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DESCRIPTION
CUSHIONING PAD



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TECHNICAL FIELD

The present invention relates to a cushioning pad, existing between an article to be packed and an outer case for containing the article, to protect the article to be packed by absorbing external force such as impact.

PRIOR ART

In general, a combination of a cushioning pad and an outer case has been used conventionally for packaging electric machinery and apparatus such as audio instrument, TV and personal computer.

A cushioning pad used here is a member that exists between an article to be packed and an outer case and protect the article to be packed by crashing itself when external force such as impact strength is added, and a foam molded plastic is widely used as a light material with superior cushioning performance.

Shape of a cushioning pad composed of a foam molded plastic may be suitably selected corresponding to a weight or a shape of an article to be packed, and usually has an opening part or a concave part to be engaged with the article to be packed. A cushioning pad is mostly used as a set of an opposing pair or each

of four corners of the article to be packed.

A cushioning pad is generally manufactured by one-piece foam molding in a mold with a desired shape (see, for example, JP-U-59-175059) or cutting out each
5 part from a plate-like foamed body, followed by unification by heat melting or adhesion with adhesives (see, for example, JP-U-54-18541).

However, manufacturing of a cushioning pad by one-piece foam molding in a mold requires to prepare a
10 mold corresponding to each shape of an article to be packed, and thus this method is economically not efficient, while the method by cutting and bonding each part followed by unification has a problem of a complicated process.

15 From recent environmental viewpoint such as effective utilization of resource or refuse reduction, reuse of resource has been increasingly required, however, a cushioning pad made of a conventional foamed plastic body has problems to reuse such as inefficient
20 transportation and storage thereof due to its bulkiness.

Recently, a cushioning pad made of an extruded foamed polyolefin plate has been developed, as an endcap for electronic parts, which has a tough and
25 smooth heat melted skin layer on surface and a hinge part formed by a notch not passing through said skin layer, and is foldable around said hinge part (see, for example, WO 01/56773).

Since this type of cushioning pad is foldable around said hinge part and has a heat-melted skin layer with superior smoothness and durability in both surfaces of an extruded foamed polyolefin plate, it is
5 useful in view of moldability, economy and reuse, but has the following problem when the heat-melted skin layer is formed only in one surface of the extruded foamed polyolefin plate or by forming said skin layer in both surfaces of said foamed plate, followed by
10 slicing said foamed plate into two plates then providing a hinge part.

Namely, if a heat-melted skin layer, on forming, is thick to some extent, warpage may occur on an extruded foamed plate in such a direction as said
15 skin layer shrinks (or said foamed plate expands).

Generation of such warpage gives problems in subsequent secondary processing such as notching or contour cutting to form a hinge part on an extruded foamed plate, and thus a cushioning material with an
20 accurate shape and dimensions to fit an article to be packed can not be obtained.

On the contrary, if a heat-melted skin layer formed is too thin, a hinge part formed in said skin layer tends to cause an inconvenience such as breaking
25 easily during transportation of the article to be packed or when a hinge part is repeatedly raised up and returned for repeated use.

DISCLOSURE OF THE INVENTION

An object of the present invention is to provide a cushioning pad comprising a polyolefin foamed plate having a heat-melted skin layer on the whole surface, a hinge part being formed by providing a notch not passing through the heat-melted skin layer, no warpage in said foamed plate, and said hinge part being superior in strength, wherein said cushioning pad is easy to produce, usable repeatedly and superior in cushioning performance.

The present inventers have studied extensively to solve said problems by a method for preparing a heat-melted skin layer and found that said skin layer with specific structure can form a hinge part with superior strength without occurrence of warpage in said foamed plate, and thus accomplished the present invention.

Thus, the present invention includes the following (1) to (8) items.

- (1) A cushioning pad comprising a polyolefin foamed plate having a heat-melted skin layer on the whole surface with a hinge part being formed by providing a notch not passing through the heat-melted skin layer, wherein
said heat-melted skin layer is composed of a bulk resin part and a single or a plurality of layered resin parts bonded to said bulk resin part roughly in parallel to a surface of said polyolefin foamed plate

in viewing a cross section in a perpendicular direction to the surface of said polyolefin foamed plate, and said bulk resin part and layered resin part(s) are distributed throughout the whole surface of said
5 polyolefin foamed plate; and

the whole surface of said polyolefin foamed plate presents an unevenness by said bulk resin part and layered resin part(s).

(2) The cushioning pad in accordance with item
10 (1), wherein a density of said polyolefin foamed plate in the central part thereof is 0.010 to 0.050 g/cm³.

(3) The cushioning pad in accordance with item (1) or item (2), wherein a thickness of said polyolefin foamed plate is 15 to 100 mm.

15 (4) The cushioning pad in accordance with any one of items (1) to (3), wherein said polyolefin foamed plate is made of a low density polyethylene (LDPE).

(5) The cushioning pad in accordance with any one of items (1) to (4), wherein said polyolefin foamed
20 plate is an extruded foamed plate.

(6) A cushioning pad in accordance with any one of items (1) to (5) for setting an article to be packed therein by means of the following procedures:

forming at least one rectangular opening
25 passing through in a thickness direction in the polyolefin foamed plate;

forming a protrusion(s) in a parallel plane to the polyolefin foamed plate, by cutting the

polyolefin foamed plate in a shape of trapezoid,
wherein each trapezoid is in contact with one of a pair
of opposing sides of said opening and at least the
central part of a longer side or a shorter side of
5 opposing two parallel sides thereof constitutes a side
of the opening, leaving a heat-melted skin layer in the
vicinity of at least both end parts of the longer side
uncut;

raising said protrusion(s) onto the heat-
10 melted skin layer of the cushioning pad by pivoting
said protrusion(s) around said hinge part as a pivoting
axis, using the heat-melted skin layer remaining uncut
as the hinge part;

engaging an article to be packed to an
15 engaging part composed of at least a vacant part in the
polyolefin foamed plate formed by pivoting said
protrusion(s) part and said opening adjacent to said
vacant part.

(7) The cushioning pad in accordance with item
20 (6) having provided with notched parts passing through
the polyolefin foamed plate, wherein said notched parts
are made in a plurality of dashed lines crossing the
polyolefin foamed plate constituting at least one side
in said two sets of opposing sides of said opening, and
25 provided in such a manner that ends of each cut line of
the adjacent dashed lines are arranged alternately.

