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## ELECTROCONDUCTIVE RESIN COMPOSITION

### FIELD OF THE INVENTION

The present invention relates to an electroconductive  
5 styrenic (or styrene-series) resin composition suitable  
for use as a container or a packaging material for  
containing or carrying a semiconductor or an electronic  
component.

### 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  
15 an integrated 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  
20 polyphenylene ether-series resin, polycarbonate-series  
resin and the like. However, such packaging materials are  
generally high in surface resistivity and are readily  
charged.

Thus, it is necessary to impart an  
25 electroconductivity of at least an antistatic level to the  
packaging materials in 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  
5 generally used since the resin is not remarkably reduced in flowability and formability even when a relatively large amount of the carbon black is mixed therewith and moreover is low in costs.

Japanese Patent Application Laid-open No.  
10 230655/1989 (JP-1-230655A) 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  
15 by weight of a carbon black having a DBP oil absorption of 100 ml/100 g or more. The composition has a melt index (MI) of 5 g/10 min. or more. However, the resin composition is not satisfactory in mechanical properties such as impact resistance, strength, etc., and, therefore, subject to a  
20 notch or a crack in postforming.

Japanese Patent Application Laid-open No.  
283584/1996 (JP-8-283584A) discloses an electroconductive resin composition for IC packaging prepared by mixing 100 parts by weight of a polystyrenic resin with 5 to 50 parts  
25 by weight of a carbon black, 1 to 30 parts by weight of an olefinic resin and 0.2 to 10 parts by weight of a styrene-conjugated diene block copolymer, and Japanese

Patent Application Laid-open No. 76423/1997 (JP-9-76423A) discloses an electroconductive composite plastic sheet formed by laminating the electroconductive resin composition on both sides of a base sheet comprising a polystyrenic resin. Both of the MI values for the resin compositions are 0.1 g/10 min. or more, and, in the examples, a resin composition having an MI of less than 3.5 g/ 10 min. is used. The resin compositions and sheets are low in formability, and burrs and shavings occur in cutting and punching or processing them. 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

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

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

Still, another object of the present invention is to provide an electroconductive resin composition as well as a sheet and a formed or shaped article which are excellent in formability and mechanical properties such as impact

resistance, strength and the like.

The inventors have conducted extensive research to solve the above problems and have found that an electroconductive resin composition obtainable by mixing  
5 a styrenic resin containing a conductant (or conductive agent) with a specific amount of an impact modifier and then adjusting the mixture to be a specific MI is suppressed in occurrences of burrs and shavings in cutting and punching, to thereby accomplish the present invention.

10 Namely, the electroconductive resin composition of the present invention is a resin composition comprising a styrenic resin (A), a conductant (B) and an impact modifier (C), wherein an amount of the impact modifier (C) relative to 100 parts by weight of the styrenic resin (A) is about  
15 11 to 44 parts by weight, a melt index (MI) of which is about 3.5g/10 min. or more. The impact modifier (C) may be a styrenic thermoplastic elastomer (C<sub>1</sub>), an olefinic thermoplastic elastomer (C<sub>2</sub>), a polyester-series thermoplastic elastomer (C<sub>3</sub>) and the like. The conductant  
20 (B) may be a carbon black. The amount of the conductant (B) relative to 100 parts by weight of the styrenic resin (A) is about 5 to 50 parts by weight. The resin composition is excellent in antistatic properties, having a surface resistivity of about  $1 \times 10^{11} \Omega/\square$  or less.

25 The invention includes a sheet comprising at least an electroconductive layer, wherein the electroconductive layer is formed of the above resin composition. A formed

or shaped article obtained from the sheet may sufficiently be used for containing and carrying an electronic component.

5                    DETAILED DESCRIPTION OF THE INVENTION

                  [Styrenic Resin (A)]

                  The styrenic (or styrene-series) resin includes a polystyrenic resin and a rubber-modified (or rubber-containing) styrenic resin. Examples of an aromatic vinyl  
10 monomer for forming the polystyrenic resin are styrene, alkyl-substituted styrene (e.g. vinyltoluene, vinylxylene, p-ethylstyrene, p-isopropylstyrene, butylstyrene, p-t-butylstyrene, etc.), halogen-substituted styrene (e.g. chlorostyrene, bromostyrene, etc.),  $\alpha$ -alkyl-substituted  
15 styrene wherein an alkyl group is substituted at the  $\alpha$  position (e.g.  $\alpha$ -methylstyrene, etc.) and the like. The above aromatic vinyl monomers are used alone or in combination thereof. Among the above monomers, generally, styrene, vinyltoluene,  $\alpha$ -methylstyrene and the like are  
20 used and, in particular, styrene, is used.

