BAG OPENING METHOD, BAG OPENING APPARATUS, AND BAG OPENING SYSTEM

CROSS-REFERENCE TO RELATED PATENT APPLICATION

This application claims the benefit of priority to Taiwan Patent Application No. 109141224 filed on November 25, 2020, and to the U.S. Provisional Patent Application Ser. No. 63/057,545 filed on July 28, 2020. The entire content of each of the above identified applications is incorporated herein by reference.

Some references, which may include patents, patent applications and various publications, may be cited and discussed in the description of this disclosure. The citation and/or discussion of such references is provided merely to clarify the description of the present disclosure and is not an admission that any such reference is "prior art" to the disclosure described herein. All references cited and discussed in this specification are incorporated herein by reference in their entireties and to the same extent as if each reference was individually incorporated by reference.

FIELD OF THE DISCLOSURE

The present disclosure relates to a bag opening method, a bag opening apparatus, and a bag opening system, and more particularly to a bag opening method, a bag opening apparatus, and a bag opening system for opening a protective bag of a semiconductor article.

BACKGROUND OF THE DISCLOSURE

Generally, when a wafer box (e.g., a front opening unified pod) carrying a

wafer is transferred, a dust protection bag or an antistatic bag is used to cover an outer periphery of the wafer box, so as to prevent dust from settling on the wafer box or to prevent the wafer in the wafer box from being affected by external static electricity. The dust protection bag or the antistatic bag covering the outer periphery of the wafer box is generally fixed by components such as tape.

In a conventional application, when the outer periphery of the wafer box is covered by the dust protection bag or the antistatic bag, and a wafer carried by such a wafer box enters a related working station for processing, the tape first needs to be cut off, and then the dust protection bag or the antistatic bag is opened manually. In this way, the efficiency is low and excessive human power is required. In addition, when technical personnel cannot go to work due to various unavoidable circumstances (such as the government announcing office closure), the overall wafer manufacturing process may be put to halt, thereby causing huge losses.

SUMMARY OF THE DISCLOSURE

In response to the above-referenced technical inadequacies, the present disclosure provides a bag opening method, a bag opening apparatus, and a bag opening system primarily configured to improve the issues associated with a conventional bag opening method (i.e., manually opening a protective bag of a semiconductor article). The conventional bag opening method requires excessive human power, and is of low efficiency. Further, when relevant technical personnel cannot go to work, the overall manufacturing process may be put to halt.

In one aspect, the present disclosure provides a bag opening method configured to open a protective bag of a semiconductor article. The semiconductor article includes the protective bag, an accommodating box, and at least one tape. The protective bag includes an accommodating space and an opening, the accommodating box is disposed in the accommodating space through the opening, the protective bag is configured to have a packaging portion and a non-packaging portion, the packaging portion covers an outer periphery of the accommodating box, the non-packaging portion is folded into a tail structure, the at least one tape is adhered to the packaging portion and the tail structure, and the at least one tape is configured to fix the tail structure to the packaging portion. The bag opening method includes a positioning step, a first cutting step, a pulling step, and a second cutting step. The positioning step is implemented by fixing the semiconductor article. The first cutting step is implemented by controlling a first knife machine to cut off the at least one tape so that the tail structure is in a movable state. The pulling step is implemented by controlling a pulling machine to hold the tail structure and to allow the tail structure to be vertically disposed relative to the non-packaging portion. The second cutting step is implemented by controlling a second knife machine to cut off a portion connecting the tail structure and the packaging portion so that the tail portion and the packaging portion are separated.

In another aspect, the present disclosure provides a bag opening apparatus configured to open a protective bag of a semiconductor article. The semiconductor article includes the protective bag, an accommodating box, and at least one tape. The protective bag includes an accommodating space and an opening, the accommodating box is disposed in the accommodating space

through the opening, the protective bag is configured to have a packaging portion and a non-packaging portion, the packaging portion covers an outer periphery of the accommodating box, the non-packaging portion is folded into a tail structure, the at least one tape is adhered to the packaging portion and the tail structure, and the at least one tape is configured to fix the tail structure to the packaging portion. The bag opening apparatus includes a processing device, a fixing machine, a first knife machine, a pulling machine, and a second knife machine. The fixing machine is electrically connected to the processing device and configured to fix the semiconductor article. The first knife machine is electrically connected to the processing device and configured to cut off the at least one tape. The pulling machine is electrically connected to the processing device. The processing device is configured to control the pulling machine to hold the tail structure, so that the tail structure is vertically disposed relative to the packaging portion. The second knife machine is electrically connected to the processing device and configured to cut off the tail structure. The processing device is configured to sequentially control the fixing machine and the first knife machine, so as to fix the semiconductor article in and then cut off the at least one tape. The processing device is configured to sequentially control the pulling machine and the second knife machine, so as to pull the tail structure and then cut off a portion connecting the tail structure and the packaging portion.

In yet another aspect, the present disclosure provides a bag opening system comprising a bag opening apparatus, a fetching apparatus, and a central control apparatus. The central control apparatus is electrically connected to the bag opening apparatus and the fetching apparatus. When the bag opening apparatus

cuts off the tail structure of the semiconductor article from the packaging portion, the central control apparatus is configured to control the fetching apparatus to take out the accommodating box disposed in the packaging portion.

Therefore, the bag opening method, the bag opening apparatus, and the bag opening system of the present disclosure can automatically cut off the tape, and then cut off the tail structure to open the protective bag. During the overall process, human operation is basically not required, thereby significantly reducing the need for human power and effectively increasing the overall efficiency.

