

Description

Title of Invention

SURFACE-CONDUCTIVE LAMINATED SHEET AND ELECTRONIC COMPONENT PACKAGING CONTAINER

Technical Field

- [0001] The present invention relates to a surface-conductive laminated sheet comprising a thermoplastic resin, and an electronic component packaging container, such as carrier tape or a tray for conveying electronic components, using said laminated sheet.

Background Art

- [0002] Vacuum-formed trays, embossed carrier tape and the like, obtained by thermoforming sheets, are used as packaging containers for intermediary products for all kinds of industrial products, such as electronic devices and automobiles. Furthermore, sheets obtained by laminating a polystyrene-based resin containing a conductive filler such as carbon black onto a substrate layer comprising a polystyrene-based resin are used as sheets for use in packaging containers for ICs, which are susceptible to static electricity, and various types of electronic components having ICs (see, for example, Patent Documents 1 to 3).

- [0003] In recent years, with the miniaturization of electronic components, it has become very difficult to extract electronic components contained in the embossed portions (also called “pockets”) of carrier tape, and when the electronic components are to be automatically mounted on printed circuit boards, to precisely pick up the electronic components without the pickup nozzle coming into contact with the carrier tape. So-called “pickup defects”, in which the pickup nozzle comes into contact with the carrier tape and causes the carrier tape to be crushed or deformed, thereby obstructing the pickup path, have become a problem.

Citation List

Patent Literature

- [0004] Patent Document 1: JP H9-76422 A
Patent Document 2: JP H9-76425 A
Patent Document 3: JP H9-174769 A

Summary of Invention

Technical Problem

[0005] The present invention addresses the problems of providing a surface-conductive laminated sheet that has excellent strength and that can, for example, in conductive carrier tape, suppress the crushing or the deformation of the carrier tape even when a pickup nozzle comes into contact with the carrier tape when mounting electronic components; and an electronic component packaging container, more specifically, carrier tape or a tray for conveying electronic components, formed by molding said surface-conductive laminated sheet.

Solution to Problem

[0006] As a result of diligently studying these problems, the present inventors discovered that a surface-conductive laminated sheet that solves all of the aforementioned problems can be obtained by including, in a substrate layer and surface layers, a polystyrene-based resin in which the conjugated diene content is within a specific range, thereby arriving at the present invention.

[0007] In other words, the present invention is a surface-conductive laminated sheet comprising: a sheet substrate layer; and surface layers laminated onto both surfaces of the sheet substrate layer; wherein the substrate layer comprises a polystyrene-based resin having a conjugated diene content of 3.0 to 8.2 mass%, the surface layer comprises a conductive resin composition containing a polystyrene-based resin having a conjugated diene content of 2.0 to 7.4 mass% and a conductive filler, and the surface-conductive laminated sheet has a Martens hardness of 50 to 130 N/mm². The conductive filler is preferably carbon black. Additionally, when the conductive filler is carbon black, the conductive resin composition in the surface layers preferably further contains an olefin-based resin and a hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin.

[0008] Additionally, the surface layer preferably contains 46 to 85 mass% of a polystyrene-based resin, 13 to 23 mass% of carbon black, 1.5 to 20 mass% of an olefin-based resin, and 0.5 to 11 mass% of a hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin.

[0009] Additionally, the conjugated diene contained in the polystyrene-based resin used in the substrate layer and the surface layers preferably has a volume-average particle diameter of 0.5 to 4.0 μm .

[0010] Furthermore, the present invention includes an electronic component packaging container, more specifically, carrier tape or a tray for conveying electronic components, formed by being molded from the aforementioned surface-conductive laminated sheet.

Advantageous Effects of Invention

[0011] According to the present invention, since a polystyrene-based resin in which the

conjugated diene content is within a specific range is used in the substrate layer and the surface layers, it is possible to obtain a surface-conductive laminated sheet that has sufficient strength for practical use and that, for example, in conductive carrier tape, is able to suppress the crushing or the deformation of the carrier tape even when a pickup nozzle comes into contact with the carrier tape when mounting electronic components; and an electronic component packaging container, such as carrier tape, using said sheet.

