

DESCRIPTION



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CUSHIONING BODY FOR GLASS SUBSTRATES



G00002

<TECHNICAL FIELD>

The invention relates to a cushioning body for conveyance, for protecting a glass substrate which comprises an electronic component, such as a semiconductor device, formed on a glass base, from damage caused by vibrations at the time of conveyance. The invention also relates to a packaged article for packaging a plurality of glass substrates together by means of the cushioning body.

<BACKGROUND ART>

In recent years, electronic and electric related equipments, in particular, liquid crystal displays and plasma displays, which are one of peripheral equipments of personal computers, and portable terminals typified by portable telephones are ones, of which amount of production has been rapidly increased with advancement in industry of information technology typified by internet, and a keen demand has been made for development in related technology of a cushioning body for use in packaging

and conveyance of such equipments. Among others, glass substrates with electronic components, such as semiconductor devices or the like, mounted thereon, for example, color filter glass substrates, TFT glass substrates (substrates having thereon circuits that incorporates thin-film transistors therein), and glass substrates such as liquid crystal panel substrates are thin to be susceptible to fall shock, vibrations or the like generated in conveyance, and very fine in structure to be influenced from outside to be difficult to handle. Particularly, in the case of conveying glass substrates prior to processing and semi-products prior to finishing, electronic components are handled in an exposed condition to be more intensively influenced by static electricity, dirt, dust and so on, whereby they are in some cases damaged in terms of function.

Hereupon, many packaging techniques have been proposed to safely convey glass substrates without damage thereon.

As one of such techniques, there is listed a technique disclosed in Japanese Patent Laid-Open No. 319456/1993. The gist of the technique resides in a cushioning body comprising a polyolefin bead foamed body having a specific characteristics, the foamed

body having a L-shaped cross section and formed inside thereof with a plurality of substrate-insertion grooves extending along the L-shape. In packaging glass substrates, the plurality of glass substrates are arranged in parallel at predetermined intervals to define a rectangular solid, corners of the respective substrates are inserted into the substrate-insertion grooves of the cushioning body, four sides of the rectangular solid perpendicular to surfaces of the substrates are fitted onto the cushioning body, and fixation is effected by means of a fastener such as rubber, tape or the like as desired.

In the case where a fastener such as rubber, tape or the like is applied on an outside of the cushioning body to fix the same, its clamping force is concentrated on the corners of the cushioning body, and so the L-shape is in some cases opened to permit the glass substrates to be disengaged from the substrate-insertion grooves at both ends thereof, whereby the protective function does not serve adequately.

Also, the above-mentioned L-shaped cushioning body is formed such that the substrate-insertion grooves have a width equal to or somewhat smaller

than a thickness of the glass substrates, and serves to fix the glass substrates making use of that elastic recovery property at the time of compression, which is characteristic of the polyolefin bead foamed body. Therefore, the cushioning body is effective in resistance against dust generation due to vibrations and friction with glass substrates in conveyance. However, there is caused a problem that frictional resistance between the cushioning body and glass substrates causes a reverse effect for the essential purpose of packaging the glass substrates such that when the glass substrates are forcedly fitted into the substrate-insertion grooves, the glass substrates being as thick as around 0.6 to 0.8 mm are liable to readily flex to be broken and it takes time when an operation is carefully done so as to avoid breakage. This is the same with the case where the glass substrates are taken out of the grooves. In particular, automatic storage devices and taking-out devices of glass substrates have been introduced in terms of labor saving in recent years but troubles have been caused due to the above problem. Thus some people have pointed out that the above cushioning body is not suitable for automation practically.

automation of taking-out, liable not to generate dust when rubbing glass substrates, excellent in durability to be capable of use several times, and economically excellent

A still other object of the invention is to provide a packaged article making use of the cushioning body.

A first aspect of the invention relates to a cushioning body for glass substrates, comprising an in-die molding of polyolefin resin foamed particles and having:

- a body having a L-shaped cross section following the shape of a corner portion of a glass substrate and provided, on a L-shaped inner surface thereof, with a plurality of substrate-insertion grooves, which extend inside along the L-shape to serve to fix two side edges defining a corner portion of a glass substrate; and

- a side wall provided on at least one L-shaped side surface of the body in parallel to the substrate-insertion grooves to extend from a corner of the L-shape toward both ends each over from 30 to 100 % of the length between the corner and the end,

Further, there is a potential problem that when glass substrates are inserted into substrate-insertion grooves, frictional resisting forces generate fine scratches on the glass substrate surface.

While such suitability to automation is a practical property which has been increasingly thought much of as glass substrates have been made large-sized recently, cushioning bodies have become large-sized and so the problem of warp and deformation has manifested itself in conventional cushioning bodies.

<DISCLOSURE OF THE INVENTION>

In view of the above problems, an object of the invention is to provide a cushioning body for glass substrates, which eliminates disengagement of glass substrates from ends of L-shaped grooves in the body when glass substrates are packaged, and which can safely protect glass substrates even if external forces such as vibrations, fall shock or the like are applied in conveyance and handling.