These and other aspects of the present disclosure will become apparent from the following description of the embodiment taken in conjunction with the following drawings and their captions, although variations and modifications therein may be affected without departing from the spirit and scope of the novel concepts of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The described embodiments may be better understood by reference to the following description and the accompanying drawings, in which:

FIG. 1 is a schematic view of a bag opening apparatus of the present disclosure;

FIG. 2 is a schematic view of a semiconductor article;

FIG. 3 is a schematic view of a protective bag and an accommodating box;

FIG. 4 to FIG. 6 are schematic views of the protective bag in different states;

FIG. 7 is a schematic view of a fixing machine of the bag opening

apparatus of the present disclosure;

FIG. 8 is a schematic view showing the fixing machine of the bag opening apparatus holding the semiconductor article according to the present disclosure;

FIG. 9 to FIG. 13 and FIG. 15 are schematic operational views showing the bag opening apparatus cutting off a tape of the semiconductor article and holding a tail structure according to the present disclosure;

FIG. 14 is a schematic view of a clamping device of the pulling machine of the bag opening apparatus of the present disclosure;

FIG. 16 and FIG. 18 to FIG. 20 are schematic operational views of the bag opening apparatus cutting off the tail structure of the semiconductor article according to the present disclosure;

FIG. 17 is a schematic view of a knife device of a second knife structure of the bag opening apparatus of the present disclosure;

FIG. 21 is a schematic view of a bag opening system of the present disclosure;

FIG. 22 is a schematic view of a bag recycling apparatus of the bag opening system and a packaging portion of the protective bag according to the present disclosure;

FIG. 23 is a schematic view showing a clamping module of the bag recycling apparatus of the bag opening system extending into the packaging portion of the protective bag according to the present disclosure;

FIG. 24 is a schematic view showing the protective bag being disposed by the bag recycling apparatus of the bag opening system onto a platform according to the present disclosure;

FIG. 25 is a flowchart of a bag opening method of the present disclosure;

and

FIG. 26 is another flowchart of the bag opening method of the present disclosure.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

The present disclosure is more particularly described in the following examples that are intended as illustrative only since numerous modifications and variations therein will be apparent to those skilled in the art. Like numbers in the drawings indicate like components throughout the views. As used in the description herein and throughout the claims that follow, unless the context clearly dictates otherwise, the meaning of “a”, “an”, and “the” includes plural reference, and the meaning of “in” includes “in” and “on”. Titles or subtitles can be used herein for the convenience of a reader, which shall have no influence on the scope of the present disclosure.

The terms used herein generally have their ordinary meanings in the art. In the case of conflict, the present document, including any definitions given herein, will prevail. The same thing can be expressed in more than one way. Alternative language and synonyms can be used for any term(s) discussed herein, and no special significance is to be placed upon whether a term is elaborated or discussed herein. A recital of one or more synonyms does not exclude the use of other synonyms. The use of examples anywhere in this specification including examples of any terms is illustrative only, and in no way limits the scope and meaning of the present disclosure or of any exemplified term. Likewise, the present disclosure is not limited to various embodiments given herein. Numbering terms such as “first”, “second” or “third” can be used

to describe various components, signals or the like, which are for distinguishing one component/signal from another one only, and are not intended to, nor should be construed to impose any substantive limitations on the components, signals or the like.

Referring to FIG. 1 to FIG. 7, a bag opening apparatus S1 of the present disclosure is configured to open a protective bag A1 of a semiconductor article A. The bag opening apparatus S1 includes a processing device 1, a fixing machine 2, a first knife machine 3, a pulling machine 4, and a second knife machine 5. The processing device 1 is electrically connected to the fixing machine 2, the first knife machine 3, the pulling machine 4, and the second knife machine 5. The processing device 1 can be, for example, various types of computers or servers. The fixing machine 2 is configured to hold the semiconductor article A. The first knife machine 3, the pulling machine 4, and the second knife machine 5 can be used in cooperation with each other, so as to open the protective bag A1 of the semiconductor article A that is held by the fixing machine 2. To clearly show the components included by the bag opening system S1, FIG. 1 omits a supporting frame for supporting the processing device 1, the first knife machine 3, the pulling machine 4, and the second knife machine 5.

Referring to FIG 1 to FIG. 3, the semiconductor article A includes the protective bag A1, an accommodating box A2, and two tapes A3. The protective bag A1 has an accommodating space A11 and an opening A12, and the accommodating box A2 is disposed in the accommodating space A11 through the opening A12. In a practical application, the accommodating box A2 can be, for example, various types of front opening unified pods (i.e., FOUP),

and the protective bag A1 can be various types of tin foil bags or anti-static bags. Referring to FIG.3 to FIG. 6, after the accommodating box A2 is disposed in the protective bag A1, a portion of the protective bag A1 covers an outer periphery of the accommodating box A2, and said portion of the protective bag A1 is defined as a packaging portion A13. The remaining portion of the protective bag A1 is defined as a non-packaging portion A14. Referring to FIG. 2, FIG. 5, and FIG. 6, a side of the non-packaging portion A14 that has the opening A12 can be operated by a technical personnel or a related machine, so that the side of the non-packaging portion A14 is repeatedly folded in a direction toward the packaging portion A13 to form a tail structure A15. The tail structure A15 is fixed to the packaging portion A13 by the two tapes A3. After the tail structure A15 is fixed to a top surface of the packaging portion A13 by the two tapes A3, the protective bag A1, the accommodating box A2 disposed in the protective bag A1, and the two tapes A3 jointly define the semiconductor article A.

