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Umehara et al.

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[54] **WAFER DICING/BONDING SHEET AND PROCESS FOR PRODUCING SEMICONDUCTOR DEVICE**

[75] Inventors: **Norito Umehara**; **Masazumi Amagai**, both of Hayami-gun; **Mamoru Kobayashi**, Yoshikawa; **Kazuyoshi Ebe**, Minamisaitama-gun, all of Japan

[73] Assignees: **Texas Instruments Japan, Ltd.**; **Lintec Corporation**, both of Japan

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Related U.S. Application Data

[62] Division of application No. 08/786,659, Jan. 21, 1997, Pat. No. 5,882,956.

[30] **Foreign Application Priority Data**

Jan. 22, 1996 [JP] Japan 8-8049

[51] **Int. Cl.**^{6} **B32B 27/06**

[52] **U.S. Cl.** **428/473.5**; 428/480

[58] **Field of Search** 428/473.5, 480, 428/213

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,687,693	8/1987	Sheyon et al.	428/148
4,793,883	12/1988	Sheyon et al.	156/235
5,110,388	5/1992	Komyama et al.	156/229
5,118,567	6/1992	Komiyama et al.	428/345
5,316,853	5/1994	Shibata et al.	428/416
5,411,921	5/1995	Negoro	438/118
5,527,998	6/1996	Anderson et al.	174/255
5,692,297	12/1997	Noda	29/845
5,705,016	1/1998	Senoo et al.	156/289

FOREIGN PATENT DOCUMENTS

0478250	4/1992	European Pat. Off. .
622833	11/1994	European Pat. Off. .
5-191918	4/1993	Japan .
5-191919	7/1993	Japan .
5-335354A	12/1993	Japan .
WO9512895	5/1995	WIPO .

Primary Examiner—D. S. Nakarani

Attorney, Agent, or Firm—Webb Ziesenheim Logsdon Orkin & Hanson, P.C.

[57] **ABSTRACT**

The wafer dicing/bonding sheet of the present invention comprises a soft film, a pressure sensitive adhesive layer formed on the soft film, a processing film for polyimide type resin composed of a heat resistant resin which has been formed on the pressure sensitive adhesive layer and a polyimide adhesive layer formed on the processing film. It is preferred that the processing film be a polyethylene naphthalate film whose surface has been subjected to an alkyd release treatment. The present invention facilitates expansion to be conducted after the wafer dicing.