                  The aromatic vinyl monomers may be used in combination with a copolymerizable monomer. Examples of the copolymerizable monomer are a vinyl cyanide-series monomer (e.g. acrylonitrile, etc.), an unsaturated polycarboxylic  
25 acid or its acid anhydride (e.g. maleic acid, itaconic acid, citraconic acid or its acid anhydride, etc.), an imide-series monomer [e.g. maleimide, N-alkylmaleimide (e.g.

N-C<sub>1-4</sub> alkylmaleimide, etc.), N-cycloalkylmaleimide (e.g. N-cyclohexylmaleimide, etc.), N-arylmaleimide (e.g. N-phenylmaleimide, etc.)], an acrylic monomer [e.g. a C<sub>1-20</sub> alkyl esters of (meth)acrylic acid such as (meth)acrylic acid, methyl (meth)acrylic acid, ethyl (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 C<sub>2-4</sub> alkyl esters of hydroxy (meth)acrylic 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. Generally, an amount of the copolymerizable monomer to be used with respect to an amount of total monomers is 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.%.

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 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 polymerization, solution polymerization, emulsion polymerization) in the presence of the rubber like polymer.

5           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 cis-type polybutadiene), polyisoprene, a styrene-butadiene copolymer, a styrene-isoprene copolymer,  
10 a butadiene-acrylonitrile copolymer, an isobutylene-isoprene copolymer, a styrene-isobutylene-butadiene-series copolymerized rubber, etc.], an ethylene-vinylacetate copolymer, an acrylic rubber (a copolymerized elastomer containing  $C_{2-8}$  alkylester of a polyacrylic acid  
15 as a major constituent, etc.), an ethylene- $\alpha$ -olefin-series copolymer [ethylene-propylene rubber (EPR), etc.], an ethylene- $\alpha$ -olefin-polyene copolymer [ethylene-propylene-diene rubber (EPDM), etc.], an urethane rubber, a silicone rubber, a butyl rubber, a hydrogenated  
20 diene-series rubber (hydrogenated styrene-butadiene copolymer, 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,  
25 a taper type, a radial teleblock type and the like. The rubber like polymers may be 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.].

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 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, for example, about 0.05 to 30  $\mu\text{m}$ , preferably about 0.1 to 10  $\mu\text{m}$ , more preferably about 0.2 to 7  $\mu\text{m}$  (particularly about 0.5 to 5  $\mu\text{m}$ ). 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 (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  $\alpha$ -methylstyrene-modified ABS resin, an imide-modified ABS resin, an MBS resin and the like are preferably used

as the rubber-modified styrenic resin.

Further, it is preferred that the styrenic resin be 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). A preferable content of the rubber like polymer (soft component) in the styrenic resin is about 3 to 40 wt.%, and a range of about 5 to 20 wt.% is particularly preferable.

A weight average molecular weight of the styrenic resin (in the graft copolymer, the styrenic resin structuring a matrix) is about 10,000 to 1,000,000, preferably about 50,000 to 500,000, more preferably about 100,000 to 500,000.

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 10 g/10 min, preferably about 1 to 5 g/10 min.

[Conductant (B)]

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 component (B). Among these conductants, the electroconductive carbon black is preferably used.

The above conductants can be used alone or in combination thereof.

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 (dibutylphthalate) 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. A specific surface area of the electroconductive carbon black may preferably be about 20 to 300 m<sup>2</sup>/g, particularly about 30 to 50 m<sup>2</sup>/g.

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 (particularly of the electroconductive carbon black) is

closely related to the ratio of the component (A), and cannot be flatly defined, however, the average particle size is typically about 1 nm to 1  $\mu$ m, preferably about 10 to 100 nm, more preferably about 40 to 60 nm.

5           The amount of component (B) relative to 100 parts by weight of the component (A) is about 5 to 50 parts by weight, preferably about 20 to 40 parts by weight, more preferably about 25 to 40 parts by weight (particularly about 30 to 40 parts by weight).

10           [Impact Modifier (C)]

          As the impact modifier, there may be used various elastomers each composed of a rigid component and a soft component, examples of which are a styrenic thermoplastic elastomer, an olefinic thermoplastic elastomer, a  
15 polyester-series thermoplastic elastomer, a polyvinyl chloride-series thermoplastic elastomer, a polyamide-series thermoplastic elastomer, a thermoplastic polyurethane and the like. Among these elastomers, thermoplastic elastomers such as the styrenic or  
20 styrene-series thermoplastic elastomer (C<sub>1</sub>), the olefinic or olefin-series thermoplastic elastomer (C<sub>2</sub>), the polyester-series thermoplastic elastomer (C<sub>3</sub>) may preferably be used.