Referring to FIG. 1, FIG. 7, and FIG. 8, the bag opening apparatus S1 can further include a transferring machine 6. The transferring machine 6 includes a rail 61 and a carrying platform 62, and the carrying platform 62 is slidably disposed on the rail 61. The processing device 1 is electrically connected to the transferring machine 6, and the carrying platform 62 is controllable by the processing device 1 to move along the rail 61. The carrying platform 62 is configured to carry the semiconductor article A (as shown in FIG. 2), the fixing machine 2 is disposed on the carrying platform 62, and the fixing machine 2 is configured to hold the semiconductor article A disposed on the carrying platform 62. The processing device 1 is configured to control the carrying

platform 62 to slide on the rail 61, so that the semiconductor article A disposed on the carrying platform 62 moves from a position near the first knife machine 3 to a position near the second knife machine 5.

The fixing machine 2 can include four pushing devices 21 and two abutting devices 22. Each of the pushing devices 21 can include a driver 211 and a pushing member 212. The driver 211 of each of the pushing devices 21 is electrically connected to the processing device 1, and in each of the pushing devices 21, the pushing member 212 is connected to the driver 211. In each of the pushing devices 21, the processing device 1 is configured to control the driver 211 to be operated so that the pushing member 212 moves toward the carrying platform 62 to push a side of the semiconductor article A disposed on the carrying platform 62, or control the driver 211 to be operated so that the pushing member 211 moves away from the carrying platform 62 to not push the side of the semiconductor article A. For example, each of the drivers 211 can include a pneumatic cylinder (or a hydraulic cylinder) and a plurality of pushing rods. The processing device 1 can control the pneumatic cylinder, so that the pushing rods and the pushing member 212 connected thereto move toward or away from the carrying platform 62.

When the semiconductor article A is disposed on the carrying platform 62, the processing device 1 controls the four pushing devices 21, so that the four pushing members 212 push four side surfaces of the semiconductor article A. In a practical application, at least one detector can be disposed on the carrying platform 62, the detector is configured to detect whether the carrying platform 62 has the semiconductor article A disposed on the carrying platform 62, and the processing device 1 determines whether the carrying platform 62 has the

semiconductor article A disposed thereon according to a detection result of the detector. When the processing device 1 determines that the carrying platform 62 has the semiconductor article A disposed thereon according to the detection result, the processing device 1 can control the four pushing devices 21 to be operated, so that the four pushing devices 21 push the four side surfaces of the semiconductor article A to hold the semiconductor article A.

In a practical application, when the semiconductor article A is disposed on the carrying platform 62, the processing device 1 can control the four pushing devices 21 to be operated at the same time, so that the four pushing members 212 push the four side surfaces of the semiconductor article A at the same time. In this way, even if placement of the semiconductor article A on the carrying platform 62 slightly deviates from a correct position on the carrying platform 62, the semiconductor article A can eventually move to the correct position through being pushed by the four pushing members 212. In other words, the four pushing devices 21 can not only hold the semiconductor article A disposed on the carrying platform 62, but also allow the semiconductor article A to be correctly disposed on the carrying platform 62 (i.e., allow the semiconductor article A to return to the correct position on the carrying platform 62).

Each of the abutting devices 22 includes a driver 221 and an abutting member 222. In each of the abutting devices 22, the driver 221 is electrically connected to the processing device 1, and the abutting member 222 is connected to the driver 221. The processing device 1 can control the two drivers 221 of the two abutting devices 22, so that the two abutting members 222 abut against the packaging portion A13. In a practical application, each of the drivers 221 can include a pneumatic cylinder and a plurality of pushing rods. The

processing device 1 can control each of the drivers 221 to be operated, so that the pushing rods extend or return to drive the abutting members 222 to abut against or no longer abut against the packaging portion A13 of the semiconductor article A.

The two abutting devices 22 can be disposed near the two pushing devices 21. Before the processing device 1 controls the pulling machine 4 to hold the tail structure A15, the processing device 1 can control the two abutting devices 21 to be operated, so that the two abutting members 212 no longer abut against the semiconductor article A. Then, the processing device 1 controls the two abutting devices 22 to be operated, so that the two abutting members 222 abut against a bottom portion A131 (as shown in FIG. 2) of the packaging portion A13. In a practical application, each of the abutting devices 22 is disposed near one of the pushing devices 21, but each of the abutting devices 22 is not limited to being disposed near one of the pushing devices 21.

Referring to FIG. 9, the first knife machine 3 can include a first knife 31, a vertical movement module 32, and a horizontal movement module 33. The first knife 31 is connected to the vertical movement module 32, and the vertical movement module 32 is connected to the horizontal movement module 33. The processing device 1 is electrically connected to the vertical movement module 32 and the horizontal movement module 33. The processing device 1 is configured to control the vertical movement module 32 to be operated, so that the first knife 31 moves in a vertical direction (e.g., vertical to the ground) toward or away from the semiconductor article A disposed on the carrying platform 62. The processing device 1 is configured to control the horizontal movement module 33 to be operated, so that the first knife 31 moves in a

horizontal direction (e.g., perpendicular to the vertical direction) toward or away from the semiconductor article A disposed on the carrying platform 62. The first knife 31 can include a main body 311, the main body 311 has at least two blades 312 respectively disposed on at least two sections of a side of the main body 311, and no blade 312 is disposed on the remaining sections of the side of the main body 311.