(8) The cushioning pad in accordance with item
(7), wherein said notched parts are formed in such a

manner that solid line parts of said dashed line are convex bent or curved at the central parts thereof, and bending or curving directions are the same within one dashed line and opposite to those in an adjacent dashed
5 line.

The effects of a heat-melted skin layer may be realized when said layer is provided in one surface of a polyolefin foamed plate, but it may be provided in both surfaces in certain circumstances, and the present
10 invention includes both embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1A is a magnified photo of particle structure in a cross-section of a polyolefin foamed plate having a heat-melted skin layer.

15 Fig. 1B is a magnified photo of particle structure in a cross-section of a polyolefin foamed plate having a heat-melted skin layer.

Figs. 2A, B and C show one embodiment of a cushioning pad of the present invention.

20 Figs. 3A, B and C show one embodiment of a cushioning pad of the present invention.

Fig. 4 shows a combination example using a cushioning pad of Figs. 2A-C.

25 Fig. 5 shows a combination example using a cushioning pad of Figs. 3A-C.

Fig. 6 shows an example of packaged body using a cushioning pad of Figs. 2A-C.

Fig. 7 shows an example of packaged body using a cushioning pad of Figs. 3A-C.

Figs. 8A and B show other embodiments of a cushioning pad of the present invention.

5 Fig. 9 shows another embodiment of a cushioning pad of the present invention.

Fig. 10 shows another embodiment of a cushioning pad of the present invention.

10 Fig. 11 is a schematic drawing of equipment for furnishing a heat-melted skin layer on a foamed plate.

Figs. 12A and B are schematic drawings of measurement for critical break energy (kgf-cm/cm) of a hinge part.

15 BEST MODE FOR CARRYING OUT THE INVENTION

Each component of the present invention will be described in detail hereinbelow.

(1) Polyolefin foamed plate

As a polyolefin foamed plate, a polyethylene
20 or polypropylene resin foamed plate is preferably used, in particular, a low density polyethylene (LDPE) foamed plate is preferable and both non-crosslinked and crosslinked polyethylene foamed plates are preferably used. Use of a low density polyethylene foamed plate
25 is preferable due to enhanced flexibility provided to a hinge part described later. When reuse to other shape of a product is important, a non-crosslinked

polyethylene foamed plate is advantageous.

Density of a polyethylene foamed plate is preferably 0.010 to 0.050 g/cm³ and more preferably 0.015 to 0.040 g/cm³. This range of density enhances flexibility of a hinge part. Thickness thereof is preferably 15 to 100 mm and more preferably 20 to 60 mm.

As a molding method for a polyolefin foamed plate, both of beads foam molding and extrusion foam molding are preferably used. The extrusion foam molding is preferable in view of efficient manufacturing.

Further, as a polyolefin foamed plate, a commercial polyolefin foamed plate (such as "Suntec Foam", a trade name of a non-crosslinked polyethylene foamed plate from Asahi Kasei Corp.) can be used.

(2) Heat-melted skin layer

(a) Specific inhomogeneous structure and dimension

A heat-melted skin layer is described here using Figs. 1A and 1B (both are magnified photos of a cross-section in perpendicular direction to a surface of polyolefin foamed plate, and scale units at right and left ends are mm).

When a cross-section in perpendicular direction to a surface of polyolefin foamed plate is observed, a heat-melted skin layer (i), is composed of a bulk resin part (ii) and a mono- or multi-layered resin part (iii) or (iv) bonded to said bulk resin part

(ii) roughly in parallel direction to said surface of polyolefin foamed plate, and said bulk resin part (ii) and layered resin part (iii) and (iv) are distributed covering the whole surface of said polyolefin foamed
5 plate.

Said bulk resin part (ii) may contain small cells (vi), and (v) represents cell membrane.

This specific inhomogeneous structure can form a hinge part with a superior strength without
10 generating warpage in a polyolefin foamed plate.

On the contrary, in a homogeneous heat-melted skin layer composed of a layered resin part only, warpage may occur when said skin layer is thick, thus giving problems in secondary processing such as
15 notching to form a hinge part or contour cutting of a cushioning pad. On the other hand, a too thin skin layer has a problem to make the hinge part weak.

A heat-melted skin layer of the present invention can prevent breaking by adjacent thick bulk
20 resin part, even if thin layered resin part is broken by external force, resulting in no effects on a function of the hinge part itself, and at the same time, an average total thickness of a heat-melted skin layer can be reduced by the presence of a thin layered
25 resin part to solve the warpage problem.

A heat-melted skin layer increases surface friction coefficient by providing a rugged shape to the surface of polyolefin foamed plate by the presence of

said bulk and layered resin parts.

This effect is explained in a cushioning pad of Figs. 2A to 2C and Figs. 3A to 3C: A protrusion part (5) raised up by pivoting 90° around a hinge part is
5 firmly held by the friction force at rugged surface of a heat-melted skin layer (12), and thus can not easily restore to the original shape by an elastic restoring force.

On the contrary, if the surface of a
10 polyolefin foamed plate is smooth, the protrusion part (5) easily slips and restores to the original shape by its restoring force.

In particular, repeated use of a cushioning pad causes wear of bottom surface of a protrusion part
15 (5), resulting in more slippery surface and causes a problem in setting work of an article to be packed to a cushioning pad.

Thickness of bulk resin part is preferably 2.0 to 13.6 times of an average thickness of cell
20 membrane at the central part of a polyolefin foamed plate.

Thickness of layered resin part is preferably 1.0 to 8.5 times of an average thickness of cell membrane at the central part of a polyolefin foamed
25 plate. Ratios of 2.0 times or more and 1.0 time or more, respectively, increase strength of a hinge part formed, while ratios within 13.6 times and 8.5 times prevent occurrence of warpage in forming a heat-melted

skin layer.

Ratio between a length of bulk resin part and a length of layered resin part is preferably 30:70 to 60:40. Most of the ratio within this range provides
5 suitable valance between a bulk resin part and a layered resin part, bringing about enhanced hinge strength without occurrence of warpage in forming of a heat-melted skin layer.