Another object of the invention is to provide a cushioning body for glass substrates, which is suitable for packaging of glass substrates and

wherein the side wall is shaped such that a cut region is provided on a corner that faces an apex of the L-shape, among corners of a rectangle defined by two sides at which the side wall contacts with the body, the side wall having an area amounting to 30 to 80 % of the area of the rectangle, and

wherein the polyolefin resin foamed particles have an average particle size of 1.5 to 5.0 mm, a fusion rate of 70 % or more, a compressive elastic exponent of 3.9 to 490, and a recovery rate of 60 % or more.

In the cushioning body, it is preferred that the body has a maximum thickness of 10 to 100 mm and a ratio of the two side lengths of the L-shape of 1.0 to 3.5 with a short side as a standard, the side wall has a thickness of 10 to 100 mm, and the substrate-insertion grooves have a depth of 3 to 15 mm and a pitch of 6 to 100 mm. In addition, it is preferred that the side wall is provided on each of the L-shaped side surfaces of the body.

A second aspect of the invention relates to a packaged article comprising:

a plurality of glass substrates;

a cushioning body as described above, which arranges said plural glass substrates in parallel to

one another at predetermined intervals by inserting corners of the respective glass substrates into the substrate-insertion grooves thereof; and

fixtures wound around a L-shaped outer surface of the cushioning body.

The packaged article can be obtained by inserting each corner of a plurality of glass substrates into the substrate-insertion grooves of the above-described cushioning body, and winding fixtures around a L-shaped outer surface of the cushioning body to clamp and fix.

<BRIEF DESCRIPTION OF THE DRAWINGS>

Fig. 1 is a perspective view showing an embodiment of a cushioning body according to the invention.

Fig. 2 is a perspective view showing another embodiment of a cushioning body according to the invention.

Fig. 3 is a perspective view showing a still other embodiment of a cushioning body according to the invention.

Fig. 4 is a perspective view showing a still other embodiment of a cushioning body according to the invention.

Fig. 5 is a perspective view showing a still other embodiment of a cushioning body according to the invention.

Fig. 6 is a perspective view showing an embodiment of a packaged article according to the invention, in which the cushioning bodies shown in Fig. 1 are used.

Fig. 7 is a perspective view showing another embodiment of a packaged article according to the invention, in which the cushioning bodies shown in Fig. 4 are used.

Figs. 8a, 8b and 8c are schematic views showing configurational examples of substrate-insertion grooves on a cushioning body according to the invention in broken, cross section.

Fig. 9 is a view illustrating an outside dimension of a cushioning body according to the invention.

Incidentally, the reference numerals in the drawings denote as follows:

- 1: cushioning body,
- 2: body,
- 3: substrate-insertion groove,
- 4: side wall,
- 5: fixture guiding groove,

6: apex,
11: glass substrate,
12: fixture,
13: ridge,
21a and 21b: cushioning plates,
22, 22a and 22b: bottom portions of substrate-
insertion grooves, and
23, 23a and 23b: apices of ridges.

<BEST MODE FOR CARRYING OUT THE INVENTION>

The cushioning body according to the invention has a feature that side wall(s) is provided on the side surface of a L-shaped body having substrate-insertion grooves, which serve to fix two side edges constituting corners of glass substrates. Thereby, in a packaged article, which makes use of a cushioning body according to the invention, a L-shaped configuration of the body is fixed by the side wall(s) and L-shape is prevented from spreading.

The cushioning body according to the invention is described below by way of embodiments.

Fig. 1 is a perspective view showing a preferred embodiment of the cushioning body according to the invention. In the figure, the reference numeral 1 denotes a cushioning body

according to the embodiment, 2 a body, 3 substrate-insertion grooves, 4 side walls, and 5 fixture guiding grooves.

The cushioning body according to the invention basically comprises the body 2 having a L-shaped cross section following the shape of corners of glass substrates, and the side wall 4 provided on at least one of both side surfaces of the L-shape of the body 2. Fig. 1 shows an example, in which the side walls 4 are provided on the both side surfaces of the body. The body 2 is provided with a plurality of substrate-insertion grooves 3, which extend inside along the L-shape to serve to fix two side edges defining corners of glass substrates, and the side walls 4 are formed in parallel to the substrate-insertion grooves 3.

The side wall 4 in the invention is formed over a length of 30 to 100 % of the length between ends and the apex of the L-shape of the body 2, and shaped such that a cut region is provided on a corner facing an apex 6 of the L-shape of the body 2 in a rectangle defined by the two sides, at which the side wall 4 contacts with the body 2. The cut region is not specifically limited in shape but may be triangular as shown in Fig. 1, outwardly convexly

arcuate as shown in Fig. 2, or rectangular as shown in Fig. 3. The cut region is adjusted in size so that the area of the side wall 4 amounts to 30 to 80 % of the area of the rectangle.

Fig. 4 shows an example, in which a side wall 4 is provided only on one side surface of the body 2. Also, Fig. 5 shows an example, in which side walls 4 are provided on both side surfaces of the body 2 to extend short of ends of the L-shape from an apex thereof.

Fig. 6 is a perspective view showing a packaged article, in which glass substrates are packaged by means of cushioning bodies.