In a practical application, the vertical movement module 32 of the first knife machine 3 can have a slide 321 and a slider 322, the slider 322 is controllable to slide on the slide 321, the horizontal movement module 33 of the first knife machine 3 can have a slide 331 an a slider 332, and the slider 332 is controllable to slide on the slide 331. The first knife 31 is connected to the slider 322 of the vertical movement module 32, and the slider 321 of the vertical movement module 32 is connected to the slider 332 of the horizontal movement module 33.

Referring to FIG. 9, in a practical application, the transferring machine 6 is configured to move the semiconductor article A along an X-axis direction, the horizontal movement module 33 of the first knife machine 3 is configured to move the first knife 31 along a Y-axis direction, and the vertical movement module 32 of the first knife machine 3 is configured to move the first knife 31 along a Z-axis direction.

Referring to FIG. 1, the pulling machine 4 of the bag opening apparatus S1 can include a flipping device 41, an auxiliary abutting device 42, a movement device 43, and a clamping device 44. The flipping device 41 and the auxiliary abutting device 42 are disposed near the first knife machine 3, the movement device 43 is configured to move from a position near the first knife machine 3

to a position near the second knife machine 5, the clamping device 44 is connected to the movement device 43, the clamping device 44 is configured to clamp the tail structure A15, and the clamping device 44 can follow the movement device 43 to move from the position near the first knife machine 3 to the position near the second knife machine 5.

It is worth mentioning that, the pulling machine 4 is primarily configured to allow the tail structure A15 of the semiconductor article A to be vertically disposed relative to the packaging portion A13. In the present embodiment, the pulling machine 4 includes the flipping device 41, the auxiliary abutting device 42, the movement device 43, and the clamping device 44, but the components included by the pulling machine 4 are not limited thereto.

Referring to FIG. 9, the flipping device 41 can include a movement module 411, a rotatable module 412, a supporting structure 413, and a plurality of suction assemblies 414. The movement module 411 and the rotatable module 412 are electrically connected to the processing device 1, the movement module 411 is connected to the rotatable module 412, and the supporting structure 413 is connected to the rotatable module 412. The suction assemblies 414 are spaced apart from each other and disposed on the supporting structure 413. Each of the suction assemblies 414 is connected to an air suction device, and the processing device 1 can control the air suction device so that each of the suction assemblies 414 has a suction force, or control the air suction device so that each of the suction assemblies 414 no longer has the suction force.

The auxiliary abutting device 42 can include a vertical movement module 421, a horizontal movement module 422, and an auxiliary abutting member 423. The vertical movement module 421 is connected to the auxiliary abutting

member 423, and the vertical movement module 421 is connected to the vertical movement module 422. The processing device 1 is electrically connected to the vertical movement module 421 and the horizontal movement module 422 of the auxiliary abutting device 42. The processing device 1 can control the vertical movement module 421 of the auxiliary abutting device 42 to be operated, so that the auxiliary abutting member 423 moves along a vertical direction (e.g., vertical to the ground, as the Z-axis direction shown in FIG. 9) toward or away from the semiconductor article A. The processing device 1 can control the horizontal movement module 422 of the auxiliary abutting device 42 to be operated, so that the auxiliary abutting member 243 moves along a horizontal direction (e.g., perpendicular to the vertical direction, as the Y-axis direction shown in FIG. 9) toward or away from the semiconductor article A.

The processing device 1 can control the movement module 411 to be operated, so that the rotatable module 412, the supporting structure 413, and the suction assemblies 414 move along a horizontal direction (e.g., parallel to the ground, as the Y-axis direction shown in FIG. 9) toward or away from the semiconductor article A disposed on the carrying platform 62. The processing device 1 can control the rotatable module 412 to be operated, so that the supporting structure 413 rotates (e.g., taking the X-axis shown in FIG. 9 as a central axis for rotation) to change a direction of the suction assemblies 414. The movement module 411 can include a driver 4111, a plurality of pushing rods 4112, and a connection member 4113. Two ends of the pushing rods 4112 are respectively connected to the driver 4111 and the connection member 4113, and the processing device 1 can control the driver 4111, so as to allow the pushing rods 4112 to move the connection member 4113 in a direction toward

or away from the driver 4111. Accordingly, the rotatable module 412, the supporting structure 413, and the suction assemblies 414 are driven to move along the horizontal direction.

Reference is made to FIG. 9 to FIG. 13, which are operation schematic views showing the bag opening apparatus cutting off the tape of the semiconductor article A and holding the tail structure according to the present disclosure. As shown in FIG. 9 and FIG. 10, when the carrying platform 62 has the semiconductor article A disposed thereon, the processing device 1 can control the auxiliary abutting device 42 to be operated, so that the auxiliary abutting member 423 moves to a position near the tail structure A15 of the semiconductor article A and the auxiliary abutting member 423 abuts against the top surface of the packaging portion A13 of the semiconductor article A. Afterwards, as shown in FIG. 10 and FIG. 11, the processing device 1 controls the first knife machine 3 to be operated, so that the two blades 312 of the first knife 31 cut off the two tapes A3 of the semiconductor article A.

Referring to FIG. 10, it is worth mentioning that the main body 311 of the first knife 31 can further include a protrusion structure313 arranged between the two blades 312, and the protrusion structure 313 is configured to push the tail structure A15. A distance between a side of the protrusion structure 313 and another side of the main body 311 (i.e., a side of the main body 311 that is away from the protrusion structure 313) is greater than a distance between a side of each of the blades 312 and said side of the main body 311.

