DESCRIPTION

METHOD AND APPARATUS FOR CUTTING SUBSTRATE

TECHNICAL FIELD

[0001]

The present invention relates to an improvement of a method and an apparatus for cutting a substrate, in which a molded substrate is cut into individual packages (pieces). Such a molded substrate is made by collectively sealing and molding a predetermined number of plural electronic components, such as integrated circuits (ICs), with a resin material. In particular, the present invention relates to a method and apparatus for examining the individual packages.

BACKGROUND ART

[0002]

Conventionally, a molded substrate is cut into individual packages by using a substrate cutting apparatus. This is performed in the following manner.

[0003]

First, a molded substrate, in which a predetermined number of electronic components are arranged on a substrate and are collectively sealed and molded with a resin material, is fixed by suction, with the substrate side directed upward. Then, cutting-plane lines are set after performing an alignment by using alignment marks formed on the substrate side, which is on the upper side of the molded substrate. The molded substrate is cut with a blade along the cutting-plane lines to form separated and individual packages. Then, the individual packages are washed and dried, and the appearance of the substrate side of the individual

packages is examined.

[0004]

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DISCLOSURE OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0005]

As previously described, when examining individual packages, only the substrate side of the individual packages is examined. Hence, the molded side, which is opposite from the substrate side, is not examined.

However, a fracture (such as a crack) may occur in a resin portion (resin compact) on the molded side due to cutting it with a blade, which deteriorates the quality and reliability of the packages (products).

This causes a problem that, in forming individual packages (products) by cutting a molded substrate, products having high quality and high reliability cannot be obtained.

Furthermore, the occurrence of a fracture in the resin portion on the molded side deteriorates the productivity of the packages (products).

This causes a problem that, in forming individual packages (products) by cutting a molded substrate, the productivity of the packages (products) cannot be improved.

Accordingly, in order to obtain products with high quality and high reliability, and in order to improve the productivity of the products, in other words, in order to solve the previously described problems relating to the cutting of a substrate, there is a demand for a method and apparatus for cutting a substrate in which both the substrate side and the molded side of the products (packages) can be examined.

[0006]

The present invention aims at, in forming products (packages) by cutting a molded substrate, obtaining products with high quality and high reliability.

The present invention also aims at, in forming products (packages) by cutting a molded substrate, enhancing the productivity of the products.

Furthermore, the present invention aims at, in order to obtain products with high quality and high reliability and in order to enhance the productivity of the products, providing a method and apparatus for cutting a substrate where both the front and back sides (the first and second sides), i.e. the substrate side and the molded side of the products (packages), can be examined.

MEANS FOR SOLVING THE PROBLEMS

[0007]

To solve the previously described technical problems, the present invention provides a method for cutting a substrate, including a package forming step for cutting a molded substrate to form individual packages and a package examination step for examining the individual packages, wherein the package examination step includes:

a first side examination step for examining a first side of the individual packages; and

a second side examination step for examining a second side, which is opposite from the first side, of the individual packages.

[0008]

To solve the previously described technical problems, the present invention also provides a method for cutting a substrate, including a package forming step for cutting a molded substrate to form individual packages and a package examination step for examining the individual packages, wherein the package examination step includes the steps of:

placing the cut individual packages on a first examination plate and holding the packages;

inverting the first examination plate holding the packages;

examining a first side, which is the exposed side of the individual packages held on the first examination plate, before or after the first examination plate is inverted;

placing the packages on a second examination plate after the first examination plate is inverted, to expose a second side, which is opposite from the first side, of the packages; and

examining the second side of the individual packages placed on the second examination plate.

[0009]

The method for cutting a substrate according to the present invention provided to solve the previously described technical problems is characterized in that, in examining the packages, either the first side or the second side of the packages is the substrate side, and the other is the molded side.

[0010]

In addition, to solve the previously described technical problems, the present invention provides a substrate cutting apparatus, including a package examination unit for examining individual packages formed by cutting a molded substrate, wherein the package examination unit includes:

a first examination unit for examining a first side of the individual packages; and

a second examination unit for examining a second side, which is opposite from the first side, of the individual packages which have been examined by the first examination unit.

[0011]

To solve the previously described technical problems, the present invention also provides a substrate cutting apparatus, including a package examination unit for examining individual packages formed by cutting a molded substrate, wherein the package examination unit includes:

a first examination plate on which the individual packages are to be placed, and which can be inverted while holding the packages;

a first examination mechanism for examining a first side, which is the exposed side of the individual packages held on the first examination plate, before or after the first examination plate is inverted;

a second examination plate on which the packages held on the first examination plate are to be placed after the first examination plate is inverted; and

a second examination mechanism for examining a second side, which is opposite from the first side, of the individual packages, the second side being exposed by placing the packages on the second examination plate.

[0012]

The substrate cutting apparatus according to the present invention provided to solve the previously described technical problems is characterized in that either the first side or the second side of the individual packages is the substrate side, and the other is the molded side.

[0013]

The first and second sides need only be the opposite sides of the packages. For example, they may be the front and back sides of a package in which the substrate is entirely covered with a resin and the substrate side is not exposed.

EFFECTS OF THE INVENTION

[0014]

The present invention has a beneficial effect of, in forming products (packages) by cutting a molded substrate, obtaining products with high quality and high reliability.

The present invention also has a beneficial effect of, in forming products (packages) by cutting a molded substrate, enhancing the productivity of the products.

