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United States Patent [19]

Komiyama et al.

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[45] **Date of Patent: May 5, 1992**

[54] **METHOD OF DICING AND BONDING SEMICONDUCTOR CHIPS USING A PHOTOCURABLE AND HEAT CURABLE ADHESIVE TAPE**

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[21] Appl. No.: **653,232**

[22] Filed: **Feb. 8, 1991**

Related U.S. Application Data

[62] Division of Ser. No. 380,548, Jul. 14, 1989.

[30] **Foreign Application Priority Data**

Jul. 21, 1988 [JP] Japan 63-183158

[51] **Int. Cl.**[5] **B32B 31/00**

[52] **U.S. Cl.** **156/229**; 156/235; 156/249; 156/256; 156/273.3; 156/273.9; 156/275.5; 156/330; 428/345

[58] **Field of Search** 156/272.2, 273.3, 273.9, 156/275.5, 250, 256, 344, 229, 249, 230, 235, 330; 428/42, 343, 345, 354, 355

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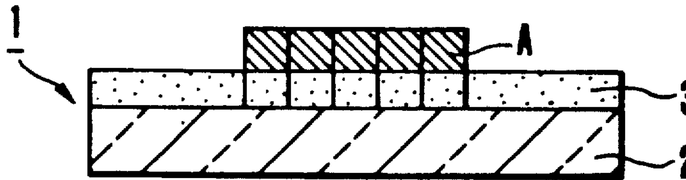
Attorney, Agent, or Firm—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

An adhesive tape comprising an energy beam transmittable base sheet having a surface tension of not more than 40 dyne/cm and an adhesive layer formed on one surface of the base sheet, the adhesive layer comprising a (meth)acrylate polymer, an epoxy resin, a photopolymerizable low molecular weight compound, a heat activatable potential curing agent for the epoxy resin and a photopolymerization initiator for the photopolymerizable low molecular weight compound. The adhesive in the adhesive layer is curable with an energy beam and the so cured adhesive develops tackiness again when heated. When the tape is used in processing a semiconductor wafer, it serves as a dicing tape for holding the wafer in position during the dicing step. Each piece of the diced and cured adhesive layer, that is attached to each chip and capable of being tackified by heating, provides an adhesive required for securely mounting the chip on the lead frame in the die-bonding step.