          The styrenic thermoplastic elastomer (C<sub>1</sub>) includes  
25 an elastomer wherein its rigid segment comprising a styrenic unit and its soft segment comprising a diene-series unit such as a styrene-diene-series block copolymer

or the hydrogenated product thereof. Examples of the styrene-diene-series block copolymer or the hydrogenated product thereof include a styrene-butadiene block copolymer, a hydrogenated styrene-butadiene block copolymer, a styrene-butadiene-styrene block copolymer (SBS), a hydrogenated styrene-butadiene-styrene block copolymer (SEBS), a styrene-isoprene block copolymer, a hydrogenated styrene-isoprene block copolymer (SEP), a styrene-isoprene-styrene block copolymer (SIS), a hydrogenated styrene-isoprene-styrene block copolymer (SEPS) and the like. In each of the above block copolymers, the terminating block may be composed of a styrene block or a diene block.

Examples of the olefinic thermoplastic elastomer ( $C_2$ ) are a copolymer of olefin and at least one monomer selected from the group consisting of (meth)acrylic monomers and vinyl ester-series monomers, a thermoplastic elastomer (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- $\alpha$ -olefin-series copolymer [ethylene-propylene rubber (EPR), etc.], an ethylene- $\alpha$ -olefin-diene copolymer [ethylene-propylene-diene rubber (EPDM), etc.], a diene-series rubber [polybutadiene (lower cis-type or higher cis-type polybutadiene), polyisoprene, a butadiene-acrylonitrile copolymer, an isobutylene-isoprene copolymer, etc.] and

the like. Among the above olefinic thermoplastic elastomers, the copolymer of olefin and the (meth)acrylic monomer as well as the copolymer of olefin and the vinylester-series monomer are preferred.

5           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 the acrylic monomer are (meth)acrylic acid, a  $C_{1-10}$  alkyl ester of (meth)acrylic acid such as methyl  
10 (meth)acrylate, ethyl (meth)acrylate, butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate and the like, preferably  $C_{1-10}$  alkyl ester of (meth)acrylic acid such as ethyl (meth)acrylate and the like. Examples of the vinylester-series monomer are aliphatic vinylester such as  
15 vinyl acetate, vinyl propionate and the like. Specifically, an ethylene-ethylacrylate copolymer, ethylene-vinylacetate copolymer and the like may preferably be used.

          Examples of the polyester-series thermoplastic  
20 elastomer ( $C_3$ ) are an elastomer wherein its rigid segment comprising an alkylene arylate unit and its soft segment comprising an aliphatic polyether or polyester unit and the like. Examples of the aliphatic polyether constituting the soft segment are a poly  $C_{2-6}$  alkyleneoxide such as  
25 polyethyleneoxide, polypropyleneoxide, polytetramethyleneoxide and the like, and examples of the aliphatic polyester are polyesters obtainable from an

aliphatic C<sub>2-6</sub> dicarboxylic acid (e.g. oxalic acid, succinic acid, adipic acid, etc.) and an aliphatic C<sub>2-6</sub> diol (e.g. ethylene glycol, propylene glycol, 1,4-butanediol, 1,3-butanediol, neopentylglycol, hexane diol, etc.).

5 Examples of the alkylene arylate constituting the rigid segment include a C<sub>2-4</sub> alkylene telephthalate such as ethylene telephthalate, butylene telephthalate, etc., a C<sub>2-4</sub> alkylene naphthalate such as ethylene naphthalate, butylene naphthalate, etc., preferably the C<sub>2-4</sub> alkylene  
10 telephthalate (particularly the ethylene telephthalate).

The molecular structure of each of the above thermoplastic elastomers is not limited and may be a triblock copolymer, an asterisk block copolymer, a multiblock copolymer, a graft copolymer, an ionomer or the  
15 like.

The above impact modifiers may be used alone or in combination thereof.

In the case where a single elastomer is used as the component (C), an amount of the component (C) relative to  
20 100 parts by weight of the component (A) is about 11 to 44 parts by weight, preferably about 15 to 40 parts by weight, more preferably about 20 to 30 parts by weight. If the ratio of the component (C) is too small, an article obtained by a postforming (vacuum forming or molding (compressed-air  
25 forming), air pressure forming, press molding, etc.) of a sheet is insufficient in dimensional accuracy, and, when the article is a container, especially, an edge of the

container becomes so thin that it tends to break when bent due to stress concentration. On the other hand, if the amount of component (C) is too large, burrs occur in the cutting or punching process, which may contaminate the  
5 content.

