

DESCRIPTION

TITLE OF INVENTION

MANUFACTURING APPARATUS OF SEMICONDUCTOR DEVICE AND SUBSTRATE CLEANING METHOD

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Technical Field

[0001] The specification discloses a manufacturing apparatus for mounting a chip on a front surface of a substrate to manufacture a semiconductor device and a cleaning method for cleaning the substrate during a manufacturing process of the semiconductor device.

10 Related Art

[0002] A manufacturing apparatus for mounting one or more chips on a front surface of a substrate to manufacture a semiconductor device is widely known in the conventional art. At the time of mounting the chip to the substrate, the front surface (that is, the mounting surface) of the substrate needs to be clean. Therefore, in many cases, before the chip is mounted, foreign matters attached to the front surface of the substrate are removed by a suction blower, etc.

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Citation List

Patent Literature

[0003] [Patent Literature 1] Japanese Laid-open No. H09-246298

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SUMMARY OF INVENTION

Technical Problem

[0004] Conventionally, various techniques have been proposed for cleaning the front surface of a substrate. However, hardly no technique has been proposed for cleaning a back surface of the substrate. In recent years, semiconductor devices are required to be more integrated or

miniaturized. To cope with such needs, some processes have been made to reduce the thicknesses of substrates and chips. As a result of substrate and chip thickness reduction, when a pressure is applied to a substrate and a chip with reduced thicknesses, the substrate and the chip may bend with a foreign matter attached to the back surface of the substrate as the center. Due to the bending, cracks may occur in the substrate and the chip.

[0005] Patent Document 1 discloses a resin mold apparatus provided with a conductive brush at a height contacting a lower surface of a product formed by sealing, with a resin, a lead frame in which a semiconductor device is subject to wire bonding, when the product is carried out to a storage cassette by an unloader. According to the technique of Patent Document 1, foreign matters attached to the lower surface of the product, which is a semiconductor device, can be removed to a certain degree by using the conductive brush. However, in Patent Document 1, the conductive brush contacts the lower surface of a finished product. Therefore, the technique of Patent Document 1 is unable to avoid manufacturing defects due to foreign matters. In addition, the conductive brush of Patent Document 1 is like a flat brush with multiple bristles lining up like lines. Therefore, in Patent Document 1, the same bristles always contact the cleaning target surface, raising the concern that a foreign matter attached to the bristles may once again be attached to the lower surface of the product.

[0006] Therefore, the specification discloses a manufacturing apparatus of a semiconductor device capable of effectively cleaning the back surface of the substrate before a chip is mounted, as well as a cleaning method.

Solution to Problem

[0007] A manufacturing apparatus of a semiconductor device disclosed in the specification includes: a conveyance mechanism, conveying a substrate in which a chip is mounted on a front surface to a downstream side of a predetermined conveyance direction in a posture in which the

front surface of the substrate faces toward an upper side of a gravity direction; one or more roll brushes, provided on a conveyance path of the substrate and on a lower side with respect to a conveyance height of the substrate, wherein the one or more roll brushes clean a back surface of the substrate by rotating about an axis tilted with respect to the conveyance direction while contacting the back surface; and a suction mechanism, sucking a foreign matter scraped off by the one or more roll brushes via one or more suction holes.

[0008] In such case, the one or more roll brushes may have: an upstream roll brush, rotating in a direction in which a movement direction at a contact point with the back surface becomes the downstream side of the conveyance direction; and a downstream roll brush, provided downstream of the upstream roll brush in the conveyance direction, and rotating in a direction in which a movement direction at a contact point with the back surface becomes an upstream side of the conveyance direction. The one or more suction holes may be provided between the upstream roll brush and the downstream roll brush.

[0009] In addition, during a period in which the substrate contacts the upstream roll brush, a conveyance speed of the substrate may be lower than a circumferential speed of the upstream roll brush.

[0010] In addition, the manufacturing apparatus may further include: a single power source; an input transmission mechanism, transmitting power output from the power source, as a rotation force, to one of the upstream roll brush and the downstream roll brush; and a relay transmission mechanism, reversing a rotation direction of rotation of one of the upstream roll brush and the downstream roll brush to transmit to another.

[0011] In addition, the manufacturing apparatus may further include a removal bar, contacting the roll brush which rotates to detach the foreign matter from the roll brush.

[0012] In such case, the removal bar is movable between a contact position contacting the roll

brush and a treat position not contacting the roll brush, and the removal bar is located at the retreat position during a period in which the substrate contacts the roll brush.

[0013] In addition, the one or more roll brushes are detachable with respect to the manufacturing apparatus, and a type of the roll brush attached to the manufacturing apparatus is
5 changeable in accordance with a type of the substrate.

[0014] In addition, the conveyance mechanism may set a conveyance speed during a cleaning period, which a period in which the substrate contacts the one or more roll brushes, to be lower than a conveyance speed during a conveyance period other than the cleaning period.

[0015] In addition, the manufacturing apparatus may further include an ionizer, removing
10 static electricity from at least one of the back surface and bristle tips of the roll brush.