In the figure, the reference numeral 11 denotes glass substrates, and 12 fixtures. As shown in Fig. 6, a set of four cushioning bodies 1 according to the invention is basically used to arrange a plurality of glass substrates 11 in parallel at predetermined intervals to define a rectangular solid, the corners of the respective substrates being inserted into substrate-insertion grooves of the cushioning bodies 1 and four sides of the rectangular solid being fitted by the cushioning bodies 1. Thereafter, lengthy fixtures 12 are wound around and secured to fixture guiding grooves 5

formed on the outside of the cushioning bodies 1, as desired. In the cushioning bodies according to the invention, the fixture guiding grooves 5 may be formed as desired.

In the cushioning body 1 according to the invention, the side walls 4 are provided on side surfaces of the body 2 as shown in Fig. 1, whereby the L-shape of the body 2 is fixed by the side walls 4 to enhance rigidity of the cushioning body itself, so that even when clamping forces of the fixtures 12 are applied on the apices of the L-shapes in a package packaged as shown in Fig. 6 in a concentrated manner, the L-shapes will not be opened and disengagement of the substrates from the grooves at ends of the L-shapes will be prevented. Such forces of constraint on the L-shapes are obtained by forming the side wall 4 on one of side surface of the body 2 and a higher effect can be obtained in the case where the side walls are provided on both side surfaces of the body 2 as shown in Figs. 1 to 3. In the case where the side wall 4 is provided only on one of the side surfaces of the body 2 as shown in Fig. 4, forces of constraint on the L-shapes are inferior to those in the case where the side walls are provided on the both side surfaces, but it is

possible to store and convey a plurality of cushioning bodies with stacking one on another.

Also, since a cut region is formed on a diagonal portion facing an apex of the L-shape of the side wall 4, warp is hard to generate on the diagonal portion of the side wall 4, so that the side wall is suppressed in contact with the glass substrate 11.

The cushioning body according to the invention is an in-die molding of a polyolefin resin. The molding is formed by charging polyolefin resin foamable particles in a mold, and heating and foaming the same to expand the same into a molding of a desired shape. Even when the mold used in the forming is complex in configuration as compared with a mold for injection molding, its manufacturing cost is 1/10 or less as much as that of the latter and it can easily and efficiently mass-produce moldings of complex configuration with high accuracy to be economical and suitable for mass production.

Further, the in-die molding of polyolefin resin foamed particles generates a very small amount of fine dust in sliding contact with glass substrates to involve a very small degree of contamination of glass substrates caused by the dust. Also, even when

subjected to external forces in a handling operation and in conveyance, such molding is hard to deform, and excellent in recovery and high in dimensional stability even in the case of being deformed. Further, such cushioning body is washed with pure water prior to use and every use in the case of repeated use, but it absorbs a small amount of water to be excellent in drying property.

The polyolefin resin used for the cushioning bodies according to the invention may be either of cross-linking and non-cross-linking type. Specifically, the resin material is preferably selected from low, medium, high density polyethylene, linear low density polyethylene, linear very low density polyethylene, polyethylene by metallocene catalyst, polyolefin resins typified by ethylene vinyl acetate copolymer resins or the like, random and block copolymer resins, of which copolymer components are ethylene, butene-1, 4-methyl pentene-1 or the like and propylene, or a composition having blended two or more of the above resins.

Particularly suitable resin material in the invention include polyethylene having a resin density of 0.927 to 0.970 g/cm³ and a random copolymer resin of propylene. Polyethylene having a

resin density of 0.927 g/cm^3 or more makes a cushioning body appropriate in compressive elastic exponent described later, and is hard to deform when exerted by external forces. Further, in order to obtain a specific compressive elastic exponent, there is no need of reducing the foaming rate of foamed particles, and so such polyethylene is preferable in terms of lightness and economy. Also, since polyethylene having a resin density of 0.970 g/cm^3 or less is adequate in flexibility and appropriate in dust generation resistance and recovery, it is preferable. Further, a random copolymer resin of polyethylene is high in compressive elastic exponent and excellent in recovery and durability in repeated use, so it is most preferably used in the invention.

In the molding constituting the cushioning body according to the invention, the foamed particles have an average particle size of 1.5 to 5.0 mm, a fusion rate of 70 % or more, a compressive elastic exponent of 3.9 to 490, and a recovery rate of 60 % or more.

As described above, the foamed particles have an average particle size of 1.5 to 5.0 mm, preferably 2.0 to 4.5 mm. In the case where foamed

particles have an average particle size of 1.5 to 5.0 mm, they can be filled in small portions of substrate-insertion grooves at the time of molding, and the reproducibility of the configuration and dimension of a mold is satisfactory. Also, an adequate foam expansion manifests itself since the surface area per one foamed particle (volume) is small in ratio and the gas (air) pressure dissipating property in the particles is small in the course of vapor heating at the time of in-die molding. As a result, voids are hard to generate between foamed particles constituting an in-die molding, and there is no possibility that dust enters such voids not to maintain cleanliness of an associated cushioning body, so that such foamed particles are preferable.