Furthermore, the present invention has a beneficial effect of, in order to obtain products with high quality and high reliability and in order to enhance the productivity of the products, providing a method and apparatus for cutting a substrate in which both the front and back sides (the first and second sides), i.e. the substrate side and the molded side, of the products (packages) can be examined.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015]

Fig. 1 is a schematic plain view schematically showing a substrate cutting apparatus according to the present invention.

Fig. 2 is a magnified schematic plain view schematically showing the magnified main portion (package examination unit) in the substrate cutting apparatus illustrated in Fig. 1.

Fig. 3 is a magnified schematic front view schematically showing the magnified main portion (package examination unit) in the substrate cutting apparatus illustrated in Fig. 2.

Fig. 4(1) and Fig. 4(2) are a magnified schematic front view schematically showing the magnified main portion of the package examination unit illustrated in Fig. 3. Fig. 4(3) is a magnified schematic side view schematically showing the magnified main portion of the package examination unit illustrated in Fig. 4(2).

Fig. 5(1) and Fig. 5(2) are a magnified schematic front view schematically showing

the magnified main portion of the package examination unit illustrated in Fig. 3. Fig. 5(3) is a magnified schematic side view schematically showing the magnified main portion of the package examination unit illustrated in Fig. 5(2).

Fig. 6(1) is a magnified schematic front view schematically showing the magnified main portion of the package examination unit illustrated in Fig. 3. Fig. 6(2) is a magnified schematic side view schematically showing the magnified main portion of the package examination unit illustrated in Fig. 6(1).

Fig. 7(1), Fig. 7(2), and Fig. 7(3) are a magnified schematic front view schematically showing the magnified main portion of the package examination unit illustrated in Fig. 3.

Fig. 8(1) is a schematic perspective view schematically showing a molded substrate used in the present invention. Fig. 8(2) is a schematic perspective view schematically showing a package formed by cutting the molded substrate illustrated in Fig. 8(1).

EXPLANATION OF NUMERALS

[0016]

1 ... Molded Substrate

1a ... Substrate Side

1b ... Molded Side

2 ... Substrate

3 ... Molded Resin

4 ... Cutting-Plane Line

5 ... Package

5a ... Substrate Side

5b ... Molded Side

5(1c) ... Entire Group of Packages

6 ... Substrate Portion

7 ... Resin Portion

8 ... Ball Electrode

9 ... Substrate Cutting Apparatus

9a ... Front Side of the Apparatus

9b ... Back Side of the Apparatus

10 ... Connector

11 ... First Package Fastening Mechanism (First Transfer)

12 ... Invertible Attachment Plate (First Examination Plate)

12a ... Package Placing Side (Invertible Attachment Plate)

12b ... Rotational Shaft (Invertible Attachment Plate)

13 ... First Examination Mechanism (Lower Camera)

14 ... Placing Plate (Second Examination Plate)

14a ... Package Placing Side (Placing Plate)

15 ... Second Examination Mechanism (Upper Camera)

16 ... Second Package Fastening Mechanism (Second Transfer)

17 ... Placing Table

17a ... Package Placing Side (Placing Table)

18 ... Means for Moving a Placing Table

18a ... Package Placing Position

18b ... Package Sorting Position

19 ... Package Transfer Mechanism

20 ... First Examination Unit (First Examination Position)

21 ... Second Examination Unit (Second Examination Position)

22 ... Means for Reciprocating an Invertible Attachment Plate

31 ... Tray

31a ... Non-Defective Product Tray

31b ... Defective Product Tray

32 ... Substrate Directing Mechanism

33 ... Table for Cutting (Cutting Table)

34 ... Cutting Table Moving Mechanism

34a ... Substrate Placement Position

34b ... Substrate Cutting Position

35 ... Alignment Mechanism

36 ... Substrate Cutting Mechanism

37 ... Package Washing Mechanism

38 ... Substrate Loader

A ... Substrate Loading Unit

B ... Substrate Cutting Unit

C ... Package Examination Unit

D ... Package Receiving Unit

BEST MODES FOR CARRYING OUT THE INVENTION

[0017]

Hereinafter, the present invention will be described in detail with reference to the figures of the embodiments.

Figs. 1, 2, and 3 show a substrate cutting apparatus according to the present invention.

Figs. 4(1) through 4(3), Figs. 5(1) through 5(3), Figs. 6(1) and 6(2), and Figs. 7(1) through 7(3) are diagrams for explaining the process of sequentially and successively

examining the substrate side and molded side of the individual packages formed by cutting a molded substrate by using the substrate cutting apparatus according to the present invention.

Fig. 8(1) shows a molded substrate used in the present invention, and Fig. 8(2) shows a package cut by the substrate cutting apparatus according to the present invention.

[0018]

(Molded Substrate and Packages)

As shown in Fig. 8(1), a molded substrate 1 has a substrate side 1a and a molded side 1b, which is opposite from the substrate side 1a.

The molded substrate 1 is composed of a substrate 2 and a molded resin 3 which is provided on the molded side 1b of the molded substrate 1 (substrate 2). Cutting-plane lines 4 are set on the substrate side 1a of the molded substrate 1 (substrate 2).

As shown in Fig. 8(2), a package 5 which was separately formed by cutting the molded substrate 1 along the cutting-plane lines 4 has, similar to the molded substrate 1, a substrate side 5a and a molded side 5b, which is opposite from the substrate side 5a.

The package 5 has a substrate portion 6 and a resin portion 7 which is provided on the molded side 5a of the package 5 (substrate portion 6).

Ball electrodes 8 may be formed on the substrate side 5a (1a) of the substrate portion 6 (substrate 2).

