ROTATABLE, HEATABLE PLACE TOOL AND DIE BONDER COMPRISING SUCH A PLACE TOOL

Introduction

The invention pertains to the field of semiconductor assembly. It relates to a rotatable, heatable place tool according to the preamble of the independent patent claim and to a chip assembly apparatus comprising such a place tool.

Prior Art

When mounting semiconductor devices, commonly referred to as dies, on a substrate by means of a chip assembly apparatus, commonly referred to as die bonder, a bonding layer, which comprises an adhesive or solder, is generally provided between individual dies and the substrate. Said bonding layer may either be applied - "dispensed" - in liquid form, usually onto the substrate. Alternatively, a tape may be applied as bonding layer. In doing so, the tape may be laminated onto the substrate prior to the die being placed. The tape may also be laminated to a rear side of a semiconductor wafer from which the dies have been obtained by means of cutting, commonly referred to as dicing. The latter case is referred to as wafer backside lamination (short: WBL) or film over wire (short: FOW).

To achieve a bond as stable and reliable as possible between die and substrate, the bonding layer often needs to be heated. To this end, die and/or substrate may e.g. be heated US laid open publication 2005/0081986 A1, which is hereby incorporated by reference in its entirety, describes a heated assembly head referred to as bond head into which a holding element for dies, commonly referred to as die collet, is inserted.

One disadvantage of this is that a heating element in the bond head is located relatively far from a support surface of the holding element for contacting the die. If a temperature of the support surface needs to be variable as a function of time, in particular, wait times become necessary due to a relatively large heat capacity of the entire holding element, which reduce an achievable throughput. In particular, this is the case if the bond head also picks the dies to be bonded from a support station for the semiconductor wafer, since heating of the dies on the support station is undesired in particular for semiconductor wafers with back side lamination.

Even if dies to be bonded are picked up from the supply station by means of a pick tool provided solely for that purpose rather than by the bond head, a variation of the temperature of the support surface with time is desired under certain circumstances to prevent sticking together of the die with the support surface. This also applies if the bond head picks the dies from a pivot tool or from an intermediate station. Related die bonders are described in 2007/118511 Al and WO 2007/033701 A1, respectively, which are hereby incorporated by reference in their entirety.

A further disadvantage is that neither bond head nor holding element may be rotated about an axis perpendicular to the wafer or substrate. Thus, neither angle corrections to correct for minor skews between wafer and substrate can be carried out, nor can different dies be placed onto the substrate with different orientation.

Description of the invention

Embodiments of the invention seek to provide a die bonder and a place tool for a die bonder without the disadvantages mentioned above.

According to a first aspect of the present invention, there is provided a place tool movable in a direction of a z-axis perpendicular to a substrate, comprising a holding element for a die, wherein the holding element comprises a heating element, a receptacle for the holding element, said receptacle being rotatably mounted at the place tool with respect to z-axis and comprising an insulating body made of heat insulating material, driving means for the receptacle, said driving means capable of rotating the receptacle around the z-axis, a supply for a cooling fluid by means of which the receptacle for the holding element may be cooled.

According to a second aspect of the present invention, there is provided a die bonder comprising a place tool as defined in the first aspect.

The aforementioned and further objectives, advantages and features of the invention will be detailed in the description of preferred embodiments below in combination with the drawings.

Brief description of the drawings

Fig. 1 shows a perspective representation of a heatable, rotatable place tool in accordance with the present Invention.

Fig. 2 shows another perspective representation of the heatable, rotatable place tool from Fig. 1,

Fig. 3 shows a cross section of the heatable, rotatable place tool from Fig. 1 and Fig. 2.

Fig. 4 shows a color version of Fig. 3, and

Fig. 5 an alternative version of Fig. 4 with reference numerals.

Description of preferred embodiments

Fig. 1 and Fig. 2 show perspective representations of a rotatable, heatable place tool 1 in accordance with the present invention from different view angles. Place tool 1 may be displaced along a z-direction by means of a slide 2 to which it is attached. Place tool 1 comprises a holding element 11 for a die, wherein the holding element comprises a heating element 12 made from Al_2O_3onto which at least one film resistor has been applied.

