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ADHESIVE TAPE FOR LASER DICING

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FIELD

The present invention relates to an adhesive tape for laser dicing.

BACKGROUND

Conventionally, there has been proposed a method in which, when performing a so-called dicing processing, such as cutting and separating a semiconductor wafer having a circuit pattern formed thereon into small element chips, the semiconductor wafer is previously attached onto a radiation-curable adhesive tape to secure it in a position, and then the wafer is cut along shapes of elements with a diamond blade (a rotary round cutter); and then radiation, such as light like ultraviolet rays or ionizing radiation like electron beam, is irradiated from the back side of the adhesive tape, before transition to the subsequent pick-up step.

The radiation-curable adhesive tape used in this method is an adhesive tape composed of a radiation-transmitting substrate and a radiation-curable adhesive layer applied on the substrate. This adhesive tape exhibits strong adhesive force before the irradiation of radiation, and, after the irradiation of the radiation,

its adhesive force lessens conspicuously. Thus, the above-described method advantageously facilitates the cutting and separating of the semiconductor wafer into small element chips in the dicing step, and allows the element chips to be easily picked up in the pick-up step following the irradiation of radiation, irrespective of the size thereof, for example, even a large element such as 25 mm^2 or more. Examples of such adhesive tapes are disclosed in JP-A-60-196956 ("JP-A" means unexamined published Japanese patent application), JP-A-60-201642, JP-A-61-28572, JP-A-1-251737, JP-A-2-187478, and the like.

In the conventional dicing device, the cutting is performed while rotating a diamond blade. Thus, when cutting a wafer into very small elements of 1 mm or less, the thickness of the blade is made as small as possible to reduce the width of the scribe lines, whereby it is possible to increase the number of elements which can be obtained from a single wafer. Even then, however, the cutting width has to be approximately 40 μm, and chipping of the elements is involved at the time of cutting, which were serious problems. Further, the small thickness of the blade leads to a short service life and a high running cost since it is easily subject to breakage. To cut a thick metal plate, it is necessary to make the cutting edge of the blade long, resulting in a very large blade

thickness of e.g., 250 μm. Even then, there is a limitation to maintaining blade strength. Further, when cutting a hard material like glass, the cutting speed is as very low as 1 to 5 mm/s. Further, since the diamond blade is a rotary round cutter, there is a limitation regarding the cutting configuration, which means it is impossible to cut into an arbitrary configuration.

Contrary to this, recently, there has been developed a novel-processing device utilizing a laser micro jet system, in which a water micro jet and a laser are combined to cut metal materials. Examples of such a processing device utilizing the laser micro jet system includes Laser Micro Jet (trade name) manufactured by SYNOVA Co. When applied to semiconductor wafer dicing, this device provides a superior effect as compared to the conventional dicing device using a diamond blade. That is, by using a laser, no chipping of elements occurs, the service life becomes longer, and there is no deterioration in quality due to blade breakage. Further, it is to be expected that even a thick material can be cut at high speed with a narrow scribe line.

However, when applying a laser micro jet type device to semiconductor wafer dicing, the conventional adhesive tape does not always allow the above problems to be solved to a sufficient degree.

SUMMARY

An object of the present invention is to provide an adhesive tape for laser dicing which, when cutting and separating (dicing) a silicon wafer, ceramic, glass, metal or the like by a laser together with a water jet, does not involve melting, breakage, or flying off of elements, and which is extensible, and which allows the material to maintain straightness at the time of extension.

Other and further object, features and advantages of the invention will appear more fully from the following description.

DETAILED DESCRIPTION

To achieve the above object, the inventors of the present invention have found out, after the intensive studies, that the above problem can be solved by using a film which allows permeation of water (water jet) as the substrate of the tape. That is, according to the present invention, there is provided the following means:

(1) An adhesive tape for laser dicing in which a laser is guided by a water jet, wherein a substrate of the tape allows permeation of jet water stream of the water jet through it;

(2) The adhesive tape for laser dicing according to

the item (1), wherein a water stream of at least 50 μm width can be permeated;

(3) The adhesive tape for laser dicing according to the item (1) or (2), wherein the substrate has a mesh-like structure with a fiber diameter of 10 μm or more and less than 50 μm;

(4) The adhesive tape for laser dicing according to any one of the items (1) to (3), wherein the substrate has a porous structure with a pore diameter of 10 to 50 μm;

(5) The adhesive tape for laser dicing according to any one of the items (1) to (4), wherein the substrate is composed of a rubber-like elastic member;

(6) The adhesive tape for laser dicing according to any one of the items (1) to (5), wherein one side of the adhesive tape has a radiation-curable adhesive layer; and

(7) The adhesive tape for laser dicing according to item (6), wherein a non-radiation-curable adhesive layer as an intermediate layer is provided between the substrate and the radiation-curable adhesive layer.