8 Claims, 2 Drawing Sheets



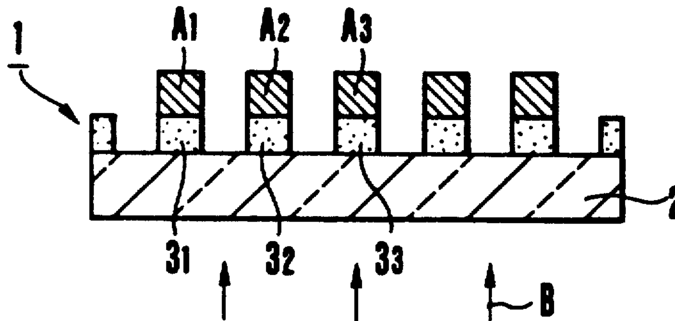


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FIG.1

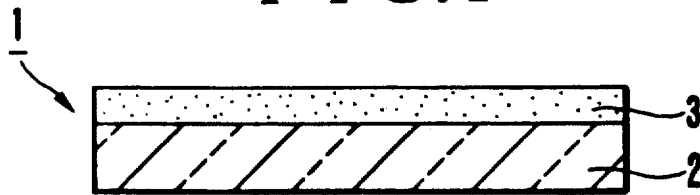

FIG.2

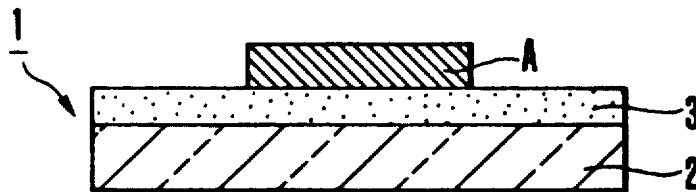

FIG.3

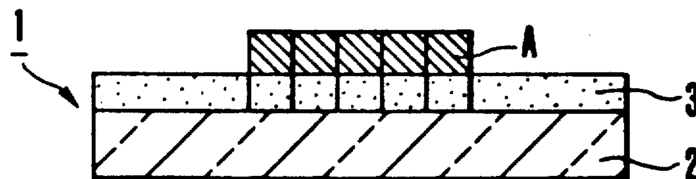

FIG.4

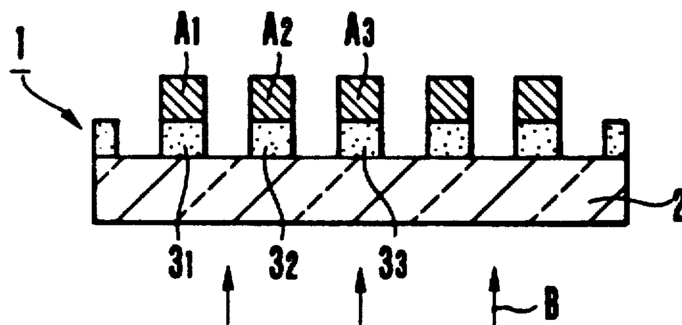

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FIG.5

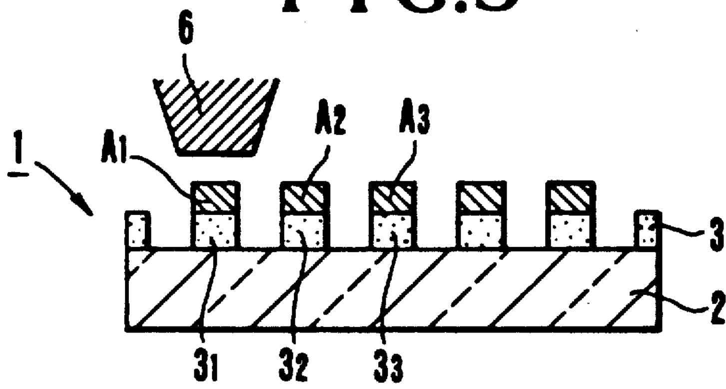


FIG.6

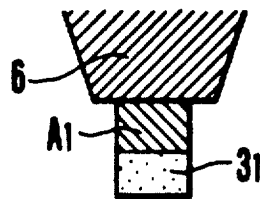


FIG.7

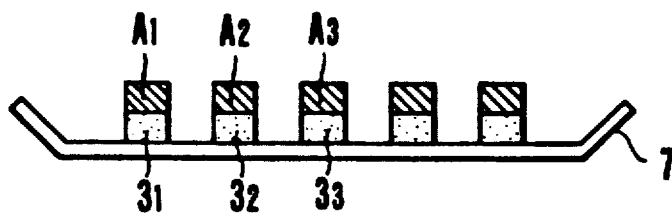
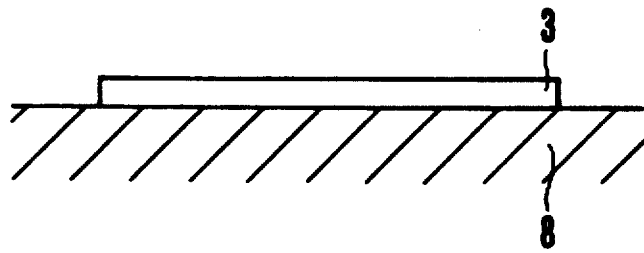


FIG.8



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METHOD OF DICING AND BONDING SEMICONDUCTOR CHIPS USING A PHOTOCURABLE AND HEAT CURABLE ADHESIVE TAPE

This application is a division of Ser. No. 07/380,548 filed Jul. 14, 1989.