In the present invention, it is preferable to use the impact modifiers in combination and, for example, it is effective to use a combination of the styrenic thermoplastic elastomer ( $C_1$ ), and the olefinic  
10 thermoplastic elastomer ( $C_2$ ) and/or the polyester-series thermoplastic elastomer ( $C_3$ ) (i.e., the combination of ( $C_1$ ) and at least one member selected from the group consisting of ( $C_2$ ) and ( $C_3$ )), particularly a combination of the styrenic thermoplastic elastomer ( $C_1$ ) and the olefinic  
15 thermoplastic elastomer ( $C_2$ ). In the above combinations, there is achieved, in addition to the effect of impact modification, an improvement in compatibility of the component (A) due to a structural unit (or structural block, segment) of the component ( $C_1$ ) that is common with that of  
20 the component (A). Further, the component ( $C_2$ ) and/or ( $C_3$ ) (particularly, the component ( $C_2$ ) such as an ethylene-series copolymer) can improve the compatibility with the component (B). Ratio (weight ratio) of the component ( $C_1$ ) relative to a total weight of the components ( $C_2$ ) and ( $C_3$ ),  
25 i.e. a ratio of  $(C_1)/(C_2 + C_3)$ , is about 3/1 to 1/10, preferably about 2/1 to 1/5, more preferably about 1/1 to 1/5. In the case of using the elastomers in combination

as the component (C), the ratio of the component (C) is not limited, and the ratio of the component (C) to 100 parts by weight of the component (A) may be about 0.1 to 100 parts by weight, preferably about 1 to 50 parts by weight, more  
5 preferably about 10 to 40 parts by weight (particularly about 20 to 30 parts by weight).

In the present invention, it is also preferable to use the polyester-series thermoplastic elastomer ( $C_3$ ) alone. In the case of using the polyester-series  
10 thermoplastic elastomer ( $C_3$ ) alone as the component (C), the ratio of the component ( $C_3$ ) is not limited, and an amount of the component (C) to 100 parts by weight of the component (A) may be about 0.1 to 100 parts by weight, preferably about 1 to 50 parts by weight, more preferably  
15 about 10 to 40 parts by weight (particularly about 20 to 30 parts by weight).

The ratio (weight ratio) of the rigid component to the soft component in the components (A) and (C) is about 95/5 to 50/50, preferably about 90/10 to 60/40, more  
20 preferably about 90/10 to 70/30. It is possible to achieve simultaneously the forming or shaping (or molding) and working properties and mechanical properties by employing the ratio of the rigid component to the soft component in the above range.

25 [Electroconductive Resin Composition]

The electroconductive resin composition may be a mixture of powders of the components (A) to (C) or may be

prepared by kneading the components (A) to (C). 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  
5 fed to a conventional melt mixer such as a uniaxial or biaxial extruder, Banbury mixer, a kneader, a mixing roller or the like to be melt-kneaded. The electroconductive resin composition may be in the form of pellets.

There may be added to the electroconductive resin  
10 composition 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 (an antioxidant, an ultraviolet rays absorbent, a thermostabilizer), a flame retardant, an antiblocking  
15 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 1 to 20 parts by weight, preferably about 3 to 15 parts by weight, of the lubricant (e.g. waxes or a C<sub>8-24</sub> higher  
20 aliphatic ester or amide, etc.) with respect to 100 parts by weight of the component (A).

The MI of the electroconductive resin composition of the present invention at a temperature of 200°C and with a load of 49N (5.0 kgf) is about 3.5 g/10 min. or more,  
25 preferably about 3.5 to 10 g/10 min., more preferably about 3.6 to 8 g/10 min. (particularly about 3.7 to 6 g/10 min.). If the MI is too low in the case where the electroconductive

resin composition is kneaded into a sheet, the degree of molecular orientation at a surface portion of the sheet is increased, thereby allowing the sheet to be subject to burrs in punching thereof. On the other hand, if the MI is too high, an irregularity in thickness tends to occur in postforming the sheet.

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

#### [Production of Sheet]

The process for producing the electroconductive resin sheet is not limited, and it is possible to form the sheet by feeding the resin composition to an ordinary extruder and kneading and then extruding the resin composition from a die (flat die, T-shaped die, circular die, etc.). The sheet may be stretched (via uniaxial stretching, biaxial stretching), and the sheet is typically a non-stretched film that is prepared by applying a draw in a direction of the extrusion. Further, if necessary, the sheet may be formed by a foamed sheet extrusion using a blowing agent (chemical foaming agent or gas).