The adhesive tape for laser dicing according to the present invention will be described below in detail.

The adhesive tape of the present invention is used when laser dicing is performed in which a laser is guided by a water jet. The water micro jet system is a system in which a laser is controlled by using a water jet as a

guide. When emitted into the air, a laser beam is diffused, whereas when water is used as a medium, the laser beam is transmitted therethrough while undergoing refraction, whereby the laser beam can be irradiated efficiently.

The pressure of the water jet is preferably 30 to 70 MPa, which should not be limited within the above-mentioned range. When the water jet pressure is too low, the water jet may be insufficient as a guide of a laser, to deteriorate the quality at the cut surface. When the water jet pressure is too high, impact when the water jet collides with a workpiece (a cut subject) or the tape is too strong, to make the tape move (flutter), resulting in deterioration of the quality at the cut surface, in some cases.

The adhesive tape of the present invention uses a film, as a substrate, that allows water (a jet water atream) to permeate through it. The diameter of the water jet that permeates the substrate, is determined by a nozzle size (generally 50, 75, 100, 150, or 200 μm) to be used for jetting. In the present invention, the diameter of the water stream that is permeated by the substrate is preferably 30 to 200 μm, more preferably 30 to 100 μm, and particularly preferably 50 to 100 μm. By using such a substrate, water from the water jet can flow out of the

adhesive tape without staying between the adhesive tape and the wafer, whereby it is possible to prevent breakage of the tape as a result of melting.

As for the substrate through which water permeates, it is preferable that the substrate has a mesh-like or a porous structure.

Examples of the substrate include fibrous materials, such as non-woven fabric, hollow yarn, woven fabric, and polyamide (nylon) mesh used as a PDP electromagnetic wave shield, and a rubber-like elastic material. In particular, non-woven fabric is preferable. It is preferable for the non-woven fabric to exhibit stretching property without any directivity. The rubber-like elastic material may have a honeycomb structure.

When using a fibrous material as the substrate, it is preferable for the fiber diameter to be 10 μm or more and less than 50 μm. In a substrate with a fiber diameter of 50 μm or more, the flat portion is fused to the chucking table, which is not preferable. Further, if the diameter of the portions where fibers are superimposed one upon the other is 50 μm or more, those portions will be melted, which is not preferable.

Further, heat resistance of the substrate to be used is appropriately selected according to laser dicing conditions, such as a cutting speed, a laser output, and a

water amount thereof. What is important is that the substrate to be used should not be melted under heat at the time of laser dicing.

Examples of the material of the substrate include polyethylene, polypropylene, ethylene/propylene copolymer, polybutene-1, ethylene/vinyl acetate copolymer, ethylene/ethyl acrylate copolymer, and homopolymers and copolymers of α-olefin such as ionomer; engineering plastics such as polyethylene terephthalate, polycarbonate and polymethyl methacrylate; polyamide such as nylon-6, nyron-6,6, nyron-12 and aramid; and thermoplastic elastomers such as polyurethane, styrene/ethylene/butene copolymer and penten-based copolymers. Moreover, the materials may be combination of two or more materials selected from the above-mentioned group. The materials can optionally be selected depending on the adhesive property with the adhesive layer. Of those, particularly preferred are polypropylene, polyethylene terephthalate and nylon-6,6.

The thickness of the substrate is preferably thin to prevent vibration of the material. The thickness of the substrate is also preferably thin so long as it maintains extension property so that the substrate is not broken. Thus, the thickness of the substrate is generally from 30 to 300 μm, preferably 30 to 200 μm, more preferably 50 to

200 μm, and particularly preferably 100 μm.