In addition, the average particle size of foamed particles constituting the cushioning body according to the invention, is determined by marking three straight lines having a length of 100 mm on the surface of an in-die molding with the use of a ball-point pen, counting the number of foamed particles in contact with the lines, and calculating an average particle size C (mm) from the following formula (A). Incidentally, estimation is done by

adopting an average of values determined by the three straight lines.

$$C = (1.626 \times L)/N \quad (A)$$

L: center line length (mm)

N: number of particles

The fusion rate of the molding according to the invention is a numerical value indicating in percentage the number of foamed particles, of which interfaces are broken (material destruction), relative to the number of all foamed particles in an area extending over the overall length in a thicknesswise direction and over a length of about 75 mm in a broken face when making a cut in a cushioning body to a depth of about 1 mm in a thicknesswise direction of the body and bent with the cut outside to be broken. In the cushioning body according to the invention, adequate mechanical strength is obtained at the fusion rate of 70 % or more, whereby upon clamping by means of fixtures, such problems that fixtures bite into and break the cushioning bodies or that the cushioning bodies are liable to break off are hardly caused. Further, the fusion rate of 70 % or more is preferable since a problem that minute voids are generated between

foamed particles to provide a water absorptivity due to the capillary phenomenon is hardly caused.

Further, in the case where the compressive elastic exponent of a molding is 3.9 or more, a cushioning body is hard to deform when subjected to external forces, and so favorable in durability as well as preferable since permanent deformation due to weight of glass substrates is hardly generated and glass substrates are easily fixed even when glass substrates are large-sized to have a size above 600 mm × 700 mm. Also, in the case where the compressive elastic exponent is 490 or less, there is no specific need of decreasing the foaming rate of the cushioning body, and so such compressive elastic exponent is preferable in terms of lightness and economy. Further, the compressive elastic exponent in the range of 490 or less is preferable since flexibility is satisfactory, dust generation resistance is excellent, and the cushioning performance for fall shock or the like is excellent.

The compressive elastic exponent in the invention is a value obtained by dividing the modulus of compressive elasticity (N/cm^2) by the foaming rate, and the modulus of compressive elasticity is a value determined with test pieces,

for which the following foaming rate has been measured, in accordance with JIS K 7220 where the compression speed is 10 mm/min. Also, in the case where the test pieces have a thickness below 20 mm, a plurality of test pieces are stacked to have a thickness of about 20 mm and then measured.

Method for Measuring the Compression Rate:

Flat test pieces having a width of 50 mm, length of 50 mm and a thickness of 20 mm are cut out from a cushioning body and measured with respect to weight (g) in unit of 10 mg, and a vernier caliper is used to measure a width, length and a thickness of the test pieces to calculate a volume (cm^3). Then the foaming rate E (cm^3/g) is calculated in accordance with the following formula:

$$E = \text{volume/weight } (\text{cm}^3/\text{g}) \quad (\text{B})$$

In addition, the recovery rate of 60 % or more with the compressive elastic exponent in the range of 3.9 to 490 is preferable in that the repetitive durability, which is a characteristic of in-die moldings of polyolefin resin foamed particles, is satisfactory and deformation is small even in the case of frequency in use. Incidentally, the recovery rate, $R(\%)$, is calculated from the following formula (C) by cutting out flat test pieces having a width

of 50 mm, length of 50 mm and a thickness of 20 mm from a cushioning body, compressing the test pieces to 50 % of the thickness thereof at the compression speed of 10 mm/min. with the use of the compression tester "Autograph AG-5000D" manufactured by Shimazu Seisakusho, immediately thereafter removing load at the same speed as the compression speed until load becomes zero, and measuring a thickness at the moment when load becomes zero. Incidentally, in the case of test pieces having a thickness below 20 mm, measurement is made with a plurality of test pieces stacked so as to have a thickness of about 20 mm.

$$R = (T_1/T_0) \times 100 \% \quad (C)$$

T_0 : thickness (mm) of test pieces
prior to testing

T_1 : thickness (mm) of test pieces
after testing (when load is zero)

An explanation will be given below to outside dimension of the cushioning body according to the invention with reference to Figs. 8 and 9. Figs. 8 are partial, cross sectional views showing embodiments of the cushioning body according to the invention in a direction perpendicular to the L-shape of the body, and Fig. 9 is a side elevational view showing the embodiment shown in Fig. 5. In Figs.

8, the reference numeral 13 denotes ridges separating adjacent substrate-insertion grooves 3, 22 bottom portions of the substrate-insertion grooves 3, and 23 top portions of the ridges 13. In Fig. 9, the reference numerals 21a and 21b denote cushioning plates, which constitute the L-shape of the body to form short and long sides of the L-shape, respectively. Also, the reference numerals 22a and 22b denote bottom portions of substrate-insertion grooves formed in the cushioning plates 21a and 21b, respectively, to correspond to the bottom portions 22 in Figs. 8. Also, the reference numerals 23a and 23b denote top portions of ridges of the cushioning plates 21a and 21b, which correspond to the top portions 23 in Figs. 8.

With the cushioning body according to the invention, the body is substantially L-shaped in cross section as shown in Fig. 9, and the maximum thickness (thickness t_1 of the ridges 13 in Figs. 8) of the cushioning plates 21a and 21b, which constitute the L-shape, and a thickness of the side wall 4 (not shown) are preferably selected in the range of 10 to 100 mm and more preferably 15 to 50 mm while depending upon a size of glass substrates. In the case where the thickness is in the above

preferable range, the cushioning body is adequate in rigidity, warp and deformation are hard to generate, and forces of constraint on the L-shape can be obtained in the side walls 4. Also, with such thickness in the above range, the cushioning body is satisfactory in productivity and the cushioning body and a packaged article are appropriate in bulk to be favorable in economy. In addition, it is preferable for the sake of obtaining the above effect that the cushioning plates 21a and 21b at the bottom portions 22a and 22b of the substrate-insertion grooves 3 have a thickness of 5 mm or more.