(b) Method for forming heat-melted skin layer

10 For example, the following methods are considered.

First, surface of a polyolefin foamed plate is heated by at least one type of heating measure including a hot-wire heater, a far-infrared heater and
15 a hot-air heater at a temperature not lower than the melting point and not higher than the melting point + 70°C of a resin composing a foamed body with the highest melting point, for example, in the case of a low density polyethylene, not lower than 110°C and not
20 higher than 180°C, for a time not shorter than 5 seconds and not longer than 20 seconds.

These heating conditions are suitable to form a heat-melted skin layer with an inhomogeneous structure, composed of said bulk and layered resin
25 parts, by generating many secondary foam protrusion parts in the surface of a polyolefin foamed plate, followed by bringing said secondary foam protrusion parts to a chill roll pressurization process described

later, without breaking said secondary foam protrusion parts but as they are.

Heating temperature not lower than 110°C provides suitable softening of said secondary foam protrusion parts and a resin just under said secondary foam protrusion parts, even if heating time is shorter than 20 seconds, while heating temperature lower than 180°C forms protrusion parts without breaking said secondary foam, and suitably promote softening of the resin just under said secondary foam protrusion parts, and thus under both conditions a heat-melted skin layer with inhomogeneous structure, composed of said bulk and layered resin parts, is easily formed.

Then, a polyolefin foamed plate, after said heating process, is passed between a pair of chill rolls. Surfaces of said chill rolls are held at 20 to 80°C, preferably at 35 to 75°C and more preferably at 50 to 70°C by cooling water flowing inside said chill rolls.

Said surface temperature within this range more easily provides a heat-melted skin layer with an inhomogeneous structure, composed of said bulk and layered resin parts.

Said pair of chill rolls compresses top surface of secondary foam protrusion parts generated in said heating process and compresses mainly top surface of cell membrane in said secondary foam protrusion parts and softened resin present just under them to

provide a laminated layer, and at the same time, standing walls of said secondary foam protrusion parts and mainly cell walls of softened resin present under them are continuously compressed and folded in to form
5 a bulk resin part, and thus said heat-melted skin layer with an inhomogeneous structure is formed.

Formation of said heat-melted skin layer with an inhomogeneous structure then provides an unevenness to the surface of a polyolefin foamed plate.

10 (3) Method for forming hinge part

A hinge part is formed by providing a notch not passing through in a heat-melted skin layer in the surface of a polyolefin foamed plate.

Said bulk and layered resin parts are
15 distributed covering the whole surface of a polyolefin foamed plate with said heat-melted skin layer, as described before, resulting in the presence of said bulk and layered resin parts also in a hinge part provided at any place of a polyolefin foamed plate.

20 (4) Cushioning pad

A cushioning pad can be applied to every cushioning pad requiring a hinge part.

Two typical examples are shown bellow.

(i) L type of cushioning pad

25 This is a cushioning pad to be used between corrugated board box and an article to be packed by placing at corners of the article to be packed by extending in L-shape around a hinge part

(ii) Engaging type of cushioning pad (inside hinge type, outside hinge type)

In this type, an opening is formed in a polyolefin foamed plate having a heat-melted skin layer
5 in the whole surface thereof, and a trapezoid-shaped protrusion part is cut out in adjacent to said opening, while leaving a part of a heat-melted skin layer uncut.

This type of cushioning pad provides a good cushioning performance in packaging of an article to be
10 packed by raising up a protrusion part from a cushioning plate using a un-cut heat-melted skin layer as a hinge part, When the cushioning pad is not in use, said protrusion part is returned to an original place to make a plate-like shape. Thus, this type of
15 cushioning pad contributes to space saving, and is suitable to reuse.

In said protrusion part, a foamed plate and a heat-melted skin layer are arranged in parallel to support an article to be packed, providing a high
20 cushioning performance.

Since said cushioning pad is manufactured by cutting a polyolefin foamed plate having a heat-melted skin layer corresponding to a shape of an article to be packed, mass production thereof is easy and the same
25 polyolefin foamed plate can respond to various cushioning pads having different shapes.

Said cushioning pad is described in more detail using Figs. 2 to 10.

At least one rectangular opening passing through a cushioning plate in thickness direction is formed, and trapezoid-shaped protrusion part is formed by cutting in contact with said opening. Here, said
5 cushioning pad is classified largely into two types depending on a direction of the trapezoidal protrusion part against an edge side of said opening.

In this cushioning pad, since longer side of two opposing parallel sides of said trapezoid acts as a
10 hinge part in raising up a protrusion part from a cushioning plate and thus, the cushioning pad is called as an inside hinge type when said longer side consists an end side of the opening, and it is called as an outside hinge type when shorter side consists an end
15 side of opening.

<Inside hinge type cushioning pad>

Figs. 2A to 2C are one embodiment of an inside hinge type cushioning pad of the present invention. In Figs. 2A to 2C, 2A is a plane view, 2B
20 is a I-II cross-section of 2A, and 2C is a I-II cross-section of 2A when a protrusion part is raised up. In this Fig., 1 is a cushioning pad of the present invention, 2 is a cushioning plate, 3 is an opening part, 4 is an end side of an opening part, 5 is a
25 protrusion part, 6 is a shorter side of a protrusion part 5, 7 is a notch part, 8 is a longer side of a protrusion part 5, 9 is a side of a protrusion part 5, 11 is a polyolefin foamed plate, 12 is a heat-melted

skin layer (shown by hatched part for simplification),
13 is a vacant part and 14 is clearance.

In said cushioning pad 1, a cushioning plate
2, which is composed of a polyolefin foamed plate 11 and
5 a heat-melted skin layer 12 as essential components,
has at least one rectangular opening 3 formed in a
thickness direction passing through the cushioning
plate 2, and a trapezoidal protrusion part 5 formed by
cutting in a plane parallel to the surface of a
10 cushioning plate 2 in contact with a pair of opposing
end sides 4 of said opening 3.

In said cushioning pad, when it is an inside
hinge type, longer side 8 in two parallel sides of a
protrusion part 5, having trapezoidal planar shape in
15 parallel to surface of a cushioning plate 2, in contact
with an opening part 3, and central part of said longer
side 8, excluding vicinity of both ends, constitutes a
pair of opposing ends 4 of the opening 3.

