METHOD AND DEVICE FOR DRYING CIRCUIT SUBSTRATES

The present invention relates to a method for drying circuit substrates, in particular semiconductor substrates, in which a circuit surface of the circuit substrate is flushed using a flushing liquid in a flushing step and the circuit surface is dried in a following drying step. Furthermore, the present invention relates to a device for performing the above method.

Semiconductor wafers in particular, which are used for manufacturing chips, are provided before their separation into chips with a terminal surface structure which allows the later contacting of the chips and comprises the implementation of suitable contact metallizations on the terminal surfaces. For this purpose, chemical deposition techniques are typically used, which allow a layered buildup of the contact metallizations. In particular to avoid corrosion on the contact-side surfaces of the wafer and/or the chips produced therefrom through separation, it is necessary to perform cleaning of the terminal or circuit surface, in which ionic or anionic contaminants contaminating the surface, which result from the deposition procedures, are removed. For this purpose, flushing the terminal surface of the semiconductor substrate repeatedly using deionized water until only a permissible ion concentration is measurable in the flushing water is known.

It has been shown that in case of drying of the terminal surface following the flushing procedure, after evaporation of flushing water residues remaining on the terminal surface, corrosion pockets remain on the terminal surface.

Therefore, in the past, different efforts have been taken in order to allow drying of the terminal surface with as little residue as possible immediately following the flushing procedure. One of these possibilities is to apply a temperature to the circuit substrate after application of

flushing liquid or after removal from a flushing bath in order to allow the most rapid and residue-free evaporation of the flushing water possible. However, this is associated with the disadvantage that the temperature strain accompanying the known drying frequently reaches or even exceeds the range of the temperature strain just permissible for perfect functioning of the circuit substrate. Furthermore, reducing the surface tension of the water through different measures in order to allow more rapid draining of the flushing water from the circuit surface with as little residue as possible is known. However, it has been established that the surfactants used as an additive to the flushing water for this purpose, for example, typically in turn cause residues on the terminal surface. Residues of this type may be avoided in the event of cleaning with the addition of alcohol, but the use of alcohol as a flushing liquid makes the supplementary use of frequently explosive materials necessary, so that performing methods of this type requires special explosion protection and is thus correspondingly costly.

The present invention is thus based on the object of suggesting a method and/or a device for performing a method which allows essentially residue-free cleaning of circuit substrates without too high a temperature strain of the circuit substrates and/or too high an outlay when performing the method and/or during operation of the corresponding device.

The above object is achieved by a method according to Claim 1 and/or a device according to Claim 7.

In the method according to the present invention, in which a circuit surface of the circuit substrate is flushed using flushing liquid in a flushing step and the circuit surface is dried in a subsequent drying step, the circuit substrate is moved in the flushing step in the direction of its planar extension, transversely and in relation to a liquid level of the flushing liquid, in such a way that at a transition area between the circuit

surface and the liquid level, which changes because of the relative movement, a liquid meniscus is formed and in the drying step thermal radiation is applied to the transition area wetted by the liquid meniscus.

When the method according to the present invention is used, the circuit substrate has thermal radiation applied to it in a transition area wetted with the liquid meniscus, so that a temperature increase of the liquid meniscus, which causes evaporation, occurs in the circuit substrate via absorption of the thermal radiation. Since a part of the circuit substrate which changes, but is always more or less large, remains in the liquid bath during the application of temperature, heat is always dissipated from the circuit substrate into the liquid bath in parallel to the temperature application, so that overheating of the substrate may be precluded as much as possible. In addition, the application of temperature through thermal radiation allows essentially convection-free heating of the circuit substrate, so that contamination by contaminants carried along in a convection flow may be precluded as much as possible.

According to a preferred variation of the method, the thermal radiation is applied using an infrared radiator, so that heat may be introduced especially effectively into the circuit substrate.

A variation which is particularly advantageous in regard to the space required when performing the method is that to perform the relative movement between the liquid level and the circuit substrate, the circuit substrate is situated in the flushing liquid, which is received by a bath container, and the liquid level is lowered.

If the thermal radiation is applied transversely to the liquid level, it is possible to apply the thermal radiation simultaneously to multiple circuit substrates situated in a composite arrangement.

In addition, it has been shown to be especially advantageous if ventilation of a container lumen implemented above the liquid level occurs essentially parallel to the liquid level, since therefore subsequent condensation of the liquid evaporated in the area of the liquid meniscus on the circuit substrate may be prevented.

If multiple flushing steps are performed through repeated flooding of the container before performing the drying step in the bath container, the method allows not only a subsequent cleaning partial step in regard to residue-free drying of the terminal surfaces of circuit substrates, but rather additionally also performing preceding multiple flushing procedures with the goal of producing the ionic and/or anionic concentration on the circuit surfaces before the subsequent drying step in an overall continuous method in a single device.