In Fig. 8(1), the entire group of the individual packages 5 formed by cutting and separating the molded substrate 1 is indicated with the numeral 5(1c). Its exterior size is as large as the molded substrate 1.

In the present invention, the substrate side 5a and the molded side 5b in the packages 5 are independently and successively examined.

[0019]

(Configuration of the Substrate Cutting Apparatus)

As shown in Fig. 1, a substrate cutting apparatus 9 according to the present invention is composed of: a substrate loading unit A for loading a molded substrate 1; a substrate cutting unit B for cutting (separating) the molded substrate 1 carried from the substrate loading unit A into individual packages 5; a package examination unit C for examining the appearance of the individual packages 5 cut by the substrate cutting unit B to sort them into a non-defective product and a defective product; and a package receiving unit D including a set of trays for separately receiving the non-defective and defective packages examined and sorted by the package examination unit C.

Therefore, a molded substrate 1 loaded on the substrate loading unit A is first carried to the substrate cutting unit B to be cut into individual packages 5, and subsequently, the cut individual packages 5 are examined and sorted by the package examination unit C. Then, the defective and non-defective packages are separately received in the package receiving unit D.

In the substrate cutting apparatus 9 according to the present invention, the aforementioned units A, B, C, and D can be attachably and removably connected to each other in this order and installed in a desired location.

For example, in the substrate cutting apparatus 9 according to the present invention, the units A, B, C, and D can be attachably and removably connected with connectors 10.

In the substrate cutting apparatus 9 illustrated in Fig. 1, the numeral 9a denotes the front side of the apparatus, and 9b denotes the back side of the apparatus.

The present invention has a characteristic configuration of the package examination unit C in the substrate cutting apparatus 9 illustrated in Fig. 1.

[0020]

(Configuration of the Substrate Loading Unit)

The substrate loading unit A has, for example, a substrate loader 38 for loading a

molded substrate 1 and a pushing element (not shown) such as a pusher for pushing out the molded substrate 1 from the substrate loader 38.

Therefore, in the substrate loading unit A, a molded substrate 1 can be pushed out and carried from the substrate loader 38 to the package examination unit C by the pushing element.

[0021]

(Configuration of the Substrate Cutting Unit)

The substrate cutting unit B has, for example: a substrate directing mechanism 32 for directing the molded substrate 1 carried form the substrate loading unit A in a predetermined direction; a table for cutting (cutting table) 33 on which the molded substrate 1 directed by the substrate directing mechanism 32 is placed; a cutting table moving mechanism 34 for moving the cutting table 33 between the substrate placement position 34a and the substrate cutting position 34b; an alignment mechanism 35 for performing an alignment of the molded substrate 1 placed on the cutting table 33; a substrate cutting mechanism (blade) 36 for cutting the molded substrate 1 placed on the cutting table 33 along the cutting-plane lines 4; a package washing mechanism 37 for washing individual packages 5 cut by the substrate cutting mechanism 36; a first package fastening mechanism (first transfer) 11 for carrying the packages 5 on the cutting table 33 to the package examination unit C; and other components.

Therefore, first, a molded substrate 1 transferred from the substrate loading unit A is directed in a predetermined direction by the substrate directing mechanism 32, and the molded substrate 1 is carried to and set on the cutting table 33 with the side of the molded resin 3 down. Then, the molded substrate 1 is moved from the substrate placement position 34a to the substrate cutting position 34b by the cutting table moving mechanism 34 of the cutting table 33. Subsequently, while the molded substrate 1 is fixed on the cutting table 33

by suction, the molded substrate 1 aligned by the alignment mechanism 35 is cut with the substrate cutting mechanism (blade) 36 to form individual packages 5(1c).

After that, the individual packages 5 can be washed by the package washing mechanism 37 and the cutting table 33 can be returned to the substrate placement position 34a.

Accordingly, the individual packages 5(1c) on the cutting table 33 in the substrate placement position 34a can be carried to the package examination unit C by the first package fastening mechanism 11.

In the present invention, the number of blades (rotary cutting blades) in the substrate cutting mechanism 36, the number of cutting tables 33, the number of package washing mechanisms 37 and other units, can be varied without any restriction.

[0022]

(Configuration of the Package Receiving Unit)

The package receiving unit D has trays 31 for receiving examined packages 5.

That is, the package receiving unit D has, for example, a non-defective product tray loader which loads a non-defective product tray 31 (31a) for receiving non-defective products, and a defective product tray loader which loads a defective product tray 31 (31b) for receiving defective products.

Accordingly, each of the packages 5 examined and sorted in the package examination unit C can be received in the non-defective product tray 31a if the package is a non-defective product or in the defective product tray 31b if the package is a defective product.

[0023]

(Configuration of the Package Examination Unit)

The package examination unit C according to the present invention has, for

example: an invertible attachment plate (first examination plate) 12 that can be inverted with the packages 5(1c) attached by suction, which have been fastened by the first package fastening mechanism 11 in the substrate cutting unit B and transferred onto the package placing side (upper side) 12a; and a first examination mechanism (lower camera) 13 for examining the appearance of the individual packages 5(1c) from below which are attached by suction on the package placing side (lower side) 12a of the inverted invertible attachment plate 12.

When the invertible attachment plate 12 is set in a stationary position with the package placing side 12a directed upward, the individual packages 5(1c) can be transferred onto the package placing side 12a, where they are attached by suction. In this state, the invertible attachment plate 12 can be inverted so that the package placing side 12a will come to the lower side.