One side of the surfaces of the adhesive tape is composed of the adhesive layer obtained by applying a solution of acrylic-based adhesive and drying, in a similar manner to the conventional adhesive tapes. Such adhesive layer is preferably composed of a radiation-curable adhesive layer. Moreover, the term "radiation" as used herein refers to light radiation such as ultraviolet rays, or ionizing radiation such as an electron beam.

The acrylic-based adhesives include a (meth)acrylic-based copolymer and a curing agent as essential components. The (meth)acrylic-based copolymer can be obtained, for example, by copolymerizing a monomer (A) such as alkyl acrylate with a monomer (B) having a functional group, which is reactive with a curing agent described later, using a solution polymerization method according to an ordinary method. The acrylic-based adhesive may be those obtained by copolymerizing two or more kinds of the monomers (A) with each other.

As the monomers (A), there are exemplified methyl acrylate, methyl methacrylate, ethyl acrylate, ethyl methacrylate, butyl acrylate, butyl methacrylate, 2-ethylhexyl acrylate, 2-ethylhexyl methacrylate, and the like. Those monomers may be used alone, or may be used in combination of two or more monomers described above.

As the monomers (B), there are exemplified acrylic acid, methacrylic acid, itaconic acid, mesaconic acid, citraconic acid, fumaric acid, maleic acid, acrylic acid-2-hydroxyethyl, methacrylic acid-2-hydroxyethyl, acrylamide, methacrylamide, and the like. Those monomers may be used alone, or may be used in combination of two or more monomers described above.

The curing agent is used to adjust an adhesive force and an cohesive force, by reacting the curing agent with a functional group in the (meth)acrylic-based copolymer. For example, examples of the curing agent include epoxy compounds having two or more epoxy groups in a molecule, such as 1,3-bis(N,N-diglycidylaminomethyl)cyclohexane, 1,3-bis(N,N-diglycigylaminomethyl)toluene, 1,3-bis(N,N-diglycidylaminomethyl)benzene, N,N,N',N'-tetraglycidyl-m-xylenediamine; isocyanate-based compounds having two or more isocyanate groups in a molecule, such as 2,4-tolylene diisocyanate, 2,6-tilylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylene diisocyanate, diphenylmethane-4,4'-diisocyanate; aziridine-based compounds having two or more aziridinyl groups in a molecule, such as tetramethylol-tri-β-aziridinyl propionate, trimethylol-tri-β-aziridinyl propionate, trimethylolpropane-tri-β-aziridinyl propionate, trimethylolpropane-tri-β-(2-methylaziridine)propionate.

The addition amount of the curing agent can be adjusted depending on its desired adhesive force. The amount of the curing agent to be used is preferably from 0.1 to 5.0 parts by weight based on 100 parts by weight of the (meth)acrylic-based copolymer.

The adhesive force is a value as measured according to JIS Z 0237 (1991) (90° peeling method, peeling rate: 50 mm/min, test sheet: silicon wafer). The adhesive force is preferably on the order of from 0.2 to 1.3 N/25-mm.

Examples of the solvent for the acrylic-based adhesive include ethyl acetate, toluene, xylene, acetone, methy ethyl ketone, n-hexane, cyclohexane, and the like.

The radiation-curable adhesive includes generally an acrylic-based adhesive and a radiation-polymerizable compound as main components. For the radiation-polymerizable compound used in the radiation-curable adhesive, for example, a low-molecular-weight compound having at least two photo-polymerizable carbon-carbon double bonds in a molecule, which is able to form a three-dimensional network structure by irradiation of light, as disclosed in JP-A-60-196956 and JP-A-60-223139, is widely used. More specifically, examples of the radiation-polymerizable compound to be used include trimethylolpropane triacrylate, tetramethylolmethane tetraacrylate, pentaerythritol triacrylate,

pentaerythritol tetraacrylate, dipentaerythritol monohydroxypentaacrylate, dipentaerythritol hexaacrylate, 1,4-butylene glycol diacrylate, 1,6-hexanediol diacrylate, polyethylene glycol diacrylate, oligoester acrylates, and the like.