FIELD OF THE INVENTION

The present invention relates to a novel adhesive tape and use thereof. More particularly, it relates to an adhesive tape suitable for use in dicing a semiconductor wafer into chips and die-bonding the chips on a lead frame, and to use of such an adhesive tape.

BACKGROUND OF THE INVENTION

Wafers of semiconductor material such as silicon and gallium-arsenic having formed thereon integrated circuits have a relatively large diameter. In the production of integrated circuits (IC), such a wafer is adhered to an adhesive tape sometimes called a dicing tape, diced into chips (IC chips), which are then released (picked up) from the dicing tape, and adhered to (mounted on) a lead frame by means of an adhesive such as an epoxy resin.

For dicing tapes suitable for use in such a wafer processing technique, it is required that they should exhibit a strong adhesion to the semiconductor wafer in the step of dicing the wafer into IC chips on the one hand, while they should also have such a reduced adhesion to the IC chips in the step of picking up the IC chips so that the IC chips may be readily released without carrying adhesive residues from the dicing tapes. Thus, in prior art dicing tapes, adhesive and releasing properties, which are conflicting, are required, and use of a dicing tape whose adhesive and releasing properties are not well balanced in wafer processing invites such a problem that the dicing and/or picking up steps of the process cannot be smoothly carried out. In particular, when a prior art dicing tape is used in wafer processing, a part of the adhesive of the dicing tape is transferred to the picked up IC chips and adversely affects the characteristics of the resulting IC. Accordingly, it has been necessary to remove the undesirable residual adhesive from the IC chips before they are mounted on a lead frame. While complete removal of the residual adhesive is difficult, the step of removing the adhesive not only makes the processing complicated, but also invites a problem of environmental pollution if an organic solvent is used, for the removal of the residual adhesive.

Furthermore, a separate adhesive such as an epoxy resin has been used for mounting the IC chips on a lead frame, as described in Japanese Patent Laid-open Publication No. 60-198,757. The use of a separate adhesive involves another problem such that unceasing application of appropriate amounts of the adhesive is technically very difficult, which results that in a case of a very small IC chip in the applied adhesive frequently bulging out of the chip, whereas in a case of a relatively large IC chip the amount of the applied adhesive tends to be too small to provide a desired adhesion.

OBJECT OF THE INVENTION

The invention intends to solve the above-discussed problems associated with the prior art and an object of the invention is to provide an adhesive tape suitable for use in processing semiconductor wafers which has both actinic radiation curability and heat curability, which can be used as a dicing tape in the dicing step and which can provide an adhesive in the mounting step.

SUMMARY OF THE INVENTION

In accordance with one aspect of the invention there is provided an adhesive tape comprising an energy beam transmittable base sheet having a surface tension of not more than 40 dyne/cm and an adhesive layer formed on one surface of said base sheet, said adhesive layer comprising a (meth)acrylate polymer, an epoxy resin, a photopolymerizable low molecular weight compound, a heat activatable potential curing agent for said epoxy resin and a photopolymerization initiator for said photopolymerizable low molecular weight compound.

In accordance with another aspect of the invention there is provided a method for using the above-mentioned adhesive tape, which method comprises the steps of adhering a semiconductor wafer to said adhesive tape, dicing said wafer into chips together with the adhesive layer of said adhesive tape, irradiating the adhesive layer of said tape with an energy beam, picking up the chips together with pieces of the diced adhesive layer adhered thereto from said base sheet, placing the chips on a lead frame so that the respective pieces of the adhesive layer may come in contact with said lead frame, and causing the pieces of the diced adhesive layer to again develop tackiness by heating thereby securely mounting the chips on said lead frame.