Description of Embodiments

- [0012] Embodiments of the present invention will be explained in detail below, but the present invention is not limited to the embodiments, including the examples, indicated below.
- [0013] A surface-conductive laminated sheet according to one embodiment of the present invention is formed from a substrate layer containing a polystyrene (PS)-based resin as the main component, and conductive surfaces layers laminated onto both surfaces of the substrate layer.
- [0014] A polystyrene (PS)-based resin refers to a resin containing, as the main component, a polystyrene resin (GPPS), a high-impact polystyrene resin (rubber-modified styrene resin, HIPS), or a mixture thereof. Examples of the aromatic vinyl monomers forming the polystyrene-based resin include styrene, o-methylstyrene, p-methylstyrene, p-tert-butylstyrene, 1,3-dimethylstyrene, α -methylstyrene, vinyl naphthalene, vinylanthracene, 1,1-diphenylethylene and the like. Of these aromatic vinyl monomers, styrene, vinyltoluene, o-methylstyrene and the like, particularly styrene, are normally used. High-impact polystyrene resins are polystyrene resins in which styrene monomers are graft-polymerized to a rubber-type elastic material containing conjugated dienes as the main component. The conjugated dienes that are used may be 1,3-butadiene, 2-methyl-1,3-butadiene (isoprene), 2,3-dimethyl-1,3-butadiene, 1,3-pentadiene, 1,3-hexadiene and the like, among which 1,3-butadiene is particularly common.
- [0015] The polystyrene-based resin used in the substrate layer contains 3.0 to 8.2 mass%, preferably 3.0 to 5.0 mass% of conjugated dienes, and the polystyrene-based resin used in the surface layers contains 2.0 to 7.4 mass%, preferably 2.0 to 4.0 mass% of conjugated dienes. By setting the conjugated diene content in the polystyrene resins used in the substrate layer and the surface layers within the aforementioned ranges, the below-mentioned Martens hardness ranges are obtained.
- [0016] While the most convenient method for adjusting the conjugated diene content in the polystyrene-based resins is by adjusting the blend between GPPS and HIPS, it may be adjusted during the HIPS production stage. Additionally, while the melt flow indices

(measured in accordance with the JIS-K-7210 standard) of the GPPS and the HIPS used in the substrate layer and the surface layers are not particularly limited, those having a melt flow index of 1 to 15 g/10 min at 200 °C with a load of 5 kg are favorable for the purpose of mold processing.

[0017] The polystyrene-based resin content in the surface layers should preferably be 46 to 85 mass%, more preferably 54 to 81 mass% and even more preferably 58 to 80 mass%. By setting the content to 85 mass% or less, the conductivity is kept from decreasing as the ratio of the added amount of conductive filler decreases, and by setting the content to 46 mass% or more, the tensile elastic modulus is kept from becoming too low.

[0018] The volume-average particle diameters of the conjugated dienes contained in the polystyrene-based resins used in the substrate layer and the surface layers are, in both cases, preferably 0.5 to 4.0 μm , more preferably 2.0 to 3.5 μm , and even more preferably 2.4 to 3.0 μm . It is possible to obtain good mechanical performance when the volume-average particle diameters are within the aforementioned ranges. By setting the volume-average particle diameters to be 4.0 μm or smaller, the tensile elastic modulus is kept from becoming too low, and by setting the volume-average particle diameters to be 0.5 μm or larger, the folding endurance is kept from decreasing.

[0019] Although the conductive fillers contained in the surface layers are not particularly limited, carbon black is particularly preferred in view of the moldability and the like. The carbon black is furnace black, channel black, acetylene black or the like, preferably with a large specific surface area. Acetylene black is particularly preferred in view of the fact that high conductivity can be obtained by adding only a small amount to the resin. The amount added to the surface layers is preferably 13 to 23 mass%, more preferably 16 to 21 mass%. By adding 13 mass% or more, sufficient surface resistance values are obtained, and by adding 23 mass% or less, the fluidity is lowered while the mechanical strength of the resulting sheet is also kept from decreasing.