Hence, first, the individual packages 5(1c) are attached by suction onto the package placing side 12a of the invertible attachment plate (first examination plate) 12. Then, the invertible attachment plate 12 is inverted so that the package placing side 12a, with the individual packages 5(1c) attached thereon by suction, will come to the lower side. And the appearance of the individual packages 5(1c) attached by suction on the package placing side (lower side) 12a of the invertible attachment plate (first examination plate) 12 can be examined by the first examination mechanism (lower camera) 13.

The invertible attachment plate 12 can be reciprocated in the horizontal direction along the front side 9a of the apparatus by a means for reciprocating an invertible attachment plate which will be described later. In addition, the invertible attachment plate 12 is vertically movable.

[0024]

The examination unit C according to the present invention also has, for example: a

placing plate (second examination plate) 14 onto which the individual first examined packages 5(1c) attached by suction onto the package placing side (lower side) 12a of the invertible attachment plate 12 are to be transferred; a second examination mechanism (upper camera) 15 for examining the appearance of the individual first examined packages 5(1c) from above which have been transferred onto the package placing side 14a provided on the upper side of the placing plate 14; and a second package fastening mechanism (second transfer) 16 for fastening the individual second-examined packages 5(1c) on the package placing side 14a of the placing plate 14.

Therefore, first, the placing plate (second examination plate) 14 is moved upward so that the package placing side 14a of the placing plate 14 will abut the first examined packages 5(1c) attached on the package placing side (lower side) 12a of the invertible attachment plate 12. Accordingly, the first examined packages 5(1c) are passed and transferred onto the package placing side 14a of the placing plate 14. Subsequently, the appearance of the first examined packages 5(1c) placed on the package placing side 14a are examined by the second examination mechanism (upper camera) 15. These second-examined packages 5(1c) can be fastened by the second package fastening mechanism (second transfer) 16 and transferred onto a placing table 17 (package placing side 17a), which will be described later.

[0025]

In addition, the examination unit C according to the present invention further includes, for example: a placing table (index table) 17 onto which the second-examined packages 5(1c) fastened on the second package fastening mechanism 16 are to be transferred and set; a table-moving means 18 for moving the placing table 17 from the package placing position 18a to the package sorting position 18b (i.e. from the front side 9a of the apparatus to the back side 9b of the apparatus); and a package transfer mechanism

19 for sorting the non-defective products from the defective products on the placing table 17 at the package sorting position 18b and putting them into the trays 31 accordingly.

The main body of the placing table 17 (package placing side 17a) is vertically movable.

Therefore, first, the packages 5 are transferred onto the package placing side 17a of the placing table 17 at the package placing position 18a by the second package fastening mechanism 16, and the placing table 17 is moved to the package sorting position 18b by the table-moving means 18. Then, on the basis of the results of the examinations by the first examination mechanism 13 and the second examination mechanism 15, each of the packages 5 can be selectively transferred into the tray 31 (31a or 31b) as a non-defective product or defective product by the package transfer mechanism 19 from the package placing side 17a of the placing table 17 which has moved to the package sorting position 18b.

[0026]

The package examination unit C further includes the following positions that are located, for example, at the front side 9a of the apparatus: a first examination position (first examination unit) 20 at which the invertible attachment plate 12 and the first examination mechanism (lower camera) 13 are provided; the package placing position 18a of the placing table 17; and a second examination position (second examination unit) 21 at which the placing plate 14 and the second examination mechanism (upper camera) are provided. These positions are arranged in this order from the substrate cutting unit B toward the package receiving unit D.

In addition, the package examination unit C has a plate-reciprocating means 22 for reciprocating the invertible attachment plate 12 between the first examination position (first examination unit) 20 and the second examination position (second examination unit)

21. With this means 22, the invertible attachment plate 12 can be moved from the first examination position (first examination unit) 20 to the second examination position (second examination unit) 21, with the individual packages 5(1c) being attached by suction onto the package placing side 12a, which is the lower side of the invertible attachment plate 12 [i.e. while the individual packages 5(1c) are placed on the package placing side 12a].

In the process performed in the package examination unit C, packages 5 move in the following order: the first examination position 20 where the first side (e.g. the substrate side 5a) of the packages 5 is examined, the second examination position 21 where the second side (e.g. the molded side 5b) of the packages 5 is examined, the package placing position 18a, and the package sorting position 18b.

[0027]

(First Examination Unit)

As previously described, the first examination unit 20 has the invertible attachment plate 12 and the first examination mechanism (lower camera) 13.

In the invertible attachment plate 12, for example, the direction of the shaft center of a rotational shaft 12b is set to be on the horizontal plane and orthogonal to the direction in which the invertible attachment plate 12 moves.

Therefore, the invertible attachment plate 12 can be inverted (and stopped), for example, by rotating it 180 degrees about this rotational shaft 12b.

Although not shown, the invertible attachment plate 12 has an appropriate suction-fixing means (attaching means) for individually fixing (attaching) individual packages 5 by suction.

Therefore, as shown in Fig. 4(1), when the package placing side 12a is set in a stationary position where it becomes the upper side of the invertible attachment plate 12,

the invertible attachment plate 12 can be inverted around the rotational shaft 12c so that the package placing side 12a will be the lower side.

In this case, since the packages 5 are attached by suction on the package placing side 12a, which is the lower side of the invertible attachment plate 12, the packages 5 do not fall off the package placing side 12a (lower side).

[0028]

As shown in Fig. 4(2), in the first examination unit 20, the individual packages 5(1c) held on the package placing side 12a, which is the lower side of the invertible attachment plate 12, can be examined from below by the first examination mechanism (lower camera) 13.