5 Claims, 2 Drawing Sheets

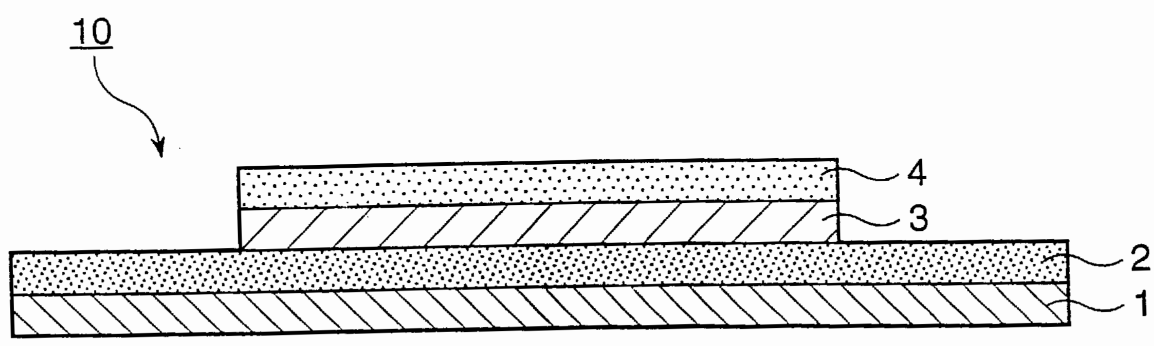


Fig. 1

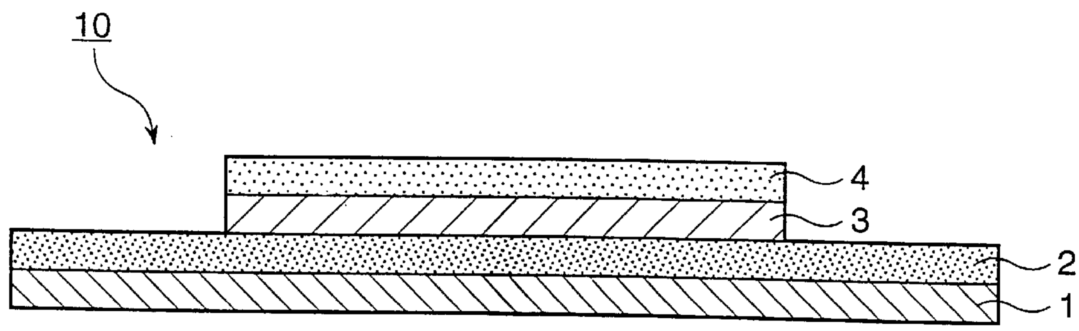


Fig. 2

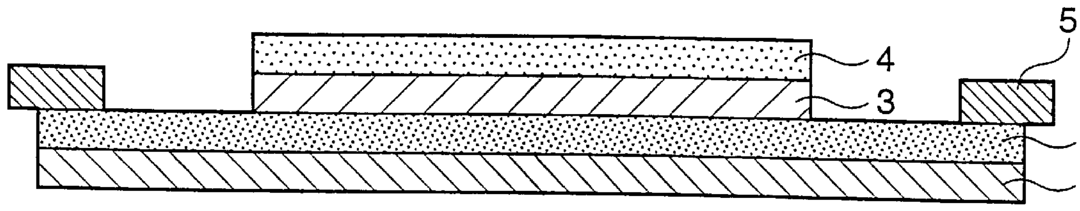


Fig. 3

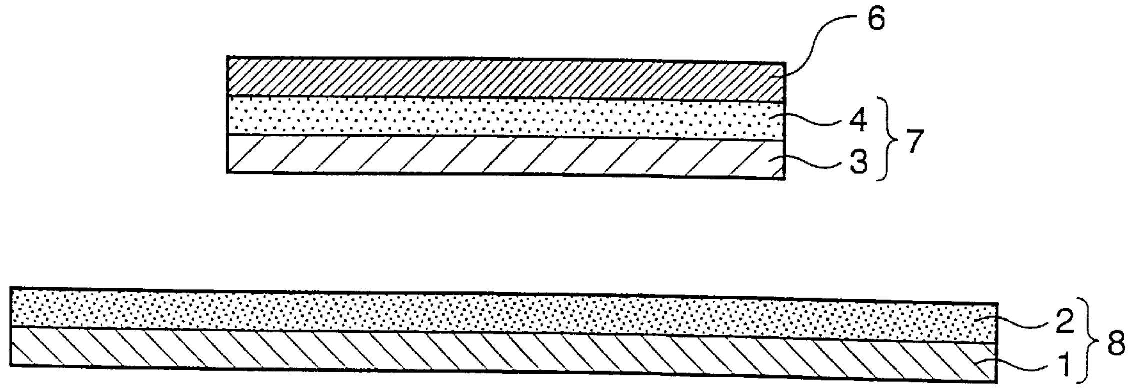


Fig.4

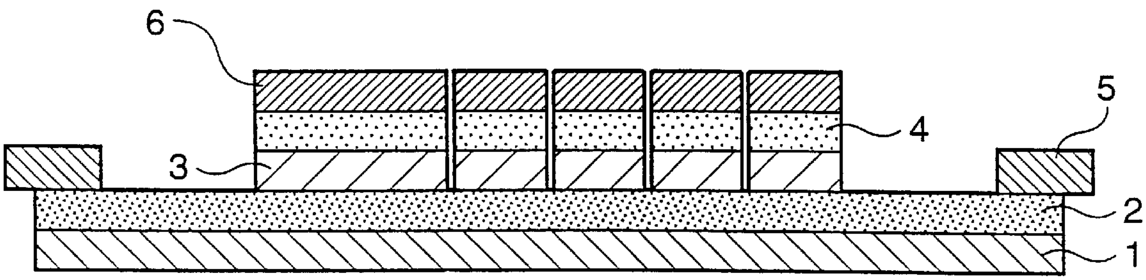
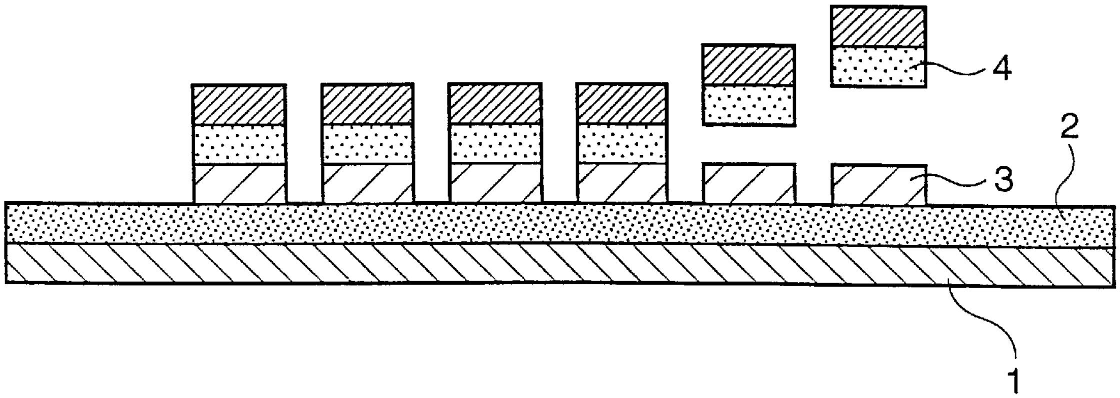


Fig.5



WAFER DICING/BONDING SHEET AND PROCESS FOR PRODUCING SEMICONDUCTOR DEVICE

CROSS REFERENCE TO RELATED APPLICATION

This application is a divisional of U.S. patent application Ser. No. 08/786,659 entitled "Wafer Dicing/Bonding Sheet and Process for Producing Semiconductor Device" filed on Jan. 21, 1997, now U.S. Pat. No. 5,882,956, which corresponds to Japanese Application No. 008049/1996 filed on Jan. 22, 1996.

FIELD OF THE INVENTION

The present invention relates to a wafer bonding sheet for use in the process in which a plurality of semiconducting integrated circuits formed on a semiconductor wafer, for example, a silicon wafer are diced into individual separate semiconducting integrated circuits, i.e., IC chips (also referred to as "chips" or "dies") and the IC chips are mounted on, for example, a lead frame for package and relates to a process for producing a semiconductor device which includes the above process.

BACKGROUND OF THE INVENTION

A semiconductor wafer of, for example silicon or gallium arsenide is produced in the form of a large diameter. This wafer is cut and separated (diced) into IC chips and is subjected to the subsequent die bonding step (also referred to as "mounting step") in which the IC chips are mounted on a lead frame for package. In this process, the semiconductor wafer undergoes dicing, cleaning, drying, expansion and pickup steps in the state of being attached to an adhesive sheet, and transferred to the subsequent die bonding step.

