

treatment to the surface of the supplied wafer 100. Configurations of the first surface treatment apparatus 20f and the second surface treatment apparatus 20s are substantially the same. Hereinafter, the two will be denoted as a “surface treatment apparatus 20” when not particularly distinguished. A specific configuration of the surface treatment apparatus 20 will be described later.

[0022] The bonding unit 16 bonds one or more chips 110 to the wafer 100 to manufacture a semiconductor device. Specifically, the bonding unit 16 includes a stage on which the wafer 100 is placed, and a bonding head that holds the chip 110 by suction and is capable of performing heating (neither of which is shown). A bonding process performed by the bonding unit 16 will be described with reference to FIG. 3.

[0023] FIG. 3 is a schematic view illustrating bonding. When manufacturing a semiconductor device, chips 110 are bonded to the top surface of a wafer 100, as shown in FIG. 3. Further, in the case of bonding two or more chips 110 in the thickness direction, another chip 110 is bonded onto the chip 110 that has been bonded to the wafer 100. Electrodes 102 and 112 are provided on the bonding surfaces, i.e., the top surface of the wafer 100, the bottom surface of the chip 110, and the top surface of the chip 110. The bonding unit 16 bonds the electrodes 112 of the chip 110 with the electrodes ~~102~~ 112 of the wafer 100 or the electrodes 112 of another chip 110 so that the electrodes are in contact with each other. Thus, the wafer 100 and the chip 110, or the chip 110 and the chip 110, are electrically connected with each other.

[0024] Hydrogen bonding is used when bonding the chip 110 with the wafer 100 or bonding the chip 110 with the chip 110. FIG. 4 is a schematic view illustrating hydrogen bonding. In FIG. 4, reference sign “130” denotes target objects to be bonded together, i.e., the chip 110 or the wafer 100. In the case where the chip 110 is the target object 130, the wafer 100 or another chip 110 is a bonded object to be bonded with the target object 130; in the case where the wafer 100 is the target object 130, the chip 110 is a bonded object to be bonded with the target object 130. In this

contain a water vapor pressure equal to or higher than the saturated water vapor pressure H_c of the bonding surface temperature T_d and lower than the saturated water vapor pressure H_a of the ambient temperature T_a . Specifically, if the humidity of the humidified air is set to be equal to or higher than $A_c\%$ and less than $A_b\%$, dew condensation occurs on the bonding surface, and dew condensation on the frame member can be prevented.

[0039] In any case, by spraying humidified air having a water vapor pressure equal to or higher than the saturated water vapor pressure corresponding to the bonding surface temperature of the target object 130, dew condensation can be generated only during the spray period, and the dew condensation can evaporate after the spray is stopped. Thus, an appropriate amount of OH groups can be easily attached to the bonding surface.

[0040] Herein, the advantage of spraying such humidified air will be described in comparison with other techniques. Conventionally, to hydrophilize the bonding surface, it has been proposed to discharge liquid pure water onto the bonding surface. This technique can also attach OH groups to the bonding surface, but in this case, the droplets remain non-uniformly on the bonding surface. The droplets remaining in this manner remain at the bonding interface even after the target object 130 is hydrogen-bonded. If the target object 130 is heated with a large amount of water molecules remaining at the bonding interface, the remaining water molecules are rapidly removed from the bonding interface, thus creating voids (microvoids). Such voids naturally cause deterioration in the bonding quality.

[0041] As another form, it is conceivable to hydrophilize the bonding surface by cooling the target object 130 until dew condensation occurs. That is, in the example of FIG. 67, if the bonding surface of the target object 130 is cooled to be equal to or lower than the dew point temperature T_c of the water vapor pressure H_c of the ambient atmosphere, dew condensation occurs on the bonding surface even without spraying humidified air. However, it takes a certain amount of time to raise the temperature of the once cooled target object 130 to a temperature at which dew

capable of covering all of the plurality of target objects 130. Further, as shown in (a) of FIG. 89, a plurality of spray holes 26a may be provided at the spray nozzle 26. With such a configuration, humidified air can be evenly dispersed more reliably. As another form, the spray hole 26a provided at the spray nozzle 26 may be one spray hole as shown in (b) of FIG. 89. With such a configuration, the configuration of the spray nozzle 26 can be simplified. Humidified air may be sprayed in a columnar pattern as shown in (b) of FIG. 89, or may be sprayed in a conical pattern expanding in diameter as it goes downstream, as shown in (c) of FIG. 89.