[0016] In addition, the manufacturing apparatus may further include a pressing member, pressing a portion of the substrate in a thickness direction of the substrate to correct a warp of the substrate at a time when the substrate contacts the one or more roll brushes.

[0017] A cleaning method of a substrate disclosed in the specification includes: a conveyance
15 process, conveying the substrate to a downstream side of a predetermined conveyance direction in a posture in which the front surface of the substrate faces toward an upper side of a gravity direction; a cleaning process, parallel to the conveyance process, cleaning a back surface of the substrate by using one or more roll brushes; and a sucking process, parallel to the cleaning process, sucking a foreign matter scraped off by using the one or more roll brushes via one or
20 more suction holes. The roll brush is provided on a conveyance path of the substrate and on a lower side with respect to a conveyance height of the substrate, and cleans a back surface of the substrate by rotating about an axis tilted with respect to the conveyance direction while contacting the back surface.

Effects of Invention

[0018] According to the technique disclosed in the specification, the back surface of the substrate before a chip is mounted can be effectively cleaned.

BRIEF DESCRIPTION OF DRAWINGS

5 **[0019]**

FIG. 1 is a schematic plan view of a manufacturing apparatus.

FIG. 2 is an enlarged view of a periphery of a cleaning part.

FIG. 3 is a cross-sectional view taken along A-A of FIG. 2.

FIG. 4 is a diagram illustrating a temporal change of a substrate conveyance speed and a
10 circumferential speed of a roll brush.

FIG. 5 is a view illustrating a state where a foreign matter is removed by an upstream roll brush.

FIG. 6 is a view illustrating a state where a foreign matter is removed by a downstream roll
brush.

FIG. 7 is a view illustrating an example of a removal bar.

15 FIG. 8 is a view illustrating a position relationship between the removal bar and a bristle.

FIG. 9 is a view illustrating a position relationship between the removal bar and a bristle.

FIG. 10 is a view illustrating another example of a cleaning part.

FIG. 11 is a view illustrating another example of a cleaning part.

FIG. 12 is a view illustrating another example of a cleaning part.

20 FIG. 13 is a view illustrating another example of a cleaning part.

DESCRIPTION OF EMBODIMENTS

[0020] In the following, a manufacturing apparatus 10 of a semiconductor device is described with reference to the drawings. FIG. 1 is a schematic plan view of the manufacturing apparatus

10. The manufacturing apparatus 10 is an apparatus for manufacturing a semiconductor device by mounting one or more chips (not shown), such as semiconductor elements, to the front surface (referred to as "mounting surface 102" in the following) of a substrate 100.

[0021] The manufacturing apparatus 10 has a loader part 12 supplying a new substrate 100 to the manufacturing apparatus 10, a bonding part 14 mounting a chip to the mounting surface 102 of the substrate 100, and a conveyance mechanism 16 conveying the substrate 100 from the loader part 12 to the bonding part 14. Among these components, details about the configurations of the loader part 12 and the bonding part 14 are omitted.

[0022] The conveyance mechanism 16 conveys the substrate 100 along a conveyance path 20.

In the example of FIG. 1, the conveyance path 20 is like a straight line extending along Y direction. However, of course, the conveyance path 20 may also be bent or curved as appropriate. In the following, a direction orthogonal to both the conveyance direction and the vertical direction is referred to as "crossing direction". In the example of FIG. 1, X direction is the crossing direction.

[0023] The conveyance mechanism 16 has multiple holding claws 18 holding the substrate 100 and an actuator (not shown) moving the holding claws 18 along the conveyance path 20. The holding claws 18 hold an end of the substrate 100 in the crossing direction. In the substrate 100, a chip is mounted to only an effective area located on the inner side and keeping a predetermined distance or more from the periphery thereof. The broken line in FIG. 1 indicates the periphery of the effective area. The outer side of the effective area is an ineffective area in which a chip is not mounted. The holding claws 18 hold the ineffective area. In addition, in this example, the actuator has a linear motor moving the holding claws 18 linearly. However, the actuator is not particularly limited as long as the actuator can move the holding claws 18. For example, a linear motion mechanism combining a motor outputting a rotational power and a

rack-and-pinion, a linear motion mechanism combining a motor and a ball spline, etc., may also be used as the actuator. Moreover, the configuration of the conveyance mechanism 16 is not particularly limited, and the holding claws 18 may be omitted, as long as the conveyance mechanism 16 can convey the substrate 100 along the conveyance path 20. For example, the conveyance mechanism 16 may also have a belt conveyor having a conveyance belt on which the substrate 100 is mounted and moved in the conveyance direction.

[0024] A cleaning part 22 is provided on the conveyance path 20. The cleaning part 20 is a part cleaning a back surface 104 of the substrate 100, i.e., a surface opposite to the mounting surface 102. One or more roll brushes 30U and 30D are provided in the cleaning part 22.

More specifically, in the cleaning part 22, an upstream roll brush 30U and a downstream roll brush 30D located downstream of the upstream roll brush 30U in the conveyance direction are provided. In addition, on the conveyance path 20, access openings 24 for exposing the two roll brushes 30U and 30D to the outside are formed at places corresponding to two roll brushes 30U and 30D. In the following, when there is no distinction between the upstream roll brush 30U and the downstream roll brush 30D, the components are generally referred to as "roll brush 30".