Adhesive sheets which are intended for use in the processing steps of wafers, from the dicing step up to the pickup step, are desired to have an adhesive force sufficient to retain wafers and/or chips thereon in the course from the dicing step up to the expanding step, but in the pickup step, they are desired to only retain an adhesion force of such an extent that no adhesive remains on the picked-up wafer and/or chips.

In the die bonding step, the picked up IC chips are fixed on IC chip mount zones (simply, mount zones) of a lead frame by means of an IC chip bonding adhesive such as an epoxy adhesive, a polyimide adhesive or a silver paste which is fed in the form of a viscous liquid to form an adhesive coat on the mount zones, followed by being subjected to the wire bonding step and resin mold step, thereby obtaining a semiconductor device. However, when the size of each of the IC chips is very small, it is difficult to uniformly apply an appropriate amount of adhesive with the use of the above liquid adhesive, so that the adhesive outflows the IC chips. On the other hand, when the size of each of the IC chips is very large, the use of the above liquid adhesive has encountered the problems such that the amount of the adhesive is short to thereby disenable bonding which ensures a satisfactory bonding strength. In recent years, the degree of integration of each semiconductor chip tends to increase, so that the chip tends to have an enlarged surface area and the wiring tends to become fine and a multilayer. On the other hand, the package in which the chips are accommodated tends to become miniaturized and thinner so that the mount on a printed wiring board can be conducted in high density. The obtained thin package with an enlarged surface area has

encountered the problems such that the thermal shock and hot moisture resistances are poor and the package is likely to crack in the surface mount step, as compared with that of the prior art.