A protrusion part 5 is formed in trapezoidal
20 shape by cutting a cushioning plate 2, and in the
vicinity of both ends of said longer side 8 extended
from end 4, only a foamed plate 11 is cut, while a
heat-melted skin layer 12 is left uncut, and in side 9
connecting ends of shorter side 6 and longer side 8,
25 both of foamed plate 11 and heat-melted skin layer 12
are cut.

Namely, a protrusion part 5 is connected to a
main body of cushioning plate 2 at vicinity of both

ends of longer side 8 with a heat-melted skin layer 12.

In using said cushioning pad 1, by using a noncut heat-melted skin layer 12 at the vicinity of longer side 8 of a protrusion part 5 as a hinge part, 5 as is shown in Fig. 2C, a protrusion part 5 is raised up while folded outward, preferably by pivoting 90° around said hinge part as a central axis.

Thus raised up protrusion part 5 remains connected to a main body of a cushioning plate 2 by a 10 heat-melted skin layer 12 at a hinge part.

Since a foamed plate 11 is cut in said hinge part but a heat-melted skin layer 12 and a foamed plate 11 are unified, a heat-melted skin layer 12 has a high hinge strength, because break of a foamed plate 11 does 15 not influence on a heat-melted skin layer 12 even when said layer 12 is folded outward.

A heat-melted skin layer 12, when folded at a hinge part, presses a protrusion part 5 in a direction of a cushioning plate 2 to the original position by 20 restoring force, however, returning of thick end part of longer side 8, which extends from end part of longer side 8 to end part of shorter side 6 in reversely tapered form, to a hollow part 13 is suppressed by a main body of a cushioning plate 2 forming side 9, and 25 thus a protrusion part 5 is substantially fixed to a main body of a cushioning plate 2 in an externally raised state.

Also in raising up a protrusion part 5, thick

end part of longer side 8 is suppressed by a main body of a cushioning plate 2 forming side 9 contrary to the above case, but it is possible for a protrusion part 5 to be raised up by bending in convex toward longer side 8 and/or compression deformation of an end part of said protrusion part 5 or a main body of a cushioning plate 2, because said cushioning pad is composed of a polyolefin foamed plate 11 with superior flexibility and elasticity and a heat-melted skin layer 12 with superior flexibility.

Also after being raised up, a protrusion part 5 and a main body of a cushioning plate 2 can be restored to original shape by good restoring force of a foamed plate 11.

Furthermore in similar way, a protrusion part 5, once raised up, can be stored in a vacant part 13 to a less bulky plate-like shape by suitably compressing or bending a protrusion part 5 or a cushioning plate 2.

Namely, a protrusion part 5 can be raised up from a cushioning plate 2 in packaging work of an article to be packed, while in storage or transportation not in use, it can take a less bulky plate state.

In said cushioning pad 1, raising up of a protrusion part 5 from a cushioning plate 2 or storing it in a vacant part 13 can be made easy by providing a notch part 7 in the central part of shorter side 6 of a protrusion part 5 due to easy bending of said

protrusion part 5. As shown in Fig. 2A, raising up of a protrusion part 5 or storing can also be made easy by forming clearance 14 between shorter side 6 of a protrusion part 5 and a main body of a cushioning plate 2.

Fig. 4 is an oblique view showing a combination in packaging work of an article to be packed using a cushioning pad of Fig. 2. Fig. 6 is an oblique view showing a packaging body of a product 51 to be packaged using a cushioning pad of Fig. 2. As shown in Figs. 4 and 6, said cushioning pad 1 is basically used as a set with an opposing pair and engaged with an article to be packed 51 from both sides using at least a vacant part 13, generated after a protrusion part 5 is raised up from a cushioning plate 2, and an opening 3 adjacent to said vacant part 13, as an engaging part.

Usually, a package of this state is further contained in an outer case such as corrugated board box for storage and transportation.

As is apparent from Fig. 4, a protrusion part 5 is pivoted 90° in raising up from a cushioning plate 2, and a supporting surface of a protrusion part 5, which holds an article to be packed 51 by contacting, is cut surface of a cushioning plate 2, and an article to be packed 51 is supported by arranging a polyolefin foamed plate 11 and a heat-melted skin layer 12 in parallel.

Also in side surface of shorter side 6 of a protrusion part 5 contacting with a case, a foamed plate 11 and a heat-melted skin layer 12 are arranged in parallel, providing higher cushioning performance in support by a foamed plate 11 and a heat-melted skin layer 12 than supporting only by a formed plate with the same thickness as a cushioning plate 2, because external force is shared by stress in plane direction of a foamed plate 11 and a heat-melted skin layer 12.

10 <Outside hinge type cushioning pad>

Figs. 3A to 3C show one embodiment of an outside hinge type cushioning pad of the present invention. In these Figs. 3A to 3C, the same codes are used as in Figs. 2A to 2C for the same parts and 21 is one embodiment of a cushioning pad of the present invention and 22 is an opening.

As shown in Figs. 3A to 3C, in this outside hinge type, contrary to inside hinge type, shorter side 6 of a protrusion part 5 composes end side of an opening 3.

In this embodiment, shorter side 6 is coincident with end side of an opening 3, however, in the present invention, as shown in Fig. 8B, it is enough that at least central part of shorter side 6 composes end of an opening 3. On the other hand, also in a protrusion part 5 of the present embodiment, longer side 8 of a protrusion part 5 acts as a hinge part. Therefore, in a cushioning plate 2, a foamed

plate 11 and a heat-melted skin layer 12 are both cut in a side 9 but in longer side 8, only a foamed plate 11 is cut and a heat-melted skin layer 12 is left uncut.

5 Therefore, also in embodiments in Figs. 3A to 3C, an uncut heat-melted skin layer 12 in longer side 8 can be utilized as a hinge part for compression deformation and bending, a protrusion part 5 is raised up from a cushioning plate 2 by pivoting 90 ° and also
10 an once raised up protrusion part 5 is stored in vacant part 13. In raised up state of a protrusion part 5, similarly in Figs. 2A to 2C, thick part of both ends of longer side 8 of a protrusion part 5 are suppressed by a main body of a cushioning plate 2 composing side 9,
15 and thus substantially fixed at a protrusion part 5 and a main body of a cushioning plate 2.

 Also in this case, bending of a protrusion part 5 can be made easy by forming a notch part 7 in the central part of shorter side 6, and thus raising up
20 and compression of a protrusion part 5 become easy.