[0025] FIG. 2 is an enlarged view of a periphery of the cleaning part 22. In addition, FIG. 3 is a cross-sectional view taken along A-A of FIG. 2. In FIGs. 2 and 3, the illustration of the conveyance path 20 is omitted. As shown in FIGs. 2 and 3 and described above, the upstream roll brush 30U and the downstream brush 30D are provided in the cleaning part 22.

[0026] The roll brush 30 has a rotation shaft 32 extending in the crossing direction, i.e., a direction orthogonal to the conveyance direction, and rotates around the rotation shaft 32 as the center. In addition, the roll brush 30 has a core material 33 long in the rotation shaft direction, and multiple brush bristles 34 planted on the core material 33. In the example, in order to prevent static electricity from being generated on the back surface of the substrate 100, the brush

bristles 34 are formed by conductive fibers, such as acrylic conductive fibers. However, the material of the brush bristles 34 is not particularly limited, and the brush bristles 34 may also be formed by fibers other than conductive fibers, as long as the material of the brush bristles 34 are flexible to an extent that it does not damage the substrate 100.

5 **[0027]** The roll brush 30 is provided at a height position at which the distance from the back surface 104 of the substrate 100 to the rotation center in the vertical direction is substantially the same as or slightly less than the radius of the roll brush 30. With such configuration, when the substrate 100 passes through the roll brush 30, at a top part Pt, which is the uppermost part of the roll brush 30 in the gravity direction, the ends of the brush bristles 34 contact the back surface
10 104 of the substrate 100. In addition, by rotating while contacting the back surface 104, the roll brush 30 effectively removes a foreign matter attached to the back surface 104.

[0028] The dimension of a brush portion (i.e., the area where the brush bristles 34 are planted) of the roll brush 30 in the crossing direction is not particularly limited. However, in order to effectively clean the entire substrate 100, the dimension of the brush portion in the crossing
15 direction may also be substantially the same or slightly greater than the dimension of the effective area of the substrate 100 in the crossing direction. In addition, the roll brush 30 may be replaceable as appropriate so that a suitable roll brush 30 can be used depending on the substrate 100 being handled. In such case, in order to be able to replace the roll brush 30 while maintaining the engagement relation of gears 42a to 42f described afterwards, the core material
20 33 of the roll brush 30 is connected to the gears 42c and 42f via a coupling 43.

[0029] In the example, the rotation directions of the two roll brushes 30U and 30D are opposite to each other. Specifically, the upstream roll brush 30U rotates in a direction (rightward direction in FIG. 2) in which the movement direction at a contact point (that is, a top point Pt) with the substrate 100 becomes a downstream side of the conveyance direction, and the

downstream roll brush 30D rotates in a direction (leftward direction in FIG. 2) in which the movement direction at the contact point with the substrate 100 becomes an upstream side of the conveyance direction. In other words, in the example, the two roll brushes 30U and 30D rotate in a direction in which the brush bristles 34 contacting the substrate 100 approach the other roll brush 30 after the contact. In the following, such rotation direction is referred to as "inward direction". In addition, the rotation in which the movement direction at the contact point becomes downstream in the conveyance direction is referred to as "forward rotation", and the rotation in which the movement direction at the contact point becomes upstream in the conveyance direction is referred to as "reverse rotation". In the example, by rotating the two roll brushes 30U and 30D in the direction inward to each other, by using the two roll brushes 30U and 30D, one suction pipe 52 can be shared and foreign matters can be reliably removed. Details in these regard will be described afterwards.

[0030] A motor 36 is further provided downstream of the downstream roll brush 30D in the conveyance direction. The motor 36 generates power for rotating the two roll brushes 30U and 30D. The output shaft of the motor 36 extends in a direction parallel to the rotation shaft 32 of the roll brush 30. In addition, the rotation of the output shaft of the motor 36 is transmitted to the downstream roll brush 30D by an input transmission mechanism 38, and the rotation direction of the rotation of the downstream roll brush 30D is reversed by a relay transmission mechanism 40 to transmit to the upstream roll brush 30U. Here, both of the input transmission mechanism 38 and the relay transmission mechanism 40 can be configured by a gear, a pulley, etc. In the example of FIG. 2, the input transmission mechanism 38 is configured by three gears 42a, 42b, and 42c, and the relay transmission mechanism 40 is configured by four gears 42c, 42d, 42e, and 42f. In the example, the two roll brushes 30U and 30D are driven by one drive source (that is, the motor 36), but the number of drive sources may also be changed as

appropriate. Therefore, one drive source may also be provided for each roll brush 30. In addition, in the example, a reduction ratio of the relay transmission mechanism 40 is "1", and the two roll brushes 30U and 30D rotate at a speed same as each other. However, a speed difference may also be set as appropriate between the two roll brushes 30U and 30D.