A film adhesive of a polyimide type resin having excellent heat resistance has been proposed for use in the bonding of IC chips to the lead frame. Further, it has been proposed to employ a dicing sheet comprising a substrate film and, detachably laminated thereto, such an adhesive for bonding of IC chips, which dicing sheet can simultaneously be used in dicing and die bonding.

However, the use of the polyimide adhesive in the above dicing sheet has encountered the limitation in employable substrate film because the solvent component of the polyimide adhesive has high boiling point and high polarity. Further, the above substrate film is generally so hard that the expansion thereof is not easy. Thus, it is difficult to enlarge the IC chip spacing with the result that erroneous operation is occasionally caused in the pickup of IC chips.

OBJECT OF THE INVENTION

The present invention has been made in the above situation of the prior art. It is an object of the present invention to facilitate the expansion of the wafer dicing/bonding sheet in which a polyimide adhesive is used. Another object of the present invention is to provide a process for producing a semiconductor device in which package cracking hardly ever occurs.

SUMMARY OF THE INVENTION

The wafer dicing/bonding sheet of the present invention is composed of

a sheet for expanding process comprising a soft film and, formed thereon, a pressure sensitive adhesive layer, and

a polyimide bonding sheet comprising a processing film for polyimide type resin and, formed thereon, a polyimide adhesive layer.

The first process for producing a semiconductor device according to the present invention comprises the steps of:

conducting a thermocompression bonding of a semiconductor wafer to a polyimide adhesive layer of the wafer dicing/bonding sheet which is composed of

a sheet for expanding process comprising a soft film and, formed thereon, a pressure sensitive adhesive layer, and a polyimide bonding sheet comprising a processing film for polyimide type resin and, formed thereon, the polyimide adhesive layer;

dicing the semiconductor wafer into IC chips;

expanding the wafer dicing/bonding sheet so as to enlarge IC chip spacings;

peeling from the processing film for polyimide type resin the IC chips having the polyimide adhesive layer sticking thereto on their backs; and

placing the IC chips on a lead frame in a manner such that the polyimide adhesive layer is interposed between the IC chips and the lead frame to thereby bond the IC chips to the lead frame.

The second process for producing a semiconductor device according to the present invention comprises the steps of:

conducting a thermocompression bonding of a semiconductor wafer to a polyimide adhesive layer of a polyimide bonding sheet which comprises

a processing film for polyimide type resin and, formed thereon, the polyimide adhesive layer;

attaching a sheet for expanding process comprising a soft film and, formed thereon, a pressure sensitive adhesive layer to the polyimide bonding sheet in a manner such that the pressure sensitive adhesive layer contacts an exposed surface of the processing film for polyimide type resin of the polyimide bonding sheet;

dicing the semiconductor wafer into IC chips;

expanding the sheet for expanding process so as to enlarge IC chip spacings;

peeling from the processing film for polyimide type resin the IC chips having the polyimide adhesive layer sticking thereto on their backs; and

placing the IC chips on a lead frame in a manner such that the polyimide adhesive layer is interposed between the IC chips and the lead frame to thereby bond the IC chips to the lead frame.

In the present invention as described above, it is preferred that the processing film for polyimide type resin as a constituent member of the polyimide bonding sheet be made from a resin having a melting point of 230° C. or higher, preferably, 250 to 300° C. The processing film for polyimide type resin is preferred to have a surface tension of less than 40 dyn/cm. In particular, in the present invention, it is preferred that the processing film for polyimide type resin be composed of a polyethylene naphthalate resin.

Further, in the present invention, it is preferred that the pressure sensitive adhesive layer have a surface area which can be supported by a wafer dicing ring frame and the polyimide adhesive layer have an outside diameter which is smaller than an inside diameter of the wafer dicing ring frame.

BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a sectional view of the wafer dicing/bonding sheet of the present invention;

FIG. **2** shows the state of fixing the wafer dicing/bonding sheet by means of a ring frame;

FIG. **3** shows the state of being about to fix the polyimide bonding sheet having a silicon wafer attached thereto by thermocompression bonding on the sheet for expanding process;

FIG. **4** shows the state of dicing the silicon wafer; and

FIG. **5** shows the state of picking up the IC chips after expanding the wafer dicing/bonding sheet.