Holding element 11 is inserted into a receptacle 13, which is rotatable around the z-direction. Receptacle 13 comprises an insulating body made from ceramics, which is srewed down to a first metallic support 132. For cooling purposes, air may be supplied to the receptacle through a supply 151, so that it may circulate within the receptacle and be subsequently discharged through an outlet 152. A second metallic support 133 is provided on a side of the receptacle 13 facing holding element 11. A temperature of the of holding element 11 may be measured or estimated by means of a thermo sensor which is located within said second metallic support 133. Arrangement of the thermo sensor within the second metallic holder 133 allows for easily exchanging holding element 11. Further, a thread is provided within the second metallic support 133 for fixation of holding element 11 by means of a screw S1. Second metallic support 133 is in turn surrounded by a ceramic sleeve 134 to avoid heat losses due to rapid movements in x- or y-direction carried out by the place tool under operation. Openings 135 in insulating body serve as through hole for connection cables for the thermo sensor and the heating element 12, to which current is supplied through spring-loaded, gold plated copper contact pins 136.

In a preferred embodiment of the invention, a flow sensor is located in or at an outlet which monitors an amount of discharged air. Further, a protective circuit is provided which reduces or interrupts a heating power of the heating element 12 when the amount

of discharged air falls below a predetermined limit value. In this way, damage can be avoided in case of a leak in the supply tubes.

The place tool 1 is mounted to the slide 2 in such a way that it may be rotated about x- and y-direction for calibration purposes.

To rotate the place tool 1 about the x-direction, clamping screws S2 need to be loosened. A position correction may then be effected by means of adjusting screws S3. Subsequently, clamping screws S2 need to be tightened again. Rotation in x-direction becomes possible by the place tool 1 being mounted on a cylindrical protrusion 5 provided on slide 2 by means of an adjustment element 3.

To rotate place tool 1 about the y direction clamping screws S2 need to be loosened. A position correction may then be effected by means of a further adjusting screw. The place tool is preloaded with respect to the adjustment element 3 by means of a leaf spring 4, and is mounted rotatably about the y-direction to the adjustment element 3.

Fig. 3 shows a cross section through the rotatable, heatable place tool according to Fig. 1 and Fig. 2. First metallic support 132 is connected to a hollow axis 7, which is in turn connected to a rotor 62 of an electric motor which may fulfill rotational movements about the z-direction in cooperation with a stator 61. A vacuum channel 10 allows for applying vacuum to vacuum channels which are provided in a lower side of holding element 11. This way, a die can be picked by means of suction an placed onto a substrate located beneath the place tool 1. Vacuum is passed on to the holding element 11 by means of trough openings provided in the first metallic support 132 and in the insulation body 131.

Although the invention is illustrated and described herein with reference to specific embodiments, the invention is not intended to be limited to the details shown. Rather, various modifications may be made in the details within the scope and range of equivalents of the claims and without departing from the invention.

Patent Claims

1) A place tool movable in a direction of a z-axis perpendicular to a substrate, comprising
   a) a holding element for a die, wherein the holding element comprises a heating element,
   b) a receptacle for the holding element, said receptacle being rotatably mounted at the place tool with respect to z-axis and comprising an insulating body made of heat insulating material,
   c) driving means for the receptacle, said driving means capable of rotating the receptacle around the z-axis,
   d) a supply for a cooling fluid by means of which the receptacle for the holding element may be cooled.

2) The place tool according to claim 1 wherein air is used as cooling fluid

3) The place tool according to one of the preceding claims, wherein the receptacle comprises an insulating body for thermally insulating the holding element from the place tool.

4) The place tool according to claim 3, characterized in that the insulating body consists of ceramics.

5) The place tool according to one of the preceding claims, characterized in that the insulating body is attached to a first metallic support which may be rotated around the z-axis.

6) A die bonder comprising a place tool according to one of the preceding claims.