 Furthermore, in this embodiment, as shown in Figs. 3A to 3C, convex bending of said protrusion part 5 toward longer side 8 becomes easy, allowing work easier, by providing an opening 22 in contact with
25 longer side 8 of protrusion part 5 at the right side of the Fig. Also, as shown in Fig. 8B, when both ends of shorter side 6 extend to outside of end side of an opening 3, raising up and storage work of a protrusion

part 5 become easy by forming a clearance 71 between shorter side 6 and a main body of a cushioning plate 2.

Fig. 5 is an oblique view showing a combination in packaging an article to be packed using a cushioning pad of Figs. 3A to 3C, and Fig. 7 is an oblique view of packaging body in packaged state of an article to be packed 51. As is shown in Figs. 5 and 7, a cushioning pad 21 of the present embodiment is basically used as a set of opposing pair similarly as in Figs. 2A to 2C, and engaged with an article to be packed 51 from both sides using at least vacant part 13, generated after a protrusion part 5 is raised up from a cushioning plate 2, and an opening 3 adjacent to said vacant part 13, as an engaging part.

Also in this embodiment, similarly as Figs. 2A to 2C, an article to be packed 51 is supported by a polyolefin foamed plate 11 and a heat-melted skin layer 12 arranged in parallel at a protrusion part 5, and thus higher cushioning performance than conventional one is obtained.

Among the above-described types, an outside hinge type cushioning pad is manufactured by simultaneously cutting a cushioning plate 2 from a foamed plate 11 (original plate) having a heat-melted skin layer 12 formed and an opening or a protrusion part, and a method such as punching, generally used in cutting a foamed body, can be adopted in said cutting work.

In said process, a zone of protrusion part where a heat-melted skin layer 12 is not cut through can be cut simultaneously by changing a height of punching blade from that used for cut-through zone.

5 Trapezoidal planar shape of a protrusion part in a cushioning pad of the present invention is not limited as long as it is a shape with decreasing length in a direction parallel to said longer side from longer side end toward shorter side end, and may includes, in
10 addition to a trapezoid with linear side 9, as shown in Figs. 2A to 2C and 3A to 3C, side 9 composition combined with linear lines with different slopes, as shown in Figs. 8A and 8B and one with curved side 9.

In these inside and outside hinge type
15 cushioning pads, as shown in Figs. 2A to 2C and Figs. 3A to 3C, a protrusion part 5 is formed fundamentally in contact with an opposing pair of end side 4 of an opening 3, and a shape of an opposing protrusion part 5 is not necessarily the same. Combination of an inside
20 hinge type of Figs. 2A to 2C and an outside hinge type of Figs. 3A to 3C may be possible.

Furthermore in said cushioning pad, the number of an opening 3 is not limited to one, and such embodiments are suitably adopted that two or more
25 opening parts 3 are formed, wherein a protrusion part 5 is formed at each opening and two or more articles to be packed are packaged in one-piece by a pair of cushioning pad; two or more openings are formed,

wherein one protrusion part 5 is formed between every adjacent opening and one engaging part is formed by connecting plural openings where adjacent vacant parts are present, formed after raising up said protrusion
5 part 5.

Cushioning performance and strength of a cushioning pad itself can simultaneously be enhanced, by arranging a protrusion part in the midst of said engaging part, in particular, when an article to be
10 packed has a planar shape and opening of engaging part has a very long shape.

Furthermore, flexibility and strength of said cushioning pad is adjustable by forming suitable notch part 15 in a main body of a cushioning plate 2, as
15 shown in Figs. 2A to 2C and Figs. 3A to 3C.

Furthermore, as shown in Figs. 4 and 5, said cushioning pad is used as a set of opposing pair, but a shape of said one set is not necessarily the same and combination of a cushioning pad with different shape
20 and of different hinge type may be combined corresponding to a shape of an article to be packed.

In said cushioning pad, cushioning performance and strength can be adjusted by laminating a similar heat-melted skin layer on a surface of a
25 foamed plate 11 with no heat-melted skin layer 12 formed.

In said cushioning pad, convenience in recovery and repeated use can be enhanced by further

reducing a volume in out of use by providing multiple notch parts in a cushioning plate 2 to obtain expandable structure.

Fig. 9 shows a typical example of such structure. In this Fig., 101 is a broken-line-like through notch part provided in a cushioning plate 2, which forms at least one pair of end side 4a and 4c or 4b and 4d of two opposing pairs of end sides 4a to 4d of an opening 3.

Fig. 9 shows an example of having a notch part at both sides, wherein, a notch part 101 is provided in such a way that cut parts of adjacent multiple broken lines crossing a cushioning plate 2 are arranged alternately, but said broken line may be provided in orthogonal direction or in obliquely crossing direction to end sides 4a to 4d.

Expansion of a cushioning plate 2 with these multiple notch parts 101, in the direction of arrows 102 and 103 so as to widen notch parts 101, provides extension of a cushioning plate 2 in a network fashion to substantially widen planar area, while not in use, said network is closed again easily to the original volume and thus provides remarkable volume reduction effect in no use.

A cushioning plate in an opening 3 is usually disposed, but in the present composition, volume of a cushioning plate disposed can be reduced and thus enhance economical efficiency, because an opening 3

itself can be smaller than a composition without providing a notch part 101.

Furthermore, such an embodiment is also preferable as a notch part 101 shown in Fig. 9 has an angle by bending or curving at the central part to make widening easy and such a bent embodiment is shown in Fig. 10.

Fig. 10 is a partial plane view of a cushioning pad having an angled notch part 101'.

Namely, as shown in Fig. 10, a notch part 101' is formed in such a way that solid line parts of said broken line are made convex, bent or curved at the central parts thereof, and the bending or curving directions are the same within a broken line and the opposite to those in the adjacent broken line.

A cushioning pad of the present invention is described in more detail using Examples on said (1) L type of cushioning pad and (2) engaging type of cushioning pad (inside hinge type and outside hinge type).

Density (ρ_f) of a foamed plate used below is measured by the following measurement method.