The device according to the present invention for performing the method for drying circuit substrates, in particular semiconductor substrates, is provided with a bath container which has an intake unit and an outlet unit and in which a receiving system for receiving at least one circuit substrate is situated in such a way that the circuit substrate extends in a plane in the direction of a container floor. In addition, the device according to the present invention is provided with a cover unit which closes a container opening of the bath container and with a thermal radiator unit situated above the receiving system.

In an especially advantageous embodiment of the device, the thermal radiator unit is provided with infrared radiators.

If the thermal radiator unit is situated on the cover unit, simple positioning of the thermal radiator unit above the liquid level is possible, which allows simultaneous application to multiple circuit

substrates received in the receiving system.

Furthermore, it is advantageous if the thermal radiator is situated above a transparent plate for separation from a container interior, so that the thermal radiator itself is situated in a protected way outside the aggressive atmosphere in the container interior.

If the bath container is provided in the area of the cover unit with a ventilation unit, the effectiveness of the device may be increased even further. It is especially advantageous for a simple design of the device if the ventilation unit is situated on the cover unit.

In the following, a preferred variant of the device according to the present invention and a device preferably usable for this purpose are explained in greater detail on the basis of the drawings.

Fig. 1 shows a sectional illustration of a device for cleaning semiconductor substrates;

Fig. 2 shows an enlarged illustration of a liquid meniscus implemented between a liquid level and a circuit surface of the semiconductor substrate.

Fig. 1 shows a bath container 11, filled with a flushing liquid 10, which is formed in the present case by deionized water, in which a receiving system 12 having wafers 13 received uniformly distributed therein is situated. The receiving system 12 may have two clamping jaws which receive the wafers 13 between them around the peripheral edge, for example, so that the wafer surfaces remain freely accessible.

The bath container 11 is provided in the area of its container floor 14 with an inflow unit 16 provided with an inlet valve 15. Furthermore, an

outflow unit 17 is provided in the area of the container floor 14, which has an outlet valve 18. In addition, the outflow unit 17 is equipped with a flow valve 19 that allows setting of the flow velocity of the flushing liquid 10 flowing out through the outflow unit 17.

In the area of the container opening 24 of the container floor 11 situated diametrically opposite the container floor 14 and which allows insertion and removal of the wafer 13 situated in the receiving system 12, a cover unit 20 closing the container opening 24 is situated, which allows operation of the bath container 11 as a processing chamber closed in relation to the environment.

The cover unit 20 is implemented in the present case like a housing having a cover interior 21, in which a thermal radiator unit 22 having thermal radiators 23 in the present case comprising multiple infrared radiators is received. To avoid heat buildup, the cover unit 20 may be provided with ventilation (not shown in greater detail here). A cover wall 25 situated directly opposite the container opening 24 is transparent and implemented in the present case as a glass plate 25 inserted into the cover unit 20. A ventilation unit 27 having multiple ventilation channels 26 running parallel to the plane of the container opening 24 is located situated neighboring the container opening 24 and above a liquid level 28 of the bath container 11, shown in the completely flooded state in Fig. 1. The ventilation channels 26 discharge in the present case from the outside into a rear container wall 34 of the bath container 11 and allow supply and removal of a ventilation flow directed parallel to the liquid level 28 and having a very low flow velocity.

For operation of the device shown in Fig. 1, the receiving system 12 having the wafers 13 received therein is inserted into the bath container 11 and the bath container 11 is closed using the cover unit 20. In a subsequent filling procedure, the bath container 11, with outlet valve 18

of the outflow unit 17 closed, is flooded with flushing liquid 10 through the inflow unit 16 until reaching a liquid level 28 shown in Fig. 1, which completely covers the wafers 13 extending toward the container floor 14.

Proceeding from the flooded state of the bath container 11 shown in Fig. 1, with open flow valve 19, the liquid level 28 is now preferably continuously lowered, so that a progressively larger part of the wafers 13 projects out of the flushing liquid 10. As the liquid level 28 is reduced, a liquid meniscus 31, 32 forms in a transition area 35 between the surfaces 29, 30 of the wafers 13 running transversely to the liquid level 28 and the liquid level 28, as shown in Fig. 2. At least one of the surfaces 29, 30 is implemented as a circuit surface having contact metallizations situated thereon.