In the method according to the invention, the adhesive tape according to the invention serves as a dicing tape for holding the wafer in position during the dicing step. Each piece of the diced and cured adhesive layer, that is attached to each chip and capable of being tackified by heating, provides an adhesive for securely mounting the chip on the lead frame in the die-bonding step.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic cross-sectional view of an adhesive tape according to the invention;

FIGS. 2 to 7 are illustrations showing states of the adhesive tape of FIG. 1 in various steps of a wafer processing technique in which it is used; and

FIG. 8 is a cross-sectional view of a modification of the adhesive tape of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

The adhesive tape and use thereof according to the invention will now be described in detail with reference to the accompanying drawings.

As schematically shown in FIG. 1, the adhesive tape 1 according to the invention comprises a base sheet 2 and an adhesive layer 3 formed on one surface of the base sheet 2. Before use of the adhesive tape it is preferable to tentatively apply a strippable release sheet (not shown) to the adhesive layer 3 for protection thereof.

It is desirable that the adhesion strength between the base sheet 2 and adhesive layer 3 is initially high and can be reduced by irradiation to a level sufficiently lower than that between the adhesive layer and a semiconductor wafer. For this purpose the base sheet 2 should have a surface tension not more than 40 dyne/cm, preferably not more than 38 dyne/cm. Further, suitable as the base sheet are materials which are low in electrical conductivity and excellent in water resistance as well as in heat resistance. From these viewpoints, synthetic resin films

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are particularly preferred. As will be stated later, the adhesive tape according to the invention, when used, is irradiated with an energy beam such as an electron beam or ultraviolet ray. When it is to be irradiated with an ultraviolet ray, it must be light transmittable, but it is not required to be light transmittable when it is to be irradiated with an electron beam. Practically, suitable as the base sheet **2** are films of such synthetic resins as polyester, polyethylene, polypropylene, polybutene, polybutadiene, vinyl chloride ionomer, ethylene-methacrylic acid copolymer, vinyl chloride-urethane copolymer as well as cross-linked films of such resins. The films may or may not be treated with a silicone.

The base sheet **2** may be either of a single layer or laminated. The thickness of the base sheet is normally from 25 to 200 μm.

The adhesive layer **3** of the adhesive tape according to the invention comprises a (meth)acrylate polymer, an epoxy resin, a photopolymerizable low molecular weight compound, a heat activatable potential curing agent for the epoxy resin and a photopolymerization initiator for the photopolymerizable low molecular weight compound.

By the term "(meth)acrylate polymer" used herein is meant polymers primarily (at least 50 mol %) comprising structural units derived from at least one (meth)acrylate, i.e. acrylate or methacrylate. Examples of the suitable (meth)acrylate include, for example, glycidyl acrylate and methacrylate as well as alkyl and hydroxyalkyl (meth)acrylates, in which the alkyl moiety has from 1 to 14 carbon atoms, such as methyl, ethyl and butyl acrylates and methacrylates, and 2-hydroxyethyl acrylate and methacrylate.

The (meth)acrylate polymer which can be used herein may be a homopolymer of a (meth)acrylate, or it may be a copolymer of at least two (meth)acrylates. Alternatively, it may be a copolymer of at least one (meth)acrylate and at least one comonomer copolymerizable therewith containing at least 50 mol % of units derived from said at least one (meth)acrylate. Examples of the comonomer include, for example, acrylic and methacrylic acid, acrylonitrile, methacrylonitrile, vinyl acetate, vinylpyrrolidones and vinyl group-containing siloxanes. Particularly preferred (meth)acrylate polymers which can be used herein are copolymers of at least one alkyl (meth)acrylate, in which the alkyl moiety has from 1 to 8 carbon atoms and at least one glycidyl (meth)acrylate containing up to 80 mol %, in particular from 5 to 50 mol % of units derived from said at least one glycidyl (meth)acrylate, and copolymers of at least one alkyl (meth)acrylate, in which the alkyl moiety has from 1 to 8 carbon atoms and at least one (meth)acrylic acid containing up to 50 mol %, in particular from 5 to 20 mol % of units derived from said at least one (meth)acrylic acid.