After the first knife 31 cuts off the two tapes A3, the processing device 1 can control the first knife 31 to move continuously, so that the first knife 31 enters between the tail structure A15 and the non-packaging portion A14 to

push the non-packaging portion A14 through the protrusion structure 313. Therefore, the tail structure A15 flips relative to the packaging portion A13, and an inner portion A151 of the tail structure A15 is exposed. In a process where the first knife 31 pushes the tail structure A15, the auxiliary abutting member 423 can still abut against the top surface of the packaging portion A13, but the present disclosure is not limited thereto. In the process, the auxiliary abutting member 423 can also not abut against the packaging portion A13.

Referring to FIG. 11 and FIG. 12, when the two tapes A3 are cut off, and the tail structure A15 is pushed by the first knife 31 such that the inner portion A151 of the tail structure A15 is exposed, the processing device 1 controls the flipping device 41 to be operated, so that the supporting structure 413 and the suction assemblies 414 disposed on the supporting structure 413 move onto the tail structure A15. At this time, the processing device 1 controls the air suction device to be operated, so that the suction assemblies 414 generate a suction force to suck on the tail structure A15. Referring to FIG. 12 and FIG. 13, after the suction assemblies 414 suck on the tail structure A15, the processing device 1 controls the rotatable module 412 to be operated, so that the supporting structure 413 and the suction assemblies 414 disposed thereon rotate 90 degrees (the degree is not limited thereto). In this way, the tail structure A15 sucked by the suction assemblies 414 are vertically disposed relative to the packaging portion A13.

Referring to FIG. 14, the clamping device 44 can include a movement module 441, a connection arm 442, and a clamper 443. The connection arm 442 is connected to the movement module 441, and the clamper 443 is connected to the connection arm 442. The processing device 1 is electrically

connected to the movement module 441, and the processing device 1 can control the movement module 441 to be operated, so that the connection arm 442 and the clamper 443 move from a position near the first knife machine 3 to a position near the second knife machine 5. The movement module 441 can include a slide 4411 and a slider 4412, the slider 4412 is connected to the connection arm 442, and the processing device 1 can control the slider 4412 to slide on the slide 4411. The clamper 443 can include a driver 4431 and two clamping arms 4432, the two clamping arms 4432 are connected to the driver 4431, and the processing device 1 can control the driver 4431 to allow the two clamping arms 4432 to rotate toward or away from each other with respect to the driver 4431, so that the two clamping arms 4432 clamp or no longer clamp the tail structure A15.

Referring to FIG. 1 and FIG. 13 to FIG. 16, when the suction assemblies 414 suck on the tail structure A15 and the tail structure A15 is vertically disposed relative to the packaging portion A13, the processing device 1 controls the clamping device 44 to be operated, so that the connection arm 442 and the clamper 443 move to a position above the tail structure A15. Then, the processing device 1 controls the clamper 443 to clamp the tail structure A15. After the clamper 443 clamps the tail structure A15, the processing device 1 controls the flipping structure 41 to be operated, so that the suction assemblies 414 no longer suck on the tail structure A15. Further, the processing device 1 controls the clamping device 44 and the carrying platform 62 to be operated at the same time, so that the clamping device 44 and the semiconductor article A move together to a position near the second knife machine 5.

Referring to FIG. 16 to FIG. 19, the second knife machine 5 is electrically

connected to the processing device 1, and the processing device 1 can control the second knife machine 5 to cut off the tail structure A15, so that the tail structure A15 and the packaging portion A13 are separated. More specifically, the second knife machine 5 can include an abutting device 51 and a knife device 52 that face toward each other. The abutting device 51 can include a driver 511 and an abutting board 512 that are connected to each other. The processing device 1 is electrically connected to the driver 511, and the processing device 1 can control the driver 511 to be operated, so that the abutting board 512 moves toward or away from the knife device 52.

Referring to FIG. 17, the knife device 52 can include a movement module 521, a shell 522, a second knife 523, and an extendable machine 524. The movement module 521 includes two drivers 5211 and a connection board 5212. The two drivers 5211 are electrically connected to the processing device 1, the connection board 5212 is connected to the two drivers 5211, and the processing device 1 can control the two drivers 5211 to be operated, so that the connection board 5212 moves toward or away from the abutting device 51. The connection board 5212 is connected to the shell 522, the second knife 523 is disposed in the shell 522, the shell 522 has a thru-hole 5221, the extendable machine 524 is disposed in the shell 522, and the extendable machine 524 is connected to the second knife 523. The extendable machine 524 can include a driver 5241 and a connection member 5242 that are connected to each other, and the connection member 5242 is connected to the second knife 523. The processing device 1 is electrically connected to the extendable machine 524, and the processing device 1 can control the driver 5241 of the extendable machine 524 to be operated, so that the connection member 5242 drives the second knife 523 to allow a portion

of the second knife 523 to protrude from the shell 522 through the thru-hole 5221. Or, the processing device 1 can control the driver 5241 of the extendable machine 524 to be operated, so that the connection member 5242 drives the second knife 523 that is in a state of protruding from the shell 522 to return to the shell 522.

Referring to FIG. 16 to FIG. 19, when the two clamping arms 4432 of the clamper 443 of the clamping device 44 clamp the tail structure A15, and the tail structure A15 is correspondingly arranged between the abutting device 51 and the knife device 52, the processing device 1 controls the abutting device 51 and the two drivers 5211 of the movement module 521 of the knife device 52 to be operated, so that the abutting board 512 and the connection board 5212 jointly hold the tail structure A15. When the abutting board 512 and the connection board 5212 jointly hold the tail structure A15, the processing device controls the extendable machine 524 to be operated, so that the second knife 523 protrudes from the thru-hole 5221 and cuts off the tail structure A15.