[0045] Next, a flow of manufacturing a semiconductor device by the manufacturing apparatus 10 of this example will be described with reference to FIG. 91. When manufacturing a semiconductor device, first, a chip 110 is transported from the chip supply unit 12 to the first surface treatment apparatus 20f (S10). In this case, the chip 110 is loaded into the first surface treatment apparatus 20f while being adhered to the dicing tape 120 stretched on the inner side of the dicing ring 122. In the first surface treatment apparatus 20f, a hydrophilic treatment is applied to the bonding surface of one or more chips 110 (S12). Specifically, with the chip 110 being placed on the support base 22, the chip 110 is cooled, and humidified air is sprayed onto the bonding surface of the chip 110 by the spray nozzle 26. Thus, a small amount of dew condensation instantaneously occurs on the bonding surface. However, this dew condensation evaporates as soon as spray of the humidified air is stopped. As the dew condensation evaporates, although droplets do not exist on the bonding surface, OH groups become bonded to the Si atoms of the bonding surface.

[0046] In parallel with the hydrophilic treatment of the chip 110, a hydrophilic treatment of the wafer 100 is also performed. That is, a wafer 100 functioning as a substrate is transported from the substrate supply unit 14 to the second surface treatment apparatus 20s (S14). Subsequently, a hydrophilic treatment is applied to the transported wafer 100 (S16). Specifically, with the wafer 100 being placed on the support base 22, the wafer 100 is cooled, and humidified air is

CLAIMS:

[Claim 1] A surface treatment apparatus which applies a hydrophilic treatment to a bonding surface of a target object bonded to a bonded object using hydrogen bonding, the hydrophilic treatment being applied prior to the bonding, the surface treatment apparatus
5 comprising:

a support base which supports a surface of the target object opposite to the bonding surface, the target object being one or more target objects; and

a spray nozzle which causes dew condensation temporarily on the bonding surface by spraying, onto the bonding surface of the target object supported by the support base, humidified
10 air having a water vapor pressure equal to or higher than a saturated water vapor pressure corresponding to a temperature of the bonding surface.

[Claim 2] The surface treatment apparatus according to claim 1, wherein

the support base further comprises a cooler which cools the temperature of the bonding surface to a temperature lower than a temperature of an ambient atmosphere and higher than a dew
15 point temperature of a water vapor pressure of the ambient atmosphere.

[Claim 3] The surface treatment apparatus according to claim 2, wherein

the one or more target objects are placed on the support base with their periphery being surrounded by a frame member, and

the cooler cools the one or more target objects, and the frame member has a position and
20 a size at which the frame member is not cooled.

[Claim 4] The surface treatment apparatus according to any one of claims 1 to 3, wherein

the spray nozzle is movable with respect to the support base while spraying the humidified air.

[Claim 5] The surface treatment apparatus according to any one of claims 1 to 3, wherein

25 the spray nozzle has a spray area covering all of the one or more target objects.

[Claim 6] The surface treatment apparatus according to any one of claims 1 to 5, wherein the target object is a chip which is a semiconductor integrated circuit or a wafer to which the chip is bonded.

[Claim 7] A manufacturing apparatus for a semiconductor device, which manufactures a semiconductor device by bonding a chip, which is a semiconductor integrated circuit, to a wafer using hydrogen bonding, the manufacturing apparatus for a semiconductor device comprising:

a bonding unit which bonds the chip to a top surface of the wafer or another chip mounted on the wafer; and

one or more surface treatment apparatuses which apply a hydrophilic treatment to a bonding surface of a target object, which is the chip or the wafer, prior to the bonding, wherein the surface treatment apparatus comprises:

a support base which supports a surface of the target object opposite to the bonding surface, the target object being one or more target objects; and

a spray nozzle which causes dew condensation temporarily on the bonding surface by spraying, onto the bonding surface of the target object supported by the support base, humidified air having a water vapor pressure equal to or higher than a saturated water vapor pressure corresponding to a temperature of the bonding surface.

[Claim 8] ~~(New)~~ The manufacturing apparatus for a semiconductor device according to claim ~~7~~1, wherein

the spray nozzle is movable with respect to the target object.