The alkyl (meth)acrylate polymer used herein is substantially free from a C—C double bond, and normally has a molecular weight of from about 40,000 to about 1,500,000, preferably from about 100,000 to 1,000,000.

The epoxy resin which can be used herein is an organic material having an average of at least 1.8 vicinal epoxy groups per molecule, and normally has an average molecular weight of from 100 to 1000. Examples of the epoxy resin include, for example, glycidyl ethers of a phenol such as Bisphenol A, Bisphenol F, resorcinol, phenol novolac and resorcinol novolac; glycidyl ethers of a polyhydric alcohol such as butanediol, polyethylene glycol and polypropylene glycol; glycidyl esters of a polycarboxylic acid such as terephthalic acid, isophthalic acid and tetrahydrophthalic acid; N,N-diglycidyl and N-alkyl-N-glycidyl compounds of an aromatic amine such as aniline isocyanurate; and alicyclic epoxides derived from an alicyclic olefin by oxidation of its olefinic double bond or bonds, such as vinylcyclohexene diepoxide, 3,4-epoxycyclohexylmethyl-3,4-dicyclohexane carboxylate and 2-(3,4-epoxy)cyclohexyl-5,5-spiro(3,4-epoxy)cyclohexane-m-dioxane. The epoxide compounds illustrated above may be used alone or in combination. Of these, diglycidyl ethers of a bisphenol are particularly preferred. As such preferred epoxy resin those which are commercially available are "Epikote" 828 having a molecular weight of 380, "Epikote" 834 having a molecular weight of 470, "Epikote" 1001 having a molecular weight of 900, "Epikote" 1002 having a molecular weight of 1060, "Epikote" 1055 having a molecular weight of 1350 and "Epikote" 1007"having a molecular weight of 2900.

The epoxy resin is used in the adhesive composition for forming the adhesive layer **3** in an amount of normally from 5 to 2000 parts by weight, preferably from 100 to 1000 parts by weight, per 100 parts by weight of the (meth)acrylate polymer.

The photopolymerizable low molecular weight compound which can be used herein is a compound having at least one carbon-carbon double bond which is crosslinkable by irradiation with an energy beam such as an ultraviolet ray and electron beam, and has a molecular weight of, normally from 100 to 30,000, preferably from 300 to 10,000. Examples of preferred photopolymerizable oligomers are those having functional groups such as hydroxy and carboxy, and include, for example, urethane acrylate, epoxy acrylate, polyester acrylate, polyether acrylate, oligomer of (meth)acrylic acid and oligomer of itaconic acid. Of these, epoxy acrylate and urethane acrylate are particularly preferred.

The photopolymerizable low molecular weight compound is used in the adhesive composition for forming the adhesive layer **3** in an amount of normally from 10 to 1000 parts by weight, preferably from 50 to 600 parts by weight, per 100 parts by weight of the (meth)acrylate polymer.

The heat activatable potential curing agent for the epoxy resin is a compound having or potentially having at least two active hydrogen atoms which are inactive at ambient temperature but are activated, when heated, to react with the epoxy resin thereby effecting or promoting curing of the epoxy resin. As such a heat activatable potential curing agent for the epoxy resin, use can be made of various onium salts, in particular aliphatic and aromatic sulfonium salts, and other high melting active hydrogen-containing compounds, alone or in combination. Among others, aliphatic sulfonium salts are preferred.

The amount of the heat activatable potential curing agent used in the adhesive composition for forming the adhesive layer **3** may practically be within the range from 0.1 to 50 parts by weight, preferably from 1 to 10 parts by weight, per 100 parts by weight of the epoxy resin, irrespective of the presence of any epoxy groups in the (meth)acrylate polymer and/or photopolymerizable low molecular weight compound.

In addition to the heat activatable potential curing agent for epoxide functionality, a heat curing agent such as a polyisocyanate compound may be incorporated in the adhesive composition for the purpose of modifying adhesive properties of the adhesive layer. When used,

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