The sheet of the present invention is a sheet composed of at least an electroconductive layer comprising the resin composition, and the sheet may be a single layer sheet or

a laminated sheet composed of a plurality of layers. The laminated sheet is formed by laminating the electroconductive layer comprising the electroconductive resin composition to/on at least one side of a base sheet.

5 Usually, it is preferred to laminate the electroconductive layer to both sides of the base sheet, although the laminated sheet prepared by laminating the electroconductive layer to only one side of the base sheet is sufficiently used on some occasions. Materials to be

10 used for the base sheet are not limited as long as the material does not deteriorate formability and impact resistant, and the material may be a thermoplastic resin such as the above-described styrenic resin, an olefinic resin (e.g. polyethylene, polypropylene, etc.), a

15 polyester-series resin (e.g. homo-polyester such as polyethylene telephthalate, polybutylene telephthalate, etc., or copolyester, etc.), a polyamide-series resin (e.g. nylon 6, nylon 66, nylon 610, nylon 612, etc.), a polycarbonate-series resin (e.g. bisphenol A polycarbonate,

20 etc.) and the like. Among the above thermoplastic resins, it is preferable to use the one being similar or same series resin as that of a resin used for the electroconductive layer, particularly the styrenic resin.

The MI ratio of the electroconductive resin

25 composition relative to the styrenic resin used for the base sheet is about 0.7 to 5, preferably about 1 to 4.5, more preferably about 1.2 to 4.5. If the MI ratio is too low,

an irregularity occurs on the surface of the sheet. If the MI ratio is too high, a difference between flowabilities of the resins is widened so much that a difference between a lamination ratio of the center portion and the edge portions is caused, to thereby result in uneven electroconductivity and mechanical properties of the sheet.

Thickness of the electroconductive sheet is about 0.01 to 5 mm, preferably about 0.05 to 3 mm, more preferably about 0.1 to 1 mm.

In the case of the laminated sheet, a thickness ratio of the base sheet/the each electroconductive layers is about 30/1 to 1/1, preferably about 20/1 to 2/1, more preferably about 15/1 to 5/1. Thickness of each of the electroconductive layers is about 1 to 500  $\mu\text{m}$ , preferably about 5 to 300  $\mu\text{m}$ , more preferably about 10 to 100  $\mu\text{m}$ . Thickness of the base sheet is about 10 to 5,000  $\mu\text{m}$ , preferably about 50 to 3,000  $\mu\text{m}$ , more preferably about 100 to 1,000  $\mu\text{m}$ .

The laminated sheet may be prepared by a heat lamination method, a dry lamination method, etc., however, it is preferable to prepare the laminated sheet by a coextrusion of the base sheet and the electroconductive layer or layers. In addition, in the lamination method, an adhesive is not essentially necessary.

#### [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 may be foamed when  
5 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  
10 treatment 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  
15 (e.g. by applying thereon 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  
20 sheet or the postformed article.

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  
25 containing a semiconductor or an electronic component, particularly an IC 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  
5 to obtain an electroconductive resin composition that is suppressed in occurrences in burrs and shavings in cutting and punching as well as occurrences of notches and cracks in postforming. The electroconductive resin composition is excellent in formability as well as mechanical  
10 properties such as impact resistance, strength and the like and, therefore, 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  
25 discharged from a 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]

The resin was pelletized and then formed into a sheet having a thickness of 300  $\mu\text{m}$  by using an extruder having  
5 a diameter of 25 mm and a T-shaped die having a width of 120 mm to measure a surface specific resistivity of the obtained sheet. Measurements at an arbitrary 10 points of the obtained sample were conducted by using a "Rolester Surface Resistivity Meter" (manufactured by Mitsubishi  
10 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 the surface specific resistivity.

15 [Folding Endurance of Formed Article]

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 operation was repeated, and the number of  
20 operations was counted until a crack occurred.

[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  $\mu\text{m}$  or more was counted by observing with a  
25 microscope.

[Abbreviation and Details of Each Component]

HIPS-1: high-impact polystyrene ("Toyo Styrol H610")

manufactured by Toyo Styrene Co., Ltd.).

HIPS-2: high-impact polystyrene ("Toyo Styrol H53C"  
manufactured by Toyo Styrene Co., Ltd.).

HIPS-3: high-impact polystyrene ("Toyo Styrol E640"  
5 manufactured by Toyo Styrene Co., Ltd.).