5 **[0031]** The manufacturing apparatus 10 further includes a suction mechanism 50 sucking and collecting foreign matters scraped off by the roll brushes 30 from the back surface 104 of the substrate 100. The suction mechanism 50 has the suction pipe 52 in which multiple suction holes 54 are formed, a vacuum generator 56 generating a vacuum force (suction force) in the suction pipe 52, and an air filter 58 capturing sucked foreign matters. The suction pipe 52 is
10 long in the crossing direction and is a hollow tubular member. On the peripheral surface of the suction pipe 52, the suction holes 54 are formed at intervals in the crossing direction. As shown in FIGs. 2 and 3, the suction pipe 52 is provided between the upstream roll brush 30U and the downstream roll brush 30D and located on a lower side with respect to the rotation shafts 32 of the two roll brushes 30. In addition, as described above, the upstream roll brush 30U and the
15 downstream roll brush 30D rotate inwardly to each other, and the brush bristles 34 contacting the substrate 100 rotates downward and in a direction approaching the suction pipe 52 after the contact. As a result, the foreign matters attached to the brush bristles 34 of the two roll brushes 30U and 30D are effectively sucked to the suction holes 54 of the single suction pipe 52. In other words, in the example, one suction pipe 52 can be shared by using the two roll brushes 30U
20 and 30D, and the number of parts can be reduced. As a result, the manufacturing cost of the manufacturing apparatus 10 can be reduced, and the cleaning part 22 can be miniaturized.

[0032] The vacuum generator 56 generates a vacuum force in the suction pipe 52. The vacuum generator 56, for example, can adopt a vacuum injector which squeezes the supplied compressed air by using a nozzle, and discharges the squeezed air at a high speed to a diffuser,

thereby generating vacuum. However, the configuration of the vacuum generator 56 is not particularly limited, as long as the vacuum generator 56 can generate a vacuum force capable of sucking foreign matters from the suction holes 54. Other configurations, such as a vacuum pump, etc., may also be adopted. The filter removes the foreign matters from air that is sucked
5 via the suction holes 54 and discharge the air to the outside.

[0033] The controller 70 controls the drive of the respective parts of the manufacturing apparatus 10. The controller 70 is a computer physically having a processor 70a and a memory 70b. In the example, the controller 70 controls the conveyance speed of the substrate 100 and the rotation speed of the roll brushes 30 so that the back surface 104 of the substrate 100 can be
10 properly cleaned. Details in this regard is described with reference to FIG. 4.

[0034] FIG. 4 is a diagram illustrating a temporal change of the conveyance speed of the substrate 100 and the circumferential speeds of the roll brushes 30. In FIG. 4, a line L1 represents the conveyance speed of the substrate 100, a line L2 represents the circumferential speed of the upstream roll brush 30U, and a line L3 represents a circumferential speed of the
15 downstream roll brush 30D. The circumferential speed refers to the moving speed of a point on the outer circumferential surface of the roll brush 30. Therefore, in the case where the diameter of the upstream roll brush 30U is set as R_u (mm) and the rotation speed is set as N_u (rpm), a circumferential speed V_u (mm/sec) of the upstream roll brush 30U is obtained by using $V_u = \pi$
 $\cdot R_u \cdot N_u / 60$.

[0035] In addition, in FIG. 4, a time t_1 represents the timing at which the front end of the substrate 100 reaches the top part P_t of the upstream roll brush 30U, and a time t_2 represents the timing at which the rear end of the substrate 100 reaches the top part P_t of the downstream roll
20 brush 30D. Therefore, the period between the time t_1 and the time t_2 can be considered as a period in which at least a portion of the substrate 100 contacts one of the roll brushes 30 and is

cleaned by the roll brush 30. In the following, the period in which the substrate 100 is in contact with either of the roll brushes 30 (the period from the time t1 to the time t2) is referred to as "cleaning period".

[0036] As clearly shown in FIG. 4, in the example, the conveyance speed (see line L1) of the substrate 100 drops temporarily during the cleaning period. That is, the substrate 100 is usually conveyed at a predetermined standard conveyance speed V1. The standard conveyance speed V1 is a speed set to be relatively high in order to facilitate the conveyance efficiency of the substrate 100. If, as a result of conveyance, the front end of the substrate 100 is about to reach the top part Pt of the upstream roll brush 30U, that is, right before the time t1, the controller 70 lowers the conveyance speed of the substrate 100 to a cleaning conveyance speed V2 sufficiently lower than the standard conveyance speed V1. The conveyance speed of the substrate 100 is so lowered to increase the time during which the substrate 100 is in contact with the roll brush 30 and to more reliably clean the back surface 104 of the substrate 100. In addition, immediately after the rear end of the substrate 100 passes through the top part Pt of the downstream roll brush 30D, that is, immediately after the time t2, the controller 70 again restores the conveyance speed of the substrate 100 to the standard conveyance speed V1.

[0037] Meanwhile, the roll brushes 30 rotate at a predetermined speed during the cleaning period, and stop rotating in a period other than the cleaning period. That is, the upstream roll brush 30U starts rotating immediately before the time t1, and stops rotating immediately after the time t2. During the cleaning period, the upstream roll brush 30U rotates at the constant circumferential speed Vu. The circumferential speed Vu is sufficiently higher than the cleaning conveyance speed V2. $V_u > V_2$ is set due to the following reason. The movement direction at the contact point (i.e., the top part Pt) of the upstream roll brush 30U with the substrate 100 is downstream in the conveyance direction, that is, the same as the movement direction of the

substrate 100. Therefore, when it is set that $V_u = V_2$, there is no speed difference between the substrate 100 and the brush bristles 34 of the upstream roll brush 30U, and the substrate 100 cannot be properly cleaned. In the example, by setting $V_u \neq V_2$, a speed difference is positively generated between the substrate 100 and the upstream roll brush 30U.