Measurement Method for Density (ρ_f) of Foamed Plate
Preparation of measurement sample

A cubic sample having a side length of 20 mm (when a thickness of foamed plate is less than 20 mm, the dimension of a sample is the thickness $\times$ 20 mm $\times$ 20 mm) is cut out from the central part of cross-

section of a polyolefin resin foamed plate.

Measurement method

After measuring a sample weight W (g), sample volume V_f (cm³) is measured by the water immersion method to calculate density ρ_f (g/cm³) of the foamed plate according to the following equation:

$$\rho_f = W/V_f$$

<L Type of Cushioning Pad>

Examples 1-2 and Comparative Examples 1-3

10 In Examples 1-2 and Comparative Examples 1-2, "Suntec Foam 45", a trade name of product from Asahi Kasei Corp. [foamed body of low density polyethylene (LDPE) having a density of 0.025 g/cm³ and nominal dimensions of 50 mm × 600 mm × 2400 mm], was used as a
15 foamed plate.

In Comparative Examples 3, "Suntec Foam 15", a trade name of product from Asahi Kasei Corp. [low density polyethylene (LDPE) having a density of 0.068 g/cm³ and nominal dimensions of 50 mm × 510 mm ×
20 2400 mm], was used as a foamed plate.

In Examples 1-2 and Comparative Examples 1-2, a heat-melted skin layer was formed on a foamed plate using the following skin layer furnishing equipment and conditions.

25 In Comparative Examples 3, the above-described "Suntec Foam 15" was used as it is (without the treatment to furnish a heat-melted skin layer).

Heat-melted Skin Layer Furnishing Equipment

As shown in Fig. 11, this equipment is equipped with a heating section b having a heater frame with dimensions of 800 mm in width and 1000 mm in length above the central part of a horizontal frame a, 5 where 18 units of rod-like far-infrared heaters (heaters with a diameter of 12 mm, an effective length of 700 mm and an output of 800 w/unit) are fixed at the bottom part of the heater frame horizontally with their longitudinal directions being perpendicular to the flow 10 direction of the equipment at an interval of about 50 mm, and the heating section b is set in such a way that a vertical distance between the horizontal frame and the heater is adjustable.

A pair of drive rolls c (with a diameter of 15 100 mm and a length of 800 mm) at an entrance of the equipment just in front of said heating section b and a pair of drive rolls d (with a diameter of 100 mm and a length of 800 mm) at an exit of the equipment at a close behind of said heating section b, are mounted, 20 respectively, allowing up-and-down movements of the rolls so that each roll gap can be adjusted. In addition, cooling water passes through inside the drive rolls d at an exit of the equipment to chill down the roll surfaces (not shown in Fig. 11).

Conditions to furnish heat-melted skin layer

Table 1

	Example 1	Example 2	Comparative Example 1	Comparative Example 2
Distance between upper surface of formed plate and heater (mm)	60	60	60	60
Passing time of foamed plate under heater (Heating time) (sec)	10	16	4	22
Driving speed of entrance and exit rolls (m/min.)	6.0	3.8	15.0	2.7
Gap between entrance rolls (mm)	50.0	50.0	50.0	50.0
Gap between exit rolls (mm)	40.0	40.0	40.0	40.0
Surface temperature of exit rolls (°C)	60-65	60-65	60-65	60-65
Representative thickness of foamed plate before the heat treatment (mm)	52.0	52.0	52.0	52.0
Heat-shrunk thickness after the heat treatment (mm)	2.5	4.5	1.1	6.0

Next, with the foamed plates formed with a heat-melted skin layer in Examples 1-2 and Comparative Examples 1-2, warpage (mm) in longitudinal and width directions, average thickness of cell membrane at the central part of the foamed plate and dimensions (μm) of bulk resin part and layered resin part of a heat-melted skin layer were measured by the following methods.

Measurement of warpage of a foamed plate with a heat-melted skin layer formed

10 An original foamed plate, after forming a heat-melted skin layer and completely cooling to room temperature, is placed on a horizontal mount with a concaved plane upward. Vertical distance (mm) between the foamed plate and the horizontal mount generated by warpage is measured. Warpage in longitudinal direction is measured at six or more points in total including three or more points at each end of width along a longitudinal direction, and an average value is calculated. Warpage in width direction is measured at 15 six or more points in total including three or more points at each longitudinal end along width direction, then an average value is calculated.

Measurement of average thickness of cell membrane at the central part of foamed plate

25 A sample with a length of about 10 cm in longitudinal direction at the central part in width direction of a foamed plate is cut out, and magnified cross-sectional photos of the central layer in

thickness direction are taken at ten or more points at almost regular intervals. Then a line is drawn at the central part in thickness direction of each photo in parallel to a skin layer, to read number and thickness
5 of each cell on the line, and thus an average thickness of cell is determined by dividing the total thickness of cells with the number of cells.

Measurement of dimensions of bulk resin part and
layered resin part of heat-melted skin layer

10 A sample with a length of about 10 cm in longitudinal direction at the central part in width direction of a foamed plate is cut out, and magnified photos of a heat-melted skin layer are taken at ten or more points at almost regular intervals. Then, by
15 observing the heat-melted skin layer on these magnified photos, maximum thickness, minimum thickness and length of layered resin part and bulk resin part of the heat-melted skin layer are measured, by defining a position where thickness starts to increase from layered resin
20 part to bulk resin part as a boundary between layered resin part and bulk resin part.

Next, a sample of 100 mm in longitudinal direction, 50 mm in width direction and 40 mm in thickness direction was cut out from each of foamed
25 plates with a heat-melted skin layer formed used in Examples 1-2 and Comparative Examples 1-2, followed by giving a notch in thickness direction at the center of longitudinal direction in perpendicular to the

longitudinal direction so as to leave the heat-melted skin layer (2 mm) un-notched. The foamed plate was opened at 90° with the heat-melted skin layer as a hinge part inside, to obtain a L type cushioning pad.

- 5 A sample in Comparative Example 3 was notched in the same manner as in Example 1, and a hinge part consisting of a surface skin layer of foamed body with a thickness of 2 mm was formed, then the foamed plate was opened similarly at 90° to obtain a L type
10 cushioning pad.

On the hinge parts of L type cushioning pads in Examples 1-2 and Comparative Examples 1-3, ultimate break energies (kgf-cm/cm) were determined by the following method.