DETAILED DESCRIPTION OF THE INVENTION

The wafer dicing/bonding sheet, process for producing a semiconductor device, polyimide bonding sheet and processing film for polyimide type resin according to the present invention will be described in detail below.

Referring to FIG. **1**, the wafer dicing/bonding sheet **10** of the present invention is composed of

a sheet for expanding process **8** comprising a soft film **1** and, formed thereon, a pressure sensitive adhesive layer **2**, and

the polyimide bonding sheet **7** comprising a processing film for polyimide type resin **3** being formed on the pressure sensitive adhesive layer **2** and, formed thereon, a polyimide adhesive layer **4**. Before the use of the wafer dicing/bonding sheet **10** of the present invention, a release film may be laminated to the upper surface thereof in order to protect the pressure sensitive adhesive layer **2** and the polyimide adhesive layer **4**.

The configuration of the wafer dicing/bonding sheet of the present invention is not particularly limited, and, for example, the wafer dicing/bonding sheet may have the form of a tape or a label.

The soft film **1** as a constituent member of the sheet for expanding process **8** is composed of a resin film which is extensible in not only the direction of the length but also the direction of the width. Although various resin films are available, it is preferred that the Young's modulus thereof be not greater than 1.0×10^4 kg/cm^2, especially, in the range of 5.0×10^1 to 5.0×10^3 kg/cm^2.

Examples of such soft film **1** include a film of polyethylene, polyvinyl chloride, polybutene, polybutadiene, polyurethane, polyester, polyamide, ethylene/vinyl acetate copolymer, ethylene/(meth) acrylic acid copolymer, ethylene/methyl (meth)acrylate copolymer, ethylene/ethyl (meth)acrylate copolymer or the like. The soft film **1** may also be a laminate of at least two films selected from among the above. The thickness of the soft film **1** generally ranges from about 10 to 300 μm, preferably, from about 50 to 200 μm.

The pressure sensitive adhesive layer **2** as a constituent member of the sheet for expanding process **8** holds the processing film for polyimide type resin **3** to adhere to the soft film **1** during the dicing and pickup steps. By adjusting the surface areas of processing film for polyimide type resin **3** and polyimide adhesive layer **4** being smaller than the inside diameter of the ring frame, it is possible to detachably support the ring frame on the pressure sensitive adhesive layer **2**.

The pressure sensitive adhesive layer **2** can be composed of various conventional pressure sensitive adhesives such as acrylic, rubber, polyurethane, silicone and polyester adhesives. Among them, acrylic adhesive is preferred from the viewpoint, for example, that the control of adhesion characteristics is easy.

The acrylic pressure sensitive adhesive comprises an acrylic copolymer as a principal component.

The acrylic copolymer is generally obtained by copolymerizing a (meth)acrylic ester monomer having an alkyl group of 1 to 18 carbon atoms as a main monomer with a monomer having a functional group such as hydroxyl, carboxyl or amino or other copolymerizable monomer.

Although the molecular weight of the acrylic copolymer is not particularly limited, the weight average molecular weight thereof generally ranges from 1.0×10^5 to 1.0×10^6, preferably, from 4.0×10^5 to 8.0×10^5.

The adhesive and cohesive forces of the acrylic pressure sensitive adhesive having a functional group can be controlled by adding an appropriate crosslinking agent. This crosslinking agent may be, for example, a polyvalent isocyanate compound, a polyvalent epoxy compound, a polyvalent aziridine compound, a metal chelate compound or the like.

The above component of the pressure sensitive adhesive can be used singly or the combination of two or more components. Further, additives such as a tackifier and a filler may be added to the pressure sensitive adhesive.

The thickness of the pressure sensitive adhesive layer **2** is preferred to range from 1 to 50 μm, especially, from 5 to 30 μm.

The processing film for polyimide type resin **3** as a constituent member of the polyimide bonding sheet **7** is preferably made from a heat resistant resin. The melting point of the above resin is preferably at least 230° C., still preferably, 250 to 300° C. and, yet still preferably, 260 to 280° C. The surface tension of the processing film for

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