[0020] Since the carbon black may desorb from a resin composition consisting only of a polystyrene-based resin and carbon black, an olefin-based resin may be added in order to prevent such desorption. The amount added to the surface layers is preferably 1.5 to 20 mass%, more preferably 2.5 to 18 mass%. By adding 1.5 mass% or more, the effects thereof are obtained, and by adding 20 mass% or less, it can be easily dispersed homogeneously in the polystyrene resin composition. By using a resin composition in which an olefin-based resin is homogeneously dispersed, it becomes less likely for the carbon to desorb from the produced sheet. Additionally, it is also possible to keep the tensile elastic modulus of the produced sheet from becoming lower and also to keep the strength of the pockets in molded electronic component packaging containers from becoming lower.

- [0021] Examples of the olefin-based resin include polyethylene resins such as high-density polyethylene, ultralow-density polyethylene and linear low-density polyethylene, polypropylenes, and ethylene- α -olefin copolymers or the like obtained by copolymerizing C_3 or greater α -olefin-based hydrocarbons such as propylene, 1-butene and 1-hexene. Additionally, not only copolymers formed from olefins, but also those formed from olefins and monomers having copolymerizable polar groups are included. Examples of such resins include ethylene-vinyl acetate copolymers, ethylene-acrylic acid copolymers, ethylene-ethyl acrylate copolymers, ethylene-methacrylic acid ester copolymers, ethylene-vinyl acetate-vinyl chloride copolymers, terpolymers with acid anhydrides and the like. Aside from being used alone, these olefin-based resins may be used in combination with other olefins.
- [0022] A hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin may be added to serve the role of a solubilizing agent for homogeneously mixing the polystyrene-based resin and the polyolefin-based resin. When the conductive resin composition in the surface layers contains a polystyrene-based resin and a polyolefin-based resin, the amount of the hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin added to the conductive resin composition in the surface layers is preferably 0.5 to 11 mass%, more preferably 0.5 to 7 mass%. By adding 0.5 mass% or more, the effects thereof are obtained, and by adding 11 mass% or less, it can be easily homogeneously dispersed in the resulting polystyrene resin composition. By using a resin composition in which the hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin is homogeneously dispersed, it becomes difficult for the carbon black to desorb from the produced sheet. Additionally, the tensile elastic modulus of the produced sheets is kept from decreasing and the rigidity of the molded electronic component packaging containers is kept from decreasing.
- [0023] Representative of hydrogenated aromatic vinyl-conjugated diene-based block copolymer resins are hydrogenated styrene-butadiene block copolymer resins, hydrogenated styrene-isoprene block copolymer resins and the like, among which hydrogenated styrene-butadiene block copolymer resins, i.e., SEBS (styrene-ethylene-butylene-styrene block copolymers) and SBBS (styrene-butadiene-butylene-styrene block copolymers) are particularly preferred.
- [0024] SEBS is obtained, for example, by hydrogenating a styrene-butadiene block copolymer having, for example, a styrene block-butadiene block-styrene block structure, a styrene block-(butadiene-styrene random block)-styrene block structure, a butadiene block-styrene block-butadiene block-styrene block structure or the like. Additionally, SBBS is obtained by selectively hydrogenating specific moieties in the butadienes. The production

methods are not particularly limited, and are reported in JP S64-38402 A, JP S60-220147 A, JP S61-33132 A, JP S61-28507 A, JP S61-57524 A and the like. Commercially available products could be directly used.

[0025] It is possible to add, to the substrate layer and the surface layers, various types of additives, such as lubricants, plasticizers, heat stabilizers, processing aids, inorganic fillers and matting agents, as needed, within a range not inhibiting the properties required to solve the problem addressed by the present invention.

[0026] The surface resistivity of the surface layers of the surface-conductive laminated sheet is preferably 10^2 to $10^{10} \Omega/\square$, 10^3 to $10^9 \Omega/\square$, or 10^4 to $10^7 \Omega/\square$. By setting the surface resistivity to $10^{10} \Omega/\square$, the electronic components can be kept from being destroyed by static electricity, and by setting the surface resistivity to $10^2 \Omega/\square$ or higher, it is made difficult for electricity to flow in from an external source due to static electricity or the like, thus keeping the electronic components from being destroyed.