Furthermore, urethane acrylate-based oligomers, in addition to the above-mentioned acrylate-based compounds, can be used as the radiation-polymerizable compound. The urethane acrylate-based oligomers can be obtained, for example, by reacting an isocyanate-terminalized urethane prepolymer obtained by reacting a polyol compound, such as a polyester-type polyol or a polyether-type polyol, with a polyisocyanate compound (for example, 2,4-tolylene diisocyanate, 2,6-tolylene diisocyanate, 1,3-xylylene diisocyanate, 1,4-xylylene diisocyanate, diphenylmethane 4,4-diisocyanate, or the like), with an acrylate or methacrylate having a hydroxyl group (for example, 2-hydroxyethyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl acrylate, 2-hydroxypropyl methacrylate, polyethylene glycol acrylate, polyethylene glycol methacrylate, or the like).

As for the blend ratio of the acrylic-based adhesive to the radiation-polymerizable compound in the radiation-curable adhesive, the radiation-polymerizable compound is preferably used in the amount of from 50 to 200 parts by

weight, more preferably from 50 to 150 parts by weight, and particularly preferably from 70 to 120 parts by weight, based on 100 parts by weight of the acrylic-based adhesive. In those cases, the resultant adhesive sheets have a great initial adhesive force, and the adhesive force also reduces significantly after the irradiation of radiation. Thus, an interface between the wafer and the radiation-curable adhesive layer can be peeled easily after completion of polishing the back side.

Moreover, the radiation-polymerizable adhesive may be formed from the radiation-curable copolymer having a radiation-polymerizable group in its side chains. Such radiation-curable copolymer possesses the property having both the adhesive property and the radiation-curable property. The radiation-curable copolymer having the radiation-polymerizable group in the side chains is described in detail in, for example, JP-A-5-32946 and JP-A-8-27239.

Further, the radiation-curable adhesive may contain a photo-polymerization-initiator such as α-hydroxycyclohexyl phenyl ketone.

The above-mentioned acrylic-based radiation-curable adhesives have a sufficient adhesive force to the wafer prior to the irradiation of radiation, and the adhesive force reduces significantly after the irradiation of

radiation. Thus, the adhesive sheet and the wafer are adhered with a sufficient adhesive force, thereby the surface of the wafer can be protected prior to the irradiation of radiation, while the adhesive sheet can be peeled easily from the abraded wafer after the irradiation of radiation.

The thickness of the radiation-curable adhesive layer is appropriately determined depending on the type of the subject to be adhered to which the adhesive tape is applied, within the range not departing from the subject of the present invention, and it is generally 500 μm or less, preferably 1 to 200 μm, more preferably 3 to 100 μm, and particularly preferably 5 to 20 μm.

In the adhesive tape for laser dicing of the present invention, it is preferable to provide, as an intermediate layer, a non-radiation-curable adhesive layer between the radiation-curable adhesive layer and the substrate, in view of, for example, the following points and the like.
(1) Prevention of inhibition of curing (N_2 purging step is unnecessary.)

In case of using, as a substrate, a substrate having a porous structure or a mesh-like structure (hereinafter, these are collectively referred to as "a porous substrate and the like"), the presence of a non-radiation-curable adhesive layer between the substrate and the radiation-

curable adhesive layer enables to block the radiation-curable adhesive from contacting with oxygen. Accordingly, inhibition of curing due to oxygen radical does not occur, and an adhesive force is reduced sufficiently after the irradiation of radiation such as ultraviolet rays. Therefor, the adhesive layer can be peeled easily at the pick up step. In this case, irradiation can be conducted under the atmosphere, and it is unnecessary to carry out N_2 purging to prevent occurrence of oxygen radical at the radiation irradiation. Therefore, such a method is good in operation property.

(2) Increase in contact area, and improvement in adhesive property between substrate and adhesive layer

In the case of using the porous substrate and the like, the substrate contacts with the radiation-curable adhesive layer in the state of point contact. By providing a non radiation-curable adhesive layer as an intermediate layer between the substrate and the radiation-curable adhesive layer, the non radiation-curable adhesive becomes infiltrated in part into the substrate, and this intermediate layer and the substrate are joined firmly. As a result, the intermediate layer and the radiation-curable adhesive layer are brought into contact in a state of an area contact. Thus, the adhesive force is improved, and the interface exfoliation (paste

remaining) is not observed between the substrate and the radiation-curable adhesive layer, at the time of peeling.