It is worth mentioning that as shown in FIG. 8, FIG. 16, and FIG. 18, in a preferred embodiment, before the processing device 1 controls the second knife machine 5 to be operated, the processing device 1 can control the two abutting devices 22 to be operated, so that the two abutting members 222 abut against the bottom portion A131 of the protective bag A1. When the two abutting members 222 abut against the bottom portion A131 of the protective bag A1, the processing device 1 controls the clamping device 44 to be operated, so that the clamper 443 moves in a direction away from the carrying platform 62. At this time, the tail structure A15 is clamped by the clamper 443, and a portion of the tail structure A15 connected to the packaging portion A13 is in a relatively

tight state. When the tail structure A15 clamped by the clamper 443 is in the relatively tight state, the processing device 1 continues to control the second knife machine 5 to be operated, so that the second knife 523 cuts off the tail structure A15 when the abutting board 512 and the connection board 5212 jointly hold the tail structure A15. Since the portion of the tail structure A15 connected to the packaging portion A13 is in the relatively tight state when the tail structure A15 is clamped by the clamper 443, and then the second knife 523 cuts off the tail structure A15, it can be ensured that the second knife 523 smoothly cuts off the connection between the tail structure A15 and the packaging portion A13.

It is worth mentioning that in an embodiment of the present disclosure, the accommodating box A2 is a front opening unified pod and the protective bag A1 is an aluminum foil bag or an anti-static bag. Since the first knife 31 and the second knife 523 are respectively used to cut off the tapes A3 of the semiconductor article A and the tail structure A15, it can be ensured that the first knife 31 and the second knife 523 can successfully and respectively cut off the tapes A3 and the tail structure A15. In addition, it can be ensured that a glue of the tapes A3 remained on the first knife 31 does not adhere to the front opening unified pod. In a practical application, the blade of the first knife 31 can be in a flat shape, and the blade of the second knife 523 can be in a jagged shape. In this way, the first knife 31 and the second knife 523 can successfully and respectively cut off the tapes A3 and the tail structure A15. If a knife having a blade that is in a jagged shape is used to sequentially cut off the tapes A3 and the tail structure A15, a substantial amount of the glue of the tapes A3 can remain on the blade after the knife is used to cut off the tapes A3 (as shown

in FIG. 2). In this way, the blade of the knife loses its sharpness, and the glue may adhere to the front opening unified pod.

Referring to FIG. 18 to FIG. 20, after the second knife 523 cuts off the tail structure A15, the processing device 1 controls the abutting device 51 and the knife device 52 to be operated, so that the abutting board 512 and the connection board 5212 no longer hold the tail structure A15. Afterwards, the processing device 1 can control the carrying platform 62 to move on the slide 61, so that the semiconductor article A disposed on the carrying platform 62 leaves the second knife structure 5. After the second knife 523 cuts off the tail structure A15, the processing device 1 can control the clamping device 44 to be operated, so that the clamping device 44 moves to a particular position. After the clamping device 44 moves to the particular position, the processing device 1 controls the two clamping arms 4432 of the clamper 443 to no longer clamp the tail structure A15, and the tail structure A15 is released to the particular position. As shown in FIG. 20, after the tail structure A15 is cut off and is separated from the packaging portion A13, the packaging portion A13 forms an opening A5. At this time, the bag opening apparatus S1 (as shown in FIG. 1) completes an operation for opening the protective bag A1 of the semiconductor article A. Afterwards, the related apparatus or the technical personnel can take out the accommodating box A2 (as shown in FIG. 3) disposed in the packaging portion A13 through the opening A5.

Referring to FIG. 21 to FIG. 24, FIG. 21 is a schematic view of a bag opening system of the present disclosure, FIG. 22 is a schematic view of a bag recycling apparatus of the bag opening system and a packaging portion of the protective bag according to the present disclosure, FIG. 23 is a schematic view

showing a clamping module of the bag recycling apparatus of the bag opening system extends into the packaging portion of the protective bag according to the present disclosure, and FIG. 24 is a schematic view showing the bag recycling apparatus of the bag opening system dispose the protective bag onto a platform according to the present disclosure. A bag opening system S of the present disclosure includes the bag opening apparatus S1, a fetching apparatus S2, a central control apparatus S3, and a bag recycling apparatus S4. The description of the bag opening system S1 is mentioned above, and will not be reiterated herein. The fetching apparatus S2 is configured to take out the accommodating box A2 disposed in the packaging portion A13. In a preferred embodiment, the bag opening system S can further include a bag stretching apparatus (not shown) configured to stretch the opening A5 (as shown in FIG. 22) of the packaging portion A13. Before the central control apparatus S3 controls the fetching apparatus A2 to take out the accommodating box A2, the central control apparatus S3 can control the bag stretching apparatus to stretch the opening A5.

The central control apparatus S3 is electrically connected to the bag opening apparatus S1, the fetching apparatus S2, and the bag recycling apparatus S4. The central control apparatus S3 can control the bag opening apparatus S1 to cut off the tail structure A15 of the semiconductor article A. Then, the central control apparatus S3 controls the fetching apparatus S2 to take out the accommodating box A2 disposed in the packaging portion A13. Finally, the central control apparatus S3 controls the bag recycling apparatus S4 to fold the packaging portion A13. The central control apparatus S3 can be, for example, various types of computers or servers. The fetching apparatus S2 can

include a robotic arm. The central control apparatus S3 mentioned herein can include the processing device 1 mentioned above. Or, the central control apparatus S3 can be an apparatus independent from the processing device 1.