5 **[0038]** Also, if it is solely to generate a speed difference, $V_2 > V_u$ may also be considered. However, in the case where the cleaning conveyance speed V_2 is increased, the substrate 100 passes through the upstream roll brush 30U within a short period of time. In this case, during the period in which the substrate 100 passes through, a total area contacting the substrate 100 and, additionally, the total number of the brush bristles 34 contacting the substrate 100 decrease,
10 and the cleaning efficiency of the substrate 100 is reduced. Therefore, in the example, the cleaning conveyance speed V_2 of the substrate 100 is lower than the circumferential speed V_u of the upstream roll brush 30U to facilitate the cleaning efficiency.

[0039] Like the upstream roll brush 30U, the downstream brush 30D starts rotating immediately before the time t_1 , and stops rotating immediately after the time t_2 . However, the
15 rotation direction of the downstream roll brush 30D is opposite to the rotation direction of the upstream roll brush 30U. Therefore, a circumferential speed V_d of the downstream roll brush 30D is a value of the same magnitude but with a reversed sign of the circumferential speed V_u of the upstream roll brush 30U. That is, $V_d = -V_u$.

[0040] Here, the movement direction at the contact point of the downstream roll brush 30D
20 with the substrate 100 is opposite to the conveyance direction of the substrate 100. Therefore, a relative speed ΔV_d between the substrate 100 and the downstream roll brush 30D is $\Delta V_d = V_2 + V_d$, and is greater than $\Delta V_u = V_2 - V_u$, which is the relative speed between the substrate 100 and the upstream roll brush 30U. Therefore, compared with the upstream roll brush 30U, the cleaning efficiency of the downstream roll brush 30D is higher, and can more effectively

remove foreign matters on the back surface 104 of the substrate 100.

[0041] In the following, the reason why the two roll brushes 30U and 30D rotate inwardly with each other is described. As described above, by rotating the two roll brushes 30U and 30D inwardly with each other, the foreign matters scraped off by the brush bristles 34 can be collected
5 between the two roll brushes 30U and 30D. Accordingly, the single suction pipe 52 can be shared between the two roll brushes 30U and 30D.

[0042] Moreover, by rotating the two roll brushes 30U and 30D inwardly with each other, the substrate 100 can be prevented from being damaged, and the back surface 104 of the substrate 100 can be more effectively cleaned. Regarding this, details are described with reference to
10 FIGs. 5 and 6. FIG. 5 is a view illustrating a state in which foreign matters 110 are removed by the upstream roll brush 30U, and FIG. 6 is a view illustrating a state in which foreign matters 110 are removed by the downstream roll brush 30D.

[0043] The upstream roll brush 30U rotates in a direction in which the movement direction at the contact point with the substrate 100 is the same as the conveyance direction of the substrate 100, that is, rotates in a forward rotation direction. Therefore, the relative speed ΔV_u between
15 the upstream roll brush 30U and the substrate 100 is relatively small, and the force with which the brush bristles 34 rub the back surface 104 is small. Meanwhile, the downstream roll brush 30D rotates in a direction in which the movement direction at the contact point with the substrate 100 is opposite to the conveyance direction of the substrate 100, that is, rotates in a reverse
20 rotation direction. Therefore, the relative speed ΔV_d between the downstream roll brush 30D and the substrate 100 is relatively large, and the force with which the brush bristles 34 rub the back surface 104 is large. That is, the force for removing the foreign matter 110 is greater in the case of reverse rotation than the case of forward rotation.

[0044] Here, for a higher effect of removing the foreign matters 110, it may be considered to

also reversely rotate the upstream roll brush 30U. However, in the case of such configuration, the brush bristles 34 of the upstream roll brush 30U rub the back surface 104 of the substrate 100 to which many foreign matters 110 are attached with a strong force. In such case, the possibility that the foreign matters 110 detached from the back surface 104 and attached to the brush bristles 34 damage the back surface 104 increases. Also, among the foreign matters 110, there may be one in close contact with and firmly attached to the back surface 104. In the case where such foreign matter 110 is strongly rubbed and scraped off by the brush bristles 34, there is also a possibility that, at the time when the foreign matter 110 detaches, a strong reaction force is generated to damage the substrate 100. That is, in the case where the upstream roll brush 30U initially contacting the substrate 100 is reversely rotated, the damage caused to the substrate 100 tends to increase. Therefore, in this example, the upstream roll brush 30U initially contacting the substrate 100 is rotated forwardly to suppress the damage caused to the substrate 100.