15 Measurement method of critical break energy (kgf-cm/cm) of hinge part

- As shown in Figs. 12 A and B (A is a front cross-sectional view and B is a I-I line cross-sectional view of A), a box (inner dimension of 90 mm ×
20 90 mm × 50 mm) made of B-flute corrugated board 104 whose two adjacent planes (90 mm × 50 mm) are open is prepared, and open sides of a L type cushioning pad (Suntec Foam (trade name)) 105 are fixed to inner
25 surface of the corrugated board box with a pressure-sensitive double-sided adhesive tape (thick type), which is then mounted on a fixing jig (made of wood) 107 with a horizontal ridge in right angle so that a hinge part of the L type cushioning pad is in contact

with this horizontal ridge through film or skin layer
106.

Then an impact is given on the top part of
the box made of B-flute corrugated board by free
5 falling of a falling ball with a predetermined weight
from a predetermined height, to determine critical
weight and height causing break in the above-described
hinge part. From the thus obtained critical weight for
break (W kgf) and height (h cm), as well as hinge
10 length (5cm), critical break energy per unit length of
hinge part is calculated based on the following
equation:

$$\text{Critical break energy (kgf-cm/cm)} = W \times H /$$

5.

15 Table 2 below shows each measurement value
for L type of cushioning pads in Examples 1-2 and
Comparative Examples 1-3. In this Table, μm ,
magnification and content (%) in the columns for resin
parts of heat-melted layer show, thicknesses of bulk
20 and layered resin parts, their magnifications to an
average thickness of cell membrane and ratio between
lengths of both resin parts, respectively.

Table 2

		Thick plate-like cushioning material before heat treatment			Thick plate-like cushioning material after heat treatment								
		Material	Bulk density (g/cm ³)	Cell membrane thickness (μm)	Total thickness (mm)	Resin part of heat-melted layer				Warpage			Critical break energy (kgf-cm/cm)
						Thickness of resin part		Thickness of layered resin part		Longitudinal (mm)	width (mm)	Judg-ment	
						(μm) / (magnifi-cation)	Content (%)	(μm) / (magnifi-cation)	Content (%)				
Example 1	LDPE	0.025	16-49	50	78-346 / 2.4-11.2	36	35-211 / 1.1-6.5	64	8	10	○	28.00	
Example 2	LDPE	0.025	16-49	48	101-429 / 3.1-13.2	53	42-267 / 1.3-8.2	47	33	16	○	36.30	
Comparative Example 1	LDPE	0.025	16-49	51	52-234 / 1.6-7.2	17	26-130 / 0.8-4.0	83	0	0	○	13.80	
Comparative Example 2	LDPE	0.025	16-49	46	114-455 / 3.5-14.0	64	52-286 / 1.6-8.8	36	52	27	×	51.60	
Comparative Example 3	LDPE	0.068	33-66	52			74-297 / 1.5-6.0					3.45	

<Engaging type cushioning pad (inside hinge type, outside hinge type)>

Example 3

Using two types of medium to light weight
5 dummies with different weight as pads to be packaged,
two types of cushioning pads (an inside hinge type and
an outside hinge type) were formed for each dummy,
followed by giving repeated dart impact as a packaged
state to evaluate durability of the hinge parts of said
10 cushioning pads.

Polyolefin foamed plate

As a polyolefin foamed plate, foamed plates
formed with a heat-melted skin layer in Examples 1-2
and Comparative Examples 1-2 were used.

15 Dummy

Medium weight dummy: 12.6 kg, 450 mm x 252 mm
x 114 mm

Light weight dummy : 6.6 kg, 330 mm x 227 mm
x 103 mm

20 Cushioning pad

Cushioning pad A (for a medium weight dummy, inside
hinge type, planar shape as shown in Fig. 8A)

In the planar shape shown in Fig. 8A, a
dimension of each part is as follows: maximum external
25 dimensions of cushioning plate 2 of 469 mm (right to
left direction in the Fig.) x 224 mm (top to bottom
direction in the Fig.), dimensions of protrusion part 5
of 194 mm in longer side 8 and 174 mm in shorter side

6, distance between longer side 8 and shorter side 6 of 46 mm, distance between two longer sides 8 of protrusion part 5 of 220 mm and width of opening 3 (top to bottom direction in the Fig.) of 114 mm.

- 5 Cushioning pad B (for medium weight dummy, outside hinge type, planar shape as shown in Fig. 8B)

In the planar shape shown in Fig. 8B, a dimension of each part is as follows: maximum external dimensions of cushioning plate 2 of 469 mm (right to
10 left direction in the Fig.) x 224 mm (top to bottom direction in the Fig.), dimensions of protrusion part 5 of 194 mm in longer side 8 and 174 mm in shorter side 6, distance between longer side 8 and shorter side 6 of 46 mm, distance between two shorter sides 6 of
15 protrusion part 5 of 260 mm and width of opening 3 (top to bottom direction in the Fig.) of 114 mm.

Cushioning pad C (for light weight dummy, outside hinge type, planar shape as shown in Fig. 2A-C)

In the planar shape shown in Fig. 2A-C, a
20 dimension of each part is as follows: maximum external dimensions of cushioning plate 2 of 328 mm (right to left direction in the Fig.) x 191 mm (top to bottom direction in the Fig.), dimensions of protrusion part 5 of 153 mm in longer side 8 and 103 mm in shorter side
25 6, distance between longer side 8 and shorter side 6 of 38 mm, distance between two longer sides 8 of protrusion part 5 of 127 mm and width of opening 3 (top to bottom direction in the Fig.) of 103 mm.

Cushioning pad D (for light weight dummy, outside hinge type, planar shape as shown in Fig. 3)

In the planar shape shown in Fig. 3, a dimension of each part is as follows: maximum external dimensions of cushioning plate 2 of 328 mm (right to left direction in the Fig.) x 191 mm (top to bottom direction in the Fig.), dimensions of protrusion part 5 of 153 mm in longer side 8 and 103 mm in shorter side 6, distance between longer side 8 and shorter side 6 of 38 mm, distance between two longer sides 8 of protrusion part 5 of 151 mm and width of opening 3 (top to bottom direction in the Fig.) of 103 mm.

Dart impact test

Each of the cushioning pads A-D was prepared, engaged with a dummy as shown in Figs. 6 and 7, packaged in an outer case (A -flute corrugated board in accordance with JIS model 0201, JIS Z1507-1989) and dropped from a height of 60 cm in the following order.