(3) Prevention of adhesive (paste) exudation into back side of substrate

By providing a non-radiation-curable adhesive layer between the substrate and the radiation-curable adhesive layer, the exudation of the adhesive into the substrate side can be prevented. When a porous substrate and the like is used as a substrate, the effect is remarkable. The hardness of the non-radiation-curable adhesive layer that is provided as an intermediate layer can be changed and adjusted regardless of the properties required for an adhesive tape, such as hardness. Therefore, the exudation of the adhesive is preferably prevented by providing such the intermediate layer. In order to prevent the exudation of the adhesive, it may be considered that the hardness of a radiation-curable adhesive is adjusted to be hard (i.e., the initial adhesive force before irradiating radiation such as ultraviolet rays is controlled to be relatively low). However, such a method is not practical, since the resultant adhesive tape is not satisfactory in light with hardness and the like, and also the adhesive property with the substrate is reduced. This problem of exudation of the adhesive may also be solved, for example, by adjusting a laminating pressure when a radiation-curable adhesive

layer and a substrate are laminated. However, it is not preferable since the operations become complicated.

In the present invention, the materials of the non-radiation-curable adhesive are not particularly limited, and any type of the conventionally known acrylic-based adhesives can be applicable.

The acrylic-based adhesives are ones which include a (meth)acrylic-based copolymer and a curing agent as essential components. Examples of the (meth)acrylic-based copolymer include, for example, polymers which have (meth)acrylate as a constitution unit of the resultant polymer, and copolymers of a (meth)acrylate ester-based copolymer with a (meth)acrylic-based polymer or a functional monomer, and combination of those polymers. As for the molecular weight of these polymers, the high molecular weight polymers which have an order of from 500,000 to 1,000,000 of the weight-average molecular weight is usually used.

As the examples of the curing agent in the non-radiation-curable adhesive, can be mentioned are those mentioned in the foregoing explanation of the radiation-curable adhesive. The addition amount of the curing agent may be adjusted depending on the desired adhesive force. The amount of the curing agent is preferably from 0.1 to 5.0 parts by weight based on 100 parts by weight of the

(meth)acrylic-based copolymer.

In the present invention, as the non-radiation-curable adhesive, use can be made of the same adhesive as the radiation-curable adhesive, however the non-radiation-curable adhesive does not include any radiation-polymerizable compound or photopolymerization initiator.

The thickness of the non radiation-curable adhesive layer, which is provided between the radiation-curable adhesive layer and the substrate, is not particularly limited, and it is preferably in the range of 1 to 100 μm. If the thickness is too thin, coating may become relatively difficult in some cases. If the thickness is too thick, the permeability of water as a guide may become poor to make it difficult to cut a wafer. Moreover, such a too-thick non-radiation-curable adhesive layer may cause paste remaining on the surface of a subject to be worked and the resultant chip after peeling. The thickness of the intermediate layer is more preferably from 3 to 20 μm, and further preferably from 5 to 10 μm.

In the present invention, the radiation-curable adhesive layer can be preferably formed on the substrate by directly coating the radiation-curable adhesive onto the substrate. Alternatively, it is preferable to form the radiation-curable adhesive layer on the adhesive tape, by a transfer coating wherein the radiation-curable

adhesive is coated on a conventional liner film, and then laminating the thus-obtained adhesive layer onto the substrate immediately after the layer is dried. When forming the radiation-curable adhesive layer using a porous substrate and the like, to enhance adhesive property and to prevent adhesive exudation, without providing an intermediate layer (i.e. a non-radiation-curable adhesive layer), it may be necessary in some cases to control conditions, such as a laminate pressure at the time of laminating on the substrate. In these cases, the operations become complicated.

When providing the non-radiation-curable adhesive layer in addition to the radiation-curable adhesive layer, these layers can be formed by coating. Alternatively, the adhesive tape of the present invention can be obtained by a method (transfer coating) wherein the respective two layers are formed separately by using a liner film or the like, and then the obtained layers are laminated. Examples of the method to form a radiation-curable adhesive layer and a non-radiation-curable adhesive layer by coating, include a simultaneous coating method wherein adhesives to form a multiple adhesive layers are coated simultaneously, and a repeated coating method wherein a layer is formed successively after the previous coating is completed. Further, an example of the above transfer

coating method is as follows. A non-radiation-curable adhesive is coated on a liner film, and then dried, to obtain a non-radiation-curable adhesive coating. Immediately after the coating is dried, the coating and a substrate is laminated so that the substrate is laminated with the coating at the non-radiation-curable coating side, to obtain an adhesive sheet. Separately, a radiation-curable adhesive coating is obtained by coating a radiation-curable adhesive on a liner film and then drying it. Immediately after the coating is dried, the above adhesive sheet and the radiation-curable adhesive coating are laminated so that the radiation-curable adhesive coating is laminated at the non-radiation-curable adhesive coating side, while peeling off the liner film of the adhesive sheet, to obtain an adhesive tape of the present invention.