[0045] Moreover, taking into account the damage taken by the substrate 100, it is also considered to forwardly rotate both the upstream roll brush 30U and the downstream roll brush 30D. However, in the case where the downstream roll brush 30D is also rotated forwardly, the ability of removing the foreign matters 110 is low, and the possibility that the foreign matters 110 remain on the substrate 100 increases. Meanwhile, after the back surface 104 is rubbed by the upstream roll brush 30U with a weak force, even if the back surface 104 is rubbed with a strong force by the downstream roll brush 30D rotating reversely, the damage taken by the substrate 100 can be reduced. That is, in such case, at the time when the downstream roll brush 30D contacts the substrate 100, the upstream roll brush 30U has roughly removed the foreign matters 110. Therefore, even if the downstream roll brush 30D is rotated reversely and the brush bristles 34 rub the back surface 104 of the substrate 100 with a strong force, since fewer

foreign matters 110 are attached to the brush bristles 34, the possibility that such foreign matters 110 damage the back surface 104 is low. In addition, with the brush bristles 34 of the upstream roll brush 30U initially rubbing the foreign matters 110 firmly attached to the back surface 104 with a weak force and vibrating the foreign matters 110, the attachment force of the foreign matter 110 to the back surface 104 is reduced. Therefore, the reaction force generated when the brush bristles 34 of the downstream roll brush 30D scrap off the foreign matters 110 afterwards can also be reduced. That is, if the upstream roll brush 30U is rotated forwardly, even if the downstream roll brush 30D is rotated reversely, the damage caused to the substrate 100 can be suppressed.

[0046] In addition, when both the upstream roll brush 30U and the downstream roll brush 30D are rotated forwardly, there is a concern that the foreign matter 110 pushed by the brush bristles 34 and sliding while being attached to the substrate 100 cannot be removed. That is, a portion of the foreign matter 110 rubbed by the brush bristles 34 is detached from the back surface 104 and falls down or attached to the brush bristles 34. However, another portion of the foreign matter 110 is pushed by the brush bristles 34 and slides on the back surface 104 while being attached to the back surface 104 of the substrate 100.

[0047] The direction in which the foreign matter 110 slides is the downstream of the conveyance direction, as shown in FIG. 5, in the case where the roll brushes 30 rotate forwardly. In such case, since the sliding foreign matter 110 moves away from the roll brush 30 through the conveyance of the substrate 100, the foreign matter 110 remains attached to the substrate 100.

[0048] Meanwhile, in the case where the roll brush 30 rotates reversely, as shown in FIG. 6, the foreign matter 110 slides upstream of the conveyance direction. Therefore, through the conveyance of the substrate 100, the foreign matter 110 contacts the roll brush 30 again. Then, by contacting the roll brush 30 again, it becomes easier to detach the foreign matter 110 from the

substrate 100. That is, by reversely rotating the roll brush 30, the remaining of the foreign matter 110 on the substrate 100 can be more reliably avoided than the case of rotating the roll brush 30 forwardly. In particular, it is difficult to remove the foreign matter 110 attached to the vicinity of the rear end of the substrate 100 by using the upstream roll brush 30U rotating forwardly. By reversely rotating the downstream roll brush 30D, the foreign matter 110 in the vicinity of the rear end can be reliably removed.

[0049] As described above, by rotating the two roll brushes 30U and 30D inwardly with each other, the ability of removing the foreign matters 110 can be facilitated step-by-step. Accordingly, the damage to the substrate 100 can be suppressed, and the foreign matters 110 can be effectively removed.

[0050] Meanwhile, a portion of the foreign matter 110 may be detached from the back surface 104 of the substrate 100 and attached to the brush bristles 34 of the roll brushes 30U and 30D. Such foreign matter 110 attached to the brush bristles 34 needs to be detached from the brush bristles 34 before the brush bristles 34 contact the back surface 104 again. In order to reliably remove such foreign matter 110 from the brush bristles 34, a removal bar contacting the rotating roll brush 30 to remove the foreign matter 110 from the roll brush 30 may also be provided. FIG. 7 is a view illustrating an example of the removal bar. In FIG. 7, removal bars 60a and 60b (referred to as "removal bar 60" in the following in the case where the two components are not distinguished from each other) are elongated components extending in a direction parallel to the rotation shaft 32. The removal bar 60 detaches the foreign matter 110 from the brush bristles 34 by contacting the vicinity of the tips of the brush bristles 34. Here, the position where the removal bar 60 is provided is not particularly limited, as long as the removal bar 60 can contact the vicinity of the tips of the brush bristles 34. In the example of FIG. 7, a portion of the removal bar 60a is provided away from the suction pipe 52 and at a position on the upper

side of the suction pipe 52. As shown in FIG. 8, the removal bar 60a is provided at a position contacted only by foremost tips of the brush bristle 34. In the case of such configuration, the brush bristle 34 is once significantly bent at the time of moving across the removal bar 60a and then elastically restored. At the time of being elastically restored, the foreign matter 110 attached to the brush bristle 34 is flipped downward, i.e., to the side of the suction pipe 52, and easily guided to the suction pipe 52.