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

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

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

EVA: ethylene-vinylacetate copolymer ("Evatate  
K4011" manufactured by Sumitomo Chemical Co., Ltd.).

SBS: styrene-butadiene block copolymer ("Tufprene  
15 126" manufactured by Asahi Kasei Corporation).

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

SBBS: styrene-butadiene-butylene block copolymer  
("Tuftec JT82P" manufactured by Asahi Kasei Corporation).

20 SEPS-1: styrene-ethylene-propylene copolymer  
("Septon 2104" manufactured by Kuraray Co., Ltd.).

SEPS-2: styrene-ethylene-propylene copolymer  
("Septon 2043" manufactured by Kuraray Co., Ltd.).

PE E: polyester elastomer ("Hytrel 4057"  
25 manufactured by Du Pont-Toray Co., Ltd.).

Examples 1 through 17 and Comparative Examples 1 through

7

Respective components in ratios shown in Table 1 and Table 2 were dry-blended using a tumbler, and then melt-kneaded at a cylindrical temperature of 210°C by using  
5 a biaxial extruder ( $L/D = 32$ ) having a diameter of 30 mm, followed by pelletizing by the strand cut method to obtain an electroconductive resin composition. 90 parts by weight of the HIPS-3 and 10 parts by weight of the SB were dry-blended by using a tumbler to obtain a resin composition  
10 composed of a base layer ( $MI = 3.1 \text{ g/10 min.}$ ).

A multi-layer extruder (equipped with three dies each having two passages) was used in the following process. The resin composition composed of the base layer was fed to a uniaxial extruder ( $L/D = 32$ ) having a diameter of 65 mm at  
15 a cylindrical temperature of 210°C, and the electroconductive resin composition was fed to another uniaxial extruder ( $L/D = 28$ ) having a diameter of 50 mm at a cylindrical temperature of 210°C. Then, the electroconductive layer was converged on each side of the  
20 base layer to laminate both sides of the base layer, and then extruded by the T die-cast method at a die temperature 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  
25 of 300  $\mu\text{m}$  (thickness ratio: electroconductive layer/base layer/electroconductive layer = 20  $\mu\text{m}$ /260  $\mu\text{m}$ /20  $\mu\text{m}$ ). The laminated sheet was slit into sections each having a width

of 24 mm, 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, followed by an embossing process to emboss a pattern of a  
5 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 with perforations 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  
10 neighboring perforation was 4 mm. Intervals between the embosses were set at 5 mm. Evaluation results of the laminated sheet and the carrier tape were shown in Table 1 and Table 2.

Table 1

|                                                  | Examples             |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |                      |
|--------------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                                                  | 1                    | 2                    | 3                    | 4                    | 5                    | 6                    | 7                    | 8                    | 9                    | 10                   | 11                   | 12                   |
| HPS-1 (parts by weight)                          | 100                  | 100                  | 100                  | 100                  | 100                  | 100                  | 100                  | 100                  | 100                  | 100                  | 100                  | 100                  |
| HPS-2 (parts by weight)                          | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| HPS-3 (parts by weight)                          | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| Lubricant(parts by weight)                       | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| CB (parts by weight)                             | 30                   | 30                   | 30                   | 30                   | 30                   | 30                   | 30                   | 30                   | 30                   | 35                   | 35                   | 33                   |
| EEA (parts by weight)                            | 25                   | 25                   | 25                   | 10                   | 10                   | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| EVA (parts by weight)                            | -                    | -                    | -                    | -                    | -                    | 25                   | 25                   | 25                   | -                    | -                    | -                    | -                    |
| SBS (parts by weight)                            | -                    | 5                    | -                    | 5                    | -                    | -                    | 5                    | -                    | 25                   | -                    | -                    | -                    |
| SEBS (parts by weight)                           | -                    | -                    | 5                    | -                    | 10                   | -                    | -                    | 5                    | -                    | 40                   | -                    | -                    |
| SBBS (parts by weight)                           | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | 40                   | -                    |
| SEPS-1 (parts by weight)                         | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | 35                   |
| SEPS-2 (parts by weight)                         | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| PE'E (parts by weight)                           | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |
| MI (g/10 min.)                                   | 7.1                  | 7.3                  | 6.3                  | 5.5                  | 4.7                  | 7.3                  | 6.5                  | 6.8                  | 5.0                  | 4.4                  | 8.4                  | 9.9                  |
| MI Ratio                                         | 2.3                  | 2.4                  | 2.0                  | 1.8                  | 1.5                  | 2.4                  | 2.1                  | 2.2                  | 1.6                  | 1.4                  | 2.7                  | 3.2                  |
| Surface Resistivity( $\Omega/\square$ )          | 1.2<br>$\times 10^5$ | 2.4<br>$\times 10^5$ | 3.2<br>$\times 10^5$ | 1.8<br>$\times 10^5$ | 1.3<br>$\times 10^5$ | 1.8<br>$\times 10^5$ | 3.1<br>$\times 10^5$ | 3.2<br>$\times 10^5$ | 2.3<br>$\times 10^5$ | 4.2<br>$\times 10^5$ | 3.9<br>$\times 10^5$ | 2.7<br>$\times 10^5$ |
| Folding Endurance (number of times of operation) | 8                    | 18                   | 13                   | 14                   | 17                   | 9                    | 16                   | 12                   | >20                  | >20                  | >20                  | >20                  |
| Burrs Occurrence Frequency (%)                   | 4                    | 1                    | 0                    | 0                    | 1                    | 3                    | 1                    | 0                    | 3                    | 3                    | 4                    | 3                    |