[0027] The Martens hardness of the surface-conductive laminated sheet may be 50 to 130 N/mm², 65 to 120 N/mm², or 70 to 120 N/mm². By setting the Martens hardness to 130 N/mm² or lower, the folding endurance can be kept from decreasing, and by setting it to 50 N/mm² or higher, it becomes easier to keep the sheet from being crushed or deformed.

Additionally, the tensile elastic modulus of the surface-conductive laminated sheet may be 1600 to 2200 MPa, 1650 to 2100 MPa, or 1650 to 2000 MPa.

Additionally, the folding endurance of the surface-conductive laminated sheet may be at least 50 folds, at least 400 folds, at least 600 folds, at least 800 folds, or at least 1000 folds.

[0028] The overall thickness of the surface-conductive laminated sheet will generally be 0.1 to 3.0 mm in view of the purpose of use thereof, and the thickness occupied by the surface layers within the overall thickness is preferably 2% to 80%, more preferably 5% to 60%. By setting the overall thickness to 0.1 mm or more, a certain level of strength is obtained even when the sheet is molded into a packaging container, and by setting the overall thickness to 3.0 mm or less, the sheet can be easily molded by means of pressure forming, vacuum forming, hot-plate forming or the like. Additionally, if the thickness of the surface layers occupies 2% or more, when the sheet is molded into a packaging container, the surface resistivity thereof is kept from becoming exceedingly high and an adequate static electricity suppression effect is obtained, and if the thickness occupies 80% or less, the moldability by pressure forming, vacuum forming, hot-plate forming or the like is kept from decreasing.

[0029] The production method of the surface-conductive laminated sheet is not particularly limited. For example, the raw materials of the substrate layer and the surface layers may be

homogeneously mixed in a high-speed mixer, or further kneaded by means of a known method using an extruder or the like, formed into pellets, then formed into the surface-conductive laminated sheet according to one embodiment of the present invention by means of a known method using an extruder or the like.

[0030] The method for laminating the surface layers onto the substrate layer may involve forming each layer into a sheet or a film by means of separate extruders, then laminating the layers in stages by means of a method such as hot lamination, dry lamination and extrusion lamination, or laminating the resin composition that is to form the surface layers, by means of a method such as extrusion coating, onto both surfaces of a preformed substrate layer sheet. However, as a less expensive production method, it is preferable to obtain a laminated sheet at once by means of multilayer coextrusion using a multi-manifold die or a feedblock. Additionally, in methods for producing laminated sheets of this type, it is common to pulverize scrap resin that has been generated during the sheet or molded container production steps, and to recycle the material into the substrate layer. The surface-conductive laminated sheet according to one embodiment of the present invention may likewise have scrap resin mixed into the substrate layer within a range not having a significant impact, such as reduction of the strength or generation of burrs in the case of a slit or the like.

[0031] The surface-conductive laminated sheet can be molded into a shape that is appropriate for the purpose of use, by means of a known thermoforming method such as vacuum forming, pressure forming or press forming.

[0032] The surface-conductive laminated sheet may be used as a material in a packaging container for semiconductors such as ICs and electronic components using ICs, such as in a vacuum-formed tray, a magazine, embossed carrier tape, or an electronic component package obtained by housing electronic components in embossed carrier tape and heat-sealing cover tape onto the upper surface thereof. The surface-conductive laminated sheet is particularly suitable for use as embossed carrier tape.

Examples

[0033] While the present invention will be explained in further detail by referring to examples below, the present invention is not in any way restricted by these examples.

[0034] [Evaluation Method]

Each evaluation was made by taking samples in the sheet extrusion direction and performing the methods indicated below.

(1) Martens hardness

In accordance with the ISO14577 standard, a sheet sample was measured at five arbitrary points on the surface using a Toyo Technica Nano Indenter G200, and the average value thereof was taken as the Martens hardness. At this time, the measurements were taken

with the indenter at an approach speed of 500 nm/s and a maximum test load of 5 mN.

(2) Tensile elastic modulus

In accordance with the JIS-K-7127 standard, a sheet sample was measured with a type 5 test piece using a Toyoseiki Strograph VE-1D.