In this process, as shown in Fig. 4(3), the first examination mechanism (lower camera) 13 can scan the packages from the back side 9b of the apparatus to the front side 9a of the apparatus to perform the first examination.

Since the substrate side 5a of the packages 5 is fastened by the first package fastening mechanism 11, the substrate side 5a of the packages 5 will be directed upwards when the packages 5 are placed on the package placing side 12a, which is set on the upper side of the invertible attachment plate 12.

After the invertible attachment plate 12 is inverted, the substrate side 5a will be the lower side of the packages 5, and this lower side, i.e. the substrate side 5a of the packages, 5 is first-examined from below as the first examination side by the first examination mechanism (lower camera) 13.

[0029]

(Second Examination Unit)

As previously described, the second examination unit 21 has the placing plate 14 and the second examination mechanism (upper camera) 15.

The placing plate 14 can be vertically reciprocated.

That is, when the invertible attachment plate 12 is moved to the position above the placing plate 14 as shown in Fig. 5(1), the placing plate 14 is moved upward so that the package placing side 14a of the placing plate 14 will abut the individual first-examined packages 5(1c) attached onto the lower side (package placing side 12a) of the invertible attachment plate 12, as shown in Fig. 5(2). Accordingly the individual first-examined packages 5(1c) on the invertible attachment plate 12 can be passed and transferred onto the package placing side 14a of the placing plate 14.

The placing plate 14 can fix (by suction) the individual first-examined packages 5(1c) on the package placing side 14a.

As shown in Fig. 5(3), the placing plate 14 can move downward with the individual packages 5(1c) transferred from the invertible attachment plate 12 being placed on the package placing side 14a of the placing plate 14.

At this point, the upper side of the first-examined packages 5(1c) placed on the package placing side 14a of the placing plate 14 is the molded side 5b.

At this point, for example, a certain distance L may be set between the package placing side 14a (upper side) of the placing plate 14 and the package placing side 12a (lower side) of the invertible attachment plate 12. Setting an adequately large distance L allows the molded side 5b, as the second examination side, of the individual packages 5(1c) placed on the package placing side 14a (upper side) of the placing plate 14 to be examined from above by the second examination mechanism (upper camera) 15.

[0030]

As shown in Fig. 6(1), the invertible attachment plate 12 can be moved toward the first examination unit 20 from the position above the placing plate 14 which has moved downward.

At this point, as described earlier, the package placing side 14a (upper side) of the placing plate 14 can be examined from above by the second examination mechanism (upper camera).

In addition, as shown in Fig. 6(2), the molded side 5b of the first-examined packages 5 can be examined by moving the second examination mechanism (upper camera) from the back side 9b of the apparatus toward the front side 9a of the apparatus.

That is, in the second examination unit 21, first, the first-examined packages 5(1c) are passed and transferred onto the package placing side 14a of the placing plate 14 from the package placing side (lower side) 12 of the invertible attachment plate 12. In this state, the placing plate 14 is moved downward, and subsequently, the molded side 5b of the first-examined packages 5(1c) placed on the package placing side 14a of the placing plate 14 can be examined by the second examination mechanism (upper camera) 15.

Accordingly, the substrate side 5a and molded side 5b of the individual unexamined packages 5(1c) can be successively examined to obtain the second-examined packages 5(1c).

Next, the second-examined packages 5(1c) on the package placing side 14a (upper side) can be carried and set onto the placing table 17 (index table) by the second package fastening mechanism 16.

The second examination mechanism and the second package fastening mechanism (second transfer) may be integrally moved.

[0031]

(Placing Table)

After the individual packages 5 are second-examined by the second examination mechanism 15, a predetermined number of the individual second-examined packages 5 can be carried and set onto the package placing side 17a of the placing table (index table) 17 by

the second package fastening mechanism 16, to be fixed by suction.

The packages 5 may be placed in a checkerboard-like arrangement on the package placing side 17a of the placing table (index table) 17.

In this case, for example, as shown in Fig. 7, if five second-examined packages 5 are fastened on the second package fastening mechanism 16 and then carried and set onto the placing table 17, three second-examined packages 5 and two second-examined packages 5 can be placed in this order at intervals of M, which is as wide as one package.

Any second-examined package (first and second-examined package) 5 that has passed both the first and second examinations is sorted as a non-defective product.

By moving the placing table 17 upward at the package placing position 18a, the packages 5(1c) attached on the package placing side 12a of the invertible attachment plate 12 can be transferred onto the package placing side 17a.

[0032]

(Examination Method in the Package Examination Unit)

First, in the first examination unit 20 in the package examination unit C, the individual packages 5(1c) fastened by the first package fastening mechanism (first transfer) 11 are carried and set onto the package placing side 12a, which is the upper side of the invertible attachment plate 12, to be attached by suction.

At this point, the upper side of the packages 5 attached onto the invertible attachment plate 12 is the substrate side 5a.

Next, as shown in Fig. 4(1), the invertible attachment plate 12 is inverted around the rotational shaft 12b so that the package placing side 12a will be the lower side. Then, as shown in Fig. 4(2), the lower side is scanned from below by the first examination mechanism (lower camera) 13 to perform the (first) examination.

Subsequently, the invertible attachment plate 12 in the inverted state is moved

toward the second examination unit 21 by the place-reciprocating means 22. Then, the placing plate 14 is moved upward and the first-examined packages 5(1c) are passed and transferred onto the package placing side 14a, which is the upper side of the placing plate 14. In this state, the placing plate 14 is moved downward to a predetermined position.