Table 2

|                                                  | Examples             |                      |                      |                      |                      |                      |                      |                      |                      |                      | Comparative examples |                      |  |  |  |  |  |
|--------------------------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|--|--|--|--|--|
|                                                  | 13                   | 14                   | 15                   | 16                   | 17                   | 1                    | 2                    | 3                    | 4                    | 5                    | 6                    | 7                    |  |  |  |  |  |
| HIPS-1(parts by weight)                          | 100                  | 100                  | -                    | -                    | -                    | 100                  | 100                  | -                    | -                    | -                    | -                    | -                    |  |  |  |  |  |
| HIPS-2(parts by weight)                          | -                    | -                    | 100                  | 100                  | -                    | -                    | -                    | 100                  | 100                  | 100                  | 100                  | -                    |  |  |  |  |  |
| HIPS-3(parts by weight)                          | -                    | -                    | -                    | -                    | 100                  | -                    | -                    | -                    | -                    | -                    | -                    | 100                  |  |  |  |  |  |
| Lubricant (parts by weight)                      | -                    | -                    | 5                    | 10                   | 10                   | -                    | -                    | -                    | -                    | -                    | -                    | -                    |  |  |  |  |  |
| CB(parts by weight)                              | 33                   | 30                   | 30                   | 40                   | 40                   | 25                   | 40                   | 30                   | 30                   | 30                   | 30                   | 30                   |  |  |  |  |  |
| EEA(parts by weight)                             | -                    | -                    | -                    | -                    | -                    | -                    | -                    | 25                   | 25                   | -                    | -                    | 25                   |  |  |  |  |  |
| EVA(parts by weight)                             | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | 25                   | 25                   | -                    |  |  |  |  |  |
| SBS(parts by weight)                             | -                    | -                    | 25                   | -                    | -                    | 10                   | 45                   | 5                    | -                    | -                    | 5                    | 5                    |  |  |  |  |  |
| SEBS(parts by weight)                            | -                    | -                    | -                    | 40                   | 40                   | -                    | -                    | -                    | 5                    | -                    | -                    | -                    |  |  |  |  |  |
| SBBS(parts by weight)                            | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |  |  |  |  |  |
| SEPS-1(parts by weight)                          | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |  |  |  |  |  |
| SEPS-2(parts by weight)                          | 35                   | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |  |  |  |  |  |
| PE-E(parts by weight)                            | -                    | 30                   | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    | -                    |  |  |  |  |  |
| MI(g/10 min.)                                    | 8.9                  | 14.1                 | 3.9                  | 7.1                  | 9.7                  | 5.2                  | 3.7                  | 2.4                  | 2.6                  | 3.1                  | 2.6                  | 1.8                  |  |  |  |  |  |
| MI Ratio                                         | 2.9                  | 4.5                  | 1.3                  | 2.3                  | 3.1                  | 1.7                  | 1.2                  | 0.77                 | 0.84                 | 1.0                  | 0.84                 | 0.58                 |  |  |  |  |  |
| Surface Resistivity ( $\Omega/\square$ )         | 5.1<br>$\times 10^5$ | 3.8<br>$\times 10^5$ | 3.2<br>$\times 10^5$ | 1.8<br>$\times 10^5$ | 4.4<br>$\times 10^5$ | 2.7<br>$\times 10^5$ | 5.1<br>$\times 10^5$ | 3.9<br>$\times 10^5$ | 4.1<br>$\times 10^5$ | 6.3<br>$\times 10^5$ | 7.8<br>$\times 10^5$ | 6.2<br>$\times 10^5$ |  |  |  |  |  |
| Folding Endurance (number of times of operation) | 15                   | 12                   | 14                   | >20                  | >20                  | 1                    | >20                  | 19                   | 15                   | 11                   | 18                   | 17                   |  |  |  |  |  |
| Burrs Occurrence Frequency (%)                   | 4                    | 3                    | 1                    | 0                    | 0                    | 2                    | 84                   | 16                   | 27                   | 31                   | 62                   | 48                   |  |  |  |  |  |