In addition, with the cushioning body according to the invention, a short side (t_S) and a long side (t_L) of the L-shape of the body preferably have a ratio (t_L/t_S) of 1.0 to 3.5, and more preferably, 1.0 to 3.3 with the short side as the standard. The ratio in the above range makes the long side and short side well-balanced, and makes rectangular-shaped glass substrates favorable in fixation stability, which makes it hard to cause damage due to flexure on glass substrates.

It is preferable in the invention that the respective cushioning bodies are fitted onto portions amounting to 10 % or more of side edges of

glass substrates at the time packaging within regions of the above short and long sides. Fitting by the respective cushioning articles amounting to 10 % or more of lengths of side edges of glass substrates are desirable because the glass substrates are adequately supported and hard to damage even when shock load is concentrated on the portions upon application of fall shock, stress applied on the cushioning bodies by the glass substrates is decreased, and dust generation due to contact friction caused by vibrations in conveyance is reduced to provide cleanliness. Also, when two cushioning bodies support respective side edges of the glass substrates over 92 % or less of the side edges, contact portions between the glass substrates and the cushioning bodies are not particularly large, so that such supporting condition is desirable in terms of cleanliness since there is caused no problem in dust generation due to contact friction generated by vibrations in conveyance and economy is also favorable since the cushioning bodies are not made more large-sized than required.

The side walls 4 of the cushioning body according to the invention must be sized to some extent for the purpose of maintaining the L-shape

comprising the cushioning plates 21a and 21b, and the sides (t_a , t_b) of the side walls 4 contacting with the body 2 must have a length of 30 to 100 % assuming that a length (t_A , t_B) extending to ends of the L-shape corresponds to 100 %. Figs. 1 to 4 show examples where $t_a = t_A$ and $t_b = t_B$, and Fig. 5 shows an example where $t_a < t_A$ and $t_b < t_B$. Incidentally, t_a/t_A and t_b/t_B may be equal to or different from each other. Further, the side wall 4 is preferably large in area for maintaining the L-shape, and in view of the provision of a cut region on a diagonal portion facing the apex 6 of the L-shape of the side wall 4 for the purpose of preventing warp, the area of the side wall 4 (the area obtained by subtracting an area removed by the cut region from the area ($t_a \times t_b$) of the rectangle) in the invention amounts to 30 to 80 % of the rectangle.

Preferably, the outside dimension is such that a short side (t_S) is 100 to 500 mm, a long side (t_L) is 100 to 1100 mm, and a length perpendicular to the L-shape is 150 to 600 mm depending upon the number of glass substrates packaged.

Subsequently, an explanation will be given to the substrate-insertion grooves 3 with reference to Figs. 8. With the cushioning body according to the

invention, the width t_3 of the plurality of substrate-insertion grooves 3 provided on the body 2 is preferably 1.0 to 4.0 times the thickness of glass substrates packaged, and more preferably, 1.2 to 3.5 times. When the value is 1.0 or more times, workability in manual insertion and taking-out of glass substrates is favorable, and damage on glass substrates is hard to generate even in the case of automatic insertion. Also, the value of 4.0 or less times is preferable in terms of cleanliness since there is of course caused no problem even in the case of insertion and taking-out of glass substrates being automated, and jolting caused by vibrations and shock in conveyance of glass substrates is eliminated to prevent damage on glass substrates and reduce generation of dust. Practically, the groove width is about 0.5 to 3 mm.

The depth t_2 of the substrate-insertion grooves 3 is preferably in the range of 3 to 15 mm in view of the size and weight of glass substrates and the compressive elastic exponent of moldings. Depth of 3 mm or more is preferable since glass substrates are prevented from being easily disengaged and damaged when subjected to vibrations and shock in conveyance and fall shock at the time of handling. Also, the

side edges and their neighbor of glass substrates in contact with the cushioning bodies are liable to be subjected to minute scratches due to vibration shock in conveyance and are cut and removed at the time of processing of glass substrates. Depth of 15 mm or less of the substrate-insertion grooves 3 is preferable since it makes the portions to be cut and removed small. Also, such depth is preferable in terms of cleanliness since generation of dust due to sliding contact between glass substrates and cushioning bodies is decreased.

Further, the pitch t_4 of the substrate-insertion grooves 3 may be selected preferably in the range of 6 to 100 mm in view of kinds of glass substrates (for example, mother glass, display-constituting substrate such as color filter glass substrate), size and weight of glass substrates, the compressive elastic exponent of moldings, groove width or the like. That is, such pitch may be set so as to prevent glass substrates from flexing and contacting with one another when subjected to vibrations and shock in conveyance and fall shock at the time of handling.

While the substrate-insertion grooves 3 provided in the cushioning body according to the

invention may have a cross sectional shape such that the bottom portions and opening portions thereof are the same in the width t_3 as shown in Fig. 8A, that is, the ridge 13 between adjacent substrate-insertion grooves is rectangular in shape, they are preferably arcuate (Fig. 8B) in cross section such that the substrate-insertion grooves 3 is enlarged in width at the opening portions thereof, that is, a cross section of a top of the ridge 13 is convex upward, and trapezoidal (Fig. 8C) in cross section.