At this point, the packages 5(1c) may be attached by suction on the package placing side 14a of the placing plate 14.

Next, the first-examined packages 5(1c) placed on the package placing side (upper side) 14a of the placing plate 14 are scanned from above by the second examination mechanism (upper camera) 15 to perform the (second) examination.

Then, the second-examined packages 5(1c) are carried and set to the placing table (index table) 17 at the package placing position 18a by the second package fastening mechanism (second transfer) 16.

Subsequently, the placing table 17, with the second-examined packages 5(1c) placed thereon, is moved to the package sorting position 18b, and each of the second-examined packages 5(1c) is sorted into a non-defective product group which will be transferred to the non-defective product tray 31a or into a defective product group which will be transferred to the defective product tray 31b.

[0033]

(Examination Side of the Packages)

In the first examination unit 20, the first package fastening mechanism 11 fastens the individual packages 5(1c) by the substrate side 5a and places them on the invertible attachment plate (first examination plate) 12, so that the substrate side 5a of the individual packages 5 on the invertible attachment plate 12 will be the upper side.

In this state, by inverting the invertible attachment plate 12, the substrate side 5a of the individual packages 5 can be the lower side, and the substrate side 5a, which is the

lower side, will be the first examination side.

At this point, the molded side 5b, which is the upper side of the individual packages 5, is touching the package placing side 12a of the invertible attachment plate 12.

Accordingly, the substrate side 5a, which is the lower side of the individual packages 5 placed on the invertible attachment plate 12, can be examined from below by the first examination mechanism (lower camera) 13.

In the second examination unit 21, the placing plate (second examination plate) 14 is moved upward to the invertible attachment plate 12, which has been moved to the second examination unit (second examination position) 21 from the first examination unit 20 by the plate-reciprocating means 22. Accordingly, the package placing side 14a of the placing plate 14 abuts the substrate side 5a of the individual first-examined packages 5 attached on the lower side (package placing side 12a) of the invertible attachment plate 12, and the individual packages 5(1c) attached to the invertible attachment plate 12 can be passed and transferred onto the placing plate 14.

At this point, the molded side 5b of the individual packages 5 transferred onto the package placing side 14a of the placing plate 14 is the upper side and the second examination side.

Hence, the molded side 5b (second examination side), which is the upper side of the individual packages 5 placed on the placing plate 14, can be examined from above by the second examination mechanism (upper camera) 15.

[0034]

(Effects of the Examination Method in the Package Examination Unit)

With the present invention, in forming packages (products) 5 by cutting a molded substrate 1, both the substrate side 5a and the molded side 5b of the packages (products) 5 can be successively examined. Therefore, products 5 with high quality and high reliability

can be obtained.

Furthermore, with the present invention, in forming packages (products) 5 by cutting a molded substrate 1, both the substrate side 5a and the molded side 5b of the packages (products) 5 can be successively examined. Therefore, the productivity of the products 5 is enhanced.

Hence, in order to obtain products with high quality and high reliability and in order to enhance the productivity of the products in forming packages (products) 5 by cutting a molded substrate 1, the present invention can provide a method and apparatus for cutting a substrate where both the front and back sides (the first and second sides), i.e. the substrate side 5a and the molded side 5b of the products (packages) 5, can be examined.

[0035]

(Another Examination Method in the Package Examination Unit)

In the configuration of the examination unit used for another examination method, the second examination unit (position) 21 and the package placing position 18a of the placing table 17 are at the same position, when viewed from above. The first examination unit 20 has the same configuration as in the previously described embodiment.

In such an examination unit used for this examination method, for example, the placing plate (second examination plate) 14 and the placing table 17 can be placed (substantially) at the same height, and the placing plate 14 and the placing table 17 are not in contact with each other at the package placing position 18a.

[0036]

In the examination unit used for this examination method, for example, the following steps can be successively performed: a step in which a predetermined number of packages 5 (e.g. five packages 5 as previously described) are lifted from the package placing side 14a of the placing plate 14 by the second package fastening mechanism 16 at

the package placing position 18a (second examination position 21); a step in which the packages 5 (three packages and then two) fastened by the second package fastening mechanism 16 are transferred onto the package placing side 17a of the placing table 17 at the package placing position 18a (second examination position 21); and a step in which the packages 5 are sorted into a non-defective product group and defective product group and transferred to the trays 31 (31a and 31b) by the package transfer mechanism 19 at the package sorting position 18b.

In this case, the placing table 17 reciprocates between the package placing position 18a and the package sorting position 18b where the placing table 17 does not come in contact with the placing plate 14. Also, a predetermined number of packages 5 are transferred onto the package placing side 17a at the package placing position 18a, and the packages 5 are sorted into a non-defective product group and defective product group and accordingly transferred to the trays 31 (31a and 31b) by the package transfer mechanism 19 at the package sorting position 18b.

In this case, the placing plate 14 vertically reciprocates, for example, between the position of the height of the placing table 17 and the position below the placing table 17 where the placing plate 14 is not in contact with the placing table 17.

Alternatively, the placing plate 14 can remain still, for example, at a position below the placing table 17 where the placing plate 14 is not in contact with the placing table 17.

[0037]

First examination: first, in the first examination unit 20 in the package examination unit C, the individual packages 5(1c) fastened by the first package fastening mechanism (first transfer) 11 are carried and set onto the package placing side 12a, which is the upper side of the invertible attachment plate 12, to be attached by suction.

Next, the invertible attachment plate 12 is inverted around the rotational shaft 12b,

so that the package placing side 12a will be the lower side. And the substrate side 5a of the packages 5 is scanned from below by the first examination mechanism (lower camera) 13 to perform the (first) examination.