Referring to FIG. 22, the bag recycling apparatus S4 can include a vertical movement module S41, a horizontal movement module S42, a clamping module S452, a platform S44, and a guiding structure S45. In the present embodiment, the bag recycling apparatus S4 includes two movement modules (i.e., the vertical movement module S41 and the horizontal movement module S42), but the quantity and the formation of the movement modules included by the bag recycling apparatus S4 are not limited thereto.

The vertical movement module S41 is connected to the clamping module S43, and the horizontal movement module S42 is connected to the vertical movement module S41. The central control apparatus S3 is electrically connected to the vertical movement module S41 and the horizontal movement module S42. The central control apparatus S3 can control the vertical movement module S41 to be operated, so that the clamping module S43 moves along a vertical direction (e.g., a direction perpendicular to the ground, such as the Z-axis direction shown in FIG. 22) toward or away from the packaging portion A13. The central control apparatus S3 can control the horizontal movement module S42 to be operated, so that the clamping module S42 moves along a horizontal direction (e.g., a direction perpendicular to the vertical direction, such as the Y-axis direction shown in FIG. 22) toward or away from the packaging portion A13.

The central control apparatus S3 is electrically connected to the clamping module S43, and the central control apparatus S43 can control the clamping

module S43 to be operated, so that the clamping module S43 clamps the packaging portion A13. The clamping module S43 can include a driving assembly S431, two clamping arms S432, and an entering member S433. The two clamping arms S432 are connected to the driving assembly S431, and the entering member S433 is arranged between the two clamping arms S432. The central control apparatus S3 is electrically connected to the driving assembly S431, and the central control apparatus S3 can control the driving assembly S431 to be operated, so that the two clamping arms S432 move in a direction toward or in a direction away from the entering member S433. The driving assembly S431 can include a rail and a related driver, and the two clamping arms S432 can be slidably disposed on the rail of the driving assembly S431.

As shown in FIG. 22, the entering member S433 has two end surfaces that are opposite to each other and defined as two first abutting surfaces S4331, each of the clamping arms S432 has a second abutting surface S4321, and each of the second abutting surfaces S4321 faces toward the corresponding one of the first abutting surfaces S4331. The first abutting surfaces S4331 and the second surfaces S4321 facing toward each other can jointly hold the packaging portion A13. In a practical application, the first abutting surfaces S4331 and the second abutting surfaces S4321 can be rectangular surfaces having a substantially uniform structure and a substantially uniform dimension. Naturally, the structure and the dimension of the first abutting surfaces S4331 and the second abutting surfaces S4321 are not limited to those shown in FIG. 22. As long as the first abutting surfaces S4331 and the second abutting surfaces S4321 facing toward each other can jointly hold the packaging portion A13, the structure and the dimensions of the first abutting surfaces S4331 and the second abutting

surfaces S4321 can be changed according to practical requirements.

The platform S44 is disposed at a side of the rail 61 of the transferring machine 6, the guiding structure S45 is disposed at an end of the platform S44, the platform S44 is disposed near the horizontal movement module S42, and the horizontal movement module S42 of the bag recycling apparatus S4 can move the clamping module S43 to a position above the platform S44.

Referring to FIG. 22 to FIG. 24, a process in which the bag recycling apparatus S4 recycles the packaging portion A13 can be as follows. As shown in FIG. 22, when the accommodating box A2 (as shown in FIG. 3) disposed in the packaging portion A13 is taken out, and the carrying platform 62 moves to a position below the bag recycling apparatus S4, the central control apparatus S3 can control the two abutting devices 22 of the fixing machine 2 to be operated, so that the two abutting members 222 abut against the bottom portion A131 of the packaging portion A13. Afterwards, the central control apparatus S3 controls the horizontal movement module S42, so that the clamping module S43 moves to a position above the opening A5 of the packaging portion A13. As shown in FIG. 23, the central control apparatus S3 then controls the vertical movement module S41 to be operated, so that the entering member S433 enters into the packaging portion A13 through the opening A5 of the packaging portion A13, and the two clamping arms S432 are correspondingly arranged outside the packaging portion A13.

As shown in FIG. 23, when the entering member S433 is arranged inside the packaging portion A13, and the two clamping arms S432 are arranged outside the packaging portion A13, the central control apparatus S3 controls the driving assembly S431 to be operated, so that each of the clamping arms S432

moves toward the entering member S433. In this way, each of the clamping arms S432 and the entering member S433 jointly hold the packaging portion A13, and the packaging portion A13 jointly held by the two clamping arms S432 and the entering member S433 folds along a plurality of creases A4 at two sides of the packaging portion A13.

After the two clamping arms S432 and the entering member S433 jointly hold the packaging portion A13, the central control apparatus S3 controls the vertical movement module S41 to move in a direction away from the packaging portion A13. At this time, the two abutting members 222 of the two abutting devices 22 still abut against the bottom portion A131 of the packaging portion A13. In this way, the packaging portion A13 is substantially in a flattened state.