As described above, a set of four cushioning bodies according to the invention are used to package glass substrates, and after packaging of glass substrates, lengthy fixtures are wound therearound to clamp and fix to make a packaged article. Fixtures used herein include lengthy items such as strap, tape or the like, and for example, polypropylene tape is preferably used. Further, the packaged article is usually placed in a clean polyethylene bag in a sealed manner, stored and conveyed so as to prevent dirt and dust from entering from outside.

While a set of four same cushioning bodies is used in the embodiment shown in Fig. 6, the invention is not limited thereto. Two kinds of

cushioning bodies having different sizes may be used in combination taking account of size of glass substrates, workability in packaging and taking-out, and positioning of taking-out positions, in particular, in the case of automatic devices. For example, it is conceivable that large-sized cushioning bodies are used for bottom portions of glass substrates, on which load is applied, and small-sized cushioning bodies are in turn used for top portions of glass substrates. Also, there is not necessarily a need of corresponding short sides of cushioning bodies to short sides of glass substrates, but two cushioning bodies may support one side of glass substrates with a short side of one of the cushioning bodies and a long side of the other of the cushioning bodies.

Furthermore, in the case where the cushioning bodies shown in Fig. 4 with a side wall only on one side surface thereof are used as shown in Fig. 7, it is preferable to use the cushioning bodies in combination such that the side walls are alternately arranged to prevent the cushioning property and the glass substrate fixing property from being localized in a packaged article.

Moreover, the cushioning body according to the invention can be used for storage use in addition to conveyance of glass substrates. Specifically, a set of two cushioning bodies according to the invention is fixed in a case of plastic corrugated cardboard and glass substrates are inserted thereto. In this case, cushioning bodies may be used or not for top portions of the glass substrates. In addition, a cover is used as desired to prevent entry of dirt and dust.

<EXAMPLES>

Cushioning bodies according to the following specifications were fabricated and used to package glass substrates, and evaluation was made.

Example 1

Specifications of glass substrates

Use: mother glass for liquid crystal display

Dimension: 850 mm × 1000 mm

Thickness: 0.7 mm

Physical properties of resin

Material: ethylene propylene random copolymer resin

Foaming rate: 20 cm³/g

Average particle size: 3.6 mm

Fusion rate: 88 %

Modulus of compressive elasticity: 559 N/cm²

Compressive elastic exponent: 28.0

Recovery rate: 88 %

Outside dimension

Number of glass substrates stored: 12

Body:

Short side: 350 mm

Long side: 460 mm

Length perpendicular to the L-shape: 415 mm

Thickness: 35 mm

Side walls:

Shape: Fig. 2 (arcuate-shaped cut region;
provided on both side surfaces of the body)

Length on L-shape: 100 % (short side) × 100 %
(long side)

Area: 70 % of a rectangle

Thickness: 35 mm

Substrate-insertion groove:

Width: 1.5 mm

Depth: 9.5 mm

Pitch: 25 mm

Shape: Fig. 3 (c), height of straight portions:
5.0 mm, height of trapezoidal-shaped portions: 4.5
mm

Evaluation 1

A set of the above four cushioning bodies was used to package twelve glass substrates and polypropylene tape as fixtures were wound at two locations to clamp and fix the bodies and substrates to provide a packaged article. In conveying the packaged article via an ordinary route, L-shaped ends of the cushioning bodies were free of warp and deformation, workability in packaging was satisfactory, the L-shape was maintained, disengagement of glass substrates from the grooves was eliminated, and thus conveyance could be made stably.

Evaluation 2

Further, in order to evaluate the cushioning property of the cushioning bodies according to the invention, the packaged article in the above Evaluation 1 was packaged in a fiberboard carton (CD-4 of JIS Z 1506 standards), and free fall tests were carried out under the following conditions.

Conditions of free fall tests:

Height of fall: 30 cm

Surface of packaged article from which fell:
only ground surface of a packaged article

Number of falls: three times

After falling three times under the above conditions, glass substrates were completely free from falling off of glass substrates and a state of packaging before testing was maintained without damage on glass substrates. Further, adhesion of dust was in no way observed when surfaces of glass substrates were visually inspected.

Evaluation 3

In order to evaluate the glass substrate fixing performance of the cushioning bodies according to the invention, a vibration test was made on the packaged article of Evaluation 1 under the conditions shown below. The vibration test was made in accordance with the testing method prescribed in JIS Z 0232 in a state, in which the packaged article was fixed to a vibrating table of a vibration testing apparatus.

Conditions of vibration test:

Direction of vibration: vertical

Vibration wave: sinusoidal wave

Sweep: logarithmic frequency sweep (frequency: 5 to 100 Hz, sweep speed: 0.5 octave/min.)

Vibration acceleration: ± 0.75 G

Vibration time: 30 minutes

After the completion of the above vibration test, a state in which the glass substrates were packaged and fixed was visually inspected. While slight loosening of the glass substrates was found, no glass substrates fell off the substrate-insertion grooves and no adhesion of dust was visually observed.

Example 2

Cushioning bodies according to the following specifications were fabricated and used to package glass substrates, and evaluation was made.