Second examination: the invertible attachment plate 12 in the inverted state is moved to the package placing position 18a by the plate-reciprocating means 22, and the placing plate 14 is moved upward so that the first-examined packages 5(1c) are passed and transferred onto the package placing side 14a, which is the upper side of the placing plate 14. In this state, the placing plate 14 is moved downward to a predetermined position and the molded side 5a of the packages 5 placed on the package placing side 14a is scanned by the second examination mechanism 15 to perform the (second) examination.

At this point, i.e. in the second examination, the placing table 17 (17a) is positioned at the package sorting position 18b so that the placing table 17 and the placing plate 14 (and the second examination mechanism 15) located at the package placing position 18a may not be in contact with each other.

In the second examination, when the placing table 17 is placed at the package placing position 18a, the placing plate 14 and the second examination mechanism 15 are placed below the placing table 17 where they are not in contact with the placing table 17.

[0038]

The packages 5 can be transferred from the placing plate 14 (14a) to the placing table 17 (17a) by the second package fastening mechanism 16.

In this case, the packages 5 can be transferred by a predetermined number of packages from the placing plate 14 (14a) to the placing table 17 (17a).

Further, in this case, as previously described, the package placing side 14a of the placing plate 14 at the package placing position 18a and the package placing side 17a of the placing table 17 at the package sorting position 18b may positioned at the same height.

In this case, as described earlier, the placing plate 14 may be positioned below the placing table 17 where the placing plate 14 is not in contact with the placing table 17.

[0039]

First, the placing table 17 is moved to the package sorting position 18b and the packages 5 are sorted and transferred to the trays 31 (31a and 31b) by the package transfer mechanism 19.

At this point, at the package placing position 18a, the placing plate 14 is moved upward to the height of the placing table 17 and a predetermined number of the packages 5 placed on the package placing side 14a of the placing plate 14 are fastened by the second package fastening mechanism 16. Simultaneously, the placing plate 14 is moved downward to a predetermined position.

Subsequently, the placing table 17 is moved from the package sorting position 18b to the package placing position 18a, and the predetermined number of the packages 5 fastened to the second package fastening mechanism 16 are transferred to a predetermined position on the package placing side 17a of the placing table 17.

Next, the placing table 17 is moved to the package sorting position 18b and the given number of examined packages 5 on the placing table 17 (17a) are sorted and transferred to the trays 31 (31a and 31b).

The aforementioned procedure of transferring the packages 5 from the placing plate 14 to the placing table 17 can be performed repeatedly.

Accordingly, the present embodiment can bring about the same effects as in the previously described embodiment.

That is, with the present invention, in forming products (packages 5) by cutting a molded substrate 1, products with high quality and high reliability can be obtained.

Also, with the present invention, in forming products (packages 5) by cutting a

molded substrate, the productivity of the products can be enhanced.

Furthermore, the present invention can provide, in order to obtain products with high quality and high reliability and in order to enhance the productivity of the products, a method and apparatus for cutting a substrate in which both the front and back sides (the first and second sides), i.e. the substrate side5a and the molded side 5b of the products (packages) 5, can be examined.

As previously described, in the case where the packages 5 are lifted from the package placing side 14a of the placing plate 14 by the second package fastening mechanism 16, the packages 5 may be lifted from the package placing side 14a by the second package fastening mechanism 16 while the placing plate 14 is placed (stopped) below the placing table 17.

[0040]

The present invention is not limited to the previously described embodiments. Those embodiments can be arbitrarily and appropriately changed and selected as necessary without departing from the scope of the present invention.

[0041]

(Case where the First Examination Position and the Second Examination Position are at the Same Position)

In the previously described embodiments, the examination of the individual packages 5 (5a and 5b) is separately performed in each of the first examination unit (position) 20 and second examination unit (position) 21. However, the first examination position 20 and the second examination position 21 may be at the same position when viewed from above in the package examination unit C.

[0042]

In this embodiment where the first examination position 20 and the second

examination position 21 are placed at the same position, for example, the placing plate (second examination plate) 14 may be provided below the invertible attachment plate (first examination plate) 12 in such a way that it is vertically movable, and the first examination mechanism (lower camera) and the second examination mechanism (upper camera) may be provided between the invertible attachment plate 12 and the placing plate 14 in such a way that they can independently perform a scan.

That is, first, the substrate side 5a of the individual packages 5(1c) attached to the package placing side 12a of the inverted invertible attachment plate (first examination plate) 12 is scanned to be examined by the first examination mechanism (lower camera).

Next, the placing plate (second examination plate) 14 provided below the invertible attachment plate 12 is moved upward and the individual packages 5(1c) are passed and transferred onto the package placing side 14a. Then, the placing plate 14 is moved downward to be returned to a predetermined position. After that, the molded side 5a of the individual packages 5(1c) placed on the package placing side 14a is scanned to be examined by the second examination mechanism (upper camera).

Subsequently, the second-examined packages 5 are transferred onto the package placing side 17a of the placing table 17 by the second package fastening mechanism 16.

In this manner, the first examination and the second examination can be performed at the same position, and the effects as in the previously described embodiments can be obtained.

In this case, the first examination mechanism (lower camera) and the second examination mechanism (upper camera) may be integrally moved.

[0043]

(Order of the Examination Side of Packages)

In each of the previously described embodiments, the substrate side and the molded

side of packages may be examined in this order or in the reverse order.