The adhesive tape obtained in the above transfer coating can be used in the manner that the liner film at the adhesive layer surface is peeled off when the adhesive tape is used. It is a general practice taht the liner film is not peeled off even after the transfer coating, until the adhesive tape is used.

Hereinafter, other preferable embodiments of the present invention are explained.

(I) In the present invention, it is preferable to pre-cut

the adhesive tape by a blade that is heated in advance. For example, the adhesive tape of the present invention is pre-cut into a shape (a diameter) fitting to a dicing frame, with a blade (e.g. a metal blade) heated to a temperature of approximately 150 °C. Cutting with such the heated blade thermally fuses the cut surface of the substrate. Therefore generation of fiber dusts from the cut surface can be prevented, even a non-woven fabric is used as a substrate.

(II) In the present invention, it is also preferable to cut the adhesive tape that is mounted on a dicing frame, with a laser beam in place of a blade. As a result of a laser beam cutting of the adhesive tape, the cut surface of the substrate is thermally fused. Therefore, generation of fiber dusts from the cut surface can be prevented, even a non-woven fabric is used as a substrate.

(III) In the present invention, a substrate, which is thermally fused entirely in advance, can be preferably used as a substrate of the adhesive tape. The method to thermally fuse a substrate is not particularly limited, as long as it is a heating treatment that can sufficiently thermally fuse the substrate entirely. A frame treatment and a heat press can be employed. Examples of such a substrate to be used include a non-woven fabric thermally fused the entire of it in advance, such as PET6030A (trade

name, manufactured by Kureha Tec. Co.). Use of the adhesive tape having a substrate thermally fused entirely can prevent generation of fiber dusts at the cut surface, even a tape cut system using an ordinary blade is employed.

In the cases as described in the above (II) and (III), generation of fiber dusts due to fraying at the cut surface of the substrate can be prevented, at the step in which the adhesive tape is cut into a prescribed shape after it is attached to a wafer frame (e.g. a step to make a hole fitting to a dicing frame shape). In the case as described in the above (I), there is no generation of fiber dusts due to fraying form the cut surface of the substrate, since such a step itself to make a hole after it is attached to a wafer frame is unnecessary. Therefore, employing any one of the above measures, scattering of the fiber dusts in a clean room can be prevented at the time of producing semiconductor chips. Further, in the case of the above (III), it is also possible to prevent a breakage of a substrate, at a pick up step wherein the adhesive tape is irradiated with a radiation after dicing process and the tape is peeled off from the subjects to be worked or the chips thereafter. Therefore, the adhesive and the broken parts of the substrate do not transfer onto the surface of the subject to be worked or chips.

The adhesive tape for laser dicing according to the

present invention exhibits such excellent effects that it can cut with a rapid cutting speed and can prevent occurrence of picking (flying-off) of the diced object (chips) or chipping of elements especially at the cut ends of the chips, without melting and breaking of the tape, when silicon wafers, ceramics, glass, metal or the like is finely cut and diced using a laser; and that it can be appropriately extended, therefore the alignment of the diced materials can be maintained even at the time of extension.

According to the present invention, by providing the non-radiation-curable adhesive layer between the substrate and the radiation-curable adhesive layer, the adhesive property between the substrate and these adhesive layers can be improved, and the exudation of the adhesive into the substrate side can be prevented, and also the inhibition of curing during the irradiation of radiation can be prevented.

The present invention will be described in more detail with reference to the following examples, but the invention is not construed as being limited thereto. In the following examples and comparative examples, part(s) is meant part(s) by weight.

EXAMPLES

Example 1

The following tape was tested using a laser dicing device (trade name: LASER-MYCROJET, made by SYNOVA Co.). Non-woven fabric (made by Kureha Tec. Co.; trade name: BONDEN; CX26026; fiber diameter: 10 μm or more and less than 50 μm; thickness: 140 μm) was used as a substrate in an adhesive tape, the following radiation-curable adhesive was coated on the substrate to have a thickness of 20 μm, to obtain the adhesive tape.