[0051] In addition, the removal bar 60b is provided on the lower side with respect to the suction pipe 52, and at a position in the vicinity of the suction pipe 52. As shown in FIG. 9, the removal bar 60b is provided at a position contacted by a slightly inner side of the tip of the brush bristle 34. In the case of such configuration, the brush bristle 34 slides on the surface of the removal bar 60 in the state in which the brush bristle 34 is significantly bent at the time of moving across the removal bar 60b. With such sliding, the foreign matter 110 attached to the brush bristle 34 is scraped off by the removal bar 60. In addition, due to the impact at the time of being scraped off, the foreign matter 110 slightly bounces up and is easily guided to the suction pipe 52 located nearby.

[0052] Meanwhile, the cleaning of the roll brush 30 by the removal bar 60 and the cleaning of the substrate 100 by the roll brush 30 may be performed in parallel or at separate timings. That is, it may be that the removal bar 60 is fixedly provided at a position contacting the roll brush 30, and the cleaning of the roll brush 30 by the removal bar 60 is necessarily carried out during the period when the roll brush 30 clean the substrate 100. Also, as another example, the removal bar 60 may also be movable between a contact position where the removal bar 60 contacts the roll brush 30 and a retreat position where the removal bar 60 does not contact the roll brush 30. Such movement can be realized by using an actuator, such as an electromagnetic plunger or an air spring. Then, in such case, during a period in which the roll brush 30 contacts the substrate

100, the removal bar 60 may retreat to the retreat position, and during a period in which the roll brush 30 does not contact the substrate 100, the removal bar 60 may move to the contact position to clean the roll brush 30. With such configuration, the foreign matter 110 detached and flying away from the brush bristles 34 can be effectively prevented from being attached to the substrate
5 100 again.

[0053] So far, the foreign matters 110 attached to the substrate 100 or the brush bristles 34 are removed by a mechanical force. However, to supplement the removal of the foreign matters 110 by the mechanical force, as shown in FIG. 10, an ionizer 74 removing static electricity may also be provided. The ionizer 74, for example, may be of a corona discharge type radiating ions
10 generated by corona discharge to a target object, and may also be of a photo-ionization type irradiating the target object with high-energy electromagnetic waves (e.g., ultraviolet rays, X-rays). Also, the target for removing static electricity may be the back surface 104 of the substrate 100, and may also be the brush bristles 34.

[0054] In addition, the configuration having been described so far is merely an example.
15 Other configurations may be changed as appropriate as long as such configurations at least have one or more roll brushes 30 rotating while contacting the back surface 104 of the substrate 100 and the suction mechanism 50 sucking the foreign matters 110 scraped off by the roll brushes 30. Therefore, the number of the roll brushes 30 may be one, as shown in FIG. 11, and may also be three or more, as shown in FIG. 12. In addition, the rotation direction of the roll brush 30 may
20 be changed as appropriate. For example, as shown in FIG. 12, all the multiple roll brushes 30 may all rotate in the same direction. In such case, the suction pipe 52 may be provided for each of the roll brushes 30.

[0055] In addition, as shown in FIG. 1, in the example, only one end of the substrate 100 in the crossing direction is held by the holding claws 18. In such case, as shown in FIG. 13, when the

substrate 100 is warped, a portion of the substrate 100 may be separated from the roll brush 30. To correct the warp of the substrate 100, a pressing member 76 pressing a portion of the substrate 100 in the thickness direction of the substrate 100 may be provided. The pressing member 76, as shown in FIG. 13, may be a clamper pressing the substrate 100 against a reference surface 78 parallel to both the rotation shaft 32 and the conveyance direction. In the case where the pressing member 76 is a clamper, during a period in which the substrate 100 is pressed against the reference surface 78, the substrate 100 cannot be fed toward the downstream direction. Therefore, in such case, a slight feeding process in which the substrate 100 is fed toward the downstream side by a slight distance after the pressing by the pressing member 76 (clamper) is removed and a pushing process pushing the substrate 100 to the reference surface 78 after the conveyance of the substrate 100 is temporarily stopped are alternately repeated. Also, in other embodiments, the pressing member 76 may also be a roller being liftable while rotating about an axis substantially parallel to the crossing direction (X direction). If the pressing member 76 is a roller, since the substrate 100 can be pressed to the roll brushes 30 by using the pressing member 76 (roller) while being conveyed downstream, it is not necessary to stop the conveyance of the substrate 100.

[0056] Moreover, the rotation shaft 32 of the roll brush 30 may also be tilted with respect to the crossing direction, as long as the rotation shaft 32 is not parallel to the conveyance direction. Furthermore, so far, brushes of the same type are used as the upstream roll brush 30U and the downstream brush 30D. However, the two roll brushes 30U and 30D may be of types different from each other. For example, at least one of the materials, thicknesses, lengths, and densities of the two roll brushes 30 may be different from each other. For example, in order for the upstream roll brush 30U to gently touch the back surface 104, the brush bristles 34 of the upstream roll brush 30U may be formed by a softer material, or formed to be thinner or longer

than the brush bristles 34 of the downstream roll brush 30D.

[0057] In addition, the magnitudes of the rotation speeds of the two roll brushes 30U and 30D may be different from each other. For example, the absolute value $|V_d|$ of the circumferential speed of the downstream roll brush 30D may also be greater than the absolute value $|V_u|$ of the circumferential speed of the upstream roll brush 30U. With such configuration, the relative speed ΔV_d between the downstream roll brush 30D and the substrate 100 can be even higher, and the foreign matters 110 can be more reliably removed. Also, in another embodiment, it may also be set that $|V_d| < |V_u|$.