Specifications of glass substrates

Same with Example 1

Physical properties of resin

Material: ethylene propylene random copolymer resin

Foaming rate: 20 cm³/g

Average particle size: 3.6 mm

Fusion rate: 86 %

Modulus of compressive elasticity: 530 N/cm²

Compressive elastic exponent: 26.5

Recovery rate: 89 %

Outside dimension

Number of glass substrates stored: 12

Body:

Same with Example 1

Side walls:

Shape: Fig. 1 (triangular cut region; provided on both side surfaces of the body)

Length on L-shape: 100 % (short side) × 100 % (long side)

Area: 50 % of a rectangle

Thickness: 35 mm

Substrate-insertion groove:

Same with Example 1

The above cushioning bodies were used to form a packaged article, and conveyance was carried out with the result that workability in packaging and property of conveyance were satisfactory.

Example 3

Cushioning bodies according to the following specifications were fabricated and used to package glass substrates, and evaluation was made.

Specifications of glass substrates

Same with Example 1

Physical properties of resin

Material: ethylene propylene random copolymer resin

Foaming rate: 20 cm³/g

Average particle size: 3.6 mm

Fusion rate: 83 %

Modulus of compressive elasticity: 510 N/cm²

Compressive elastic exponent: 25.5

Recovery rate: 88 %

Outside dimension

Number of glass substrates stored: 12

Body:

Same with Example 1

Side walls:

Shape: Fig. 3 (rectangular-shaped cut region;
provided on both side surfaces of the body)

Length on L-shape: 100 % (short side) × 100 %
(long side)

Area: 60 % of a rectangle

Thickness: 35 mm

Substrate-insertion groove:

Same with Example 1

The above cushioning bodies were used to form a packaged article in the same manner as in Example 1, and conveyance was carried out with the result that workability in packaging and property of conveyance were satisfactory.

Example 4

Cushioning bodies according to the following specifications were fabricated and used to package glass substrates, and evaluation was made.

Specifications of glass substrates

Same with Example 1

Physical properties of resin

Material: ethylene propylene random copolymer resin

Foaming rate: 20 cm³/g

Average particle size: 3.6 mm

Fusion rate: 87 %

Modulus of compressive elasticity: 539 N/cm²

Compressive elastic exponent: 27.0

Recovery rate: 89 %

Outside dimension

Number of glass substrates stored: 12

Body:

Same with Example 1

Side wall:

Shape: A side wall provided with the arcuate-shaped cut region shown in Fig. 2 is provided only on one side surface of the body

Length on L-shape: 100 % (short side) × 100 %
(long side)

Area: 70 % of a rectangle

Thickness: 35 mm

Substrate-insertion groove:

Same with Example 1

The above cushioning bodies were used to package glass substrates with the side walls alternately arranged as shown in Fig. 7 to form a packaged article, and conveyance was carried out with the result that workability in packaging and property of conveyance were satisfactory. Also, since the side wall was provided only on one side surface of the body, space saving was realized at the time of storage.

Example 5

Cushioning bodies were fabricated in the same manner as in Example 2, except that the following resin was used, and used to package glass substrates, and evaluation was made.

Physical properties of resin

Material: cross-link polyethylene resin

Resin density: 0.930 g/cm³

Foaming rate: 10 cm³/g

Average particle size: 2.8 mm

Fusion rate: 98 %

Modulus of compressive elasticity: 539 N/cm²

Compressive elastic exponent: 27.0

Recovery rate: 93 %

The above cushioning bodies were used to form a packaged article, and conveyance was carried out with the result that workability in the same manner as in Example 1 and conveyance was carried out with the result that workability packaging and property of conveyance were satisfactory.

Comparative Example 1

Cushioning bodies without any side wall or walls were fabricated according to the following specifications and used to package glass substrates, and evaluation was made.

Specifications of glass substrates

Same with Example 1

Physical properties of resin

Material: ethylene propylene random copolymer resin

Foaming rate: 20 cm³/g

Average particle size: 3.6 mm

Fusion rate: 86 %

Modulus of compressive elasticity: 549 N/cm²

Compressive elastic exponent: 27.5

Recovery rate: 87 %

Outside dimension

Number of glass substrates stored: 12

Body:

Short side: 350 mm

Long side: 460 mm

Length perpendicular to the L-shape: 400 mm

Thickness: 35 mm

Substrate-insertion groove:

Same with Example 1

Evaluation

A set of the above four cushioning bodies was used to provide a packaged article in the same manner as in Example 1. In conveying the packaged article thus obtained via the same route as in Example 1, L-shaped ends of the cushioning bodies were in many cases subjected to warp and deformation. Also, clamping forces of fixtures caused the L-shape to be opened, and disengagement from the grooves was found, so that the same Evaluations 2 and 3 as that in Example 1 could not be carried out.

Comparative Example 2

Cushioning bodies were fabricated in the same manner as in Example 1 except that the following resin was used.