That is, in each of the previously described embodiments, the substrate side 5a of the packages 5 is first examined as the first side, and then the molded side 5b of the packages 5 is examined as the second side. However, the molded side 5b of the packages 5 may be examined as the first side and then the substrate side 5a of the packages 5 may be examined as the second side.

In this case, for example, a molded substrate 1 with the side of the molded resin 3 directed upward is carried and set onto the cutting table 33. Then, the molded substrate 1 is directed using alignment marks formed on the substrate side (edge portion) of the molded resin 5, and cut along the cutting-plane lines 4. After that, as previously described, the molded side 5b and the substrate side 5a of the packages 5 can be sequentially and successively examined.

[0044]

(Examining Either One Side of Packages)

In the case where either one side (only one side) of the packages 5 is to be examined in the package examination unit C, the examination by the second examination unit 21 can be omitted.

[0045]

The embodiment in which either one side (5a or 5b) of the packages 5 is examined is performed in the following manner for example: first, the first side (substrate side 5a or molded side 5b) of the packages 5(1c) of the package placing side 12a of the inverted invertible attachment plate 12 is examined by the first examination mechanism (lower camera) 15, and then the packages 5(1c) being attached onto the package placing side 12a are passed and transferred onto the package placing side 17a of the placing table 17.

In this case, for example, the placing table 17 may be moved upward, or

alternatively, the invertible attachment plate 12 may be moved downward.

That is, the aforementioned configuration enables a collective transfer of the packages 5(1c) from the invertible attachment plate 12 to the placing table 17(17a), which can enhance the productivity of the products (packages).

Therefore, only either one side of the packages 5 can be efficiently examined, enhancing the productivity of the products (packages).

[0046]

In the embodiment where only either one side of the packages 5 is examined, the second package fastening mechanism 16 can be used.

For example, after the first examination is performed by the first examination mechanism 13, first, the invertible attachment table 12 is inverted again, so that the package placing side 12a will be the upper side, and then, the packages 5 placed on the package placing side 12a are transferred onto the package placing side 17a of the placing table 17 by the second package fastening mechanism 16.

In this case, for example, the placing table 17 may be moved upward, or alternatively, the invertible attachment plate 12 may be moved downward.

The package placing side 17a of the placing table 17 and the package placing side 12a of the invertible attachment plate 12 may be placed on the same level (in a horizontal plane).

Therefore, only either one side of the packages 5 can be efficiently examined, enhancing the productivity of the products (packages).

[0047]

In the embodiment where only either one side of the packages 5 is examined, the second package fastening mechanism 16 and the placing plate (second examination plate) 14 can be used.

For example, first, the first side (substrate side 5a or molded side 5b) of the packages 5(1c) of the packages placing side 12a of the inverted invertible attachment plate 12 is examined by the first examination mechanism (lower camera) 15, and then the packages 5(1c) being attached on the package placing side 12a are passed and transferred onto the package placing side 14a of the placing plate 14. Subsequently, the packages 5(1c) on the package placing side 14a of the placing plate 14 are transferred onto the package placing side 17a of the placing plate 17 by the second package fastening mechanism 16.

Therefore, only either one side of the packages 5 can be efficiently examined, enhancing the productivity of the products (packages).

[0048]

(Other Configurations of the Substrate Cutting Unit)

The substrate cutting unit B in the substrate cutting apparatus 9 according to the present invention uses a blade (rotary cutting blade) as a means for cutting a substrate. In the substrate cutting apparatus 9 according to the present invention, a substrate cutting unit having a laser light, wire saw, band saw, high-pressure cutting water, or other unit can be used as the means for cutting.

CLAIMS

1. A method for cutting a substrate, including a package forming step for cutting a molded substrate to form individual packages and a package examination step for examining the individual packages, wherein the package examination step includes:

a first side examination step for examining a first side of the individual packages; and

a second side examination step for examining a second side, which is opposite from the first side, of the individual packages.

2. A method for cutting a substrate, including a package forming step for cutting a molded substrate to form individual packages and a package examination step for examining the individual packages, wherein the package examination step includes the steps of:

placing the cut individual packages on a first examination plate and holding the packages;

inverting the first examination plate holding the packages;

examining a first side, which is an exposed side of the individual packages held on the first examination plate, before or after the first examination plate is inverted;

placing the packages on a second examination plate after the first examination plate is inverted, to expose a second side, which is opposite from the first side, of the packages; and

examining the second side of the individual packages placed on the second examination plate.

3. The method for cutting a substrate according to claim 1 or 2, wherein: in

examining the packages, either the first side or the second side of the packages is a substrate side and an other is a molded side.

4. A substrate cutting apparatus, including a package examination unit for examining individual packages formed by cutting a molded substrate, wherein the package examination unit comprises:

a first examination unit for examining a first side of the individual packages; and

a second examination unit for examining a second side, which is opposite from the first side, of the individual packages which have been examined by the first examination unit.

5. A substrate cutting apparatus, including a package examination unit for examining individual packages formed by cutting a molded substrate, wherein the package examination unit comprises:

a first examination plate on which the individual packages are to be placed, and which can be inverted while holding the packages;

a first examination mechanism for examining a first side, which is an exposed side of the individual packages held on the first examination plate, before or after the first examination plate is inverted;

a second examination plate on which the packages held on the first examination plate are to be placed after the first examination plate is inverted; and

a second examination mechanism for examining a second side, which is opposite from the first side, of the individual packages, the second side being exposed by placing the packages on the second examination plate.

6. The substrate cutting apparatus according to claim 4 or 5, wherein either the first side or the second side of the individual packages is a substrate side and an other is a molded side.