From the results of Table 1 and Table 2, 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  
5 Example 1 are low in strength, while the occurrence of burrs are increased in the products of Comparative Examples 2 through 7.

What is claimed is:

1. An electroconductive resin composition comprising a styrenic resin (A), a conductant (B) and an impact modifier (C), wherein a ratio of the impact modifier (C) relative to 100 parts by weight of the styrenic resin (A) is about 11 to 44 parts by weight, the electroconductive resin composition having a melt index (MI) of 3.5 g/10 min. or more.

2. The composition according to Claim 1, wherein the impact modifier (C) is a thermoplastic elastomer.

3. The composition according to Claim 1, wherein the impact modifier (C) is at least one selected from the group consisting of a styrenic thermoplastic elastomer (C<sub>1</sub>), an olefinic thermoplastic elastomer (C<sub>2</sub>) and a polyester-series thermoplastic elastomer (C<sub>3</sub>).

4. The composition according to Claim 3, wherein the styrenic thermoplastic elastomer (C<sub>1</sub>) is at least one member selected from the group consisting of a styrene-diene-series block copolymer and a hydrogenated styrene-diene-series block copolymer.

5. The composition according to Claim 3, wherein the olefinic thermoplastic elastomer (C<sub>2</sub>) is a copolymer of olefin and at least one member selected from the group consisting of a (meth)acrylic monomer and a vinyl ester-series monomer.

6. The composition according to Claim 1, wherein a ratio (weight ratio) of a rigid component to a soft

component in the styrenic resins (A) and the impact modifier (C) is about 95/5 to 50/50.

7. The composition according to Claim 1, wherein the impact modifier (C) comprises at least one member selected  
5 from the group consisting of the styrenic thermoplastic elastomer (C<sub>1</sub>), the olefinic thermoplastic elastomer (C<sub>2</sub>) and the polyester-series thermoplastic elastomer (C<sub>3</sub>), and the ratio (weight ratio) of the component (C<sub>1</sub>) to a total amount of the components (C<sub>2</sub>) and (C<sub>3</sub>) is about 5/1 to 1/20.

10 8. The composition according to Claim 1, wherein the conductant (B) is an electroconductive carbon black.

9. The composition according to Claim 1, wherein a ratio of the component (B) relative to 100 parts by weight of the component (A) is about 5 to 50 parts by weight.

15 10. The composition according to Claim 1, wherein the styrenic resin (A) comprises at least a rubber-modified styrenic resin.

11. The composition according to Claim 1, wherein a surface specific resistivity is  $1 \times 10^{11} \Omega/\square$  or less.

20 12. An electroconductive resin composition comprising a rubber-modified styrenic resin (A), an electroconductive carbon black (B) and an impact modifier (C), which comprises about 10 to 40 parts by weight of the component (B) and about 15 to 40 parts by weight of the  
25 component (C) relative to 100 parts by weight of the component (A), has a melt index (MI) of about 3.5 to 10 g/10 min., and has a surface resistivity of about  $1 \times 10^1$  to 1

$\times 10^8 \Omega/\square$ .

13. An electroconductive resin composition comprising a styrenic resin (A), a conductant (B) and an impact modifier (C), wherein the impact modifier (C) is  
5 composed of a combination of a styrenic thermoplastic elastomer ( $C_1$ ) and an olefinic thermoplastic elastomer ( $C_2$ ) or a polyester-series thermoplastic elastomer ( $C_3$ ).

14. A sheet comprising at least an electroconductive layer, wherein the electroconductive layer comprises the  
10 composition of Claim 1.

15. The sheet according to Claim 14, wherein the electroconductive layer is laminated on at least one side of a base sheet.

16. The sheet according to Claim 14, wherein the  
15 electroconductive layer is laminated on both sides of a base sheet comprising a styrenic resin.

17. A formed or shaped article that is obtainable from the sheet of Claim 14.

18. The formed or shaped article according to Claim  
20 17, which is used for containing or carrying an electronic component.