet
10 is adversely affected, gloss ununiformity and striped patterns are present (or are generated) as well as formation of gel occurs in a part of the sheet. In Comparative Example 5, the external appearance of the sheet is adversely affected as well as gloss ununiformity and striped patterns are present (or are
15 generated) because the ratio of ethylene-ethyl acrylate resin is too large. In Comparative Example 6, it is difficult to conduct an extrusion forming because the ratio of ethylene-ethyl acrylate resin is small and MI ratio is large. Further, with respect to the external appearance of the sheet,
20 the thickness variance is too much and electroconductivity of the sheet surface is not uniform.

What is claimed is:

1. An electroconductive resin sheet comprising a base layer and an electroconductive layer formed on the base layer, wherein the base layer comprises a resin composition (A)
5 composed of a styrenic resin, and the electroconductive layer comprises a resin composition (B) composed of 5 to 50 parts by weight of a conductant (B2) and 30 to 100 parts by weight of an olefinic elastomer (B3) relative to 100 parts by weight of a styrenic resin (B1), and wherein a ratio of a melt index
10 (MIA) of the resin composition (A) relative to a melt index (MIB) of the resin composition (B) is 0.1 to 10.

2. A sheet according to Claim 1, wherein the olefinic elastomer (B3) is at least one member selected from:

a copolymer of an olefinic monomer and at least one
15 polymerizable monomer selected from the group consisting of a (meth)acrylic monomer and a vinylester-series monomer,
a thermoplastic elastomer,
an ethylene- α -olefin-series copolymer,
an ethylene- α -olefin-diene copolymer, and
20 a diene-series rubber.

3. A sheet according to Claim 1, wherein the olefinic elastomer (B3) comprises a copolymer of an olefinic monomer and at least one polymerizable monomer selected from the group consisting of a (meth)acrylic monomer and a vinylester-series
25 monomer.

4. A sheet according to Claim 1, wherein the olefinic elastomer (B3) comprises an ethylene-C₁₋₄alkyl (meth)acrylate

copolymer.

5. A sheet according to Claim 2, the weight ratio of the olefinic monomer relative to the polymerizable monomer in the olefinic elastomer (B3) is 97/3 to 50/50.

5 6. A sheet according to Claim 1, wherein the styrenic resin (B1) comprises 3 to 40 weight % of a rubber like polymer.

7. A sheet according to Claim 1, wherein the styrenic resin (B1) comprises a graft copolymer obtainable by polymerizing at least an aromatic vinyl monomer in the presence
10 of a rubber like polymer.

8. A sheet according to Claim 1, wherein the styrenic resin (B1) comprises a diene-series rubber.

9. A sheet according to Claim 1, wherein the resin composition (A) and the styrenic resin (B1) comprise a
15 rubber-modified polymer.

10. A sheet according to Claim 1, wherein the conductant (B2) has an average specific surface area of 20 to 80 m²/g.

11. A sheet according to Claim 1, wherein the conductant (B2) has an average particle size of 1 nm to 1 μm.

20 12. A sheet according to Claim 1, wherein the conductant (B2) is at least one member selected from the group consisting of a furnace black, a channel black, a gas black, an acetylene black, an arc black and Ketchen black.

13. A sheet according to Claim 1, wherein the conductant
25 (B2) comprises a furnace black.

14. A sheet according to Claim 1, wherein the conductant (B2) comprises an electroconductive carbon black having an

average specific surface area of 20 to 80 m²/g.

15. A sheet according to Claim 1, wherein the resin composition (B) comprises 0.01 to 10 parts by weight of a lubricant relative to 100 parts by weight of the styrenic resin (B1).

16. A sheet according to Claim 1, which has a surface specific resistivity of $1 \times 10^{11} \Omega/\square$ or less.

17. A sheet according to Claim 1, wherein the electroconductive layer is formed on both sides of the base layer.

18. A resin sheet comprising a base layer and electroconductive layers each formed on both sides of the base layer, wherein the base layer comprises a resin composition (A) composed of a rubber-modified styrenic resin, and the electroconductive layer comprises a resin composition (B) composed of 20 to 40 parts by weight of an electroconductive carbon black (B2) having an average specific surface area of 30 to 80 m²/g and 30 to 60 parts by weight of an ethylene-C₁₋₄alkyl (meth)acrylate copolymer (B3) relative to 100 parts by weight of a rubber-modified styrenic resin (B1), and wherein a thickness ratio of the base layer to each electroconductive layer is 15/1 to 10/1, and a ratio of a melt index (MIA) of the composition (A) relative to a melt index (MIB) of the composition (B) is 1.5 to 5.

19. A shaped article formed with a sheet recited in Claim 1.

20. A shaped article according to Claim 19, which has a

concaved area or recesses for containing or carrying an electronic component or parts.

21. A method for producing a shaped article, which comprises thermoforming a sheet recited in Claim 1 into an
5 article having a concaved area or recesses.