(Radiation-curable adhesive)

To 100 parts by weight of acrylic-based adhesive (copolymer of 2-ethylhexyl acrylate and n-butyl acrylate), 3 parts by weight of a polyisocyanate compound (made by Nippon Polyurethane Co.; trade name: KOLONATE L), 60 parts by weight of tris-2-acryloxyethyl isocyanurate as an isocyanurate compound, and 1 part by weight of α-hydroxycyclohexyl phenyl ketone as a photo-polymerization initiator were added and mixed, to prepare the radiation-curable adhesive.

Laser dicing was performed using the adhesive tape made as mentioned above and the laser dicing device (trade name: LASER-MICROJET; made by SYNOVA Co.). Silicon wafers divided into two to four pieces were bonded on the adhesive tape located in the device. A YAG laser (wavelength: 1064 nm, output: 200w) was then irradiated to

the wafers, with water jet (nozzle size: 50 μm, water pressure: 50 MPa) at the rate of 10 mm/s such that scribe line was 50 μm, whereby the wafers were cut into 1 mm X 1 mm size of elements.

In the test, water stream of the water jet was permeated through the substrate and flowed out, and picking (flying out) of chips and chipping of chips were not caused at all. Furthermore, such a good result that the adhesive tape of the present invention was not melted and broken could be obtained.

Comparative Example 1

An adhesive tape was prepared in the same manner as in Example 1, except that the substrate was exchanged for polyethylene (high density polyethylene) film made by Toyobo Co. (trade name: LIX FILM, thickness: 60 μm). Also, the dicing test was performed in the same manner as in Example 1. As a result, since water could not be permeated through the film, the substrate was melted and the tape was broken.

Example 2

A non radiation (ultraviolet rays)-curable adhesive, composed of 100 parts by weight of an acrylate-based copolymer and 2 parts by weight of a polyisocyanate

compound (KOLONATE L (trade name), manufactured by Nippon Polyurethane Co.) as a curing agent, was coated onto one surface of a liner film having a thickness of 38 μm, to have a coating thickness of 10 μm, and the resulting coating was then dried at 110°C for two minutes. Immediately after the drying, non-woven fabric (made by Kureha Tec. Co.; trade name: BONDEN; CX26026; thickness: 140 μm) as a substrate was laminated over the above-mentioned coating, to prepare an adhesive sheet. Separately, the same radiation (ultraviolet rays)-curable adhesive as used in Example 1 was coated onto one surface of a liner film having a thickness of 38 μm, to have a coating thickness of 10 μm, and the resulting coating was then dried at 110°C for two minutes. Immediately after the drying, the adhesive sheet composed of the porous substrate and the non radiation-curable adhesive layer obtained as described above was laminated over the above-mentioned coating of the radiation-curable adhesive such that the non radiation-curable adhesive coating side and the radiation-curable adhesive coating would be laminated, while peeling off the liner film on the adhesive sheet, to obtain an adhesive tape for laser dicing. The resulting adhesive tape was used after peeling off the liner film when mounting onto a frame.

Example 3

An adhesive tape for laser dicing was obtained in the same manner as in Example 2, except that the non-radiation-curable adhesive was coated onto one surface of the liner film to have a thickness of 50 μm.

Example 4

An adhesive tape for laser dicing was obtained in the same manner as in Example 2, except that a non-radiation-curable adhesive composed of 100 parts by weight of the acrylate copolymer and 1 part by weight of the curing agent, was used.

With respect to the thus-obtained adhesive tapes in Examples 2 to 4, the following tests and evaluations were carried out.

(a) Whether inhibition of curing was observed or not, and the adhesive property between the substrate and the adhesive layer

Silicon wafer of a size of 6 inches having a thickness of 100 μm was bonded, supported and fixed with each adhesive tape for laser dicing which was bonded and fixed to a 6-inches ring flame. This was placed in the LASER-MICROJET dicing device. Then, dicing was performed into chip size of 2 mm X 2 mm, under the conditions of

cutting speed of 100 mm/s and laser beam diameter (water jet diameter) of 40 μm.