(3) Folding endurance

In accordance with the JIS-P-8115 (2001) standard, a test piece having a length of 150 mm, a width of 15 mm and a thickness of 0.2 mm was prepared from a sheet sample, and the MIT folding endurance was measured using a Toyoseiki MIT folding fatigue tester. At this time, the tests were performed with a folding angle of 135°, a folding speed of 175 folds per minute, and a measurement load of 250 g.

(4) Surface resistance

Measured using a Mitsubishi Chemical Analytic Hiresta-UX (MCP-HT800).

(5) Conjugated diene content

The conjugated diene content in a high-impact polystyrene was determined by measuring the light absorption level at 960 cm⁻¹ and 910 cm⁻¹ by infrared absorption spectrometry, which is commonly used for rubber-modified polystyrene.

(6) Volume-average particle diameter

The volume-average particle diameter of the dispersed particles was measured by dissolving 0.5 g of high-impact polystyrene into 100 g of dimethylformamide, and using a Nikkaki Coulter counter (LS-230).

[0035] The polystyrene-based resins used in the examples and comparative examples are shown in Table 1.

[0036] [Table 1]

Polystyrene-based Resin	Conjugated Diene Content (mass%)	MFR (g/10 min)	Volume-average Particle Diameter (μm)
Polystyrene resin	-	5.6	-
High-impact polystyrene resin A	7.4	11	2.5
High-impact polystyrene resin B	8.7	3.2	2.8
High-impact polystyrene resin C	13.2	2.8	0.6
High-impact polystyrene resin D	6.4	3	3.9

[0037] (Example 1)

As carbon black, acetylene black granules manufactured by Denka were used.

As an olefin-based resin, an ethylene-ethyl acrylate copolymer resin (hereinafter referred to as EEA) wherein ethyl acrylate content (measured in accordance with the JIS-K-7192 standard) = 18% and melt flow index (measured in accordance with the JIS-K-7192 standard) = 5.0 g/10 min was used. Additionally, as a high-density polyethylene

resin (hereinafter referred to as HDPE), one wherein melt flow index (measured in accordance with the JIS-K-6922-2 standard) = 0.20 g/10 min was used.

As a hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin, a styrene-ethylene-butylene-styrene block copolymer (hereinafter referred to as SEBS) wherein melt flow index (measured in accordance with the JIS-K-7192 standard) = 4.0 g/10 min and the mass% ratio between styrene and butadiene was 60:40 was used.

For use in the surface layers, a polystyrene resin and a high-impact polystyrene resin A, carbon black, EEA, HDPE and SEBS were respectively measured out at the ratio 29:31:20:9:8:3, as shown in Table 2, homogeneously mixed in a high-speed mixer, then kneaded using a ϕ 45 mm vent-type twin-screw extruder, and pelletized by means of a strand-cutting method to obtain a conductive resin composition.

Meanwhile, for use in the substrate layer, a polystyrene resin and a high-impact polystyrene resin B were measured out so as to have the ratio 43:57, as shown in Table 2, and homogenized by means of a high-speed mixer to obtain a mixture.

The aforementioned pellet-shaped conductive resin composition and the homogeneous mixture of the polystyrene resin and the high-impact polystyrene resin B were used to laminate surface layers, to approximately the same thickness, onto both surfaces of a substrate layer, by means of the feedblock method using a ϕ 65 mm extruder ($L/D = 28$) for the substrate layer, a ϕ 40 mm extruder ($L/D = 26$) for the surface layers, and a 500 mm-wide T-die, thereby obtaining a surface-conductive laminated sheet having an overall thickness of 0.2 mm, in which the thickness ratio between the surface layers and the substrate layer was 1:18:1.

[0038] (Examples 2 to 13 and Comparative Examples 1 to 4)

A surface-conductive laminated sheet was obtained in accordance with the method in Example 1. The raw materials and the mixing ratios thereof are shown in Tables 2 and 3.

[0039] The evaluation results of the sheets produced in the examples and the comparative examples are shown together in Tables 2 and 3.