Physical properties of resin

Material: ethylene propylene random copolymer resin

Foaming rate: 20 cm³/g

Average particle size: 3.6 mm

Fusion rate: 60 %

Modulus of compressive elasticity: 549 N/cm²

Compressive elastic exponent: 27.5

Recovery rate: 85 %

The above cushioning bodies were used to form a packaged article, and conveyance was carried out with the result that the L-shaped ends were free of warp and deformation, workability in packaging was satisfactory, and disengagement from the grooves was eliminated. However, when the same free fall tests as those of Evaluation 2 in Example 1 were made, though glass substrates were free from falling off, there were caused minute chips on those ends of glass substrates, which contacted with the substrate-insertion grooves extending in a direction along the long sides of the cushioning bodies placed on the ground surface. As a result of closely inspecting the cushioning bodies for the purpose of investigating the cause of such chips, generation of cracks were found between foamed particles, and it is considered that fall shock caused the glass substrates to bite into the cushioning bodies. Also, there was recognized an indication that the foamed

particles fell off, and it was found that durability in repeated use was inferior to that of the cushioning bodies in Example 1. That is, it is considered that since the fusion rate of moldings, which constituted the cushioning bodies, was below 70 %, the cushioning bodies were poor in their inherent mechanical strength and excessive strain was generated when subjected to fall shock.

Comparative Example 3

Cushioning bodies were fabricated according to the following specifications and used to package glass substrates, and evaluation was made.

Specifications of glass substrates

Same with Example 1

Physical properties of resin

Material: ethylene propylene random copolymer resin

Foaming rate: 20 cm³/g

Average particle size: 3.6 mm

Fusion rate: 86 %

Modulus of compressive elasticity: 530 N/cm²

Compressive elastic exponent: 26.5

Recovery rate: 89 %

Outside dimension

Number of glass substrates stored: 12

Body:

Short side: 350 mm

Long side: 460 mm

Length perpendicular to the L-shape: 415 mm

Thickness: 35 mm

Side wall:

Shape: Fig. 5 (triangular cut region; provided on both side surfaces of the body)

Length on L-shape: $25 \% \text{ (short side)} \times 25 \% \text{ (long side)}$

Area: 31 % of a rectangle

Thickness: 35 mm

Substrate-insertion groove:

Same with Example 1

Evaluation

A set of the above four cushioning bodies was used to provide a packaged article in the same manner as in Example 1. In conveying the packaged article thus obtained via the same route as in Example 1, forces of L-shaped constraint on the side walls were insufficient, and so L-shaped ends of the cushioning bodies were subjected to warp and deformation.

Example 6

Cushioning bodies were fabricated in the same manner as in Example 1 except that a thickness of the side walls was changed to 8 mm, and evaluation was made with the result that L-shaped ends of the cushioning bodies were subjected to warp and deformation to some extent because the side walls were small in thickness.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications can be made therein without departing from the spirit and scope thereof.

The present application is based on Japanese Patent Application No. 2001-164291 filed on May 31, 2001, and the contents of the basic application is herein incorporated by reference.

<INDUSTRIAL APPLICABILITY>

As described above, according to the invention, a side wall(s) is provided on a cushioning body. Therefore, the rigidity thereof is enhanced, and forces of L-shaped constraint of the body are great. Accordingly, in the packaged article, in which glass

substrates are packaged by means of the cushioning bodies, deformation of the cushioning bodies is prevented, glass substrates are free of disengagement from the grooves at the L-shaped ends, glass substrates are surely fixed and protected, and sliding contact between glass substrates and the cushioning bodies is prevented from causing generation of dust and damage on the glass substrates. Therefore, the invention is highly effective in protecting glass substrates, good in workability in packaging and removing, suitable for to automation of the operations, and reusable, and can remarkably enhance the economic efficiency in packaging, storage and conveyance of glass substrates.

CLAIMS

1. A cushioning body for glass substrates, comprising an in-die molding of polyolefin resin foamed particles and having:

a body having a L-shaped cross section and provided on a L-shaped inner surface thereof with a plurality of substrate-insertion grooves in parallel to L-shaped sides thereof; and

a side wall provided on at least one L-shaped side surface of the body in parallel to the substrate-insertion grooves to extend from a corner of the L-shape toward both ends each over from 30 to 100 % of the length between the corner and the end,

wherein the side wall is shaped such that a cut region is provided on a corner that faces an apex of the L-shape, among corners of a rectangle defined by two sides at which the side wall contacts with the body, the side wall having an area amounting to 30 to 80 % of the area of the rectangle, and

wherein the polyolefin resin foamed particles have an average particle size of 1.5 to 5.0 mm, a fusion rate of 70 % or more, a compressive elastic

exponent of 3.9 to 490, and a recovery rate of 60 % or more.

2. The cushioning body according to claim 1, wherein the body has a maximum thickness of 10 to 100 mm and a ratio of the two side lengths of the L-shape of 1.0 to 3.5 with a short side as a standard, the side wall has a thickness of 10 to 100 mm, and the substrate-insertion grooves have a depth of 3 to 15 mm and a pitch of 6 to 100 mm.

3. The cushioning body according to claim 1 or 2, wherein the side wall is provided on each of the L-shaped side surfaces of the body.

4. A packaged article comprising:
a plurality of glass substrates;
a cushioning body according to any one of claims 1 to 3, which arranges said plural glass substrates in parallel to one another at predetermined intervals by inserting corners of the respective glass substrates into the substrate-insertion grooves thereof; and

fixtures wound around a L-shaped outer surface of the cushioning body.