When the packaging portion A13 is substantially in the flattened state, the central control apparatus S3 controls the two abutting devices 22 to no longer abut against the bottom portion A131 of the packaging portion A13. Afterwards, the central control apparatus S3 controls the horizontal movement module S42 to be operated, so that the packaging portion A13 clamped by the clamping module S43 moves toward the platform S44. When the clamping module S3 moves, the packaging portion A13 is guided by the guiding structure S45 and falls toward the platform S44. As shown in FIG. 24, after the packaging portion A13 falls toward the platform S44, the central control apparatus S3 controls the clamping module S43 to no longer clamp the packaging portion A13, and the folded packaging portion A13 is placed on the platform S44. In a practical application, when the central control apparatus S3 controls the clamping module S43 to no longer clamp the packaging portion A13, the central control apparatus S3 can further control the vertical movement

module S41 to be operated, so that the entering member S433 abuts against the packaging portion A13 lying flat on the platform S44.

In other embodiments, the platform S44 can be connected to a movement module S46, the central control apparatus S3 is electrically connected to the movement module S46, and the central control apparatus S3 can control the movement module S46 to be operated, so that the platform S44 moves toward the carrying platform 62. In a process where the central control apparatus S3 controls the horizontal movement module S42 to allow the packaging portion A13 clamped by the clamping module S43 to move toward the platform S44, the central control apparatus S3 can further control the movement module S46 to be operated at the same time, so that the movement module S46 moves toward the carrying platform 62 and the platform S44 pushes the packaging portion A13 clamped by the clamping module S43. In this way, the packaging portion A13 can easily lie flat on the platform S44.

Reference is made to FIG. 25, which is a flowchart of a bag opening method of the present disclosure. A bag opening method of the present disclosure is configured to open the protective bag A1 (as shown in FIG. 3) of the semiconductor article A (as shown in FIG. 3). The description of the semiconductor article A is mentioned above, and will not be reiterated herein. The bag opening method includes a positioning step S101, a first cutting step S102, a pulling step S103, and a second cutting step S104.

The positioning step S101 is implemented by fixing the semiconductor article.

The first cutting step S102 is implemented by controlling a first knife machine to cut off the tape, so that the tail structure is in a movable state.

The pulling step S103 is implemented by controlling a pulling machine to hold the tail structure and to allow the tail structure to be vertically disposed relative to the non-packaging portion.

The second cutting step S104 is implemented by controlling a second knife machine to cut off a portion connecting the tail structure and the packaging portion, so that the tail structure and the packaging portion are separated.

The bag opening method of the present disclosure can be accomplished by the bag opening apparatus S1 mentioned above, but the present disclosure is not limited thereto. It should be noted that the first knife machine includes a first knife particularly used for cutting off the tape, the second knife machine includes a second knife particularly used for cutting off the protective bag, the first knife can have a blade in a flat shape, and the second knife can have a blade in a jagged shape. Since the first knife and the second knife that have different blades are respectively used to cut off the tape and the protective bag, a service life of the two types of knives (i.e., the first knife and the second knife) can be prolonged, and the glue of the tape can be prevented from adhering to the accommodating box of the semiconductor article.

Reference is made to FIG. 26, which is another flowchart of the bag opening method of the present disclosure. The bag opening method of the present embodiment can include a position step S101, a first cutting step S102, a pushing step SX, a pulling step S103A, and a second cutting step S104.

The positioning step S101 is implemented by fixing the semiconductor article.

The first cutting step S102 is implemented by controlling a first knife machine to cut off the tape, so that the tail structure is in a movable state.

The pushing step SX is implemented by controlling the first knife machine to extend between the tail structure and the packaging and to push the tail structure to unfold at least one portion of the tail structure, so that an inner portion of the tail structure is exposed.

The pulling step S103A is implemented by controlling a plurality of suction assemblies of a pulling machine to suck on the tail structure and controlling a rotatable module of the pulling machine to rotate a supporting structure connected to the suction assemblies so that the tail structure is vertically disposed relative to the non-packaging portion, and then by controlling a clamping device of the pulling machine to clamp the non-packing portion so that the clamped non-packaging portion is pulled in a direction away from the packaging portion.

The second cutting step S104 is implemented by controlling a second knife machine to cut off a portion connecting the tail structure and the packaging portion, so that the tail structure and the packaging portion are separated.

The difference between the present embodiment and the previous embodiment is that the bag opening method of the present embodiment includes the pushing step SX between the first cutting step S102 and the pulling step S103A. Further, in the pulling step S103A, the suction assemblies suck on the tail structure, the clamping device clamps the non-packaging portion, and the non-packaging portion moves away from the packaging portion. Through the design of the pushing step SX, the suction assemblies, and the clamping device, the second knife can more easily cut off the connection between the tail structure and the packaging portion in the second cutting step S104.

[Beneficial Effects of the Embodiments]

In conclusion, the bag opening apparatus of the present disclosure can automatically and swiftly cut off the tail structure of the semiconductor article and allow the packaging portion of the semiconductor article to be in an opened state. Essentially, no human power is involved in the bag opening process. In this way, the need for human power can be effectively reduced. In a conventional application, the tape and the tail structure are manually cut off. Therefore, excessive human power is required and the efficiency is low. Moreover, the wafer stored in the accommodating box is very expensive. When the packaging portion of the semiconductor article is manually opened, there is also a possibility of the technical personnel damaging the wafer in the accommodating box due to various reasons.

The foregoing description of the exemplary embodiments of the disclosure has been presented only for the purposes of illustration and description and is not intended to be exhaustive or to limit the disclosure to the precise forms disclosed. Many modifications and variations are possible in light of the above teaching.

The embodiments were chosen and described in order to explain the principles of the disclosure and their practical application so as to enable others skilled in the art to utilize the disclosure and various embodiments and with various modifications as are suited to the particular use contemplated. Alternative embodiments will become apparent to those skilled in the art to which the present disclosure pertains without departing from its spirit and scope.