After the completion of dicing, the diced chip was ultraviolet-radiated under the atmosphere or a nitrogen atmosphere. Further, with respect to the resulting chip, the pick-up property, and the adhesive property between the substrate and the adhesive layer, were confirmed.

The pick up property was evaluated by the degree of adhesive force after the ultraviolet ray irradiation, which degree changed depending on the occurrence or absence of the curing inhibition. As a results of the irradiation of ultraviolet ray, the case wherein the adhesive force of the adhesive tape was sufficiently reduced due to curing of the adhesive and peeling of the chip from the adhesive tape was easy is rated "○" (good); and the case wherein the adhesive force was not sufficiently reduced due to curing inhibition, and peeling from the adhesive tape was hindered is rated "×" (poor).

Further, with respect to the adhesive property, the case wherein the interface exfoliation was not observed between the substrate and the adhesive layer at the time of peeling them off is rated as "○"; and the case wherein the interface exfoliation was observed is rated as "×".

(b) Operation (working) property

The operation property during the ultraviolet-rays

irradiation was observed. Further, the operation property during the laminating was observed. The case wherein the operation could be conducted under the atmosphere at the time of ultraviolet ray irradiation without conducting nitrogen purge and, at the same time, control of the laminating pressure was unnecessary at the time of laminating of the adhesive sheet, is rated as "○"; the case wherein the nitrogen purge was necessary at the time of ultraviolet ray irradiation or control of laminate pressure was necessary at the time of laminating the adhesive sheet is rated as "×"; and the case wherein both the nitrogen purge and the control of laminating pressure were necessary is rated as "××" (particularly poor operation property).

(c) Confirmation of the exudation state of the adhesive

The substrate side of the adhesive tape for laser dicing obtained by laminating was observed with the naked eye, to observe whether the exudation of the adhesive was occurred or not.

The results obtained by testing the above-mentioned evaluation items are described in Table 1.

Table 1

		Example 2	Example 3	Example 4
OPERATION CONTENTS	NITROGEN PURGING	-	-	-
	ADJUSTMENT OF LAMINATE PRESSURE	-	-	-
EVALUATION ITEMS	ADHESIVE FORCE AFTER UV IRRADIATION (INHIBITION OF CURING)	○	○	○
	OPERATION PROPERTY	○	○	○
	ADHESIVE PROPERTY	○	○	○
	EXUDATION OF THE ADHESIVE	NONE	NONE	NONE

(Note) "-" means the operation was not conducted because such was not necessary.

The results of evaluation

Examples 2 to 4: When observed after laminating, the exudation of the adhesive was not observed. With respect to the pick up property after dicing, since each adhesive tape of the present invention was not subject to inhibition of curing, the adhesive force was sufficiently reduced even under the atmosphere, and the satisfactory pick up property was obtained. Also, the adhesive property between the substrate and the adhesive was satisfactory, and paste remaining on the workpieces was

not observed. Further, the adhesive tapes of the present invention were good in operation property, and both the nitrogen purge at the time of ultraviolet ray irradiation and the adjustment of laminate pressure at the time of laminating were unnecessary.

Having described our invention as related to the present embodiments, it is our intention that the invention is not be limited by any of the details of the description, unless otherwise specified, but rather be construed broadly within its spirit and scope as set out in the accompanying claims.

WHAT IS CLAIMED IS:

1. An adhesive tape for laser dicing in which a laser is guided by a water jet, wherein a substrate of the tape allows permeation of jet water stream of the water jet.

2. The adhesive tape for laser dicing as claimed in claim 1, wherein a water stream of at least 50 μm width can be permeated.

3. The adhesive tape for laser dicing as claimed in claim 1 or 2, wherein the substrate has a mesh-like structure with a fiber diameter of 10 μm or more and less than 50 μm.

4. The adhesive tape for laser dicing as claimed in claim 1 or 2, wherein the substrate has a porous structure with a pore diameter of 10 to 50 μm.

5. The adhesive tape for laser dicing as claimed in claim 1 or 2, wherein the substrate is composed of a rubber-like elastic member.

6. The adhesive tape for laser dicing as claimed in

claim 1 or 2, wherein one side of the adhesive tape has a radiation-curable adhesive layer.

7. The adhesive tape for laser dicing as claimed in claim 6, wherein a non-radiation-curable adhesive layer is provided between the substrate and the radiation-curable adhesive layer.