Reference Signs List

[0058] 10: Manufacturing apparatus; 12: Loader part; 14: Bonding part; 16: Conveyance mechanism; 18: Holding claw; 20: Conveyance path; 22: Cleaning part; 24: Access opening; 30D: Downstream roll brush; 30U: Upstream roll brush; 32: Rotation shaft; 33: Core material; 34: Brush bristle; 36: Motor; 38: Input transmission mechanism; 40: Relay transmission mechanism; 42a to 42f: Gear; 43: Coupling; 50: Suction mechanism; 52: Suction pipe; 54: Suction hole; 56: Vacuum generator; 58: Air filter; 60: Removal bar; 70: Controller; 70a: Processor; 70b: Memory; 74: Ionizer; 76: Pressing member; 78: Reference surface; 100: Substrate; 102: Mounting surface; 104: Back surface; 110: Foreign matter.

WHAT IS CLAIMED IS:

1. A manufacturing apparatus of a semiconductor device, the manufacturing apparatus comprising:

a conveyance mechanism, conveying a substrate in which a chip is mounted on a front surface to a downstream side of a predetermined conveyance direction in a posture in which the front surface of the substrate faces toward an upper side of a gravity direction;

one or more roll brushes, provided on a conveyance path of the substrate and on a lower side with respect to a conveyance height of the substrate, wherein the one or more roll brushes clean a back surface of the substrate by rotating about an axis tilted with respect to the conveyance direction while contacting the back surface; and

a suction mechanism, sucking a foreign matter scraped off by the one or more roll brushes via one or more suction holes.

2. The manufacturing apparatus of the semiconductor device as claimed in claim 1, wherein the one or more roll brushes has:

an upstream roll brush, rotating in a direction in which a movement direction at a contact point with the back surface becomes the downstream side of the conveyance direction; and

a downstream roll brush, provided downstream of the upstream roll brush in the conveyance direction, and rotating in a direction in which a movement direction at a contact point with the back surface becomes an upstream side of the conveyance direction,

wherein the one or more suction holes are provided between the upstream roll brush and the downstream roll brush.

3. The manufacturing apparatus of the semiconductor device as claimed in claim 2, wherein during a period in which the substrate contacts the upstream roll brush, a conveyance speed of the substrate is lower than a circumferential speed of the upstream roll brush.

4. The manufacturing apparatus of the semiconductor device as claimed in claim 2 or 3, further comprising:

a single power source;

an input transmission mechanism, transmitting power output from the power source, as a rotation force, to one of the upstream roll brush and the downstream roll brush; and

a relay transmission mechanism, reversing a rotation direction of rotation of one of the upstream roll brush and the downstream roll brush to transmit to another.

5. The manufacturing apparatus of the semiconductor device as claimed in any one of claims 1 to 4, further comprising:

a removal bar, contacting the roll brush which rotates to detach the foreign matter from the roll brush.

6. The manufacturing apparatus of the semiconductor device as claimed in claim 5, wherein the removal bar is movable between a contact position contacting the roll brush and a retreat position not contacting the roll brush, and

the removal bar is located at the retreat position during a period in which the substrate contacts the roll brush.

7. The manufacturing apparatus of the semiconductor device as claimed in any one of claims 1 to 6, wherein the one or more roll brushes are detachable with respect to the manufacturing apparatus, and

a type of the roll brush attached to the manufacturing apparatus is changeable in accordance with a type of the substrate.

8. The manufacturing apparatus of the semiconductor device as claimed in any one of claims 1 to 7, wherein the conveyance mechanism sets a conveyance speed during a cleaning period, which is a period in which the substrate contacts the one or more roll brushes, to be lower

than a conveyance speed during a conveyance period other than the cleaning period.

9. The manufacturing apparatus of the semiconductor device as claimed in any one of claims 1 to 8, further comprising:

an ionizer, removing static electricity from at least one of the back surface and bristle tips of
5 the roll brush.

10. The manufacturing apparatus of the semiconductor device as claimed in any one of claims 1 to 9, further comprising:

a pressing member, pressing a portion of the substrate in a thickness direction of the substrate to correct a warp of the substrate at a time when the substrate contacts the one or more
10 roll brushes.

11. A cleaning method of a substrate in which a chip is mounted on a front surface, the cleaning method comprising:

a conveyance process, conveying the substrate to a downstream side of a predetermined conveyance direction in a posture in which the front surface of the substrate faces toward an
15 upper side of a gravity direction;

a cleaning process, parallel to the conveyance process, cleaning a back surface of the substrate by using one or more roll brushes; and

a sucking process, parallel to the cleaning process, sucking a foreign matter scraped off by using the one or more roll brushes via one or more suction holes,

20 wherein the roll brush is provided on a conveyance path of the substrate and on a lower side with respect to a conveyance height of the substrate, and cleans a back surface of the substrate by rotating about an axis tilted with respect to the conveyance direction while contacting the back surface.