(1) Dropping with one corner of a bottom surface being faced downward

(2) Dropping with each of three ridges consisting the corner dropped in above (1) being faced downward, in the order of shorter ridge first, following the rest

(3) Dropping with each of six surfaces being faced downward in the order of right (one side surface with the cushioning pad engaged), left (another side surface with the cushioning pad engaged), front, rear, bottom and top surfaces

(4) Repeating above procedure (3) five times.

Evaluation

For each of cushioning pads, easiness in raising the protrusion part (organoleptic test) and self-standing property of the raised protrusion part (organoleptic test) were first evaluated, then the above drop tests (1) to (4) were performed to evaluate durability of a hinge part of each cushioning pad after the test, according to the following criteria at the most severely damaged hinge part:

○: length of broken hinge part is less than $1/2$ of original length of hinge part

×: length of broken hinge part is not less than $1/2$ of original length of hinge part.

The results of this test are shown in Table 3.

Table 3, Damage state of hinge part in drop test of package body

	Example 1	Example 2	Comparative Example 1	Comparative Example 2
Cushioning pad A	○	○	×	○
Cushioning pad B	○	○	×	○
Cushioning pad C	○	○	×	○
Cushioning pad D	○	○	○	○

INDUSTRIAL APPLICABILITY

As described above, the present invention can provide a cushioning material made of a polyolefin foamed plate having a heat-melted skin layer at the surface thereof and a hinge part formed by a notch not passing through said skin layer, and a cushioning pad that has no warpage in said foamed plate and superior strength in said hinge part, and is easy to produce, usable repeatedly and superior in cushioning performance.

The present invention can provide the following remarkable effects, in particular, in the cases of the above-described inside and outside hinge types.

(1) Since the protrusion part is made by raising it from the cushioning plate only when an article to be packed is packaged, and in other case said protrusion part can be stored within the cushioning plate, space saving can be attained in packaging work, storage and transportation of the cushioning pad, and also an efficiency in repeated use can be improved.

(2) Since said protrusion part can be substantially fixed to a main body of the cushioning plate when the protrusion part is raised up, packaging work is easy similarly as in the case of conventional one-piece molded cushioning pad, because said protrusion part does not move during transportation of the packaged body.

(3) Since the cushioning pad is manufactured by cutting a foamed body with a heat-melted skin layer formed, it can be manufactured quickly and in a large scale by using punching or the like. In addition, the
5 cushioning pad can be provided quickly at low cost, because the same cushioning plate can be used for cushioning pads having different shapes, and the cushioning pad can easily respond to a design change. Further, various managing works such as confirmation of
10 amount thereof are easy.

(4) Since the cushioning pad is formed by a foamed body with a heat-melted skin layer, and an article to be packed is supported by both of the cushioning pad and the heat-melted skin layer aligned
15 in parallel, it can provide a high cushioning performance to firmly protect the article to be packed. In addition, since a thinner or a smaller cushioning pad can be used to obtain the same cushioning performance, space saving of the cushioning pad can be
20 attained. Further, a cushioning performance and strength of a hinge part can be easily adjusted by suitably selecting each thickness, expansion ratio or the like of foamed body and heat-melted skin layer. In conclusion, the present cushioning pad can be
25 preferably used, in particular, for packaging of an easily damageable article to be packed, an article to be packed with a heavy weight, or in distribution route under severe conditions.

CLAIMS

1. A cushioning pad comprising a polyolefin foamed plate having a heat-melted skin layer on the whole surface with a hinge part being formed by providing a notch not passing through the heat-melted skin layer, wherein

said heat-melted skin layer is composed of a bulk resin part and a single or a plurality of layered resin parts bonded to said bulk resin part roughly in parallel to a surface of said polyolefin foamed plate in viewing a cross section in a perpendicular direction to the surface of said polyolefin foamed plate, and said bulk resin part and layered resin part(s) are distributed throughout the whole surface of said polyolefin foamed plate; and

the whole surface of said polyolefin foamed plate presents an unevenness by said bulk resin part and layered resin part(s).

2. The cushioning pad in accordance with claim 1, wherein a density of said polyolefin foamed plate in the central part thereof is 0.010 to 0.050 g/cm³.

3. The cushioning pad in accordance with claim 1 or claim 2, wherein a thickness of said polyolefin foamed plate is 15 to 100 mm.

4. The cushioning pad in accordance with any one of claims 1 to 3, wherein said polyolefin foamed plate is made of a low density polyethylene (LDPE).

5. The cushioning pad in accordance with any one

of claims 1 to 4, wherein said polyolefin foamed plate is an extruded foamed plate.

6. A cushioning pad in accordance with any one of claims 1 to 5 for engaging with an article to be packed therein by means of the following procedures:

forming at least one rectangular opening passing through in a thickness direction in the polyolefin foamed plate;

forming a protrusion(s) in a parallel plane to the polyolefin foamed plate, by cutting the polyolefin foamed plate in a shape of trapezoid, wherein each trapezoid is in contact with one of a pair of opposing sides of said opening and at least the central part of a longer side or a shorter side of opposing two parallel sides thereof constitutes a side of the opening, leaving a heat-melted skin layer in the vicinity of at least both end parts of the longer side uncut;

raising said protrusion(s) onto the heat-melted skin layer of the cushioning pad by pivoting said protrusion(s) around said hinge part as a pivoting axis, using the heat-melted skin layer remaining uncut as the hinge part;

engaging an article to be packed to an engaging part composed of at least a vacant part in the polyolefin foamed plate formed by pivoting said protrusion(s) and said opening adjacent to said vacant part.

7. The cushioning pad in accordance with claim 6 having provided with notched parts passing through the polyolefin foamed plate, wherein said notched parts are made in a plurality of dashed lines crossing the polyolefin foamed plate constituting at least one side in said two sets of opposing sides of said opening, and provided in such a manner that ends of each cut line of the adjacent dashed lines are arranged alternately.

8. The cushioning pad in accordance with claim 7, wherein said notched parts are formed in such a manner that solid line parts of said dashed line are convex bent or curved at the central parts thereof, and bending or curving directions are the same within a dashed line and opposite to those in an adjacent dashed line.