As the liquid level 28 is lowered, the thermal radiator unit 22, which emits IR radiation in the present exemplary embodiment, is in operation using the thermal radiators 23, which are separated from the liquid level 28 by the glass plate 25. As a result of the absorption of the thermal radiation 36 in the semiconductor material of the wafers 13, the part of the wafers 13 situated above the liquid level 28 is heated, while in contrast the part of the wafers 13 situated in the flushing liquid 10 is relatively cooled by the heat transfer between the semiconductor material and the flushing liquid 10. This prevents overheating of the semiconductor material, which impairs the function of the wafer, from being able to occur in spite of the fact that heating of the semiconductor material is sufficient for evaporation of the flushing liquid 10 in the area of the liquid meniscus 31, 32. Through the evaporation of the flushing liquid 10 in the area of the liquid meniscus 31, 32, it is ensured that essentially no residues of flushing liquid remain on the surfaces 29, 30 of the wafers 13. In addition to the evaporation of the flushing liquid in area of the liquid meniscus 31, 32, the surface tension of the liquid meniscus is also reduced through the heating of the semiconductor

material in the area of the liquid meniscus 31, 32, so that the wetting properties of the flushing liquid 10 are increased in area of the surface meniscus 31, 32 and better drainage of the flushing liquid 10 from the surfaces 29, 30 is achieved.

The thermal transition, which is essentially restricted to the boundary area between the surfaces 29, 30 of the wafer 13 and the liquid meniscus 31, 32, ensures that heating and reduction of the surface tension of the flushing liquid associated therewith only occurs in the above-mentioned boundary area, so that adjacent thereto, the surface tension of the flushing liquid is essentially maintained and drops are prevented from forming in the area of the liquid meniscus 31, 32. This advantageous effect is also supported by the selection of a lowering speed of the liquid level 28 which allows a contact time between the surfaces 29, 30 of the wafer 13 and a liquid meniscus 31, 32 sufficient to achieve the above-mentioned effects.

Proceeding from the flooded state of the bath container 11 illustrated in Fig. 1, a lumen 33 formed between the liquid level 28 and the glass plate 25 becomes continuously larger as the liquid level 28 is reduced. In order to prevent flushing liquid 10 evaporated as a result of the application of thermal radiation 36 from condensing above the liquid level 28 on the surfaces 29, 30 of the wafer 13 again after cooling, the lumen 23 is ventilated by the ventilation unit 27.

CLAIMS

1. A method for drying circuit substrates (13), in particular semiconductor substrates, in which a circuit surface (29, 30) of the circuit substrate received in a receiving system (12) is flushed using a flushing liquid (10) in a flushing step and the circuit surface is dried in a subsequent drying step, the circuit substrate being moved in the flushing step in the direction of its planar extension transversely and in relation to a liquid level (28) of the flushing liquid in such way that a liquid meniscus (31, 32) forms at a transition area (35) between the circuit surface and the liquid level, which changes because of the relative movement, and thermal radiation (36) is applied to the transition area wetted by the liquid meniscus in the drying step using a thermal radiator unit (22),
characterized in that
thermal radiation is applied using the thermal radiator unit which is situated both above the receiving system (12) and above the circuit substrate.

2. The method according to claim 1,
characterized in that
thermal radiation (36) is applied using an infrared radiator.

3. The method according to claim 1 or 2,
characterized in that
to perform the relative movement between the liquid level (28) and the circuit substrate (13), the circuit substrate is situated in the flushing liquid (10) received by bath container (11) and the liquid level is lowered.

4. The method according to one of the preceding claims,
characterized in that

thermal radiation (36) is applied transversely to the liquid level (28).

5. The method according to one of the preceding claims, characterized in that multiple flushing steps are performed through repeated flooding of the bath container before performing the drying step in the bath container (11).

6. A device for performing a method for drying circuit substrates (13), in particular semiconductor substrates, according to one more of claims 1 through 5, having a bath container (11), which is provided with an inflow unit (16) and an outflow unit (17) and is closable using a cover unit (20), and a receiving system (12), which is situated in the bath container, for receiving at least one circuit substrate in such a way that the circuit substrate extends in a plane in the direction of a container floor (14), and having a thermal radiator unit (22), characterized in that the thermal radiator unit is situated above the receiving system so as to allow simultaneous application to multiple circuit substrates received in the receiving system.

7. The device according to claim 6, characterized in that the thermal radiator unit (22) is provided with infrared radiators.

8. The device according to claim 6 or 7, characterized in that the thermal radiator unit (22) is situated on the cover unit (20).

9. The device according to one more claims 6 through 8,

characterized in that
the thermal radiator unit (22) is situated above a transparent plate (25) for separation from a container interior.

10. The device according to one of claims 6 through 9,
characterized in that
the bath container (11) is provided in the area of the cover unit (20) with a ventilation unit (27).

11. The device according to claim 10,
characterized in that
the ventilation unit (27) is situated on the cover unit (20).