[0041] [Table 3]

		Examples		Comparative Examples			
		12	13	1	2	3	4
Surface layer (mass%)	Polystyrene resin	42	22	29	29	50	5
	High-impact polystyrene resin A	0	0	31	31	10	0
	High-impact polystyrene resin B	0	0	0	0	0	55
	High-impact polystyrene resin C	18	0	0	0	0	0
	High-impact polystyrene resin D	0	38	0	0	0	0
	Acetylene black	20	20	20	20	20	20
	EEA	9	9	9	9	9	9
	HDPE	8	8	8	8	8	8
	SBBS	3	3	3	3	3	3
Substrate layer (mass%)	Polystyrene resin	62	22	71	32	43	43
	High-impact polystyrene resin B	0	0	29	0	57	57
	High-impact polystyrene resin C	38	0	0	68	0	0
	High-impact polystyrene resin D	0	78	0	0	0	0
Conjugated diene content (mass%)	Surface layer	4.0	4.1	3.8	3.8	1.2	8.0
	Substrate layer	5.0	5.0	2.5	9.0	5.0	5.0
Volume-average particle diameter (μm)	Surface layer	0.6	3.9	2.5	2.5	2.5	2.8
	Substrate layer	0.6	3.9	2.8	0.6	2.8	2.8
Layer structure	Thickness of surface layer on one side (%)	5	5	5	5	5	5
Measured value	Tensile elastic modulus (MPa)	2200	1900	2200	1550	2000	1580
	Martens hardness (N/mm^2)	115	75	140	40	135	43
	Folding endurance (folds)	800	>1000	10	>1000	30	>1000
	Surface resistivity ($\Omega/\square$)	6.0×10^5	5.0×10^5	6.5×10^5	6.5×10^5	9.2×10^5	7.0×10^5

[0042] The following conclusions were clear from the results shown in Tables 2 and 3. It was confirmed that the surface-conductive laminated sheets in the respective examples had high Martens hardnesses while retaining sufficient tensile elastic moduli, folding endurance

and surface resistivities for practical use as various types of electronic component packaging sheets, and the carrier tapes obtained by molding these sheets were not crushed or deformed even when contacted by pickup nozzles. In contrast therewith, it was confirmed that the surface-conductive laminated sheets of Comparative Examples 1 and 3 had overly high Martens hardnesses and low folding endurances, and the surface-conductive laminated sheets of Comparative Examples 2 and 4 had Martens hardnesses that were too low, so that carrier tapes obtained by molding these sheets were crushed or deformed when contacted by pickup nozzles.

Claims

- [Claim 1] A surface-conductive laminated sheet comprising a sheet substrate layer having surface layers laminated onto both surfaces of the sheet substrate layer,
 wherein the substrate layer comprises a polystyrene-based resin having a conjugated diene content of 3.0 to 8.2 mass%,
 the surface layer comprises a conductive resin composition containing a polystyrene-based resin having a conjugated diene content of 2.0 to 7.4 mass% and a conductive filler, and
 the surface-conductive laminated sheet has a Martens hardness of 50 to 130 N/mm².
- [Claim 2] The surface-conductive laminated sheet according to claim 1, wherein the conductive filler is carbon black.
- [Claim 3] The surface-conductive laminated sheet according to claim 2, wherein the conductive resin composition in the surface layers further contains an olefin-based resin and a hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin.
- [Claim 4] The surface-conductive laminated sheet according to claim 3, wherein the surface layer contains 46 to 85 mass% of a polystyrene-based resin, 13 to 23 mass% of carbon black, 1.5 to 20 mass% of an olefin-based resin, and 0.5 to 11 mass% of a hydrogenated aromatic vinyl-conjugated diene-based block copolymer resin.
- [Claim 5] The surface-conductive laminated sheet according to any one of claims 1 to 4, wherein the conjugated diene contained in the polystyrene-based resin used in the substrate layer and the surface layers has a volume-average particle diameter of 0.5 to 4.0 μm.
- [Claim 6] An electronic component packaging container formed by being molded from the surface-conductive laminated sheet according to one of claims 1 to 5.
- [Claim 7] The electronic component packaging container according to claim 6, which is carrier tape or a tray for conveying electronic components.